# *Northshore Mining Co. - Stream Mitigation Plan*

## *Tailings Basin Progression Project*

June 30, 2020

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Table of Contents


1.0 Introduction....6

2.0 Project Description....6

3.0 Stream Impacts....7

3.1 Hydrology....7

3.2 Hydraulics....7

3.3 Geomorphology....7

3.4 Physiochemical....7

3.5 Biology/Connectivity....7

3.6 Functional Loss....8

3.7 Existing Uses....8

4.0 Mitigation Sites....9

4.1 Project Site Identification and Location....9

4.1.1 Restoration Goals....9

4.1.2 Existing Use Considerations....9

4.2 Site Characterizations – Existing Conditions....10

4.2.1 Little 39 Diversion Ditch Site....10

4.2.2 Big 39 Diversion Site....11

4.2.3 East Branch Beaver River + Culvert Replacement....12

4.2.4 East Branch Tributaries....13

4.2.5 Berm Removal Site....14

4.2.6 White Rock Creek Site....15

4.3 Site Characterizations – Proposed Conditions/Restoration Approach....17

4.3.1 Little 39 Diversion Ditch Site....17

4.3.2 Big 39 Diversion Site....17

4.3.3 East Branch Beaver River + Culvert Site....17

4.3.4 East Branch Tributaries Site....18

4.3.5 Berm Removal Site....19

4.3.6 White Rock Creek Site....19

4.4 Summary of Proposed Mitigation Function Lift....20

5.0 Non-SQT Scored Lift ..... 21
5.1 HUC 10 Beaver River – Lake Superior Frontal Watershed (0401010201) ..... 21
5.1.1 Beaver River East (Subwatershed 1) ..... 21
5.1.2 West Unnamed Creek (Subwatershed 4) ..... 22
5.1.3 Lower East Branch Beaver River (Subwatershed 7) ..... 23
5.1.4 Upper Middle Beaver River (Subwatershed 11) ..... 23
5.1.5 Lower Beaver River Watershed (Subwatershed 16- Watershed Assessment) ..... 25
6.0 Construction Methods and Schedule ..... 25
6.1 Construction Methods ..... 25
6.2 Construction Sequencing ..... 25
6.3 Schedule ..... 26
7.0 Performance Standards and Monitoring ..... 26
7.1 Performance Standards ..... 26
7.2 Monitoring ..... 26
7.2.1 Annual Monitoring Report ..... 26
7.2.2 As-Built Stream Survey ..... 26
8.0 References ..... 27

## List of Tables


| | |
|---|---|
| Table 1 | Big and Little 39 Creek Remnant Debit |
| Table 2 | Little 39 Diversion Existing Conditions |
| Table 3 | Big 39 Diversion Existing Conditions |
| Table 4 | East Branch + Culvert Existing Conditions |
| Table 5 | Trib F-Channel Existing Conditions |
| Table 6 | East Br. Trib. Ditched Channel Existing Conditions |
| Table 7 | Berm Removal Existing Conditions |
| Table 8 | White Rock Creek Existing Conditions |
| Table 9 | Little 39 Diversion Ditch Site Functional Lift – SQT Output Table |
| Table 10 | Big 39 Diversion Site Functional Lift – SQT Output Table |
| Table 11 | East Branch + Culvert Site Functional Lift – SQT Output Table |
| Table 12 | East Br. F-Channel Functional Lift – SQT Output Table |
| Table 13 | East Br. Ditch Channel Functional Lift – SQT Output Table |
| Table 14 | Berm Removal Site Functional Lift – SQT Output Table |
| Table 15 | White Rock Creek Site Functional Lift – SQT Output Table |
| Table 16 | Summary of Proposed Mitigation Restoration and Functional Lift |


## List of Figures


| | |
|---|---|
| Figure 1: | Proposed mitigation projects |
| Figure 2: | Subwatersheds |


## List of Appendices


| | |
|---|---|
| Appendix A | Impact Stream Debit Calculation |
| Appendix B | Restoration Project SQT Functional Lift Calculations |
| Appendix C | 30% Project Design Sheets |
| Appendix D | Debit Calculation Field Forms |
| Appendix E | Watershed Assessment |
| Appendix F | Lake Superior South Watershed Restoration and Protection Strategy Report |

# 1.0 Introduction

Northshore Mining Company (Northshore) is undergoing environmental permitting for the proposed railroad relocation and tailings basin progression project (project). As part of the project, Northshore is pursuing a permit from the U.S. Army Corps of Engineers (Corps), consistent with the basin projection plans outlined in the 1977 Corps Environmental Impact Statement (EIS).

The proposed project will directly impact 5,150 feet of a remnant of the Big 39 Creek and 3,420 feet of a remnant of the Little 39 Creek.

The following is the mitigation proposal to provide compensatory mitigation for the loss of function in the remnants of Big and Little 39 Creeks. Compensatory stream mitigation is required by the Corps as part of the Clean Water Act Section 404 authorization. The Minnesota Pollution Control Agency (MPCA) requires stream mitigation as part of the Clean Water Act Section 401 certification, under the Antidegradation policy.

# 2.0 Project Description

The project area encompasses approximately 1,200 acres, made up of tailings storage area and supporting infrastructure, and is located about 6 miles west of Silver Bay, in Lake County, Minnesota (Figure 1). Some of the project area consists of lands disturbed by past activities, including depleted borrow pits and access roads. The project area takes advantage of the existing tailings storage facility footprint and land adjacent to it, progressing westerly as contemplated in the 1977 Corps EIS and original state and federal permits. Tailings would be stored over the existing, approximately 2,100 acre tailings storage area an additional 113 feet in height above the existing permitted basin to a total height of about 233 feet at its highest point. In addition, tailings would be stored within approximately 850 acres of adjacent tailings storage area to an elevation of 1365 feet as the natural topography allows storage to extend generally northwesterly, but excluding about 1,100 acres of the storage area evaluated in the EIS.

# 3.0 Stream Impacts

The proposed project will impact 8,570 linear feet of remnant stream; 5,150 linear feet of Big 39 Creek and 3,420 linear feet of Little 39 Creek. The Corps has proposed use of a tool to quantify the function of the proposed impacts using the Minnesota Stream Quantification Tool – Debit Calculator. The functional feet calculated using this tool has been used to determine the scale of the proposed mitigation.

## 3.1 Hydrology

Hydrology parameters entered into the SQT Debit Tool determined the hydrology of the remnants are classified as "Functioning" based on existing conditions. Historically, there had been a significant modification to the remnant watersheds. The tool only looks at the existing conditions and does not account for the changes in watershed areas that occurred historically in these watersheds. This is discussed in detail in the Watershed Assessment (Appendix E)

## 3.2 Hydraulics

Hydraulic parameters entered into the SQT Debit tool determined the channel area remnants are classified as "Functioning at Risk" due to high Bank Height Ratio (BHR) and a low entrenchment ratio. This is due to the existing channels that were formed under a larger watershed, therefore, under the existing conditions the channels are considered incised with a high BHR.

Hydraulic parameters entered into the SQT Debit tool determined the beaver dam area remnants as "Functioning". The impounded areas filled the channel, so the BHR is 1 and the entrenchment ratios are low. Were the beaver dams removed, the remaining channel would show the same characteristics as the channel areas.

## 3.3 Geomorphology

Geomorphological data was collected and used to complete the Debit Calculation (Appendix A). Generally, both Big 39 Creek and Little 39 Creek are Rosgen Type B streams in an unconfined alluvial valley. Both remnants are a series of stream-like reaches broken up by several beaver dams. The beaver dams create approximately 3,925 feet of pooling in Big 39 Creek and approximately 1,340 feet of pooling in Little 39 Creek. The channel areas both score as "Functioning" and both beaver dam areas score as "Functioning at Risk" due to the lack of bedform diversity.

## 3.4 Physiochemical

Physiochemical data was collected on one reach in each remnant in order to evaluate the level of function to be used in the SQT Debit Tool. Both remnants scored "Functioning at Risk", primarily due to low Dissolved Oxygen (DO) and high summer temperatures.

## 3.5 Biology/Connectivity

Fish and macroinvertebrate sampling was completed in order to calculate an Index of Biotic Integrity (IBI) for the Debit Calculator. A reach was scored on each remnant. All scored reaches received a "Not Functioning" score in the SQT Debit Tool based on their individual Index of IBI scores. Further information can be found in the Debit Calculation (Appendix A), and the field forms can be found in Appendix D. Connectivity is often considered as a major factor in the biological function. It is important to note that these remnants are not well connected to the downstream receiving water as a result of over 6,000' of ditch between the natural portion of the West Unnamed Creek and the impoundment, called Murphy's Pond. Murphy's Pond lies over a portion of the remnants that has been inundated. See Figure 1 for Murphy's Pond and diversion ditch location.

## 3.6 Functional Loss

| Table 1: Big and Little 39 Creek Remnant Debit**Stream ID by Reach** | **Impact Description** | **Debit Option** | **Existing Stream Length** | **Existing Condition Score** | **Proposed Length** | **Impact Severity Tier** | **Proposed Condition Score** | **Change in Functional Feet** |
|---|---|---|---|---|---|---|---|---|
| Big 39, Beaver Dam Areas | Tailings Progression | 2 | 3925 | 0.64 | 0 | Tier 5 | 0.00 | -2512 |
| Big 39 Stream Areas | Tailings Progression | 2 | 1225 | 0.55 | 0 | Tier 5 | 0.00 | -673.8 |
| Little 39, Beaver Dam Areas | Tailings Progression | 2 | 1340 | 0.64 | 0 | Tier 5 | 0.00 | -857.6 |
| Little 39, Stream Areas | Tailings Progression | 2 | 2080 | 0.56 | 0 | Tier 5 | 0.00 | -1164.8 |
| | | | | | | | **Total Functional Loss (Debits in FF):** | **-5,208.2** |

## 3.7 Existing Uses

The following table contains the Assessment Units and uses for the Big and Little 39 Remnants. The complete list of uses is 1B (Drinking Water), 2Ag (Cold water Fish/Macroinvertebrate), 3B (Industrial), 4A (Agriculture), 4B (Livestock/Wildlife), 5 (Aesthetic), and 6 (Other). All of these uses were obtained prior to the Big and Little 39 Diversions.

**Table 2: Big and Little 39 Creek Remnant Existing Uses**

| **Reach Name and Description** | **Assessment Unit Identification (AUID)** | **Uses** |
|---|---|---|
| Unnamed creek (Little Thirtynine Creek Tributary) – Little Thirtynine Cr to T56 R8W S29, south line | 04010102-B52 | 1B, 2Ag, 3B, 3C, 4A, 4B, 5, 6 |
| Unnamed creek (Big Thirtynine Creek Tributary) – Big Thirtynine Cr to T56 R8W S29, south line | 04010102-B53 | 1B, 2Ag, 3B, 3C, 4A, 4B, 5, 6 |

# 4.0 Mitigation Sites

## 4.1 Project Site Identification and Location

The six proposed stream restoration projects are all located near Silver Bay, MN. Only one of the projects lies completely off Northshore land and another crosses a private landowner for a portion of the project. All other project sites are wholly on Northshore-owned land. See Figure 1 for an overview of all proposed mitigation projects. NSM is proposing that the following projects provide sufficient mitigation for the impacts based on the calculated functional lift and non-scored SQT lift.

### 4.1.1 Restoration Goals

There are several general goals for the proposed stream mitigation plan that are illustrated in detail in the 30% design plans in Appendix C. The general goals include:

1. Address elements of the restoration sites that have a low function score in the SQT tool.
2. Target geographic areas that have been noted as having high restoration potential in the WRAPS report by conducting the following activities:
    a. Re-meander channelized tributaries/reaches
    b. Restore the Beaver River's historic flow pattern where possible
    c. Reconnect channelized tributaries/reaches to their floodplains
    d. Establish a riffle/pool sequence that would replicate a stable natural channel and score high in the SQT protocol.
3. Improve aquatic and floodplain habitat
4. Improve multiple reaches within the Beaver River watershed with the opportunity to have a greater degree of positive impact on a single watershed.

### 4.1.2 Existing Use Considerations

Table 2 outlines the existing uses in the Big and Little 39 Creek remnants. The uses listed were obtained prior to the MP7 basin being constructed. The ascribed uses are common among Northshore coldwater (trout) streams. The Beaver River and its tributaries that surround the project continue to attain those uses. The restoration projects proposed directly correlate to improving those same uses in approximately 21,522' immediately adjacent stream reaches. The only exception is the White Rock Creek project.

The Type 1B use will not be impacted by the project or the restoration projects. The availability and quality for drinking water will remain unchanged.

The Type 2A use will be improved in the restoration reaches through increased baseflow (reduces thermal stress), LWD (habitat), and bedform diversity (thermal refuge/spawning/habitat)

The Type 3B use will improve due to increased baseflow, but it is unlikely that the quantity of water before or after the restoration projects would have ever provided a necessary quantity of water for any common industrial use.

The Type 4A use will improve due to increased baseflow, but it is unlikely that the quantity of water before or after the restoration projects would have been able to provide a quantity necessary to support an agricultural use.

The Type 5 use will be improved in all six projects. Each project is in a reach that was channelized, has experienced excess erosion or development. All projects aim to return the reaches to a stable more natural

condition. The White Rock creek project also aims to improve the aesthetics and usability of the reach by providing a more natural flow path and access for residents.

The Type 6 use is general/other use and there are no anticipated impacts to beneficial uses.

## 4.2 Site Characterizations – Existing Conditions

### 4.2.1 Little 39 Diversion Ditch Site

**Project Area Existing Conditions:**

The Little 39 Diversion Ditch site is an excavated channel that redirected flow that would have gone into Reserve Mining Company's Mile Post 7 (MP7) tailings basin, Southwest to the Big 39 Creek very near the point that the Big 39 Creek was diverted to the Beaver River channel as part of MP7 tailings basin construction in the 1970s. This 5700' long diversion added approximately 6.5 square miles of new watershed area to the Beaver River main branch. The existing channel is mostly an excavated ditch and downstream diversion berm designed to efficiently move water away from the MP7 tailings basin. The diversion lacks sinuosity, an appropriately sized floodplain, large woody debris (LWD), bedform diversity and habitat diversity. The riparian vegetation is mostly native and functioning. The Little 39 Creek watershed was identified in the Lake Superior South Watershed Restoration and Protection Strategy (WRAPS) Report. The lower portion, which includes the Little 39 Diversion Ditch was identified in Figure 27 of the WRAPS report as a targeted area for restoration activities.

**Hydrology:** The Little 39 Diversion Ditch receives a "Functioning" score for hydrology (Table 3) due to the very small amount of development in the area (Land use Coefficient) and the lack of any concentrated flow points.

**Hydraulics:** The Little 39 Diversion Ditch scores a "Functioning at Risk" score due to its lack of a floodplain and resulting high BHR.

**Gemorphology:** The Little 39 Diversion Ditch is "Functioning at Risk" based on the SQT tool. The Rosgen Type Bc stream lacks the bedform diversity and large woody debris (LWD) typically associated with the stream type.

**Physiochemical:** No water quality data was collected and is not part of the lift calculation.

**Habitat/Connectivity:** The Little 39 Diversion Ditch was not assessed specifically for habitat. Based on the bank armoring (prevents overhanging bank), lack of bedform diversity and lack of LWD there is very little macroinvertebrate or fish habitat. The lack of floodplain and adjacent wetland also decreases the likelihood of quality amphibian habitat. A ditched stream without velocity refuge is problematic for fish passage and macroinvertebrate establishment. A stream without an established floodplain for a long distance also prevents other riverine species from traveling up and down the stream.

**Biology:** Macroinvertebrate and fish sampling was not completed, because it is not part of the functional lift Northshore is proposing. However, the proposed mitigation will add habitat elements to the site which is anticipated to increase the potential for macroinvertebrate and fish presence in this reach.

**Table 3: Little 39 Diversion Existing Conditions**

| EXISTING CONDITION ASSESSMENT | | | | | Roll Up Scoring | | |
|---|---|---|---|---|---|---|---|
| Functional Category | Function-Based Parameter | Metric | Field Value | Index Value | Parameter | Category | Category |
| Hydrology | Reach Runoff | Land Use Coefficient | 35 | 1.00 | 1.00 | 1.00 | Functioning |
| | | BMP MIDS Rv Coefficient | | | | | |
| | | Concentrated Flow Points / 1,000 feet | 0 | 1.00 | | | |
| Hydraulics | Floodplain Connectivity | Bank Height Ratio | 3 | 0.00 | 0.40 | 0.40 | Functioning At Risk |
| | | Entrenchment Ratio | 1.65 | 0.79 | | | |
| Geomorphology | Large Woody Debris | LWD Index | | | 0.05 | 0.53 | Functioning At Risk |
| | | No. of LWD Pieces / 100 meters | 1 | 0.05 | | | |
| | Lateral Migration | Dominant BEHI/NBS | VL/L | 1.00 | 0.67 | | |
| | | Percent Streambank Erosion (%) | 0 | 1.00 | | | |
| | | Percent Armoring (%) | 100 | 0.00 | | | |
| | Bed Material Characterization | Size Class Pebble Count Analyzer (p-value) | | | | | |
| | Bed Form Diversity | Pool Spacing Ratio | 6 | 0.70 | 0.39 | | |
| | | Pool Depth Ratio | 1.7 | 0.46 | | | |
| | | Percent Riffle (%) | 6 | 0.00 | | | |
| | | Aggradation Ratio | | | | | |
| | Riparian Vegetation | Riparian Buffer Width (%) | 100 | 1.00 | 1.00 | | |
| | | Canopy Cover (%) | 80 | 1.00 | | | |
| | | Herbaceous Vegetation Cover (%) | 80 | 1.00 | | | |
| | | Woody Stem Basal Area (sqm/hectare) | 14 | 1.00 | | | |

## 4.2.2 Big 39 Diversion Site

**Project Area Existing Conditions:**

The Big 39 Diversion site is a 1700' long excavated channel that redirected flow from the remnant channel Southwest to the Beaver River as part of Reserve Mining Company's MP7 tailings basin construction in the 1970s. The existing channel is an excavated ditch with the remnants of a weir that was used to temporarily divert flow back into the basin via a water supply culvert. The diversion lacks sinuosity, a connection to its floodplain at channel forming flow, LWD, bedform diversity and habitat diversity. The riparian vegetation is mostly an invasive species (reed canary grass) with stretches of overhanging shrubs. The Big 39 Creek watershed was identified in the (WRAPS) Report. The lower portion, which includes the Big 39 Diversion site was identified in Figure 27 of the WRAPS report as a targeted area for restoration activities.

**Hydrology:** The Big 39 Diversion receives a "Functioning" score for hydrology (Table 4) due to the very small amount of development in the area (Land Use Coefficient) and the lack of any concentrated flow points.

**Hydraulics:** The Big 39 Diversion scores a low "Not Functioning" score due to its lack of connection to a floodplain (Bank height ratio of 2.0).

**Gemorphology:** The Big 39 Diversion is "Functioning at Risk" based on the SQT tool. The Rosgen Type B stream lacks the bedform diversity, a functioning riparian vegetation community and LWD typically associated with the stream type.

**Physiochemical:** No water quality data was collected and is not part of the lift calculation.

**Habitat/Connectivity:** The Big 39 Diversion was not assessed specifically for habitat. Based on the lack of bedform diversity and lack of LWD, there is very little macroinvertebrate or fish habitat. The lack of floodplain and adjacent wetland also decreases the likelihood of quality amphibian habitat. At moderate flow conditions there are likely no barriers for fish or macroinvertebrates. At high flows there is an area that was restricted for the construction of a weir that may be a fish velocity barrier. Also, the remnants of the weir created a cascade and is a fish barrier at very low flows.

**Biology:** Macroinvertebrate and fish sampling was not completed, because it is not part of the functional lift Northshore is proposing. However, the proposed mitigation will add habitat elements to the site which is anticipated to increase the potential for macroinvertebrate and fish presence in this reach.

**Table 4: Big 39 Diversion Existing Conditions**

| Functional Category | Function-Based Parameter | Metric | Field Value | Index Value | Parameter | Category | Category |
|---|---|---|---|---|---|---|---|
| Hydrology | Reach Runoff | Land Use Coefficient | 35 | 1.00 | 1.00 | 1.00 | Functioning |
| | | BMP MIDS Rv Coefficient | | | | | |
| | | Concentrated Flow Points / 1,000 feet | 0 | 1.00 | | | |
| Hydraulics | Floodplain Connectivity | Bank Height Ratio | 2 | 0.00 | 0.25 | 0.25 | Not Functioning |
| | | Entrenchment Ratio | 1.3 | 0.50 | | | |
| Geomorphology | Large Woody Debris | LWD Index | | | 0.00 | 0.34 | Functioning At Risk |
| | | No. of LWD Pieces / 100 meters | 0 | 0.00 | | | |
| | Lateral Migration | Dominant BEHI/NBS | VL/L | 1.00 | 0.73 | | |
| | | Percent Streambank Erosion (%) | 0 | 1.00 | | | |
| | | Percent Armoring (%) | 40 | 0.20 | | | |
| | Bed Material Characterization | Size Class Pebble Count Analyzer (p-value) | | | | | |
| | Bed Form Diversity | Pool Spacing Ratio | 10 | 0.00 | 0.33 | | |
| | | Pool Depth Ratio | 4.2 | 1.00 | | | |
| | | Percent Riffle (%) | 15 | 0.00 | | | |
| | | Aggradation Ratio | | | | | |
| | Riparian Vegetation | Riparian Buffer Width (%) | 100 | 1.00 | 0.30 | | |
| | | Canopy Cover (%) | 20 | 0.00 | | | |
| | | Herbaceous Vegetation Cover (%) | 20 | 0.00 | | | |
| | | Woody Stem Basal Area (sqm/hectare) | 10 | 0.20 | | | |

### 4.2.3 East Branch Beaver River + Culvert Replacement

**Project Area Existing Conditions:**

The East Branch Beaver River + Culvert Replacement starts at a culvert installed on a MP7 Basin access road and goes downstream approximately 3000' to a set of box culverts installed under Lake County Highway 4. This reach was identified in the Lake Superior South WRAPS Report as a Targeted Restoration Area (Figure 27 of WRAPS Report). It was targeted due to erosion and lateral migration in this reach of stream. The increased erosion may be attributed to a poorly placed (perched) culvert and increased watershed area due to the diversion of the Big/Little 39 Creek remnants to the East Branch Beaver River as part of Reserve Mining Company's MP7 tailings basin construction in the 1970s.

**Hydrology:** The East Branch Beaver River receives a "Functioning" score for hydrology (Table 5) due to the very small amount of development in the area (Land use Coefficient) and the lack of any concentrated flow points.

**Hydraulics:** The East Branch Beaver River receives a "Functioning" score due to its connection to the floodplain

**Gemorphology:** The East Branch Beaver River is "Functioning at Risk" based on the SQT tool. The Rosgen Type C stream shows signs of lateral migration and lacks the LWD typical of a stream of this type.

**Physiochemical:** No water quality data was collected and is not part of the lift calculation in this instance.

**Habitat/Connectivity:** The East Branch Beaver River lacks LWD, but based on other parameters, has acceptable habitat. Excessive erosion often will blind off good macroinvertebrate habitat, but that has not been documented as part of this assessment. At most flow conditions there are likely no barriers for fish or macroinvertebrates within the East Branch Reach downstream from the culvert, but the culvert is a barrier at almost all flow conditions. The culvert outlet is well above water surface elevation at low flows and likely a velocity barrier at high flows. There are 17.6 miles of stream isolated from upstream migration due to this culvert.

**Biology:** Macroinvertebrate and fish sampling was not completed, because it is not part of the functional lift Northshore is proposing. However, the proposed mitigation will add habitat elements to the site which is anticipated to increase the potential for macroinvertebrate and fish presence in this reach.

**Table 5: East Branch + Culvert Existing Conditions**

| EXISTING CONDITION ASSESSMENT | | | | | Roll Up Scoring | | |
|---|---|---|---|---|---|---|---|
| Functional Category | Function-Based Parameter | Metric | Field Value | Index Value | Parameter | Category | Category |
| Hydrology | Reach Runoff | Land Use Coefficient | 35 | 1.00 | 1.00 | 1.00 | Functioning |
| | | BMP MIDS Rv Coefficient | | | | | |
| | | Concentrated Flow Points / 1,000 feet | 0 | 1.00 | | | |
| Hydraulics | Floodplain Connectivity | Bank Height Ratio | 1 | 1.00 | 1.00 | 1.00 | Functioning |
| | | Entrenchment Ratio | 7.9 | 1.00 | | | |
| Geomorphology | Large Woody Debris | LWD Index | | | 0.32 | 0.63 | Functioning At Risk |
| | | No. of LWD Pieces / 100 meters | 6 | 0.32 | | | |
| | Lateral Migration | Dominant BEHI/NBS | M/M | 0.50 | 0.50 | | |
| | | Percent Streambank Erosion (%) | 82 | 0.00 | | | |
| | | Percent Armoring (%) | 0 | 1.00 | | | |
| | Bed Material Characterization | Size Class Pebble Count Analyzer (p-value) | | | | | |
| | Bed Form Diversity | Pool Spacing Ratio | 3.2 | 0.88 | 0.71 | | |
| | | Pool Depth Ratio | 2.6 | 0.88 | | | |
| | | Percent Riffle (%) | 44 | 0.96 | | | |
| | | Aggradation Ratio | 1.5 | 0.13 | | | |
| | Riparian Vegetation | Riparian Buffer Width (%) | 100 | 1.00 | 1.00 | | |
| | | Canopy Cover (%) | 80 | 1.00 | | | |
| | | Herbaceous Vegetation Cover (%) | 80 | 1.00 | | | |
| | | Woody Stem Basal Area (sqm/hectare) | 14 | 1.00 | | | |

## 4.2.4 East Branch Tributaries

**Project Area Existing Conditions:**

The East Branch Tributaries site starts at the base of the proposed MP7 Dam 2 and goes east towards the East Branch Beaver River. This area was identified in the Lake Superior South WRAPS Report as a Targeted Restoration Area (Figure 27 of WRAPS Report). It was targeted due to historical alterations and changes related to added watershed area to the East Branch Beaver River.

**Hydrology:** The East Branch Beaver Tributaries are split into two distinct reaches, but will be one continuous 4855' long restoration site. These tributaries comprise much of what has been called "West Unnamed Creek" in other documents related to this project. The upper portion of the site is ditched and currently receives the Big/Little 39 Remnant creek flows, which is then directed to an unaltered portion of the stream. The 1200' long upper portion has been called the ditched channel reach and the 3655' long lower unaltered portion has been called the East Branch Tributary-F channel. The Ditched Channel reach scores "Functioning" for hydrology (Table 7) with some downward adjustment due to the land use coefficient related to a portion of its watershed being part of the constructed MP7 Basin. The lower East Branch Tributary, F-channel scores "Functioning" (Table 6) as well and has as similar land use coefficient.

**Hydraulics:** The reaches score "Not Functioning" and "Functioning at Risk" for hydraulics. This is primarily due to the lack of connection to a floodplain. The ditched channel has less flow and has created a small floodplain within the ditch. The score may not accurately reflect the hydraulic condition of this reach.

**Gemorphology:** The F-channel reach scores "Functioning at Risk" primarily due to extreme bank erosion, lack of bedform diversity and lack of LWD. The Ditch Channel scores "Functioning at Risk" primarily due to a complete lack of LWD, poor riparian vegetative diversity/cover and low bedform diversity.

**Physiochemical:** No water quality data was collected and is not part of the lift calculation in this instance.

**Habitat/Connectivity:** The Ditched Channel reach is artificially created and lacks habitat, bedform diversity and LWD. The F-channel portion is a natural stream, but lacks the LWD, bedform diversity, and has a poor connection to its floodplain. The lack of these features reduces fish and macroinvertebrate habitat.

**Biology:** Macroinvertebrate and fish sampling was not completed, because it is not part of the functional lift Northshore is proposing. However, the proposed mitigation will add habitat elements to the site which is anticipated to increase the potential for macroinvertebrate and fish presence in this reach.

**Table 6: Trib F-Channel Existing Conditions**

| EXISTING CONDITION ASSESSMENT | | | | | Roll Up Scoring | | |
|---|---|---|---|---|---|---|---|
| Functional Category | Function-Based Parameter | Metric | Field Value | Index Value | Parameter | Category | Category |
| Hydrology | Reach Runoff | Land Use Coefficient | 58 | 0.81 | 0.91 | 0.91 | Functioning |
| | | BMP MIDS Rv Coefficient | | | | | |
| | | Concentrated Flow Points / 1,000 feet | 0 | 1.00 | | | |
| Hydraulics | Floodplain Connectivity | Bank Height Ratio | 3 | 0.00 | 0.25 | 0.25 | Not Functioning |
| | | Entrenchment Ratio | 1.3 | 0.50 | | | |
| Geomorphology | Large Woody Debris | LWD Index | | | 0.27 | 0.45 | Functioning At Risk |
| | | No. of LWD Pieces / 100 meters | 5 | 0.27 | | | |
| | Lateral Migration | Dominant BEHI/NBS | H/H | 0.20 | 0.10 | | |
| | | Percent Streambank Erosion (%) | 100 | 0.00 | | | |
| | | Percent Armoring (%) | | | | | |
| | Bed Material Characterization | Size Class Pebble Count Analyzer (p-value) | | | | | |
| | Bed Form Diversity | Pool Spacing Ratio | 3.8 | 1.00 | 0.60 | | |
| | | Pool Depth Ratio | 2.3 | 0.79 | | | |
| | | Percent Riffle (%) | 90 | 0.00 | | | |
| | | Aggradation Ratio | | | | | |
| | Riparian Vegetation | Riparian Buffer Width (%) | 100 | 1.00 | 0.83 | | |
| | | Canopy Cover (%) | 80 | 1.00 | | | |
| | | Herbaceous Vegetation Cover (%) | 60 | 0.33 | | | |
| | | Woody Stem Basal Area (sqm/hectare) | 100 | 1.00 | | | |

**Table 7: East Br. Trib. Ditched Channel Existing Conditions**

| EXISTING CONDITION ASSESSMENT | | | | | Roll Up Scoring | | |
|---|---|---|---|---|---|---|---|
| Functional Category | Function-Based Parameter | Metric | Field Value | Index Value | Parameter | Category | Category |
| Hydrology | Reach Runoff | Land Use Coefficient | 58 | 0.81 | 0.91 | 0.91 | Functioning |
| | | BMP MIDS Rv Coefficient | | | | | |
| | | Concentrated Flow Points / 1,000 feet | 0 | 1.00 | | | |
| Hydraulics | Floodplain Connectivity | Bank Height Ratio | 3 | 0.00 | 0.41 | 0.41 | Functioning At Risk |
| | | Entrenchment Ratio | 1.7 | 0.81 | | | |
| Geomorphology | Large Woody Debris | LWD Index | | | 0.00 | 0.34 | Functioning At Risk |
| | | No. of LWD Pieces / 100 meters | 0 | 0.00 | | | |
| | Lateral Migration | Dominant BEHI/NBS | VL/L | 1.00 | 0.67 | | |
| | | Percent Streambank Erosion (%) | 0 | 1.00 | | | |
| | | Percent Armoring (%) | 100 | 0.00 | | | |
| | Bed Material Characterization | Size Class Pebble Count Analyzer (p-value) | | | | | |
| | Bed Form Diversity | Pool Spacing Ratio | 16 | 0.00 | 0.42 | | |
| | | Pool Depth Ratio | 3.6 | 1.00 | | | |
| | | Percent Riffle (%) | 82 | 0.27 | | | |
| | | Aggradation Ratio | | | | | |
| | Riparian Vegetation | Riparian Buffer Width (%) | 100 | 1.00 | 0.25 | | |
| | | Canopy Cover (%) | 0 | 0.00 | | | |
| | | Herbaceous Vegetation Cover (%) | 20 | 0.00 | | | |
| | | Woody Stem Basal Area (sqm/hectare) | 0 | 0.00 | | | |

### 4.2.5 Berm Removal Site

**Project Area Existing Conditions:**

The Berm Removal site extends from a pond created by a diversion constructed in approximately 1987 downstream approximately 2,766' to where it enters the East Branch Tributary Ditch Channel referred to in section 4.2.4. The berm was used to divert water to the East Branch Beaver River approximately 1.5 river miles upstream of where it would have naturally entered the same stream. The origin of this diversion is not evident from available records, but is not required for Northshore operations under the current basin progression design. This area was identified in the Lake Superior South WRAPS Report as a Targeted Restoration Area (Figure 27 of WRAPS Report). It was targeted due to historical alterations and changes related to added watershed area to the East Branch Beaver River. This diversion did not add watershed area to the East Branch, but did move some watershed area upstream of where it naturally would have entered.

**Hydrology:** The area is a native forest community and there are no concentrated flow points. The reach receives a "Functioning" score for hydrology (Table 8).

**Hydraulics:** The current channel is oversized due to the removal of watershed related to the construction of the diversion. The oversized channel prevents current flows from reaching its floodplain. The reach is "Functioning at Risk" for this parameter due to the disconnection.

**Gemorphology:** The berm removed watershed and reduced flows in the stream, but the actual high gradient Eb type channel was unaltered. The Bedform Diversity and Lateral Migration parameters receive high scores because of their unaltered state. The adjacent plant community is native and mature, so LWD is available for the stream. The reach scores "Functioning" for this parameter.

**Physiochemical:** No water quality data was collected and is not part of the lift calculation in this instance.

**Habitat/Connectivity:** All elements of fish and macroinvertebrate habitat and passage are present, but are limited by the lack of flow.

**Biology:** Macroinvertebrate and fish sampling was not completed, because it is not part of the functional lift Northshore is proposing. However, the proposed mitigation will add more water to the site which is anticipated to increase the potential for macroinvertebrate and fish presence in this reach.

**Table 8: Berm Removal Existing Conditions**

| EXISTING CONDITION ASSESSMENT | | | | | Roll Up Scoring | | |
|---|---|---|---|---|---|---|---|
| Functional Category | Function-Based Parameter | Metric | Field Value | Index Value | Parameter | Category | Category |
| Hydrology | Reach Runoff | Land Use Coefficient | 35 | 1.00 | 1.00 | 1.00 | Functioning |
| | | BMP MIDS Rv Coefficient | | | | | |
| | | Concentrated Flow Points / 1,000 feet | 0 | 1.00 | | | |
| Hydraulics | Floodplain Connectivity | Bank Height Ratio | 2 | 0.00 | 0.50 | 0.50 | Functioning At Risk |
| | | Entrenchment Ratio | 5 | 1.00 | | | |
| Geomorphology | Large Woody Debris | LWD Index | | | 0.74 | 0.94 | Functioning |
| | | No. of LWD Pieces / 100 meters | 15 | 0.74 | | | |
| | Lateral Migration | Dominant BEHI/NBS | L/M | 1.00 | 1.00 | | |
| | | Percent Streambank Erosion (%) | 0 | 1.00 | | | |
| | | Percent Armoring (%) | | | | | |
| | Bed Material Characterization | Size Class Pebble Count Analyzer (p-value) | | | | | |
| | Bed Form Diversity | Pool Spacing Ratio | 3.8 | 1.00 | 1.00 | | |
| | | Pool Depth Ratio | 3 | 1.00 | | | |
| | | Percent Riffle (%) | 50 | 1.00 | | | |
| | | Aggradation Ratio | | | | | |
| | Riparian Vegetation | Riparian Buffer Width (%) | 100 | 1.00 | 1.00 | | |
| | | Canopy Cover (%) | 80 | 1.00 | | | |
| | | Herbaceous Vegetation Cover (%) | 80 | 1.00 | | | |
| | | Woody Stem Basal Area (sqm/hectare) | 100 | 1.00 | | | |

## 4.2.6 White Rock Creek Site

**Project Area Existing Conditions:**

The White Rock Creek site is within the City of Silver Bay and is the only restoration site that is not predominantly on Northshore property. The reach extends 3501' from the intersection of Penn and Edison Blvd to an area south of the Rukavina Arena (Silver Bay Hockey Arena). The valley and stream have been altered for city development, and there are several concentrated flow points from parking lots, street drainage and ditching. Stream crossings within this reach were identified in the Lake Superior South WRAPS report in Figure 24 of that report. The crossings were noted to have scour and/or bank erosion.

**Hydrology:** Land use is a mix of forest, urban development and roads and the reach has five concentrated flow points. This equates to a "Functioning at Risk" score (Table 9) in the SQT matrix.

**Hydraulics:** The channel in this reach is incised due to the effects of increased peak flows from urbanization and channel alterations related to development. For this parameter the reach is rated as "Functioning at Risk."

**Gemorphology:** The moderate gradient F-type channel is altered and cleared in order to prevent culvert blockage. Only one piece of LWD was found during reach survey and banks have a high rate of erosion. Bedform diversity also scored very low with almost the entire reach being a riffle. The geomorphology parameter scores "Functioning at Risk."

**Physiochemical:** No water quality data was collected and is not part of the lift calculation in this instance.

**Habitat/Connectivity:** Habitat elements are not present in abundance. Lack of pools reduces likelihood of healthy fish populations and lack of LWD and high rate of erosion reduces likelihood of the habitat necessary to maintain a healthy macroinvertebrate community. The largest impediment to connectivity is flow. It is typically low and during precipitation events it is very high because of the amount of impervious surface and concentrated flow points. Fish and macroinvertebrate movement would be made difficult at baseflow and during precipitation events. The proposed mitigation does not address stormwater, but an accessible floodplain will help maintain baseflow and reduce peak flows.

**Biology:** Macroinvertebrate and fish sampling was not completed, because it is not part of the functional lift Northshore is proposing. However, the proposed mitigation will add habitat elements to the site which is anticipated to increase the potential for macroinvertebrate and fish presence in this reach.

**Table 9: White Rock Creek Existing Conditions**

| EXISTING CONDITION ASSESSMENT | | | | | Roll Up Scoring | | |
|---|---|---|---|---|---|---|---|
| Functional Category | Function-Based Parameter | Metric | Field Value | Index Value | Parameter | Category | Category |
| Hydrology | Reach Runoff | Land Use Coefficient | 61 | 0.78 | 0.44 | 0.44 | Functioning At Risk |
| | | BMP MIDS Rv Coefficient | | | | | |
| | | Concentrated Flow Points / 1,000 feet | 2.9 | 0.10 | | | |
| Hydraulics | Floodplain Connectivity | Bank Height Ratio | 2.5 | 0.00 | 0.33 | 0.33 | Functioning At Risk |
| | | Entrenchment Ratio | 1.38 | 0.66 | | | |
| Geomorphology | Large Woody Debris | LWD Index | | | 0.05 | 0.41 | Functioning At Risk |
| | | No. of LWD Pieces / 100 meters | 1 | 0.05 | | | |
| | Lateral Migration | Dominant BEHI/NBS | VH/H | 0.20 | 0.35 | | |
| | | Percent Streambank Erosion (%) | 80 | 0.00 | | | |
| | | Percent Armoring (%) | 8 | 0.84 | | | |
| | Bed Material Characterization | Size Class Pebble Count Analyzer (p-value) | | | | | |
| | Bed Form Diversity | Pool Spacing Ratio | 5 | 0.70 | 0.72 | | |
| | | Pool Depth Ratio | 4.4 | 1.00 | | | |
| | | Percent Riffle (%) | 76 | 0.47 | | | |
| | | Aggradation Ratio | | | | | |
| | Riparian Vegetation | Riparian Buffer Width (%) | 100 | 1.00 | 0.50 | | |
| | | Canopy Cover (%) | 20 | 0.00 | | | |
| | | Herbaceous Vegetation Cover (%) | 80 | 1.00 | | | |
| | | Woody Stem Basal Area (sqm/hectare) | 5 | 0.00 | | | |

## 4.3 Site Characterizations – Proposed Conditions/Restoration Approach

### 4.3.1 Little 39 Diversion Ditch Site

The restoration design will address deficiencies noted in the existing conditions analysis. The proposed conditions will add a bankfull bench, add LWD, and increase bedform diversity through the addition of riffles and pools where appropriate, on the approximately 5,575 feet of stream mitigation reach. Preliminary design and SQT analysis indicate a functional lift of 1,171 feet (Table 10). The 30% Engineering plan set is available in Appendix C.

**Table 10: Little 39 Diversion Ditch Site Functional Lift – SQT Output Table**

| FUNCTIONAL CHANGE SUMMARY | | MITIGATION SUMMARY | | |
|---|---|---|---|---|
| Existing Condition Score (ECS) | 0.39 | 1171 | (FF) | Lift |
| Proposed Condition Score (PCS) | 0.60 | | | |
| Change in Functional Condition (PCS - E | 0.21 | | | |
| Existing Stream Length (ft) | 5575 | | | |
| Proposed Stream Length (ft) | 5575 | | | |
| Change in Stream Length (ft) | 0 | | | |
| Existing Functional Feet (FF) | 2174 | | | |
| Proposed Functional Feet (FF) | 3345 | | | |
| Proposed FF - Existing FF | 1171 | | | |
| Percent Change in FF (%) | 54% | | | |
| FF Yield (FF/ft) | 0.21 | | | |

### 4.3.2 Big 39 Diversion Site

The restoration design will address deficiencies noted in the existing conditions analysis. The proposed conditions will create an accessible floodplain (bankfull bench) by excavating material adjacent to the existing channel, adding LWD, adding sinuosity (meander) and maximizing the bedform diversity parameter through the addition of riffles and pools. Preliminary design and SQT analysis indicate a functional lift of 511 feet (Table 11). The 30% engineering plan set is available in Appendix C.

**Table 11: Big 39 Diversion Site Functional Lift – SQT Output Table**

| FUNCTIONAL CHANGE SUMMARY | | MITIGATION SUMMARY | | |
|---|---|---|---|---|
| Existing Condition Score (ECS) | 0.32 | 511 | (FF) | Lift |
| Proposed Condition Score (PCS) | 0.60 | | | |
| Change in Functional Condition (PCS - E | 0.28 | | | |
| Existing Stream Length (ft) | 1590 | | | |
| Proposed Stream Length (ft) | 1700 | | | |
| Change in Stream Length (ft) | 110 | | | |
| Existing Functional Feet (FF) | 509 | | | |
| Proposed Functional Feet (FF) | 1020 | | | |
| Proposed FF - Existing FF | 511 | | | |
| Percent Change in FF (%) | 100% | | | |
| FF Yield (FF/ft) | 0.30 | | | |

### 4.3.3 East Branch Beaver River + Culvert Site

The restoration design will address deficiencies noted in the existing conditions analysis. The proposed conditions will reposition a set of perched culverts, make floodplain accessible, move channel away from eroding banks, add LWD and improve bedform diversity. The design includes improved width/depth ratio, which is a strategy identified in Table 12 of the Lake Superior South WRAPS report. Preliminary design and SQT analysis indicate a functional lift of 316 feet (Table 12), although this does not include the added connectivity benefit of repositioning perched culverts discussed in section 5.1.13. The culvert placement reconnects the East Branch Beaver River (Subwatershed 1) to the rest of the Beaver River watershed.

Currently the 17.6 stream miles are isolated from the rest of the watershed. The 30% engineering plan set is available in Appendix C.

**Table 12: East Branch + Culvert Site Functional Lift – SQT Output Table**

| FUNCTIONAL CHANGE SUMMARY | | MITIGATION SUMMARY | | |
|---|---|---|---|---|
| Existing Condition Score (ECS) | 0.53 | 316 | (FF) | Lift |
| Proposed Condition Score (PCS) | 0.60 | | | |
| Change in Functional Condition (PCS - EC | 0.07 | | | |
| Existing Stream Length (ft) | 2800 | | | |
| Proposed Stream Length (ft) | 3000 | | | |
| Change in Stream Length (ft) | 200 | | | |
| Existing Functional Feet (FF) | 1484 | | | |
| Proposed Functional Feet (FF) | 1800 | | | |
| Proposed FF - Existing FF | 316 | | | |
| Percent Change in FF (%) | 21% | | | |
| FF Yield (FF/ft) | 0.11 | | | |

### 4.3.4 East Branch Tributaries Site

The restoration design will address deficiencies noted in the existing conditions analysis. The proposed conditions for the F-channel portion will include a floodplain that is accessible in the anticipated flow conditions add bedform diversity and add LWD. The proposed conditions for the ditched channel portion includes a similar plan to create floodplain inside ditched channel, add bedform diversity and LWD. Preliminary design and SQT analysis indicate a functional lift of 1,250 (950'+300') feet (Tables 13 and 14). The 30% engineering plan set is available in Appendix C.

**Table 13: East Br. F-Channel Functional Lift – SQT Output Table**

| FUNCTIONAL CHANGE SUMMARY | | MITIGATION SUMMARY | | |
|---|---|---|---|---|
| Existing Condition Score (ECS) | 0.32 | 950 | (FF) | Lift |
| Proposed Condition Score (PCS) | 0.58 | | | |
| Change in Functional Condition (PCS - EC | 0.26 | | | |
| Existing Stream Length (ft) | 3655 | | | |
| Proposed Stream Length (ft) | 3655 | | | |
| Change in Stream Length (ft) | 0 | | | |
| Existing Functional Feet (FF) | 1170 | | | |
| Proposed Functional Feet (FF) | 2120 | | | |
| Proposed FF - Existing FF | 950 | | | |
| Percent Change in FF (%) | 81% | | | |
| FF Yield (FF/ft) | 0.26 | | | |

**Table 14: East Br. Ditch Channel Functional Lift – SQT Output Table**

| FUNCTIONAL CHANGE SUMMARY | | MITIGATION SUMMARY | | |
|---|---|---|---|---|
| Existing Condition Score (ECS) | 0.33 | 300 | (FF) | Lift |
| Proposed Condition Score (PCS) | 0.58 | | | |
| Change in Functional Condition (PCS - E | 0.25 | | | |
| Existing Stream Length (ft) | 1200 | | | |
| Proposed Stream Length (ft) | 1200 | | | |
| Change in Stream Length (ft) | 0 | | | |
| Existing Functional Feet (FF) | 396 | | | |
| Proposed Functional Feet (FF) | 696 | | | |
| Proposed FF - Existing FF | 300 | | | |
| Percent Change in FF (%) | 76% | | | |
| FF Yield (FF/ft) | 0.25 | | | |

### 4.3.5 Berm Removal Site

The restoration design will address deficiencies noted in the existing conditions analysis through the removal of the berm and reestablishment of the full watershed area. The proposed conditions will increase flow volume to the existing channel. The added volume will reconnect flow to the floodplain and address the low hydraulics score. Preliminary design and SQT analysis indicate a functional lift of 304 feet (Table 15). The 30% engineering plan set is available in Appendix C.

**Table 15: Berm Removal Site Functional Lift – SQT Output Table**

| FUNCTIONAL CHANGE SUMMARY | | MITIGATION SUMMARY | | |
|---|---|---|---|---|
| Existing Condition Score (ECS) | 0.49 | 304 | (FF) | Lift |
| Proposed Condition Score (PCS) | 0.60 | | | |
| Change in Functional Condition (PCS - E | 0.11 | | | |
| Existing Stream Length (ft) | 2766 | | | |
| Proposed Stream Length (ft) | 2766 | | | |
| Change in Stream Length (ft) | 0 | | | |
| Existing Functional Feet (FF) | 1355 | | | |
| Proposed Functional Feet (FF) | 1660 | | | |
| Proposed FF - Existing FF | 304 | | | |
| Percent Change in FF (%) | 22% | | | |
| FF Yield (FF/ft) | 0.11 | | | |

### 4.3.6 White Rock Creek Site

The restoration design will address deficiencies noted in the existing conditions analysis. The proposed conditions will create a floodplain within the confines of the narrowed valley, improve bedform diversity and add LWD. A riparian planting plan will also improve the vegetative community. Preliminary design and SQT analysis indicate a functional lift of 988 feet (Table 16). The 30% engineering plan set is available in Appendix C.

**Table 16: White Rock Creek Site Functional Lift – SQT Output Table**

| FUNCTIONAL CHANGE SUMMARY | | MITIGATION SUMMARY | | |
|---|---|---|---|---|
| Existing Condition Score (ECS) | 0.24 | 988 | (FF) | Lift |
| Proposed Condition Score (PCS) | 0.49 | | | |
| Change in Functional Condition (PCS | 0.25 | | | |
| Existing Stream Length (ft) | 3951 | | | |
| Proposed Stream Length (ft) | 3951 | | | |
| Change in Stream Length (ft) | 0 | | | |
| Existing Functional Feet (FF) | 948 | | | |
| Proposed Functional Feet (FF) | 1936 | | | |
| Proposed FF - Existing FF | 988 | | | |
| Percent Change in FF (%) | 104% | | | |
| FF Yield (FF/ft) | 0.25 | | | |

## 4.4 Summary of Proposed Mitigation Function Lift

Table 17 shows the actual feet of stream to be restored and the associated function lift associated with each project.

**Table 17: Summary of Proposed Mitigation Restoration and Functional Lift**

| River Reach | Total Restoration Feet | Functional Foot Lift |
|---|---|---|
| Big 39 Diversion | 1,700 | 511 |
| Tributary to East Branch, Steep Ditch | 4,855 | 1,250 |
| East Branch | 3,000 | 316 |
| Little 39, Diversion | 5,700 | 1,171 |
| White Rock Creek | 3,501 | 988 |
| Berm Channel | 2,766 | 304 |
| **Totals** | 21,522 | 4,540 |

# 5.0 Non-SQT Scored Lift

The SQT tool is designed to evaluate functional feet, or in the case of restoration, the functional lift associated with an improvement to a stream's function. This tool assesses that lift, within the restoration reach, associated with a certain physical alteration. Many of these alterations within a restoration reach are actually designed to increase, or improve stream function downstream of the restoration. The functional lift in the downstream reaches from work done within the restoration reach is not assessed within the current SQT format. It is Northshore's understanding that the SQT tool is meant to inform the mitigation project scale and the exact output is not used to define the functional feet of mitigation. The functional debit (Table 1) and the proposed functional lift (Table 17) are 668.2' apart, with the deficit on the proposed functional lift. The proposed functional lift (Table 17) directly satisfies 87% of the functional debits (Table 1) considering only the functional lift within the project reaches. It is NSM's conclusion that the scope of the restoration activities (21,522' of stream) and the lift provided downstream of each restoration reach, provides adequate mitigation for the 668.2' deficit.

This section will address the functional lift provided by the proposed restoration activities that was not scored within the SQT framework.

## 5.1 HUC 10 Beaver River – Lake Superior Frontal Watershed (0401010201)

The Beaver River watershed has been highly altered. During the construction of the MP7 tailings basin, water was diverted out of the valley in which the basin was constructed. This was done to reduce water input to the basin and reduce impounded volume. The watersheds were altered and sections of stream were redirected in constructed channels and riparian areas were disturbed. Many of the areas disturbed from construction have since revegetated with invasive species (primarily reed canary grass). The pre-settlement and existing conditions are explained in detail in sections 4.1 and 4.2 of the Watershed Assessment (Appendix E).

In December 2018 the MPCA published the Lake Superior South Watershed Restoration and Protection Strategy (WRAPS) Report. This report was completed to identify areas with high restoration potential and areas of special concern for protection. This report is included in Appendix F. This report identified the watersheds that were altered during the construction of the MP7 tailings basin. See Table 9, "10-year targeted geographic areas for restoration and protection" and Figure 27, "Targeted geographic areas" in the WRAPS report.

The targeted geographic areas are all watersheds downstream of, or within the footprint of the MP7 tailings basin. The restoration activities proposed will be in, or provide lift to all targeted areas shown in Figure 27 (within Beaver River watershed). It is important to acknowledge and understand the scale and concentrated effort of these restoration activities. It is unlikely that there has been a restoration effort in the state of Minnesota with this amount of activity in a single watershed. These activities are also exactly as proposed by the Lake Superior South WRAPS Report. They directly target identified stressors, impairments and address the likely causes of those impairments rather than trying to armor or adjust to the upstream impacts. The unscored functional benefits anticipated in each of the affected subwatersheds is discussed further below. See Figure 2 for watershed locations.

### 5.1.1 Beaver River East (Subwatershed 1)

Beaver River East, by area, is mostly unaffected by previous alterations and will be mostly unaffected by restoration activities, but the extreme lower portion will receive noteworthy restoration activity and ancillary benefits. The unscored elements of those benefits include:

**Connectivity**

- The culvert repositioning in the lower portion of Subwatershed 1 will allow fish migration above the culverts. The culverts are currently "perched" and at lower flows are approximately 2' above the water elevation downstream. Water velocity and depth within the culverts during a wide range of flows are likely a barrier. This project will connect approximately 17.6 stream miles of upstream habitat for fish in the East Branch. These types of projects are recognized in "Instream Flows for Riverine Resource Stewardship" and vital to the health of the streams. Currently the SQT does not have a scoring tool for watershed connectivity and therefore no score is given for uplift for this project.
- The East Branch + Culvert project contains design elements to reconnect or enhance floodplain access for flood flows. This connection provides better riparian habitat for amphibians and provides a more complete corridor for riparian species to move up and downstream.

**Sediment Reduction** (See Table 12 in WRAPS report for identified strategy in Beaver River)

- The East Branch + Culvert project contains design elements to reduce erosion by moving stream away from eroding banks and installing bankfull floodplain benches. This reduces sediment load in the project reach as well as downstream.
- Installation of LWD also reduces sediment loading, by creating sediment traps with low velocity and provides some bed/bank armoring.

**Wetland Creation/Enhancement**

- Allowing a stream to better access its floodplain will enhance riparian wetlands. Wetlands attenuate peak flows by holding water like a sponge and maintaining baseflows by releasing it slowly after peaks begin to recede.
- The amount of wetland created or enhanced in this project reach has not been quantified.

### 5.1.2 West Unnamed Creek (Subwatershed 4)

Two restoration projects are proposed in this subwatershed. The East Branch Tributaries site and the Berm Removal site. Since a large portion of this watershed will contain restoration activities, much of it is scored in the SQT Functional Lift calculation. However, there will be some unscored lift provided by the following:

**Wetland Creation/Enhancement**

- The Berm Removal site had 60% of its watershed removed when the berm was constructed in approximately 1987. The restoration proposes to recover the removed watershed. This new watershed relates to a higher baseflow to sustain a riparian wetland community and a higher flood flow to replenish the riparian community with needed nutrients and water when it floods.
- The site is approximately 2,766' long and much of that reach is within a Type 7 wetland that will now receive the flood flows and higher water table it had prior to the berm construction.

**Connectivity**

- The Berm Removal project removes a berm/dam which prevented any fish or macroinvertebrate passage into the above wetland complex.
- The East Branch Tributaries project reduces flow velocities, creates a bankfull bench, increases bedform diversity and adds LWD. All of these design elements improve the ability for fish and macroinvertebrate passage. The creation of the bankfull bench also provides a corridor for amphibian species.

**Sediment Reduction** (See Table 12 in WRAPS report for identified strategy in Beaver River)

- The Berm Removal project restores the watershed to a pre-settlement flow path. Presently the flow from this watershed is directed to an upstream point in the Beaver River East, (Subwatershed 1) and increasing watershed sizes typically leads to increased flows and erosion.
- The East Branch Tributaries project aims to use Natural Channel Design (NCD) to mimic a more natural stream with lower peak flows and higher baseflows. The Beaver River East (Subwatershed 1) will receive the benefits of these activities.
- Installation of LWD also reduces sediment loading by creating sediment traps with low velocity and provides bed/bank armoring.

### 5.1.3 Lower East Branch Beaver River (Subwatershed 7)

This subwatershed experienced a 4% increase in size (approximately 2 sq. miles) upon the construction of a ditch to divert water from an impounded area on the northwest side of the MP7 tailings basin. The proposed basin progression will inundate much of the watershed area that was diverted to the East Branch during the construction of the MP7 basin. The redirection of the inundated watershed to subwatershed 14 will return subwatershed 7 to a size very close to the pre-settlement size (-0.2%), but the ditches that remain drain the landscape faster than a natural channel with floodplain. The proposed restoration activities in Subwatersheds 1 and 4 will target those areas specifically. The Berm Removal project, East Branch Tributaries project and the East Branch + Culvert Project will provide the following benefits to Subwatershed 7.

**Sediment Reduction** (See Table 12 in WRAPS report for identified strategy in Beaver River)

- The East Branch + Culvert project contains design elements to reduce erosion by moving stream flow off of eroding banks. This reduces sediment load in the project reach as well as downstream in Subwatershed 7.
- The redirecting of flow to its pre-settlement channel at the Berm Removal site will reduce peak flows in a section of the East Branch Beaver River that did not historically receive the drainage. The pre-settlement channel is also a natural channel with an accessible floodplain, unlike the drainage ditch used to direct flow to the East Branch. Flow through a natural channel with an accessible floodplain will be lower at peaks.

**Baseflow Maintenance**

- The restoration projects in subwatershed 1 and 4 all aim to reduce peak flows and provide better floodplain access or creation. Floodplain access and area act to reduce peaks by spreading out water onto the floodplain at peaks and also hold some of that water and release it slowly over time. This sponge-like behavior helps to maintain a higher baseflow. The benefits of higher baseflow are primarily biological and will persist through the entire watershed downstream of the restoration activities.

**Connectivity**

- A higher baseflow allows for fish migration and refuge during low flow/high temperature months.

### 5.1.4 Upper Middle Beaver River (Subwatershed 11)

The Upper Middle Beaver River (Subwatershed 11) saw the most change related to the construction of the MP7 tailings basin. The cumulative watershed area change was +97.6%, or approximately + 24.3 square miles. This addition of watershed area was substantial and exacerbated by ditched channels and resulting

higher peak flows from those channels. The diversions to add the drainage area lacked sinuosity and natural channel elements. As a result, these subwatersheds received additional drainage but lacked natural channels with floodplains. The added area would have destabilized the downstream reaches alone, but was made worse by the removal of flood storage as a result of the coincident ditching. The designs will consist of the addition of a floodplain where the Big and Little 39 Creek diversion channels currently lack any such feature. These floodplains will allow the annual or semiannual peak flows to spread out on the floodplain and slow the peak flows. The newly created floodplains will also allow for infiltration which will further reduce or stabilize the peak flows entering from these watersheds. The historic ditching has led to excessive erosion that causes hydraulic, geomorphologic, physiochemical and biological problems. The restoration projects proposed will not physically alter these watersheds, but this watershed will receive many benefits not accounted for in the SQT score of the individual restoration reaches as a result of the proposed mitigation work upstream of this subwatershed.

**Wetland Creation/Enhancement**

- The Little 39 Diversion Ditch and Big 39 Diversion projects create wetlands. It is estimated that approximately 5.1 acres of riparian wetlands will be created through the addition of floodplains. The Big 39 site will excavate the riparian area and create a floodplain where one does not exist currently. The Little 39 restoration plan is to create a floodplain inside the existing confined valley.
- There are areas adjacent to the Big 39 Diversion that would qualify as wetlands, but the natural channel design will enhance these wetlands by backing up and slowing down flow by increased sinuosity, LWD installation and other in-stream design elements.

**Connectivity**

- The ditches created to divert the upper reaches of Big and Little 39 Creeks are very effective at moving water. The velocities, lack of floodplain and lack of bedform diversity inhibit fish passage and macroinvertebrate establishment. The reaches are not likely complete barriers, but create conditions that reduce the ability for species to move up and downstream at high flows and low flows.
- The floodplain wetland creation/enhancement will provide a continuous and improved corridor for amphibian species and other species that use riparian areas to travel.

**Sediment Reduction** (See Table 12 in WRAPS report for identified strategy in Beaver River)

- The restoration activities associated with the Big and Little 39 diversions are very well suited to reduce sediment loading on the reach and downstream in the Middle Beaver River and Lower Beaver River. The most effort in these reaches will be put into establishing a stable channel with greater sinuosity, synonymous with adding “Stream Meanders.” This practice is called out explicitly in the WRAPS report as a “Strategy Type” for the Beaver River. It is called out again as a “Strategy Type” in the same table as “Re-meander Channelized Tributaries”. It is likely that the channelized tributaries the report refers to are the exact channelized tributaries the restoration plan intends to “re-meander.”
- Floodplain creation and the addition of LWD will also reduce sediment downstream and area also called out as “Strategy Types” in Table 12 of the WRAPS report

### 5.1.5 Lower Beaver River Watershed (Subwatershed 16- Watershed Assessment)

This watershed has cumulatively the same drainage area prior to the MP7 tailings basin construction and the proposed condition. It will experience all of the restoration benefits explained in Section 5.1.4, but due to a steep and rocky channel and valley, the effects will likely not be measurable. A reduction in sediment load to the watershed will likely be seen, but due to the gradient and substrate, the reduced load will not be as important as in a depositional watershed.

# 6.0 Construction Methods and Schedule

Sites will be permitted separately and in the year prior to construction. There are not complete construction plans yet, so all required permitting is not yet known. The individual projects will all trigger Work in Public Waters, possibly construction stormwater and possibly 404/Wetland Conservation Act permits. Due to the nature of the projects, environmental review under Minnesota Rule 4410 is anticipated to be part of the permitting process. A formal construction plan is anticipated to be developed for each project, but will work from the following general guidelines.

## 6.1 Construction Methods

When possible, construction will work from downstream to upstream. This allows for temporary blocks to be installed for construction day(s), and work will be done in daily segments in mostly dewatered conditions. The block will be removed daily to prevent overtopping. There may be segments where a bypass will be necessary and this will be done with pumps or excavations.

The exact construction plan has not been determined for the individual reaches. The plan will likely be heavily influenced by the bidding contractor and weather.

## 6.2 Construction Sequencing

When possible, the projects will be constructed during late-summer, low-flow conditions. However, construction may need to occur in the winter due to the wet, soft soil conditions in the project area. Project permit conditions may also drive project timing. In general, project construction methods and sequencing will be planned to minimize the potential for erosion and downstream sedimentation to the extent practicable. Stream restoration construction will be sequenced to limit the area of open soil disturbance during construction, typically completing construction of each component of the project by the end of each day. The equipment employed is expected to include a tracked excavator, small dozer, and loaders. The equipment will be selected by the chosen contractor for each project site with specifications that the contractor shall minimize disturbance to the extent practicable.

The downstream end of each project area will be equipped with a sediment control best management practice (BMP). This may be rock vanes, silt curtains or rock/geotextile BMPs depending on the amount of flow. These BMPs will minimize, not eliminate, downstream transport of sediment. Timing and duration will be the most effective sediment control aspects.

The approximate project construction limits are shown on the 30% sheets in Appendix C. Perimeter controls are not planned for the entire construction limits, only around temporary soil storage areas. Most soil storage areas will be confined within the individual project construction limits. It is possible, however, that some material may be taken to, or from other project areas depending on material balance. Some excess material may also be placed within the tailings basin or used for tailings basin construction.

When possible, new stream meanders that are not coincident with the existing channel will be excavated first and maintained offline from the existing flows. Other project design elements may also be able to be constructed or installed when flow is offline.

### 6.3 Schedule

Construction is anticipated during the construction seasons of 2021, 2022 and 2023. It has not been determined which projects will be constructed in which year, but it is likely that 2 projects will be completed per year. The material balance and contractor input will determine which projects are done concurrently, or sequentially within any given year.

## 7.0 Performance Standards and Monitoring

### 7.1 Performance Standards

Due to the inherent variability in natural systems Northshore proposes a 10% threshold on monitoring results to trigger adaptive management or additional mitigation. The departure from design will be reviewed annually and discussion regarding the departure and potential for adaptive management will be included in the report.

### 7.2 Monitoring

Annual monitoring will be completed consistent with the SQT guidance and will result in a complete monitoring tab included in the SQT spreadsheet.

#### 7.2.1 Annual Monitoring Report

1. Complete SQT "Monitoring Data" tab on project spreadsheet that contains existing conditions, design and the year(s) of monitoring results.
2. Interpretation of annual results and previous years if applicable.
3. Description of adaptive management or additional mitigation if required.
4. To be completed for 5 years, with year 1 being the year after project completion.
5. Biological monitoring (fish/macroinvertebrate) will not be completed, because was not considered as part of the functional lift.
6. Reference photo locations will be selected and photos will be taken annually from those locations in the cardinal directions.

#### 7.2.2 As-Built Stream Survey

A survey will be conducted to document the dimension, pattern, and profile of the pre-restoration degraded channel prior to restoration and the restored channel after construction. The parameters required to complete the as-built portion of the SQT spreadsheet will be collected and documented in that project's SQT summary. The results of the as-built survey will be reported with the first annual report.

# 8.0 References

Minnesota Pollution Control Agency. 2018. Lake Superior South Watershed Restoration and Protection Strategy Report. Prepared by the Minnesota Pollution Control Agency, Duluth, MN.

Annear, T., I. Chisholm, H. Beecher, A. Locke, P. Aarrestad, C. Coomer, C. Estes, J. Hunt, R. Jacobson, G. Jöbsis, J. Kauffman, J. Marshall, K. Mayes, G. Smith, R. Wentworth, and C. Stalnaker. 2004. Instream Flows for Riverine Resource Stewardship, Revised Edition. Instream Flow Council, Cheyenne, WY. 268 pp.

*Figures*

Stream Survey Location

Ditch Diversion

Culvert Replacement Location

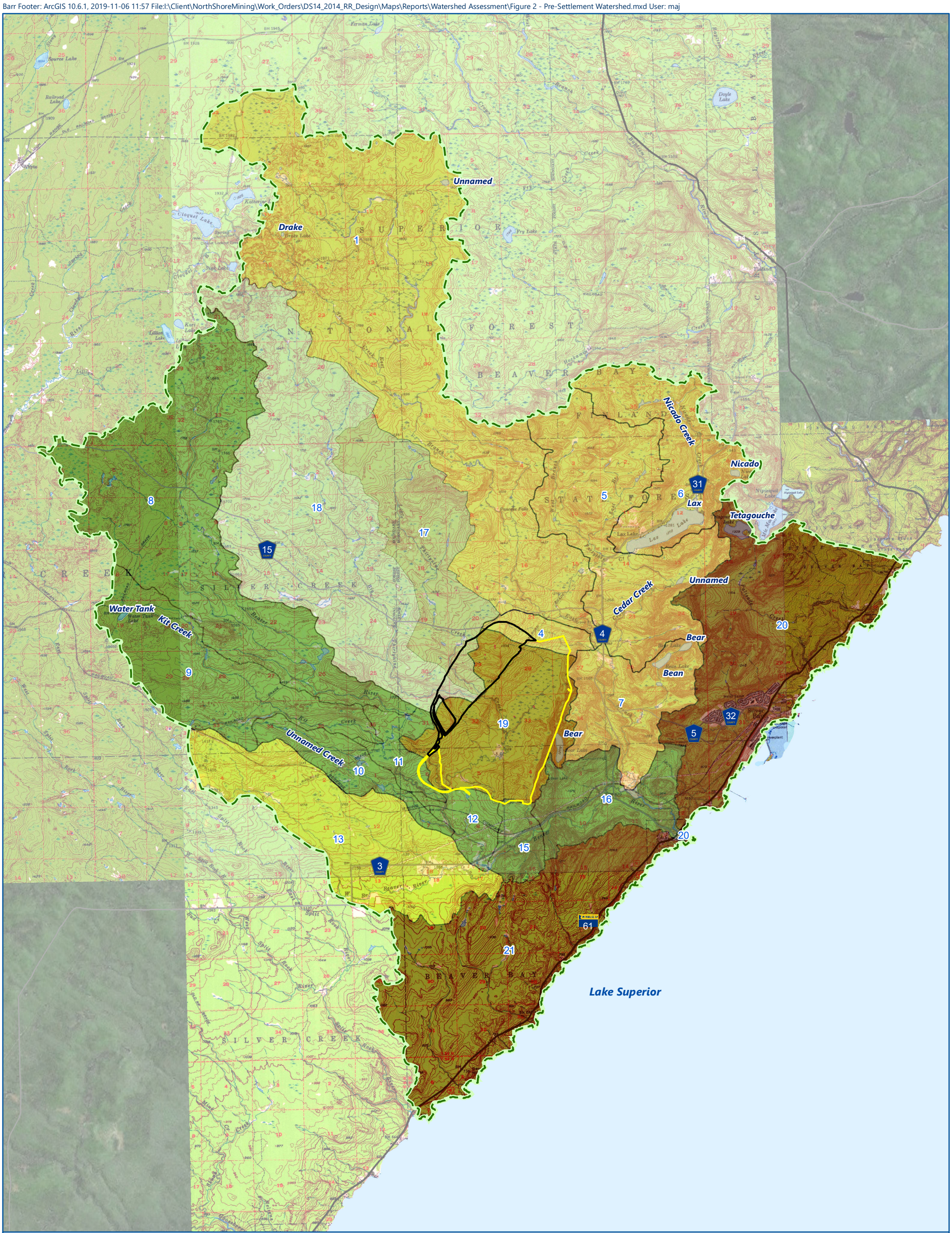
0 1
Miles

PROPOSED PROJECT LOCATIONS
Tailings Basin Progression Report
Northshore Mining Co.
Lake County, Minnesota

FIGURE 1

BARR

Barr Footer: ArcGIS 10.6.1, 2019-11-06 11:57 File:I:\Client\NorthShoreMining\Work_Orders\DS14_2014_RR_Design\Maps\Reports\Watershed Assessment\Figure 2 - Pre-Settlement Watershed.mxd User: maj




## Legend

- Pre-Settlement Watershed
- Future Northshore Mine Operations
- Existing Northshore Mine Operations

**Subwatersheds**

- Big Thirtynine Creek
- Little Thirtynine Creek
- Thirtynine Creek
- East Branch Beaver River
- West Branch Beaver River
- Beaver River
- Lake Superior

N

0 1.75 3.5
Miles

BARR

BEAVER RIVER WATERSHEDS
Stream Mitigation Proposal
Northshore Mining Company
Lake County, Minnesota

FIGURE 2

# *Appendix A*

# *Impact Stream Debit Calculation*

# Minnesota SQT Debit Tool

| | | | | |
|---|---|---|---|---|
| **Project Name** | MP7 Tailings Basin and West Ridge Railroad | | | **Total Debits** |
| | Big/Little 39 Remnants | | | |
| **Applicant** | Northshore Mining Co. | | | |
| **Project ID/Permit Number(s) (optional)** | MP Tailings Basin Progression and West Ridge Railroad | **Date** | **6/12/20** | -5208.15 |
| **Project Description** | MP7 Tailings Basin progression and West Ridge Railroad Construction | | | |

| Stream ID By Reach | Impact Description | Latitude | Longitude |
|---|---|---|---|
| Big 39, Beaver Dam Areas | Tier 5 - Fill/Tailings deposition | 47 18'11.9N | 91 23'05.05 W |
| Big 39 Stream Areas | Tier 5 - Fill/Tailings deposition | 47 18'11.9N | 91 23'05.05 W |
| Little 39, Beaver Dam Areas | Tier 5 - Fill/Tailings deposition | 47 18'11.9N | 91 23'05.05 W |
| Little 39, Stream Areas | Tier 5 - Fill/Tailings deposition | 47 18'11.9N | 91 23'05.05 W |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

**NOTICE:** If you find errors or problems, please contact April Marcangeli at April.N.Marcangeli@usace.army.mil

Users Input Values

**The Minnesota Stream Quantification Tool Credits:**
**Lead Agency:** U.S. Army Corps of Engineers, St. Paul District
**Contributing Agencies:** U.S. Environmental Protection Agency
Minnesota Board of Water and Soil Resources
Minnesota Department of Natural Resources
Minnesota Pollution Control Agency

**Contractors:**
Ecosystem Planning and Restoration (EPR) through a contract with the U.S. Environmental Projection Agency (Contract No. EP-C-17-001).
Stream Mechanics as a sub-contractor to EPR

Version 1.2
Version Last Updated 1/30/2020

# MN SQT DEBIT TOOL v1.0

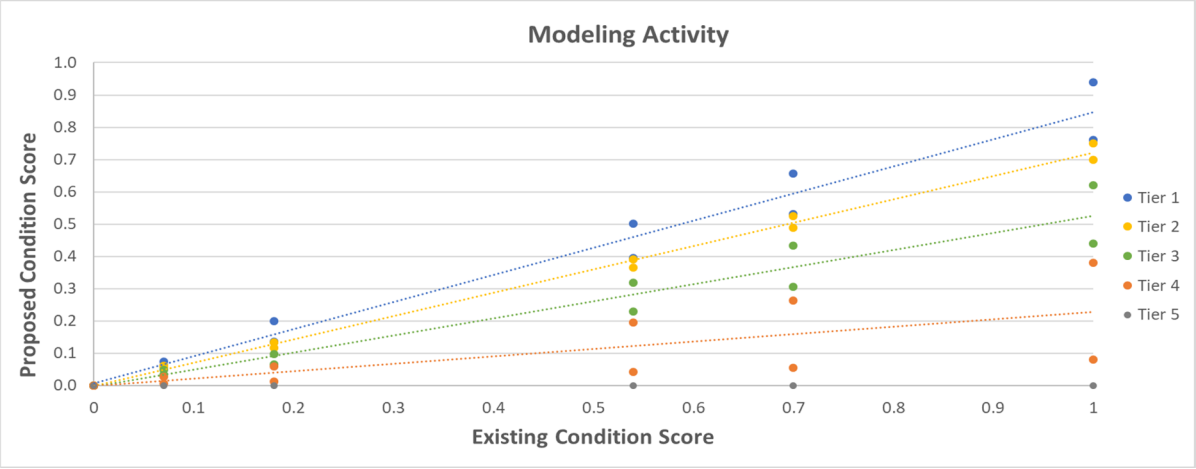
| | |
|---|---|
| Name: | MP7 Tailings Basin and West Ridge Railroad |
| | Big/Little 39 Remnants |
| Date: | 6/12/2020 |
| Project ID/ Permit Applicant Number(s): | Northshore Mining Co. |

| Users Input Values |
|---|
| Users select values from a pull-down menu |

| Stream ID by Reach | Impact Description | Debit Option | Existing Stream Length | Existing Condition Score | Proposed Length | Impact Severity Tier | Proposed Condition Score | Change in Functional Feet |
|---|---|---|---|---|---|---|---|---|
| Big 39, Beaver Dar | Tailings Progression | 2 | 3925 | 0.64 | 0 | Tier 5 | 0.00 | -2512.0 |
| Big 39 Stream Are | Tailings Progression | 2 | 1225 | 0.55 | 0 | Tier 5 | 0.00 | -673.8 |
| Little 39, Beaver D | Tailings Progression | 2 | 1340 | 0.64 | 0 | Tier 5 | 0.00 | -857.6 |
| Little 39, Stream A | Tailings Progression | 2 | 2080 | 0.56 | 0 | Tier 5 | 0.00 | -1164.8 |
| 0 | 0 | | | | | | | |
| 0 | 0 | | | | | | | |
| 0 | 0 | | | | | | | |
| 0 | 0 | | | | | | | |
| 0 | 0 | | | | | | | |
| 0 | 0 | | | | | | | |
| | | | | | | | **Total Functional Loss (Debits in FF):** | **-5208.2** |

# MN SQT DEBIT TOOL v1.0

| Impact Severity Tiers | Impact Factors | Percent Functional Loss |
|---|---|---|
| Tier 0 | 1.00 | 0% |
| Tier 1 | 0.84 | 16% |
| Tier 2 | 0.72 | 28% |
| Tier 3 | 0.53 | 47% |
| Tier 4 | 0.23 | 77% |
| Tier 5 | 0 | 100% |



## Reach Information and Reference Selection

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Reach ID: | Big 39, Beaver Dam Areas | Use Class: | 2A | Fish IBI Class: | Northern Coldwater | Upstream Latitude: | |
| Existing Stream Type: | DA | River Nutrient Regions: | North | Valley Type: | Unconfined Alluvial | Upstream Longitude: | |
| Reference Stream Type: | Bc | Proposed Bed Material: | Cobble | Outstanding Resource Waters: | No | Downstream Latitude: | |
| Woody Veg Natural Component: | Yes | Macroinvertebrate IBI Class: | Northern Coldwater | Proposed BMPs: | No | Downstream Longitude: | |
| Stream/Wetland Complex? | Yes | Is Armoring present? | No | | | | |

| EXISTING CONDITION ASSESSMENT | | | | | Roll Up Scoring | | | |
|---|---|---|---|---|---|---|---|---|
| **Functional Category** | **Function-Based Parameters** | **Measurement Method** | **Field Value** | **Index Value** | **Parameter** | **Category** | **Category** | **ECS** |
| Hydrology | Reach Runoff | Land Use Coefficient | 56.65 | 0.82 | 0.91 | 0.91 | Functioning | 0.64 |
| | | BMP MIDS Rv Coefficient | | | | | | |
| | | Concentrated Flow Points / 1,000 feet | 0 | 1.00 | | | | |
| Hydraulics | Floodplain Connectivity | Bank Height Ratio | 1 | 1.00 | 1.00 | 1.00 | Functioning | |
| | | Entrenchment Ratio | | | | | | |
| Geomorphology | Large Woody Debris | Large Woody Debris Index | | | 0.80 | 0.65 | Functioning At Risk | |
| | | # Pieces | | 0.80 | | | | |
| | Lateral Migration | Dominant BEHI/NBS | L/L | | 1.00 | | | |
| | | Percent Streambank Erosion (%) | 0 | 1.00 | | | | |
| | | Percent Armoring (%) | 0 | 1.00 | | | | |
| | Bed Material Characterization | Size Class Pebble Count Analyzer (p-value) | | | | | | |
| | Bed Form Diversity | Pool Spacing Ratio | 12 | 0.00 | 0.00 | | | |
| | | Pool Depth Ratio | 0 | 0.00 | | | | |
| | | Percent Riffle (%) | 0 | 0.00 | | | | |
| | | Aggradation Ratio | 2 | 0.00 | | | | |
| | Riparian Vegetation | Riparian Buffer Width (%) | | 0.80 | 0.80 | | | |
| | | Canopy Cover (%) | | 0.80 | | | | |
| | | Herbaceous Vegetation Cover (%) | | 0.80 | | | | |
| | | Woody Stem Basal Area (sqm/hectare) | | 0.80 | | | | |
| Physicochemical | Temperature | Summer Average ($^{o}$C) | 20 | 0.21 | 0.21 | 0.52 | Functioning At Risk | |
| | Dissolved Oxygen | DO (mg/L) | 6.5 | 0.36 | 0.36 | | | |
| | Total Suspended Solids | TSS (mg/L) | 1.7 | 1.00 | 1.00 | | | |
| Biology | Macroinvertebrates | Macroinvertebrate IBI | 30.6 | 0.27 | 0.27 | 0.14 | Not Functioning | |
| | Fish | Fish IBI | 19 | 0.00 | 0.00 | | | |

## Reach Information and Reference Selection

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Reach ID: | Little 39 Beaver Dam Areas | Use Class: | 2A | Fish IBI Class: | Northern Coldwater | Upstream Latitude: | |
| Existing Stream Type: | DA | River Nutrient Regions: | North | Valley Type: | Unconfined Alluvial | Upstream Longitude: | |
| Reference Stream Type: | B | Proposed Bed Material: | Cobble | Outstanding Resource Waters: | No | Downstream Latitude: | |
| Woody Veg Natural Component: | Yes | Macroinvertebrate IBI Class: | Northern Coldwater | Proposed BMPs: | No | Downstream Longitude: | |
| Stream/Wetland Complex? | Yes | Is Armoring present? | No | | | | |

| EXISTING CONDITION ASSESSMENT | | | | | Roll Up Scoring | | | |
|---|---|---|---|---|---|---|---|---|
| **Functional Category** | **Function-Based Parameters** | **Measurement Method** | **Field Value** | **Index Value** | **Parameter** | **Category** | **Category** | **ECS** |
| Hydrology | Reach Runoff | Land Use Coefficient | 55 | 0.84 | 0.92 | 0.92 | Functioning | 0.64 |
| | | BMP MIDS Rv Coefficient | | | | | | |
| | | Concentrated Flow Points / 1,000 feet | 0 | 1.00 | | | | |
| Hydraulics | Floodplain Connectivity | Bank Height Ratio | 1 | 1.00 | 1.00 | 1.00 | Functioning | |
| | | Entrenchment Ratio | 1.1 | | | | | |
| Geomorphology | Large Woody Debris | Large Woody Debris Index | | | 0.80 | 0.65 | Functioning At Risk | |
| | | # Pieces | | 0.80 | | | | |
| | Lateral Migration | Dominant BEHI/NBS | L/L | | 1.00 | | | |
| | | Percent Streambank Erosion (%) | 0 | 1.00 | | | | |
| | | Percent Armoring (%) | 0 | 1.00 | | | | |
| | Bed Material Characterization | Size Class Pebble Count Analyzer (p-value) | | | | | | |
| | Bed Form Diversity | Pool Spacing Ratio | 12 | 0.00 | 0.00 | | | |
| | | Pool Depth Ratio | 0 | 0.00 | | | | |
| | | Percent Riffle (%) | 0 | 0.00 | | | | |
| | | Aggradation Ratio | 2 | 0.00 | | | | |
| | Riparian Vegetation | Riparian Buffer Width (%) | | 0.80 | 0.80 | | | |
| | | Canopy Cover (%) | | 0.80 | | | | |
| | | Herbaceous Vegetation Cover (%) | | 0.80 | | | | |
| | | Woody Stem Basal Area (sqm/hectare) | | 0.80 | | | | |
| Physicochemical | Temperature | Summer Average (ºC) | 15.8 | 0.45 | 0.45 | 0.55 | Functioning At Risk | |
| | Dissolved Oxygen | DO (mg/L) | 5.9 | 0.19 | 0.19 | | | |
| | Total Suspended Solids | TSS (mg/L) | 1.1 | 1.00 | 1.00 | | | |
| Biology | Macroinvertebrates | Macroinvertebrate IBI | 25 | 0.13 | 0.13 | 0.07 | Not Functioning | |
| | Fish | Fish IBI | 16 | 0.00 | 0.00 | | | |

## Reach Information and Reference Selection

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Reach ID: | Big 39, channel areas | Use Class: | 2A | Fish IBI Class: | Northern Coldwater | Upstream Latitude: | |
| Existing Stream Type: | B | River Nutrient Regions: | North | Valley Type: | Unconfined Alluvial | Upstream Longitude: | |
| Reference Stream Type: | B | Proposed Bed Material: | Cobble | Outstanding Resource Waters: | No | Downstream Latitude: | |
| Woody Veg Natural Component: | Yes | Macroinvertebrate IBI Class: | Northern Coldwater | Proposed BMPs: | No | Downstream Longitude: | |
| Stream/Wetland Complex? | No | Is Armoring present? | No | | | | |

| EXISTING CONDITION ASSESSMENT | | | | | Roll Up Scoring | | | |
|---|---|---|---|---|---|---|---|---|
| **Functional Category** | **Function-Based Parameters** | **Measurement Method** | **Field Value** | **Index Value** | **Parameter** | **Category** | **Category** | **ECS** |
| Hydrology | Reach Runoff | Land Use Coefficient | 56.65 | 0.82 | 0.91 | 0.91 | Functioning | 0.55 |
| | | BMP MIDS Rv Coefficient | | | | | | |
| | | Concentrated Flow Points / 1,000 feet | 0 | 1.00 | | | | |
| Hydraulics | Floodplain Connectivity | Bank Height Ratio | 2 | 0.00 | 0.36 | 0.36 | Functioning At Risk | |
| | | Entrenchment Ratio | 1.44 | 0.72 | | | | |
| Geomorphology | Large Woody Debris | Large Woody Debris Index | | | 0.80 | 0.80 | Functioning | |
| | | # Pieces | | 0.80 | | | | |
| | Lateral Migration | Dominant BEHI/NBS | L/M | 1.00 | 1.00 | | | |
| | | Percent Streambank Erosion (%) | 0 | 1.00 | | | | |
| | | Percent Armoring (%) | | | | | | |
| | Bed Material Characterization | Size Class Pebble Count Analyzer (p-value) | | | | | | |
| | Bed Form Diversity | Pool Spacing Ratio | | 0.80 | 0.60 | | | |
| | | Pool Depth Ratio | | 0.80 | | | | |
| | | Percent Riffle (%) | | 0.80 | | | | |
| | | Aggradation Ratio | 3.2 | 0.00 | | | | |
| | Riparian Vegetation | Riparian Buffer Width (%) | | 0.80 | 0.80 | | | |
| | | Canopy Cover (%) | | 0.80 | | | | |
| | | Herbaceous Vegetation Cover (%) | | 0.80 | | | | |
| | | Woody Stem Basal Area (sqm/hectare) | | 0.80 | | | | |
| Physicochemical | Temperature | Summer Average (°C) | 20 | 0.21 | 0.21 | 0.52 | Functioning At Risk | |
| | Dissolved Oxygen | DO (mg/L) | 6.5 | 0.36 | 0.36 | | | |
| | Total Suspended Solids | TSS (mg/L) | 1.7 | 1.00 | 1.00 | | | |
| Biology | Macroinvertebrates | Macroinvertebrate IBI | 30.6 | 0.27 | 0.27 | 0.14 | Not Functioning | |
| | Fish | Fish IBI | 19 | 0.00 | 0.00 | | | |

## Reach Information and Reference Selection

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Reach ID: | Little 39 channel areas | Use Class: | 2A | Fish IBI Class: | Northern Coldwater | Upstream Latitude: | |
| Existing Stream Type: | B | River Nutrient Regions: | North | Valley Type: | Unconfined Alluvial | Upstream Longitude: | |
| Reference Stream Type: | B | Proposed Bed Material: | Cobble | Outstanding Resource Waters: | No | Downstream Latitude: | |
| Woody Veg Natural Component: | Yes | Macroinvertebrate IBI Class: | Northern Coldwater | Proposed BMPs: | No | Downstream Longitude: | |
| Stream/Wetland Complex? | No | Is Armoring present? | No | | | | |

| EXISTING CONDITION ASSESSMENT | | | | | Roll Up Scoring | | | |
|---|---|---|---|---|---|---|---|---|
| **Functional Category** | **Function-Based Parameters** | **Measurement Method** | **Field Value** | **Index Value** | **Parameter** | **Category** | **Category** | **ECS** |
| Hydrology | Reach Runoff | Land Use Coefficient | 55 | 0.84 | 0.92 | 0.92 | Functioning | 0.56 |
| | | BMP MIDS Rv Coefficient | | | | | | |
| | | Concentrated Flow Points / 1,000 feet | 0 | 1.00 | | | | |
| Hydraulics | Floodplain Connectivity | Bank Height Ratio | 2 | 0.00 | 0.46 | 0.46 | Functioning At Risk | |
| | | Entrenchment Ratio | 1.98 | 0.92 | | | | |
| Geomorphology | Large Woody Debris | Large Woody Debris Index | | | 0.80 | 0.78 | Functioning | |
| | | # Pieces | | 0.80 | | | | |
| | Lateral Migration | Dominant BEHI/NBS | L/M | 1.00 | 1.00 | | | |
| | | Percent Streambank Erosion (%) | 0 | 1.00 | | | | |
| | | Percent Armoring (%) | | | | | | |
| | Bed Material Characterization | Size Class Pebble Count Analyzer (p-value) | | | | | | |
| | Bed Form Diversity | Pool Spacing Ratio | 4.32 | 0.92 | 0.54 | | | |
| | | Pool Depth Ratio | 1.5 | 0.30 | | | | |
| | | Percent Riffle (%) | 48 | 0.93 | | | | |
| | | Aggradation Ratio | 8.6 | 0.00 | | | | |
| | Riparian Vegetation | Riparian Buffer Width (%) | | 0.80 | 0.80 | | | |
| | | Canopy Cover (%) | | 0.80 | | | | |
| | | Herbaceous Vegetation Cover (%) | | 0.80 | | | | |
| | | Woody Stem Basal Area (sqm/hectare) | | 0.80 | | | | |
| Physicochemical | Temperature | Summer Average (°C) | 15 | 0.50 | 0.50 | 0.56 | Functioning At Risk | |
| | Dissolved Oxygen | DO (mg/L) | 5.9 | 0.19 | 0.19 | | | |
| | Total Suspended Solids | TSS (mg/L) | 1.1 | 1.00 | 1.00 | | | |
| Biology | Macroinvertebrates | Macroinvertebrate IBI | 25 | 0.13 | 0.13 | 0.07 | Not Functioning | |
| | Fish | Fish IBI | 16 | 0.00 | 0.00 | | | |

# *Appendix B*

# *Restoration Project SQT Functional Lift Calculations*

| Site Information and Reference Selection | |
|---|---|
| Project Name: | West Ridge RR Stream Mitigation |
| Reach ID: | East Branch Trib, Berm_channel |
| Restoration Potential: | Partial |
| Existing Stream Type: | B |
| Reference Stream Type: | E |
| Woody Vegetation Natural Component: | Yes |
| Use Class: | 2A |
| River Nutrient Regions: | North |
| Drainage Area (sq.mi.): | 0.7 |
| Proposed Bed Material: | Cobble |
| Existing Stream Length (ft): | 2766 |
| Proposed Stream Length (ft): | 2766 |
| Macroinvertebrate IBI Class: | Northern Coldwater |
| Fish IBI Class: | Northern Coldwater |
| Valley Type: | Confined Alluvial |

| Notes |
|---|
| 1. Users input values that are highlighted based on restoration potential |
| 2. Users select values from a pull-down menu |
| 3. Leave values blank for field values that were not measured |

| FUNCTIONAL CHANGE SUMMARY | |
|---|---|
| Existing Condition Score (ECS) | 0.49 |
| Proposed Condition Score (PCS) | 0.60 |
| Change in Functional Condition (PCS - EC | 0.11 |
| Existing Stream Length (ft) | 2766 |
| Proposed Stream Length (ft) | 2766 |
| Change in Stream Length (ft) | 0 |
| Existing Functional Feet (FF) | 1355 |
| Proposed Functional Feet (FF) | 1660 |
| Proposed FF - Existing FF | 304 |
| Percent Change in FF (%) | 22% |
| FF Yield (FF/ft) | 0.11 |

| MITIGATION SUMMARY | | |
|---|---|---|
| 304 | (FF) | Lift |

| FUNCTION BASED PARAMETERS SUMMARY | | | |
|---|---|---|---|
| Functional Category | Function-Based Parameters | Existing Parameter | Proposed Parameter |
| Hydrology | Reach Runoff | 1.00 | 1.00 |
| Hydraulics | Floodplain Connectivity | 0.50 | 1.00 |
| Geomorphology | Large Woody Debris | 0.74 | 1.00 |
| | Lateral Migration | 1.00 | 1.00 |
| | Bed Material Characterization | | |
| | Bed Form Diversity | 1.00 | 1.00 |
| | Riparian Vegetation | 1.00 | 1.00 |
| Physicochemical | Temperature | | |
| | Dissolved Oxygen | | |
| | Total Suspended Solids | | |
| Biology | Macroinvertebrates | | |
| | Fish | | |

| FUNCTIONAL CATEGORY REPORT CARD | | | |
|---|---|---|---|
| Functional Category | ECS | PCS | Functional Change |
| Hydrology | 1.00 | 1.00 | 0.00 |
| Hydraulics | 0.50 | 1.00 | 0.50 |
| Geomorphology | 0.94 | 1.00 | 0.06 |
| Physicochemical | | | |
| Biology | | | |

| EXISTING CONDITION ASSESSMENT | | | | | Roll Up Scoring | | |
|---|---|---|---|---|---|---|---|
| **Functional Category** | **Function-Based Parameter** | **Metric** | **Field Value** | **Index Value** | **Parameter** | **Category** | **Category** |
| Hydrology | Reach Runoff | Land Use Coefficient | 35 | 1.00 | 1.00 | 1.00 | Functioning |
| | | BMP MIDS Rv Coefficient | | | | | |
| | | Concentrated Flow Points / 1,000 feet | 0 | 1.00 | | | |
| Hydraulics | Floodplain Connectivity | Bank Height Ratio | 2 | 0.00 | 0.50 | 0.50 | Functioning At Risk |
| | | Entrenchment Ratio | 5 | 1.00 | | | |
| Geomorphology | Large Woody Debris | LWD Index | | | 0.74 | 0.94 | Functioning |
| | | No. of LWD Pieces / 100 meters | 15 | 0.74 | | | |
| | Lateral Migration | Dominant BEHI/NBS | L/M | 1.00 | 1.00 | | |
| | | Percent Streambank Erosion (%) | 0 | 1.00 | | | |
| | | Percent Armoring (%) | | | | | |
| | Bed Material Characterization | Size Class Pebble Count Analyzer (p-value) | | | | | |
| | Bed Form Diversity | Pool Spacing Ratio | 3.8 | 1.00 | 1.00 | | |
| | | Pool Depth Ratio | 3 | 1.00 | | | |
| | | Percent Riffle (%) | 50 | 1.00 | | | |
| | | Aggradation Ratio | | | | | |
| | Riparian Vegetation | Riparian Buffer Width (%) | 100 | 1.00 | 1.00 | | |
| | | Canopy Cover (%) | 80 | 1.00 | | | |
| | | Herbaceous Vegetation Cover (%) | 80 | 1.00 | | | |
| | | Woody Stem Basal Area (sqm/hectare) | 100 | 1.00 | | | |
| Physicochemical | Temperature | Summer Average ($^{o}$C) | | | | | |
| | Dissolved Oxygen | DO (mg/L) | | | | | |
| | Total Suspended Solids | TSS (mg/L) | | | | | |
| Biology | Macroinvertebrates | Macroinvertebrate IBI | | | | | |
| | Fish | Fish IBI | | | | | |

| PROPOSED CONDITION ASSESSMENT | | | | | Roll Up Scoring | | |
|---|---|---|---|---|---|---|---|
| Functional Category | Function-Based Parameter | Metric | Field Value | Index Value | Parameter | Category | Category |
| Hydrology | Reach Runoff | Land Use Coefficient | 35 | 1.00 | 1.00 | 1.00 | Functioning |
| | | BMP MIDS Rv Coefficient | | | | | |
| | | Concentrated Flow Points / 1,000 feet | 0 | 1.00 | | | |
| Hydraulics | Floodplain Connectivity | Bank Height Ratio | 1 | 1.00 | 1.00 | 1.00 | Functioning |
| | | Entrenchment Ratio | 5 | 1.00 | | | |
| Geomorphology | Large Woody Debris | LWD Index | | | 1.00 | 1.00 | Functioning |
| | | No. of LWD Pieces / 100 meters | 30 | 1.00 | | | |
| | Lateral Migration | Dominant BEHI/NBS | L/M | 1.00 | 1.00 | | |
| | | Percent Streambank Erosion (%) | 0 | 1.00 | | | |
| | | Percent Armoring (%) | | | | | |
| | Bed Material Characterization | Size Class Pebble Count Analyzer (p-value) | | | | | |
| | Bed Form Diversity | Pool Spacing Ratio | 6 | 1.00 | 1.00 | | |
| | | Pool Depth Ratio | 5 | 1.00 | | | |
| | | Percent Riffle (%) | 55 | 1.00 | | | |
| | | Aggradation Ratio | 1 | 1.00 | | | |
| | Riparian Vegetation | Riparian Buffer Width (%) | 100 | 1.00 | 1.00 | | |
| | | Canopy Cover (%) | 80 | 1.00 | | | |
| | | Herbaceous Vegetation Cover (%) | 80 | 1.00 | | | |
| | | Woody Stem Basal Area (sqm/hectare) | 14 | 1.00 | | | |
| Physicochemical | Temperature | Summer Average ($^{o}$C) | | | | | |
| | Dissolved Oxygen | DO (mg/L) | | | | | |
| | Total Suspended Solids | TSS (mg/L) | | | | | |
| Biology | Macroinvertebrates | Macroinvertebrate IBI | | | | | |
| | Fish | Fish IBI | | | | | |

| Site Information and Reference Selection | |
|---|---|
| Project Name: | West Ridge RR Stream Mitigation |
| Reach ID: | Big 39 Diversion Area |
| Restoration Potential: | Partial |
| Existing Stream Type: | B |
| Reference Stream Type: | B |
| Woody Vegetation Natural Component: | Yes |
| Use Class: | 2A |
| River Nutrient Regions: | North |
| Drainage Area (sq.mi.): | 23.8 |
| Proposed Bed Material: | Cobble |
| Existing Stream Length (ft): | 1590 |
| Proposed Stream Length (ft): | 1700 |
| Macroinvertebrate IBI Class: | Northern Forest Streams Riffle-run |
| Fish IBI Class: | Northern Headwaters |
| Valley Type: | Confined Alluvial |

| Notes |
|---|
| 1. Users input values that are highlighted based on restoration potential |
| 2. Users select values from a pull-down menu |
| 3. Leave values blank for field values that were not measured |

| FUNCTIONAL CHANGE SUMMARY | |
|---|---|
| Existing Condition Score (ECS) | 0.32 |
| Proposed Condition Score (PCS) | 0.60 |
| Change in Functional Condition (PCS - EC | 0.28 |
| Existing Stream Length (ft) | 1590 |
| Proposed Stream Length (ft) | 1700 |
| Change in Stream Length (ft) | 110 |
| Existing Functional Feet (FF) | 509 |
| Proposed Functional Feet (FF) | 1020 |
| Proposed FF - Existing FF | 511 |
| Percent Change in FF (%) | 100% |
| FF Yield (FF/ft) | 0.30 |

| MITIGATION SUMMARY | | |
|---|---|---|
| 511 | (FF) | Lift |

| FUNCTION BASED PARAMETERS SUMMARY | | | |
|---|---|---|---|
| Functional Category | Function-Based Parameters | Existing Parameter | Proposed Parameter |
| Hydrology | Reach Runoff | 1.00 | 1.00 |
| Hydraulics | Floodplain Connectivity | 0.25 | 1.00 |
| Geomorphology | Large Woody Debris | 0.00 | 1.00 |
| | Lateral Migration | 0.73 | 1.00 |
| | Bed Material Characterization | | |
| | Bed Form Diversity | 0.33 | 1.00 |
| | Riparian Vegetation | 0.30 | 1.00 |
| Physicochemical | Temperature | | |
| | Dissolved Oxygen | | |
| | Total Suspended Solids | | |
| Biology | Macroinvertebrates | | |
| | Fish | | |

| FUNCTIONAL CATEGORY REPORT CARD | | | |
|---|---|---|---|
| Functional Category | ECS | PCS | Functional Change |
| Hydrology | 1.00 | 1.00 | 0.00 |
| Hydraulics | 0.25 | 1.00 | 0.75 |
| Geomorphology | 0.34 | 1.00 | 0.66 |
| Physicochemical | | | |
| Biology | | | |

| EXISTING CONDITION ASSESSMENT | | | | | Roll Up Scoring | | |
|---|---|---|---|---|---|---|---|
| **Functional Category** | **Function-Based Parameter** | **Metric** | **Field Value** | **Index Value** | **Parameter** | **Category** | **Category** |
| Hydrology | Reach Runoff | Land Use Coefficient | 35 | 1.00 | 1.00 | 1.00 | Functioning |
| | | BMP MIDS Rv Coefficient | | | | | |
| | | Concentrated Flow Points / 1,000 feet | 0 | 1.00 | | | |
| Hydraulics | Floodplain Connectivity | Bank Height Ratio | 2 | 0.00 | 0.25 | 0.25 | Not Functioning |
| | | Entrenchment Ratio | 1.3 | 0.50 | | | |
| Geomorphology | Large Woody Debris | LWD Index | | | 0.00 | 0.34 | Functioning At Risk |
| | | No. of LWD Pieces / 100 meters | 0 | 0.00 | | | |
| | Lateral Migration | Dominant BEHI/NBS | VL/L | 1.00 | 0.73 | | |
| | | Percent Streambank Erosion (%) | 0 | 1.00 | | | |
| | | Percent Armoring (%) | 40 | 0.20 | | | |
| | Bed Material Characterization | Size Class Pebble Count Analyzer (p-value) | | | | | |
| | Bed Form Diversity | Pool Spacing Ratio | 10 | 0.00 | 0.33 | | |
| | | Pool Depth Ratio | 4.2 | 1.00 | | | |
| | | Percent Riffle (%) | 15 | 0.00 | | | |
| | | Aggradation Ratio | | | | | |
| | Riparian Vegetation | Riparian Buffer Width (%) | 100 | 1.00 | 0.30 | | |
| | | Canopy Cover (%) | 20 | 0.00 | | | |
| | | Herbaceous Vegetation Cover (%) | 20 | 0.00 | | | |
| | | Woody Stem Basal Area (sqm/hectare) | 10 | 0.20 | | | |
| Physicochemical | Temperature | Summer Average ($^{o}$C) | | | | | |
| | Dissolved Oxygen | DO (mg/L) | | | | | |
| | Total Suspended Solids | TSS (mg/L) | | | | | |
| Biology | Macroinvertebrates | Macroinvertebrate IBI | | | | | |
| | Fish | Fish IBI | | | | | |

| PROPOSED CONDITION ASSESSMENT | | | | | Roll Up Scoring | | |
|---|---|---|---|---|---|---|---|
| Functional Category | Function-Based Parameter | Metric | Field Value | Index Value | Parameter | Category | Category |
| Hydrology | Reach Runoff | Land Use Coefficient | 35 | 1.00 | 1.00 | 1.00 | Functioning |
| | | BMP MIDS Rv Coefficient | | | | | |
| | | Concentrated Flow Points / 1,000 feet | 0 | 1.00 | | | |
| Hydraulics | Floodplain Connectivity | Bank Height Ratio | 1 | 1.00 | 1.00 | 1.00 | Functioning |
| | | Entrenchment Ratio | 2.2 | 1.00 | | | |
| Geomorphology | Large Woody Debris | LWD Index | | | 1.00 | 1.00 | Functioning |
| | | No. of LWD Pieces / 100 meters | 28 | 1.00 | | | |
| | Lateral Migration | Dominant BEHI/NBS | VL/L | 1.00 | 1.00 | | |
| | | Percent Streambank Erosion (%) | 0 | 1.00 | | | |
| | | Percent Armoring (%) | | | | | |
| | Bed Material Characterization | Size Class Pebble Count Analyzer (p-value) | | | | | |
| | Bed Form Diversity | Pool Spacing Ratio | 3 | 1.00 | 1.00 | | |
| | | Pool Depth Ratio | 5 | 1.00 | | | |
| | | Percent Riffle (%) | 55 | 1.00 | | | |
| | | Aggradation Ratio | 1 | 1.00 | | | |
| | Riparian Vegetation | Riparian Buffer Width (%) | 100 | 1.00 | 1.00 | | |
| | | Canopy Cover (%) | 80 | 1.00 | | | |
| | | Herbaceous Vegetation Cover (%) | 80 | 1.00 | | | |
| | | Woody Stem Basal Area (sqm/hectare) | 14 | 1.00 | | | |
| Physicochemical | Temperature | Summer Average ($^{o}$C) | | | | | |
| | Dissolved Oxygen | DO (mg/L) | | | | | |
| | Total Suspended Solids | TSS (mg/L) | | | | | |
| Biology | Macroinvertebrates | Macroinvertebrate IBI | | | | | |
| | Fish | Fish IBI | | | | | |

| Site Information and Reference Selection | |
|---|---|
| Project Name: | West Ridge RR Stream Mitigation |
| Reach ID: | East Branch Beaver River |
| Restoration Potential: | Partial |
| Existing Stream Type: | C |
| Reference Stream Type: | C |
| Woody Vegetation Natural Component: | Yes |
| Use Class: | 2A |
| River Nutrient Regions: | North |
| Drainage Area (sq.mi.): | 30.27 |
| Proposed Bed Material: | Cobble |
| Existing Stream Length (ft): | 2800 |
| Proposed Stream Length (ft): | 3000 |
| Macroinvertebrate IBI Class: | Northern Coldwater |
| Fish IBI Class: | Northern Coldwater |
| Valley Type: | Unconfined Alluvial |

| Notes |
|---|
| 1. Users input values that are highlighted based on restoration potential |
| 2. Users select values from a pull-down menu |
| 3. Leave values blank for field values that were not measured |

| FUNCTIONAL CHANGE SUMMARY | |
|---|---|
| Existing Condition Score (ECS) | 0.53 |
| Proposed Condition Score (PCS) | 0.60 |
| Change in Functional Condition (PCS - EC | 0.07 |
| Existing Stream Length (ft) | 2800 |
| Proposed Stream Length (ft) | 3000 |
| Change in Stream Length (ft) | 200 |
| Existing Functional Feet (FF) | 1484 |
| Proposed Functional Feet (FF) | 1800 |
| Proposed FF - Existing FF | 316 |
| Percent Change in FF (%) | 21% |
| FF Yield (FF/ft) | 0.11 |

| MITIGATION SUMMARY | | |
|---|---|---|
| 316 | (FF) | Lift |

| FUNCTION BASED PARAMETERS SUMMARY | | | |
|---|---|---|---|
| Functional Category | Function-Based Parameters | Existing Parameter | Proposed Parameter |
| Hydrology | Reach Runoff | 1.00 | 1.00 |
| Hydraulics | Floodplain Connectivity | 1.00 | 1.00 |
| Geomorphology | Large Woody Debris | 0.32 | 1.00 |
| | Lateral Migration | 0.50 | 1.00 |
| | Bed Material Characterization | | |
| | Bed Form Diversity | 0.71 | 1.00 |
| | Riparian Vegetation | 1.00 | 1.00 |
| Physicochemical | Temperature | | |
| | Dissolved Oxygen | | |
| | Total Suspended Solids | | |
| Biology | Macroinvertebrates | | |
| | Fish | | |

| FUNCTIONAL CATEGORY REPORT CARD | | | |
|---|---|---|---|
| Functional Category | ECS | PCS | Functional Change |
| Hydrology | 1.00 | 1.00 | 0.00 |
| Hydraulics | 1.00 | 1.00 | 0.00 |
| Geomorphology | 0.63 | 1.00 | 0.37 |
| Physicochemical | | | |
| Biology | | | |

| EXISTING CONDITION ASSESSMENT | | | | | Roll Up Scoring | | |
|---|---|---|---|---|---|---|---|
| **Functional Category** | **Function-Based Parameter** | **Metric** | **Field Value** | **Index Value** | **Parameter** | **Category** | **Category** |
| Hydrology | Reach Runoff | Land Use Coefficient | 35 | 1.00 | 1.00 | 1.00 | Functioning |
| | | BMP MIDS Rv Coefficient | | | | | |
| | | Concentrated Flow Points / 1,000 feet | 0 | 1.00 | | | |
| Hydraulics | Floodplain Connectivity | Bank Height Ratio | 1 | 1.00 | 1.00 | 1.00 | Functioning |
| | | Entrenchment Ratio | 7.9 | 1.00 | | | |
| Geomorphology | Large Woody Debris | LWD Index | | | 0.32 | 0.63 | Functioning At Risk |
| | | No. of LWD Pieces / 100 meters | 6 | 0.32 | | | |
| | Lateral Migration | Dominant BEHI/NBS | M/M | 0.50 | 0.50 | | |
| | | Percent Streambank Erosion (%) | 82 | 0.00 | | | |
| | | Percent Armoring (%) | 0 | 1.00 | | | |
| | Bed Material Characterization | Size Class Pebble Count Analyzer (p-value) | | | | | |
| | Bed Form Diversity | Pool Spacing Ratio | 3.2 | 0.88 | 0.71 | | |
| | | Pool Depth Ratio | 2.6 | 0.88 | | | |
| | | Percent Riffle (%) | 44 | 0.96 | | | |
| | | Aggradation Ratio | 1.5 | 0.13 | | | |
| | Riparian Vegetation | Riparian Buffer Width (%) | 100 | 1.00 | 1.00 | | |
| | | Canopy Cover (%) | 80 | 1.00 | | | |
| | | Herbaceous Vegetation Cover (%) | 80 | 1.00 | | | |
| | | Woody Stem Basal Area (sqm/hectare) | 14 | 1.00 | | | |
| Physicochemical | Temperature | Summer Average ($^{o}$C) | | | | | |
| | Dissolved Oxygen | DO (mg/L) | | | | | |
| | Total Suspended Solids | TSS (mg/L) | | | | | |
| Biology | Macroinvertebrates | Macroinvertebrate IBI | | | | | |
| | Fish | Fish IBI | | | | | |

| PROPOSED CONDITION ASSESSMENT | | | | | Roll Up Scoring | | |
|---|---|---|---|---|---|---|---|
| Functional Category | Function-Based Parameter | Metric | Field Value | Index Value | Parameter | Category | Category |
| Hydrology | Reach Runoff | Land Use Coefficient | 35 | 1.00 | 1.00 | 1.00 | Functioning |
| | | BMP MIDS Rv Coefficient | | | | | |
| | | Concentrated Flow Points / 1,000 feet | 0 | 1.00 | | | |
| Hydraulics | Floodplain Connectivity | Bank Height Ratio | 1 | 1.00 | 1.00 | 1.00 | Functioning |
| | | Entrenchment Ratio | 7.9 | 1.00 | | | |
| Geomorphology | Large Woody Debris | LWD Index | | | 1.00 | 1.00 | Functioning |
| | | No. of LWD Pieces / 100 meters | 30 | 1.00 | | | |
| | Lateral Migration | Dominant BEHI/NBS | VL/L | 1.00 | 1.00 | | |
| | | Percent Streambank Erosion (%) | 5 | 1.00 | | | |
| | | Percent Armoring (%) | 0 | 1.00 | | | |
| | Bed Material Characterization | Size Class Pebble Count Analyzer (p-value) | | | | | |
| | Bed Form Diversity | Pool Spacing Ratio | 5 | 1.00 | 1.00 | | |
| | | Pool Depth Ratio | 5 | 1.00 | | | |
| | | Percent Riffle (%) | 55 | 1.00 | | | |
| | | Aggradation Ratio | 1 | 1.00 | | | |
| | Riparian Vegetation | Riparian Buffer Width (%) | 100 | 1.00 | 1.00 | | |
| | | Canopy Cover (%) | 80 | 1.00 | | | |
| | | Herbaceous Vegetation Cover (%) | 80 | 1.00 | | | |
| | | Woody Stem Basal Area (sqm/hectare) | 14 | 1.00 | | | |
| Physicochemical | Temperature | Summer Average ($^{o}$C) | | | | | |
| | Dissolved Oxygen | DO (mg/L) | | | | | |
| | Total Suspended Solids | TSS (mg/L) | | | | | |
| Biology | Macroinvertebrates | Macroinvertebrate IBI | | | | | |
| | Fish | Fish IBI | | | | | |

| Site Information and Reference Selection | |
|---|---|
| Project Name: | West Ridge RR Stream Mitigation |
| Reach ID: | East Branch Trib, Ditched Channel |
| Restoration Potential: | Partial |
| Existing Stream Type: | B |
| Reference Stream Type: | B |
| Woody Vegetation Natural Component: | Yes |
| Use Class: | 2A |
| River Nutrient Regions: | North |
| Drainage Area (sq.mi.): | 0.3 |
| Proposed Bed Material: | Cobble |
| Existing Stream Length (ft): | 1200 |
| Proposed Stream Length (ft): | 1200 |
| Macroinvertebrate IBI Class: | Northern Coldwater |
| Fish IBI Class: | Northern Coldwater |
| Valley Type: | Confined Alluvial |

| Notes |
|---|
| 1. Users input values that are highlighted based on restoration potential |
| 2. Users select values from a pull-down menu |
| 3. Leave values blank for field values that were not measured |

| FUNCTIONAL CHANGE SUMMARY | |
|---|---|
| Existing Condition Score (ECS) | 0.33 |
| Proposed Condition Score (PCS) | 0.58 |
| Change in Functional Condition (PCS - EC | 0.25 |
| Existing Stream Length (ft) | 1200 |
| Proposed Stream Length (ft) | 1200 |
| Change in Stream Length (ft) | 0 |
| Existing Functional Feet (FF) | 396 |
| Proposed Functional Feet (FF) | 696 |
| Proposed FF - Existing FF | 300 |
| Percent Change in FF (%) | 76% |
| FF Yield (FF/ft) | 0.25 |

| MITIGATION SUMMARY | | |
|---|---|---|
| 300 | (FF) | Lift |

| FUNCTION BASED PARAMETERS SUMMARY | | | |
|---|---|---|---|
| Functional Category | Function-Based Parameters | Existing Parameter | Proposed Parameter |
| Hydrology | Reach Runoff | 0.91 | 0.91 |
| Hydraulics | Floodplain Connectivity | 0.41 | 1.00 |
| Geomorphology | Large Woody Debris | 0.00 | 1.00 |
| | Lateral Migration | 0.67 | 1.00 |
| | Bed Material Characterization | | |
| | Bed Form Diversity | 0.42 | 1.00 |
| | Riparian Vegetation | 0.25 | 1.00 |
| Physicochemical | Temperature | | |
| | Dissolved Oxygen | | |
| | Total Suspended Solids | | |
| Biology | Macroinvertebrates | | |
| | Fish | | |

| FUNCTIONAL CATEGORY REPORT CARD | | | |
|---|---|---|---|
| Functional Category | ECS | PCS | Functional Change |
| Hydrology | 0.91 | 0.91 | 0.00 |
| Hydraulics | 0.41 | 1.00 | 0.59 |
| Geomorphology | 0.34 | 1.00 | 0.66 |
| Physicochemical | | | |
| Biology | | | |

| EXISTING CONDITION ASSESSMENT | | | | | Roll Up Scoring | | |
|---|---|---|---|---|---|---|---|
| **Functional Category** | **Function-Based Parameter** | **Metric** | **Field Value** | **Index Value** | **Parameter** | **Category** | **Category** |
| Hydrology | Reach Runoff | Land Use Coefficient | 58 | 0.81 | 0.91 | 0.91 | Functioning |
| | | BMP MIDS Rv Coefficient | | | | | |
| | | Concentrated Flow Points / 1,000 feet | 0 | 1.00 | | | |
| Hydraulics | Floodplain Connectivity | Bank Height Ratio | 3 | 0.00 | 0.41 | 0.41 | Functioning At Risk |
| | | Entrenchment Ratio | 1.7 | 0.81 | | | |
| Geomorphology | Large Woody Debris | LWD Index | | | 0.00 | 0.34 | Functioning At Risk |
| | | No. of LWD Pieces / 100 meters | 0 | 0.00 | | | |
| | Lateral Migration | Dominant BEHI/NBS | VL/L | 1.00 | 0.67 | | |
| | | Percent Streambank Erosion (%) | 0 | 1.00 | | | |
| | | Percent Armoring (%) | 100 | 0.00 | | | |
| | Bed Material Characterization | Size Class Pebble Count Analyzer (p-value) | | | | | |
| | Bed Form Diversity | Pool Spacing Ratio | 16 | 0.00 | 0.42 | | |
| | | Pool Depth Ratio | 3.6 | 1.00 | | | |
| | | Percent Riffle (%) | 82 | 0.27 | | | |
| | | Aggradation Ratio | | | | | |
| | Riparian Vegetation | Riparian Buffer Width (%) | 100 | 1.00 | 0.25 | | |
| | | Canopy Cover (%) | 0 | 0.00 | | | |
| | | Herbaceous Vegetation Cover (%) | 20 | 0.00 | | | |
| | | Woody Stem Basal Area (sqm/hectare) | 0 | 0.00 | | | |
| Physicochemical | Temperature | Summer Average ($^{o}$C) | | | | | |
| | Dissolved Oxygen | DO (mg/L) | | | | | |
| | Total Suspended Solids | TSS (mg/L) | | | | | |
| Biology | Macroinvertebrates | Macroinvertebrate IBI | | | | | |
| | Fish | Fish IBI | | | | | |

| PROPOSED CONDITION ASSESSMENT | | | | | Roll Up Scoring | | |
|---|---|---|---|---|---|---|---|
| Functional Category | Function-Based Parameter | Metric | Field Value | Index Value | Parameter | Category | Category |
| Hydrology | Reach Runoff | Land Use Coefficient | 58 | 0.81 | 0.91 | 0.91 | Functioning |
| | | BMP MIDS Rv Coefficient | | | | | |
| | | Concentrated Flow Points / 1,000 feet | 0 | 1.00 | | | |
| Hydraulics | Floodplain Connectivity | Bank Height Ratio | 1 | 1.00 | 1.00 | 1.00 | Functioning |
| | | Entrenchment Ratio | 2.2 | 1.00 | | | |
| Geomorphology | Large Woody Debris | LWD Index | | | 1.00 | 1.00 | Functioning |
| | | No. of LWD Pieces / 100 meters | 28 | 1.00 | | | |
| | Lateral Migration | Dominant BEHI/NBS | VL/L | 1.00 | 1.00 | | |
| | | Percent Streambank Erosion (%) | 0 | 1.00 | | | |
| | | Percent Armoring (%) | | | | | |
| | Bed Material Characterization | Size Class Pebble Count Analyzer (p-value) | | | | | |
| | Bed Form Diversity | Pool Spacing Ratio | 3 | 1.00 | 1.00 | | |
| | | Pool Depth Ratio | 5 | 1.00 | | | |
| | | Percent Riffle (%) | 55 | 1.00 | | | |
| | | Aggradation Ratio | 1 | 1.00 | | | |
| | Riparian Vegetation | Riparian Buffer Width (%) | 100 | 1.00 | 1.00 | | |
| | | Canopy Cover (%) | 80 | 1.00 | | | |
| | | Herbaceous Vegetation Cover (%) | 80 | 1.00 | | | |
| | | Woody Stem Basal Area (sqm/hectare) | 14 | 1.00 | | | |
| Physicochemical | Temperature | Summer Average ($^{o}$C) | | | | | |
| | Dissolved Oxygen | DO (mg/L) | | | | | |
| | Total Suspended Solids | TSS (mg/L) | | | | | |
| Biology | Macroinvertebrates | Macroinvertebrate IBI | | | | | |
| | Fish | Fish IBI | | | | | |

| Site Information and Reference Selection | |
|---|---|
| Project Name: | West Ridge RR Stream Mitigation |
| Reach ID: | East Branch Trib, F_channel |
| Restoration Potential: | Partial |
| Existing Stream Type: | F |
| Reference Stream Type: | B |
| Woody Vegetation Natural Component: | Yes |
| Use Class: | 2A |
| River Nutrient Regions: | North |
| Drainage Area (sq.mi.): | 2.7 |
| Proposed Bed Material: | Cobble |
| Existing Stream Length (ft): | 3655 |
| Proposed Stream Length (ft): | 3655 |
| Macroinvertebrate IBI Class: | Northern Coldwater |
| Fish IBI Class: | Northern Coldwater |
| Valley Type: | Confined Alluvial |

| Notes |
|---|
| 1. Users input values that are highlighted based on restoration potential |
| 2. Users select values from a pull-down menu |
| 3. Leave values blank for field values that were not measured |

| FUNCTIONAL CHANGE SUMMARY | |
|---|---|
| Existing Condition Score (ECS) | 0.32 |
| Proposed Condition Score (PCS) | 0.58 |
| Change in Functional Condition (PCS - EC | 0.26 |
| Existing Stream Length (ft) | 3655 |
| Proposed Stream Length (ft) | 3655 |
| Change in Stream Length (ft) | 0 |
| Existing Functional Feet (FF) | 1170 |
| Proposed Functional Feet (FF) | 2120 |
| Proposed FF - Existing FF | 950 |
| Percent Change in FF (%) | 81% |
| FF Yield (FF/ft) | 0.26 |

| MITIGATION SUMMARY | | |
|---|---|---|
| 950 | (FF) | Lift |

| FUNCTION BASED PARAMETERS SUMMARY | | | |
|---|---|---|---|
| Functional Category | Function-Based Parameters | Existing Parameter | Proposed Parameter |
| Hydrology | Reach Runoff | 0.91 | 0.91 |
| Hydraulics | Floodplain Connectivity | 0.25 | 1.00 |
| Geomorphology | Large Woody Debris | 0.27 | 1.00 |
| | Lateral Migration | 0.10 | 1.00 |
| | Bed Material Characterization | | |
| | Bed Form Diversity | 0.60 | 1.00 |
| | Riparian Vegetation | 0.83 | 1.00 |
| Physicochemical | Temperature | | |
| | Dissolved Oxygen | | |
| | Total Suspended Solids | | |
| Biology | Macroinvertebrates | | |
| | Fish | | |

| FUNCTIONAL CATEGORY REPORT CARD | | | |
|---|---|---|---|
| Functional Category | ECS | PCS | Functional Change |
| Hydrology | 0.91 | 0.91 | 0.00 |
| Hydraulics | 0.25 | 1.00 | 0.75 |
| Geomorphology | 0.45 | 1.00 | 0.55 |
| Physicochemical | | | |
| Biology | | | |

| EXISTING CONDITION ASSESSMENT | | | | | Roll Up Scoring | | |
|---|---|---|---|---|---|---|---|
| **Functional Category** | **Function-Based Parameter** | **Metric** | **Field Value** | **Index Value** | **Parameter** | **Category** | **Category** |
| Hydrology | Reach Runoff | Land Use Coefficient | 58 | 0.81 | 0.91 | 0.91 | Functioning |
| | | BMP MIDS Rv Coefficient | | | | | |
| | | Concentrated Flow Points / 1,000 feet | 0 | 1.00 | | | |
| Hydraulics | Floodplain Connectivity | Bank Height Ratio | 3 | 0.00 | 0.25 | 0.25 | Not Functioning |
| | | Entrenchment Ratio | 1.3 | 0.50 | | | |
| Geomorphology | Large Woody Debris | LWD Index | | | 0.27 | 0.45 | Functioning At Risk |
| | | No. of LWD Pieces / 100 meters | 5 | 0.27 | | | |
| | Lateral Migration | Dominant BEHI/NBS | H/H | 0.20 | 0.10 | | |
| | | Percent Streambank Erosion (%) | 100 | 0.00 | | | |
| | | Percent Armoring (%) | | | | | |
| | Bed Material Characterization | Size Class Pebble Count Analyzer (p-value) | | | | | |
| | Bed Form Diversity | Pool Spacing Ratio | 3.8 | 1.00 | 0.60 | | |
| | | Pool Depth Ratio | 2.3 | 0.79 | | | |
| | | Percent Riffle (%) | 90 | 0.00 | | | |
| | | Aggradation Ratio | | | | | |
| | Riparian Vegetation | Riparian Buffer Width (%) | 100 | 1.00 | 0.83 | | |
| | | Canopy Cover (%) | 80 | 1.00 | | | |
| | | Herbaceous Vegetation Cover (%) | 60 | 0.33 | | | |
| | | Woody Stem Basal Area (sqm/hectare) | 100 | 1.00 | | | |
| Physicochemical | Temperature | Summer Average ($^{o}$C) | | | | | |
| | Dissolved Oxygen | DO (mg/L) | | | | | |
| | Total Suspended Solids | TSS (mg/L) | | | | | |
| Biology | Macroinvertebrates | Macroinvertebrate IBI | | | | | |
| | Fish | Fish IBI | | | | | |

| PROPOSED CONDITION ASSESSMENT | | | | | Roll Up Scoring | | |
|---|---|---|---|---|---|---|---|
| Functional Category | Function-Based Parameter | Metric | Field Value | Index Value | Parameter | Category | Category |
| Hydrology | Reach Runoff | Land Use Coefficient | 58 | 0.81 | 0.91 | 0.91 | Functioning |
| | | BMP MIDS Rv Coefficient | | | | | |
| | | Concentrated Flow Points / 1,000 feet | 0 | 1.00 | | | |
| Hydraulics | Floodplain Connectivity | Bank Height Ratio | 1 | 1.00 | 1.00 | 1.00 | Functioning |
| | | Entrenchment Ratio | 2.2 | 1.00 | | | |
| Geomorphology | Large Woody Debris | LWD Index | | | 1.00 | 1.00 | Functioning |
| | | No. of LWD Pieces / 100 meters | 30 | 1.00 | | | |
| | Lateral Migration | Dominant BEHI/NBS | VL/L | 1.00 | 1.00 | | |
| | | Percent Streambank Erosion (%) | 0 | 1.00 | | | |
| | | Percent Armoring (%) | | | | | |
| | Bed Material Characterization | Size Class Pebble Count Analyzer (p-value) | | | | | |
| | Bed Form Diversity | Pool Spacing Ratio | 3 | 1.00 | 1.00 | | |
| | | Pool Depth Ratio | 5 | 1.00 | | | |
| | | Percent Riffle (%) | 55 | 1.00 | | | |
| | | Aggradation Ratio | 1 | 1.00 | | | |
| | Riparian Vegetation | Riparian Buffer Width (%) | 100 | 1.00 | 1.00 | | |
| | | Canopy Cover (%) | 80 | 1.00 | | | |
| | | Herbaceous Vegetation Cover (%) | 80 | 1.00 | | | |
| | | Woody Stem Basal Area (sqm/hectare) | 14 | 1.00 | | | |
| Physicochemical | Temperature | Summer Average ($^{o}$C) | | | | | |
| | Dissolved Oxygen | DO (mg/L) | | | | | |
| | Total Suspended Solids | TSS (mg/L) | | | | | |
| Biology | Macroinvertebrates | Macroinvertebrate IBI | | | | | |
| | Fish | Fish IBI | | | | | |

| Site Information and Reference Selection | |
|---|---|
| Project Name: | West Ridge RR Stream Mitigation |
| Reach ID: | Little 39 Diversion Ditch |
| Restoration Potential: | Partial |
| Existing Stream Type: | Bc |
| Reference Stream Type: | Bc |
| Woody Vegetation Natural Component: | Yes |
| Use Class: | 2A |
| River Nutrient Regions: | North |
| Drainage Area (sq.mi.): | 2 |
| Proposed Bed Material: | Cobble |
| Existing Stream Length (ft): | 5575 |
| Proposed Stream Length (ft): | 5575 |
| Macroinvertebrate IBI Class: | Northern Forest Streams Riffle-run |
| Fish IBI Class: | Northern Headwaters |
| Valley Type: | Colluvial/V-Shaped |

| Notes |
|---|
| 1. Users input values that are highlighted based on restoration potential |
| 2. Users select values from a pull-down menu |
| 3. Leave values blank for field values that were not measured |

| FUNCTIONAL CHANGE SUMMARY | |
|---|---|
| Existing Condition Score (ECS) | 0.39 |
| Proposed Condition Score (PCS) | 0.60 |
| Change in Functional Condition (PCS - EC | 0.21 |
| Existing Stream Length (ft) | 5575 |
| Proposed Stream Length (ft) | 5575 |
| Change in Stream Length (ft) | 0 |
| Existing Functional Feet (FF) | 2174 |
| Proposed Functional Feet (FF) | 3345 |
| Proposed FF - Existing FF | 1171 |
| Percent Change in FF (%) | 54% |
| FF Yield (FF/ft) | 0.21 |

| MITIGATION SUMMARY | | |
|---|---|---|
| 1171 | (FF) | Lift |

| FUNCTION BASED PARAMETERS SUMMARY | | | |
|---|---|---|---|
| Functional Category | Function-Based Parameters | Existing Parameter | Proposed Parameter |
| Hydrology | Reach Runoff | 1.00 | 1.00 |
| Hydraulics | Floodplain Connectivity | 0.40 | 1.00 |
| Geomorphology | Large Woody Debris | 0.05 | 1.00 |
| | Lateral Migration | 0.67 | 1.00 |
| | Bed Material Characterization | | |
| | Bed Form Diversity | 0.39 | 1.00 |
| | Riparian Vegetation | 1.00 | 1.00 |
| Physicochemical | Temperature | | |
| | Dissolved Oxygen | | |
| | Total Suspended Solids | | |
| Biology | Macroinvertebrates | | |
| | Fish | | |

| FUNCTIONAL CATEGORY REPORT CARD | | | |
|---|---|---|---|
| Functional Category | ECS | PCS | Functional Change |
| Hydrology | 1.00 | 1.00 | 0.00 |
| Hydraulics | 0.40 | 1.00 | 0.60 |
| Geomorphology | 0.53 | 1.00 | 0.47 |
| Physicochemical | | | |
| Biology | | | |

| EXISTING CONDITION ASSESSMENT | | | | | Roll Up Scoring | | |
|---|---|---|---|---|---|---|---|
| **Functional Category** | **Function-Based Parameter** | **Metric** | **Field Value** | **Index Value** | **Parameter** | **Category** | **Category** |
| Hydrology | Reach Runoff | Land Use Coefficient | 35 | 1.00 | 1.00 | 1.00 | Functioning |
| | | BMP MIDS Rv Coefficient | | | | | |
| | | Concentrated Flow Points / 1,000 feet | 0 | 1.00 | | | |
| Hydraulics | Floodplain Connectivity | Bank Height Ratio | 3 | 0.00 | 0.40 | 0.40 | Functioning At Risk |
| | | Entrenchment Ratio | 1.65 | 0.79 | | | |
| Geomorphology | Large Woody Debris | LWD Index | | | 0.05 | 0.53 | Functioning At Risk |
| | | No. of LWD Pieces / 100 meters | 1 | 0.05 | | | |
| | Lateral Migration | Dominant BEHI/NBS | VL/L | 1.00 | 0.67 | | |
| | | Percent Streambank Erosion (%) | 0 | 1.00 | | | |
| | | Percent Armoring (%) | 100 | 0.00 | | | |
| | Bed Material Characterization | Size Class Pebble Count Analyzer (p-value) | | | | | |
| | Bed Form Diversity | Pool Spacing Ratio | 6 | 0.70 | 0.39 | | |
| | | Pool Depth Ratio | 1.7 | 0.46 | | | |
| | | Percent Riffle (%) | 6 | 0.00 | | | |
| | | Aggradation Ratio | | | | | |
| | Riparian Vegetation | Riparian Buffer Width (%) | 100 | 1.00 | 1.00 | | |
| | | Canopy Cover (%) | 80 | 1.00 | | | |
| | | Herbaceous Vegetation Cover (%) | 80 | 1.00 | | | |
| | | Woody Stem Basal Area (sqm/hectare) | 14 | 1.00 | | | |
| Physicochemical | Temperature | Summer Average ($^{o}$C) | | | | | |
| | Dissolved Oxygen | DO (mg/L) | | | | | |
| | Total Suspended Solids | TSS (mg/L) | | | | | |
| Biology | Macroinvertebrates | Macroinvertebrate IBI | | | | | |
| | Fish | Fish IBI | | | | | |

| PROPOSED CONDITION ASSESSMENT | | | | | Roll Up Scoring | | |
|---|---|---|---|---|---|---|---|
| Functional Category | Function-Based Parameter | Metric | Field Value | Index Value | Parameter | Category | Category |
| Hydrology | Reach Runoff | Land Use Coefficient | 35 | 1.00 | 1.00 | 1.00 | Functioning |
| | | BMP MIDS Rv Coefficient | | | | | |
| | | Concentrated Flow Points / 1,000 feet | 0 | 1.00 | | | |
| Hydraulics | Floodplain Connectivity | Bank Height Ratio | 1 | 1.00 | 1.00 | 1.00 | Functioning |
| | | Entrenchment Ratio | 2.2 | 1.00 | | | |
| Geomorphology | Large Woody Debris | LWD Index | | | 1.00 | 1.00 | Functioning |
| | | No. of LWD Pieces / 100 meters | 28 | 1.00 | | | |
| | Lateral Migration | Dominant BEHI/NBS | VL/L | 1.00 | 1.00 | | |
| | | Percent Streambank Erosion (%) | 0 | 1.00 | | | |
| | | Percent Armoring (%) | | | | | |
| | Bed Material Characterization | Size Class Pebble Count Analyzer (p-value) | | | | | |
| | Bed Form Diversity | Pool Spacing Ratio | 5 | 1.00 | 1.00 | | |
| | | Pool Depth Ratio | 5 | 1.00 | | | |
| | | Percent Riffle (%) | 55 | 1.00 | | | |
| | | Aggradation Ratio | 1 | 1.00 | | | |
| | Riparian Vegetation | Riparian Buffer Width (%) | 100 | 1.00 | 1.00 | | |
| | | Canopy Cover (%) | 80 | 1.00 | | | |
| | | Herbaceous Vegetation Cover (%) | 80 | 1.00 | | | |
| | | Woody Stem Basal Area (sqm/hectare) | 14 | 1.00 | | | |
| Physicochemical | Temperature | Summer Average ($^{o}$C) | | | | | |
| | Dissolved Oxygen | DO (mg/L) | | | | | |
| | Total Suspended Solids | TSS (mg/L) | | | | | |
| Biology | Macroinvertebrates | Macroinvertebrate IBI | | | | | |
| | Fish | Fish IBI | | | | | |

| Site Information and Reference Selection | |
|---|---|
| Project Name: | West Ridge RR Stream Mitigation |
| Reach ID: | White Rock Creek (Silver Bay) |
| Restoration Potential: | Partial |
| Existing Stream Type: | F |
| Reference Stream Type: | B |
| Woody Vegetation Natural Component: | Yes |
| Use Class: | 2A |
| River Nutrient Regions: | North |
| Drainage Area (sq.mi.): | 0.7 |
| Proposed Bed Material: | Cobble |
| Existing Stream Length (ft): | 3951 |
| Proposed Stream Length (ft): | 3951 |
| Macroinvertebrate IBI Class: | Northern Forest Streams Riffle-run |
| Fish IBI Class: | Northern Headwaters |
| Valley Type: | Confined Alluvial |

| Notes |
|---|
| 1. Users input values that are highlighted based on restoration potential |
| 2. Users select values from a pull-down menu |
| 3. Leave values blank for field values that were not measured |

| FUNCTIONAL CHANGE SUMMARY | |
|---|---|
| Existing Condition Score (ECS) | 0.24 |
| Proposed Condition Score (PCS) | 0.49 |
| Change in Functional Condition (PCS - EC | 0.25 |
| Existing Stream Length (ft) | 3951 |
| Proposed Stream Length (ft) | 3951 |
| Change in Stream Length (ft) | 0 |
| Existing Functional Feet (FF) | 948 |
| Proposed Functional Feet (FF) | 1936 |
| Proposed FF - Existing FF | 988 |
| Percent Change in FF (%) | 104% |
| FF Yield (FF/ft) | 0.25 |

| MITIGATION SUMMARY | | |
|---|---|---|
| 988 | (FF) | Lift |

| FUNCTION BASED PARAMETERS SUMMARY | | | |
|---|---|---|---|
| Functional Category | Function-Based Parameters | Existing Parameter | Proposed Parameter |
| Hydrology | Reach Runoff | 0.44 | 0.44 |
| Hydraulics | Floodplain Connectivity | 0.33 | 1.00 |
| Geomorphology | Large Woody Debris | 0.05 | 1.00 |
| | Lateral Migration | 0.35 | 1.00 |
| | Bed Material Characterization | | |
| | Bed Form Diversity | 0.72 | 1.00 |
| | Riparian Vegetation | 0.50 | 1.00 |
| Physicochemical | Temperature | | |
| | Dissolved Oxygen | | |
| | Total Suspended Solids | | |
| Biology | Macroinvertebrates | | |
| | Fish | | |

| FUNCTIONAL CATEGORY REPORT CARD | | | |
|---|---|---|---|
| Functional Category | ECS | PCS | Functional Change |
| Hydrology | 0.44 | 0.44 | 0.00 |
| Hydraulics | 0.33 | 1.00 | 0.67 |
| Geomorphology | 0.41 | 1.00 | 0.59 |
| Physicochemical | | | |
| Biology | | | |

| EXISTING CONDITION ASSESSMENT | | | | | Roll Up Scoring | | |
|---|---|---|---|---|---|---|---|
| **Functional Category** | **Function-Based Parameter** | **Metric** | **Field Value** | **Index Value** | **Parameter** | **Category** | **Category** |
| Hydrology | Reach Runoff | Land Use Coefficient | 61 | 0.78 | 0.44 | 0.44 | Functioning At Risk |
| | | BMP MIDS Rv Coefficient | | | | | |
| | | Concentrated Flow Points / 1,000 feet | 2.9 | 0.10 | | | |
| Hydraulics | Floodplain Connectivity | Bank Height Ratio | 2.5 | 0.00 | 0.33 | 0.33 | Functioning At Risk |
| | | Entrenchment Ratio | 1.38 | 0.66 | | | |
| Geomorphology | Large Woody Debris | LWD Index | | | 0.05 | 0.41 | Functioning At Risk |
| | | No. of LWD Pieces / 100 meters | 1 | 0.05 | | | |
| | Lateral Migration | Dominant BEHI/NBS | VH/H | 0.20 | 0.35 | | |
| | | Percent Streambank Erosion (%) | 80 | 0.00 | | | |
| | | Percent Armoring (%) | 8 | 0.84 | | | |
| | Bed Material Characterization | Size Class Pebble Count Analyzer (p-value) | | | | | |
| | Bed Form Diversity | Pool Spacing Ratio | 5 | 0.70 | 0.72 | | |
| | | Pool Depth Ratio | 4.4 | 1.00 | | | |
| | | Percent Riffle (%) | 76 | 0.47 | | | |
| | | Aggradation Ratio | | | | | |
| | Riparian Vegetation | Riparian Buffer Width (%) | 100 | 1.00 | 0.50 | | |
| | | Canopy Cover (%) | 20 | 0.00 | | | |
| | | Herbaceous Vegetation Cover (%) | 80 | 1.00 | | | |
| | | Woody Stem Basal Area (sqm/hectare) | 5 | 0.00 | | | |
| Physicochemical | Temperature | Summer Average ($^{o}$C) | | | | | |
| | Dissolved Oxygen | DO (mg/L) | | | | | |
| | Total Suspended Solids | TSS (mg/L) | | | | | |
| Biology | Macroinvertebrates | Macroinvertebrate IBI | | | | | |
| | Fish | Fish IBI | | | | | |

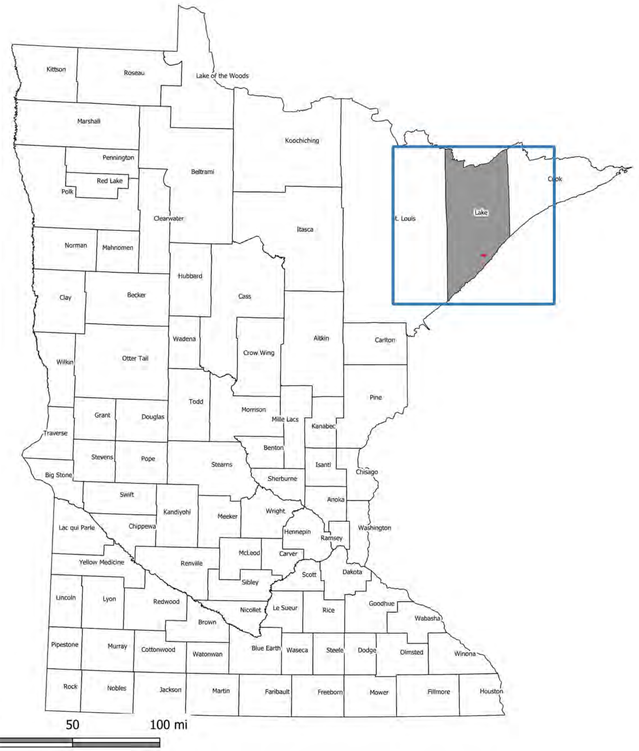
| PROPOSED CONDITION ASSESSMENT | | | | | Roll Up Scoring | | |
|---|---|---|---|---|---|---|---|
| **Functional Category** | **Function-Based Parameter** | **Metric** | **Field Value** | **Index Value** | **Parameter** | **Category** | **Category** |
| Hydrology | Reach Runoff | Land Use Coefficient | 61 | 0.78 | 0.44 | 0.44 | Functioning At Risk |
| | | BMP MIDS Rv Coefficient | | | | | |
| | | Concentrated Flow Points / 1,000 feet | 2.9 | 0.10 | | | |
| Hydraulics | Floodplain Connectivity | Bank Height Ratio | 1 | 1.00 | 1.00 | 1.00 | Functioning |
| | | Entrenchment Ratio | 2.2 | 1.00 | | | |
| Geomorphology | Large Woody Debris | LWD Index | | | 1.00 | 1.00 | Functioning |
| | | No. of LWD Pieces / 100 meters | 28 | 1.00 | | | |
| | Lateral Migration | Dominant BEHI/NBS | VL/L | 1.00 | 1.00 | | |
| | | Percent Streambank Erosion (%) | 5 | 1.00 | | | |
| | | Percent Armoring (%) | | | | | |
| | Bed Material Characterization | Size Class Pebble Count Analyzer (p-value) | | | | | |
| | Bed Form Diversity | Pool Spacing Ratio | 4 | 1.00 | 1.00 | | |
| | | Pool Depth Ratio | 5 | 1.00 | | | |
| | | Percent Riffle (%) | 55 | 1.00 | | | |
| | | Aggradation Ratio | 1 | 1.00 | | | |
| | Riparian Vegetation | Riparian Buffer Width (%) | 100 | 1.00 | 1.00 | | |
| | | Canopy Cover (%) | 80 | 1.00 | | | |
| | | Herbaceous Vegetation Cover (%) | 80 | 1.00 | | | |
| | | Woody Stem Basal Area (sqm/hectare) | 14 | 1.00 | | | |
| Physicochemical | Temperature | Summer Average ($^{o}$C) | | | | | |
| | Dissolved Oxygen | DO (mg/L) | | | | | |
| | Total Suspended Solids | TSS (mg/L) | | | | | |
| Biology | Macroinvertebrates | Macroinvertebrate IBI | | | | | |
| | Fish | Fish IBI | | | | | |

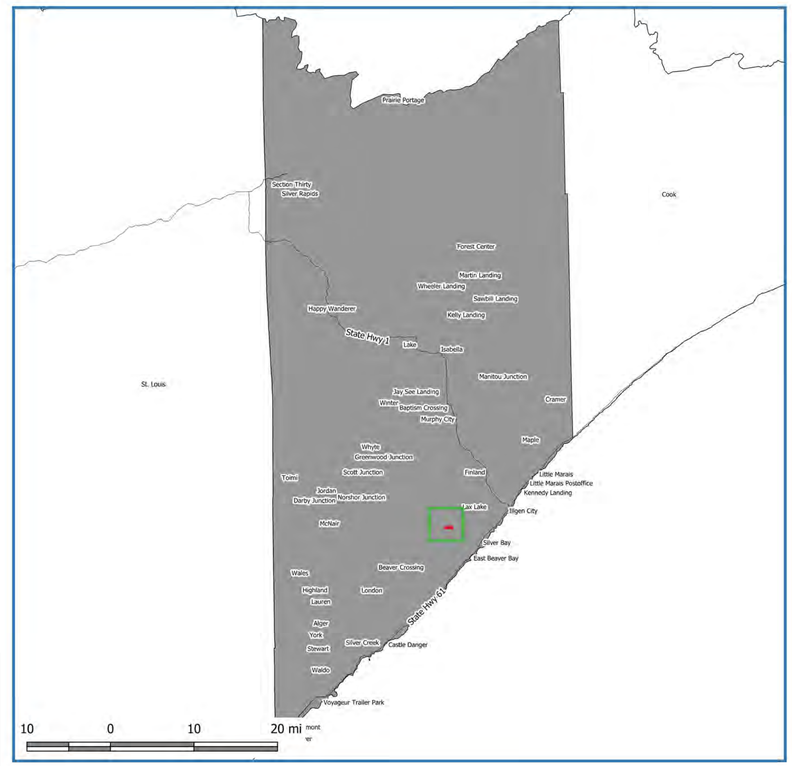
# *Appendix C*

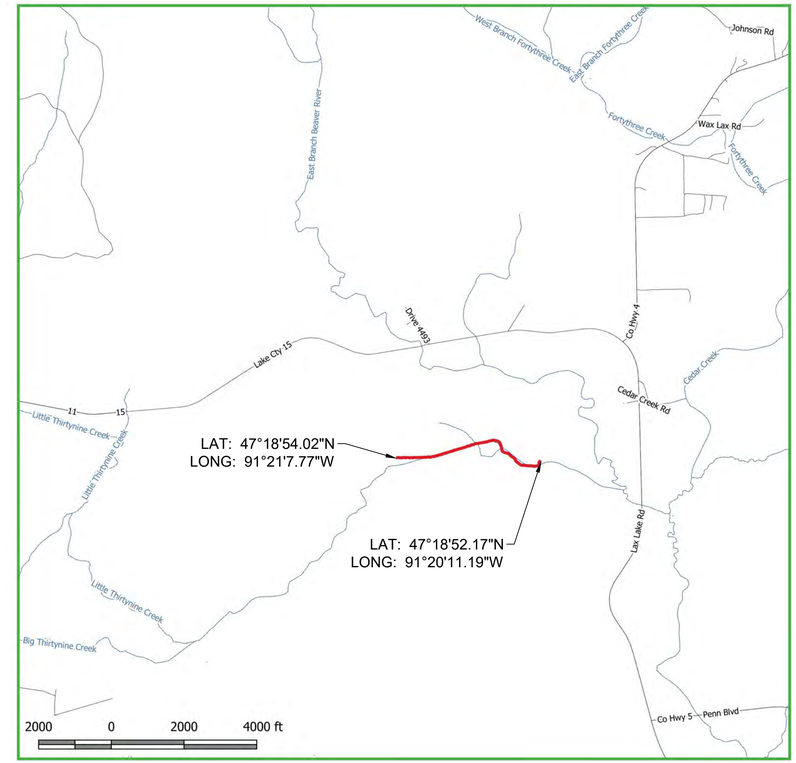
# *30% Project Design Sheets*

# DRAFT 30% DESIGN - NOT FOR CONSTRUCTION
# EAST BRANCH TRIBUTARY BEAVER RIVER
# STREAM RESTORATION

NEAR SILVER BAY
LAKE COUNTY, MN
3/03/2020




| Sheet List Table | | | |
|---|---|---|---|
| SHEET # | SHEET TITLE | DRAWING TITLE | REVISION DATE |
| 1 | COVER | eastBranchTrib_coverNotes.dwg | Tuesday, March 3, 2020 10:07:32 AM |
| 2 | NOTES | eastBranchTrib_coverNotes.dwg | Tuesday, March 3, 2020 10:07:32 AM |
| 3 | QUANTITIES | eastBranchTrib_coverNotes.dwg | Tuesday, March 3, 2020 10:07:32 AM |
| 4 | OVERVIEW | eastBranchTrib_pp.dwg | Friday, February 28, 2020 3:11:31 PM |
| 5 | EAST BRANCH TRIB PP - (1) | eastBranchTrib_pp.dwg | Friday, February 28, 2020 3:11:31 PM |
| 6 | EAST BRANCH TRIB PP - (2) | eastBranchTrib_pp.dwg | Friday, February 28, 2020 3:11:31 PM |
| 7 | EAST BRANCH TRIB PP - (3) | eastBranchTrib_pp.dwg | Friday, February 28, 2020 3:11:31 PM |
| 8 | EAST BRANCH TRIB PP - (4) | eastBranchTrib_pp.dwg | Friday, February 28, 2020 3:11:31 PM |
| 9 | EAST BRANCH TRIB PP - (5) | eastBranchTrib_pp.dwg | Friday, February 28, 2020 3:11:31 PM |
| 10 | EAST BRANCH TRIB PP - (6) | eastBranchTrib_pp.dwg | Friday, February 28, 2020 3:11:31 PM |
| 11 | EAST BRANCH TRIB PP - (7) | eastBranchTrib_pp.dwg | Friday, February 28, 2020 3:11:31 PM |
| 12 | EAST BRANCH TRIB PP - (8) | eastBranchTrib_pp.dwg | Friday, February 28, 2020 3:11:31 PM |
| 13 | EAST BRANCH TRIB SECTION - (1) | eastBranchTrib_sections.dwg | Friday, February 28, 2020 2:59:45 PM |
| 14 | DTL - LOG J-HOOK | eastBranchTrib_MasterDetail.dwg | Friday, February 28, 2020 3:17:48 PM |
| 15 | DTL - TOE WOOD | eastBranchTrib_MasterDetail.dwg | Friday, February 28, 2020 3:17:48 PM |
| 16 | DTL - BOULDER J-HOOK | eastBranchTrib_MasterDetail.dwg | Friday, February 28, 2020 3:17:48 PM |
| 17 | DTL - LOG DROP | eastBranchTrib_MasterDetail.dwg | Friday, February 28, 2020 3:17:48 PM |
| 18 | DTL - CONSTRUCTED LOG RIFFLE | eastBranchTrib_MasterDetail.dwg | Friday, February 28, 2020 3:17:48 PM |

CLIFFS

NORTHSHORE MINING CO
10 OUTER DR
SILVER BAY, MN 55614

BEAVER RIVER CONSULTING

BEAVER RIVER CONSULTING, LLC.
5752 EAGLE VIEW DRIVE
DULUTH, MN 55803

FOR REVIEW ONLY
NOT FOR
CONSTRUCTION

NOTES:

GENERAL CONSTRUCTION NOTES:

1. THE WORK ON THIS PROJECT SHALL ADHERE TO THE FOLLOWING SPECIFICATIONS, STANDARDS AND/OR REGULATIONS: MN DOT STANDARD SPECIFICATIONS FOR CONSTRUCTION, 2016 EDITION, THE FOLLOWING SPECIFICATIONS EITHER MODIFY OR REPLACE APPROPRIATE MN DOT SPECIFICATIONS.
2. INSTREAM STRUCTURES SHALL BE INSTALLED AS THE CHANNEL IS BEING CONSTRUCTED AND NOT POST CONSTRUCTION. FILTER FABRIC INSTALLED AS PART OF THE INSTREAM STRUCTURE SHALL BE MIRAFI 170N SERIES NONWOVEN GEOTEXTILE, OR ENGINEER'S APPROVED ALTERNATIVE, UNLESS OTHERWISE SPECIFIED IN STRUCTURE DETAILS OR SPECIFICATIONS.
3. WHERE PRACTICABLE, EXISTING TREES AND VEGETATION SHOULD BE LEFT IN PLACE TO FACILITATE NATURAL REGENERATION AND SOIL STABILIZATION.
4. DEFINITIONS:
   A. BANKFULL ELEVATION IS THE POINT OF INCIPIENT FLOODING IN AN ALLUVIAL CHANNEL. THIS ELEVATION IS THE REFERENCE FOR DEPTHS ON OR ALONG THE CHANNEL PROFILE AND STRUCTURES DESCRIBED IN THESE SHEETS.
   B. THE BANKFULL BENCH IS A CONSTRUCTED FLOODPLAIN ADJACENT TO THE CHANNEL. THE BANKFULL BENCH IS CONSTRUCTED AT THE BANKFULL ELEVATION.
   C. THE THALWEG IS THE LOWEST PORTION OF THE CHANNEL.
   D. THE VANE LENGTH IS THE STRAIGHT LINE DISTANCE BETWEEN THE VANE ARM AND A LINE TANGENT TO THE STREAMBANK AT THE POINT WHERE THE VANE ARM INTERSECTS THE STREAMBANK.
   E. THE VANE ANGLE IS THE ANGLE BETWEEN THE VANE ARM AND A LINE TANGENT TO THE STREAMBANK AT THE POINT WHERE THE VANE ARM INTERSECTS THE STREAMBANK.
   F. SOD MATS ARE GRASS AND WILLOW TRANSPLANTS THAT STILL CONTAIN ROOTING DEPTH. APPROXIMATELY 9-12IN OF DEPTH WILL BE NEEDED WHEN HARVESTING THE SOD MATS.
6. THE CONTRACTOR SHALL STAKE OUT THE PROPOSED STREAM CENTERLINE FOR REVIEW BY THE ENGINEER BEFORE INITIATING EXCAVATION. DEPENDING ON ENCOUNTERED CONDITIONS SOME SHIFTING OF THE STREAM CHANNEL MAY BE NECESSARY. ANY COST ASSOCIATED WITH CHANGING STRUCTURE LOCATIONS OR ALIGNMENT SHALL BE CONSIDERED INCIDENTAL TO CONSTRUCTION. STAKING MAY BE OMITTED FOR PORTIONS OF THE STREAM WHEN SURVEY-GRADE GPS IS USED TO CONSTRUCT THE CHANNEL. IF GPS IS USED IN LIEU OF STAKING THE CHANNEL IN THE FIELD, THE CONTRACTOR ASSUMES ALL RESPONSIBILITY FOR THE STREAM BEING CONSTRUCTED AS DESIGNED, INCLUDING ANY ISSUES RELATED TO PROJECTIONS, BASE POINTS OR CONVERSION OF DIGITAL TERRAIN MODELS.
7. PRIOR TO CLEARING AND GRUBBING, CONTRACTOR SHALL MARK THE LIMITS OF CLEARING NEAR TREES FOR VERIFICATION OF INTENT BY THE ENGINEER. SOME MINOR ADJUSTMENT OF CHANNEL ALIGNMENT MAY BE REQUIRED TO PRESERVE TREES OR MINIMIZE IMPACT TO TREES.
8. ANY HARVESTING OF WILLOWS AND SOD FROM ONSITE MUST BE APPROVED BY THE ENGINEER.
9. CONTRACTOR SHALL MINIMIZE, TO THE MAXIMUM EXTENT POSSIBLE, IMPACTS TO THE ADJACENT TREES. CONSTRUCTION EQUIPMENT TRACKS AND PATHWAYS SHALL BE GRADED AND RECONTOURED AFTER CONSTRUCTION TO PREVENT RILL AND GULLY EROSION.
10. THE PROPOSED GRADING IS SHOWN ON THESE PLAN SHEETS. THE CONTRACTOR MAY EXTEND THE LIMITS OF DISTURBANCE ONLY WITH THE APPROVAL OF THE ENGINEER.
11. CONTRACTOR SHALL USE AN EXCAVATOR WITH A HYDRAULIC THUMB TO INSTALL INSTREAM STRUCTURES.
12. CHANNEL RELOCATION WORK SHALL BE COMPLETED AND STABILIZED PRIOR TO ALLOWING FLOW TO ENTER INTO THE NEWLY CONSTRUCTED STREAM CHANNEL. THE CONTRACTOR SHALL NOT OPEN UP MORE THAN 200 FEET OF CHANNEL WITHOUT EROSION CONTROL BLANKET IN PLACE OR BY APPROVAL OF THE ENGINEER.
13. THE PROPOSED STREAM CHANNEL SHALL BE CONSTRUCTED BY FIRST GRADING THE FLOODPLAIN ADJACENT TO THE CHANNEL TO THE ELEVATION INDICATED ON THESE PLANS. THIS MAY BE DONE AS GENERAL EXCAVATION. THE PROPOSED STREAM CHANNEL SHALL THEN BE EXCAVATED TO THE PROPER DEPTHS INDICATED ON THE PROFILE AND PROPOSED CONTOURS. THIS SHALL BE DONE AS SPECIALIZED EXCAVATION AND IS TYPICALLY ACCOMPLISHED WITH A TRACK EXCAVATOR. THE PROFILES AND CONTOURS SHOWN PROVIDE WIDTHS AND SLOPES FOR AID IN CONSTRUCTING THE CHANNEL TO THE APPROPRIATE DIMENSIONS. THE THALWEG CAN FIRST BE EXCAVATED TO THE POINT INDICATED ON THE PROFILE. EXCAVATION AND FINE GRADING OF THE CROSS SECTIONS SHALL THEN BE PERFORMED AS SHOWN ON THE TYPICAL CROSS SECTIONS AND PROPOSED CONTOURS. ANY STOCKPILING OF MATERIALS OR “DOUBLE HANDLING” NECESSARY TO BUILD THE CHANNEL SHALL BE CONSIDERED INCIDENTAL TO CONSTRUCTION.
14. IF THE EXISTING GROUND IS LESS THAN 0.2 FEET HIGHER THAN THE PROPOSED BANKFULL ELEVATION, IT IS NOT NECESSARY TO EXCAVATE MATERIAL TO THE PROPOSED ELEVATION SHOWN ON THE PROFILE.
15. THE SURFACE OF ALL INSTREAM STRUCTURES SHALL BE FINISHED TO A SMOOTH LINE IN ACCORDANCE WITH THE LINES, GRADES, AND CROSS SECTIONS OR ELEVATIONS SHOWN ON THE DRAWINGS. THE DEGREE OF FINISH FOR THE VANE SLOPES AND INVERT ELEVATIONS SHALL BE WITHIN 0.1 VERTICAL FEET OF THE GRADES AND ELEVATIONS INDICATED. ALL GAPS OR VOIDS BETWEEN THE ROCKS SHALL BE PLUGGED WITH SMALL GRAVEL TO FORM A TIGHT-FITTING SEAL.
16. CONSTRUCTION SPECIFICATIONS FOR BANKFULL CHANNEL DIMENSIONS OR CROSS SECTIONS WILL BE HELD TO THE DIMENSIONS SHOWN ON THE TYPICAL CROSS SECTIONS. ELEVATIONS SHALL BE CONSTRUCTED WITHIN 0.1 VERTICAL FEET; WIDTHS AND MEAN DEPTHS MUST FALL WITHIN THE RANGES SHOWN IN THE DRAWINGS.
17. THE IN-STRUCTURE BID ITEMS SHALL INCLUDE ALL LABOR AND MATERIALS NECESSARY TO CONSTRUCT THE STRUCTURE. BID ITEMS INCLUDE SEEDING, PLANTING, AND MULCH AND EROSION CONTROL BLANKETS AND INCLUDE ALL LABOR AND MATERIALS NECESSARY TO STABILIZE AREAS DISTURBED DURING CONSTRUCTION OF STRUCTURES. AFTER THE STRUCTURE IS COMPLETE AND FLOW IS RESTORED TO THE CHANNEL, SOME ADJUSTMENT TO THE STRUCTURE OR ADDITIONAL STABILIZATION MEASURES MAY BE NECESSARY TO ACHIEVE DESIRED EFFECT. ANY COSTS ASSOCIATED WITH THESE ADJUSTMENTS SHALL BE CONSIDERED INCIDENTAL TO CONSTRUCTION.
18. THE CONSTRUCTED STREAM CHANNEL SHALL BE STABILIZED AS SOON AS POSSIBLE BY SEEDING IN ACCORDANCE WITH THE PLOT SCHEDULE, ADDING STRAW MULCH TO BARE SOIL, AND BY INSTALLING EROSION CONTROL BLANKET FROM THE INNER BERM TO BEYOND THE TOP OF THE BANKFULL CHANNEL. SEE EROSION CONTROL BLANKET DETAIL. PRIOR TO INSTALLING BLANKET, PREPARE THE BED BY LOOSENING THE SOIL 3 TO 6 INCHES, APPLY SEED AND THEN STRAW MULCH. SEED SHALL BE BROADCAST EVENLY OVER THE AREA USING A BROADCAST SPREADER PRIOR TO COVERING WITH THE EROSION CONTROL BLANKET. THE BLANKET SHALL BE ROLLED OUT IN THE DIRECTION OF THE ANTICIPATED RUN-OFF FLOW. INSTALL BLANKET IN ACCORDANCE WITH DETAIL SHOWN HEREIN. REWORKING OF AREAS THAT DO NOT ESTABLISH VEGETATION OR BECOME UNSTABLE SHALL BE NECESSARY IF THE EROSION CONTROL BLANKET SEPARATES FROM THE SOIL. SEE SEEDING AND PLANTING DETAIL FOR BLANKET SPECIFIATIONS. SEEDING OF THE BANKFULL BENCH SHALL BE IN ACCORDANCE WITH THE PLANTING TABLE. REFER TO CONTROL BLANKET DETAIL FOR PLACEMENT OF EROSION CONTROL BLANKET.
19. IF THE TIMING OF PROJECT IS SUCH THAT RIPARIAN SEED MIX CANNOT BE PLACED IN THE FALL, THEN THE CONTRACTOR SHALL SEED WITH TEMPORARY COVER ACCORDING TO THE EROSION AND SEDIMENT PLAN OR APPROVED BY THE ENGINEER UNTIL RIPARIAN MIX CAN BE SEEDED IN THE SPRING.
20. THE HARVESTING AND INSTALLATION OF LIVE STAKES SHALL BE PERFORMED ONLY DURING THE DORMANT SEASON TYPICALLY BETWEEN NOVEMBER 1 AND APRIL 15. CONTRACTOR SHALL NOTIFY ENGINEER 7 DAYS PRIOR TO HARVESTING TO REVIEW AND APPROVE ALL HARVESTING SITES. UPON APPROVAL BY ENGINEER, THE CONTRACTOR SHALL BE RESPONSIBLE FOR HARVESTING AND TRANSPORTING THE LIVE STAKE CUTTINGS TO THE JOB SITE.
21. LIVE STAKES SHALL BE INSTALLED ALONG THE OUTSIDE MEANDER BEND AND ALONG RIFFLES WHERE INDICATED ON THE DRAWINGS AND DETAILS. LIVE STAKES SHALL BE INSTALLED INTO THE EROSION CONTROL BLANKET IN ADDITION TO THE DEAD STAKES.
22. EXCESS SPOIL MATERIAL MAY BE SPREAD AND GRADED ONSITE OR IN THE ONSITE PIT AS APPROVED BY THE ENGINEER. PLACEMENT OF ANY ON-SITE OR OFF-SITE SPOIL MATERIAL SHALL BE CONSIDERED INCIDENTAL TO CONSTRUCTION.
23. TOPSOIL SHALL BE REMOVED FROM EXCAVATION AND SPOIL AREAS PRIOR TO CUT OR FILL AND RE-APPLIED TO AREAS AFTER ROUGH GRADING IS COMPLETE. SIX INCHES OF TOPSOIL SHALL BE PLACED ON DISTURBED AREAS TO MEET GRADE. STOCKPILING AND PLACEMENT OF TOPSOIL SHALL BE CONSIDERED INCIDENTAL TO CONSTRUCTION AND APPROVED BY THE ENGINEER.
24. SPOIL AREAS SHALL BE SEEDED WITH TEMPORARY VEGETATION WITHIN 7 DAYS FOLLOWING GRADING.
25. THE PLACEMENT OF STRAW MULCH SHALL OCCUR A MAXIMUM 48 HOURS AFTER SEEDING. MULCH WILL BE SPREAD TO COVER THE INSTALLED AREAS AT A MINIMUM RATE OF 1.5 TONS PER ACRE. MULCH SHALL BE KEPT OUT OF THE CROWNS OF SHRUBS AND GROUND COVER.
26. IF SOFT SOILS ARE ENCOUNTERED WHEN RECONSTRUCTING STREAM BANKS, RESTORE BANK WITH SOD MAT COVERING ALONG RIFFLES AND WOOD TOE SOD MAT ALONG BENDS.
27. CONTRACTOR SHALL CALL GOPHER STATE ONE CALL FOR UTILITY MARKING AT LEAST 48 HOURS PRIOR TO START OF CONSTRUCTION. THE LOCATIONS OF THE UTILITIES SHOWN ON THESE DRAWINGS ARE APPROXIMATE ONLY (UTILITY QUALITY LEVEL D) AND MAY NOT BE ACCURATE. LOCATING UTILITIES IS THE SOLE RESPONSIBILITY OF THE CONTRACTOR. THE ENGINEER AND PROJECT OWNER WILL NOT BE RESPONSIBLE FOR ANY DAMAGES TO UTILITIES.
28. CONTRACTOR SHALL UTILIZE NATIVE MATERIAL FROM THE SITE WHERE AVAILABLE AND ALLOWED BY THE ENGINEER. NATIVE MATERIAL THAT CAN BE FOUND ON SITE INCLUDE TREES THAT CAN PROVIDE LIVE STAKES AND TREES THAT CAN BE USED FOR LOG STRUCTURES AND WOOD DEBRIS.
29. AFTER CONSTRUCTION, THE ACCESS ROADS LEADING TO THE PROJECT SITE SHALL BE RESTORED TO AS GOOD OR BETTER CONDITION THAN BEFORE CONSTRUCTION AT THE ENGINEER'S DISCRETION.
30. FOOTER DEPTH ON ALL STRUCTURES REQUIRING FOOTERS SHALL BE AT LEAST 6 TIMES GREATER THAN THE DROP BETWEEN THE STRUCTURE AND THE FOOTERED STRUCTURE DIRECTLY UPSTREAM OR APPROVED BY THE ONSITE ENGINEER.

EROSION/SEDIMENTATION CONTROL NOTES:

1. ALL CONTROL MEASURES SHALL BE CHECKED, AND REPAIRED AS NECESSARY, MONTHLY IN DRY PERIODS, AND WITHIN 24 HOURS AFTER ANY RAINFALL AT THE SITE OF .75 INCHES OR GREATER WITHIN A 24 HOUR PERIOD. DAILY CHECKING AND, IF NECESSARY, REPAIRING SHALL BE DONE DURING PROLONGED RAINFALLS. THE PERMITTEE SHALL MAINTAIN WRITTEN RECORDS OF SUCH CHECKS AND REPAIRS ON-SITE AT ALL TIMES, AND RECORDS SHALL BE SUBJECT TO INSPECTION AT ANY REASONABLE TIME.
2. THE CONSTRUCTION ACCESS POINTS SHALL BE MAINTAINED AS REQUIRED TO PREVENT SILT/SEDIMENT FROM LEAVING THE SITE. THIS INCLUDES BUT IS NOT LIMITED TO WASH DOWN OF THE CONSTRUCTION ACCESS POINTS, INSTALLING AND UTILIZING A VEHICLE WASH DOWN AREA, INSTALLING ADDITIONAL STONE, ETC.
3. ANY AND ALL SILT/SEDIMENTATION SHALL BE FREQUENTLY REMOVED FROM THE SILT FENCE, DITCHES, CHECK DAMS AND RETENTION AREAS. AT THE END OF CONSTRUCTION, THESE AREAS SHALL BE COMPLETELY FREE OF SILT/SEDIMENTATION AND SHALL BE STABILIZED AS STATED IN THE PLANS AND SPECIFICATIONS.
4. ALL BMPS SHALL BE DESIGNED AND INSTALLED IN ACCORDANCE WITH THE MINNESOTA POLLUTION CONTROL AGENCY (MPCA) CONSTRUCTION OF GENERAL PERMITS FOR STORMWATER CONTROL. IF CONFLICTS ARISE BETWEEN THESE REQUIREMENTS, THE MORE STRINGENT SHALL APPLY.
5. BMPS SHOWN ALONG THE PERIMETER OF THE DISTURBED AREAS SHALL BE INSTALLED PRIOR TO DISTURBANCE ACTIVITY. OTHER BMPS SHALL BE INSTALLED AS SOON AS CONSTRUCTION SEQUENCES ALLOW.
6. TEMPORARY DIVERSION OF RUNOFF/RUNON WATER SHALL BE INSTALLED AS NEEDED TO FACILITATE CONSTRUCTION OR AS DIRECTED ON-SITE BY THE ENGINEER.
7. ALL DISTURBED AREAS SHALL BE PERMANENTLY STABILIZED IMMEDIATELY AFTER THE COMPLETION OF THE GRADING OPERATION. AREAS REQUIRING COCONUT COIR MATTING SHALL BE SEEDED AND MULCHED FOR STABILIZATION PRIOR TO THE INSTALLATION OF THE MATTING.
8. TEMPORARY STABILIZATION OF DISTURBED AREAS MUST BE INITIATED IMMEDIATELY WHENEVER WORK TOWARD PROJECT COMPLETION AND FINAL STABILIZATION OF ANY PORTION OF THE SITE HAS TEMPORARILY CEASED AND WILL NOT RESUME FOR A PERIOD EXCEEDING THIRTEEN (7) CALENDAR DAYS. THOSE AREAS SHALL BE SEEDED AND MULCHED IN ACCORDANCE WITH THE PLANS AND SPECIFICATIONS.
9. NECESSARY MEASURES SHALL BE TAKEN TO PRODUCE AND MAINTAIN AN ACCEPTABLE STAND OF GRASS. SAID MEASURES TO INCLUDE (BUT NOT LIMITED TO) WATERING, RE-SEEDING, REGRADING ERODED AREAS, RE-FERTILIZING, ETC.
10. CONTRACTOR IS RESPONSIBLE FOR KEEPING MUD AND DEBRIS OFF CITY/STATE STREETS AND ROW. CLEANUP IS REQUIRED DAILY.
11. CONTRACTOR SHALL KEEP A COPY OF THE NPDES CONSTRUCTION GENERAL PERMIT AND THE "CONSTRUCTION BEST MANAGEMENT PRACTICES PLAN" ON SITE AT ALL TIMES FOR THE LIFE OF THE PROJECT.
12. ALL HAZARDOUS SUBSTANCES USED FOR THIS PROJECT (PAINT, OIL, GREASE, AND OTHER PETROLEUM PRODUCTS) SHALL BE STORED IN ACCORDANCE WITH SPCC REGULATIONS. THESE SUBSTANCES SHALL BE STORED AWAY FROM DRAINS AND DITCHES IN WATERTIGHT CONTAINERS. DISPOSAL OF THESE SUBSTANCES SHALL BE IN ACCORDANCE WITH ADEM REGULATIONS. DAILY INSPECTIONS SHALL BE PERFORMED FOR LEAK DETECTION. IF LEAKS OCCUR, APPROPRIATE ACTION SHALL BE TAKEN TO CONTAIN AND REMEDIATE THE SPILL. ADEQUATE TRASH CONTAINERS SHALL BE KEPT ON SITE FOR THE DISPOSAL OF CONSTRUCTION MATERIALS WASTE. NECESSARY MEASURES SHALL BE TAKEN TO PREVENT ANY TRASH OR OTHER POLLUTANTS FROM ENTERING "WATERS OF THE UNITED STATES."
13. ALL TEMPORARY MEASURES SHALL BE REMOVED ONCE ACCEPTABLE PERMANENT STABILIZATION IS ACHIEVED. THE ENGINEER SHALL DETERMINE IF THE PERMANENT STABILIZATION IS ACCEPTABLE.

SPECIAL NOTES:

THE ELEVATIONS SHOWN HEREIN ARE BASED ON DATA SURVEY THAT ENCOMPASSES THE EXISTING GROUND SURFACE FROM WHICH ALL COMPUTATIONS FOR CUT/FILL ARE BASED. SLIGHT DISCREPANCIES BETWEEN THE EXISTING GROUND DIGITAL SURFACE AND FIELD CONDITIONS CAN RESULT IN SIGNIFICANT VARIATIONS IN TOTAL EXCAVATED QUANTITIES. THUS, THE CONTRACTOR SHALL COMPARE QUANTITIES OF MATERIAL EXCAVATED TO THOSE SHOWN ON THE DRAWINGS TO MANAGE THE MOVEMENT OF MATERIAL ACROSS THE SITE.

TOPOGRAPHIC INFORMATION:

EXISTING GROUND SURFACES ARE BASED ON A SURVEY COMPLETED XXXX BLENDED WITH STATE OF MN LIDAR. BENCHMARKS WERE SET THROUGHOUT THE SITE AND CAN BE PROVIDED AT ANY TIME. CHANGES IN EXISTING SURFACES SHALL BE INCIDENTAL TO CONSTRUCTION.

SPECIAL GRADING NOTE:

THE AGREED UPON INTENT OF THIS GRADING PLAN IS TO MAINTAIN A “LIVE” SURFACE SO THAT ANY CHANGES THAT ARISE DURING CONSTRUCTION CAN BE QUICKLY ENCOMPASSED INTO THE THREE-DIMENSIONAL SURFACE GENERATED DURING THIS DESIGN PROCESS. AS SUCH, FINE TUNING OF THE SURFACE THAT WOULD ELIMINATE THE APPEARANCE OF JAGGED CONTOUR LINES WHERE SLIGHT VARIATIONS BETWEEN THE EXISTING AND PROPOSED SURFACES WAS NOT COMPLETED.

APPROVED BY: KA | CHECKED BY: MJG | DRAWN BY: GET

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EAST BRANCH TRIBUTARY BEAVER RIVER
STREAM RESTORATION
NEAR SILVER BAY
LAKE COUNTY, MN

DRAFT 30% DESIGN - NOT FOR CONSTRUCTION

GENERAL NOTES

CLIFFS
NORTHSHORE MINING CO
10 OUTER DR
SILVER BAY, MN 55614

BEAVER RIVER CONSULTING
BEAVER RIVER CONSULTING, LLC.
5752 EAGLE VIEW DRIVE
DULUTH, MN 55803

CONCEPT DESIGN
NOT FOR
CONSTRUCTION

DATE: 3/03/2020

SHEET NUMBER
2 OF 18

E:\DROPBOX (SSSR)\NORTHSHOREMINING\C3D\SHEETS\EASTBRANCHTRIB_COVERNOTES.DWG | GREGTALLACO | SAVED: Tuesday, March 3, 2020 10:07:40 AM | ACAD.CTB | | PLOTTED: Tuesday, March 3, 2020 10:08:06 AM

| STATEMENT OF ESTIMATED QUANTITIES | | | | |
|---|---|---|---|---|
| NO. | ITEM | MNDOT SPEC. | QUANTITY | UNIT |
| 1 | MOBILIZATION | 2021.501 | 1 | LS |
| 2 | CUT COMMON CHANNEL EXCAVATION | 2105.511 | 75000 | CU YD |
| 3 | FILL COMMON CHANNEL EXCAVATION | 2105.511 | 10000 | CU YD |
| 4 | STREAM DIVERSION SYSTEM | 2105.601 | 1 | LS |
| 5 | LOG J-HOOK | 2577.604 | 15 | EACH |
| 6 | BOULDER J HOOK | 2577.604 | 5 | EACH |
| 7 | TOE WOOD | 2577.610 | 1500 | LIN FT |
| 8 | AUGMENTED RIFFLE | 2577.611 | 0 | CY |
| 9 | CONSTRUCTED LOG RIFFLE | 2577.612 | 21 | EACH |
| 10 | LOG STEP | 2577.613 | 60 | EACH |
| 11 | ROCK STEP | 2577.613 | 35 | EACH |
| 12 | MULCH MATERIAL TYPE 1 | 2575.511 | 8.0 | TON |
| 13 | CONIFEROUS TREE, 1.5' HT CONT | 2571.501 | 0 | EACH |
| 14 | DECIDUOUS TREE, 1.5' HT CONT | 2571.502 | 0 | EACH |
| 15 | DECIDUOUS SHRUB, 1.5" HT CONT | 2571.505 | 0 | EACH |
| 16 | SEED MIXTURE FLOODPLAIN | 2575.502 | 0 | LBS |
| 17 | EROSION CONTROL BLANKETS CATEGORY 4N | 2575.523 | 3000 | SQ YD |
| 18 | EROSION CONTROL BLANKET- 700 GRAM COCUNUT FIBER WITH CAT. 3N BLANKET | 2575.601 | 0 | SQ YD |

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EAST BRANCH TRIBUTARY BEAVER RIVER
STREAM RESTORATION
NEAR SILVER BAY
LAKE COUNTY, MN

DRAFT 30% DESIGN - NOT FOR CONSTRUCTION
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QUANTITIES

CLIFFS

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10 OUTER DR
SILVER BAY, MN 55614
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DULUTH, MN 55803
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CONCEPT DESIGN
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CONSTRUCTION

DATE: 3/03/2020

SHEET NUMBER
3 OF 18

E:\DROPBOX (SSSR)\NORTHSHOREMINING\C3D\SHEETS\EASTBRANCHTRIB_COVERNOTES.DWG | GREGTALLACQ | SAVED: Tuesday, March 3, 2020 10:07:40 AM | ACAD.CTB | | PLOTTED: Tuesday, March 3, 2020 10:08:07 AM

| APPROVED BY: KA | CHECKED BY: MJG | DRAWN BY: GET | |
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# EAST BRANCH TRIBUTARY BEAVER RIVER STREAM RESTORATION NEAR SILVER BAY LAKE COUNTY, MN

DRAFT 30% DESIGN - NOT FOR CONSTRUCTION

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OVERVIEW

CLIFFS

NORTHSHORE MINING CO
10 OUTER DR
SILVER BAY, MN 55614

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5752 EAGLE VIEW DRIVE
DULUTH, MN 55803

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CONCEPT DESIGN
NOT FOR
CONSTRUCTION

DATE: 3/03/2020
SCALE (34"X22"): 1" = 150'
SCALE (17"X11"): 1" = 300'

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SCALE IN FEET

SHEET NUMBER
4 OF 18

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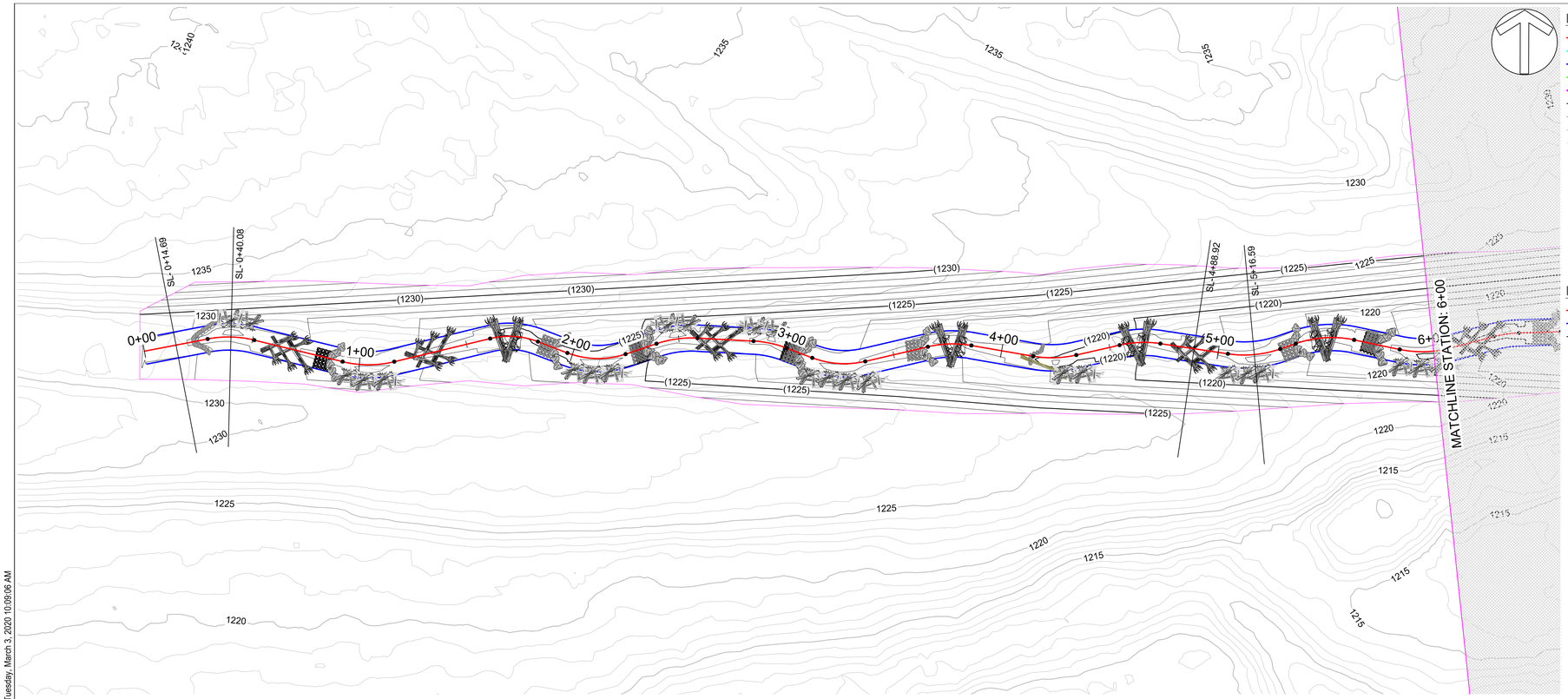
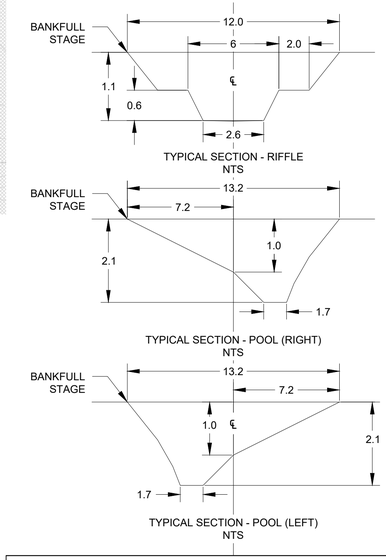


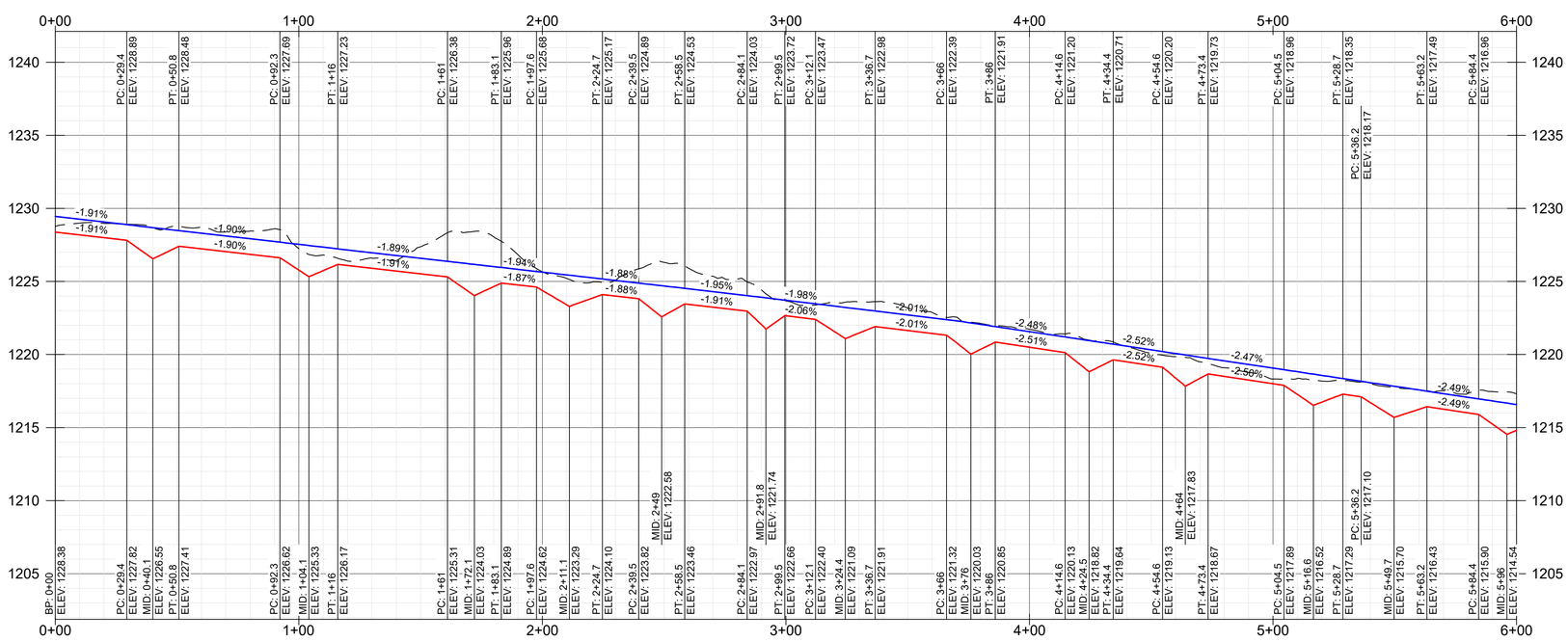

## PLAN LEGEND

- PROPOSED STREAM CENTER LINE
- PROPOSED INNER BERM
- PROPOSED GEOMORPHIC CHANNEL TOB
- PROPOSED FLOODPLAIN TOE
- LIMITS OF DISTURBANCE
- (483) PROPOSED MAJOR CONTOUR
- PROPOSED MINOR CONTOUR
- 479 EXISTING MAJOR CONTOUR
- EXISTING MINOR CONTOUR
- LOG J-HOOK
- CONSTRUCTED LOG RIFFLE
- TOE WOOD
- BOULDER J-HOOK
- BOULDER DROP
- LOG DROP

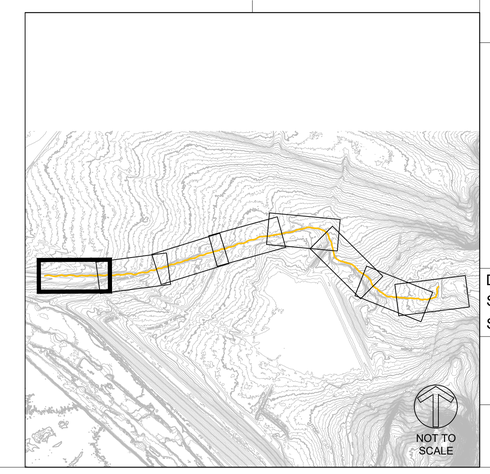
## PROFILE LEGEND

- PROPOSED STREAM CENTER LINE
- PROPOSED BANKFULL TOB
- EXISTING GROUND




SCALE: HOR 1" =1'; VERT 1"= 0'

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# EAST BRANCH TRIBUTARY BEAVER RIVER
## STREAM RESTORATION
## NEAR SILVER BAY
## LAKE COUNTY, MN

DRAFT 30% DESIGN - NOT FOR CONSTRUCTION

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PLAN AND PROFILE - (1)
STA 0+00 TO 6+00


CLIFFS
NORTHSHORE MINING CO
10 OUTER DR
SILVER BAY, MN 55614
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CONCEPT DESIGN
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CONSTRUCTION

DATE: 3/03/2020
SCALE (34"X22"): 1" = 30'
SCALE (17"X11"): 1" = 60'

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SHEET NUMBER
5 OF 18


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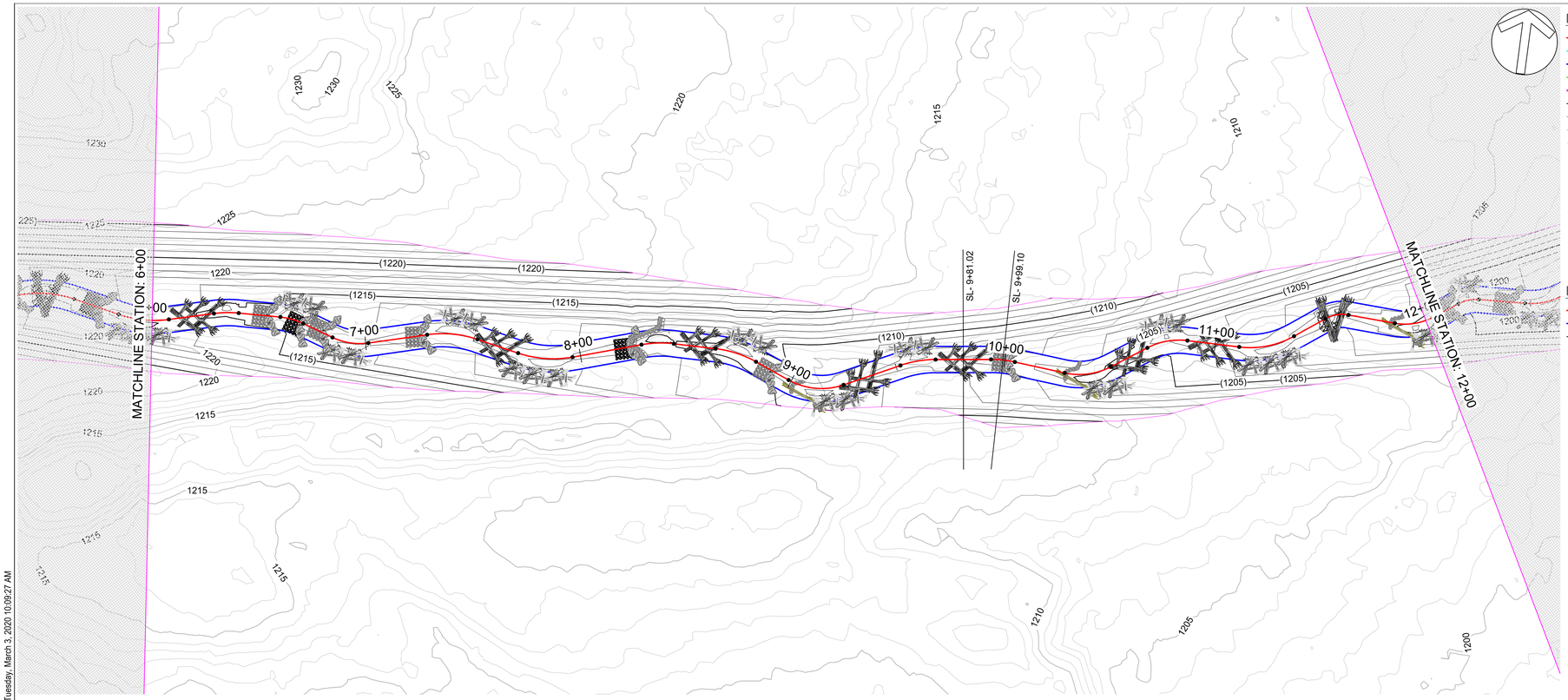


## PLAN LEGEND

- PROPOSED STREAM CENTER LINE
- PROPOSED INNER BERM
- PROPOSED GEOMORPHIC CHANNEL TOB
- PROPOSED FLOODPLAIN TOE
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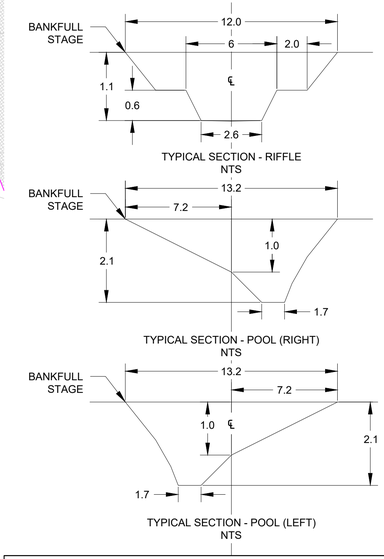
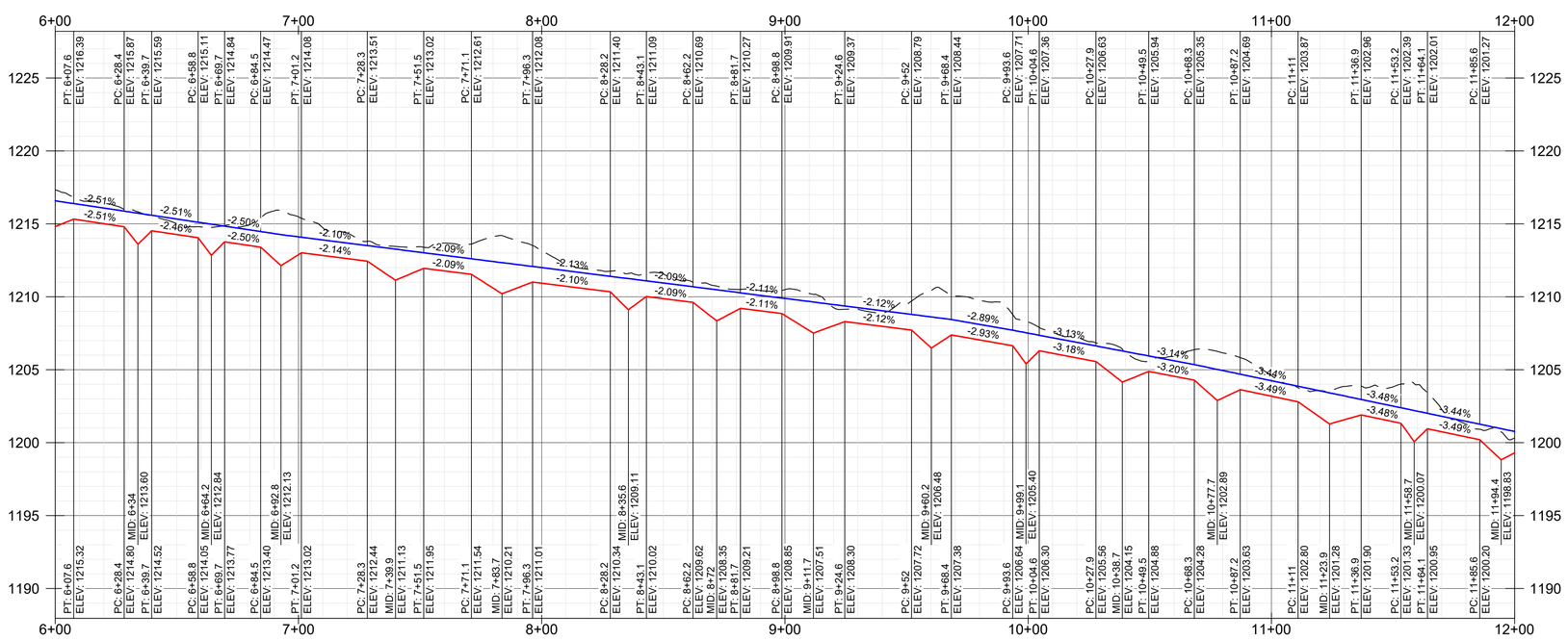
- BOULDER DROP
- LOG DROP

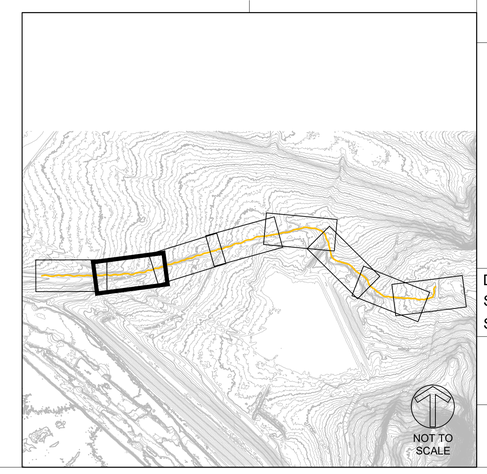
## PROFILE LEGEND

- PROPOSED STREAM CENTER LINE
- PROPOSED BANKFULL TOB
- EXISTING GROUND




SCALE: HOR 1" =1'; VERT 1"= 0'




| APPROVED BY: KA | CHECKED BY: MJG | DRAWN BY: GET |
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# EAST BRANCH TRIBUTARY BEAVER RIVER
## STREAM RESTORATION
## NEAR SILVER BAY
## LAKE COUNTY, MN

DRAFT 30% DESIGN - NOT FOR CONSTRUCTION

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PLAN AND PROFILE - (2)
STA 6+00 TO 12+00


CLIFFS
NORTHSHORE MINING CO
10 OUTER DR
SILVER BAY, MN 55614
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BEAVER RIVER CONSULTING
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5752 EAGLE VIEW DRIVE
DULUTH, MN 55803
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CONCEPT DESIGN
NOT FOR
CONSTRUCTION

DATE: 3/03/2020
SCALE (34"X22"): 1" = 30'
SCALE (17"X11"): 1" = 60'

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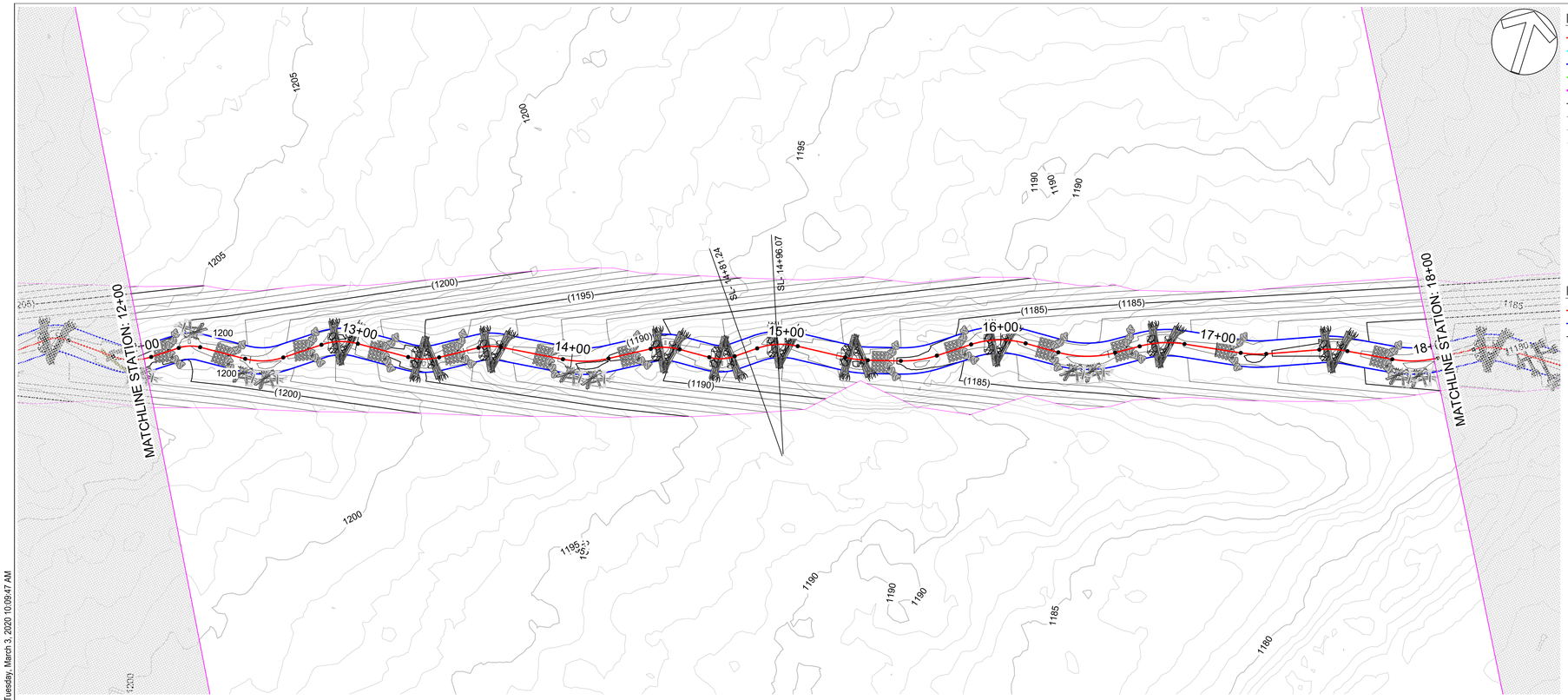
SCALE IN FEET

SHEET NUMBER
6 OF 18


E:\DROPBOX (SSSR)\NORTHSHOREMINING\C3D\SHEETS\EASTBRANCHTRIB_PP.DWG | GREGTAILLACQ | SAVED: Friday, February 28, 2020 3:11:33 PM | ACAD.CTB | | PLOTTED: Tuesday, March 3, 2020 10:09:27 AM

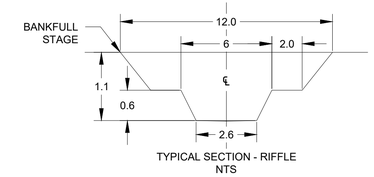



## PLAN LEGEND

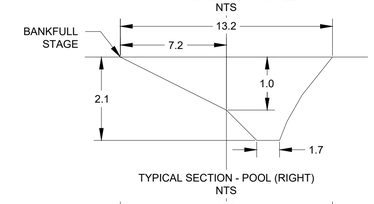
- PROPOSED STREAM CENTER LINE
- PROPOSED INNER BERM
- PROPOSED GEOMORPHIC CHANNEL TOB
- PROPOSED FLOODPLAIN TOE
- LIMITS OF DISTURBANCE
- (483) PROPOSED MAJOR CONTOUR
- PROPOSED MINOR CONTOUR
- 479 EXISTING MAJOR CONTOUR
- EXISTING MINOR CONTOUR
- LOG J-HOOK
- CONSTRUCTED LOG RIFFLE
- TOE WOOD
- BOULDER J-HOOK
- BOULDER DROP
- LOG DROP

## PROFILE LEGEND

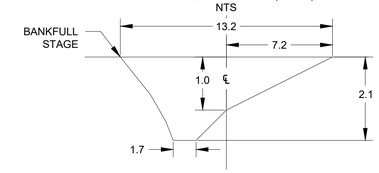
- PROPOSED STREAM CENTER LINE
- PROPOSED BANKFULL TOB
- EXISTING GROUND



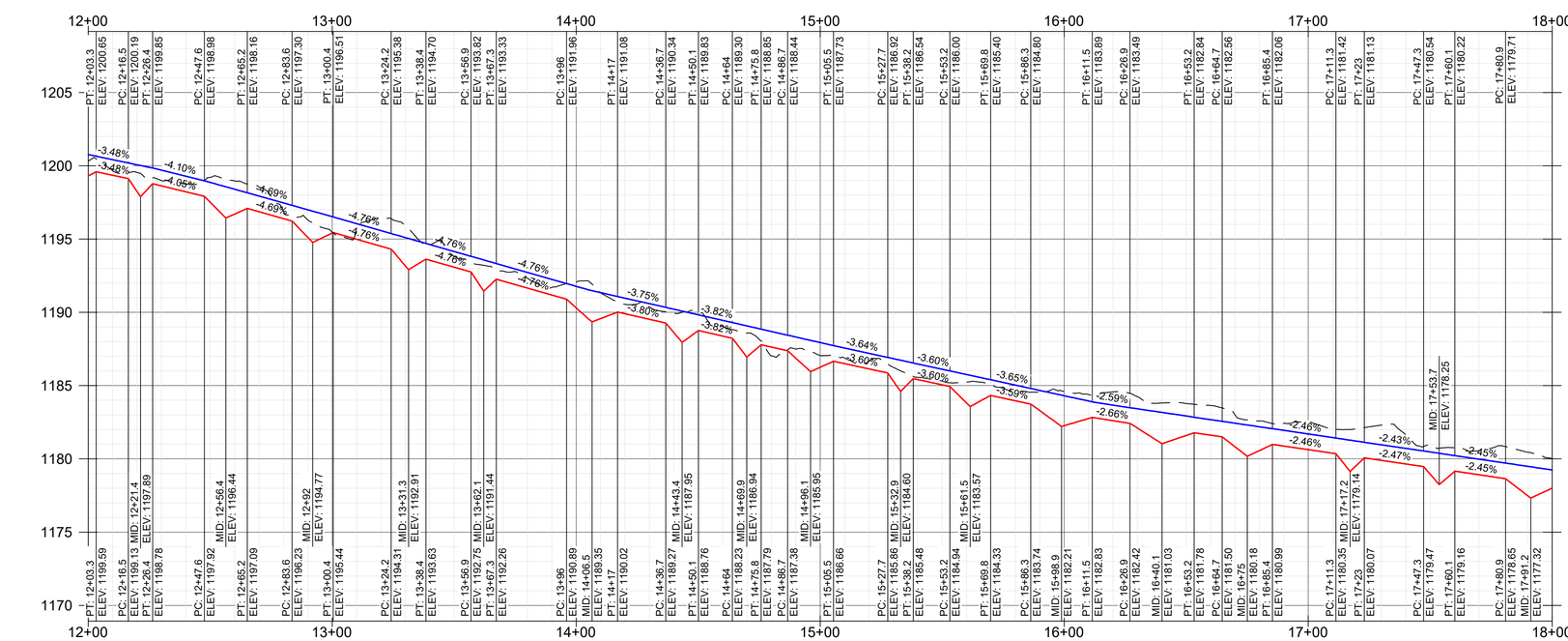

TYPICAL SECTION - RIFFLE
NTS



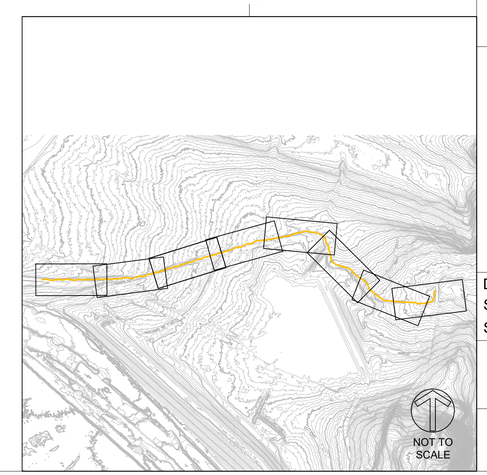

TYPICAL SECTION - POOL (RIGHT)
NTS




TYPICAL SECTION - POOL (LEFT)
NTS




SCALE: HOR 1" =1'; VERT 1"= 0'




| APPROVED BY: KA | CHECKED BY: MJG | DRAWN BY: GET |
|---|---|---|

| REV | DESCRIPTION | APPRV |
|---|---|---|
| 1 | DRAFT 30% DESIGN | XX |
| XX | XX | XX |
| XX | XX | XX |
| XX | XX | XX |
| XX | XX | XX |
| XX | XX | XX |
| XX | XX | XX |
| XX | XX | XX |

# EAST BRANCH TRIBUTARY BEAVER RIVER
## STREAM RESTORATION
## NEAR SILVER BAY
## LAKE COUNTY, MN

DRAFT 30% DESIGN - NOT FOR CONSTRUCTION

---

PLAN AND PROFILE - (3)
STA 12+00 TO 18+00


CLIFFS
NORTHSHORE MINING CO
10 OUTER DR
SILVER BAY, MN 55614
---
BEAVER RIVER CONSULTING
BEAVER RIVER CONSULTING, LLC.
5752 EAGLE VIEW DRIVE
DULUTH, MN 55803
---

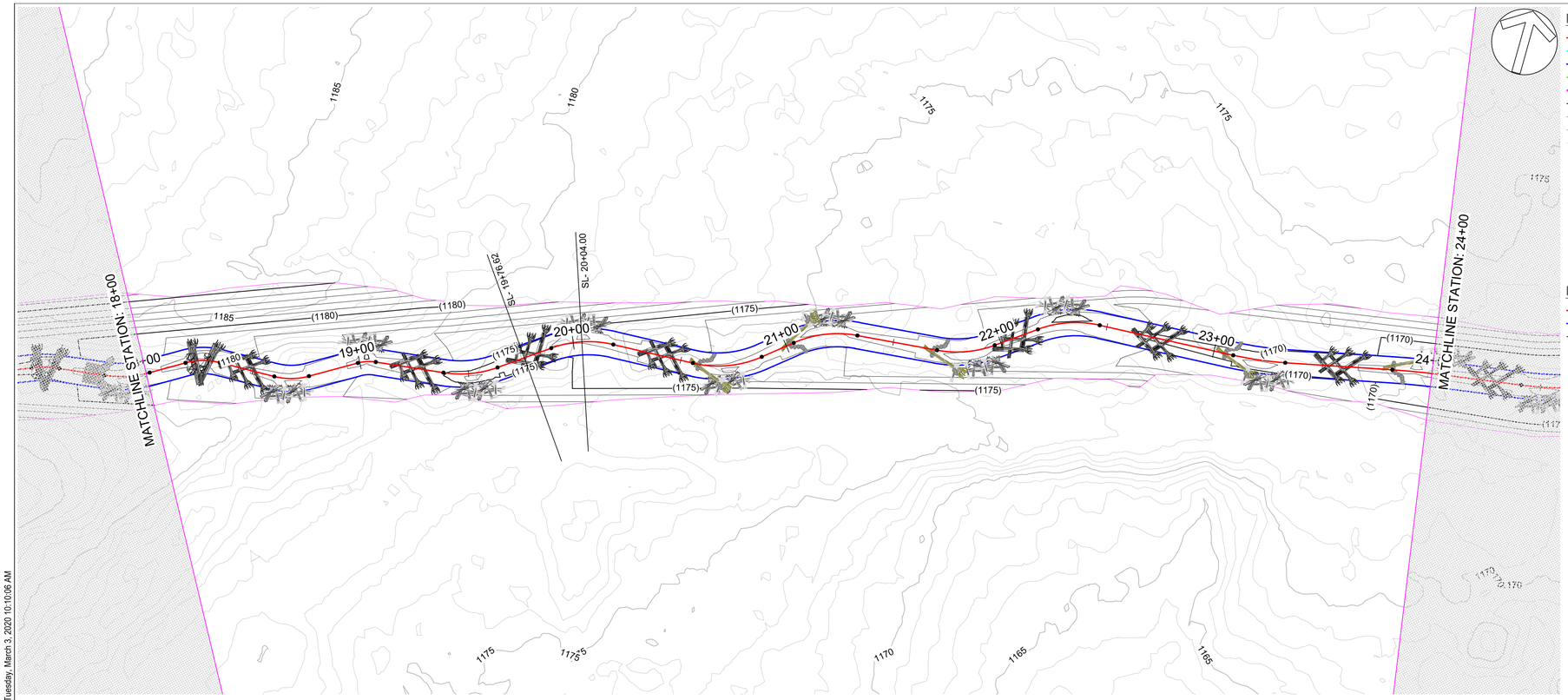

CONCEPT DESIGN
NOT FOR
CONSTRUCTION

DATE: 3/03/2020
SCALE (34"X22"): 1" = 30'
SCALE (17"X11"): 1" = 60'

0 30 60
SCALE IN FEET

SHEET NUMBER
7 OF 18


E:\DROPBOX (SSSR)\NORTHSHOREMINING\C3D\SHEETS\EASTBRANCHTRIB_PP.DWG | GREGTAILLACQ | SAVED: Friday, February 28, 2020 3:11:33 PM | ACAD.CTB | | PLOTTED: Tuesday, March 3, 2020 10:09:47 AM

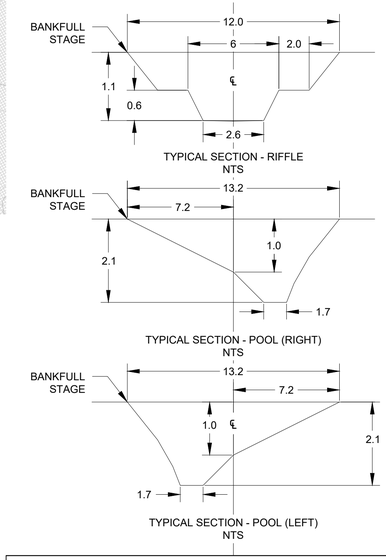


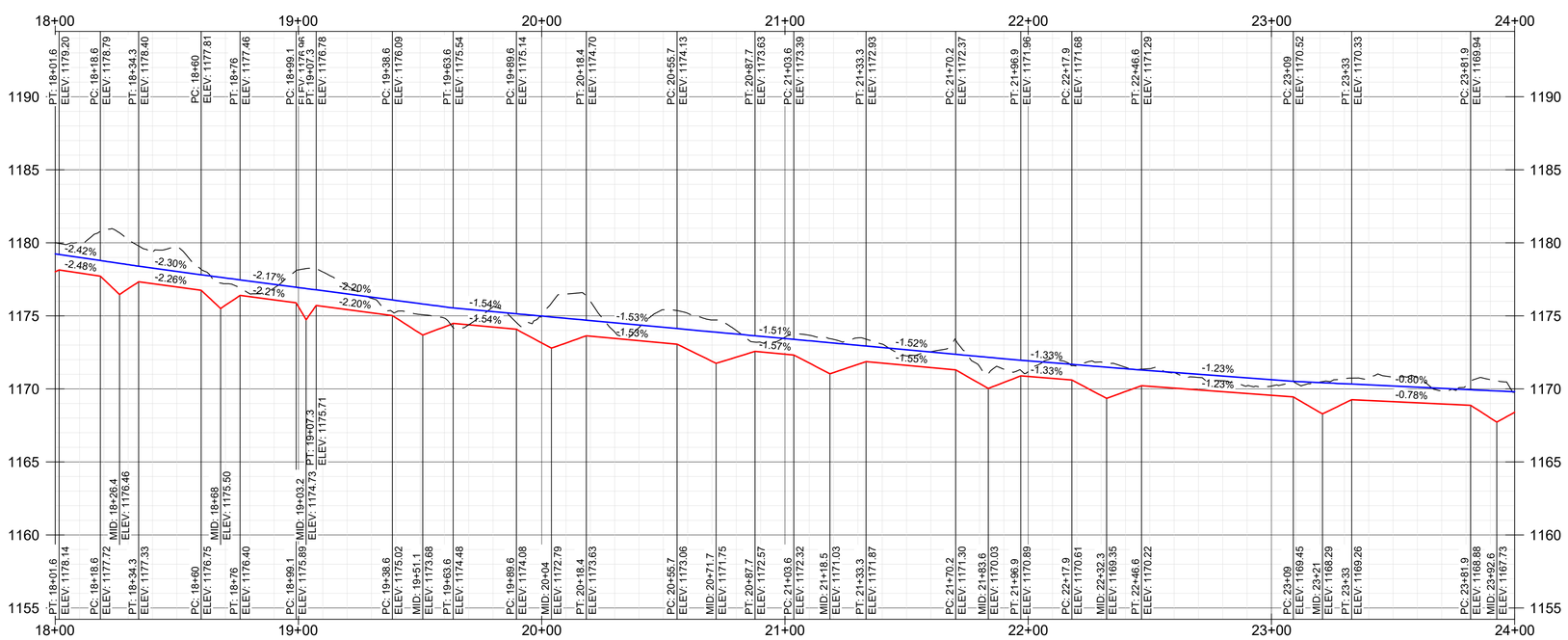

## PLAN LEGEND

- PROPOSED STREAM CENTER LINE
- PROPOSED INNER BERM
- PROPOSED GEOMORPHIC CHANNEL TOB
- PROPOSED FLOODPLAIN TOE
- LIMITS OF DISTURBANCE
- (483) PROPOSED MAJOR CONTOUR
- PROPOSED MINOR CONTOUR
- 479 EXISTING MAJOR CONTOUR
- EXISTING MINOR CONTOUR
- LOG J-HOOK
- CONSTRUCTED LOG RIFFLE
- TOE WOOD
- BOULDER J-HOOK
- BOULDER DROP
- LOG DROP

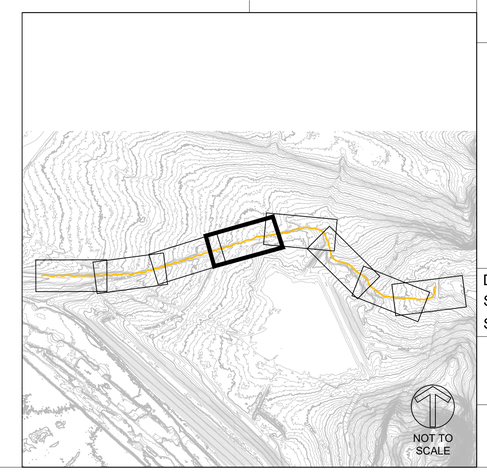
## PROFILE LEGEND

- PROPOSED STREAM CENTER LINE
- PROPOSED BANKFULL TOB
- EXISTING GROUND




SCALE: HOR 1" =1'; VERT 1"= 0'




| REV | DESCRIPTION | APPROVED BY: KA | CHECKED BY: MJG | DRAWN BY: GET | APPRV |
|---|---|---|---|---|---|
| 1 | DRAFT 30% DESIGN | XX | XX | XX | XX |
| XX | XX | XX | XX | XX | XX |
| XX | XX | XX | XX | XX | XX |
| XX | XX | XX | XX | XX | XX |
| XX | XX | XX | XX | XX | XX |
| XX | XX | XX | XX | XX | XX |
| XX | XX | XX | XX | XX | XX |

# EAST BRANCH TRIBUTARY BEAVER RIVER
## STREAM RESTORATION
## NEAR SILVER BAY
## LAKE COUNTY, MN

DRAFT 30% DESIGN - NOT FOR CONSTRUCTION

---

PLAN AND PROFILE - (4)
STA 18+00 TO 24+00


CLIFFS
NORTHSHORE MINING CO
10 OUTER DR
SILVER BAY, MN 55614
---
BEAVER RIVER CONSULTING
BEAVER RIVER CONSULTING, LLC.
5752 EAGLE VIEW DRIVE
DULUTH, MN 55803
---

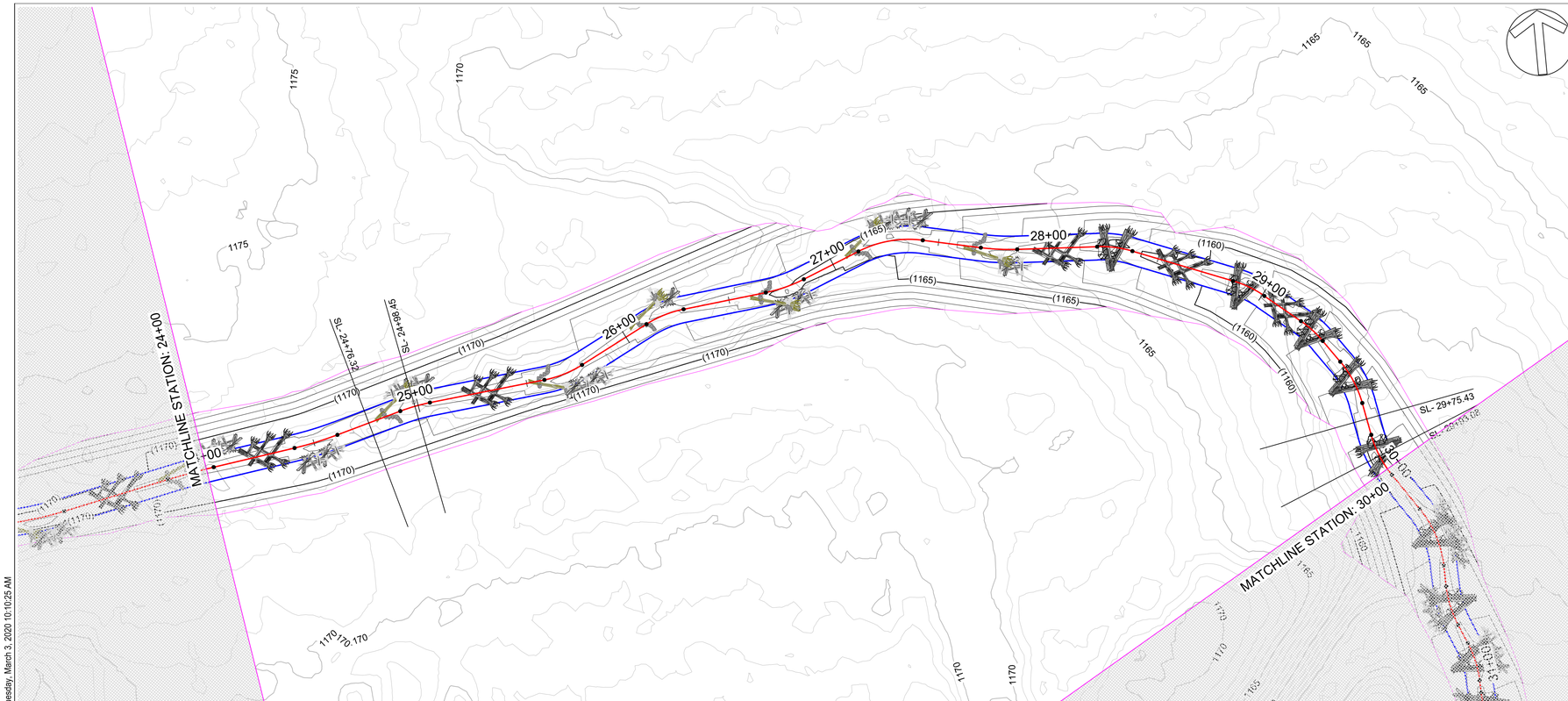

CONCEPT DESIGN
NOT FOR
CONSTRUCTION

DATE: 3/03/2020
SCALE (34"X22"): 1" = 30'
SCALE (17"X11"): 1" = 60'

0 30 60
SCALE IN FEET

SHEET NUMBER
8 OF 18


E:\DROPBOX (SSSR)\NORTHSHOREMINING\C3D\SHEETS\EASTBRANCHTRIB_PP.DWG | GREGTAILLACQ | SAVED: Friday, February 28, 2020 3:11:33 PM | ACAD.CTB | | PLOTTED: Tuesday, March 3, 2020 10:10:06 AM

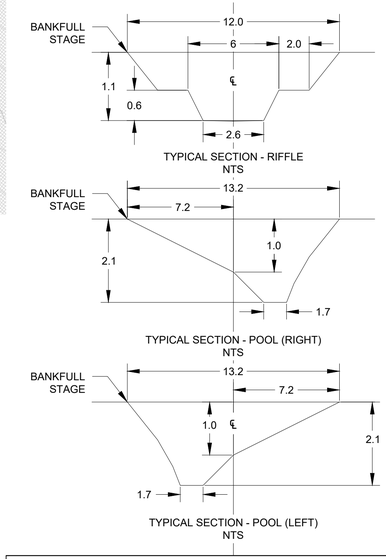


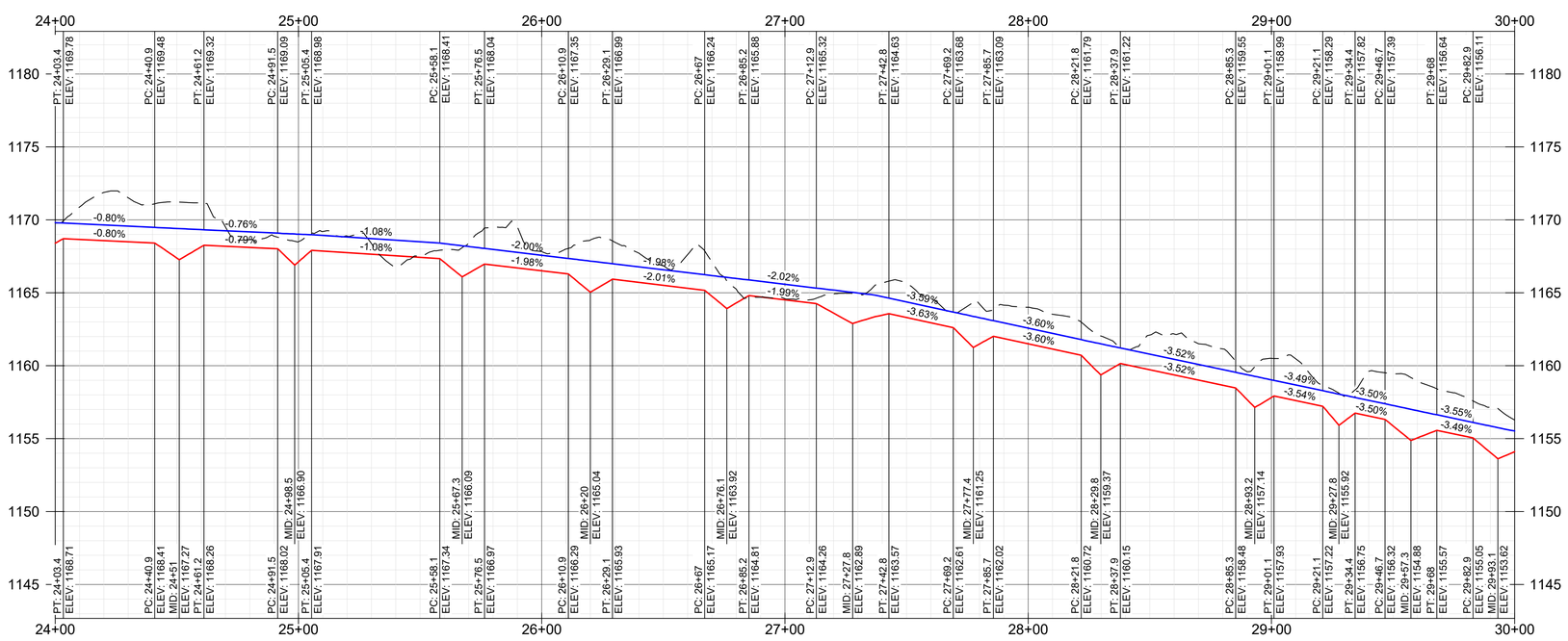

## PLAN LEGEND

- PROPOSED STREAM CENTER LINE
- PROPOSED INNER BERM
- PROPOSED GEOMORPHIC CHANNEL TOB
- PROPOSED FLOODPLAIN TOE
- LIMITS OF DISTURBANCE
- (483) PROPOSED MAJOR CONTOUR
- PROPOSED MINOR CONTOUR
- 479 EXISTING MAJOR CONTOUR
- EXISTING MINOR CONTOUR
- LOG J-HOOK
- CONSTRUCTED LOG RIFFLE
- TOE WOOD
- BOULDER J-HOOK
- BOULDER DROP
- LOG DROP

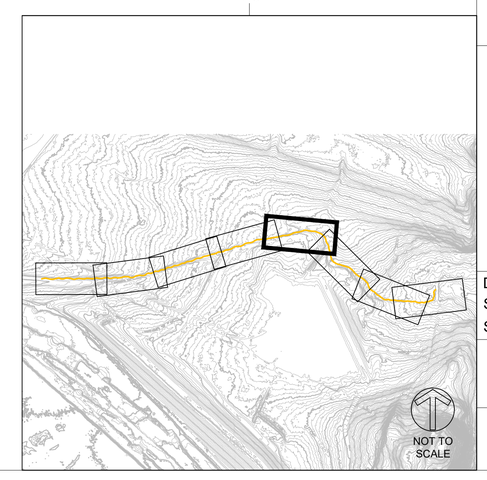
## PROFILE LEGEND

- PROPOSED STREAM CENTER LINE
- PROPOSED BANKFULL TOB
- EXISTING GROUND




SCALE: HOR 1" =1'; VERT 1"= 0'




| APPROVED BY: KA | CHECKED BY: MJG | DRAWN BY: GET |
|---|---|---|
| REV | DESCRIPTION | APPRV |
| 1 | DRAFT 30% DESIGN | XX |
| XX | XX | XX |
| XX | XX | XX |
| XX | XX | XX |
| XX | XX | XX |
| XX | XX | XX |
| XX | XX | XX |
| XX | XX | XX |

# EAST BRANCH TRIBUTARY BEAVER RIVER
## STREAM RESTORATION
## NEAR SILVER BAY
## LAKE COUNTY, MN

DRAFT 30% DESIGN - NOT FOR CONSTRUCTION

---

PLAN AND PROFILE - (5)
STA 24+00 TO 30+00


CLIFFS
NORTHSHORE MINING CO
10 OUTER DR
SILVER BAY, MN 55614
---
BEAVER RIVER CONSULTING
BEAVER RIVER CONSULTING, LLC.
5752 EAGLE VIEW DRIVE
DULUTH, MN 55803
---

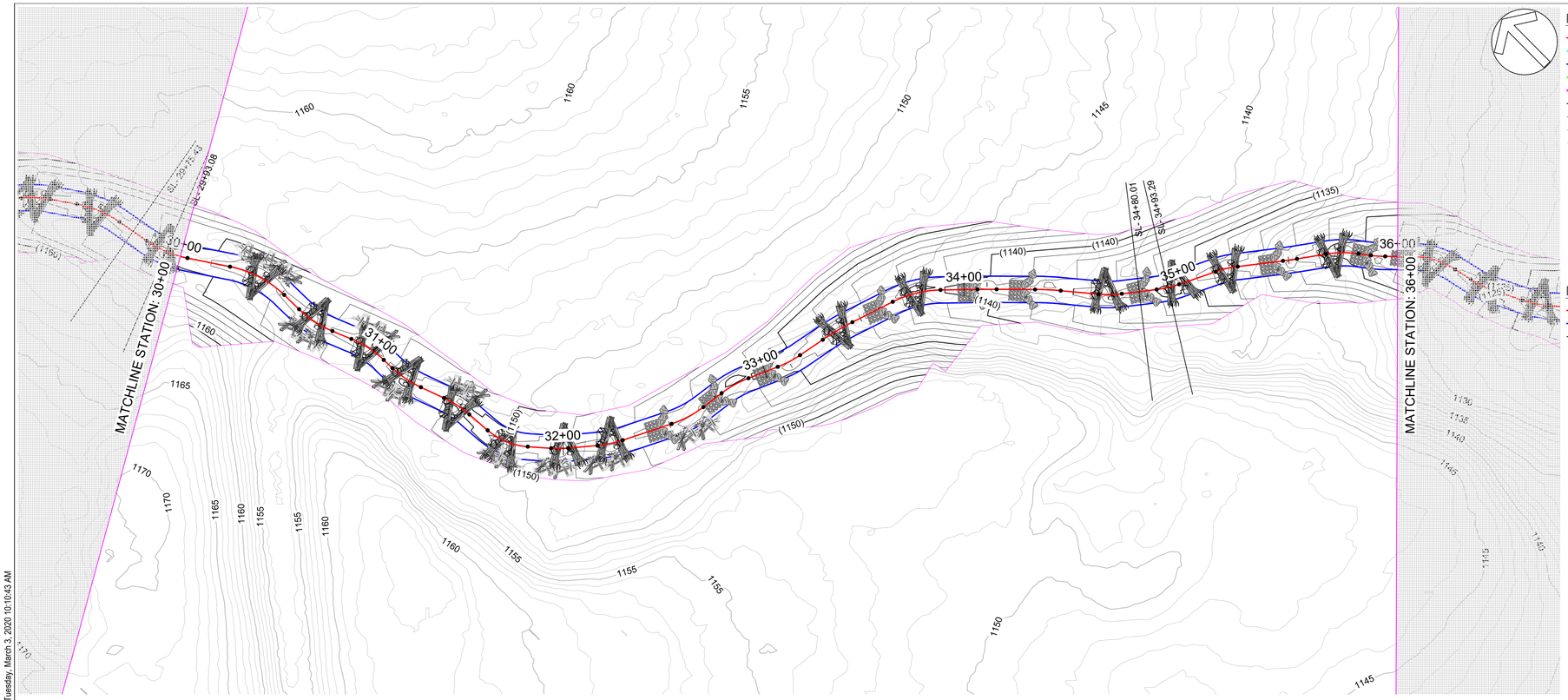

CONCEPT DESIGN
NOT FOR
CONSTRUCTION

DATE: 3/03/2020
SCALE (34"X22"): 1" = 30'
SCALE (17"X11"): 1" = 60'

0 30 60
SCALE IN FEET




E:\DROPBOX (SSSR)\NORTHSHOREMINING\C3D\SHEETS\EASTBRANCHTRIB_PP.DWG | GREGTAILLACQ | SAVED: Friday, February 28, 2020 3:11:33 PM | ACAD.CTB | | PLOTTED: Tuesday, March 3, 2020 10:10:25 AM

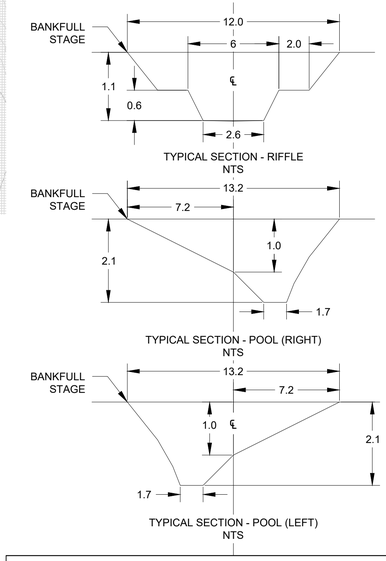


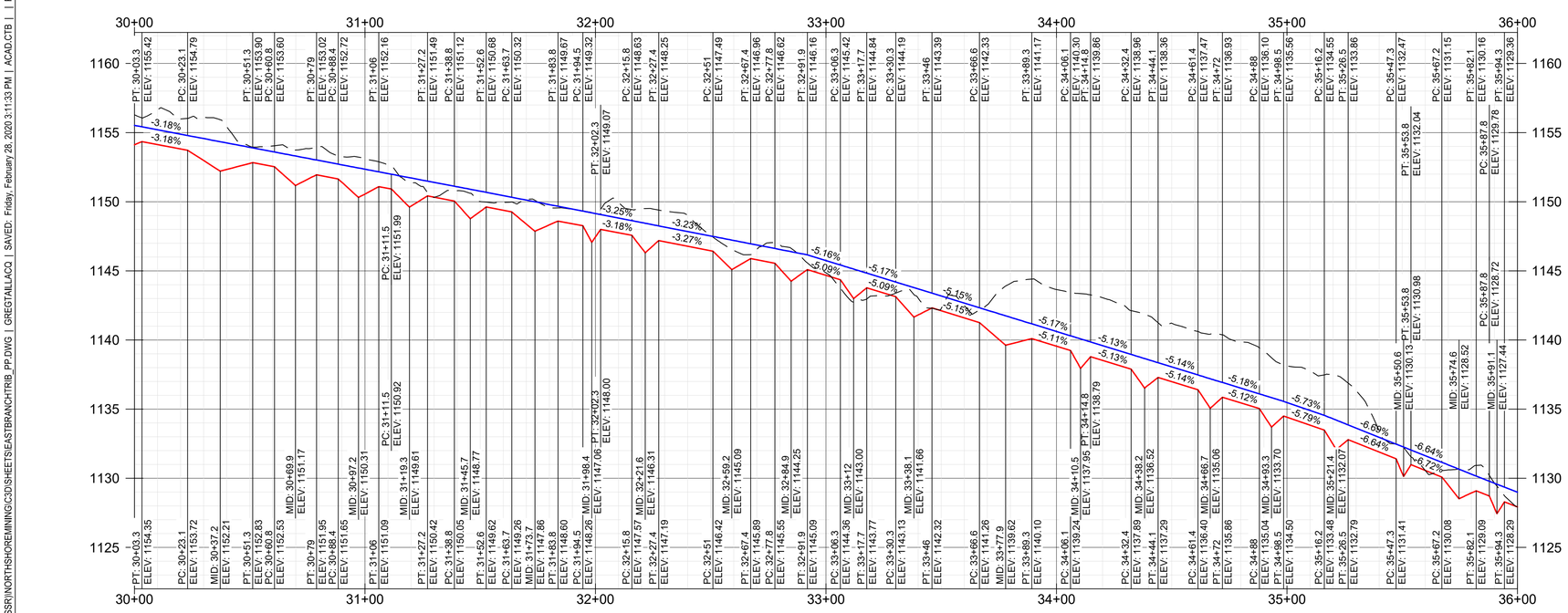

## PLAN LEGEND

- PROPOSED STREAM CENTER LINE
- PROPOSED INNER BERM
- PROPOSED GEOMORPHIC CHANNEL TOB
- PROPOSED FLOODPLAIN TOE
- LIMITS OF DISTURBANCE
- (483) PROPOSED MAJOR CONTOUR
- PROPOSED MINOR CONTOUR
- 479 EXISTING MAJOR CONTOUR
- EXISTING MINOR CONTOUR
- LOG J-HOOK
- CONSTRUCTED LOG RIFFLE
- TOE WOOD
- BOULDER J-HOOK
- BOULDER DROP
- LOG DROP

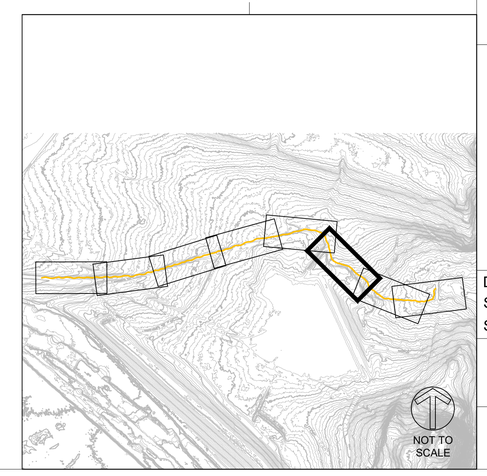
## PROFILE LEGEND

- PROPOSED STREAM CENTER LINE
- PROPOSED BANKFULL TOB
- EXISTING GROUND




SCALE: HOR 1" =1'; VERT 1"= 0'




| APPROVED BY: KA | CHECKED BY: MJG | DRAWN BY: GET | |
|---|---|---|---|
| REV | DESCRIPTION | | APPRV |
| 1 | DRAFT 30% DESIGN | | XX |
| XX | XX | XX | XX |
| XX | XX | XX | XX |
| XX | XX | XX | XX |
| XX | XX | XX | XX |
| XX | XX | XX | XX |
| XX | XX | XX | XX |

# EAST BRANCH TRIBUTARY BEAVER RIVER
STREAM RESTORATION
NEAR SILVER BAY
LAKE COUNTY, MN

DRAFT 30% DESIGN - NOT FOR CONSTRUCTION

---

PLAN AND PROFILE - (6)
STA 30+00 TO 36+00


CLIFFS
NORTHSHORE MINING CO
10 OUTER DR
SILVER BAY, MN 55614
---
BEAVER RIVER CONSULTING
BEAVER RIVER CONSULTING, LLC.
5752 EAGLE VIEW DRIVE
DULUTH, MN 55803
---

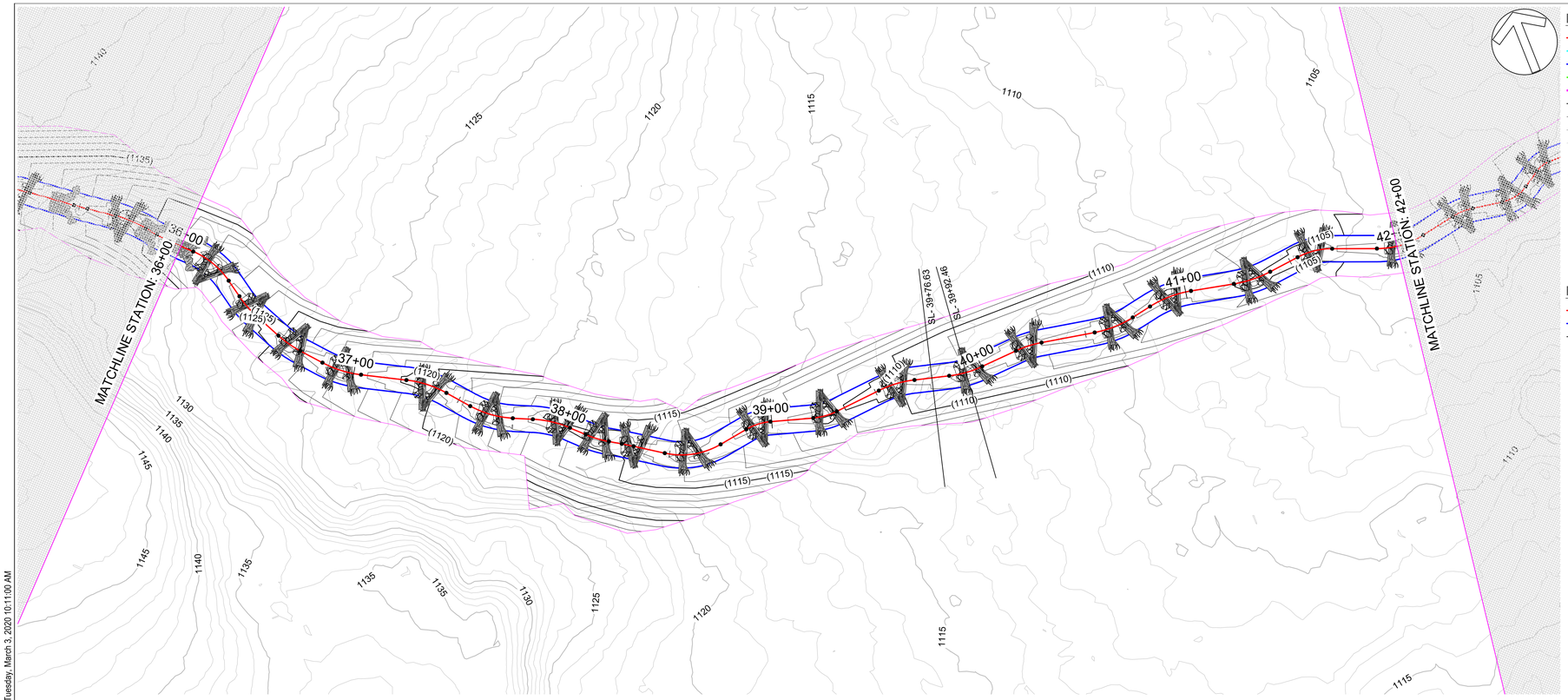

CONCEPT DESIGN
NOT FOR
CONSTRUCTION

DATE: 3/03/2020
SCALE (34"X22"): 1" = 30'
SCALE (17"X11"): 1" = 60'

0 30 60
SCALE IN FEET




E:\DROPBOX (SSSR)\NORTHSHOREMINING\C3D\SHEETS\EASTBRANCHTRIB_PP.DWG | GREGTAILLACQ | SAVED: Friday, February 28, 2020 3:11:33 PM | ACAD.CTB | | PLOTTED: Tuesday, March 3, 2020 10:10:43 AM

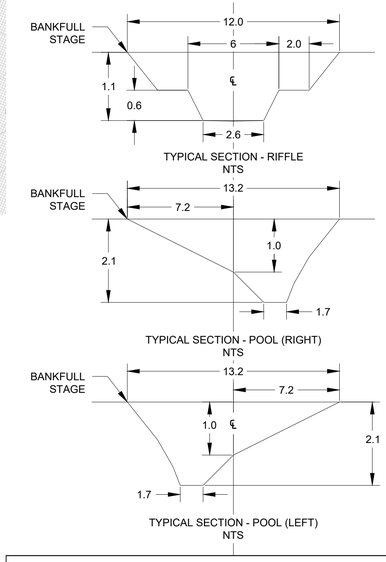


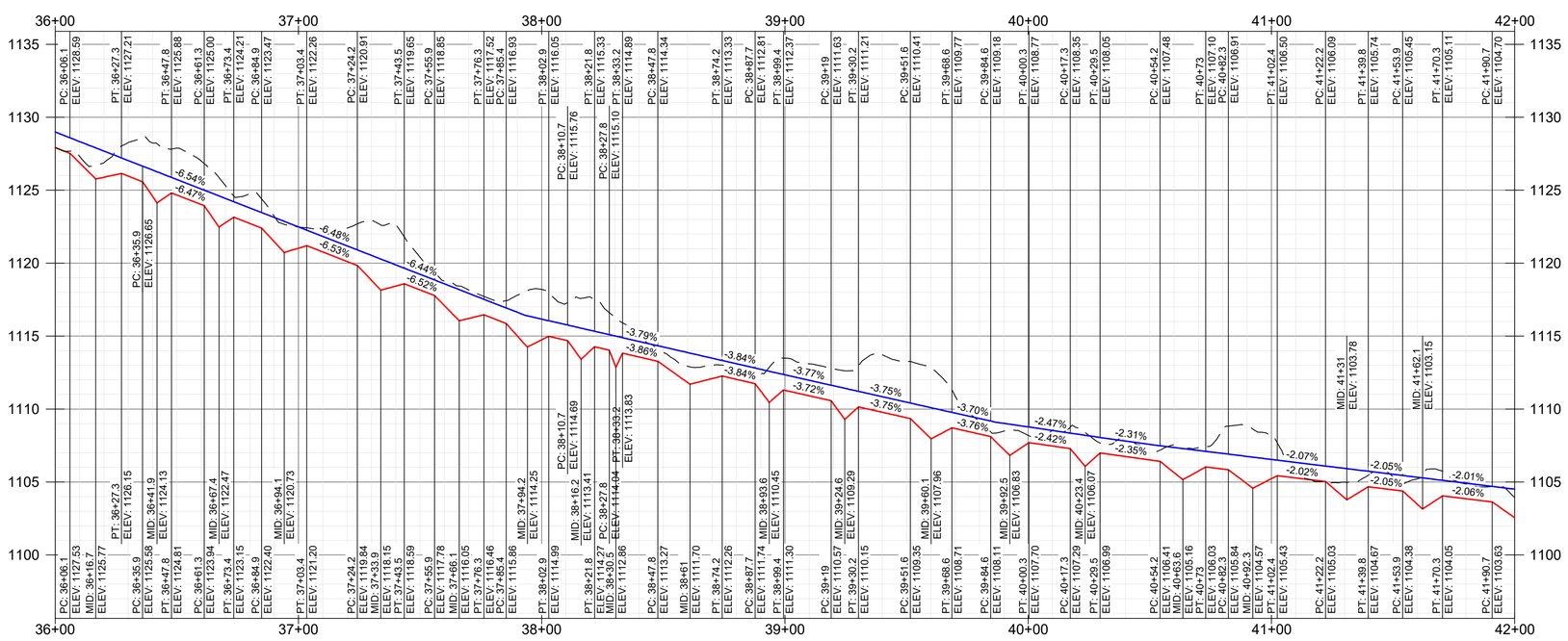

## PLAN LEGEND

- PROPOSED STREAM CENTER LINE
- PROPOSED INNER BERM
- PROPOSED GEOMORPHIC CHANNEL TOB
- PROPOSED FLOODPLAIN TOE
- LIMITS OF DISTURBANCE
- (483) PROPOSED MAJOR CONTOUR
- PROPOSED MINOR CONTOUR
- 479 EXISTING MAJOR CONTOUR
- EXISTING MINOR CONTOUR
- LOG J-HOOK
- CONSTRUCTED LOG RIFFLE
- TOE WOOD
- BOULDER J-HOOK
- BOULDER DROP
- LOG DROP

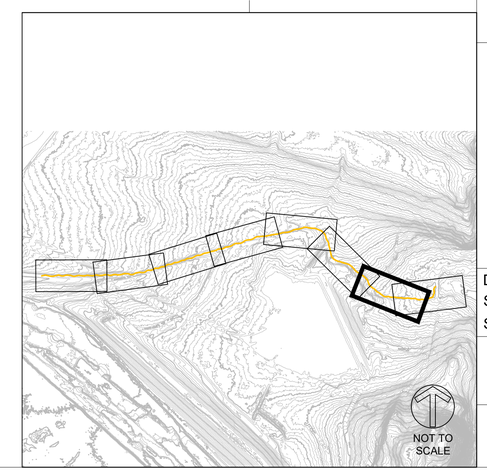
## PROFILE LEGEND

- PROPOSED STREAM CENTER LINE
- PROPOSED BANKFULL TOB
- EXISTING GROUND




SCALE: HOR 1" =1'; VERT 1"= 0'




| REV | DESCRIPTION | APPROVED BY: KA | CHECKED BY: MJG | DRAWN BY: GET |
|---|---|---|---|---|
| 1 | DRAFT 30% DESIGN | | | APPRV |
| XX | | XX | XX | XX |
| XX | | XX | XX | XX |
| XX | | XX | XX | XX |
| XX | | XX | XX | XX |
| XX | | XX | XX | XX |
| XX | | XX | XX | XX |
| XX | | XX | XX | XX |

# EAST BRANCH TRIBUTARY BEAVER RIVER
## STREAM RESTORATION
## NEAR SILVER BAY
## LAKE COUNTY, MN

DRAFT 30% DESIGN - NOT FOR CONSTRUCTION

---

PLAN AND PROFILE - (7)
STA 36+00 TO 42+00


CLIFFS
NORTHSHORE MINING CO
10 OUTER DR
SILVER BAY, MN 55614
---
BEAVER RIVER CONSULTING
BEAVER RIVER CONSULTING, LLC.
5752 EAGLE VIEW DRIVE
DULUTH, MN 55803
---

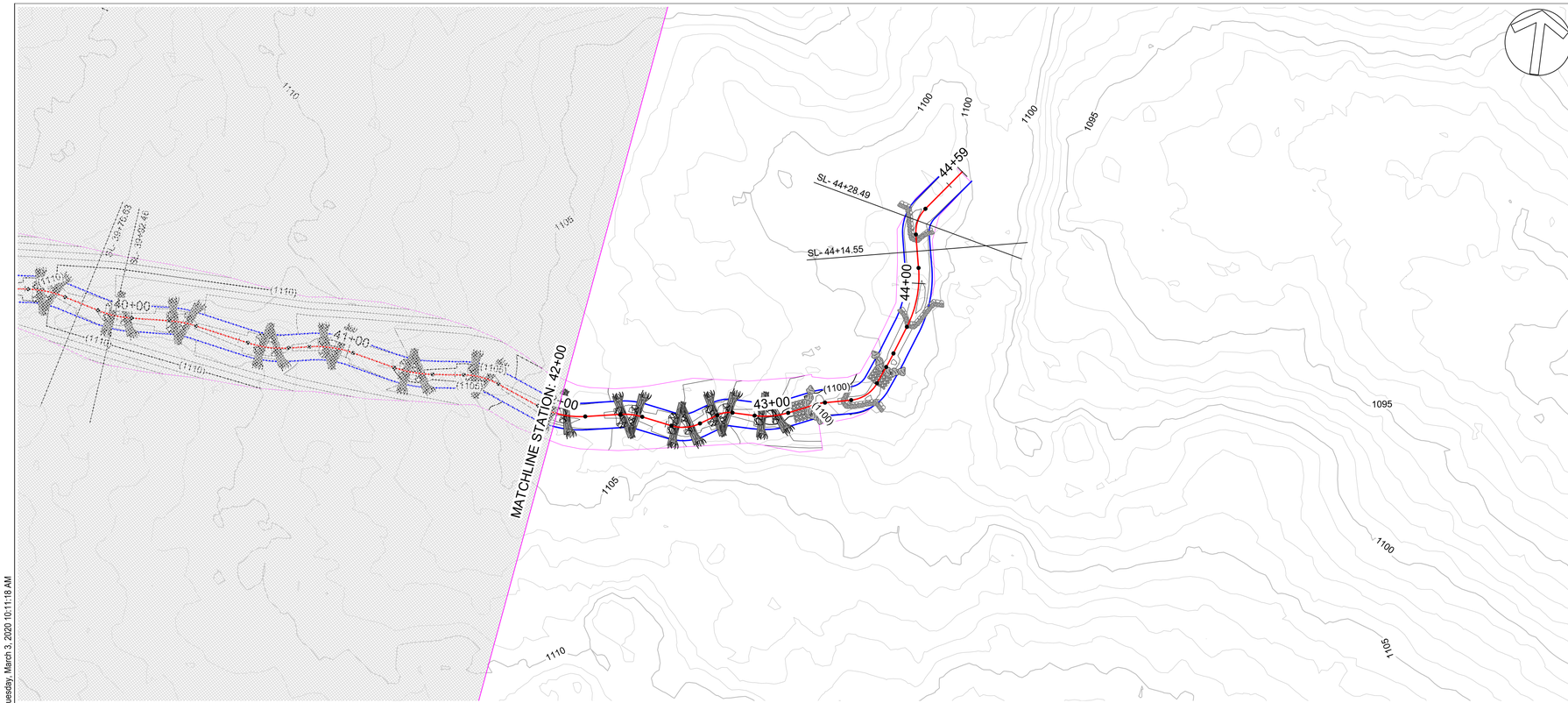

CONCEPT DESIGN
NOT FOR
CONSTRUCTION

DATE: 3/03/2020
SCALE (34"X22"): 1" = 30'
SCALE (17"X11"): 1" = 60'

0 30 60
SCALE IN FEET

SHEET NUMBER
11 OF 18


E:\DROPBOX (SSSR)\NORTHSHOREMINING\C3D\SHEETS\EASTBRANCHTRIB_PP.DWG | GREGTAILLACQ | SAVED: Friday, February 28, 2020 3:11:33 PM | ACAD.CTB | | PLOTTED: Tuesday, March 3, 2020 10:11:00 AM

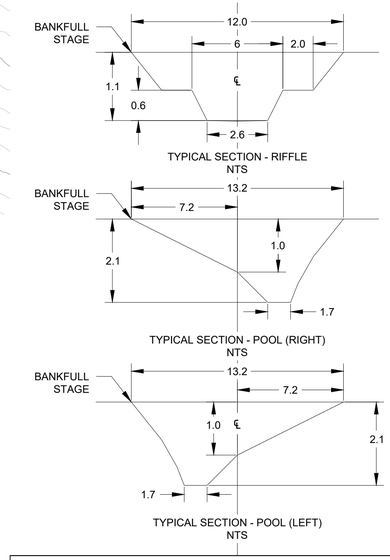


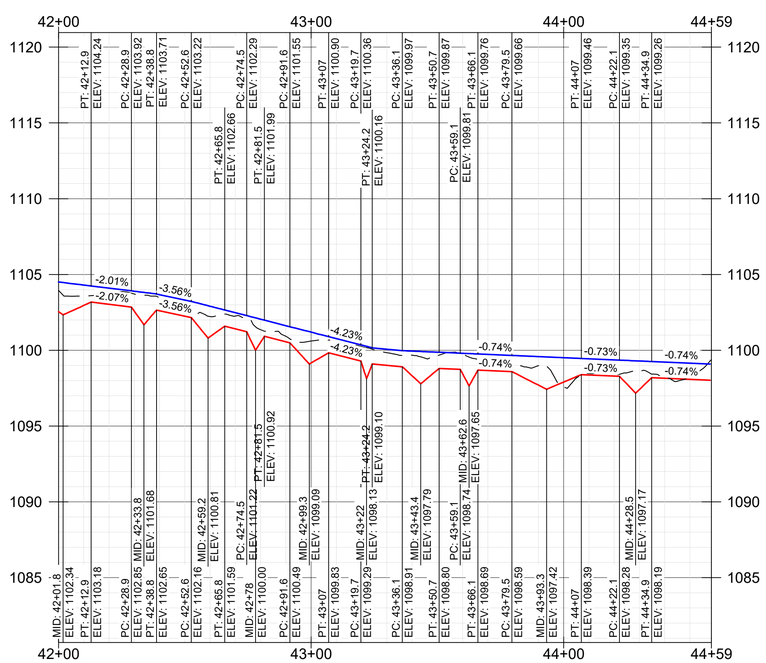

## PLAN LEGEND

- PROPOSED STREAM CENTER LINE
- PROPOSED INNER BERM
- PROPOSED GEOMORPHIC CHANNEL TOB
- PROPOSED FLOODPLAIN TOE
- LIMITS OF DISTURBANCE
- (483) PROPOSED MAJOR CONTOUR
- PROPOSED MINOR CONTOUR
- 479 EXISTING MAJOR CONTOUR
- EXISTING MINOR CONTOUR
- LOG J-HOOK
- CONSTRUCTED LOG RIFFLE
- TOE WOOD
- BOULDER J-HOOK
- BOULDER DROP
- LOG DROP

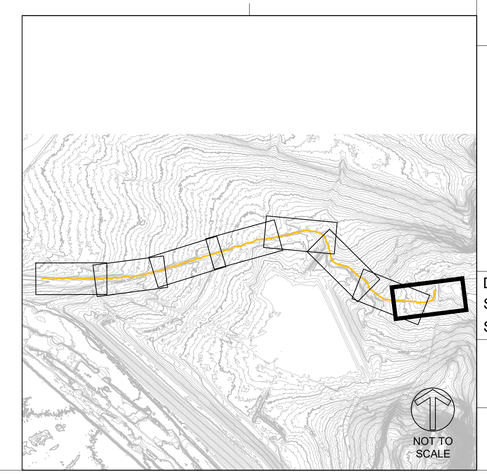
## PROFILE LEGEND

- PROPOSED STREAM CENTER LINE
- PROPOSED BANKFULL TOB
- EXISTING GROUND




SCALE: HOR 1" =1'; VERT 1"= 0'




| APPROVED BY: KA | CHECKED BY: MJG | DRAWN BY: GET |
|---|---|---|
| REV | DESCRIPTION | APPRV |
| 1 | DRAFT 30% DESIGN | XX |
| XX | XX | XX |
| XX | XX | XX |
| XX | XX | XX |
| XX | XX | XX |
| XX | XX | XX |
| XX | XX | XX |
| XX | XX | XX |

# EAST BRANCH TRIBUTARY BEAVER RIVER
## STREAM RESTORATION
## NEAR SILVER BAY
## LAKE COUNTY, MN

DRAFT 30% DESIGN - NOT FOR CONSTRUCTION

---

PLAN AND PROFILE - (8)
STA 42+00 TO 44+59


CLIFFS
NORTHSHORE MINING CO
10 OUTER DR
SILVER BAY, MN 55614
---
BEAVER RIVER CONSULTING
BEAVER RIVER CONSULTING, LLC.
5752 EAGLE VIEW DRIVE
DULUTH, MN 55803
---

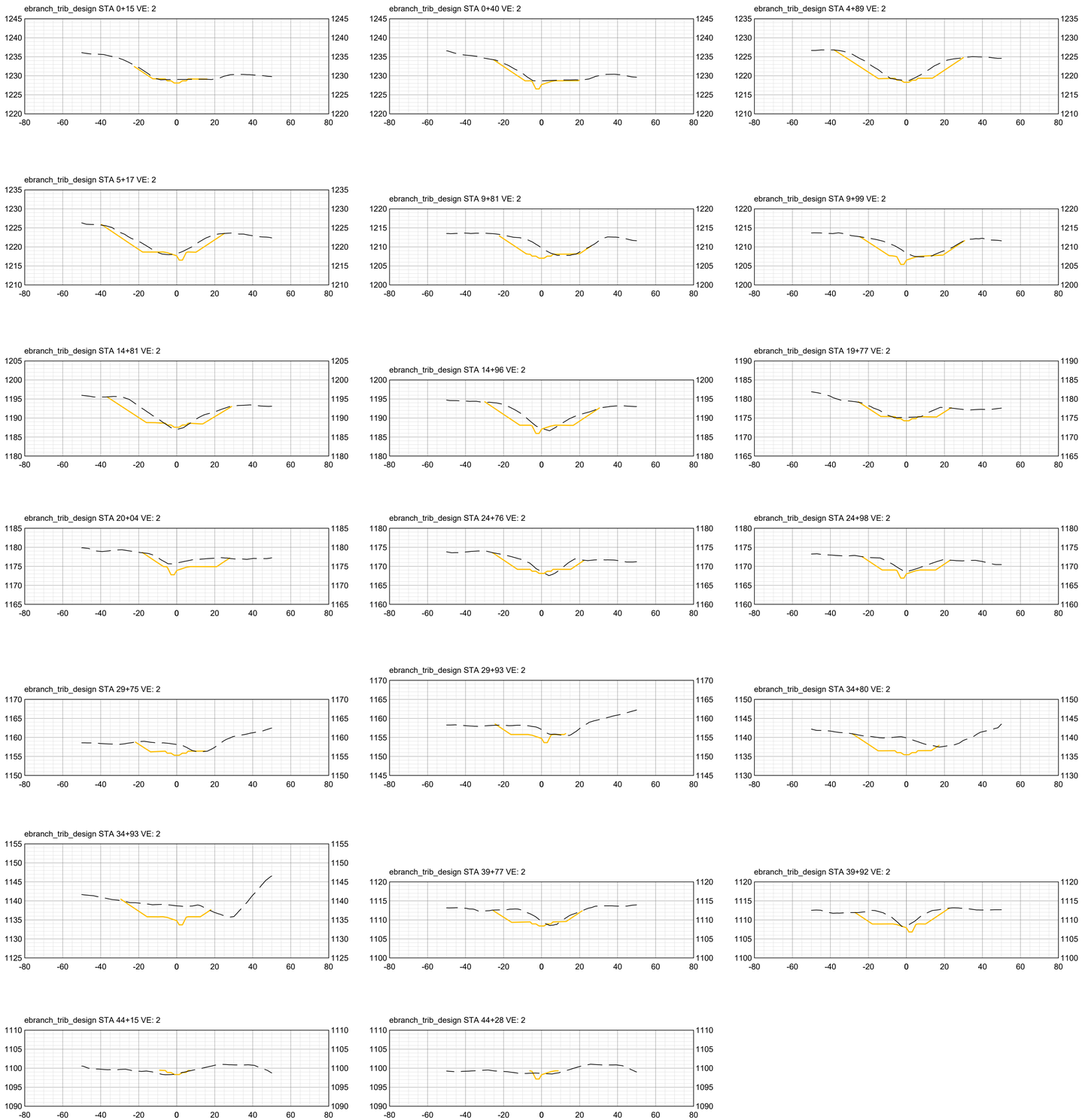

CONCEPT DESIGN
NOT FOR
CONSTRUCTION

DATE: 3/03/2020
SCALE (34"X22"): 1" = 30'
SCALE (17"X11"): 1" = 60'

0 30 60
SCALE IN FEET

SHEET NUMBER
12 OF 18


E:\DROPBOX (SSSR)\NORTHSHOREMINING\C3D\SHEETS\EASTBRANCHTRIB_PP.DWG | GREGTAILLACQ | SAVED: Friday, February 28, 2020 3:11:33 PM | ACAD.CTB | | PLOTTED: Tuesday, March 3, 2020 10:11:18 AM




SECTION LEGEND

DESIGN SURFACE

EXISTING GROUND

| REV | DESCRIPTION | APPROVED BY: KA | CHECKED BY: MJG | DRAWN BY: GET | APPRV |
|---|---|---|---|---|---|
| 1 | DRAFT 30% DESIGN | XX | XX | XX | XX |
| XX | | XX | XX | XX | XX |
| XX | | XX | XX | XX | XX |
| XX | | XX | XX | XX | XX |
| XX | | XX | XX | XX | XX |
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# EAST BRANCH TRIBUTARY BEAVER RIVER
## STREAM RESTORATION
## NEAR SILVER BAY
## LAKE COUNTY, MN

DRAFT 30% DESIGN - NOT FOR CONSTRUCTION

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SECTIONS - (1)

STA 0+15 TO 44+28

CLIFFS

NORTHSHORE MINING CO
10 OUTER DR
SILVER BAY, MN 55614
---

BEAVER RIVER CONSULTING

BEAVER RIVER CONSULTING, LLC.
5752 EAGLE VIEW DRIVE
DULUTH, MN 55803
---

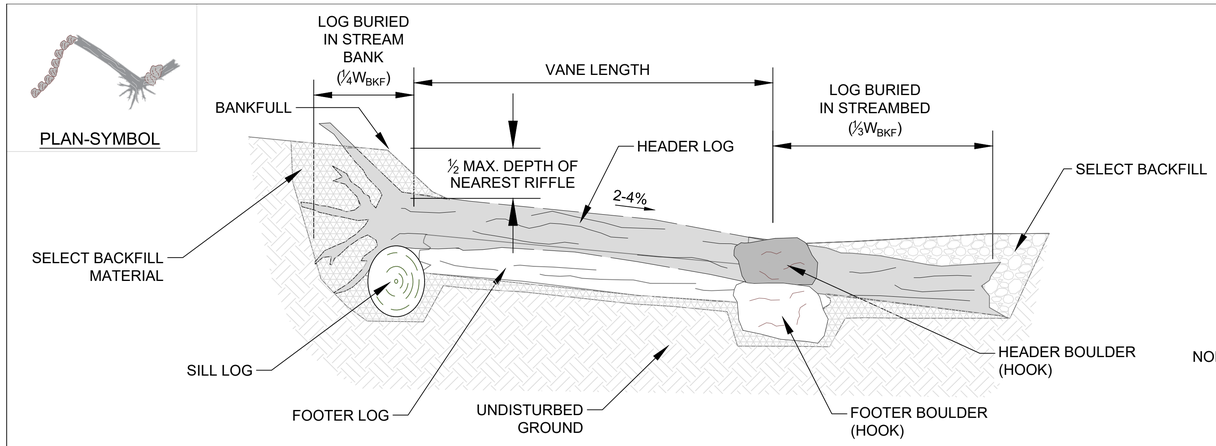
CONCEPT DESIGN
NOT FOR
CONSTRUCTION

DATE: 3/03/2020
SCALE (34"X22"): 1" = 30'
SCALE (17"X11"): 1" = 60'

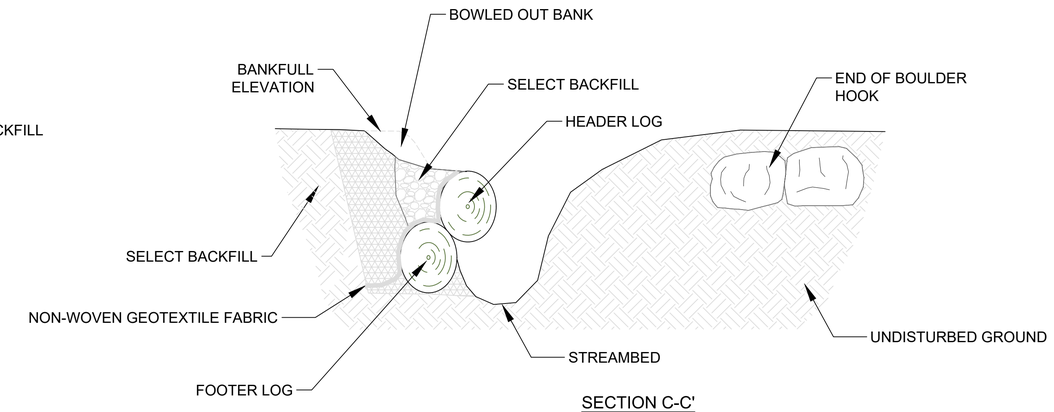
0 30 60
SCALE IN FEET

SHEET NUMBER
13 OF 18

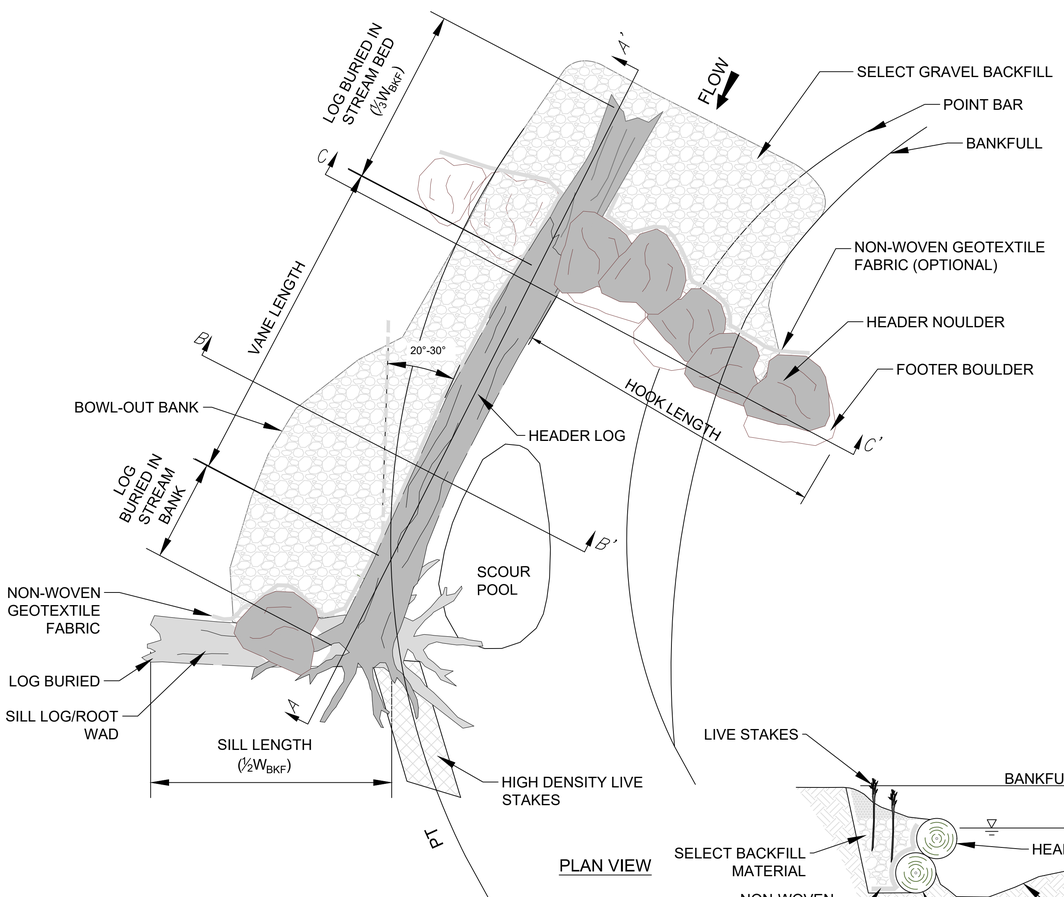
E:\DROPBOX (SSSR)\NORTHSHOREMINING\C3D\SHEETS\EASTBRANCHTRIB_SECTIONS.DWG | GREGTAILLACQ | SAVED: Friday, February 28, 2020 2:59:45 PM | ACAD.CTB | | PLOTTED: Tuesday, March 3, 2020 10:11:34 AM



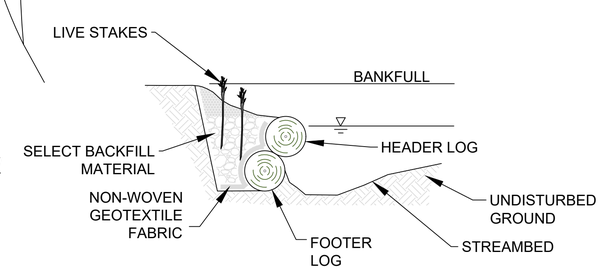

SECTION A-A'




SECTION C-C'




PLAN VIEW




SECTION B-B'

# DETAIL - LOG J-HOOK WITH ROOTWAD

NOT TO SCALE

NOTES:

1. THE LOG J-HOOK WITH ROOT WAD IS USED TO STABILIZE THE OUTSIDE BANK OF A STREAM CHANNEL IN A BEND BY PHYSICALLY PROTECTING THE BANK AND HELPING TURN THE WATER TOWARD THE CENTER OF THE CHANNEL. THE LOG J-HOOK WITH ROOT WAD CAN BE USED TO HELP STABILIZE AN EXISTING CHANNEL OR TO PROTECT THE BANK OF A NEWLY CONSTRUCTED CHANNEL.

2. THE STRUCTURE IS COMPRISED OF BOTH LOGS AND BOULDERS. LOGS SHALL HAVE A MINIMUM DIAMETER OF 18". THE LENGTH OF THE LOGS WILL BE DETRMINED BY THE SIZE AND SHAPE OF THE CHANNEL. ALL LOGS SHALL BE RELATIVELY STRAIGHT AND LIMBS SHALL BE TRIMMED FLUSH. THE SIZE OF THE BOULDERS VARIES WITH THE SIZE OF THE CHANNEL.

3. HEADER LOGS/BOULDERS SHALL BE UNDERLAIN BY FOOTER LOGS/BOULDERS UNLESS OTHERWISE DIRECTED BY THE ENGINEER. FOOTER LOGS PROVIDE SCOUR PROTECTION FOR HEADER LOGS. FOOTER BOULDERS PROVIDE SCOUR PROTECTION AND A FOUNDATION FOR THE HEADER BOULDERS.

4. THE SILL LOG WITH ROOT WAD IS GENERALLY INSTALLED FIRST. THE CONTRACTOR SHALL DIG A TRENCH PERPENDICULAR TO THE BANKFULL FLOW DIRECTION AND INSTALL THE SILL LOG. IT MAY BE NECESSARY TO CUT THE SILL LOG ROOTWAD TO PREVENT THE ROOTWAD FROM PROTRUDING ABOVE THE BANKFULL ELEVATION. A BOULDER OR HEADER SILL LOG SHALL BE PLACED ON THE SILL LOG TO EFFECTIVELY EXTEND THE SILL FURTHER INTO THE BANK.

5. THE HEADER LOG OF THE VANE ARM IS GENERALLY INSTALLED NEXT. THE CONTRACTOR SHALL DIG A TRENCH TO FACILIATE THE INSTALLATION OF THE VANE ARM. THE HEADER LOG SHALL TIE INTO THE STREAM BANK AT A MINIMUM ELEVATION OF 1/4 DMAX (MEASURED AT THE NEXT DOWNSTREAM RIFFLE) BELOW BANKFULL ELEVATION AND A MINIMUM ELEVATION OF 1/2 DMAX (MEASURED AT THE NEXT DOWNSTREAM RIFFLE) BELOW BANKFULL ELEVATION UNLESS OTHERWISE DIRECTED BY THE ENGINEER. THE HEADER LOG SHALL EXTEND FROM THE SILL LOG TO BEYOND THE HOOK PORTION OF THE STRUCTURE, GENERALLY AT A SLOPE OF 2 - 4%. THE VANE ARM FOOTER LOG SHALL BE CUT TO FIT BETWEEN SILL LOG AND THE BOULDER HOOK PORTION OF THE STRUCTURE. THE FOOTER LOG OF THE VANE ARM SHALL BE INSTALLED FROM UPSTREAM SIDE AND INSTALLED AGAINST THE LOWER HALF OF THE HEADER LOG RESULTING IN A STAGGER WITH THE HEADER LOG BEING SLIGHTLY MORE DOWNSTREAM THAN THE FOOTER LOG. ANY GAPS BETWEEN THE HEADER AND FOOTER LOGS WIDER THAN 1" SHALL BE CHINKED WITH BRANCHES AND/OR BRUSH FROM THE UPSTREAM SIDE. WHEN COMPLETE THE FOOTER LOG WILL NOT BE VISIBLE BUT THE HEADER LOG WILL BE VISIBLE DURING LOW FLOWS.

6. THE HOOK PORTION OF THE STRUCTURE CONSISTS OF BOULDERS. THE CONTRACTOR SHALL EXCAVATE A TRENCH TO FACILIATE THE INSTALLATION OF A ROW OF FOOTER BOULDERS THAT EXTEND FROM THE END OF THE FOOTER LOG OF THE VANE ARM ACROSS THE CHANNEL TO BEYOND BANKFULL ON THE OTHER SIDE OF THE CHANNEL CREATING A BURIED SILL. THE CONTRACTOR SHALL INSTALL HEADER BOULDERS ON TOP OF THE FOOTER BOULDERS. ALL BOULDERS SHALL BE FIT TIGHLTY TOGETHER AND ANY GAPS WIDER THAN 1" SHALL BE CHINKED WITH GRAVEL AND COBBLE FROM THE UPSTREAM SIDE WITH ROCKS. WHEN COMPLETE THE FOOTER BOULDERS WILL NOT BE VISIBLE BUT THE HEADER BOULDERS WILL BE VISIBLE DURING LOW FLOWS.

7. THE LOCATION AND ELEVATION OF THE SILL, VANE ARM AND THE BOULDER HOOK STRUCTURE MAY NOT VARY FROM THOSE SPECIFIED IN THE PLANSHEETS UNLESS DIRECTED OTHERWISE BY THE ENGINEER. THE FOOTER DEPTH ON ALL STRUCTURES REQUIRING FOOTERS SHALL BE 6 TIMES GREATER THAN THE DROP BETWEEN THE STRUCTURE AND THE FOOTERED STRUCTURE DIRECTLY DOWNSTREAM.

8. ON THE UPSTREAM SIDE OF THE LOGS AND BOULDERS NON-WOVEN GEOTEXTILE FABRIC SHALL BE PLACED AS SHOWN IN THE DETAIL PLANVIEW DRAWING. THE GEOTEXTILE FABRIC SHALL BE NAILED TO UPSTREAM SIDE OF THE HEADER LOGS USING 3" 10D GALVANZED COMMON NAILS ON 12" SPACING. THE GEOTEXTILE FABRIC SHALL BE CAREFULLY PLACED AGAINST THE UPSTREAM SIDE OF THE BOULDERS AND HELD IN PLACE BY BACKFILL MATERIAL.

9. THE EXCAVATED AREAS UPSTREAM OF THE SILL, VANE ARM AND BOULDER HOOK SHOULD BE FILLED WITH SELECT BACKFILL MATERIAL AS SPECIFIED AND APPROVED BY THE ENGINEER. THE SELECT BACKFILL AND SOIL BACKFILL MATERIAL SHALL BE OVER COMPACTED USING EQUIPMENT SO THAT FUTURE SETTLEMENT IS KEPT TO A MINIMUM. THE STEAMBANK SHOULD BE BOWLED OUT BEHIND THE VANE ARM AT THE DOWNSTREAM END OF THE VANE ARM.

10. THE SURFACE OF THIS STRUCTURE SHALL BE FINISHED TO A SMOOTH AND COMPACT SURFACE IN ACCORDANCE WITH THE LINES, GRADES, AND CROSS-SECTIONS OR ELEVATIONS SHOWN ON THE DRAWINGS . THE DEGREE OF FINISH FOR ELEVATIONS SHALL BE WITHIN 0.1' OF THE GRADES AND ELEVATIONS INDICATED. DRESSING OF THE CHANNEL, BANKFULL BENCH AND FLOODPLAIN WILL LIKELY BE REQUIRED FOLLOWING INSTALLATION OF THIS STRUCTURE AND SHALL BE CONSIDERED INCIDENTAL TO CONSTRUCTION.

11. DETAILS REGARDING PLANTING REQUIREMENTS. NO LIVE STAKES SHALL BE INSTALLED ON THE UPSTREAM SIDE OF THE LOG VANE AT OR BELOW THE TIE-IN ELEVATION OF THE HEADER LOG WITH THE STREAMBANK UNLESS OTHERWISE DIRECTED BY THE ENGINEER. INSTALL LIVE STAKES PER THE PLAN VIEW DRAWING AND THE LIVE STAKE DETAIL. LIVE STAKES SHOULD BE INSTALLED BEHIND THE VANE ARM ABOVE THE BANKFULL ELEVATION ON 12" CENTERS. LIVE STAKES SHOULD BE INSTALLED DOWNSTREAM OF THE ROOT WAD ALONG THE TOP OF BANK AT A HIGHER DENSITY (I.E. 10" CENTERS).

| APPROVED BY: KA | CHECKED BY: MJG | DRAWN BY: GET | |
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| 1 | DRAFT 30% DESIGN | | XX |
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EAST BRANCH TRIBUTARY BEAVER RIVER
STREAM RESTORATION
NEAR SILVER BAY
LAKE COUNTY, MN

DRAFT 30% DESIGN - NOT FOR CONSTRUCTION

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DETAIL - LOG J-HOOK

CLIFFS
NORTHSHORE MINING CO
10 OUTER DR
SILVER BAY, MN 55614

BEAVER RIVER CONSULTING
BEAVER RIVER CONSULTING, LLC.
5752 EAGLE VIEW DRIVE
DULUTH, MN 55803

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NTS

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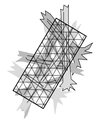
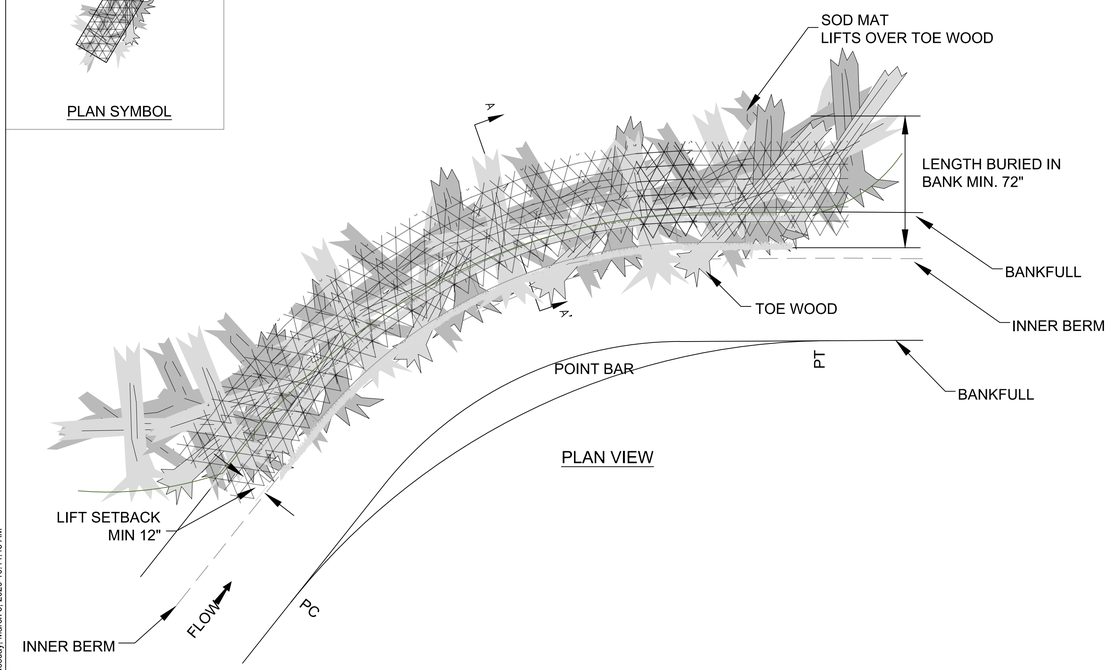
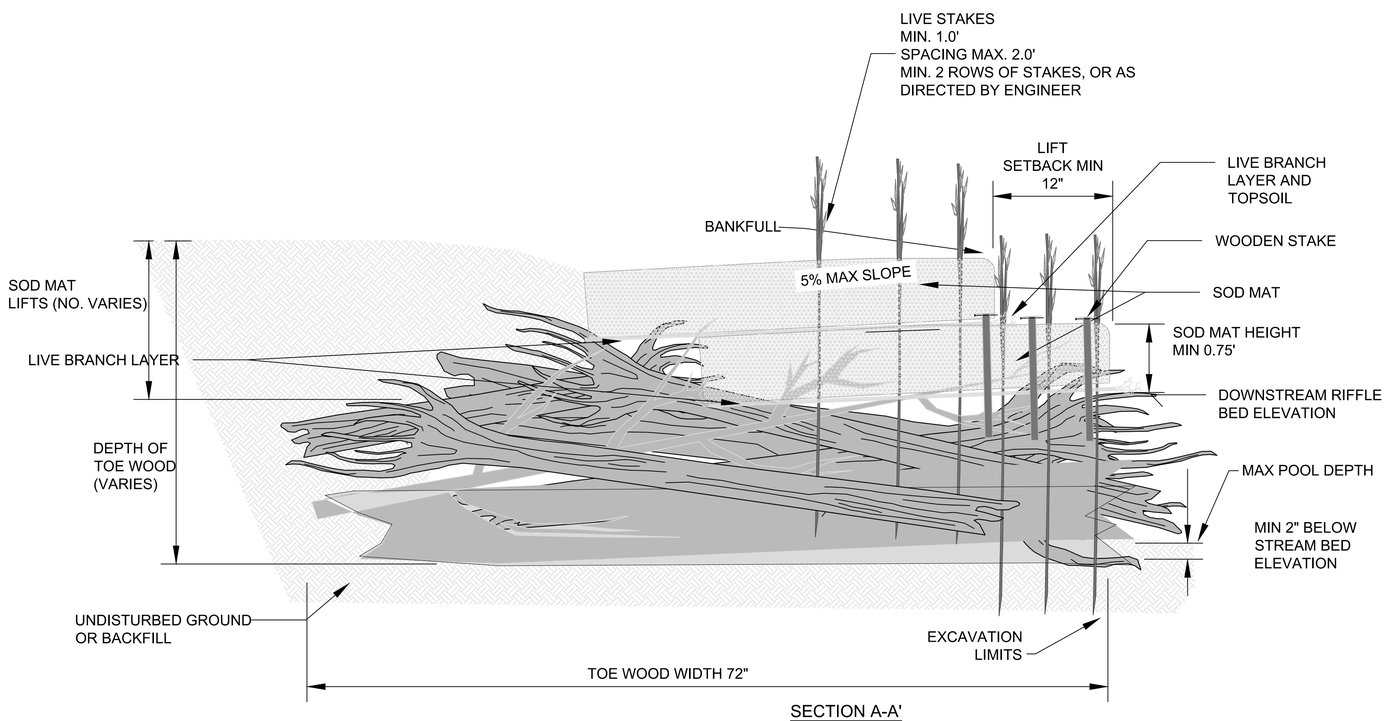


PLAN SYMBOL




PLAN VIEW




SECTION A-A'

DETAIL - TOE WOOD WITH SOD MAT

NOT TO SCALE

TOE WOOD WITH SOD MAT
CONSTRUCTED NOVEMBER 2018

NOTES:

1. THIS STRUCTURE PROVIDES PROTECTION TO THE BANKS OF NEWLY CONSTRUCTED STREAM CHANNELS. WOODY DEBRIS OF ALL SIZES CAN BE USED IN THE CONSTRUCTION OF THIS STRUCTURE. THE STABILITY OF THE LOWER PORTION OF THE STREAMBANK IS CRITICAL TO THE SUCCESS OF THE PROJECT. THE INSTALLATION OF ALTERNATE BANK PROTECTION STRUCTURES (E.G., HAY/STRAW BALES) WILL ONLY BE CONSIDERED IF WOOD IS NOT AVAILABLE ONSITE.

2. COARSE/LARGE WOODY DEBRIS CONSISTS OF LOGS, ROOTWADS, AND LARGE BRANCHES WHICH ARE NOT SUITABLE FOR CONSTRUCTION OF LOG STRUCTURES. ALL MATERIALS ARE TO BE APPROVED BY THE ENGINEER.

3. A TRENCH SHALL BE EXCAVATED ALONG THE OUTER BANK OF THE POOL. THE BOTTOM ELEVATION OF THE TRENCH SHALL BE AT OR BELOW MAX. POOL DEPTH.

4. COARSE/LARGE WOODY DEBRIS SHALL BE INSTALLED IN THE TRENCH WITH THE LARGEST MATERIAL PLACED FIRST. THE LOGS OR WOOD MATERIAL SHALL BE PLACED PERPENDICULAR TO THE FLOW OF WATER. LOGS SHALL BE PLACED IN A CROSSING PATTERN OR WEAVE SUCH THAT EACH LOG/BRANCH IS ANCHORED BY ANOTHER LOG/BRANCH. THE COARSE/LARGE WOODY DEBRIS SHALL BE INSTALLED TO A HEIGHT OF 3/4 OF THE FINISHED HEIGHT OF THE WOODY DEBRIS WITH THE FINE/SMALL WOODY DEBRIS MAKING UP THE REMAINING 1/4 OF THE TOTAL HEIGHT.

5. FINE/SMALL WOODY DEBRIS CONSISTS OF MEDIUM TO SMALL LIMBS, BRANCHES, BUSHES, AND/OR SMALL LOGS. INVASIVE SPECIES SHALL NOT BE USED. ALL MATERIALS ARE TO BE APPROVED BY THE ENGINEER.

6. FINE/SMALL WOODY DEBRIS SHALL BE PLACED ON TOP OF THE COARSE/LARGE WOODY DEBRIS WITH THE LARGEST MATERIAL BEING PLACED FIRST AND THE SMALLEST MATERIAL PLACED LAST. THE FINE WOODY DEBRIS SHALL BE INSTALLED TO AN ELEVATION EQUAL TO THE INVERT OF THE DOWNTREAM RIFFLE.

7. ALL WOODY DEBRIS SHALL BE COMPACTED WITH THE EXCAVATOR BUCKET IN ORDER TO REDUCE THE PRESENCE OF VOIDS IN THE SMALL/FINE WOODY DEBRIS LAYER AND TO KEEP FUTURE SETTLING TO A MIN.

8. SELECT BACKFILL/TOPSOIL SHALL BE INSTALLED ON TOP OF WOODY DEBRIS TO CREATE A LEVEL SUBSTRATE FOR THE SOD MATS.

9. A THIN LAYER OF LIVE BRANCHES (3-5' IN LENGTH) AND TOPSOIL SHALL BE PLACED ON TOP OF THE BALES. THE LIVE BRANCHES SHALL BE OF THE SPECIES SPECIFIED FOR LIVE STAKES OR APPROVED BY THE ENGINEER AND SHALL EXCLUDE INVASIVE SPECIES.

10. NATIVE SOD MATS SHALL BE HARVESTED ONSITE. THEY SHALL BE WEED FREE AND APPROXIMATELY 3' X 3' WITH A MINIMUM OF 8" OF INTACT SOIL AND ROOTMASS ATTACHED. THE SOD MATS ARE TO BE INSTALLED ON TOP OF THE LIVE BRANCH LAYER.

11. REPEAT NUMBERS 9 AND 10 UNTIL THE FINISHED ELEVATION EQUALS THE ELEVATION OF BANKFULL.

12. THE TOP OF THE SOD MAT SHALL BE FLAT WITHIN THE LIFT SETBACK DISTANCE SPECIFIED IN THE STRUCTURE TABLE. BEYOND THE LIFT SETBACK DISTANCE, THE SOIL BACKFILL SHALL BE SLOPED AT AN APPROXIMATE 5% SLOPE AWAY FROM THE STREAM.

13. THE SURFACE OF THIS STRUCTURE SHALL BE FINISHED TO A SMOOTH AND COMPACT SURFACE IN ACCORDANCE WITH THE LINES, GRADES, AND CROSS-SECTIONS OR ELEVATIONS SHOWN ON THE DRAWINGS. THE DEGREE OF FINISH FOR ELEVATIONS SHALL BE WITHIN +/- 0.1' OF THE GRADES AND ELEVATIONS INDICATED ON THE PLANS OR APPROVED BY THE ENGINEER.

14. DRESSING OF CHANNEL AND BANKFULL BENCH/FLOODPLAIN WILL LIKELY BE REQUIRED FOLLOWING INSTALLATION OF BANK STRUCTURES AND SHALL BE CONSIDERED INCIDENTAL TO CONSTRUCTION.

15. LIVE STAKES SHALL BE OF SPECIES APPROVED BY THE ENGINEER. LIVE STAKES SHALL BE 2-3' LONG AND A MIN. OF 1" IN DIAMETER AND INSTALLED WITH 2/3 OF THE LENGTH BELOW GROUND WITH A MINIMUM OF 2 BUD SCARS BELOW THE GROUND AND 2 ABOVE GROUND. SEE LIVE STAKE DETAIL.

16. LIVE STAKES SHALL BE PLACED ON THE SLOPE FROM THE INNER BERM TO HALF BANK FULL HEIGHT.

17. WOODEN STAKES SHALL BE 1 X 2" AND A MIN.. OF 18" LONG. WOODEN STAKES SHALL BE INSTALLED FROM THE INNER BERM TO BANKFULL ON 18-24" CENTERS PER THE ENGINEER'S INSTRUCTIONS.

APPROVED BY: KA | CHECKED BY: MJG | DRAWN BY: GET

| REV | DESCRIPTION | APPRV |
|---|---|---|
| 1 | DRAFT 30% DESIGN | XX |
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EAST BRANCH TRIBUTARY BEAVER RIVER
STREAM RESTORATION
NEAR SILVER BAY
LAKE COUNTY, MN

DRAFT 30% DESIGN - NOT FOR CONSTRUCTION
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DETAIL - TOE WOOD WITH SOD MAT


CLIFFS
NORTHSHORE MINING CO
10 OUTER DR
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BEAVER RIVER CONSULTING
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5752 EAGLE VIEW DRIVE
DULUTH, MN 55803
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CONCEPT DESIGN
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NTS

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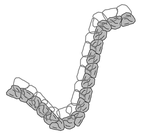

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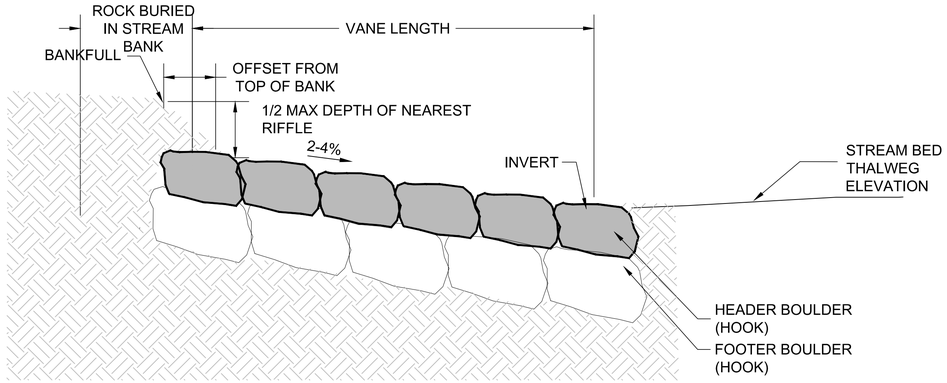

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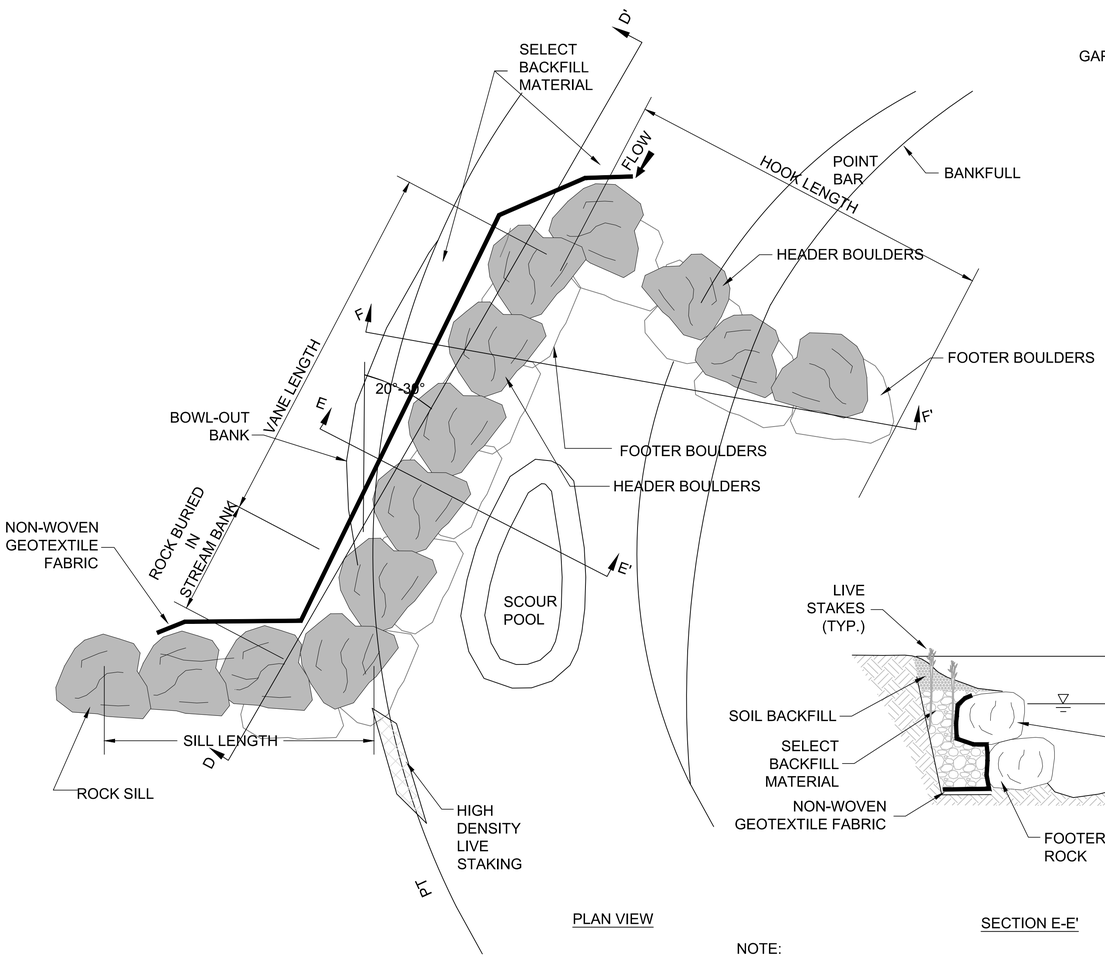


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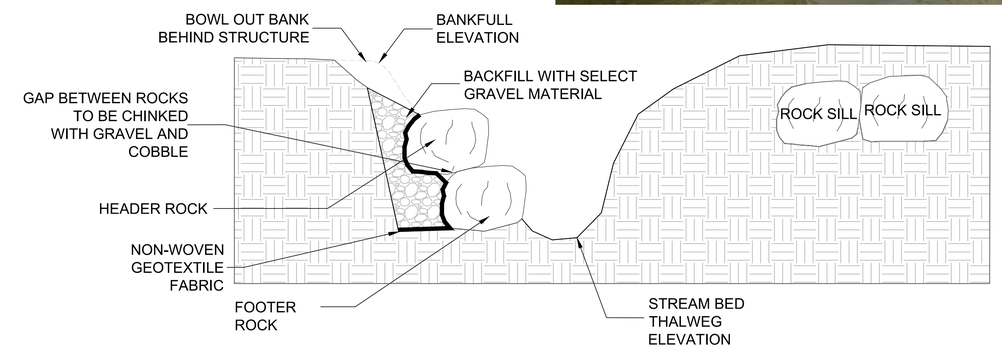
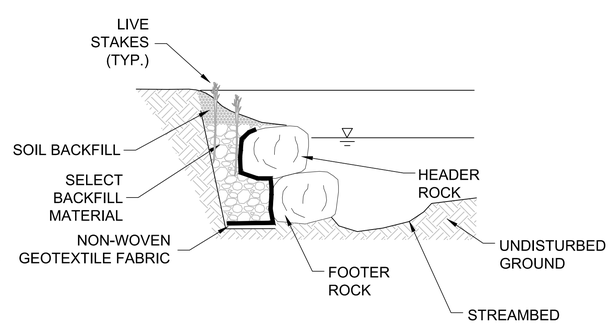



SECTION F-F'




SECTION E-E'

NOTE:

THE DEPARTURE ANGLE SHOWN ABOVE IS DEPICTED IN SUCH A WAY TO EMPHASIZE DETAIL. ACTUAL DEPARTURE ANGLE AND STRUCTURE LOCATION SHALL BE AS SHOWN ON THE PLAN AND PROFILE SHEETS AND WILL BE PROVIDED TO THE CONTRACTOR AS A 2004 FORMAT DWG FILE AND LN3 FILE.

NOTES:

1. BOULDERS FOR THE CONSTRUCTED RIFFLE MUST BE A MINIMUM OF 1-2 TN BOULDER WITH A MIN. DIAMETER OF 2-3FT.
2. FOOTER BOULDERS ARE BOULDERS PLACED TO PROVIDE A FOUNDATION AND SCOUR PROTECTION FOR THE HEADER BOULDERS.
3. HEADER BOULDERS SHALL BE UNDERLAIN BY FOOTER BOULDERS UNLESS OTHERWISE DIRECTED BY THE ENGINEER.
4. HEADER BOULDERS ARE THE TOP MOST BOULDER USED IN EACH STRUCTURE. ALL HEADER BULDERS CAN BE SEEN PARTIALLY PROTRUDING FROM THE WATER SURFACE DURING EXTREMELY LOW FLOWS.
5. HEADER BOULDERS SHALL BE OFFSET SLIGHTLY DOWNSTREAM OF THE FOOTING BOULDERS WHERE SCOUR POOLS ARE ANTICIPATED TO FORM AS SHOWN IN THE DETAIL.
6. SILL BOULDERS SHALL BE PLACED PERPENDICULAR TO THE BANKFULL FLOW DIRECTION.
7. THE FOOTER BOULDERS SHALL EXTEND FROM THE SILL BOULDER TO THE END OF THE HEADER BOULDER TOWARD THE BANK.
8. HOOK BOULDERS SHALL EXTEND FROM THE HEADER BOULDER TO BEYOND BANKFULL WIDTH.
9. SET INVERTS AT ELEVATION SHOWN ON THE PLAN AND PROFILE SHEETS. INVERTS AND ELEVATIONS WILL BE PROVIDED TO THE CONTRACTOR AS A 2004 FORMAT DWG FILE. NO ELEVATIONS OF THE BOULDER DROPS STRUCTURE MAY VARY FROM THE PLAN LOCATIONS WITHOUT DIRECTIONS FROM THE ENGINEER.
10. HEADER BOULDER SHALL TIE INTO THE STREAM BANK AT A MINIMUM ELEVATION OF 1/4 DMAX (MEASURED AT THE NEXT DOWNSTREAM RIFFLE) BELOW BANKFULL ELEVATION AND A MINIMUM ELEVATION OF 1/2 DMAX (MEASURED AT THE NEXT DOWNSTREAM RIFFLE) BELOW BANKFULL ELEVATION UNLESS OTHERWISE DIRECTED BY THE ENGINEER.
11. ALL GAPS/VOIDS LARGER THAN 1 INCH BETWEEN THE HEADER AND FOOTING BOULDERS SHALL BE CHINKED WITH GRAVEL AND COBBLES.
12. ON THE UPSTREAM SIDE OF THE BOULDERS NON-WOVEN GEOTEXTILE FABRIC SHALL BE PLACED AS SHOWN IN THE GEOTEXTILE PLACEMENT AND SELECT BACKFILL DETAIL FOR THE ENTIRE LENGTH OF THE BOULDER HOOK.
13. BACKFILL STRUCTURE WITH SELECT BACKFILL MATERIAL AS SHOWN AND DEFINED IN THE GEOTEXTILE PLACEMENT AND SELECT BACKFILL DETAIL.
14. SELECT BACKFILL AND SOIL BACKFILL MATERIAL SHALL BE COMPACTED SUCH THAT FUTURE SETTLEMENT OF THE MATERIAL IS KEPT TO A MINIMUM.
15. THE SURFACE OF THIS STRUCTURE SHALL BE FINISHED TO A SMOOTH AND COMPACT SURFACE IN ACCORDANCE WITH THE LINES, GRADES, AND CROSS-SECTIONS OR ELEVATIONS SHOWN ON THE DRAWINGS. THE DEGREE OF FINISH FOR INVERT ELEVATIONS SHALL BE WITHIN 0.1 FT OF THE GRADES AND ELEVATIONS INDICATED.
16. RE-DRESSING OF CHANNEL AND BANKFULL BENCH/FLOODPLAIN WILL LIKELY BE REQUIRED FOLLOWING INSTALLATION OF IN-STREAM STRUCTURES AND SHALL BE CONSIDERED INCIDENTAL TO CONSTRUCTION.
17. SEE THE PLANTING TABLE FOR DETAILS ON HIGH DENSITY LIVE STAKING.
18. NO LIVE STAKES SHALL BE INSTALLED ON THE UPSTREAM SIDE OF THE VANE AT OR BELOW THE TIE-IN ELEVATION OF THE HEADER LOG WITH THE STREAM BANK UNLESS OTHERWISE DIRECTED BY THE ENGINEER.
19. FOOTER DEPTH ON ALL STRUCTURES REQUIRING FOOTERS SHALL BE 6 TIMES GREATER THAN THE DROP BETWEEN THE STRUCTURE AND THE FOOTERED STRUCTURE DIRECTLY UPSTREAM.

DETAIL - BOULDER J-HOOK
NOT TO SCALE

APPROVED BY: KA | CHECKED BY: MJG | DRAWN BY: GET

| REV | DESCRIPTION | APPRV |
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| 1 | DRAFT 30% DESIGN | XX |
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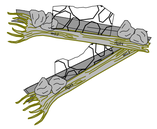

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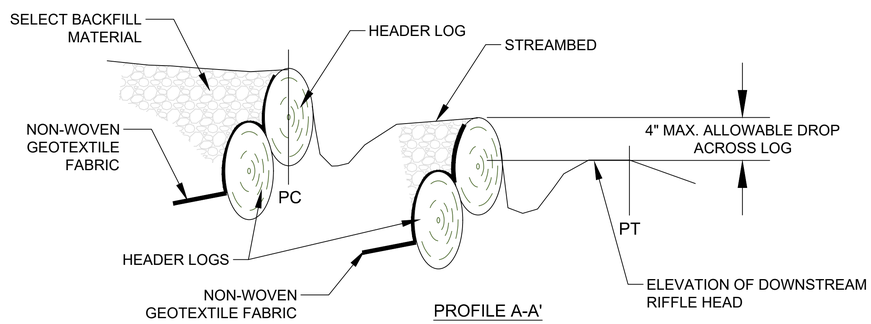
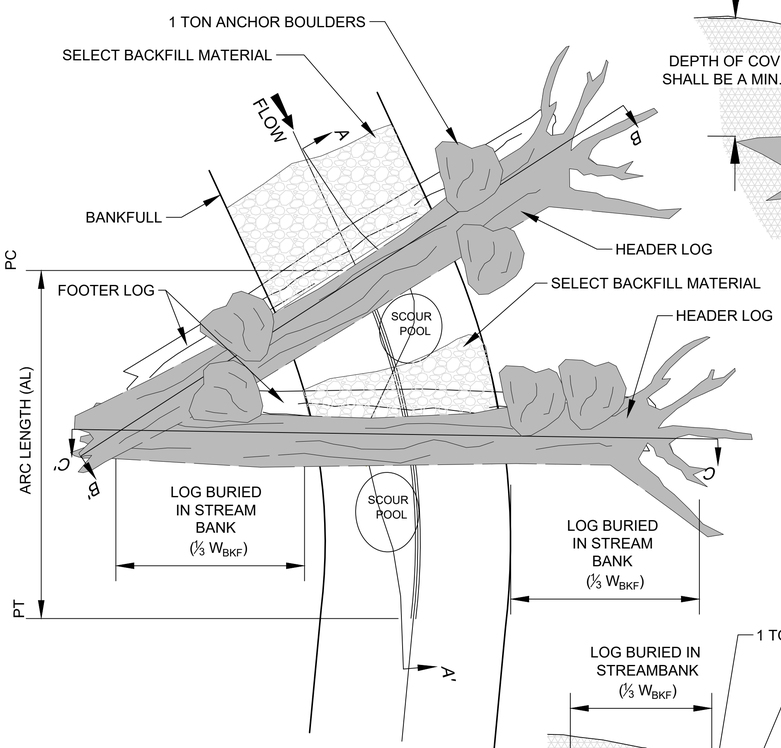
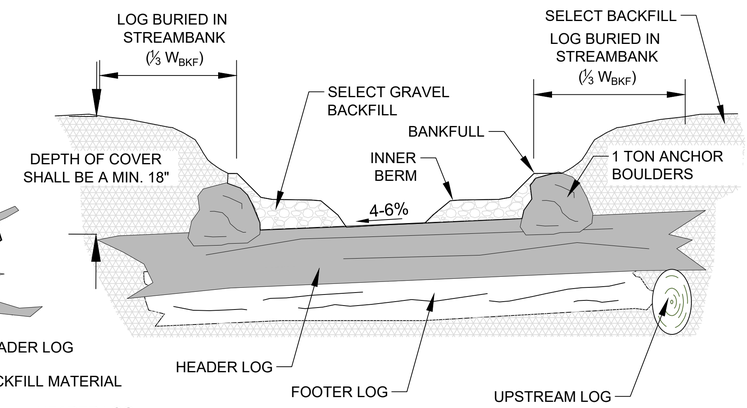


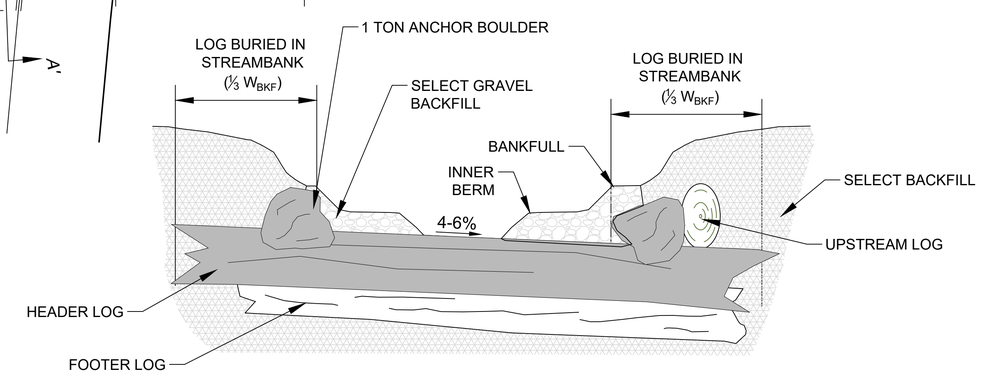

PROFILE A-A'




PLANVIEW




SECTION B-B'




SECTION C-C'

# DETAIL - LOG DROP STRUCTURE
NOT TO SCALE

NOTES:

1. THE LOG DROP STRUCTURE CAN BE USED TO PROVIDE GRADE CONTROL IN A NEWLY CONSTRUCTED CHANNEL. IT CAN ALSO BE INSTALLED IN AN EXISTING DEGRADED CHANNEL TO PREVENT ANY FURTHER DOWNCUTTING. THIS STRUCTURE IS GENERALLY USED ON REACHES WITH A SMALL BUT STEEP DRAINAGE AREA.
2. THE LOG DROP STRUCTURE IS GENERALLY USED ON CHANNELS WITH A BANKFULL WIDTH OF BETWEEN 8 AND 14', WITH SLOPES THAT RANGE FROM 2.5 TO 5.0%.
3. THIS STRUCTURE REQUIRES LOGS THAT ARE SIGNIFICANTLY LONGER THAN THE BANKFULL WIDTH. THE MINIMUM LOG LENGTH FOR THIS STRUCTURE IS 2 TIMES THE BANKFULL WIDTH OF THE CHANNEL BEING CONSTRUCTED. THE LOGS USED IN THIS STRUCTURE SHALL HAVE MINIMUM DIAMETER OF 12" AND BE RELATIVELY STRAIGHT WITH THE LIMBS TRIMMED FLUSH. WHERE POSSIBLE, THE CONTRATOR SHOULD OBTAIN THE LOGS NEEDED FOR THIS STRUCTURE ON-SITE.
4. THIS STRUCTURE CONSISTS OF 2 PAIRS OF LOGS INSTALLED AT AN ANGLE TO ONE ANOTHER IN A "V" PATTERN. EACH PAIR OF LOGS IS STACKED ONE ON TOP OF THE OTHER.
5. THE CONTRACTOR SHALL DIG TRENCHES SUITABLE FOR THE PLACEMENT OF EACH ARM OF THE STRUCTURE SUCH THAT THE INVERT OF THE HEADER LOG WILL BE AT THE SPECIFIED ELEVATION SHOWN ON THE PLANSHEETS. THE ANGLE BETWEEN THE UPSTREAM AND DOWNSTREAM ARMS OF THE STRUCTURE WILL VARY DEPENDING ON THE RADIUS OF CURVATURE OF THE MEANDER AND DROP ACROSS THE STRUCTURE. PLANSHEETS WILL BE PROVIDED TO THE CONTRACTOR AS A 2004 FORMAT DWG FILE AND LN3 FILE. LOCATIONS, ELEVATIONS AND ANGLES MUST MATCH THOSE SPECIFIED IN THE PLANSHEETS UNLESS DIRECTED OTHERWISE BY THE ENGINEER. THE ANGLE BETWEEN THE TWO ARMS OF THE STRUCTURE AS SHOWN IN THE DETAIL PLANVIEW DRAWING SHOULD NOT BE USED TO GUIDE CONSTRUCTION.
6. EACH ARM OF THE STRUCTURE WILL CONSIST OF A HEADER LOG AND A FOOTER LOG STACKED ON TOP OF ONE ANOTHER. THE HEADER LOG SHALL BE UNDERLAIN BY A FOOTER LOG (SOMETIMES CALLED A BACKER LOG). THE HEADER LOG SHALL BE INSTALLED BEFORE THE FOOTER LOG. THE HEADER LOG DOES NOT REST ON THE TOP OF THE FOOTER LOG. THE FOOTER LOG IS INSTALLED FROM THE UPSTREAM SIDE AND INSTALLED AGAINST THE LOWER HALF OF THE HEADER LOG RESULTING IN A STAGGER WITH THE HEADER LOG BEING SLIGHTLY MORE DOWNSTREAM THAN THE FOOTER LOG. THE FOOTER LOG PROVIDES SCOUR PROTECTION FOR THE HEADER LOG. WHEN FINISHED, THE FOOTER SHOULD NOT BE VISIBLE AND THE HEADER LOGS SHOULD BE VISIBLE ONLY BETWEEN THE INNER BERMS.
7. ALL LOGS ARE PLACED SUCH THAT THEY OVERLAP THE NEXT DOWNSTREAM LOG; THEREFORE, IT IS RECOMMENDED THAT THE STRUCTURE BE CONSTRUCTED IN A DOWNSTREAM TO UPSTREAM DIRECTION.
8. IT IS LIKELY THE LOGS WILL REQUIRE NOTCHING WHERE THEY OVERLAP IN ORDER TO NOT EXCEED THE MAXIMUM VERTICAL SLOPE SPECIFICATION. NOTCHING SHALL BE CONSIDERED INCIDENTAL TO CONSTRUCTION. THE NOTCH DEPTH FOR ANY LOG SHALL NOT EXCEED HALF THE DIAMETER OF THE LOG BEING NOTCHED UNLESS OTHERWISE DIRECTED BY THE ENGINEER. NOTCHED LOGS SHALL BE APPROVED BY THE ENGINEER AFTER INSTALLATION AND PRIOR TO BACKFILLING.
9. THE DROP IN ELEVATION ACROSS EACH PAIR OF LOGS (HEADER AND FOOTER) SHALL NOT EXCEED 4" UNLESS DIRECTED OTHERWISE BY THE ENGINEER. THE MAXIMUM DROP ACROSS THE ENTIRE STRUCTURE SHALL NOT EXCEED 8" UNLESS DIRECTED OTHERWISE BY THE ENGINEER.
10. THE VERTICAL SLOPE OF EACH LOG SHALL NOT EXCEED 6% UNLESS OTHERWISE DIRECTED BY THE ENGINEER.
11. ALL GAPS/VOIDS LARGER THAN 1" BETWEEN THE HEADER AND FOOTER LOGS SHALL BE CHINKED WITH LIMBS AND/OR BRUSH FROM THE UPSTREAM SIDE.
12. AFTER THE CHINKING HAS BEEN COMPLETED, THE CONTRATOR SHALL INSTALL A LAYER OF NON-WOVEN GEOTEXTILE FABRIC SHALL BE INSTALLED ON THE UPSTREAM SIDE OF EACH PAIR OF LOGS PLACED AS SHOWN IN THE DETAIL PROFILE DRAWING ALONG THE ENTIRE LENGTH OF THE LOG THE GEOTEXTILE FABRIC SHALLE BE FASTENED TO THE UPSTREAM SIDE OF THE HEADER LOG USING 3" 10D GALVANIZED COMMON NAILS ON 12" SPACING.
13. SIX 1 TON ANCHOR BOULDERS SHALL BE INSTALLED PER THE DETAIL PLANVIEW DRAWING OF THE DTO HELP SECURE THE LOGS.
14. THE CONTRACTOR SHALL BACKFILL WITHIN THE STREAM CHANNEL WITH SELECT GRAVEL BACKFILL AS SPECIFED AND APPROVED BY THE ENGINEER. BEYOND THE CHANNEL, THE CONTRACTOR WILL BACKFILL WITH SELECT BACKFILL MATERIAL AS SPECIFIED AND APPROACHED BY THE ENGINEER. THE DEPTH OF COVER OVER THE LOGS OUTSIDE OF THE CHANNEL SHALL BE A MIN. OF 18". THE BACKFILL MATERIAL SHALL BE COMPACTED USING EQUIPMENT SUCH THAT FUTURE SETTLEMENT OF THE MATERIAL IS MINIMAL.
15. THE SURFACE OF THIS STRUCTURE SHALL BE FINISHED TO A SMOOTH AND COMPACTED SURFACE IN ACCORDANCE WITH THE LINES, GRADES, AND CROSS-SECTIONS OR ELEVATIONS SHOWN ON THE PLANSHEETS. THE FINISHED ELECATIONS SHALL BE WITHIN 0.1' OF THE GRADES AND ELEVATIONS SHOWN ON THE PLANSHEETS.
16. DRESSING OF THE CHANNEL, BANKFULL BENCH AND FLOODPLAIN WILL LIKELY BE REQUIRED FOLLOWING INSTALLATION OF THE STRUCTURE AND SHALL BE CONSIDERED INCIDENTAL TO CONSTRUCTION.

| REV | DESCRIPTION | APPROVED BY: KA | CHECKED BY: MJG | DRAWN BY: GET | APPRV |
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EAST BRANCH TRIBUTARY BEAVER RIVER
STREAM RESTORATION
NEAR SILVER BAY
LAKE COUNTY, MN

DRAFT 30% DESIGN - NOT FOR CONSTRUCTION
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DETAIL - LOG DROP STRUCTURE


CLIFFS
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10 OUTER DR
SILVER BAY, MN 55614
---
BEAVER RIVER CONSULTING
BEAVER RIVER CONSULTING, LLC.
5752 EAGLE VIEW DRIVE
DULUTH, MN 55803
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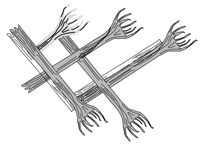
CONCEPT DESIGN
NOT FOR
CONSTRUCTION

DATE: 3/03/2020

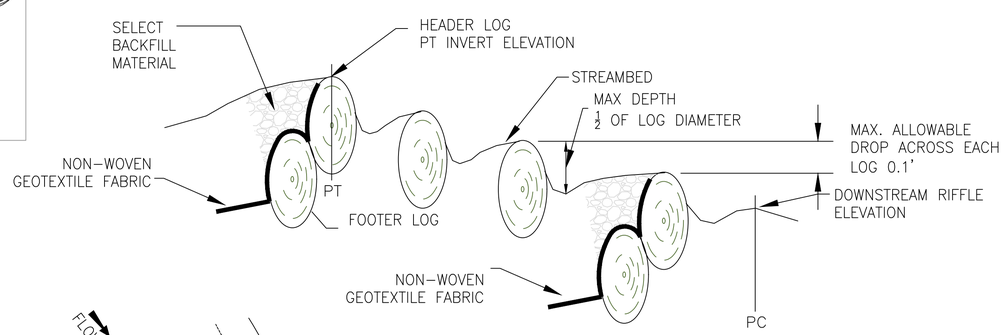
NTS

SHEET NUMBER
17 OF 18

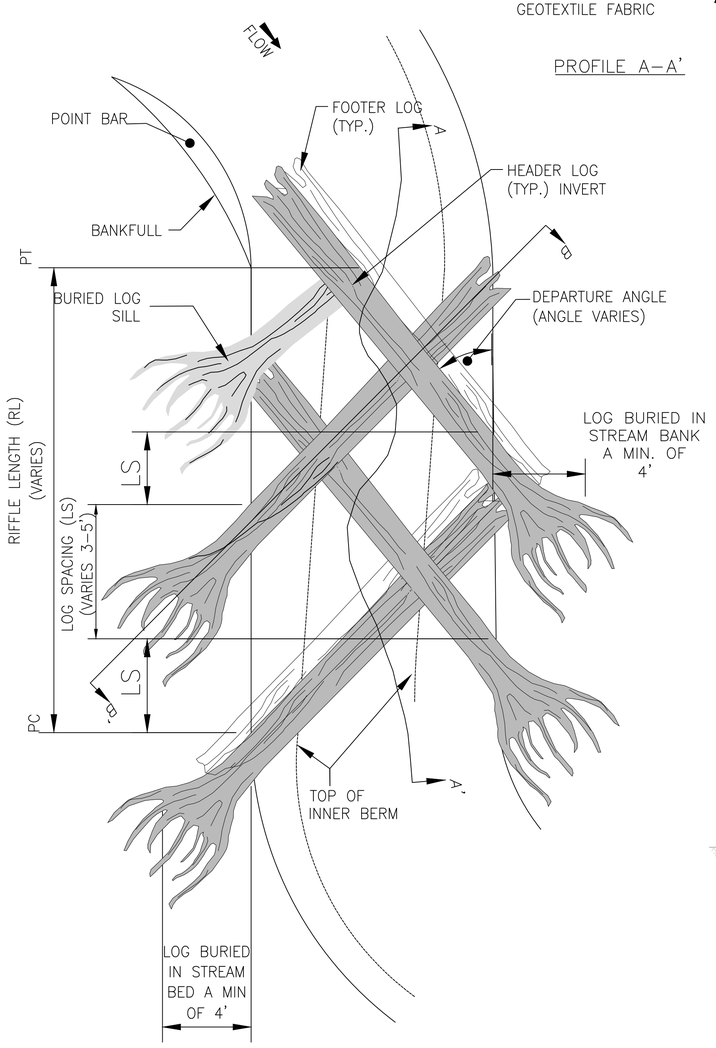

E:\DROPBOX (SSSR)\NORTHSHOREMINING\C3D\SHEETS\EASTBRANCHTRIB_MASTERDETAIL.DWG | GREGTALLACQ | SAVED: Friday, February 28, 2020 3:17:48 PM | ACAD.CTB | | PLOTTED: Tuesday, March 3, 2020 10:11:47 AM



PLAN–SYMBOL

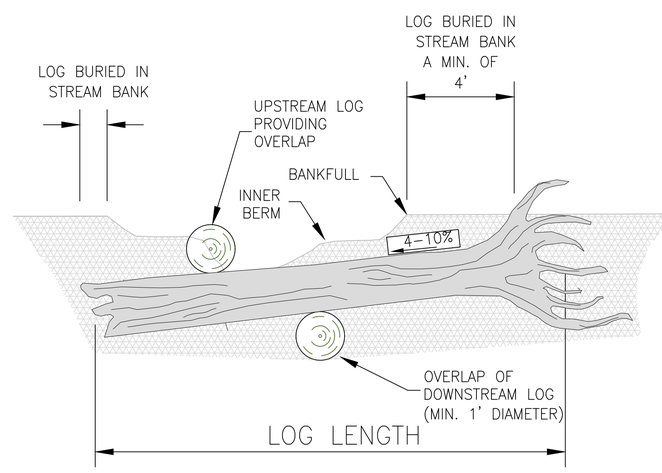



PROFILE A–A'




PLANVIEW

CONSTRUCTED LOG RIFFLE
CONSTRUCTED FEBRUARY 2019




SECTION B–B'

DETAIL – CONSTRUCTED LOG RIFFLE
NOT TO SCALE

NOTES:

1. THIS STRUCTURE HELPS MAINTAIN GRADE WITHIN A NEWLY CONSTRUCTED STREAM CHANNEL. IN GENERAL, IT IS USED IN LOCATIONS WHERE COARSE SUBSTRATE USED TO CONSTRUCT OTHER GRADE CONTROL STRUCTURES (E.G., AUGMENTED RIFFLE) IS NOT AVAILABLE. IF SUITABLE COARSE SUBSTRATE IS DISCOVERED ON SITE, THE CONTRACTOR MAY INSTALL A DIFFERENT GRADE CONTROL STRUCTURE WITH THE ENGINEER'S APPROVAL.

2. THE CONSTRUCTED LOG RIFFLE SHALL BE INSTALLED ON PERENNIAL REACHES THAT ARE REMOTE. BANKFULL WIDTHS OF THESE REACHES WILL BE BETWEEN 8-11', WITH SLOPES THAT RANGE FROM OF 1.5-2.5%. THE CONSTRUCTED LOG RIFFLE STRUCTURES ARE INTENDED FOR REACHES WITH LIMITED ACCESS AND WITH TREES AVAILABLE ONSITE.

3. LOGS SHALL HAVE MIN. DIAMETER OF 12". LOGS SHALL HAVE A MINIMUM LENGTH OF 10-50' DEPENDING ON THE REACH.

4. ALL LOGS SHALL BE RELATIVELY STRAIGHT AND LIMBS SHALL BE TRIMMED FLUSH.

5. THE LOGS AT THE UPSTREAM AND DOWNSTREAM END OF THE STRUCTURE WILL BE UNDERLAIN BY A FOOTER LOG (SOMETIMES CALLED A BACKER LOG) UNLESS OTHERWISE DIRECTED BY ENGINEER. THE HEADER LOG IS THE TOP LOG USED IN EACH PAIR. WHEN FINISHED, THE HEADER LOG IS VISIBLE ONLY BETWEEN THE INNER BERMS. THE HEADER LOG SHALL BE INSTALLED BEFORE THE FOOTER LOG. THE HEADER LOG DOES NOT REST ON THE TOP OF THE FOOTER LOG. THE FOOTER LOG IS INSTALLED FROM THE UPSTREAM SIDE AND INSTALLED AGAINST THE LOWER HALF OF THE HEADER LOG RESULTING IN A STAGGER WITH THE HEADER LOG BEING SLIGHTLY MORE DOWNSTREAM THAN THE FOOTER LOG.

6. THE OTHER LOGS IN THE STRUCTURE ARE SINGLE LOGS WITH NO FOOTER LOG.

7. SET INVERTS AT ELEVATIONS SHOWN ON THE PLAN AND PROFILE SHEETS. PLAN AND PROFILE SHEETS WILL BE PROVIDED TO THE CONTRACTOR AS A DWG FILE AND LN3 FILE. THE ELEVATIONS OF THE LOGS COMPRISING THE LOG CONSTRUCTED RIFFLE SHALL NOT VARY FROM THE PLAN UNLESS OTHERWISE DIRECTED BY THE ENGINEER.

8. THE MOST UPSTREAM LOG SHALL BE PLACED SUCH THAT THE BANK TIE-IN IS ON THE SAME SIDE AS THE NEXT UPSTREAM OUTSIDE BEND IN ORDER TO SERVE AS A VANE AND HELP DIRECT STREAM FLOW AWAY FROM THE PREVIOUS OUTSIDE BEND. LOCATION OF ALL RIFFLE LOG ARMS ARE SHOWN ON THE PLAN AND PROFILE SHEETS AND WILL BE PROVIDED TO THE CONTRACTOR AS A DWG FILE AND LN3 FILE. NO ELEVATIONS OF THE CONSTRUCTED RIFFLE ARMS MAY VARY FROM THE PLAN LOCATIONS WITHOUT DIRECTION FROM ENGINEER.

9. THE MOST DOWNSTREAM LOG SHALL BE PLACED SUCH THAT THE HIGH POINT IS ON THE SAME SIDE AS THE NEXT DOWNSTREAM OUTSIDE BEND IN ORDER TO HELP DIRECT STREAM FLOW AWAY FROM THE NEXT OUTSIDE BEND.

10. ALL LOGS ARE PLACED SUCH THAT THEY OVERLAP THE NEXT DOWNSTREAM LOG. THEREFORE, IT IS RECOMMENDED THAT THIS STRUCTURE BE CONSTRUCTED FROM DOWNSTREAM TO UPSTREAM.

11. THE VERTICAL SLOPE OF EACH LOG SHALL NOT EXCEED 10% WITH THE SPECIFIC VERTICAL SLOPE OF EACH LOG DETERMINED BY THE ENGINEER.

12. IT IS LIKELY THAT THE LOGS WILL REQUIRE NOTCHING WHERE THEY OVERLAP IN ORDER TO NOT EXCEED THE MAXIMUM VERTICAL SLOPE SPECIFICATION. THE CONTRACTOR SHOULD CHOOSE LOGS THAT CAN MEET THE SPECIFICATIONS OF THIS DETAIL

13. THE NOTCH DEPTH FOR ANY LOG SHALL NOT EXCEED HALF THE DIAMETER OF THE LOG UNLESS OTHERWISE DIRECTED BY THE ENGINEER. ANY NOTCHED LOGS SHALL BE APPROVED BY THE ENGINEER BEFORE THE LOGS ARE BACKFILLED.

14. ALL GAPS/VOIDS LARGER THAN 1" BETWEEN THE HEADER AND FOOTER LOGS SHALL BE CHINKED WITH LIMBS AND/OR BRUSH ON THE UPSTREAM SIDE PRIOR TO PLACEMENT OF THE GEOTEXTILE.

15. ON THE UPSTREAM SIDE OF THE LOGS A LAYER OF NON-WOVEN GEOTEXTILE FABRIC SHALL BE PLACED AS SHOWN IN THE DETAIL THE ENTIRE LENGTH OF THE LOG. SECURE THE GEOTEXTILE FABRIC TO THE UPSTREAM SIDE OF THE HEADER LOG USING 3" 10D GALVANIZED COMMON NAIL ON 12" SPACING.

16. SELECT BACKFILL MATERIAL SHALL BE PLACED UPSTREAM OF EACH LOG SUCH THAT FUTURE SETTLEMENT OF THE MATERIAL WILL BE MINIMAL. SELECT BACKFILL MATERIAL SHALL BE HAVE A MINIMUM D50 OF 60 MM. ANY DEVIATIONS IN THE GRADATION MUST BE APPROVED BY THE ENGINEER.

17. THE SURFACE OF THIS STRUCTURE SHALL BE FINISHED TO A SMOOTH AND COMPACT SURFACE IN ACCORDANCE WITH THE LINES, GRADES, AND CROSS-SECTIONS OR ELEVATIONS SHOWN ON THE DRAWINGS. THE DEGREE OF FINISH FOR INVERT ELEVATIONS SHALL BE WITHIN 0.1' OF THE GRADES AND ELEVATIONS INDICATED, PROVIDED ANY HEIGHT DOES NOT EXCEED MAX. ALLOWABLE DROP OF 0.1' OVER ANY ONE LOG AND 0.5' FOR THE ENTIRE STRUCTURE.

18. DRESSING OF CHANNEL AND BANKFULL BENCH/FLOODPLAIN WILL LIKELY BE REQUIRED FOLLOWING INSTALLATION OF IN-STREAM STRUCTURES.

19. THE DEPARTURE ANGLE SHOWN IN THE PLAN VIEW DRAWING IS DEPICTED IN SUCH A WAY TO EMPHASIZE DETAIL. ACTUAL DEPARTURE ANGLE SHALL BE AS SHOWN ON THE PLAN AND PROFILE SHEETS AND WILL BE PROVIDED TO THE CONTRACTOR AS A DWG FILE AND LN3 FILE.

1.

APPROVED BY: KA | CHECKED BY: MJG | DRAWN BY: GET

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EAST BRANCH TRIBUTARY BEAVER RIVER
STREAM RESTORATION
NEAR SILVER BAY
LAKE COUNTY, MN

DRAFT 30% DESIGN - NOT FOR CONSTRUCTION
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DETAIL - LOG CONSTRUCTED RIFFLE


CLIFFS
NORTHSHORE MINING CO
10 OUTER DR
SILVER BAY, MN 55614
---
BEAVER RIVER CONSULTING
BEAVER RIVER CONSULTING, LLC.
5752 EAGLE VIEW DRIVE
DULUTH, MN 55803
---


CONCEPT DESIGN
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DATE: 3/03/2020

NTS

SHEET NUMBER
18 OF 18


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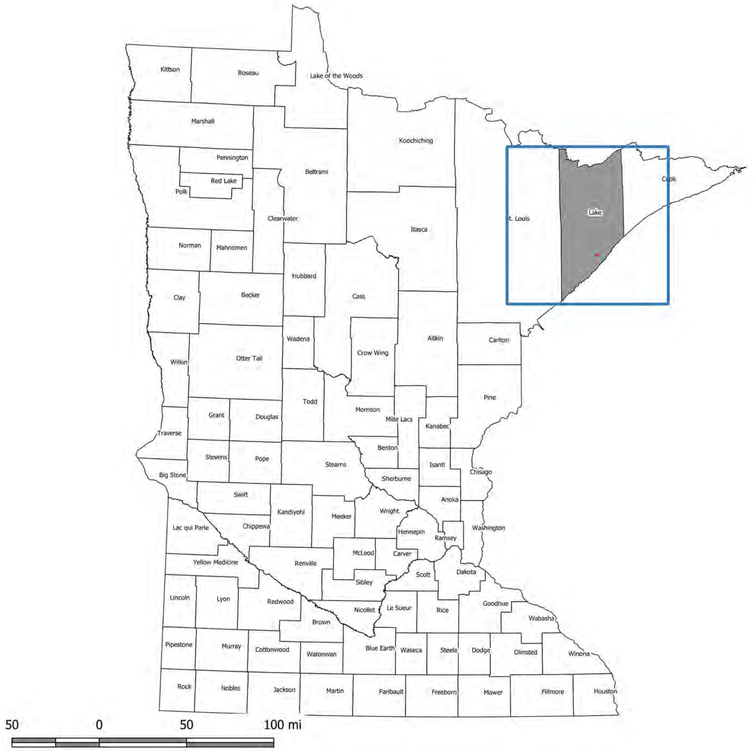
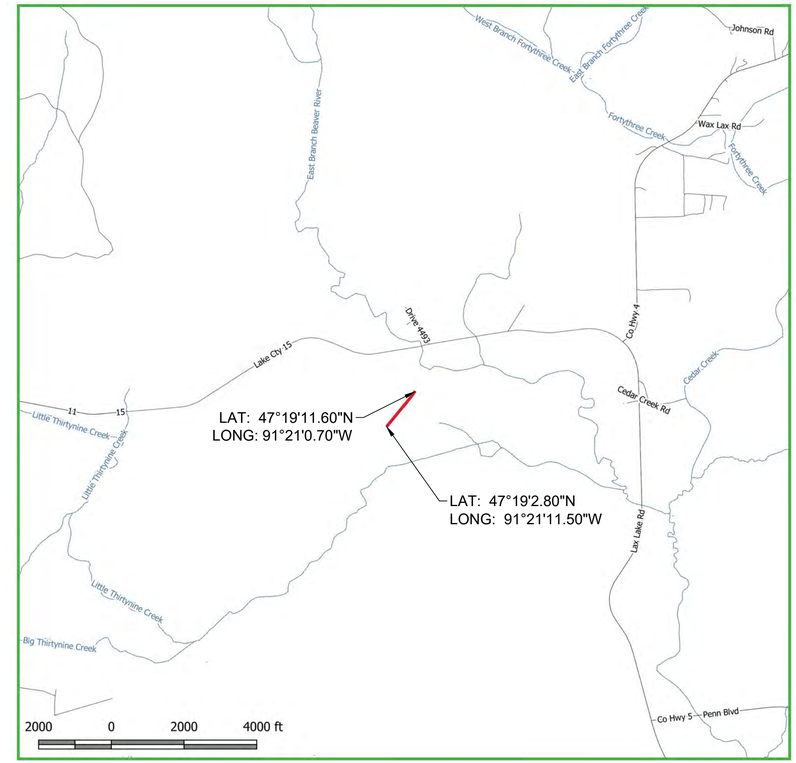
# DRAFT 30% DESIGN - NOT FOR CONSTRUCTION
# BERM STREAM
# BERM REMOVAL AND STREAM RESTORATION

NEAR SILVER BAY
LAKE COUNTY, MN
2/17/2020






| Sheet List Table | | | |
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| SHEET # | SHEET TITLE | DRAWING TITLE | REVISION DATE |
| 1 | COVER | northshoreBermCoverNotes.dwg | Friday, February 28, 2020 12:12:38 PM |
| 2 | NOTES | northshoreBermCoverNotes.dwg | Friday, February 28, 2020 12:12:38 PM |
| 3 | Berm Removal PP - (1) | bermRemove_pp.dwg | Friday, February 28, 2020 12:08:30 PM |
| 4 | Berm Removal PP - (2) | bermRemove_pp.dwg | Friday, February 28, 2020 12:08:30 PM |
| 5 | Berm Removal SECTION - (1) | bermRemoveSections.dwg | Friday, February 28, 2020 10:52:34 AM |

CLIFFS

NORTHSHORE MINING CO
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SILVER BAY, MN 55614

BEAVER RIVER CONSULTING

BEAVER RIVER CONSULTING, LLC.
5752 EAGLE VIEW DRIVE
DULUTH, MN 55803

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NOTES:

GENERAL CONSTRUCTION NOTES:

1. THE WORK ON THIS PROJECT SHALL ADHERE TO THE FOLLOWING SPECIFICATIONS, STANDARDS AND/OR REGULATIONS: MN DOT STANDARD SPECIFICATIONS FOR CONSTRUCTION, 2016 EDITION, THE FOLLOWING SPECIFICATIONS EITHER MODIFY OR REPLACE APPROPRIATE MN DOT SPECIFICATIONS.
2. INSTREAM STRUCTURES SHALL BE INSTALLED AS THE CHANNEL IS BEING CONSTRUCTED AND NOT POST CONSTRUCTION. FILTER FABRIC INSTALLED AS PART OF THE INSTREAM STRUCTURE SHALL BE MIRAFI 170N SERIES NONWOVEN GEOTEXTILE, OR ENGINEER'S APPROVED ALTERNATIVE, UNLESS OTHERWISE SPECIFIED IN STRUCTURE DETAILS OR SPECIFICATIONS.
3. WHERE PRACTICABLE, EXISTING TREES AND VEGETATION SHOULD BE LEFT IN PLACE TO FACILITATE NATURAL REGENERATION AND SOIL STABILIZATION.
4. DEFINITIONS:
   A. BANKFULL ELEVATION IS THE POINT OF INCIPIENT FLOODING IN AN ALLUVIAL CHANNEL. THIS ELEVATION IS THE REFERENCE FOR DEPTHS ON OR ALONG THE CHANNEL PROFILE AND STRUCTURES DESCRIBED IN THESE SHEETS.
   B. THE BANKFULL BENCH IS A CONSTRUCTED FLOODPLAIN ADJACENT TO THE CHANNEL. THE BANKFULL BENCH IS CONSTRUCTED AT THE BANKFULL ELEVATION.
   C. THE THALWEG IS THE LOWEST PORTION OF THE CHANNEL.
   D. THE VANE LENGTH IS THE STRAIGHT LINE DISTANCE BETWEEN THE VANE ARM AND A LINE TANGENT TO THE STREAMBANK AT THE POINT WHERE THE VANE ARM INTERSECTS THE STREAMBANK.
   E. THE VANE ANGLE IS THE ANGLE BETWEEN THE VANE ARM AND A LINE TANGENT TO THE STREAMBANK AT THE POINT WHERE THE VANE ARM INTERSECTS THE STREAMBANK.
   F. SOD MATS ARE GRASS AND WILLOW TRANSPLANTS THAT STILL CONTAIN ROOTING DEPTH. APPROXIMATELY 9-12IN OF DEPTH WILL BE NEEDED WHEN HARVESTING THE SOD MATS.
6. THE CONTRACTOR SHALL STAKE OUT THE PROPOSED STREAM CENTERLINE FOR REVIEW BY THE ENGINEER BEFORE INITIATING EXCAVATION. DEPENDING ON ENCOUNTERED CONDITIONS SOME SHIFTING OF THE STREAM CHANNEL MAY BE NECESSARY. ANY COST ASSOCIATED WITH CHANGING STRUCTURE LOCATIONS OR ALIGNMENT SHALL BE CONSIDERED INCIDENTAL TO CONSTRUCTION. STAKING MAY BE OMITTED FOR PORTIONS OF THE STREAM WHEN SURVEY-GRADE GPS IS USED TO CONSTRUCT THE CHANNEL. IF GPS IS USED IN LIEU OF STAKING THE CHANNEL IN THE FIELD, THE CONTRACTOR ASSUMES ALL RESPONSIBILITY FOR THE STREAM BEING CONSTRUCTED AS DESIGNED, INCLUDING ANY ISSUES RELATED TO PROJECTIONS, BASE POINTS OR CONVERSION OF DIGITAL TERRAIN MODELS.
7. PRIOR TO CLEARING AND GRUBBING, CONTRACTOR SHALL MARK THE LIMITS OF CLEARING NEAR TREES FOR VERIFICATION OF INTENT BY THE ENGINEER. SOME MINOR ADJUSTMENT OF CHANNEL ALIGNMENT MAY BE REQUIRED TO PRESERVE TREES OR MINIMIZE IMPACT TO TREES.
8. ANY HARVESTING OF WILLOWS AND SOD FROM ONSITE MUST BE APPROVED BY THE ENGINEER.
9. CONTRACTOR SHALL MINIMIZE, TO THE MAXIMUM EXTENT POSSIBLE, IMPACTS TO THE ADJACENT TREES. CONSTRUCTION EQUIPMENT TRACKS AND PATHWAYS SHALL BE GRADED AND RECONTOURED AFTER CONSTRUCTION TO PREVENT RILL AND GULLY EROSION.
10. THE PROPOSED GRADING IS SHOWN ON THESE PLAN SHEETS. THE CONTRACTOR MAY EXTEND THE LIMITS OF DISTURBANCE ONLY WITH THE APPROVAL OF THE ENGINEER.
11. CONTRACTOR SHALL USE AN EXCAVATOR WITH A HYDRAULIC THUMB TO INSTALL INSTREAM STRUCTURES.
12. CHANNEL RELOCATION WORK SHALL BE COMPLETED AND STABILIZED PRIOR TO ALLOWING FLOW TO ENTER INTO THE NEWLY CONSTRUCTED STREAM CHANNEL. THE CONTRACTOR SHALL NOT OPEN UP MORE THAN 200 FEET OF CHANNEL WITHOUT EROSION CONTROL BLANKET IN PLACE OR BY APPROVAL OF THE ENGINEER.
13. THE PROPOSED STREAM CHANNEL SHALL BE CONSTRUCTED BY FIRST GRADING THE FLOODPLAIN ADJACENT TO THE CHANNEL TO THE ELEVATION INDICATED ON THESE PLANS. THIS MAY BE DONE AS GENERAL EXCAVATION. THE PROPOSED STREAM CHANNEL SHALL THEN BE EXCAVATED TO THE PROPER DEPTHS INDICATED ON THE PROFILE AND PROPOSED CONTOURS. THIS SHALL BE DONE AS SPECIALIZED EXCAVATION AND IS TYPICALLY ACCOMPLISHED WITH A TRACK EXCAVATOR. THE PROFILES AND CONTOURS SHOWN PROVIDE WIDTHS AND SLOPES FOR AID IN CONSTRUCTING THE CHANNEL TO THE APPROPRIATE DIMENSIONS. THE THALWEG CAN FIRST BE EXCAVATED TO THE POINT INDICATED ON THE PROFILE. EXCAVATION AND FINE GRADING OF THE CROSS SECTIONS SHALL THEN BE PERFORMED AS SHOWN ON THE TYPICAL CROSS SECTIONS AND PROPOSED CONTOURS. ANY STOCKPILING OF MATERIALS OR “DOUBLE HANDLING” NECESSARY TO BUILD THE CHANNEL SHALL BE CONSIDERED INCIDENTAL TO CONSTRUCTION.
14. IF THE EXISTING GROUND IS LESS THAN 0.2 FEET HIGHER THAN THE PROPOSED BANKFULL ELEVATION, IT IS NOT NECESSARY TO EXCAVATE MATERIAL TO THE PROPOSED ELEVATION SHOWN ON THE PROFILE.
15. THE SURFACE OF ALL INSTREAM STRUCTURES SHALL BE FINISHED TO A SMOOTH LINE IN ACCORDANCE WITH THE LINES, GRADES, AND CROSS SECTIONS OR ELEVATIONS SHOWN ON THE DRAWINGS. THE DEGREE OF FINISH FOR THE VANE SLOPES AND INVERT ELEVATIONS SHALL BE WITHIN 0.1 VERTICAL FEET OF THE GRADES AND ELEVATIONS INDICATED. ALL GAPS OR VOIDS BETWEEN THE ROCKS SHALL BE PLUGGED WITH SMALL GRAVEL TO FORM A TIGHT-FITTING SEAL.
16. CONSTRUCTION SPECIFICATIONS FOR BANKFULL CHANNEL DIMENSIONS OR CROSS SECTIONS WILL BE HELD TO THE DIMENSIONS SHOWN ON THE TYPICAL CROSS SECTIONS. ELEVATIONS SHALL BE CONSTRUCTED WITHIN 0.1 VERTICAL FEET; WIDTHS AND MEAN DEPTHS MUST FALL WITHIN THE RANGES SHOWN IN THE DRAWINGS.
17. THE IN-STRUCTURE BID ITEMS SHALL INCLUDE ALL LABOR AND MATERIALS NECESSARY TO CONSTRUCT THE STRUCTURE. BID ITEMS INCLUDE SEEDING, PLANTING, AND MULCH AND EROSION CONTROL BLANKETS AND INCLUDE ALL LABOR AND MATERIALS NECESSARY TO STABILIZE AREAS DISTURBED DURING CONSTRUCTION OF STRUCTURES. AFTER THE STRUCTURE IS COMPLETE AND FLOW IS RESTORED TO THE CHANNEL, SOME ADJUSTMENT TO THE STRUCTURE OR ADDITIONAL STABILIZATION MEASURES MAY BE NECESSARY TO ACHIEVE DESIRED EFFECT. ANY COSTS ASSOCIATED WITH THESE ADJUSTMENTS SHALL BE CONSIDERED INCIDENTAL TO CONSTRUCTION.
18. THE CONSTRUCTED STREAM CHANNEL SHALL BE STABILIZED AS SOON AS POSSIBLE BY SEEDING IN ACCORDANCE WITH THE PLOT SCHEDULE, ADDING STRAW MULCH TO BARE SOIL, AND BY INSTALLING EROSION CONTROL BLANKET FROM THE INNER BERM TO BEYOND THE TOP OF THE BANKFULL CHANNEL. SEE EROSION CONTROL BLANKET DETAIL. PRIOR TO INSTALLING BLANKET, PREPARE THE BED BY LOOSENING THE SOIL 3 TO 6 INCHES, APPLY SEED AND THEN STRAW MULCH. SEED SHALL BE BROADCAST EVENLY OVER THE AREA USING A BROADCAST SPREADER PRIOR TO COVERING WITH THE EROSION CONTROL BLANKET. THE BLANKET SHALL BE ROLLED OUT IN THE DIRECTION OF THE ANTICIPATED RUN-OFF FLOW. INSTALL BLANKET IN ACCORDANCE WITH DETAIL SHOWN HEREIN. REWORKING OF AREAS THAT DO NOT ESTABLISH VEGETATION OR BECOME UNSTABLE SHALL BE NECESSARY IF THE EROSION CONTROL BLANKET SEPARATES FROM THE SOIL. SEE SEEDING AND PLANTING DETAIL FOR BLANKET SPECIFIATIONS. SEEDING OF THE BANKFULL BENCH SHALL BE IN ACCORDANCE WITH THE PLANTING TABLE. REFER TO CONTROL BLANKET DETAIL FOR PLACEMENT OF EROSION CONTROL BLANKET.
19. IF THE TIMING OF PROJECT IS SUCH THAT RIPARIAN SEED MIX CANNOT BE PLACED IN THE FALL, THEN THE CONTRACTOR SHALL SEED WITH TEMPORARY COVER ACCORDING TO THE EROSION AND SEDIMENT PLAN OR APPROVED BY THE ENGINEER UNTIL RIPARIAN MIX CAN BE SEEDED IN THE SPRING.
20. THE HARVESTING AND INSTALLATION OF LIVE STAKES SHALL BE PERFORMED ONLY DURING THE DORMANT SEASON TYPICALLY BETWEEN NOVEMBER 1 AND APRIL 15. CONTRACTOR SHALL NOTIFY ENGINEER 7 DAYS PRIOR TO HARVESTING TO REVIEW AND APPROVE ALL HARVESTING SITES. UPON APPROVAL BY ENGINEER, THE CONTRACTOR SHALL BE RESPONSIBLE FOR HARVESTING AND TRANSPORTING THE LIVE STAKE CUTTINGS TO THE JOB SITE.
21. LIVE STAKES SHALL BE INSTALLED ALONG THE OUTSIDE MEANDER BEND AND ALONG RIFFLES WHERE INDICATED ON THE DRAWINGS AND DETAILS. LIVE STAKES SHALL BE INSTALLED INTO THE EROSION CONTROL BLANKET IN ADDITION TO THE DEAD STAKES.
22. EXCESS SPOIL MATERIAL MAY BE SPREAD AND GRADED ONSITE OR IN THE ONSITE PIT AS APPROVED BY THE ENGINEER. PLACEMENT OF ANY ON-SITE OR OFF-SITE SPOIL MATERIAL SHALL BE CONSIDERED INCIDENTAL TO CONSTRUCTION.
23. TOPSOIL SHALL BE REMOVED FROM EXCAVATION AND SPOIL AREAS PRIOR TO CUT OR FILL AND RE-APPLIED TO AREAS AFTER ROUGH GRADING IS COMPLETE. SIX INCHES OF TOPSOIL SHALL BE PLACED ON DISTURBED AREAS TO MEET GRADE. STOCKPILING AND PLACEMENT OF TOPSOIL SHALL BE CONSIDERED INCIDENTAL TO CONSTRUCTION AND APPROVED BY THE ENGINEER.
24. SPOIL AREAS SHALL BE SEEDED WITH TEMPORARY VEGETATION WITHIN 7 DAYS FOLLOWING GRADING.
25. THE PLACEMENT OF STRAW MULCH SHALL OCCUR A MAXIMUM 48 HOURS AFTER SEEDING. MULCH WILL BE SPREAD TO COVER THE INSTALLED AREAS AT A MINIMUM RATE OF 1.5 TONS PER ACRE. MULCH SHALL BE KEPT OUT OF THE CROWNS OF SHRUBS AND GROUND COVER.
26. IF SOFT SOILS ARE ENCOUNTERED WHEN RECONSTRUCTING STREAM BANKS, RESTORE BANK WITH SOD MAT COVERING ALONG RIFFLES AND WOOD TOE SOD MAT ALONG BENDS.
27. CONTRACTOR SHALL CALL GOPHER STATE ONE CALL FOR UTILITY MARKING AT LEAST 48 HOURS PRIOR TO START OF CONSTRUCTION. THE LOCATIONS OF THE UTILITIES SHOWN ON THESE DRAWINGS ARE APPROXIMATE ONLY (UTILITY QUALITY LEVEL D) AND MAY NOT BE ACCURATE. LOCATING UTILITIES IS THE SOLE RESPONSIBILITY OF THE CONTRACTOR. THE ENGINEER AND PROJECT OWNER WILL NOT BE RESPONSIBLE FOR ANY DAMAGES TO UTILITIES.
28. CONTRACTOR SHALL UTILIZE NATIVE MATERIAL FROM THE SITE WHERE AVAILABLE AND ALLOWED BY THE ENGINEER. NATIVE MATERIAL THAT CAN BE FOUND ON SITE INCLUDE TREES THAT CAN PROVIDE LIVE STAKES AND TREES THAT CAN BE USED FOR LOG STRUCTURES AND WOOD DEBRIS.
29. AFTER CONSTRUCTION, THE ACCESS ROADS LEADING TO THE PROJECT SITE SHALL BE RESTORED TO AS GOOD OR BETTER CONDITION THAN BEFORE CONSTRUCTION AT THE ENGINEER'S DISCRETION.
30. FOOTER DEPTH ON ALL STRUCTURES REQUIRING FOOTERS SHALL BE AT LEAST 6 TIMES GREATER THAN THE DROP BETWEEN THE STRUCTURE AND THE FOOTERED STRUCTURE DIRECTLY UPSTREAM OR APPROVED BY THE ONSITE ENGINEER.

EROSION/SEDIMENTATION CONTROL NOTES:

1. ALL CONTROL MEASURES SHALL BE CHECKED, AND REPAIRED AS NECESSARY, MONTHLY IN DRY PERIODS, AND WITHIN 24 HOURS AFTER ANY RAINFALL AT THE SITE OF .75 INCHES OR GREATER WITHIN A 24 HOUR PERIOD. DAILY CHECKING AND, IF NECESSARY, REPAIRING SHALL BE DONE DURING PROLONGED RAINFALLS. THE PERMITTEE SHALL MAINTAIN WRITTEN RECORDS OF SUCH CHECKS AND REPAIRS ON-SITE AT ALL TIMES, AND RECORDS SHALL BE SUBJECT TO INSPECTION AT ANY REASONABLE TIME.
2. THE CONSTRUCTION ACCESS POINTS SHALL BE MAINTAINED AS REQUIRED TO PREVENT SILT/SEDIMENT FROM LEAVING THE SITE. THIS INCLUDES BUT IS NOT LIMITED TO WASH DOWN OF THE CONSTRUCTION ACCESS POINTS, INSTALLING AND UTILIZING A VEHICLE WASH DOWN AREA, INSTALLING ADDITIONAL STONE, ETC.
3. ANY AND ALL SILT/SEDIMENTATION SHALL BE FREQUENTLY REMOVED FROM THE SILT FENCE, DITCHES, CHECK DAMS AND RETENTION AREAS. AT THE END OF CONSTRUCTION, THESE AREAS SHALL BE COMPLETELY FREE OF SILT/SEDIMENTATION AND SHALL BE STABILIZED AS STATED IN THE PLANS AND SPECIFICATIONS.
4. ALL BMPS SHALL BE DESIGNED AND INSTALLED IN ACCORDANCE WITH THE MINNESOTA POLLUTION CONTROL AGENCY (MPCA) CONSTRUCTION OF GENERAL PERMITS FOR STORMWATER CONTROL. IF CONFLICTS ARISE BETWEEN THESE REQUIREMENTS, THE MORE STRINGENT SHALL APPLY.
5. BMPS SHOWN ALONG THE PERIMETER OF THE DISTURBED AREAS SHALL BE INSTALLED PRIOR TO DISTURBANCE ACTIVITY. OTHER BMPS SHALL BE INSTALLED AS SOON AS CONSTRUCTION SEQUENCES ALLOW.
6. TEMPORARY DIVERSION OF RUNOFF/RUNON WATER SHALL BE INSTALLED AS NEEDED TO FACILITATE CONSTRUCTION OR AS DIRECTED ON-SITE BY THE ENGINEER.
7. ALL DISTURBED AREAS SHALL BE PERMANENTLY STABILIZED IMMEDIATELY AFTER THE COMPLETION OF THE GRADING OPERATION. AREAS REQUIRING COCONUT COIR MATTING SHALL BE SEEDED AND MULCHED FOR STABILIZATION PRIOR TO THE INSTALLATION OF THE MATTING.
8. TEMPORARY STABILIZATION OF DISTURBED AREAS MUST BE INITIATED IMMEDIATELY WHENEVER WORK TOWARD PROJECT COMPLETION AND FINAL STABILIZATION OF ANY PORTION OF THE SITE HAS TEMPORARILY CEASED AND WILL NOT RESUME FOR A PERIOD EXCEEDING THIRTEEN (7) CALENDAR DAYS. THOSE AREAS SHALL BE SEEDED AND MULCHED IN ACCORDANCE WITH THE PLANS AND SPECIFICATIONS.
9. NECESSARY MEASURES SHALL BE TAKEN TO PRODUCE AND MAINTAIN AN ACCEPTABLE STAND OF GRASS. SAID MEASURES TO INCLUDE (BUT NOT LIMITED TO) WATERING, RE-SEEDING, REGRADING ERODED AREAS, RE-FERTILIZING, ETC.
10. CONTRACTOR IS RESPONSIBLE FOR KEEPING MUD AND DEBRIS OFF CITY/STATE STREETS AND ROW. CLEANUP IS REQUIRED DAILY.
11. CONTRACTOR SHALL KEEP A COPY OF THE NPDES CONSTRUCTION GENERAL PERMIT AND THE "CONSTRUCTION BEST MANAGEMENT PRACTICES PLAN" ON SITE AT ALL TIMES FOR THE LIFE OF THE PROJECT.
12. ALL HAZARDOUS SUBSTANCES USED FOR THIS PROJECT (PAINT, OIL, GREASE, AND OTHER PETROLEUM PRODUCTS) SHALL BE STORED IN ACCORDANCE WITH SPCC REGULATIONS. THESE SUBSTANCES SHALL BE STORED AWAY FROM DRAINS AND DITCHES IN WATERTIGHT CONTAINERS. DISPOSAL OF THESE SUBSTANCES SHALL BE IN ACCORDANCE WITH ADEM REGULATIONS. DAILY INSPECTIONS SHALL BE PERFORMED FOR LEAK DETECTION. IF LEAKS OCCUR, APPROPRIATE ACTION SHALL BE TAKEN TO CONTAIN AND REMEDIATE THE SPILL. ADEQUATE TRASH CONTAINERS SHALL BE KEPT ON SITE FOR THE DISPOSAL OF CONSTRUCTION MATERIALS WASTE. NECESSARY MEASURES SHALL BE TAKEN TO PREVENT ANY TRASH OR OTHER POLLUTANTS FROM ENTERING "WATERS OF THE UNITED STATES."
13. ALL TEMPORARY MEASURES SHALL BE REMOVED ONCE ACCEPTABLE PERMANENT STABILIZATION IS ACHIEVED. THE ENGINEER SHALL DETERMINE IF THE PERMANENT STABILIZATION IS ACCEPTABLE.

SPECIAL NOTES:

THE ELEVATIONS SHOWN HEREIN ARE BASED ON DATA SURVEY THAT ENCOMPASSES THE EXISTING GROUND SURFACE FROM WHICH ALL COMPUTATIONS FOR CUT/FILL ARE BASED. SLIGHT DISCREPANCIES BETWEEN THE EXISTING GROUND DIGITAL SURFACE AND FIELD CONDITIONS CAN RESULT IN SIGNIFICANT VARIATIONS IN TOTAL EXCAVATED QUANTITIES. THUS, THE CONTRACTOR SHALL COMPARE QUANTITIES OF MATERIAL EXCAVATED TO THOSE SHOWN ON THE DRAWINGS TO MANAGE THE MOVEMENT OF MATERIAL ACROSS THE SITE.

TOPOGRAPHIC INFORMATION:

EXISTING GROUND SURFACES ARE BASED ON A SURVEY COMPLETED XXXX BLENDED WITH STATE OF MN LIDAR. BENCHMARKS WERE SET THROUGHOUT THE SITE AND CAN BE PROVIDED AT ANY TIME. CHANGES IN EXISTING SURFACES SHALL BE INCIDENTAL TO CONSTRUCTION.

SPECIAL GRADING NOTE:

THE AGREED UPON INTENT OF THIS GRADING PLAN IS TO MAINTAIN A “LIVE” SURFACE SO THAT ANY CHANGES THAT ARISE DURING CONSTRUCTION CAN BE QUICKLY ENCOMPASSED INTO THE THREE-DIMENSIONAL SURFACE GENERATED DURING THIS DESIGN PROCESS. AS SUCH, FINE TUNING OF THE SURFACE THAT WOULD ELIMINATE THE APPEARANCE OF JAGGED CONTOUR LINES WHERE SLIGHT VARIATIONS BETWEEN THE EXISTING AND PROPOSED SURFACES WAS NOT COMPLETED.

APPROVED BY: KA | CHECKED BY: MJG | DRAWN BY: GET

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BERM STREAM
BERM REMOVAL AND STREAM RESTORATION
NEAR SILVER BAY
LAKE COUNTY, MN

DRAFT 30% DESIGN - NOT FOR CONSTRUCTION
---
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GENERAL NOTES

CLIFFS
NORTHSHORE MINING CO
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BEAVER RIVER CONSULTING
BEAVER RIVER CONSULTING, LLC.
5752 EAGLE VIEW DRIVE
DULUTH, MN 55803
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CONCEPT DESIGN
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DATE: 2/17/2020

SHEET NUMBER
2 OF 5

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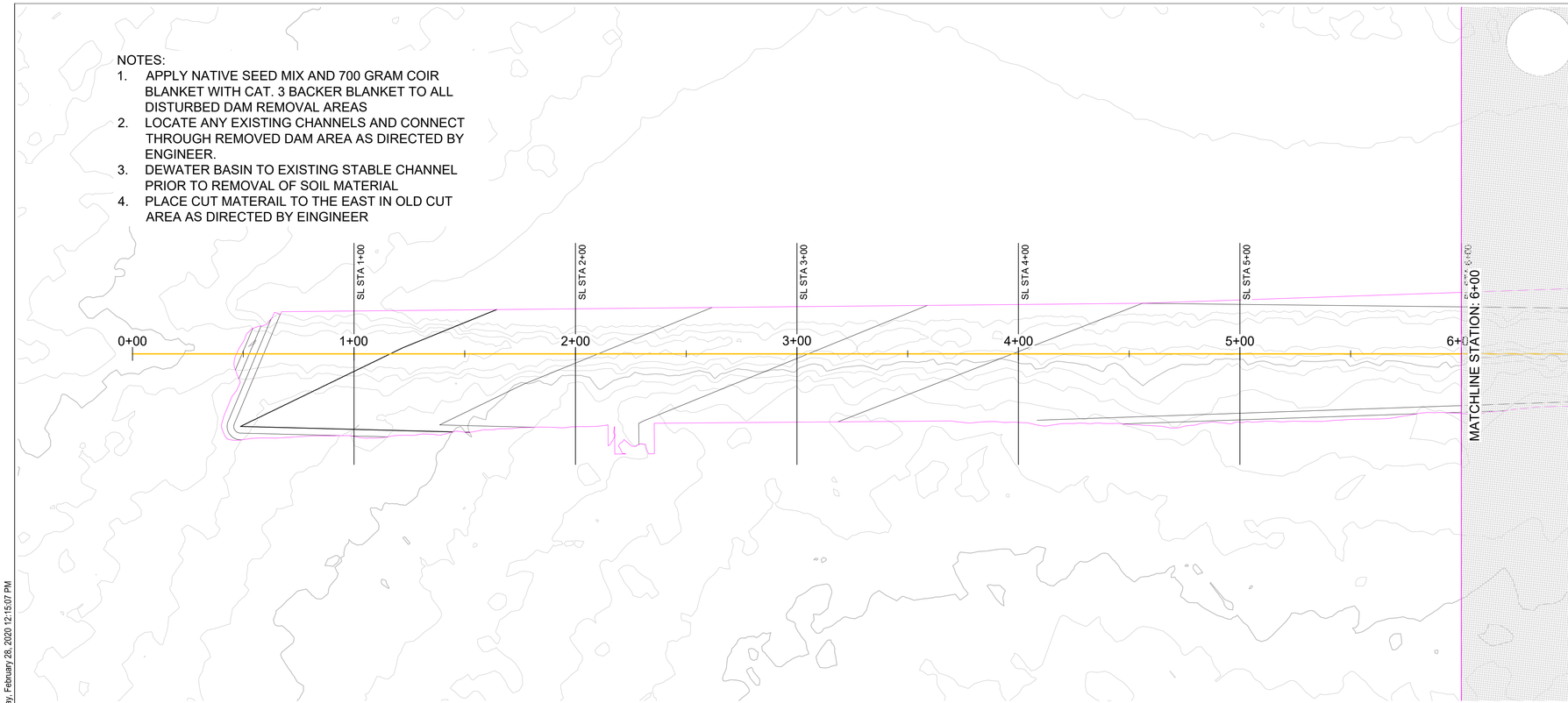
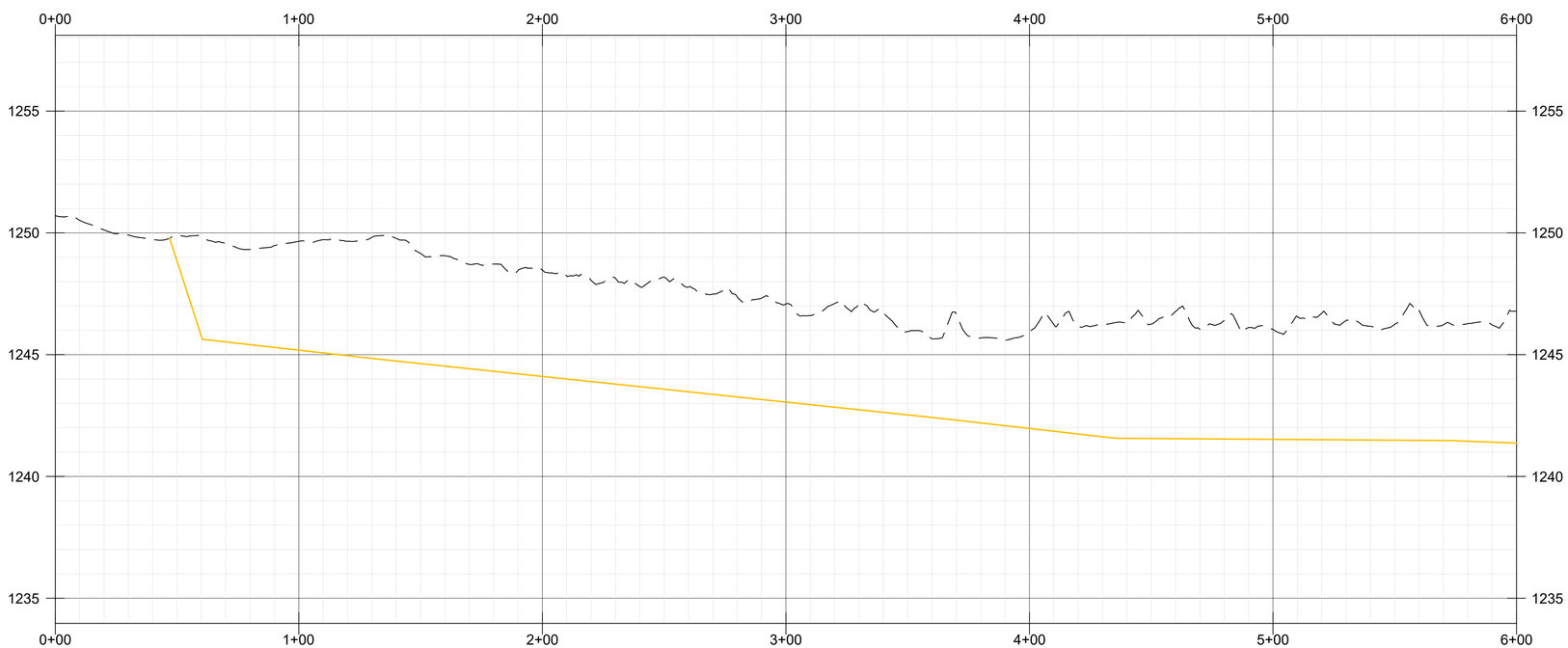
NOTES:
1. APPLY NATIVE SEED MIX AND 700 GRAM COIR BLANKET WITH CAT. 3 BACKER BLANKET TO ALL DISTURBED DAM REMOVAL AREAS
2. LOCATE ANY EXISTING CHANNELS AND CONNECT THROUGH REMOVED DAM AREA AS DIRECTED BY ENGINEER.
3. DEWATER BASIN TO EXISTING STABLE CHANNEL PRIOR TO REMOVAL OF SOIL MATERIAL
4. PLACE CUT MATERAIL TO THE EAST IN OLD CUT AREA AS DIRECTED BY EINGINEER




PLAN LEGEND
- ALIGNMENT
- LIMITS OF DISTURBANCE
- (483) PROPOSED MAJOR CONTOUR
- PROPOSED MINOR CONTOUR
- 479 EXISTING MAJOR CONTOUR
- EXISTING MINOR CONTOUR

PROFILE LEGEND
- PROPOSED STREAM CENTER LINE
- EXISTING GROUND

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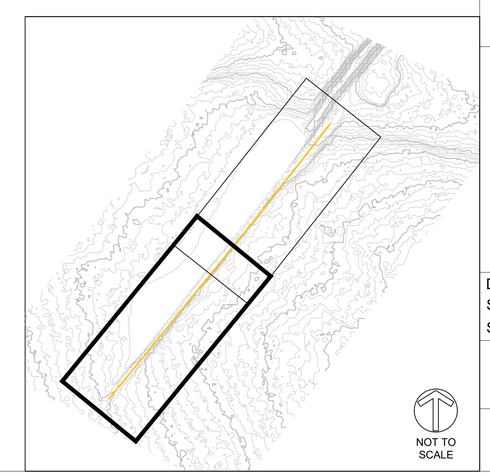


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BERM STREAM
BERM REMOVAL AND STREAM RESTORATION
NEAR SILVER BAY
LAKE COUNTY, MN

DRAFT 30% DESIGN - NOT FOR CONSTRUCTION
---
PLAN AND PROFILE - (1)
STA 0+00 TO 6+00

CLIFFS

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SILVER BAY, MN 55614
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5752 EAGLE VIEW DRIVE
DULUTH, MN 55803
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CONCEPT DESIGN
NOT FOR
CONSTRUCTION

DATE: 2/17/2020
SCALE (34"X22"): 1" = 30'
SCALE (17"X11"): 1" = 60'

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SCALE IN FEET

SHEET NUMBER
3 OF 5

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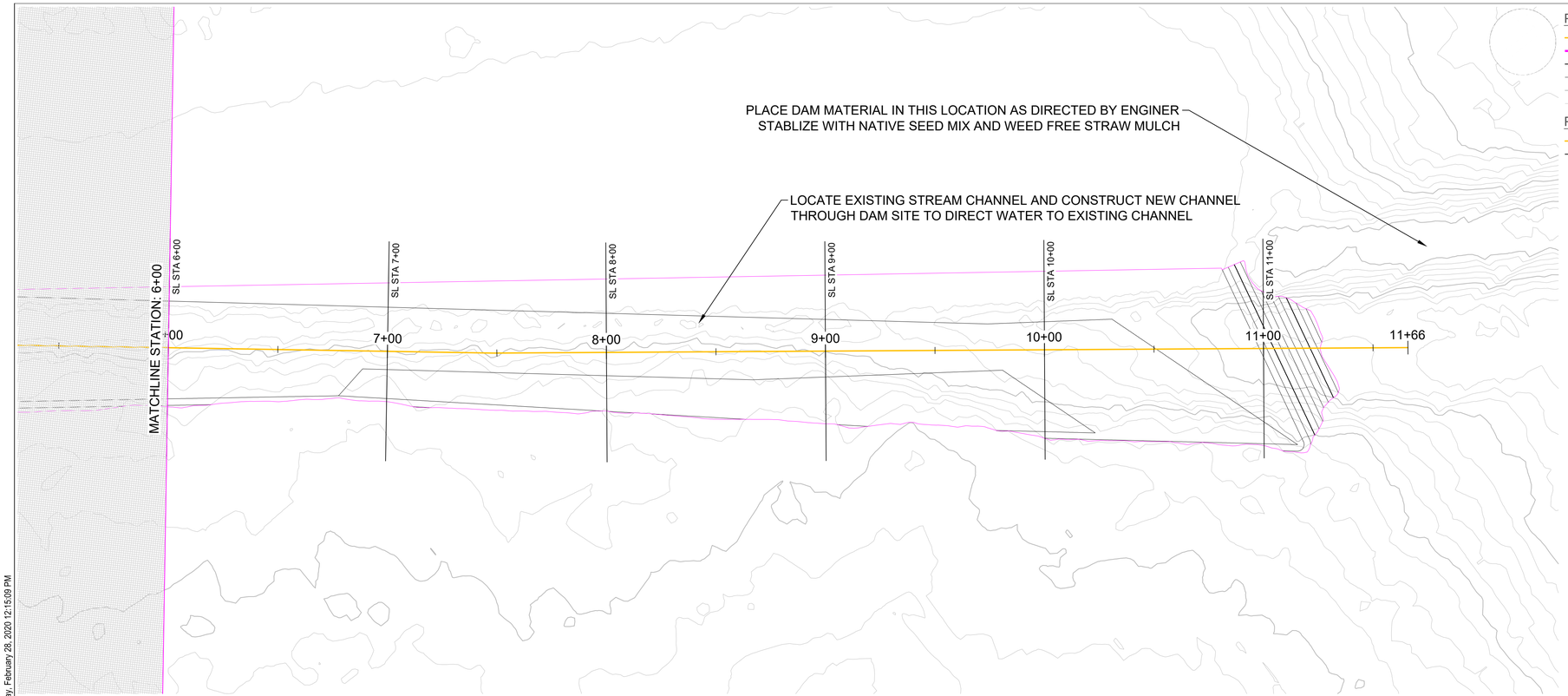
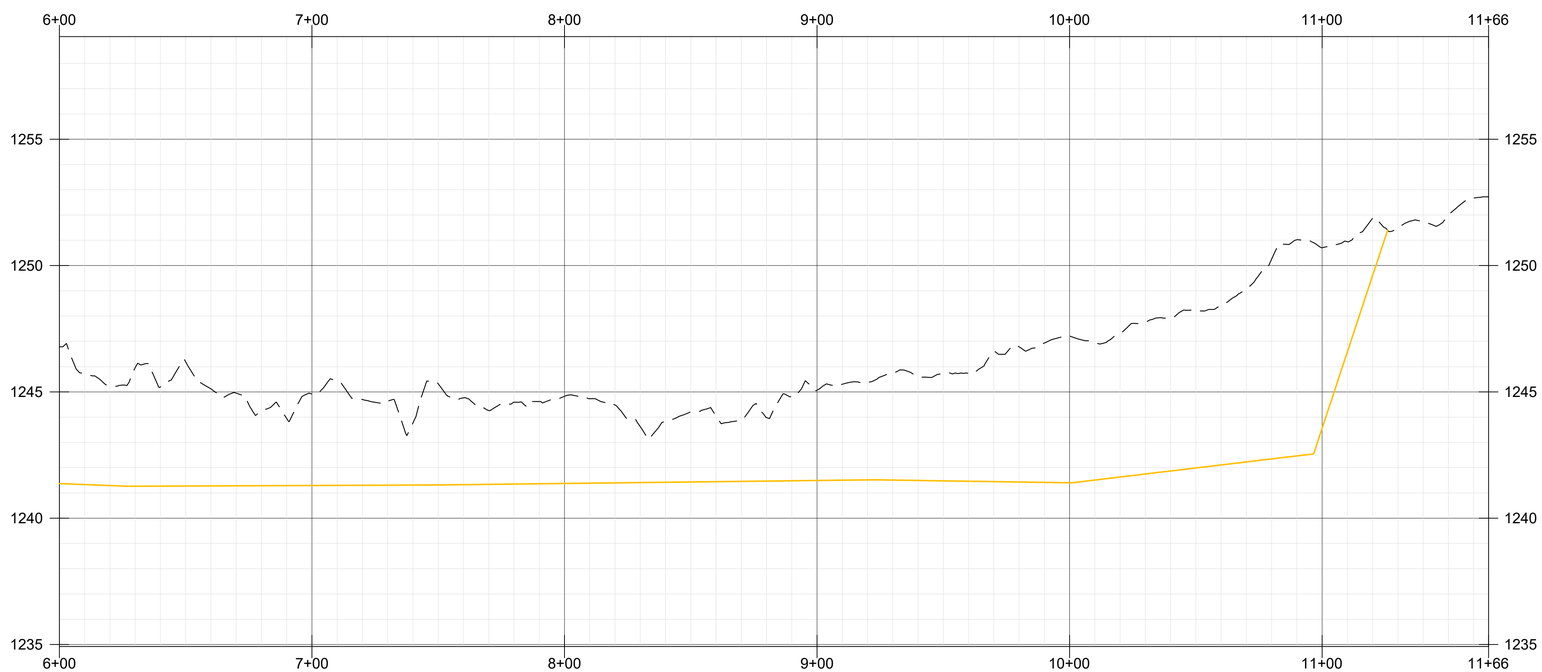



## PLAN LEGEND

- ALIGNMENT
- LIMITS OF DISTURBANCE
- (483) PROPOSED MAJOR CONTOUR
- PROPOSED MINOR CONTOUR
- 479 EXISTING MAJOR CONTOUR
- EXISTING MINOR CONTOUR

## PROFILE LEGEND

- PROPOSED STREAM CENTER LINE
- EXISTING GROUND

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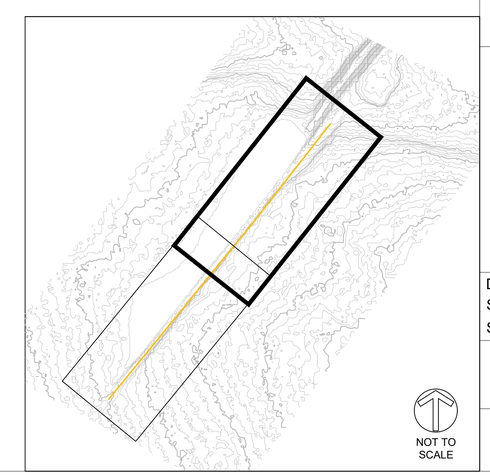


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BERM STREAM
BERM REMOVAL AND STREAM RESTORATION
NEAR SILVER BAY
LAKE COUNTY, MN

DRAFT 30% DESIGN - NOT FOR CONSTRUCTION
---
PLAN AND PROFILE - (2)
STA 6+00 TO 11+66

CLIFFS

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DATE: 2/17/2020
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SCALE (17"X11"): 1" = 60'

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SHEET NUMBER
4 OF 5

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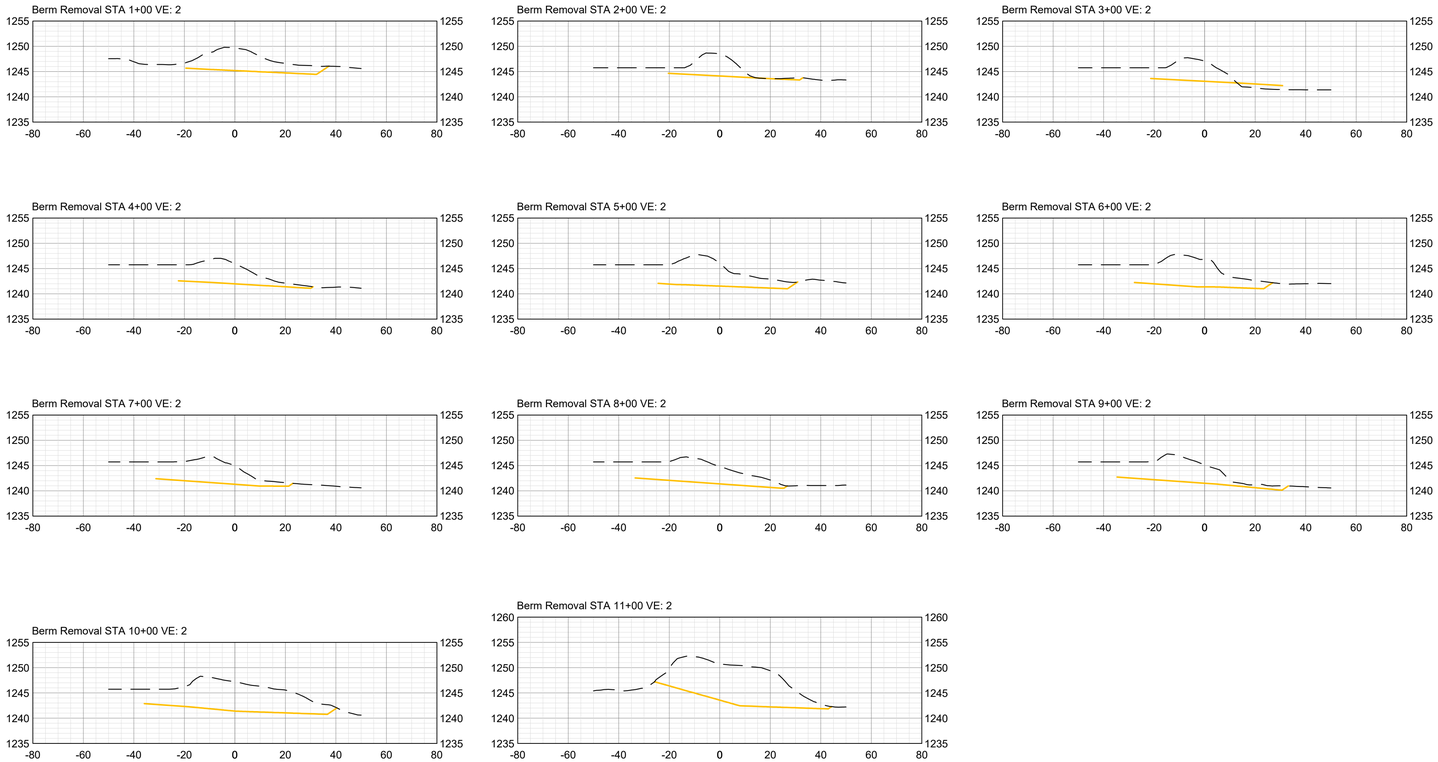


SECTION LEGEND

DESIGN SURFACE

EXISTING GROUND

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BERM STREAM
BERM REMOVAL AND STREAM RESTORATION
NEAR SILVER BAY
LAKE COUNTY, MN

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SECTIONS - (1)
STA 1+00 TO 11+00

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SCALE (17"X11"): 1" = 60'

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5 OF 5

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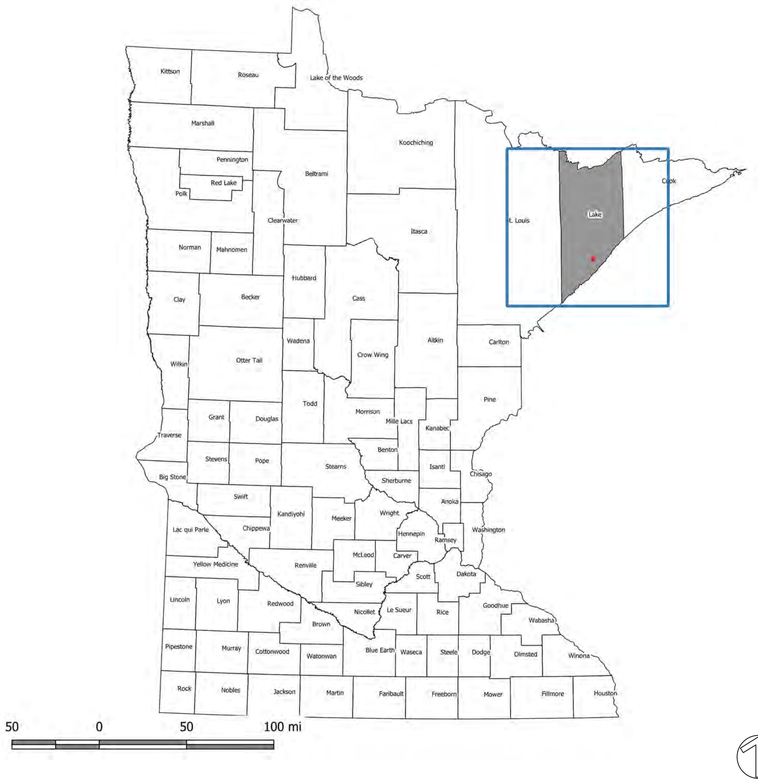
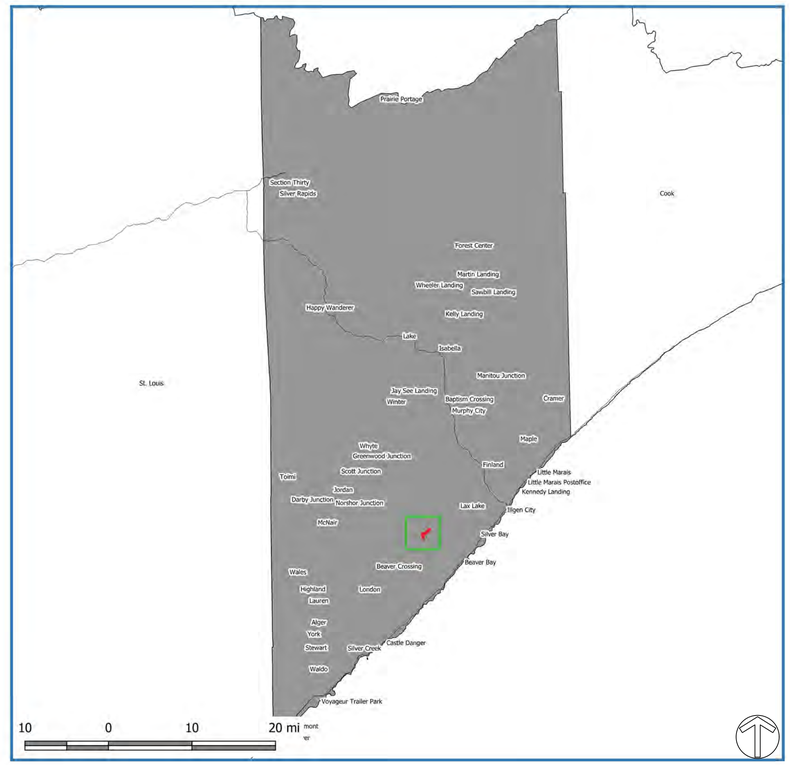
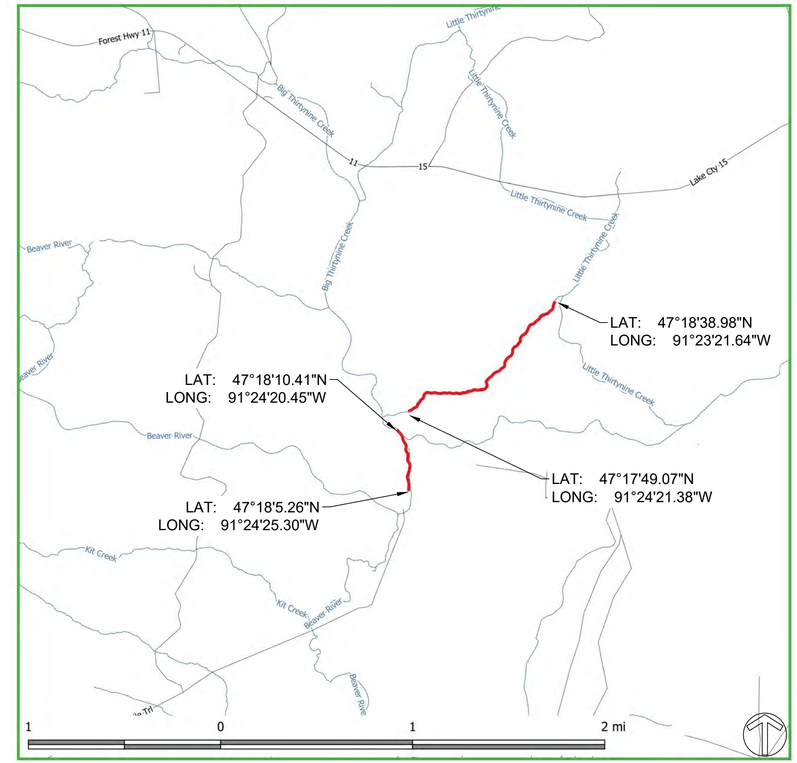
# BIG AND LITTLE 39
# STREAM RESTORATION

NEAR SILVER BAY
LAKE COUNTY, MN
1/31/2020

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DULUTH, MN 55803

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| Sheet List Table | | | |
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| 1 | COVER | northshore39CoverNotes.dwg | Friday, January 31, 2020 10:39:56 AM |
| 2 | TABLE OF CONTENTS | northshore39CoverNotes.dwg | Friday, January 31, 2020 10:39:56 AM |
| 3 | NOTES | northshore39CoverNotes.dwg | Friday, January 31, 2020 10:39:56 AM |
| 4 | QUANTITIES | northshore39CoverNotes.dwg | Friday, January 31, 2020 10:39:56 AM |
| 5 | OVERVIEW | big39_pp.dwg | Friday, January 24, 2020 12:57:55 PM |
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| 7 | BIG 39 PP - (2) | big39_pp.dwg | Friday, January 24, 2020 12:57:55 PM |
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| 24 | DTL - TYPICAL SECTIONS - LITTLE 39 | northshore39MasterDetail.dwg | Friday, January 31, 2020 10:42:03 AM |
| 25 | DTL - AUGMENTED RIFFLE | northshore39MasterDetail.dwg | Friday, January 31, 2020 10:42:03 AM |
| 26 | DTL - LOG J-HOOK | northshore39MasterDetail.dwg | Friday, January 31, 2020 10:42:03 AM |
| 27 | DTL - TOE WOOD | northshore39MasterDetail.dwg | Friday, January 31, 2020 10:42:03 AM |
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| 32 | DTL - HABITAT LOG | northshore39MasterDetail.dwg | Friday, January 31, 2020 10:42:03 AM |
| 33 | DTL - PLANTING | northshore39MasterDetail.dwg | Friday, January 31, 2020 10:42:03 AM |

APPROVED BY: KA | CHECKED BY: MJG | DRAWN BY: GET

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BIG AND LITTLE 39
STREAM RESTORATION
NEAR SILVER BAY
LAKE COUNTY, MN

DRAFT 30% DESIGN - NOT FOR CONSTRUCTION
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TABLE OF CONTENTS

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DATE: 1/31/2020

SHEET NUMBER
2 OF 33

E:\DROPBOX (ISSR)\NORTHSHOREMINING\C3D\SHEETS\NORTHSHORE39COVERNOTES.DWG | GREGTAILLACQ | SAVED: Friday, January 31, 2020 10:42:59 AM | ACAD.CTB | | PLOTTED: Friday, January 31, 2020 10:43:39 AM

NOTES:

GENERAL CONSTRUCTION NOTES:

1. THE WORK ON THIS PROJECT SHALL ADHERE TO THE FOLLOWING SPECIFICATIONS, STANDARDS AND/OR REGULATIONS: MN DOT STANDARD SPECIFICATIONS FOR CONSTRUCTION, 2016 EDITION, THE FOLLOWING SPECIFICATIONS EITHER MODIFY OR REPLACE APPROPRIATE MN DOT SPECIFICATIONS.
2. INSTREAM STRUCTURES SHALL BE INSTALLED AS THE CHANNEL IS BEING CONSTRUCTED AND NOT POST CONSTRUCTION. FILTER FABRIC INSTALLED AS PART OF THE INSTREAM STRUCTURE SHALL BE MIRAFI 170N SERIES NONWOVEN GEOTEXTILE, OR ENGINEER'S APPROVED ALTERNATIVE, UNLESS OTHERWISE SPECIFIED IN STRUCTURE DETAILS OR SPECIFICATIONS.
3. WHERE PRACTICABLE, EXISTING TREES AND VEGETATION SHOULD BE LEFT IN PLACE TO FACILITATE NATURAL REGENERATION AND SOIL STABILIZATION.
4. DEFINITIONS:
   A. BANKFULL ELEVATION IS THE POINT OF INCIPIENT FLOODING IN AN ALLUVIAL CHANNEL. THIS ELEVATION IS THE REFERENCE FOR DEPTHS ON OR ALONG THE CHANNEL PROFILE AND STRUCTURES DESCRIBED IN THESE SHEETS.
   B. THE BANKFULL BENCH IS A CONSTRUCTED FLOODPLAIN ADJACENT TO THE CHANNEL. THE BANKFULL BENCH IS CONSTRUCTED AT THE BANKFULL ELEVATION.
   C. THE THALWEG IS THE LOWEST PORTION OF THE CHANNEL.
   D. THE VANE LENGTH IS THE STRAIGHT LINE DISTANCE BETWEEN THE VANE ARM AND A LINE TANGENT TO THE STREAMBANK AT THE POINT WHERE THE VANE ARM INTERSECTS THE STREAMBANK.
   E. THE VANE ANGLE IS THE ANGLE BETWEEN THE VANE ARM AND A LINE TANGENT TO THE STREAMBANK AT THE POINT WHERE THE VANE ARM INTERSECTS THE STREAMBANK.
   F. SOD MATS ARE GRASS AND WILLOW TRANSPLANTS THAT STILL CONTAIN ROOTING DEPTH. APPROXIMATELY 9-12IN OF DEPTH WILL BE NEEDED WHEN HARVESTING THE SOD MATS.
6. THE CONTRACTOR SHALL STAKE OUT THE PROPOSED STREAM CENTERLINE FOR REVIEW BY THE ENGINEER BEFORE INITIATING EXCAVATION. DEPENDING ON ENCOUNTERED CONDITIONS SOME SHIFTING OF THE STREAM CHANNEL MAY BE NECESSARY. ANY COST ASSOCIATED WITH CHANGING STRUCTURE LOCATIONS OR ALIGNMENT SHALL BE CONSIDERED INCIDENTAL TO CONSTRUCTION. STAKING MAY BE OMITTED FOR PORTIONS OF THE STREAM WHEN SURVEY-GRADE GPS IS USED TO CONSTRUCT THE CHANNEL. IF GPS IS USED IN LIEU OF STAKING THE CHANNEL IN THE FIELD, THE CONTRACTOR ASSUMES ALL RESPONSIBILITY FOR THE STREAM BEING CONSTRUCTED AS DESIGNED, INCLUDING ANY ISSUES RELATED TO PROJECTIONS, BASE POINTS OR CONVERSION OF DIGITAL TERRAIN MODELS.
7. PRIOR TO CLEARING AND GRUBBING, CONTRACTOR SHALL MARK THE LIMITS OF CLEARING NEAR TREES FOR VERIFICATION OF INTENT BY THE ENGINEER. SOME MINOR ADJUSTMENT OF CHANNEL ALIGNMENT MAY BE REQUIRED TO PRESERVE TREES OR MINIMIZE IMPACT TO TREES.
8. ANY HARVESTING OF WILLOWS AND SOD FROM ONSITE MUST BE APPROVED BY THE ENGINEER.
9. CONTRACTOR SHALL MINIMIZE, TO THE MAXIMUM EXTENT POSSIBLE, IMPACTS TO THE ADJACENT TREES. CONSTRUCTION EQUIPMENT TRACKS AND PATHWAYS SHALL BE GRADED AND RECONTOURED AFTER CONSTRUCTION TO PREVENT RILL AND GULLY EROSION.
10. THE PROPOSED GRADING IS SHOWN ON THESE PLAN SHEETS. THE CONTRACTOR MAY EXTEND THE LIMITS OF DISTURBANCE ONLY WITH THE APPROVAL OF THE ENGINEER.
11. CONTRACTOR SHALL USE AN EXCAVATOR WITH A HYDRAULIC THUMB TO INSTALL INSTREAM STRUCTURES.
12. CHANNEL RELOCATION WORK SHALL BE COMPLETED AND STABILIZED PRIOR TO ALLOWING FLOW TO ENTER INTO THE NEWLY CONSTRUCTED STREAM CHANNEL. THE CONTRACTOR SHALL NOT OPEN UP MORE THAN 200 FEET OF CHANNEL WITHOUT EROSION CONTROL BLANKET IN PLACE OR BY APPROVAL OF THE ENGINEER.
13. THE PROPOSED STREAM CHANNEL SHALL BE CONSTRUCTED BY FIRST GRADING THE FLOODPLAIN ADJACENT TO THE CHANNEL TO THE ELEVATION INDICATED ON THESE PLANS. THIS MAY BE DONE AS GENERAL EXCAVATION. THE PROPOSED STREAM CHANNEL SHALL THEN BE EXCAVATED TO THE PROPER DEPTHS INDICATED ON THE PROFILE AND PROPOSED CONTOURS. THIS SHALL BE DONE AS SPECIALIZED EXCAVATION AND IS TYPICALLY ACCOMPLISHED WITH A TRACK EXCAVATOR. THE PROFILES AND CONTOURS SHOWN PROVIDE WIDTHS AND SLOPES FOR AID IN CONSTRUCTING THE CHANNEL TO THE APPROPRIATE DIMENSIONS. THE THALWEG CAN FIRST BE EXCAVATED TO THE POINT INDICATED ON THE PROFILE. EXCAVATION AND FINE GRADING OF THE CROSS SECTIONS SHALL THEN BE PERFORMED AS SHOWN ON THE TYPICAL CROSS SECTIONS AND PROPOSED CONTOURS. ANY STOCKPILING OF MATERIALS OR “DOUBLE HANDLING” NECESSARY TO BUILD THE CHANNEL SHALL BE CONSIDERED INCIDENTAL TO CONSTRUCTION.
14. IF THE EXISTING GROUND IS LESS THAN 0.2 FEET HIGHER THAN THE PROPOSED BANKFULL ELEVATION, IT IS NOT NECESSARY TO EXCAVATE MATERIAL TO THE PROPOSED ELEVATION SHOWN ON THE PROFILE.
15. THE SURFACE OF ALL INSTREAM STRUCTURES SHALL BE FINISHED TO A SMOOTH LINE IN ACCORDANCE WITH THE LINES, GRADES, AND CROSS SECTIONS OR ELEVATIONS SHOWN ON THE DRAWINGS. THE DEGREE OF FINISH FOR THE VANE SLOPES AND INVERT ELEVATIONS SHALL BE WITHIN 0.1 VERTICAL FEET OF THE GRADES AND ELEVATIONS INDICATED. ALL GAPS OR VOIDS BETWEEN THE ROCKS SHALL BE PLUGGED WITH SMALL GRAVEL TO FORM A TIGHT-FITTING SEAL.
16. CONSTRUCTION SPECIFICATIONS FOR BANKFULL CHANNEL DIMENSIONS OR CROSS SECTIONS WILL BE HELD TO THE DIMENSIONS SHOWN ON THE TYPICAL CROSS SECTIONS. ELEVATIONS SHALL BE CONSTRUCTED WITHIN 0.1 VERTICAL FEET; WIDTHS AND MEAN DEPTHS MUST FALL WITHIN THE RANGES SHOWN IN THE DRAWINGS.
17. THE IN-STRUCTURE BID ITEMS SHALL INCLUDE ALL LABOR AND MATERIALS NECESSARY TO CONSTRUCT THE STRUCTURE. BID ITEMS INCLUDE SEEDING, PLANTING, AND MULCH AND EROSION CONTROL BLANKETS AND INCLUDE ALL LABOR AND MATERIALS NECESSARY TO STABILIZE AREAS DISTURBED DURING CONSTRUCTION OF STRUCTURES. AFTER THE STRUCTURE IS COMPLETE AND FLOW IS RESTORED TO THE CHANNEL, SOME ADJUSTMENT TO THE STRUCTURE OR ADDITIONAL STABILIZATION MEASURES MAY BE NECESSARY TO ACHIEVE DESIRED EFFECT. ANY COSTS ASSOCIATED WITH THESE ADJUSTMENTS SHALL BE CONSIDERED INCIDENTAL TO CONSTRUCTION.
18. THE CONSTRUCTED STREAM CHANNEL SHALL BE STABILIZED AS SOON AS POSSIBLE BY SEEDING IN ACCORDANCE WITH THE PLOT SCHEDULE, ADDING STRAW MULCH TO BARE SOIL, AND BY INSTALLING EROSION CONTROL BLANKET FROM THE INNER BERM TO BEYOND THE TOP OF THE BANKFULL CHANNEL. SEE EROSION CONTROL BLANKET DETAIL. PRIOR TO INSTALLING BLANKET, PREPARE THE BED BY LOOSENING THE SOIL 3 TO 6 INCHES, APPLY SEED AND THEN STRAW MULCH. SEED SHALL BE BROADCAST EVENLY OVER THE AREA USING A BROADCAST SPREADER PRIOR TO COVERING WITH THE EROSION CONTROL BLANKET. THE BLANKET SHALL BE ROLLED OUT IN THE DIRECTION OF THE ANTICIPATED RUN-OFF FLOW. INSTALL BLANKET IN ACCORDANCE WITH DETAIL SHOWN HEREIN. REWORKING OF AREAS THAT DO NOT ESTABLISH VEGETATION OR BECOME UNSTABLE SHALL BE NECESSARY IF THE EROSION CONTROL BLANKET SEPARATES FROM THE SOIL. SEE SEEDING AND PLANTING DETAIL FOR BLANKET SPECIFIATIONS. SEEDING OF THE BANKFULL BENCH SHALL BE IN ACCORDANCE WITH THE PLANTING TABLE. REFER TO CONTROL BLANKET DETAIL FOR PLACEMENT OF EROSION CONTROL BLANKET.
19. IF THE TIMING OF PROJECT IS SUCH THAT RIPARIAN SEED MIX CANNOT BE PLACED IN THE FALL, THEN THE CONTRACTOR SHALL SEED WITH TEMPORARY COVER ACCORDING TO THE EROSION AND SEDIMENT PLAN OR APPROVED BY THE ENGINEER UNTIL RIPARIAN MIX CAN BE SEEDED IN THE SPRING.
20. THE HARVESTING AND INSTALLATION OF LIVE STAKES SHALL BE PERFORMED ONLY DURING THE DORMANT SEASON TYPICALLY BETWEEN NOVEMBER 1 AND APRIL 15. CONTRACTOR SHALL NOTIFY ENGINEER 7 DAYS PRIOR TO HARVESTING TO REVIEW AND APPROVE ALL HARVESTING SITES. UPON APPROVAL BY ENGINEER, THE CONTRACTOR SHALL BE RESPONSIBLE FOR HARVESTING AND TRANSPORTING THE LIVE STAKE CUTTINGS TO THE JOB SITE.
21. LIVE STAKES SHALL BE INSTALLED ALONG THE OUTSIDE MEANDER BEND AND ALONG RIFFLES WHERE INDICATED ON THE DRAWINGS AND DETAILS. LIVE STAKES SHALL BE INSTALLED INTO THE EROSION CONTROL BLANKET IN ADDITION TO THE DEAD STAKES.
22. EXCESS SPOIL MATERIAL MAY BE SPREAD AND GRADED ONSITE OR IN THE ONSITE PIT AS APPROVED BY THE ENGINEER. PLACEMENT OF ANY ON-SITE OR OFF-SITE SPOIL MATERIAL SHALL BE CONSIDERED INCIDENTAL TO CONSTRUCTION.
23. TOPSOIL SHALL BE REMOVED FROM EXCAVATION AND SPOIL AREAS PRIOR TO CUT OR FILL AND RE-APPLIED TO AREAS AFTER ROUGH GRADING IS COMPLETE. SIX INCHES OF TOPSOIL SHALL BE PLACED ON DISTURBED AREAS TO MEET GRADE. STOCKPILING AND PLACEMENT OF TOPSOIL SHALL BE CONSIDERED INCIDENTAL TO CONSTRUCTION AND APPROVED BY THE ENGINEER.
24. SPOIL AREAS SHALL BE SEEDED WITH TEMPORARY VEGETATION WITHIN 7 DAYS FOLLOWING GRADING.
25. THE PLACEMENT OF STRAW MULCH SHALL OCCUR A MAXIMUM 48 HOURS AFTER SEEDING. MULCH WILL BE SPREAD TO COVER THE INSTALLED AREAS AT A MINIMUM RATE OF 1.5 TONS PER ACRE. MULCH SHALL BE KEPT OUT OF THE CROWNS OF SHRUBS AND GROUND COVER.
26. IF SOFT SOILS ARE ENCOUNTERED WHEN RECONSTRUCTING STREAM BANKS, RESTORE BANK WITH SOD MAT COVERING ALONG RIFFLES AND WOOD TOE SOD MAT ALONG BENDS.
27. CONTRACTOR SHALL CALL GOPHER STATE ONE CALL FOR UTILITY MARKING AT LEAST 48 HOURS PRIOR TO START OF CONSTRUCTION. THE LOCATIONS OF THE UTILITIES SHOWN ON THESE DRAWINGS ARE APPROXIMATE ONLY (UTILITY QUALITY LEVEL D) AND MAY NOT BE ACCURATE. LOCATING UTILITIES IS THE SOLE RESPONSIBILITY OF THE CONTRACTOR. THE ENGINEER AND PROJECT OWNER WILL NOT BE RESPONSIBLE FOR ANY DAMAGES TO UTILITIES.
28. CONTRACTOR SHALL UTILIZE NATIVE MATERIAL FROM THE SITE WHERE AVAILABLE AND ALLOWED BY THE ENGINEER. NATIVE MATERIAL THAT CAN BE FOUND ON SITE INCLUDE TREES THAT CAN PROVIDE LIVE STAKES AND TREES THAT CAN BE USED FOR LOG STRUCTURES AND WOOD DEBRIS.
29. AFTER CONSTRUCTION, THE ACCESS ROADS LEADING TO THE PROJECT SITE SHALL BE RESTORED TO AS GOOD OR BETTER CONDITION THAN BEFORE CONSTRUCTION AT THE ENGINEER'S DISCRETION.
30. FOOTER DEPTH ON ALL STRUCTURES REQUIRING FOOTERS SHALL BE AT LEAST 6 TIMES GREATER THAN THE DROP BETWEEN THE STRUCTURE AND THE FOOTERED STRUCTURE DIRECTLY UPSTREAM OR APPROVED BY THE ONSITE ENGINEER.

EROSION/SEDIMENTATION CONTROL NOTES:

1. ALL CONTROL MEASURES SHALL BE CHECKED, AND REPAIRED AS NECESSARY, MONTHLY IN DRY PERIODS, AND WITHIN 24 HOURS AFTER ANY RAINFALL AT THE SITE OF .75 INCHES OR GREATER WITHIN A 24 HOUR PERIOD. DAILY CHECKING AND, IF NECESSARY, REPAIRING SHALL BE DONE DURING PROLONGED RAINFALLS. THE PERMITTEE SHALL MAINTAIN WRITTEN RECORDS OF SUCH CHECKS AND REPAIRS ON-SITE AT ALL TIMES, AND RECORDS SHALL BE SUBJECT TO INSPECTION AT ANY REASONABLE TIME.
2. THE CONSTRUCTION ACCESS POINTS SHALL BE MAINTAINED AS REQUIRED TO PREVENT SILT/SEDIMENT FROM LEAVING THE SITE. THIS INCLUDES BUT IS NOT LIMITED TO WASH DOWN OF THE CONSTRUCTION ACCESS POINTS, INSTALLING AND UTILIZING A VEHICLE WASH DOWN AREA, INSTALLING ADDITIONAL STONE, ETC.
3. ANY AND ALL SILT/SEDIMENTATION SHALL BE FREQUENTLY REMOVED FROM THE SILT FENCE, DITCHES, CHECK DAMS AND RETENTION AREAS. AT THE END OF CONSTRUCTION, THESE AREAS SHALL BE COMPLETELY FREE OF SILT/SEDIMENTATION AND SHALL BE STABILIZED AS STATED IN THE PLANS AND SPECIFICATIONS.
4. ALL BMPS SHALL BE DESIGNED AND INSTALLED IN ACCORDANCE WITH THE MINNESOTA POLLUTION CONTROL AGENCY (MPCA) CONSTRUCTION OF GENERAL PERMITS FOR STORMWATER CONTROL. IF CONFLICTS ARISE BETWEEN THESE REQUIREMENTS, THE MORE STRINGENT SHALL APPLY.
5. BMPS SHOWN ALONG THE PERIMETER OF THE DISTURBED AREAS SHALL BE INSTALLED PRIOR TO DISTURBANCE ACTIVITY. OTHER BMPS SHALL BE INSTALLED AS SOON AS CONSTRUCTION SEQUENCES ALLOW.
6. TEMPORARY DIVERSION OF RUNOFF/RUNON WATER SHALL BE INSTALLED AS NEEDED TO FACILITATE CONSTRUCTION OR AS DIRECTED ON-SITE BY THE ENGINEER.
7. ALL DISTURBED AREAS SHALL BE PERMANENTLY STABILIZED IMMEDIATELY AFTER THE COMPLETION OF THE GRADING OPERATION. AREAS REQUIRING COCONUT COIR MATTING SHALL BE SEEDED AND MULCHED FOR STABILIZATION PRIOR TO THE INSTALLATION OF THE MATTING.
8. TEMPORARY STABILIZATION OF DISTURBED AREAS MUST BE INITIATED IMMEDIATELY WHENEVER WORK TOWARD PROJECT COMPLETION AND FINAL STABILIZATION OF ANY PORTION OF THE SITE HAS TEMPORARILY CEASED AND WILL NOT RESUME FOR A PERIOD EXCEEDING THIRTEEN (7) CALENDAR DAYS. THOSE AREAS SHALL BE SEEDED AND MULCHED IN ACCORDANCE WITH THE PLANS AND SPECIFICATIONS.
9. NECESSARY MEASURES SHALL BE TAKEN TO PRODUCE AND MAINTAIN AN ACCEPTABLE STAND OF GRASS. SAID MEASURES TO INCLUDE (BUT NOT LIMITED TO) WATERING, RE-SEEDING, REGRADING ERODED AREAS, RE-FERTILIZING, ETC.
10. CONTRACTOR IS RESPONSIBLE FOR KEEPING MUD AND DEBRIS OFF CITY/STATE STREETS AND ROW. CLEANUP IS REQUIRED DAILY.
11. CONTRACTOR SHALL KEEP A COPY OF THE NPDES CONSTRUCTION GENERAL PERMIT AND THE "CONSTRUCTION BEST MANAGEMENT PRACTICES PLAN" ON SITE AT ALL TIMES FOR THE LIFE OF THE PROJECT.
12. ALL HAZARDOUS SUBSTANCES USED FOR THIS PROJECT (PAINT, OIL, GREASE, AND OTHER PETROLEUM PRODUCTS) SHALL BE STORED IN ACCORDANCE WITH SPCC REGULATIONS. THESE SUBSTANCES SHALL BE STORED AWAY FROM DRAINS AND DITCHES IN WATERTIGHT CONTAINERS. DISPOSAL OF THESE SUBSTANCES SHALL BE IN ACCORDANCE WITH ADEM REGULATIONS. DAILY INSPECTIONS SHALL BE PERFORMED FOR LEAK DETECTION. IF LEAKS OCCUR, APPROPRIATE ACTION SHALL BE TAKEN TO CONTAIN AND REMEDIATE THE SPILL. ADEQUATE TRASH CONTAINERS SHALL BE KEPT ON SITE FOR THE DISPOSAL OF CONSTRUCTION MATERIALS WASTE. NECESSARY MEASURES SHALL BE TAKEN TO PREVENT ANY TRASH OR OTHER POLLUTANTS FROM ENTERING "WATERS OF THE UNITED STATES."
13. ALL TEMPORARY MEASURES SHALL BE REMOVED ONCE ACCEPTABLE PERMANENT STABILIZATION IS ACHIEVED. THE ENGINEER SHALL DETERMINE IF THE PERMANENT STABILIZATION IS ACCEPTABLE.

SPECIAL NOTES:

THE ELEVATIONS SHOWN HEREIN ARE BASED ON DATA SURVEY THAT ENCOMPASSES THE EXISTING GROUND SURFACE FROM WHICH ALL COMPUTATIONS FOR CUT/FILL ARE BASED. SLIGHT DISCREPANCIES BETWEEN THE EXISTING GROUND DIGITAL SURFACE AND FIELD CONDITIONS CAN RESULT IN SIGNIFICANT VARIATIONS IN TOTAL EXCAVATED QUANTITIES. THUS, THE CONTRACTOR SHALL COMPARE QUANTITIES OF MATERIAL EXCAVATED TO THOSE SHOWN ON THE DRAWINGS TO MANAGE THE MOVEMENT OF MATERIAL ACROSS THE SITE.

TOPOGRAPHIC INFORMATION:

EXISTING GROUND SURFACES ARE BASED ON A SURVEY COMPLETED XXXX BLENDED WITH STATE OF MN LIDAR. BENCHMARKS WERE SET THROUGHOUT THE SITE AND CAN BE PROVIDED AT ANY TIME. CHANGES IN EXISTING SURFACES SHALL BE INCIDENTAL TO CONSTRUCTION.

SPECIAL GRADING NOTE:

THE AGREED UPON INTENT OF THIS GRADING PLAN IS TO MAINTAIN A “LIVE” SURFACE SO THAT ANY CHANGES THAT ARISE DURING CONSTRUCTION CAN BE QUICKLY ENCOMPASSED INTO THE THREE-DIMENSIONAL SURFACE GENERATED DURING THIS DESIGN PROCESS. AS SUCH, FINE TUNING OF THE SURFACE THAT WOULD ELIMINATE THE APPEARANCE OF JAGGED CONTOUR LINES WHERE SLIGHT VARIATIONS BETWEEN THE EXISTING AND PROPOSED SURFACES WAS NOT COMPLETED.

APPROVED BY: KA | CHECKED BY: MJG | DRAWN BY: GET

| REV | DESCRIPTION | APPRV |
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| 1 | DRAFT 30% DESIGN | XX |
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BIG AND LITTLE 39
STREAM RESTORATION
NEAR SILVER BAY
LAKE COUNTY, MN

DRAFT 30% DESIGN - NOT FOR CONSTRUCTION

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NOTES

CLIFFS
NORTHSHORE MINING CO
10 OUTER DR
SILVER BAY, MN 55614
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BEAVER RIVER CONSULTING
BEAVER RIVER CONSULTING, LLC.
5752 EAGLE VIEW DRIVE
DULUTH, MN 55803
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CONCEPT DESIGN
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CONSTRUCTION

DATE: 1/31/2020



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BIG 39

| STATEMENT OF ESTIMATED QUANTITIES | | | | | |
|---|---|---|---|---|---|
| NOTE | NO. | ITEM | MNDOT SPEC. | QUANTITY | UNIT |
| | 1 | MOBILIZATION | 2021.501 | 1 | LS |
| | 2 | ACCESS TRAIL, INSTALLATION/DECOMMISION | 2021.600 | 1 | LS |
| | 3 | CUT COMMON CHANNEL EXCAVATION | 2105.511 | 19000 | CU YD |
| | 4 | FILL COMMON CHANNEL EXCAVATION | 2105.511 | 1000 | CU YD |
| | 5 | STREAM DIVERSION SYSTEM | 2105.601 | 1 | LS |
| | 6 | J-HOOK | 2577.601 | 10 | EACH |
| | 7 | BOULDER CONSTRUCTED RIFFLE | 2577.604 | 2 | EACH |
| | 8 | TOE WOOD | 2577.610 | 767 | LIN FT |
| | 9 | HABITAT LOGS | 2577.611 | 20 | EACH |
| | 10 | MULCH MATERIAL TYPE 1 | 2575.511 | 2 | TON |
| | 11 | CONIFEROUS TREE, 1.5' HT CONT | 2571.501 | 1190 | EACH |
| | 12 | DECIDUOUS TREE, 1.5' HT CONT | 2571.502 | 1190 | EACH |
| | 13 | DECIDUOUS SHRUB, 1.5" HT CONT | 2571.505 | 3719 | EACH |
| | 14 | SEED MIXTURE FLOODPLAIN | 2575.502 | 187 | LBS |
| | 15 | SEED MIXTURE SIDE SLOPES | 2575.502 | 140 | LBS |
| | 16 | EROSION CONTROL BLANKETS CATEGORY 4N | 2575.523 | 11333 | SQ YD |
| | 17 | EROSION CONTROL BLANKET- 700 GRAM COCUNUT FIBER WITH CAT. 3N BLANKET | 2575.601 | 2330 | SQ YD |

LITTLE 39

| Item Description | MNDOT SPEC. | Estimated Quantity | Unit |
|---|---|---|---|
| Construction Surveying | | *1* | *LS* |
| Construction Oversight | | *1* | *LS* |
| Mobilization | 2021.501 | *1* | *LS* |
| Temporary Construction Access Roads | 2021.600 | *1* | *LS* |
| Grading Cut | 2105.511 | 20000 | CU YD |
| Grading Fill | 2105.511 | 5000 | CU YD |
| Clearing and Grubbing (As Directed) | 2105.511 | *8* | *Acres* |
| Log J-Hook with Rootwad | 2577.601 | 7 | Each |
| Rock J-Hook | 2577.601 | 3 | Each |
| Log Vane | 2577.601 | 3 | Each |
| Wood Toe | 2577.610 | 1222 | ft |
| Rock Toe | 2577.610 | 224 | ft |
| Soil Lifts | 2577.610 | 1007 | ft |
| Transplants | 2577.610 | 308 | ft |
| Constructed Rock Riffle | 2577.611 | 9 | Each |
| Constructred Log Riffle | 2577.611 | 6 | Each |
| Constructred Rock/Log Riffle (Short) | 2577.611 | 5 | Each |
| Constructred Rock/Log Riffle (Long) | 2577.611 | 2 | Each |
| Temporary Construction Entrance | | *2* | *Each* |
| Temporary Silt Fence | | *1200* | *Ln. Ft.* |
| Erosion Control Matting (and stakes) | | 1650 | Sq. Yds. |
| Pump Around | | *0* | *Each* |
| Mulch straw | | 8 | Acres |
| Temporary Seeding | | 8 | Acres |
| Permanent Seeding | | 8 | Acres |
| Vegetation | | *5* | *Acres* |

| APPROVED BY: KA | CHECKED BY: MJG | DRAWN BY: GET |
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| REV | DESCRIPTION | APPRV |
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| 1 | DRAFT 30% DESIGN | XX |
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BIG AND LITTLE 39
STREAM RESTORATION
NEAR SILVER BAY
LAKE COUNTY, MN

DRAFT 30% DESIGN - NOT FOR CONSTRUCTION
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QUANTITIES

CLIFFS

NORTHSHORE MINING CO
10 OUTER DR
SILVER BAY, MN 55614
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BEAVER RIVER CONSULTING

BEAVER RIVER CONSULTING, LLC.
5752 EAGLE VIEW DRIVE
DULUTH, MN 55803
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CONCEPT DESIGN
NOT FOR
CONSTRUCTION

DATE: 1/31/2020

SHEET NUMBER
4 OF 33

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| REV | DESCRIPTION | | APPRV |
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BIG AND LITTLE 39
STREAM RESTORATION
NEAR SILVER BAY
LAKE COUNTY, MN

DRAFT 30% DESIGN - NOT FOR CONSTRUCTION
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BIG 39
OVERVIEW

CLIFFS

NORTHSHORE MINING CO
10 OUTER DR
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BEAVER RIVER CONSULTING

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DULUTH, MN 55803
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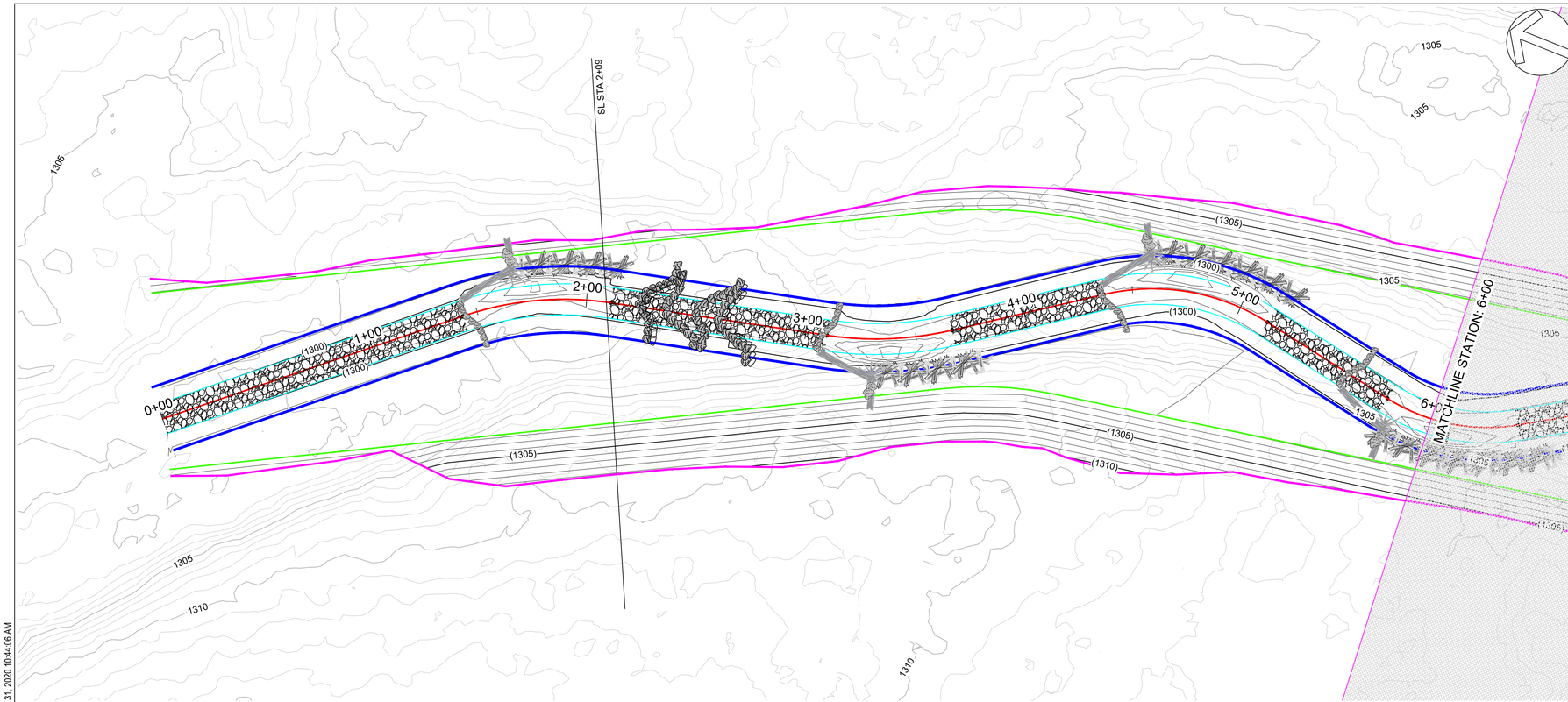
CONCEPT DESIGN
NOT FOR
CONSTRUCTION

DATE: 1/31/2020
SCALE (34"X22"): 1" = 100'
SCALE (17"X11"): 1" = 200'

0 100 200
SCALE IN FEET

SHEET NUMBER
5 OF 33

E:\DROPBOX (SSSR)\NORTHSHOREMINING\C3D\SHEETS\BIG39_PP.DWG | GREGTAILLACQ | SAVED: Friday, January 24, 2020 12:57:56 PM | ACAD.CTB | | PLOTTED: Friday, January 31, 2020 10:44:00 AM

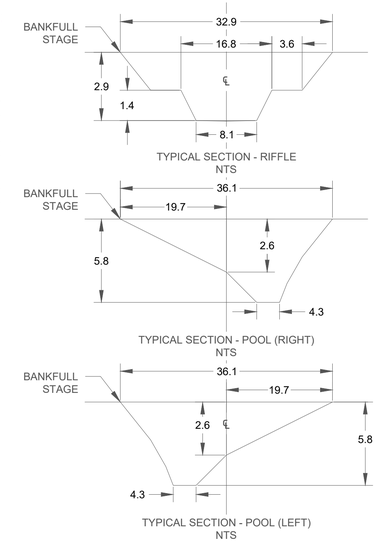


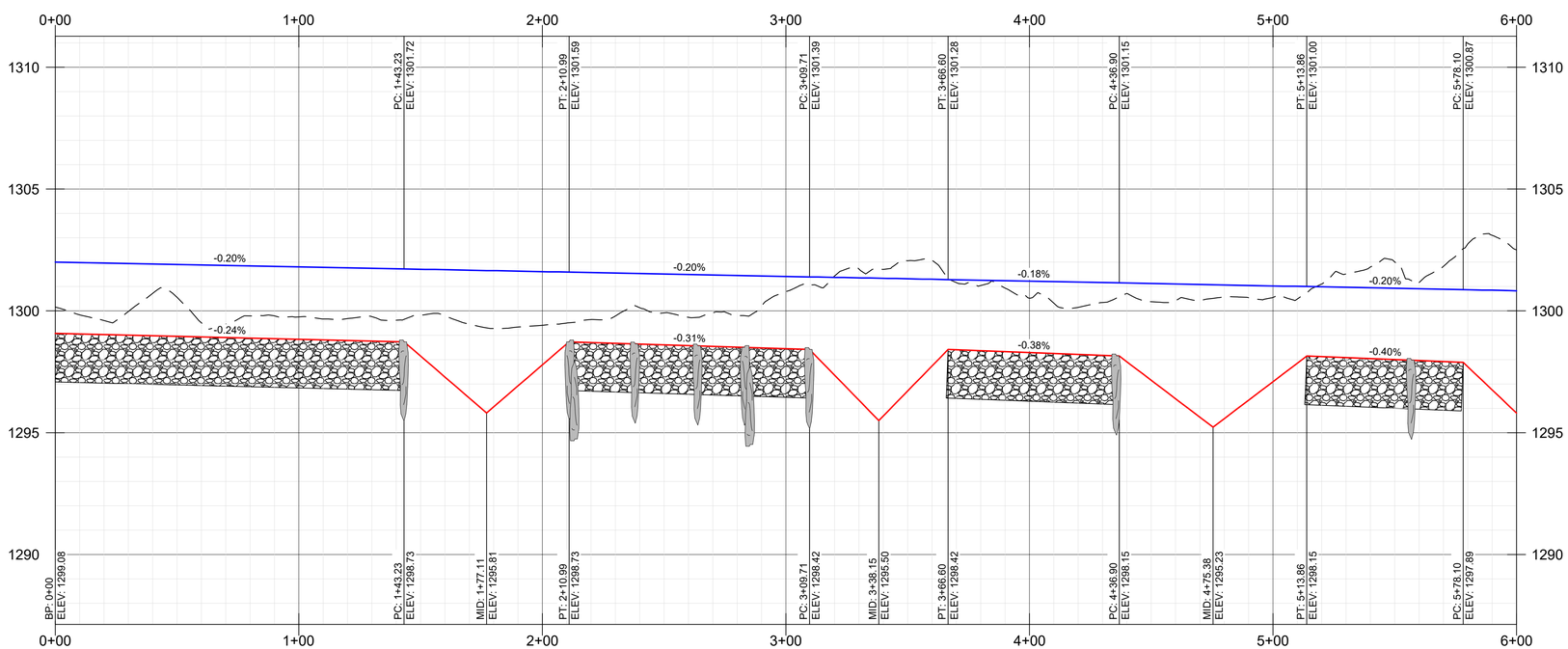

## PLAN LEGEND

- PROPOSED STREAM CENTER LINE
- PROPOSED INNER BERM
- PROPOSED GEOMORPHIC CHANNEL TOB
- PROPOSED FLOODPLAIN TOE
- LIMITS OF DISTURBANCE
- (483) PROPOSED MAJOR CONTOUR
- PROPOSED MINOR CONTOUR
- 479 EXISTING MAJOR CONTOUR
- EXISTING MINOR CONTOUR
- AUGMENTED RIFFLE
- LOG J-HOOK
- TOE WOOD
- CONSTRUCTED RIFFLE

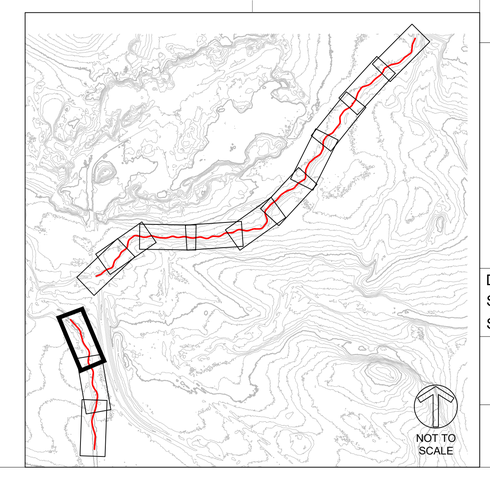
## PROFILE LEGEND

- PROPOSED STREAM CENTER LINE
- PROPOSED BANKFULL TOB
- EXISTING GROUND
- STRUCTURE BOULDER
- HEADER AND FOOTER BOULDER
- AUGMENTED RIFFLE




SCALE: HOR 1" =30'; VERT 1"= 3'




| REV | DESCRIPTION | APPROVED BY: KA | CHECKED BY: MJG | DRAWN BY: GET | APPRV |
|---|---|---|---|---|---|
| 1 | DRAFT 30% DESIGN | XX | XX | XX | XX |
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| XX | XX | XX | XX | XX | XX |
| XX | XX | XX | XX | XX | XX |

# BIG AND LITTLE 39 STREAM RESTORATION NEAR SILVER BAY LAKE COUNTY, MN

DRAFT 30% DESIGN - NOT FOR CONSTRUCTION

BIG 39

PLAN AND PROFILE - (1)

STA 0+00 TO 6+00

CLIFFS
NORTHSHORE MINING CO
10 OUTER DR
SILVER BAY, MN 55614
---
BEAVER RIVER CONSULTING
BEAVER RIVER CONSULTING, LLC.
5752 EAGLE VIEW DRIVE
DULUTH, MN 55803
---

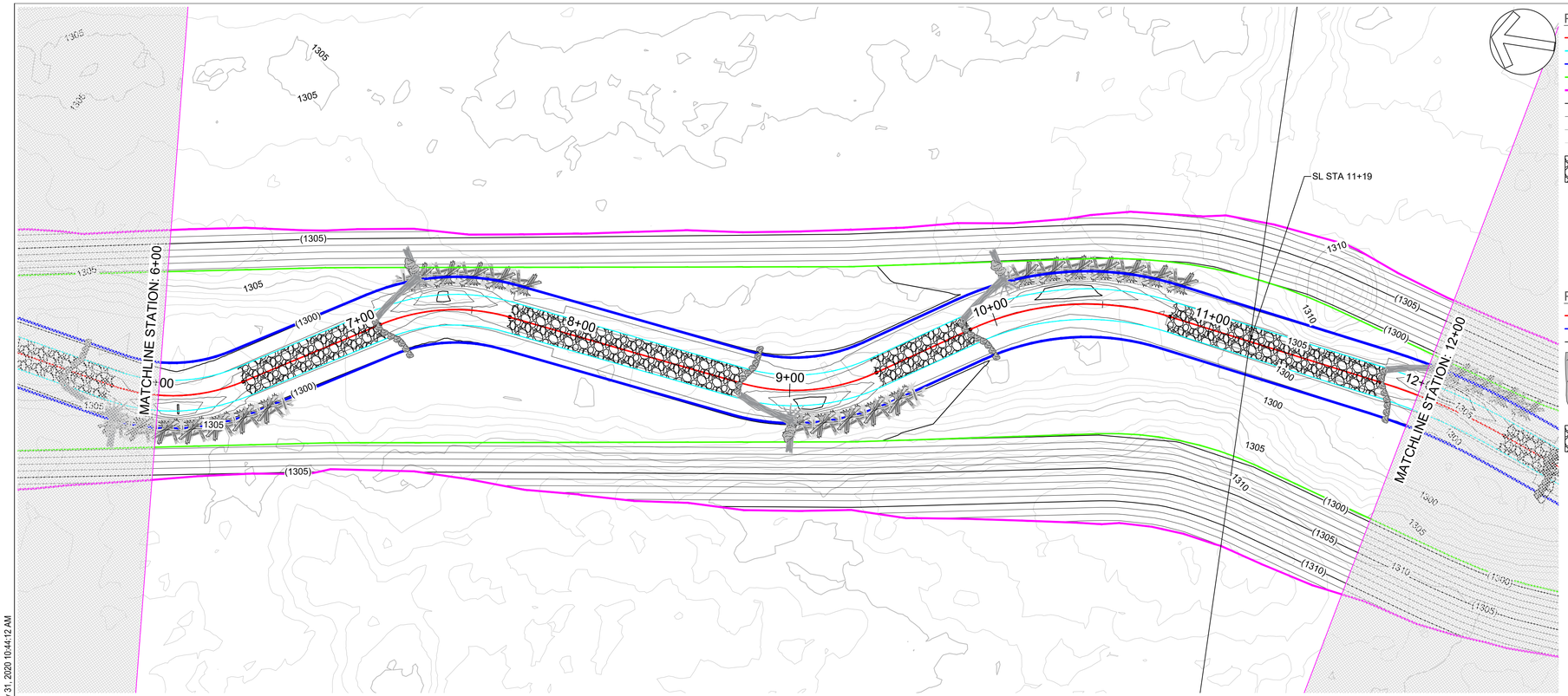
CONCEPT DESIGN
NOT FOR
CONSTRUCTION

DATE: 1/31/2020
SCALE (34"X22"): 1" = 30'
SCALE (17"X11"): 1" = 60'

0 30 60
SCALE IN FEET

SHEET NUMBER
6 OF 33

E:\DROPBOX (SSSR)\NORTHSHOREMINING\C3D\SHEETS\BIG39_PP.DWG | GREGTAILLACQ | SAVED: Friday, January 24, 2020 12:57:56 PM | ACAD.CTB | | PLOTTED: Friday, January 31, 2020 10:44:06 AM

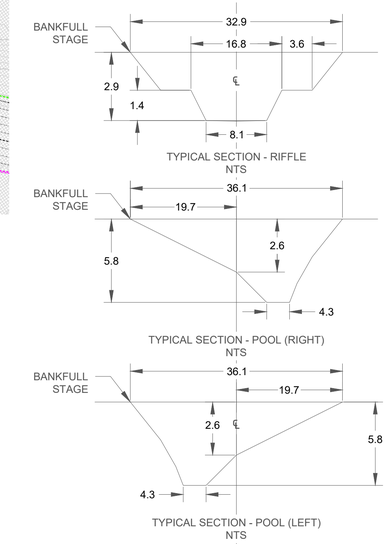


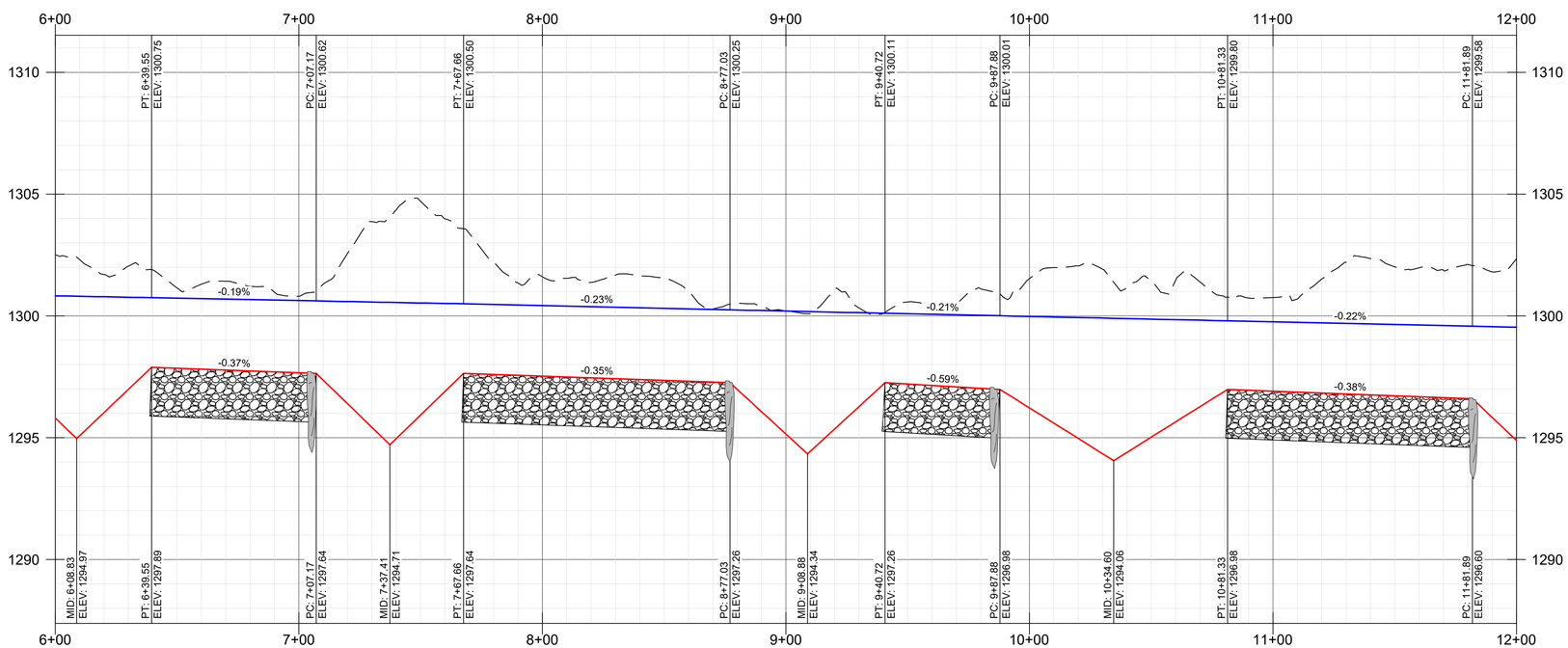

## PLAN LEGEND

- PROPOSED STREAM CENTER LINE
- PROPOSED INNER BERM
- PROPOSED GEOMORPHIC CHANNEL TOB
- PROPOSED FLOODPLAIN TOE
- LIMITS OF DISTURBANCE
- (483) PROPOSED MAJOR CONTOUR
- PROPOSED MINOR CONTOUR
- 479 EXISTING MAJOR CONTOUR
- EXISTING MINOR CONTOUR
- AUGMENTED RIFFLE
- LOG J-HOOK
- TOE WOOD
- CONSTRUCTED RIFFLE

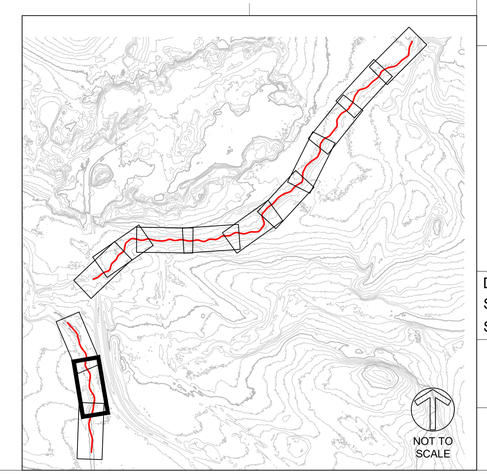
## PROFILE LEGEND

- PROPOSED STREAM CENTER LINE
- PROPOSED BANKFULL TOB
- EXISTING GROUND
- STRUCTURE BOULDER
- HEADER AND FOOTER BOULDER
- AUGMENTED RIFFLE




SCALE: HOR 1" =30'; VERT 1"= 3'




| APPROVED BY: KA | CHECKED BY: MJG | DRAWN BY: GET |
|---|---|---|
| REV | DESCRIPTION | APPRV |
| 1 | DRAFT 30% DESIGN | XX |
| XX | XX | XX |
| XX | XX | XX |
| XX | XX | XX |
| XX | XX | XX |
| XX | XX | XX |
| XX | XX | XX |
| XX | XX | XX |

# BIG AND LITTLE 39 STREAM RESTORATION NEAR SILVER BAY LAKE COUNTY, MN

## DRAFT 30% DESIGN - NOT FOR CONSTRUCTION

BIG 39

PLAN AND PROFILE - (2)

STA 6+00 TO 12+00


CLIFFS

NORTHSHORE MINING CO
10 OUTER DR
SILVER BAY, MN 55614

BEAVER RIVER CONSULTING

BEAVER RIVER CONSULTING, LLC.
5752 EAGLE VIEW DRIVE
DULUTH, MN 55803

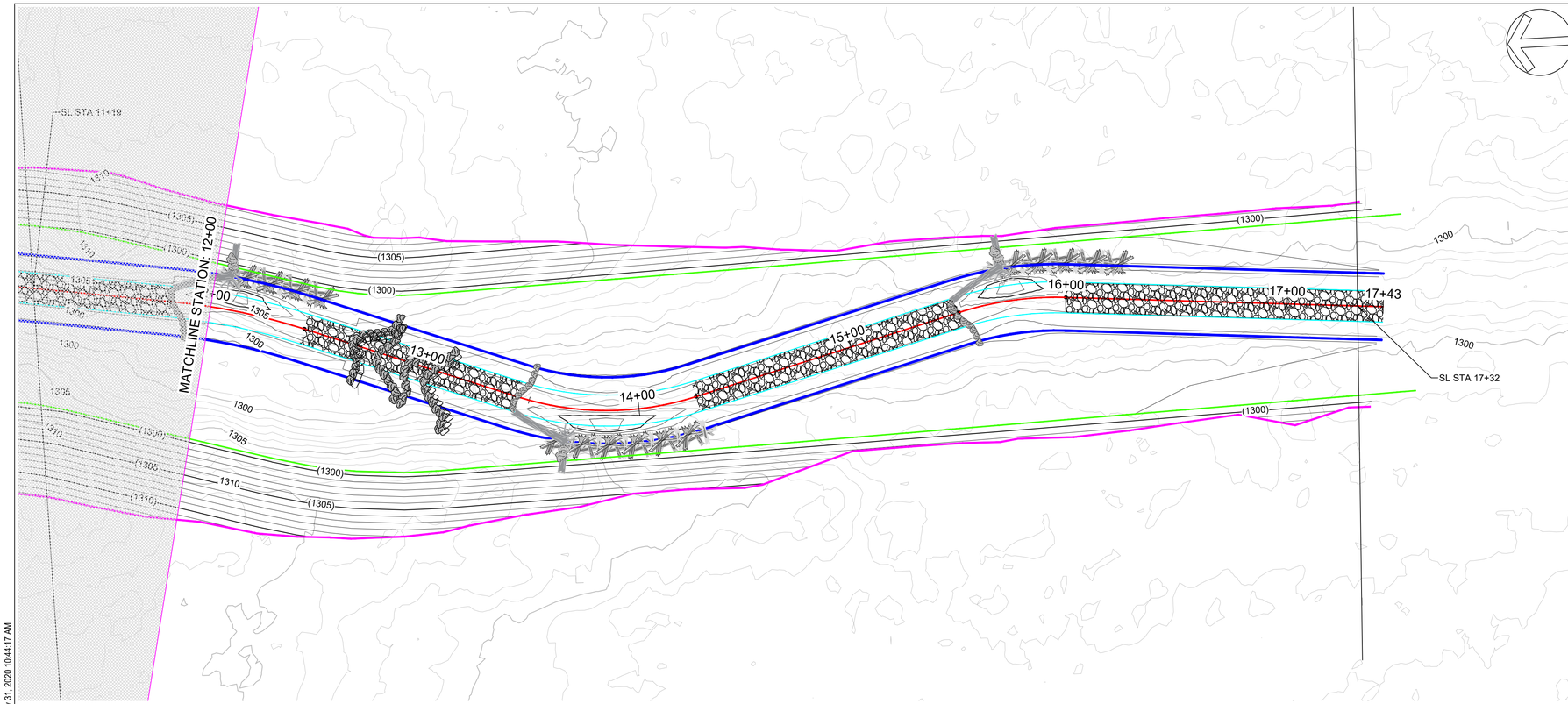

CONCEPT DESIGN
NOT FOR
CONSTRUCTION

DATE: 1/31/2020
SCALE (34"X22"): 1" = 30'
SCALE (17"X11"): 1" = 60'

0 30 60
SCALE IN FEET

SHEET NUMBER
7 OF 33


E:\DROPBOX (SSSR)\NORTHSHOREMINING\C3D\SHEETS\BIG39_PP.DWG | GREGTAILLACQ | SAVED: Friday, January 24, 2020 12:57:56 PM | ACAD.CTB | | PLOTTED: Friday, January 31, 2020 10:44:12 AM

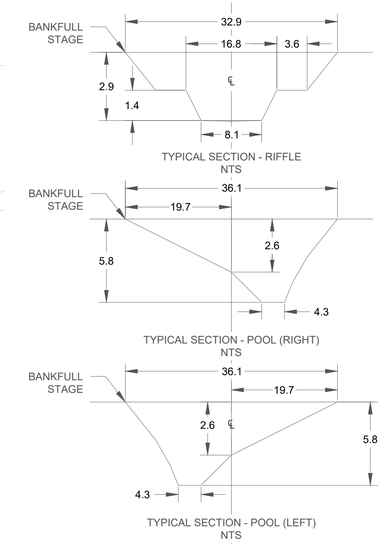


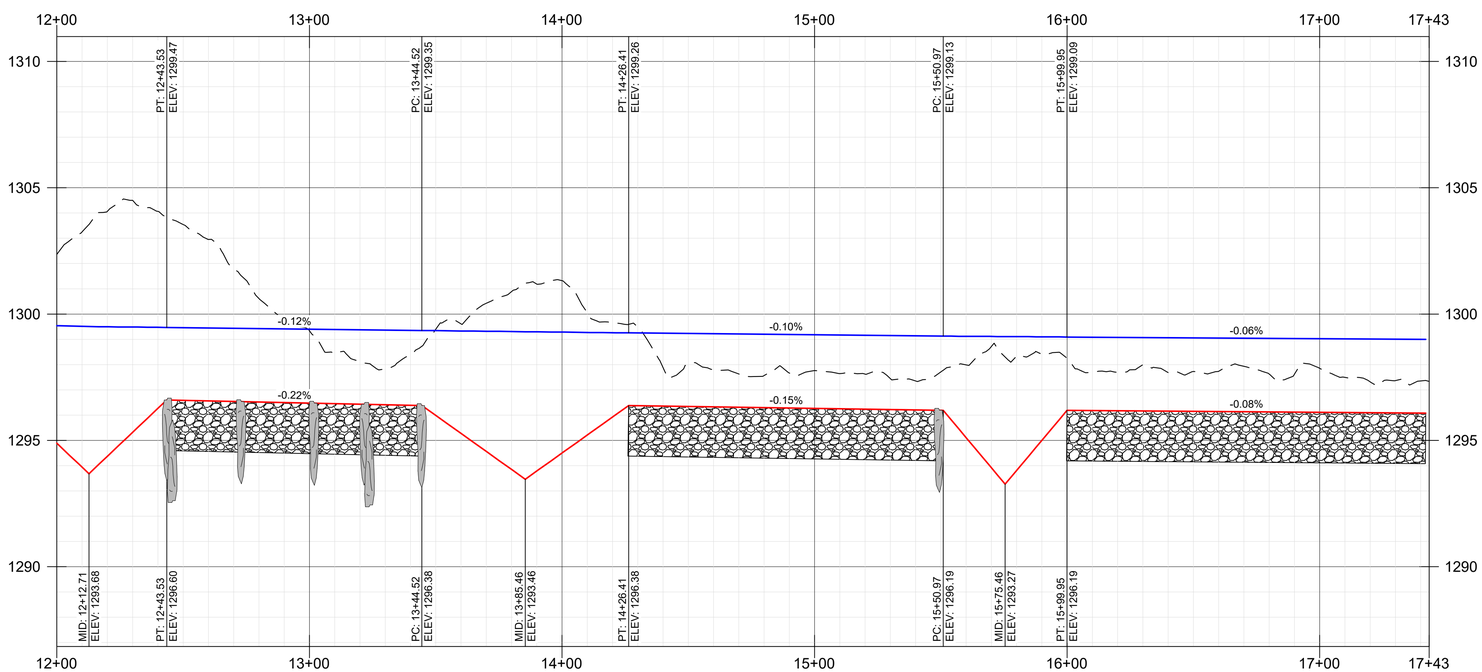

## PLAN LEGEND

- PROPOSED STREAM CENTER LINE
- PROPOSED INNER BERM
- PROPOSED GEOMORPHIC CHANNEL TOB
- PROPOSED FLOODPLAIN TOE
- LIMITS OF DISTURBANCE
- (483) PROPOSED MAJOR CONTOUR
- PROPOSED MINOR CONTOUR
- 479 EXISTING MAJOR CONTOUR
- EXISTING MINOR CONTOUR
- AUGMENTED RIFFLE
- LOG J-HOOK
- TOE WOOD
- CONSTRUCTED RIFFLE

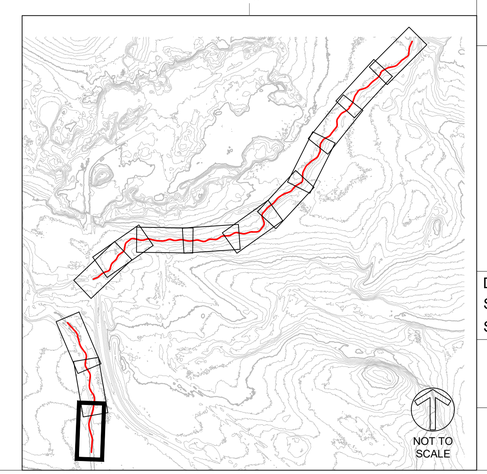
## PROFILE LEGEND

- PROPOSED STREAM CENTER LINE
- PROPOSED BANKFULL TOB
- EXISTING GROUND
- STRUCTURE BOULDER
- HEADER AND FOOTER BOULDER
- AUGMENTED RIFFLE




SCALE: HOR 1" =30'; VERT 1"= 3'




| REV | DESCRIPTION | APPROVED BY: KA | CHECKED BY: MJG | DRAWN BY: GET | APPRV |
|---|---|---|---|---|---|
| 1 | DRAFT 30% DESIGN | XX | XX | XX | XX |
| XX | | XX | XX | XX | XX |
| XX | | XX | XX | XX | XX |
| XX | | XX | XX | XX | XX |
| XX | | XX | XX | XX | XX |
| XX | | XX | XX | XX | XX |
| XX | | XX | XX | XX | XX |

# BIG AND LITTLE 39 STREAM RESTORATION NEAR SILVER BAY LAKE COUNTY, MN

DRAFT 30% DESIGN - NOT FOR CONSTRUCTION

BIG 39

PLAN AND PROFILE - (3)

STA 12+00 TO 17+43


CLIFFS

NORTHSHORE MINING CO
10 OUTER DR
SILVER BAY, MN 55614

BEAVER RIVER CONSULTING

BEAVER RIVER CONSULTING, LLC.
5752 EAGLE VIEW DRIVE
DULUTH, MN 55803


CONCEPT DESIGN
NOT FOR
CONSTRUCTION

DATE: 1/31/2020
SCALE (34"X22"): 1" = 30'
SCALE (17"X11"): 1" = 60'

0 30 60
SCALE IN FEET

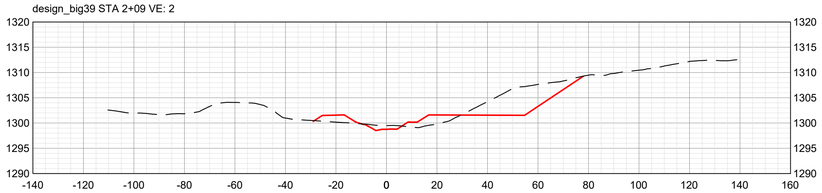
SHEET NUMBER
8 OF 33

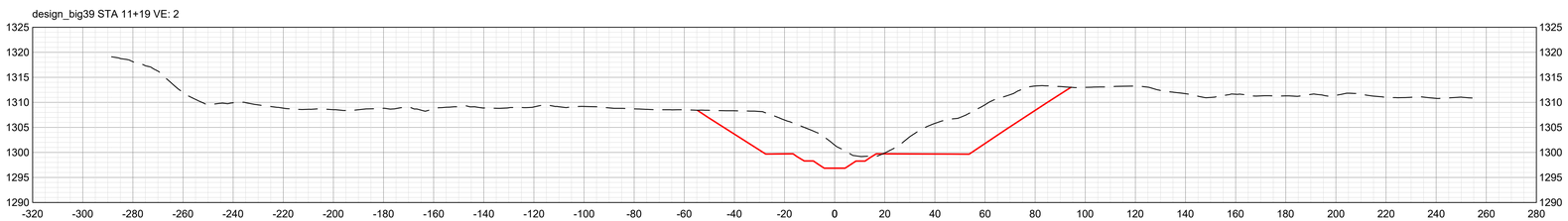

E:\DROPBOX (SSSR)\NORTHSHOREMINING\C3D\SHEETS\BIG39_PP.DWG | GREGTAILLACQ | SAVED: Friday, January 24, 2020 12:57:56 PM | ACAD.CTB | | PLOTTED: Friday, January 31, 2020 10:44:17 AM

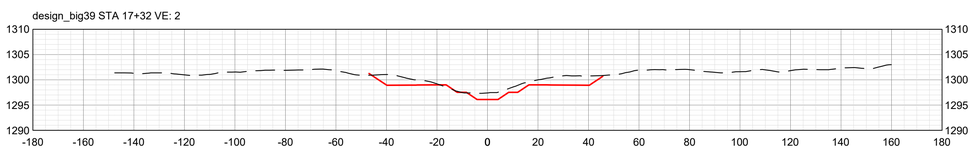
SECTION LEGEND

DESIGN SURFACE

EXISTING GROUND




| APPROVED BY: KA | CHECKED BY: MJG | DRAWN BY: GET |
|---|---|---|
| REV | DESCRIPTION | APPRV |
| 1 | DRAFT 30% DESIGN | XX |
| XX | XX | XX |
| XX | XX | XX |
| XX | XX | XX |
| XX | XX | XX |
| XX | XX | XX |
| XX | XX | XX |
| XX | XX | XX |

BIG AND LITTLE 39
STREAM RESTORATION
NEAR SILVER BAY
LAKE COUNTY, MN

DRAFT 30% DESIGN - NOT FOR CONSTRUCTION
BIG 39
SECTION - (1)
STA 2+09 TO 17+32

CLIFFS

NORTHSHORE MINING CO
10 OUTER DR
SILVER BAY, MN 55614
---

BEAVER RIVER CONSULTING

BEAVER RIVER CONSULTING, LLC.
5752 EAGLE VIEW DRIVE
DULUTH, MN 55803
---

CONCEPT DESIGN
NOT FOR
CONSTRUCTION

DATE: 1/31/2020
SCALE (34"X22"): 1" = 30'
SCALE (17"X11"): 1" = 60'

0 30 60
SCALE IN FEET

SHEET NUMBER
9 OF 33

E:\DROPBOX (SSSR)\NORTHSHOREMINING\C3D\SHEETS\BIG39_SECTIONS.DWG | GREGTAILLACQ | SAVED: Friday, January 24, 2020 11:41:13 AM | ACAD.CTB | | PLOTTED: Friday, January 31, 2020 10:44:25 AM

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|---|---|---|---|
| REV | DESCRIPTION | | APPRV |
| 1 | DRAFT 30% DESIGN | | XX |
| XX | XX | | XX |
| XX | XX | | XX |
| XX | XX | | XX |
| XX | XX | | XX |
| XX | XX | | XX |
| XX | XX | | XX |

BIG AND LITTLE 39
STREAM RESTORATION
NEAR SILVER BAY
LAKE COUNTY, MN

DRAFT 30% DESIGN - NOT FOR CONSTRUCTION

---

LITTLE 39
OVERVIEW

CLIFFS

NORTHSHORE MINING CO
10 OUTER DR
SILVER BAY, MN 55614

---

BEAVER RIVER CONSULTING

BEAVER RIVER CONSULTING, LLC.
5752 EAGLE VIEW DRIVE
DULUTH, MN 55803

---

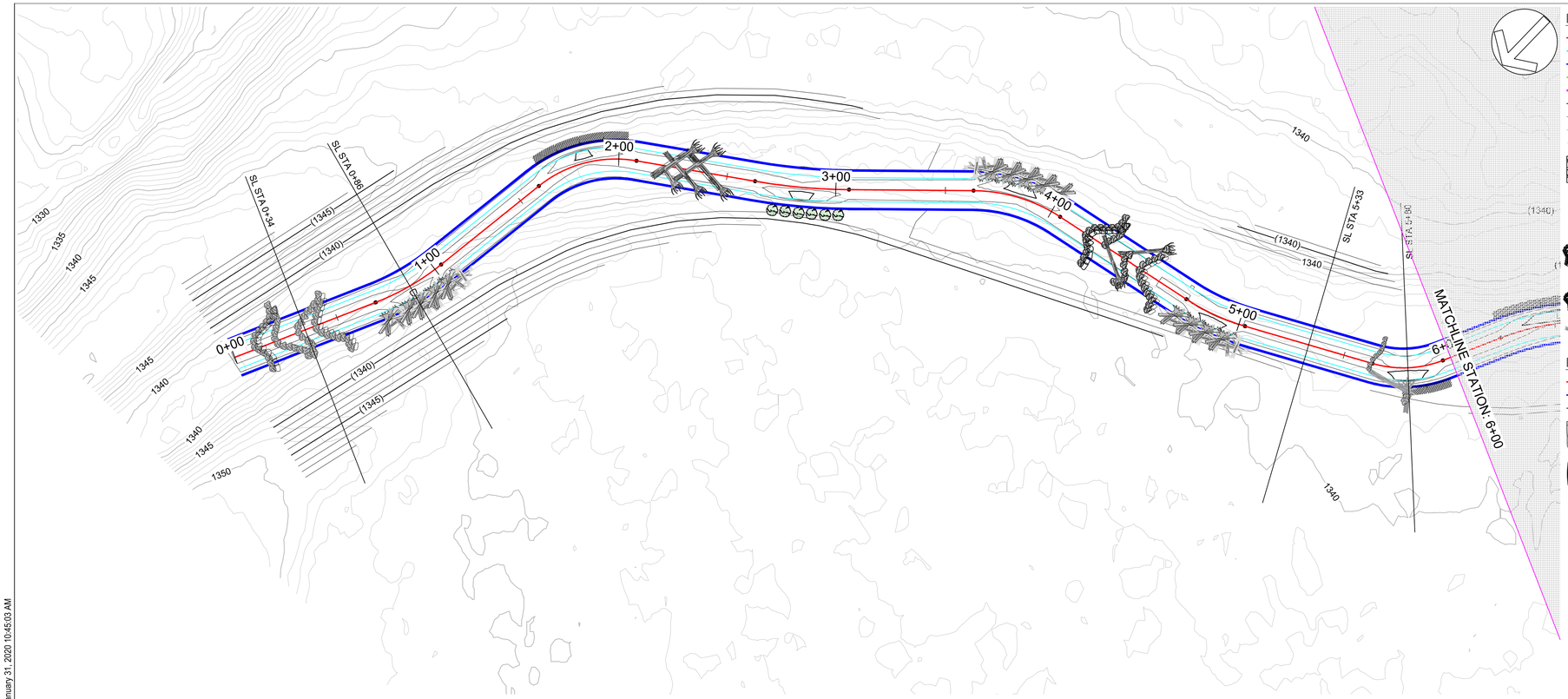
CONCEPT DESIGN
NOT FOR
CONSTRUCTION

DATE: 1/31/2020
SCALE (34"X22"): 1" = 200'
SCALE (17"X11"): 1" = 400'

0 200 400
SCALE IN FEET

SHEET NUMBER
10 OF 33

E:\DROPBOX (SSR)\NORTHSHOREMINING\C3D\SHEETS\LITTLE39_PP.DWG | GREGTAILLACQ | SAVED: Monday, January 27, 2020 10:54:36 AM | ACAD.CTB | | PLOTTED: Friday, January 31, 2020 10:44:49 AM

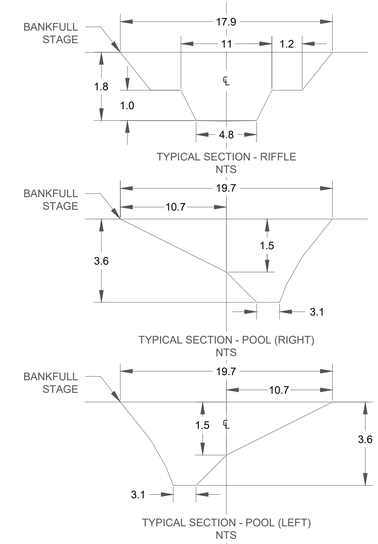


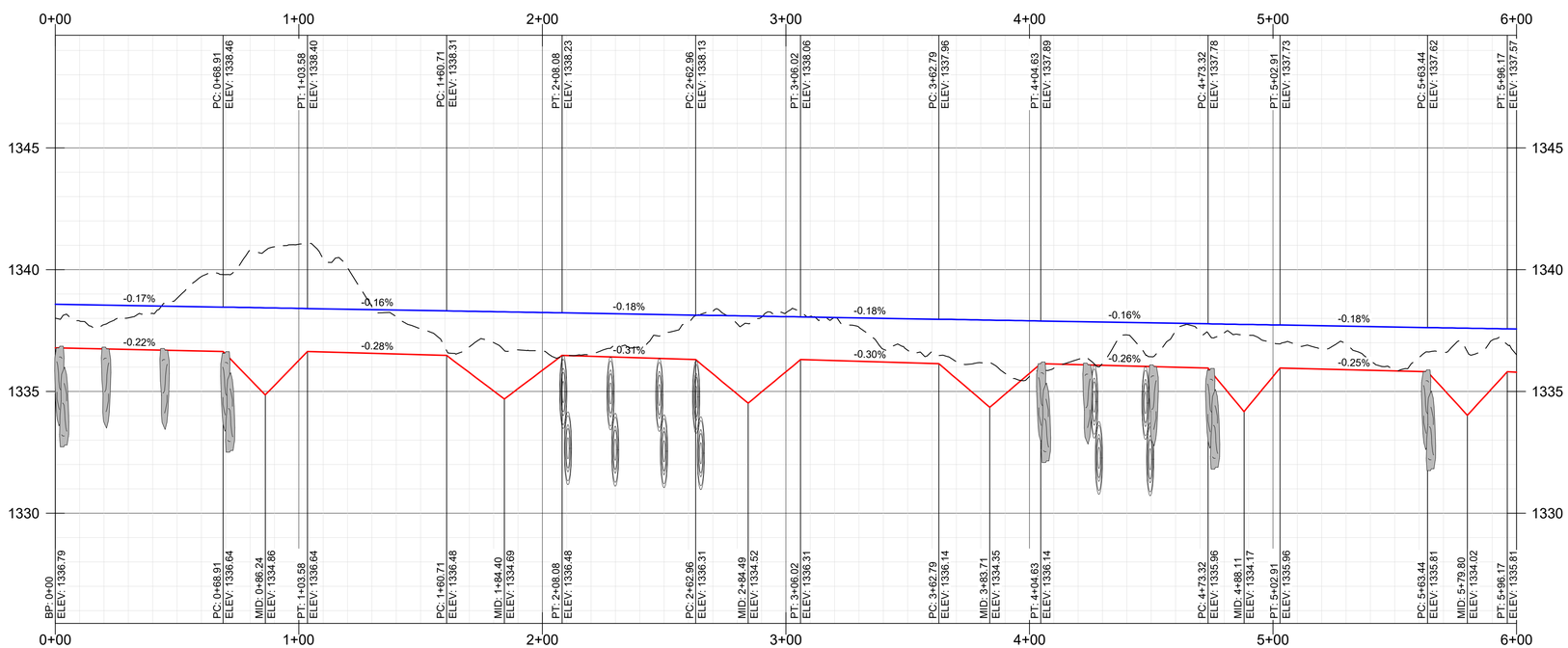

## PLAN LEGEND

- PROPOSED STREAM CENTER LINE
- PROPOSED INNER BERM
- PROPOSED GEOMORPHIC CHANNEL TOB
- PROPOSED FLOODPLAIN TOE
- LIMITS OF DISTURBANCE
- (483) PROPOSED MAJOR CONTOUR
- PROPOSED MINOR CONTOUR
- 479 EXISTING MAJOR CONTOUR
- EXISTING MINOR CONTOUR
- AUGMENTED RIFFLE
- LOG J-HOOK
- CONSTRUCTED LOG RIFFLE
- TOE WOOD
- NOT SURE?
- CONSTRUCTED RIFFLE
- BOULDER J-HOOK
- CONSTRUCTED BOULDER/LOG RIFFLE
- BOULDER TOE?
- LOG VANE
- TRANSPLANTS?

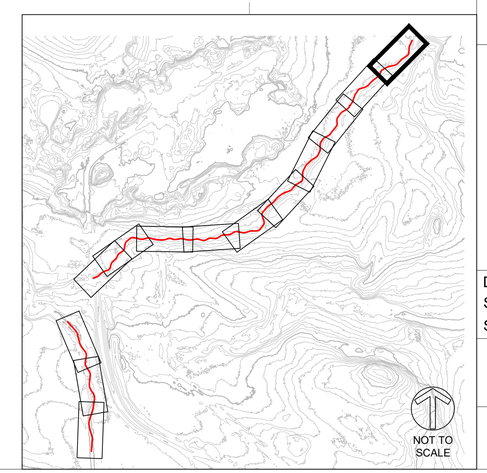
## PROFILE LEGEND

- PROPOSED STREAM CENTER LINE
- PROPOSED BANKFULL TOB
- EXISTING GROUND
- STRUCTURE BOULDER
- HEADER AND FOOTER BOULDER
- STRUCTURE LOG
- AUGMENTED RIFFLE




SCALE: HOR 1" =30'; VERT 1"= 3'




| REV | DESCRIPTION | APPROVED BY: KA | CHECKED BY: MJG | DRAWN BY: GET | APPRV |
|---|---|---|---|---|---|
| 1 | DRAFT 30% DESIGN | XX | XX | XX | XX |
| XX | | XX | XX | XX | XX |
| XX | | XX | XX | XX | XX |
| XX | | XX | XX | XX | XX |
| XX | | XX | XX | XX | XX |
| XX | | XX | XX | XX | XX |
| XX | | XX | XX | XX | XX |

# BIG AND LITTLE 39 STREAM RESTORATION NEAR SILVER BAY LAKE COUNTY, MN

## DRAFT 30% DESIGN - NOT FOR CONSTRUCTION
## LITTLE 39
## PLAN AND PROFILE - (1)
## STA 0+00 TO 6+00


CLIFFS
NORTHSHORE MINING CO
10 OUTER DR
SILVER BAY, MN 55614
---

BEAVER RIVER CONSULTING
BEAVER RIVER CONSULTING, LLC.
5752 EAGLE VIEW DRIVE
DULUTH, MN 55803
---

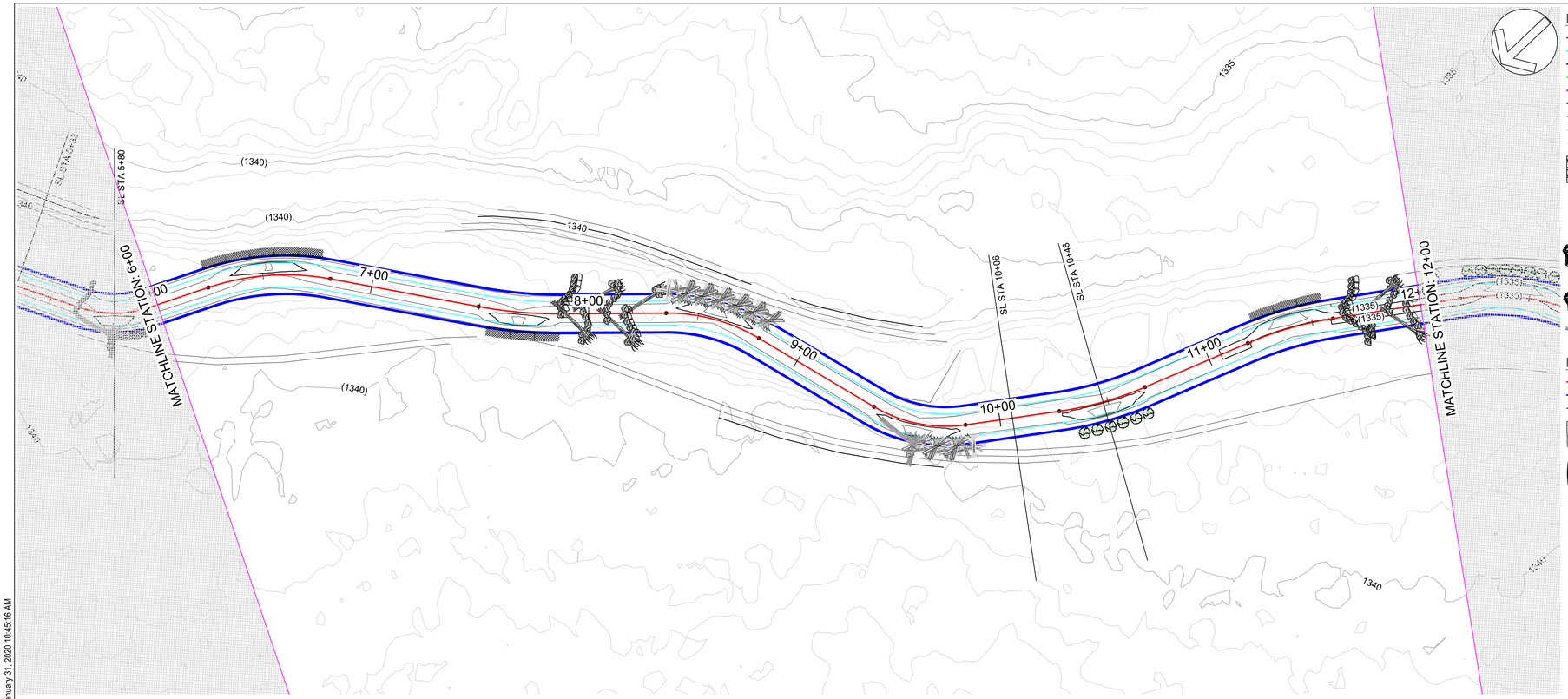

CONCEPT DESIGN
NOT FOR
CONSTRUCTION

DATE: 1/31/2020
SCALE (34"X22"): 1" = 30'
SCALE (17"X11"): 1" = 60'

0 30 60
SCALE IN FEET

SHEET NUMBER
11 OF 33


E:\DROPBOX (SSSR)\NORTHSHOREMINING\C3D\SHEETS\LITTLE39_PP.DWG | GREGTAILLACQ | SAVED: Monday, January 27, 2020 10:54:36 AM | ACAD.CTB | | PLOTTED: Friday, January 31, 2020 10:45:03 AM

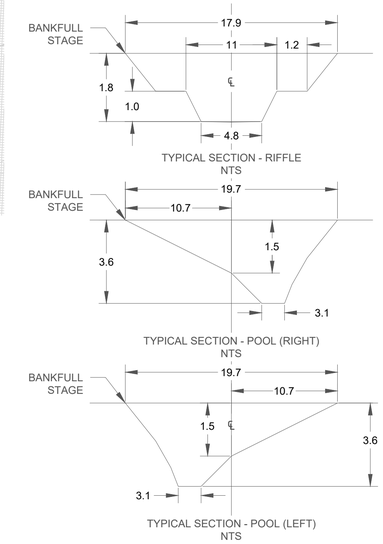


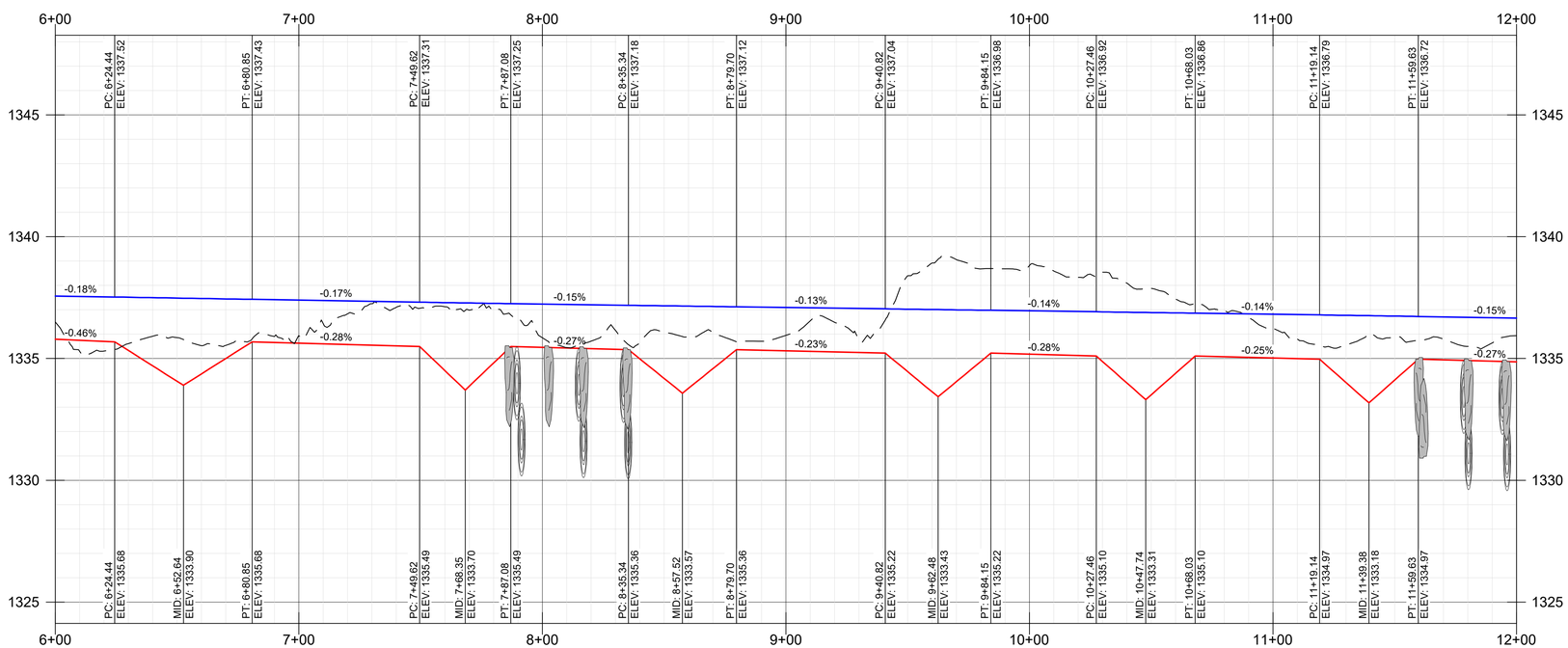

## PLAN LEGEND

- PROPOSED STREAM CENTER LINE
- PROPOSED INNER BERM
- PROPOSED GEOMORPHIC CHANNEL TOB
- PROPOSED FLOODPLAIN TOE
- LIMITS OF DISTURBANCE
- (483) PROPOSED MAJOR CONTOUR
- PROPOSED MINOR CONTOUR
- 479 EXISTING MAJOR CONTOUR
- EXISTING MINOR CONTOUR
- AUGMENTED RIFFLE
- LOG J-HOOK
- CONSTRUCTED LOG RIFFLE
- TOE WOOD
- NOT SURE?
- CONSTRUCTED RIFFLE
- BOULDER J-HOOK
- CONSTRUCTED BOULDER/LOG RIFFLE
- BOULDER TOE?
- LOG VANE
- TRANSPLANTS?

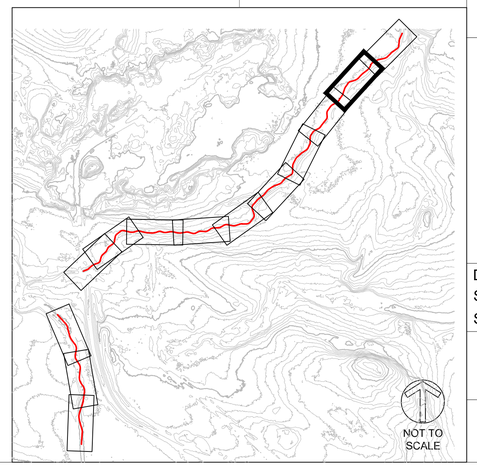
## PROFILE LEGEND

- PROPOSED STREAM CENTER LINE
- PROPOSED BANKFULL TOB
- EXISTING GROUND
- STRUCTURE BOULDER
- HEADER AND FOOTER BOULDER
- STRUCTURE LOG
- AUGMENTED RIFFLE




SCALE: HOR 1" =30'; VERT 1"= 3'




| APPROVED BY: KA | CHECKED BY: MJG | DRAWN BY: GET |
|---|---|---|
| REV | DESCRIPTION | APPRV |
| 1 | DRAFT 30% DESIGN | XX |
| XX | XX | XX |
| XX | XX | XX |
| XX | XX | XX |
| XX | XX | XX |
| XX | XX | XX |
| XX | XX | XX |
| XX | XX | XX |

# BIG AND LITTLE 39 STREAM RESTORATION NEAR SILVER BAY LAKE COUNTY, MN

## DRAFT 30% DESIGN - NOT FOR CONSTRUCTION

LITTLE 39
PLAN AND PROFILE - (2)
STA 6+00 TO 12+00


CLIFFS
NORTHSHORE MINING CO
10 OUTER DR
SILVER BAY, MN 55614
---
BEAVER RIVER CONSULTING
BEAVER RIVER CONSULTING, LLC.
5752 EAGLE VIEW DRIVE
DULUTH, MN 55803
---

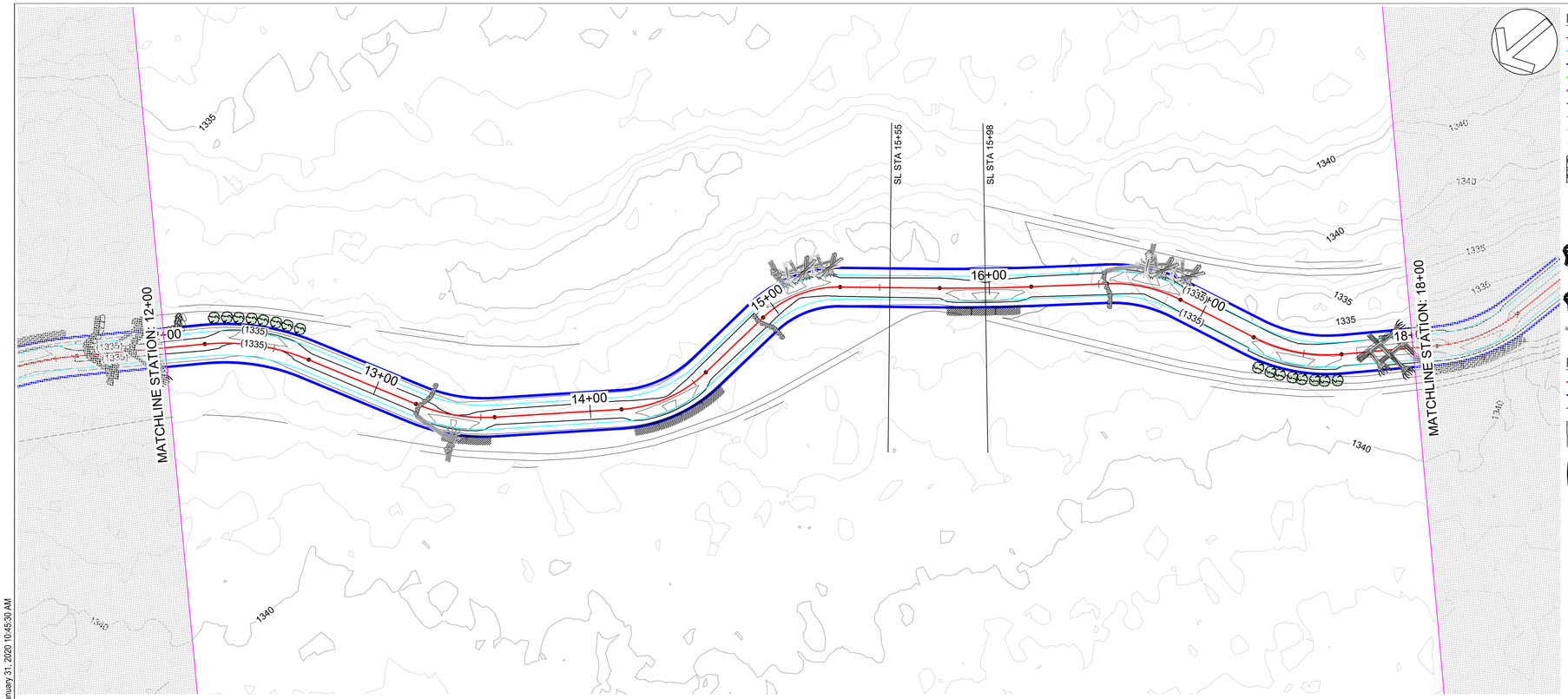

CONCEPT DESIGN
NOT FOR
CONSTRUCTION

DATE: 1/31/2020
SCALE (34"X22"): 1" = 30'
SCALE (17"X11"): 1" = 60'

0 30 60
SCALE IN FEET




E:\DROPBOX (SSSR)\NORTHSHOREMINING\C3D\SHEETS\LITTLE39_PP.DWG | GREGTAILLACQ | SAVED: Monday, January 27, 2020 10:54:36 AM | ACAD.CTB | | PLOTTED: Friday, January 31, 2020 10:45:16 AM

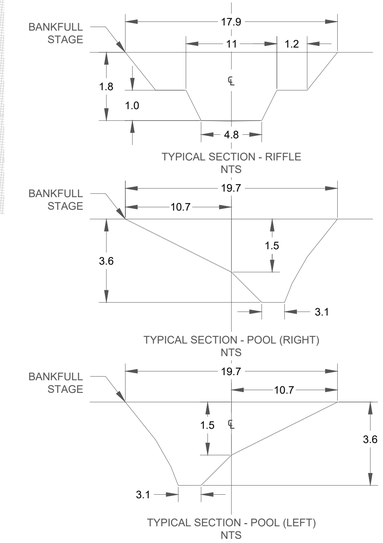


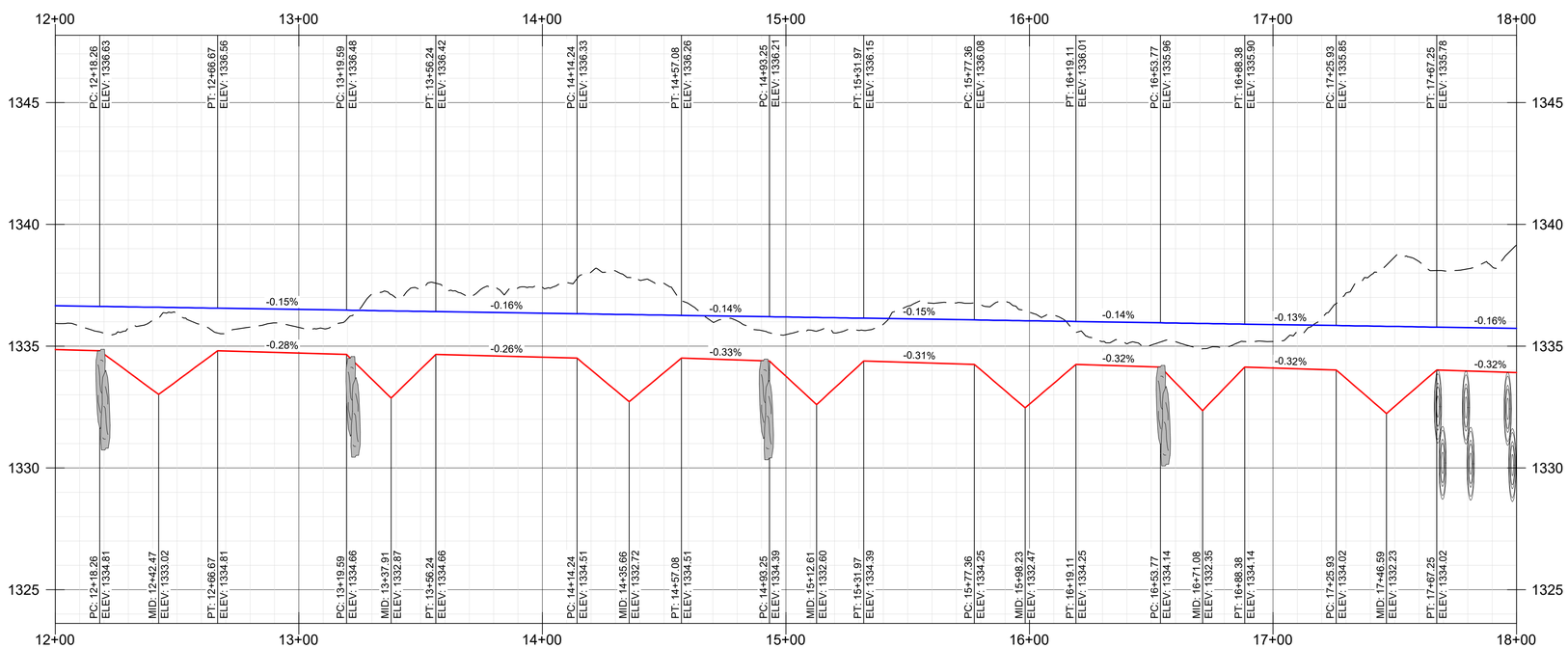

## PLAN LEGEND

- PROPOSED STREAM CENTER LINE
- PROPOSED INNER BERM
- PROPOSED GEOMORPHIC CHANNEL TOB
- PROPOSED FLOODPLAIN TOE
- LIMITS OF DISTURBANCE
- (483) PROPOSED MAJOR CONTOUR
- PROPOSED MINOR CONTOUR
- 479 EXISTING MAJOR CONTOUR
- EXISTING MINOR CONTOUR
- AUGMENTED RIFFLE
- LOG J-HOOK
- CONSTRUCTED LOG RIFFLE
- TOE WOOD
- NOT SURE?
- CONSTRUCTED RIFFLE
- BOULDER J-HOOK
- CONSTRUCTED BOULDER/LOG RIFFLE
- BOULDER TOE?
- LOG VANE
- TRANSPLANTS?

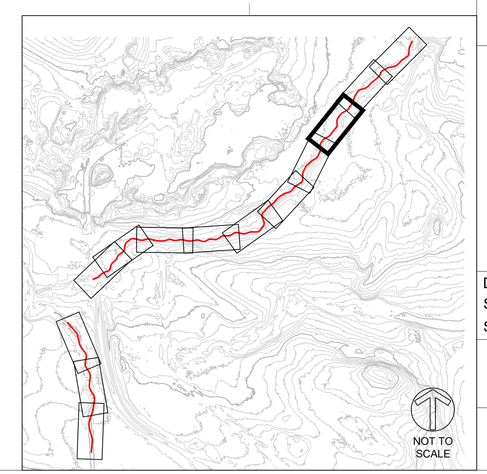
## PROFILE LEGEND

- PROPOSED STREAM CENTER LINE
- PROPOSED BANKFULL TOB
- EXISTING GROUND
- STRUCTURE BOULDER
- HEADER AND FOOTER BOULDER
- STRUCTURE LOG
- AUGMENTED RIFFLE




SCALE: HOR 1" =30'; VERT 1"= 3'




| REV | DESCRIPTION | APPROV | CHECKED BY: MJG | DRAWN BY: GET | APPROVED BY: KA |
|---|---|---|---|---|---|
| 1 | DRAFT 30% DESIGN | XX | XX | XX | XX |
| XX | XX | XX | XX | XX | XX |
| XX | XX | XX | XX | XX | XX |
| XX | XX | XX | XX | XX | XX |
| XX | XX | XX | XX | XX | XX |
| XX | XX | XX | XX | XX | XX |
| XX | XX | XX | XX | XX | XX |

# BIG AND LITTLE 39 STREAM RESTORATION NEAR SILVER BAY LAKE COUNTY, MN

## DRAFT 30% DESIGN - NOT FOR CONSTRUCTION
## LITTLE 39
## PLAN AND PROFILE - (3)
## STA 12+00 TO 18+00


CLIFFS
NORTHSHORE MINING CO
10 OUTER DR
SILVER BAY, MN 55614
---
BEAVER RIVER CONSULTING
BEAVER RIVER CONSULTING, LLC.
5752 EAGLE VIEW DRIVE
DULUTH, MN 55803
---

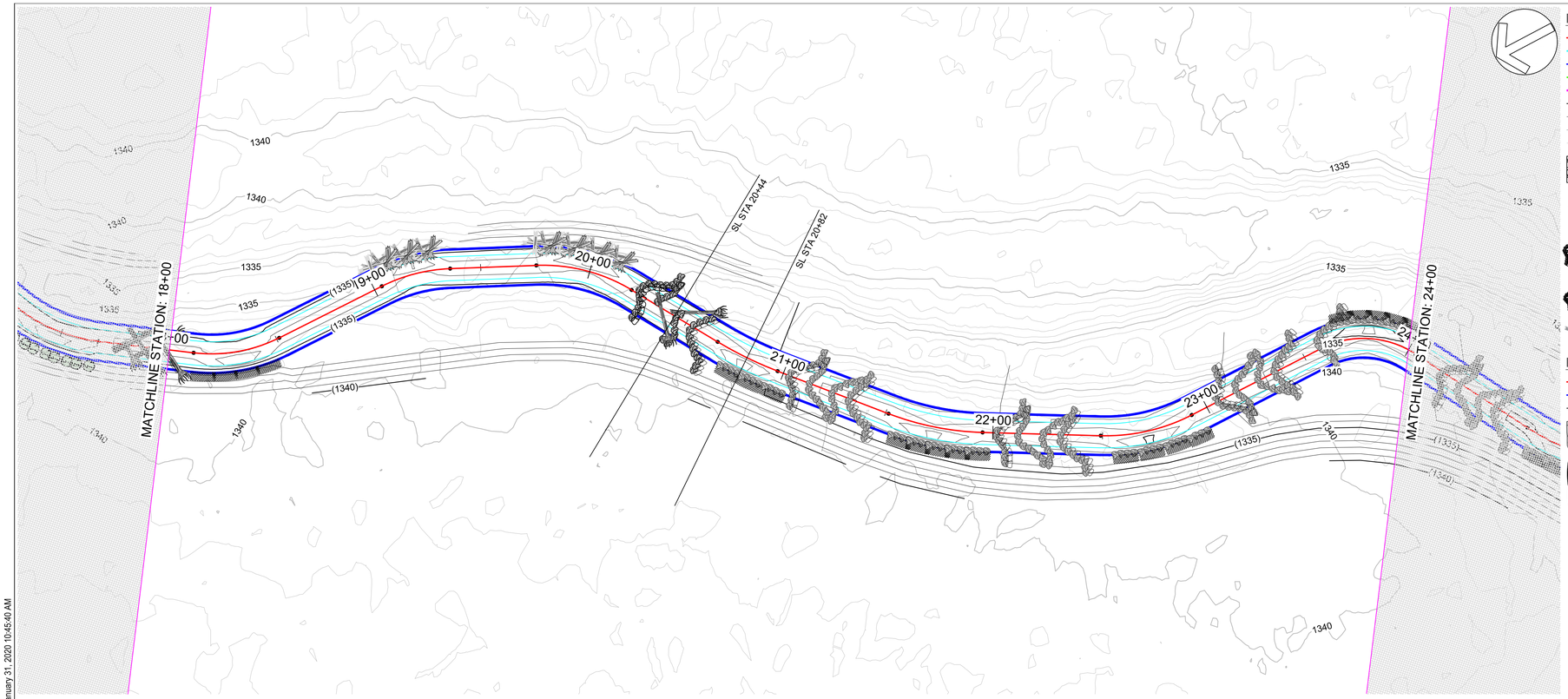

CONCEPT DESIGN
NOT FOR
CONSTRUCTION

DATE: 1/31/2020
SCALE (34"X22"): 1" = 30'
SCALE (17"X11"): 1" = 60'

0 30 60
SCALE IN FEET

SHEET NUMBER
13 OF 33


E:\DROPBOX (SSSR)\NORTHSHOREMINING\C3D\SHEETS\LITTLE39_PP.DWG | GREGSTAILLACQ | SAVED: Monday, January 27, 2020 10:54:36 AM | ACAD.CTB | | PLOTTED: Friday, January 31, 2020 10:45:30 AM

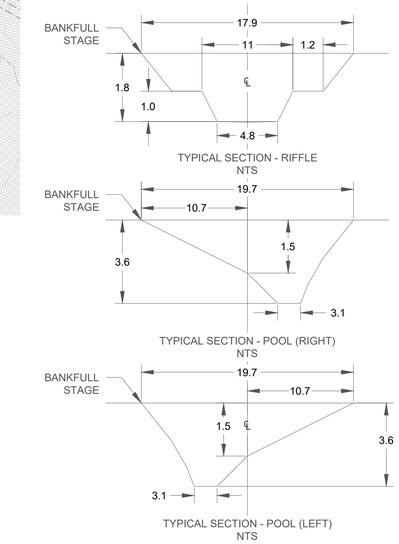


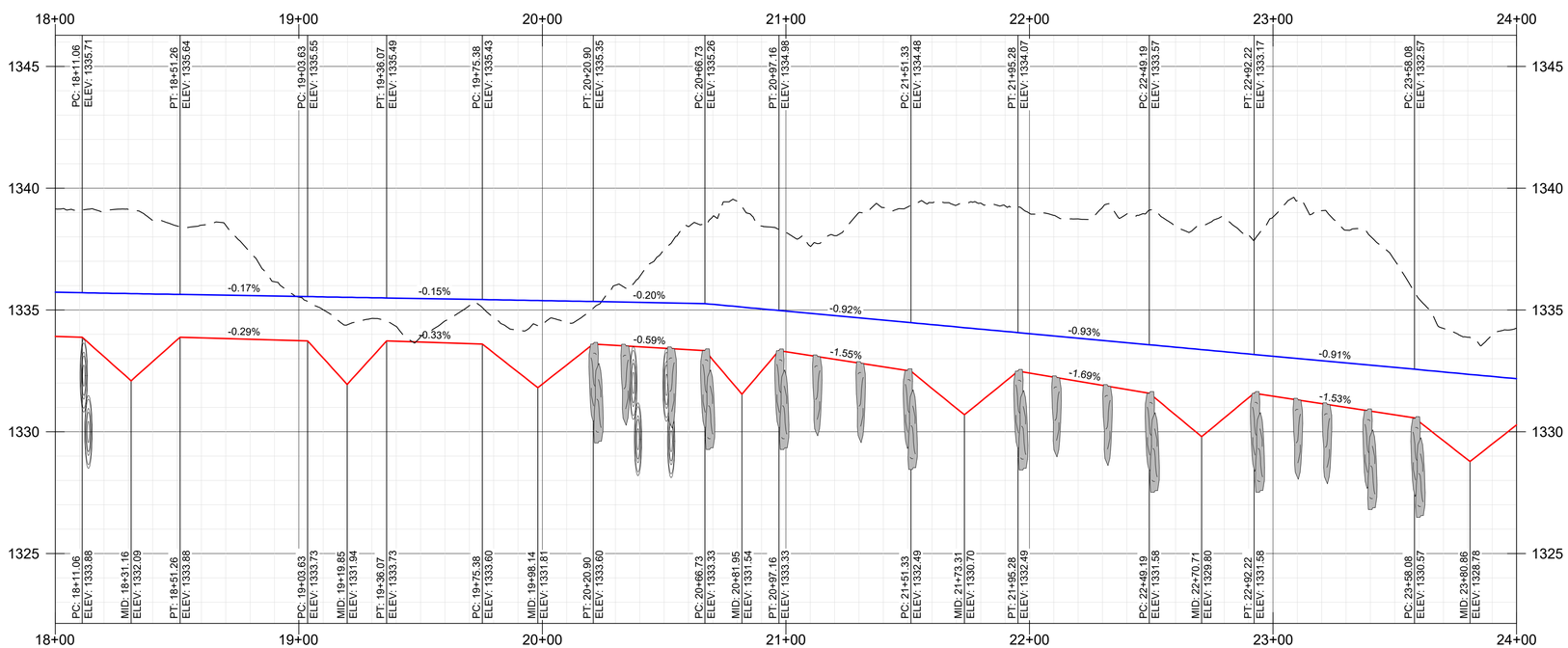

## PLAN LEGEND

- PROPOSED STREAM CENTER LINE
- PROPOSED INNER BERM
- PROPOSED GEOMORPHIC CHANNEL TOB
- PROPOSED FLOODPLAIN TOE
- LIMITS OF DISTURBANCE
- (483) PROPOSED MAJOR CONTOUR
- PROPOSED MINOR CONTOUR
- 479 EXISTING MAJOR CONTOUR
- EXISTING MINOR CONTOUR
- AUGMENTED RIFFLE
- LOG J-HOOK
- CONSTRUCTED LOG RIFFLE
- TOE WOOD
- NOT SURE?
- CONSTRUCTED RIFFLE
- BOULDER J-HOOK
- CONSTRUCTED BOULDER/LOG RIFFLE
- BOULDER TOE?
- LOG VANE
- TRANSPLANTS?

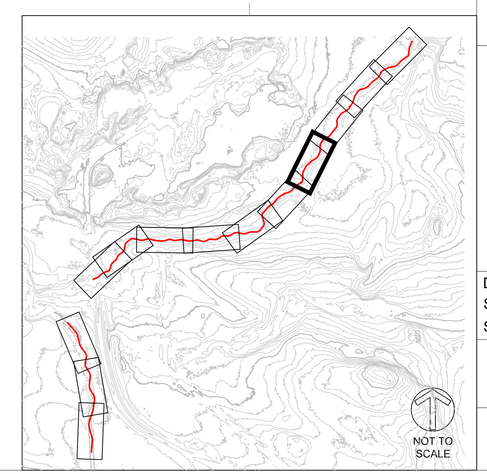
## PROFILE LEGEND

- PROPOSED STREAM CENTER LINE
- PROPOSED BANKFULL TOB
- EXISTING GROUND
- STRUCTURE BOULDER
- HEADER AND FOOTER BOULDER
- STRUCTURE LOG
- AUGMENTED RIFFLE




SCALE: HOR 1" =30'; VERT 1"= 3'




| REV | DESCRIPTION | APPROVED BY: KA | CHECKED BY: MJG | DRAWN BY: GET | APPRV |
|---|---|---|---|---|---|
| 1 | DRAFT 30% DESIGN | XX | XX | XX | XX |
| XX | | XX | XX | XX | XX |
| XX | | XX | XX | XX | XX |
| XX | | XX | XX | XX | XX |
| XX | | XX | XX | XX | XX |
| XX | | XX | XX | XX | XX |
| XX | | XX | XX | XX | XX |

# BIG AND LITTLE 39 STREAM RESTORATION NEAR SILVER BAY LAKE COUNTY, MN

## DRAFT 30% DESIGN - NOT FOR CONSTRUCTION
LITTLE 39
PLAN AND PROFILE - (4)
STA 18+00 TO 24+00


CLIFFS
NORTHSHORE MINING CO
10 OUTER DR
SILVER BAY, MN 55614
---
BEAVER RIVER CONSULTING
BEAVER RIVER CONSULTING, LLC.
5752 EAGLE VIEW DRIVE
DULUTH, MN 55803
---

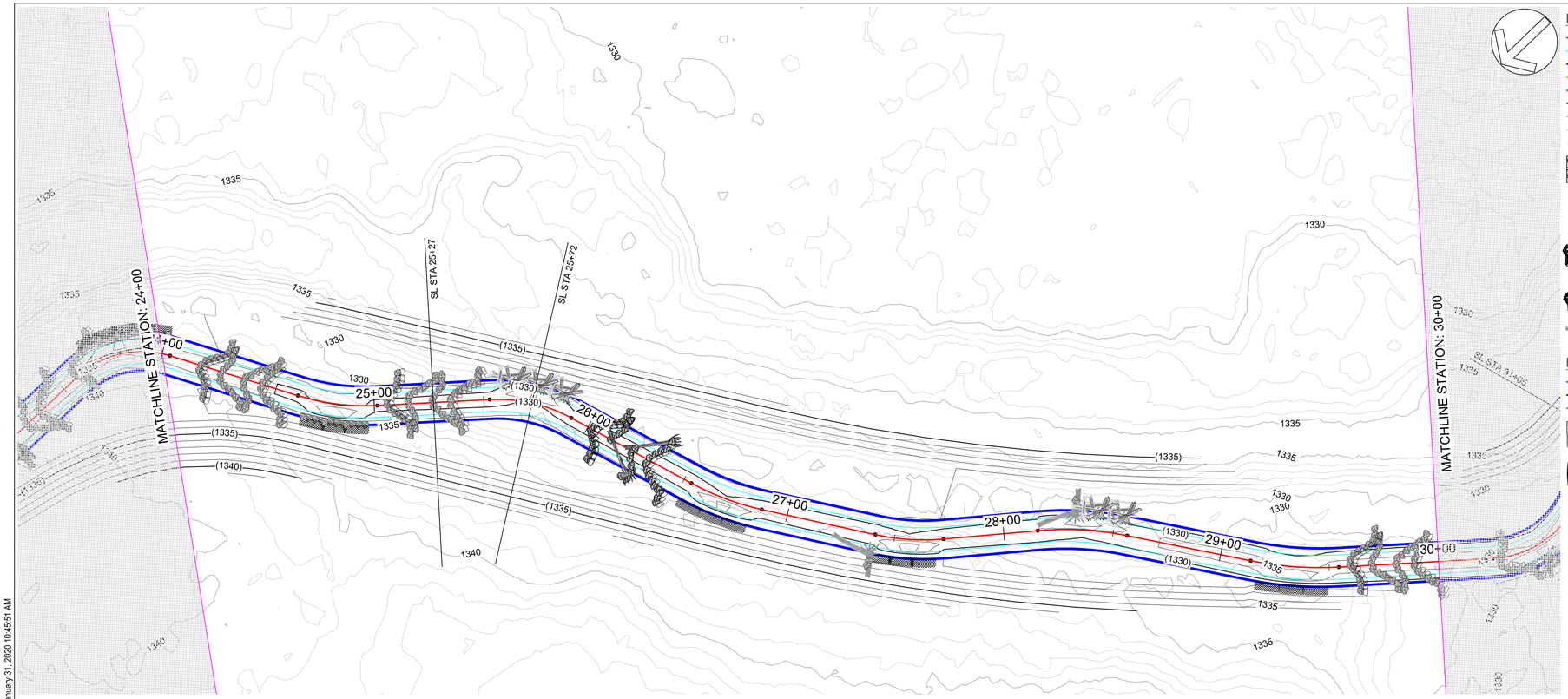

CONCEPT DESIGN
NOT FOR
CONSTRUCTION

DATE: 1/31/2020
SCALE (34"X22"): 1" = 30'
SCALE (17"X11"): 1" = 60'

0 30 60
SCALE IN FEET




E:\DROPBOX (SSSR)\NORTHSHOREMINING\C3D\SHEETS\LITTLE39_PP.DWG | GREGTAILLACQ | SAVED: Monday, January 27, 2020 10:54:36 AM | ACAD.CTB | | PLOTTED: Friday, January 31, 2020 10:45:40 AM

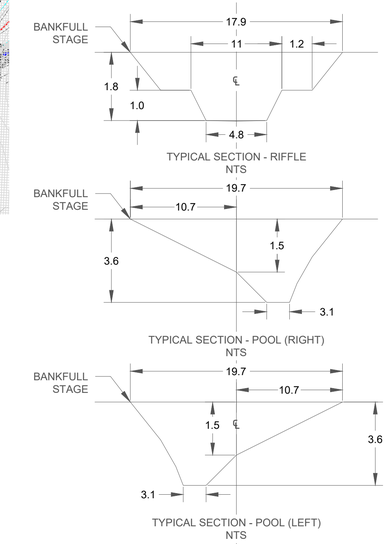


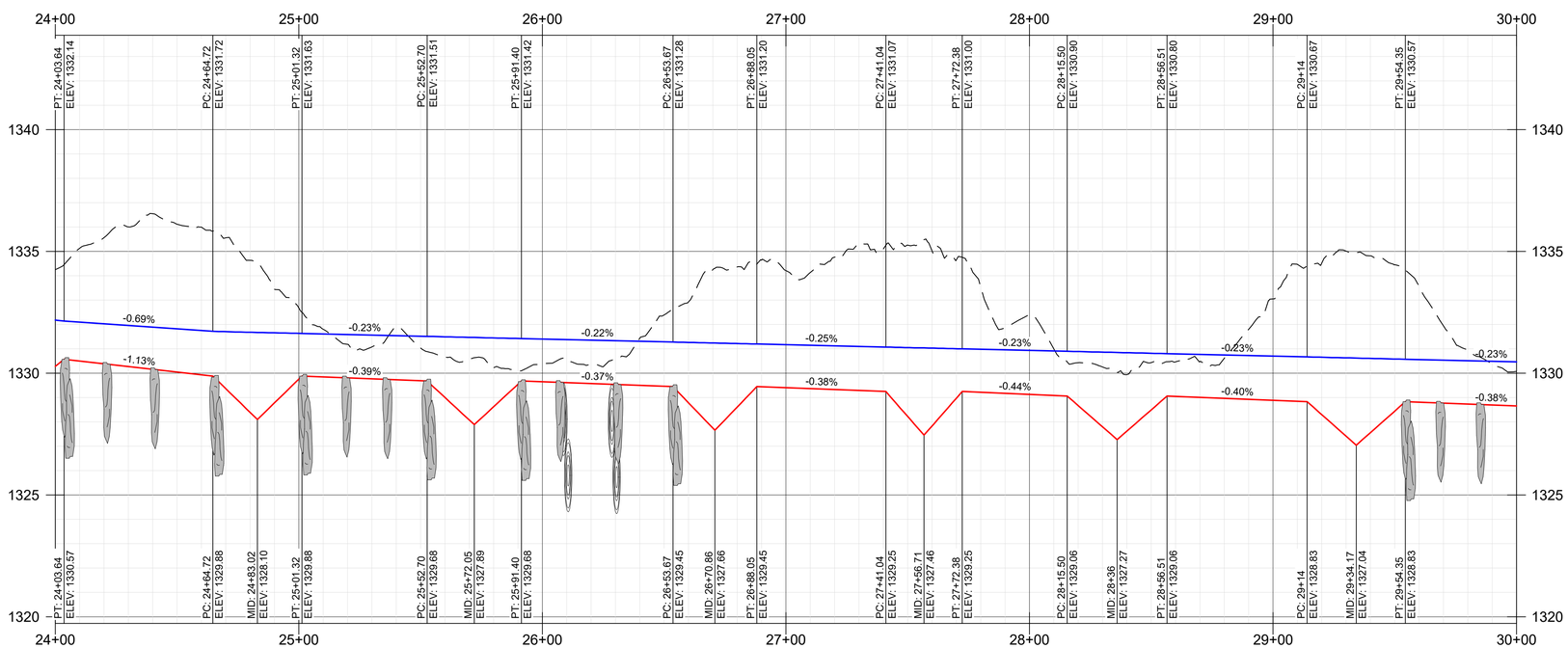

## PLAN LEGEND

- PROPOSED STREAM CENTER LINE
- PROPOSED INNER BERM
- PROPOSED GEOMORPHIC CHANNEL TOB
- PROPOSED FLOODPLAIN TOE
- LIMITS OF DISTURBANCE
- (483) PROPOSED MAJOR CONTOUR
- PROPOSED MINOR CONTOUR
- 479 EXISTING MAJOR CONTOUR
- EXISTING MINOR CONTOUR
- AUGMENTED RIFFLE
- LOG J-HOOK
- CONSTRUCTED LOG RIFFLE
- TOE WOOD
- NOT SURE?
- CONSTRUCTED RIFFLE
- BOULDER J-HOOK
- CONSTRUCTED BOULDER/LOG RIFFLE
- BOULDER TOE?
- LOG VANE
- TRANSPLANTS?

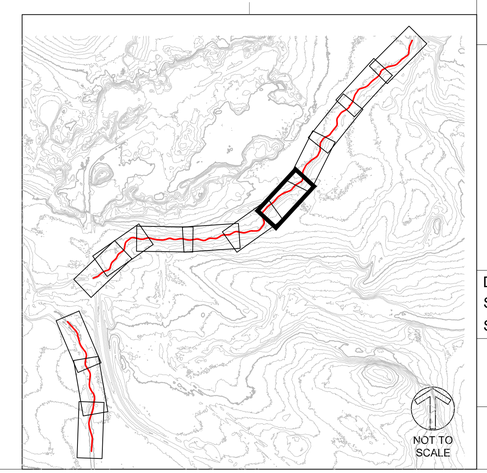
## PROFILE LEGEND

- PROPOSED STREAM CENTER LINE
- PROPOSED BANKFULL TOB
- EXISTING GROUND
- STRUCTURE BOULDER
- HEADER AND FOOTER BOULDER
- STRUCTURE LOG
- AUGMENTED RIFFLE




SCALE: HOR 1" =30'; VERT 1"= 3'




| REV | DESCRIPTION | APPROVED BY: KA | CHECKED BY: MJG | DRAWN BY: GET | APPRV |
|---|---|---|---|---|---|
| 1 | DRAFT 30% DESIGN | | | | XX |
| XX | | XX | XX | XX | XX |
| XX | | XX | XX | XX | XX |
| XX | | XX | XX | XX | XX |
| XX | | XX | XX | XX | XX |
| XX | | XX | XX | XX | XX |
| XX | | XX | XX | XX | XX |

# BIG AND LITTLE 39 STREAM RESTORATION NEAR SILVER BAY LAKE COUNTY, MN

## DRAFT 30% DESIGN - NOT FOR CONSTRUCTION
## LITTLE 39
## PLAN AND PROFILE - (6)
## STA 24+00 TO 30+00


CLIFFS
NORTHSHORE MINING CO
10 OUTER DR
SILVER BAY, MN 55614
---
BEAVER RIVER CONSULTING
BEAVER RIVER CONSULTING, LLC.
5752 EAGLE VIEW DRIVE
DULUTH, MN 55803
---

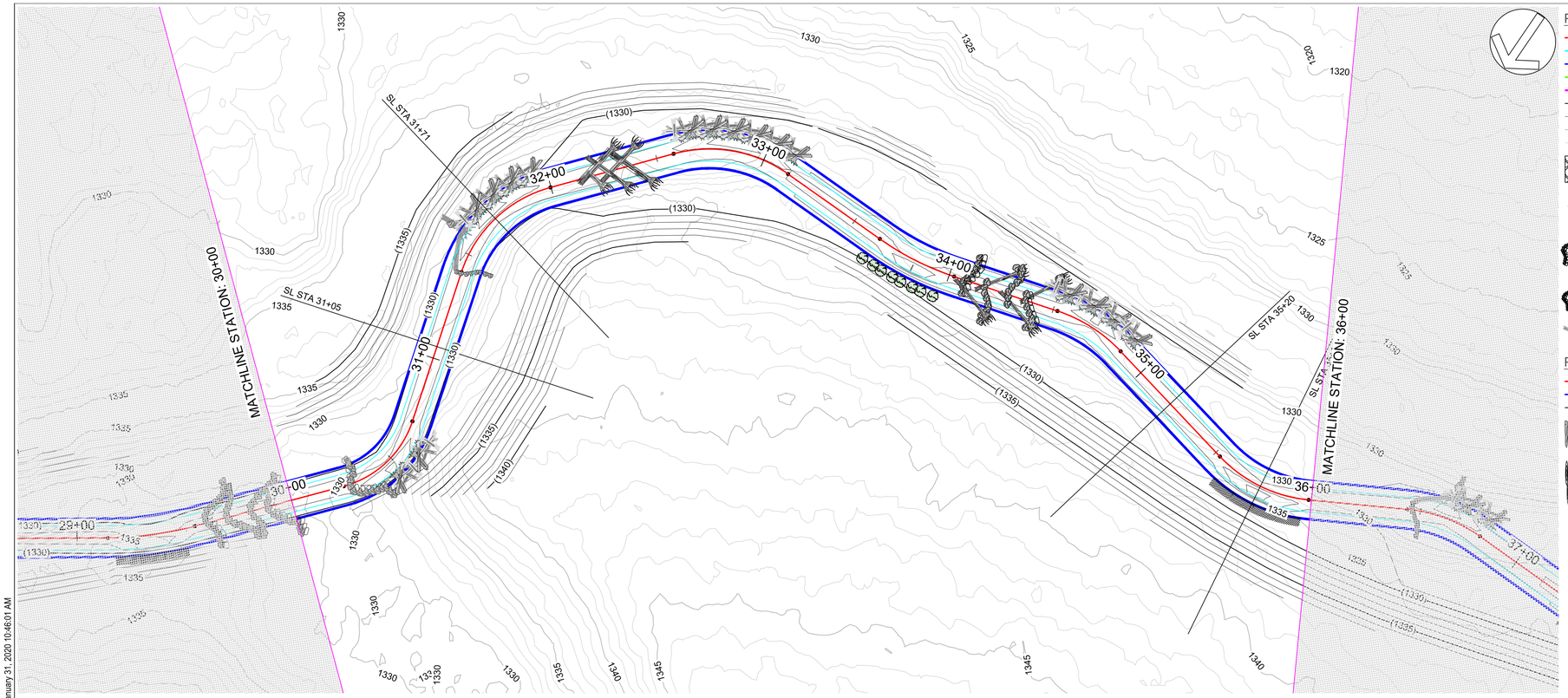

CONCEPT DESIGN
NOT FOR
CONSTRUCTION

DATE: 1/31/2020
SCALE (34"X22"): 1" = 30'
SCALE (17"X11"): 1" = 60'

0 30 60
SCALE IN FEET

SHEET NUMBER
15 OF 33


E:\DROPBOX (SSSR)\NORTHSHOREMINING\C3D\SHEETS\LITTLE39_PP.DWG | GREGTAILLACQ | SAVED: Monday, January 27, 2020 10:54:36 AM | ACAD.CTB | | PLOTTED: Friday, January 31, 2020 10:45:51 AM

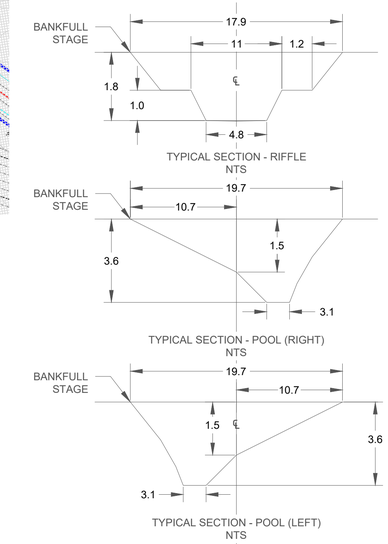


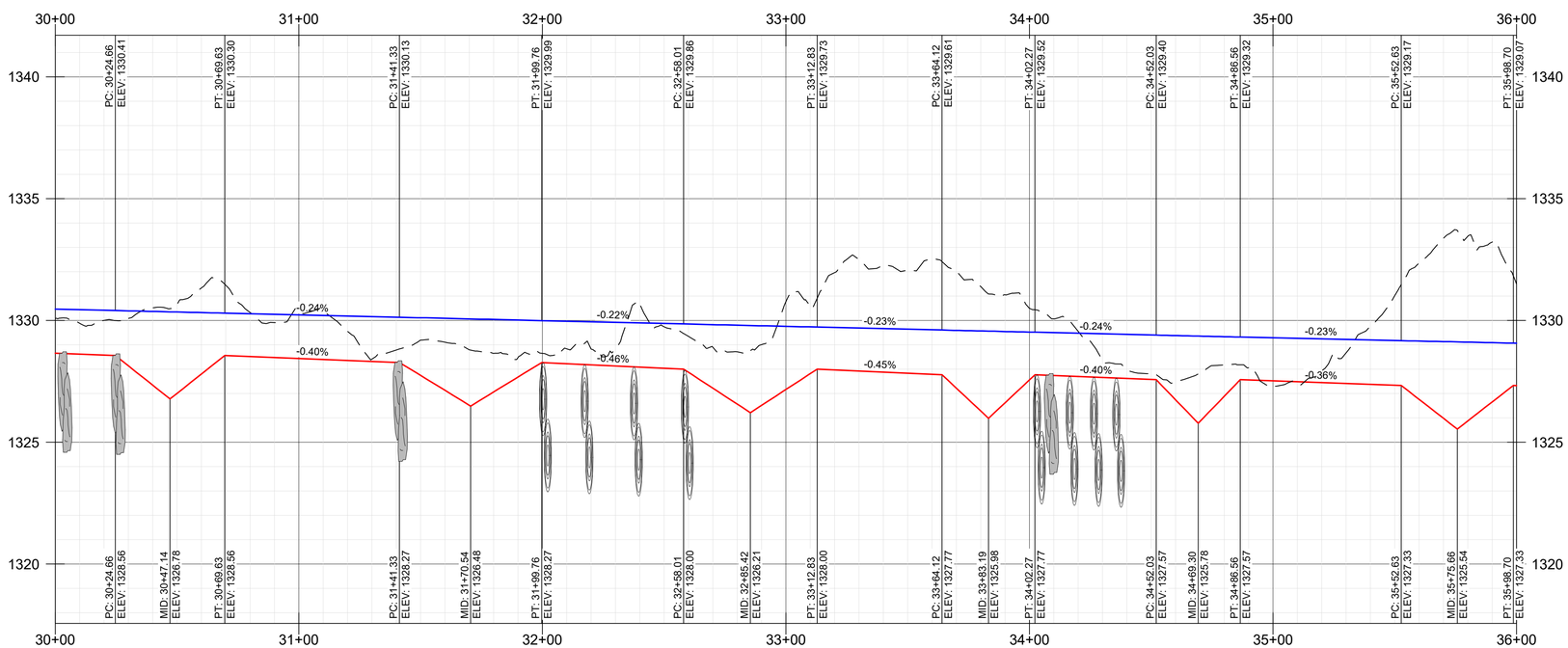

## PLAN LEGEND

- PROPOSED STREAM CENTER LINE
- PROPOSED INNER BERM
- PROPOSED GEOMORPHIC CHANNEL TOB
- PROPOSED FLOODPLAIN TOE
- LIMITS OF DISTURBANCE
- (483) PROPOSED MAJOR CONTOUR
- PROPOSED MINOR CONTOUR
- 479 EXISTING MAJOR CONTOUR
- EXISTING MINOR CONTOUR
- AUGMENTED RIFFLE
- LOG J-HOOK
- CONSTRUCTED LOG RIFFLE
- TOE WOOD
- NOT SURE?
- CONSTRUCTED RIFFLE
- BOULDER J-HOOK
- CONSTRUCTED BOULDER/LOG RIFFLE
- BOULDER TOE?
- LOG VANE
- TRANSPLANTS?

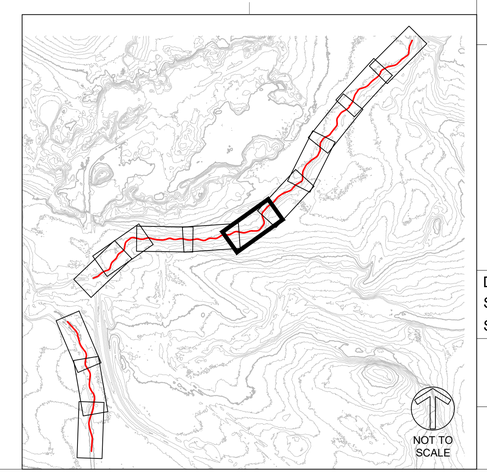
## PROFILE LEGEND

- PROPOSED STREAM CENTER LINE
- PROPOSED BANKFULL TOB
- EXISTING GROUND
- STRUCTURE BOULDER
- HEADER AND FOOTER BOULDER
- STRUCTURE LOG
- AUGMENTED RIFFLE




SCALE: HOR 1" =30'; VERT 1"= 3'




| REV | DESCRIPTION | APPROVED BY: KA | CHECKED BY: MJG | DRAWN BY: GET | APPRV |
|---|---|---|---|---|---|
| 1 | DRAFT 30% DESIGN | XX | XX | XX | XX |
| XX | | XX | XX | XX | XX |
| XX | | XX | XX | XX | XX |
| XX | | XX | XX | XX | XX |
| XX | | XX | XX | XX | XX |
| XX | | XX | XX | XX | XX |
| XX | | XX | XX | XX | XX |

# BIG AND LITTLE 39 STREAM RESTORATION NEAR SILVER BAY LAKE COUNTY, MN

## DRAFT 30% DESIGN - NOT FOR CONSTRUCTION

LITTLE 39
PLAN AND PROFILE - (6)
STA 30+00 TO 36+00


CLIFFS
NORTHSHORE MINING CO
10 OUTER DR
SILVER BAY, MN 55614
---
BEAVER RIVER CONSULTING
BEAVER RIVER CONSULTING, LLC.
5752 EAGLE VIEW DRIVE
DULUTH, MN 55803
---

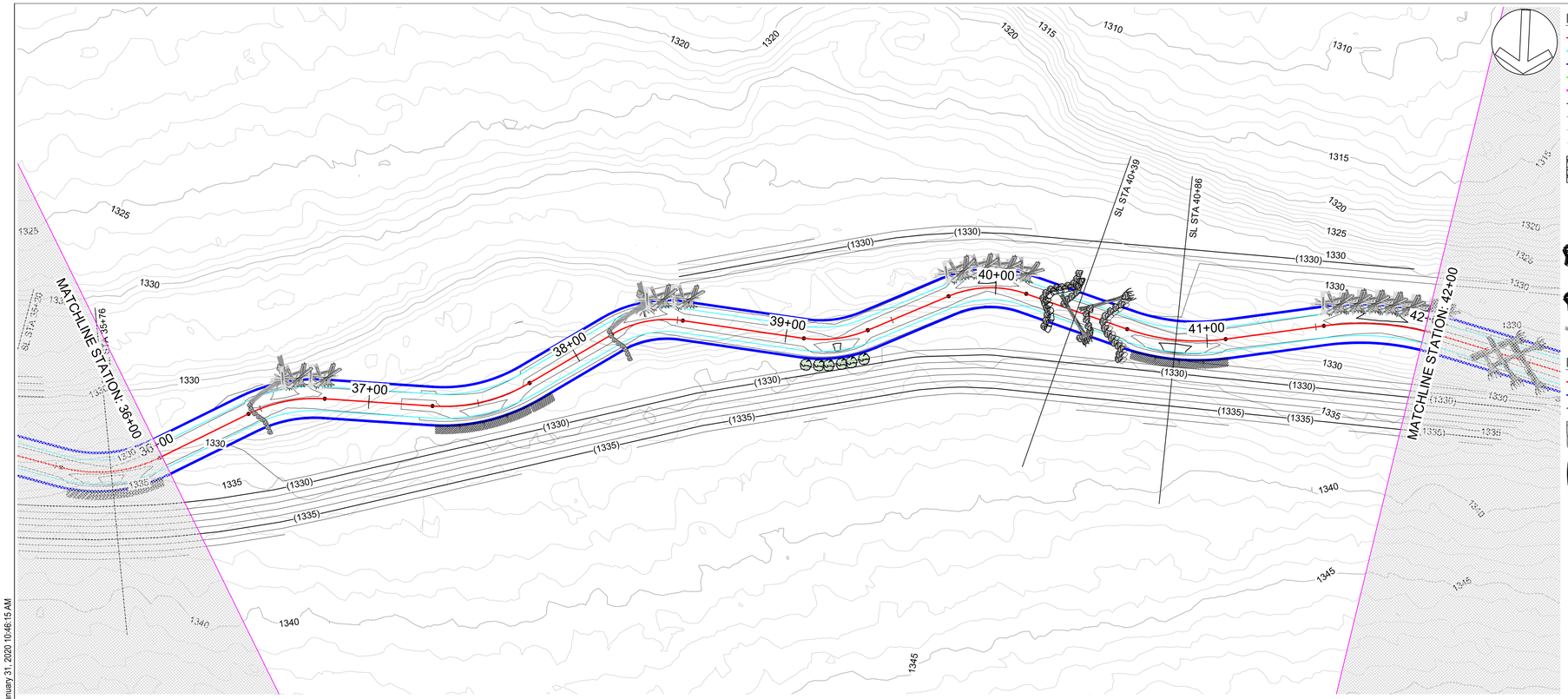

CONCEPT DESIGN
NOT FOR
CONSTRUCTION

DATE: 1/31/2020
SCALE (34"X22"): 1" = 30'
SCALE (17"X11"): 1" = 60'

0 30 60
SCALE IN FEET




E:\DROPBOX (SSSR)\NORTHSHOREMINING\C3D\SHEETS\LITTLE39_PP.DWG | GREGTAILLACQ | SAVED: Monday, January 27, 2020 10:54:36 AM | ACAD.CTB | | PLOTTED: Friday, January 31, 2020 10:46:01 AM

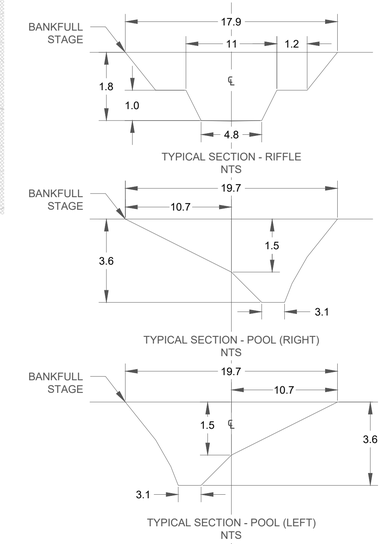


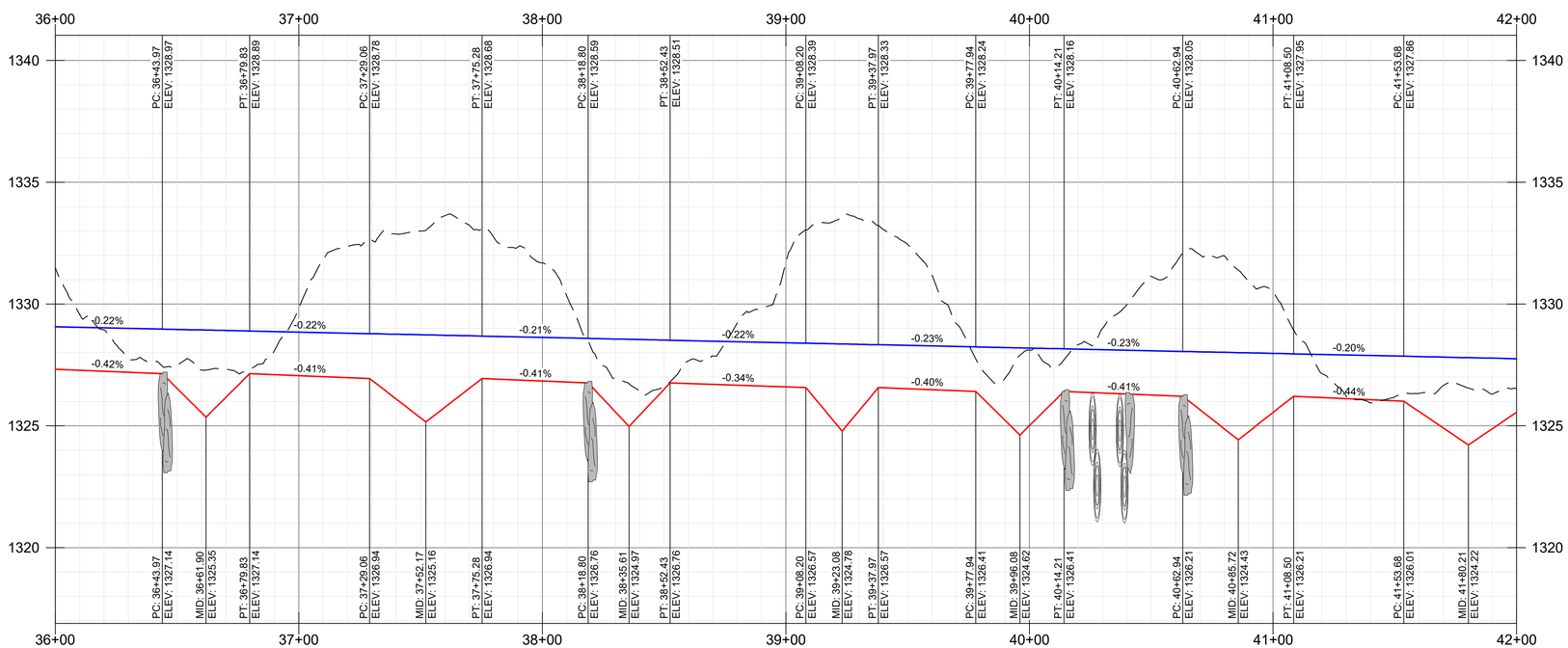

## PLAN LEGEND

- PROPOSED STREAM CENTER LINE
- PROPOSED INNER BERM
- PROPOSED GEOMORPHIC CHANNEL TOB
- PROPOSED FLOODPLAIN TOE
- LIMITS OF DISTURBANCE
- (483) PROPOSED MAJOR CONTOUR
- PROPOSED MINOR CONTOUR
- 479 EXISTING MAJOR CONTOUR
- EXISTING MINOR CONTOUR
- AUGMENTED RIFFLE
- LOG J-HOOK
- CONSTRUCTED LOG RIFFLE
- TOE WOOD
- NOT SURE?
- CONSTRUCTED RIFFLE
- BOULDER J-HOOK
- CONSTRUCTED BOULDER/LOG RIFFLE
- BOULDER TOE?
- LOG VANE
- TRANSPLANTS?

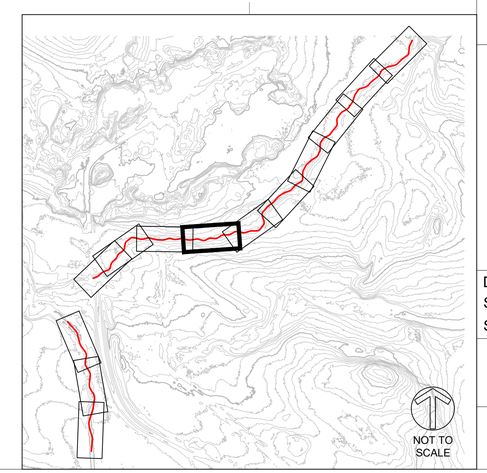
## PROFILE LEGEND

- PROPOSED STREAM CENTER LINE
- PROPOSED BANKFULL TOB
- EXISTING GROUND
- STRUCTURE BOULDER
- HEADER AND FOOTER BOULDER
- STRUCTURE LOG
- AUGMENTED RIFFLE




SCALE: HOR 1" =30'; VERT 1"= 3'




| REV | DESCRIPTION | APPROVED BY: KA | CHECKED BY: MJG | DRAWN BY: GET | APPRV |
|---|---|---|---|---|---|
| 1 | DRAFT 30% DESIGN | XX | XX | XX | XX |
| XX | | XX | XX | XX | XX |
| XX | | XX | XX | XX | XX |
| XX | | XX | XX | XX | XX |
| XX | | XX | XX | XX | XX |
| XX | | XX | XX | XX | XX |
| XX | | XX | XX | XX | XX |

# BIG AND LITTLE 39 STREAM RESTORATION NEAR SILVER BAY LAKE COUNTY, MN

## DRAFT 30% DESIGN - NOT FOR CONSTRUCTION
LITTLE 39
PLAN AND PROFILE - (7)
STA 36+00 TO 42+00


CLIFFS
NORTHSHORE MINING CO
10 OUTER DR
SILVER BAY, MN 55614
---
BEAVER RIVER CONSULTING
BEAVER RIVER CONSULTING, LLC.
5752 EAGLE VIEW DRIVE
DULUTH, MN 55803
---

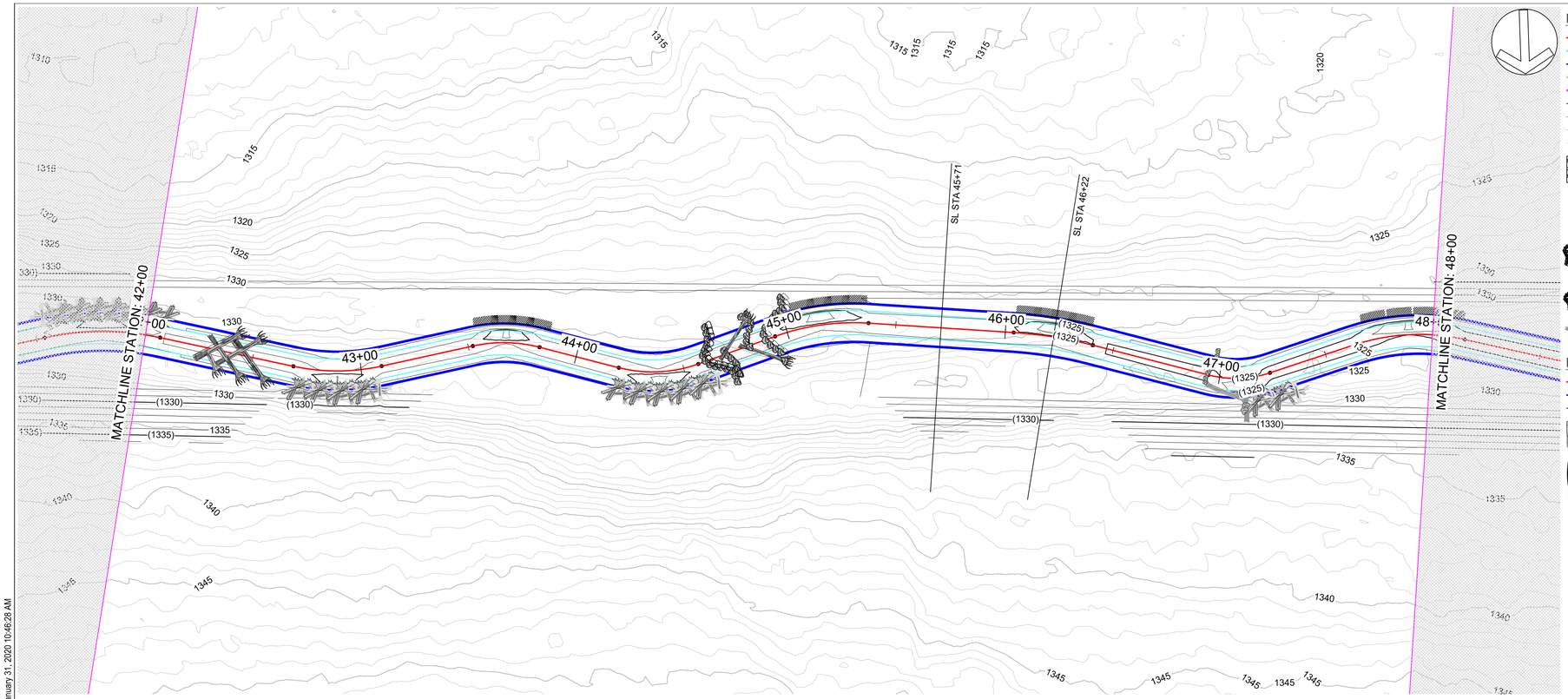

CONCEPT DESIGN
NOT FOR
CONSTRUCTION

DATE: 1/31/2020
SCALE (34"X22"): 1" = 30'
SCALE (17"X11"): 1" = 60'

0 30 60
SCALE IN FEET




E:\DROPBOX (SSSR)\NORTHSHOREMINING\C3D\SHEETS\LITTLE39_PP.DWG | GREGSTAILLACQ | SAVED: Monday, January 27, 2020 10:54:36 AM | ACAD.CTB | | PLOTTED: Friday, January 31, 2020 10:46:15 AM

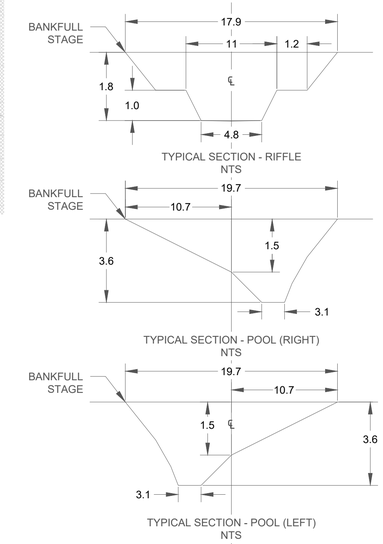


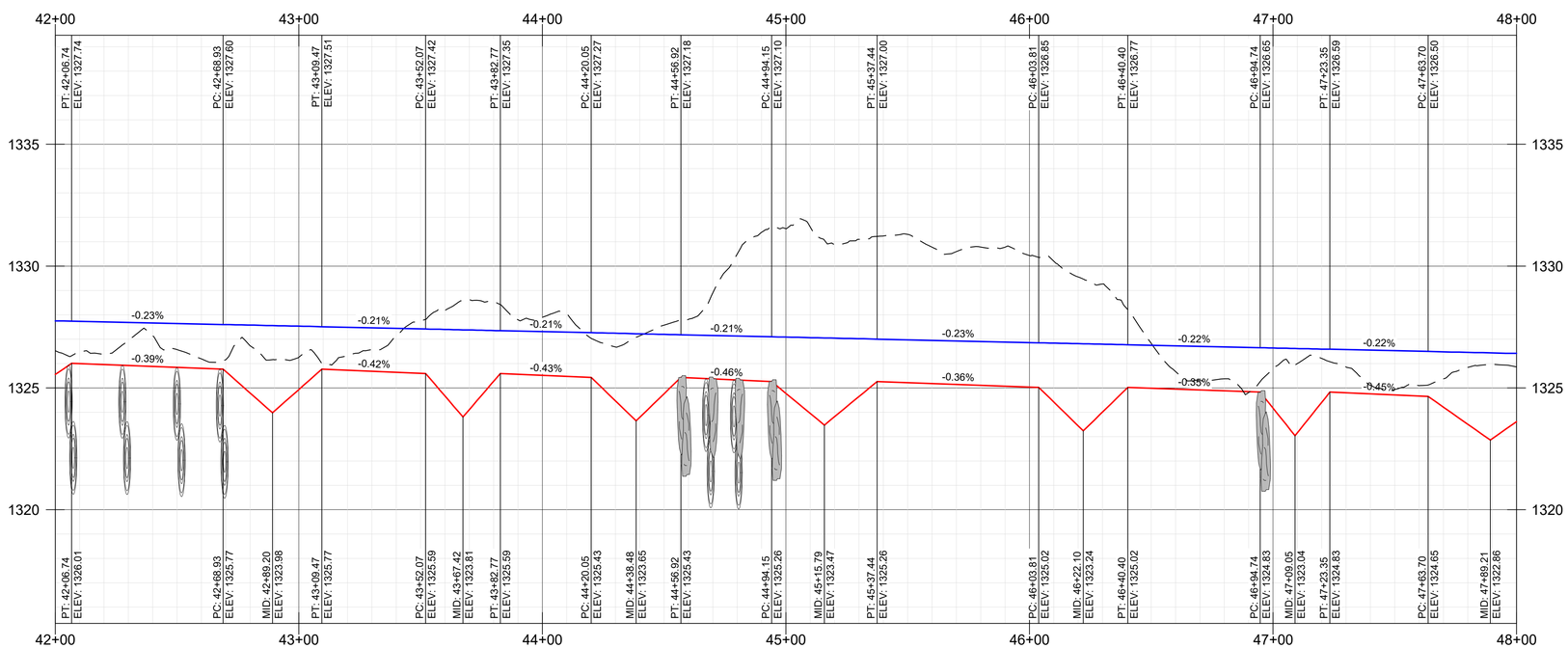

## PLAN LEGEND

- PROPOSED STREAM CENTER LINE
- PROPOSED INNER BERM
- PROPOSED GEOMORPHIC CHANNEL TOB
- PROPOSED FLOODPLAIN TOE
- LIMITS OF DISTURBANCE
- (483) PROPOSED MAJOR CONTOUR
- PROPOSED MINOR CONTOUR
- 479 EXISTING MAJOR CONTOUR
- EXISTING MINOR CONTOUR
- AUGMENTED RIFFLE
- LOG J-HOOK
- CONSTRUCTED LOG RIFFLE
- TOE WOOD
- NOT SURE?
- CONSTRUCTED RIFFLE
- BOULDER J-HOOK
- CONSTRUCTED BOULDER/LOG RIFFLE
- BOULDER TOE?
- LOG VANE
- TRANSPLANTS?

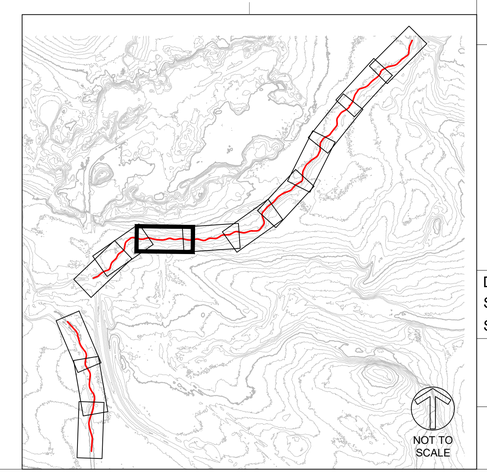
## PROFILE LEGEND

- PROPOSED STREAM CENTER LINE
- PROPOSED BANKFULL TOB
- EXISTING GROUND
- STRUCTURE BOULDER
- HEADER AND FOOTER BOULDER
- STRUCTURE LOG
- AUGMENTED RIFFLE




SCALE: HOR 1" =30'; VERT 1"= 3'




| REV | DESCRIPTION | APPROVED BY: KA | CHECKED BY: MJG | DRAWN BY: GET | APPRV |
|---|---|---|---|---|---|
| 1 | DRAFT 30% DESIGN | XX | XX | XX | XX |
| XX | | XX | XX | XX | XX |
| XX | | XX | XX | XX | XX |
| XX | | XX | XX | XX | XX |
| XX | | XX | XX | XX | XX |
| XX | | XX | XX | XX | XX |
| XX | | XX | XX | XX | XX |

# BIG AND LITTLE 39 STREAM RESTORATION NEAR SILVER BAY LAKE COUNTY, MN

## DRAFT 30% DESIGN - NOT FOR CONSTRUCTION
## LITTLE 39
## PLAN AND PROFILE - (8)
## STA 42+00 TO 48+00


CLIFFS
NORTHSHORE MINING CO
10 OUTER DR
SILVER BAY, MN 55614
---
BEAVER RIVER CONSULTING
BEAVER RIVER CONSULTING, LLC.
5752 EAGLE VIEW DRIVE
DULUTH, MN 55803
---

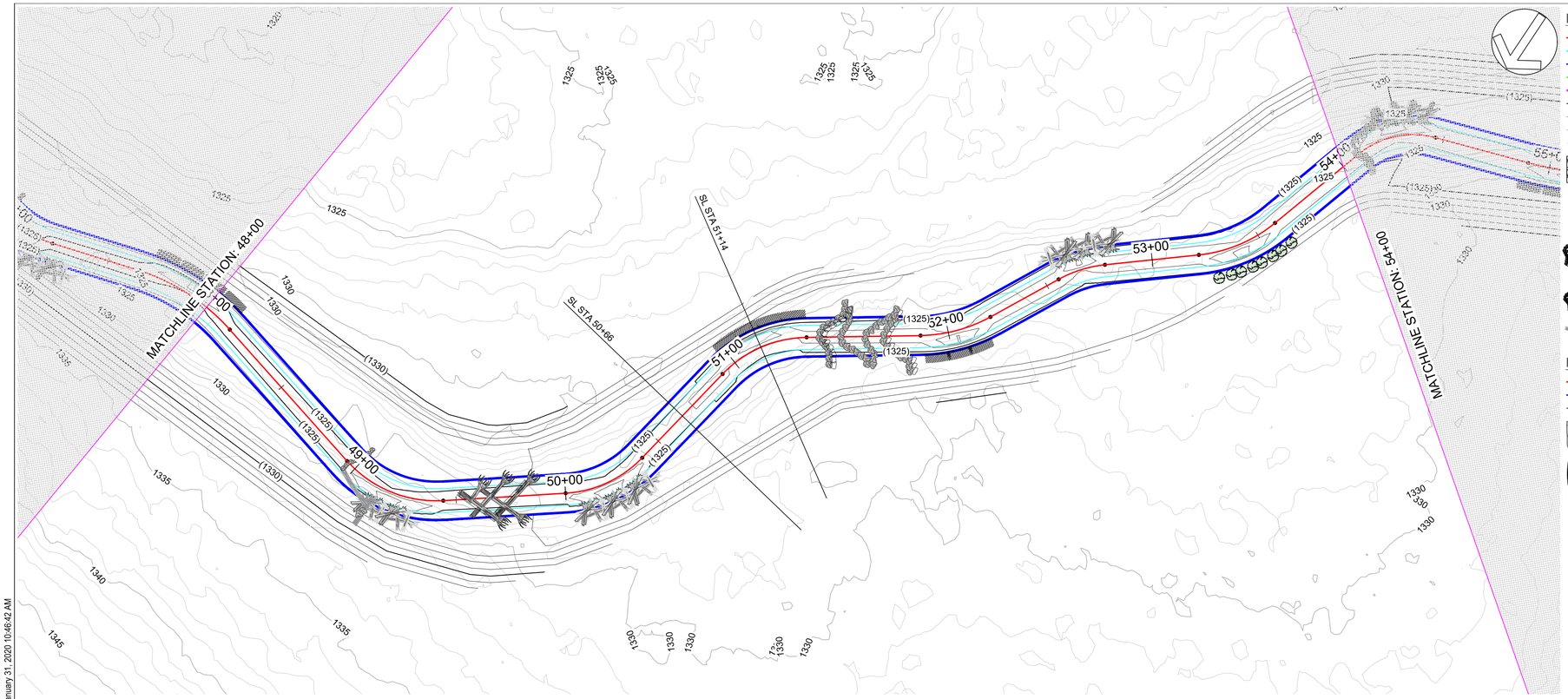

CONCEPT DESIGN
NOT FOR
CONSTRUCTION

DATE: 1/31/2020
SCALE (34"X22"): 1" = 30'
SCALE (17"X11"): 1" = 60'

0 30 60
SCALE IN FEET

SHEET NUMBER
18 OF 33


E:\DROPBOX (SSSR)\NORTHSHOREMINING\C3D\SHEETS\LITTLE39_PP.DWG | GREGTAILLACQ | SAVED: Monday, January 27, 2020 10:54:36 AM | ACAD.CTB | | PLOTTED: Friday, January 31, 2020 10:46:28 AM

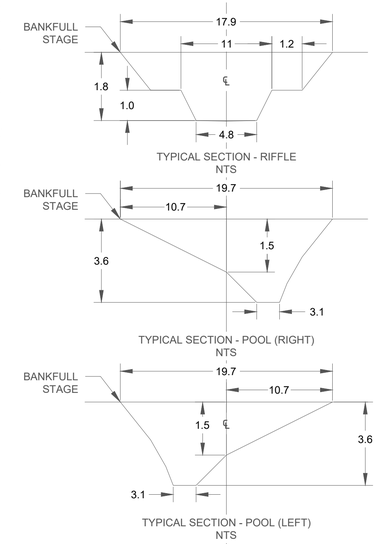


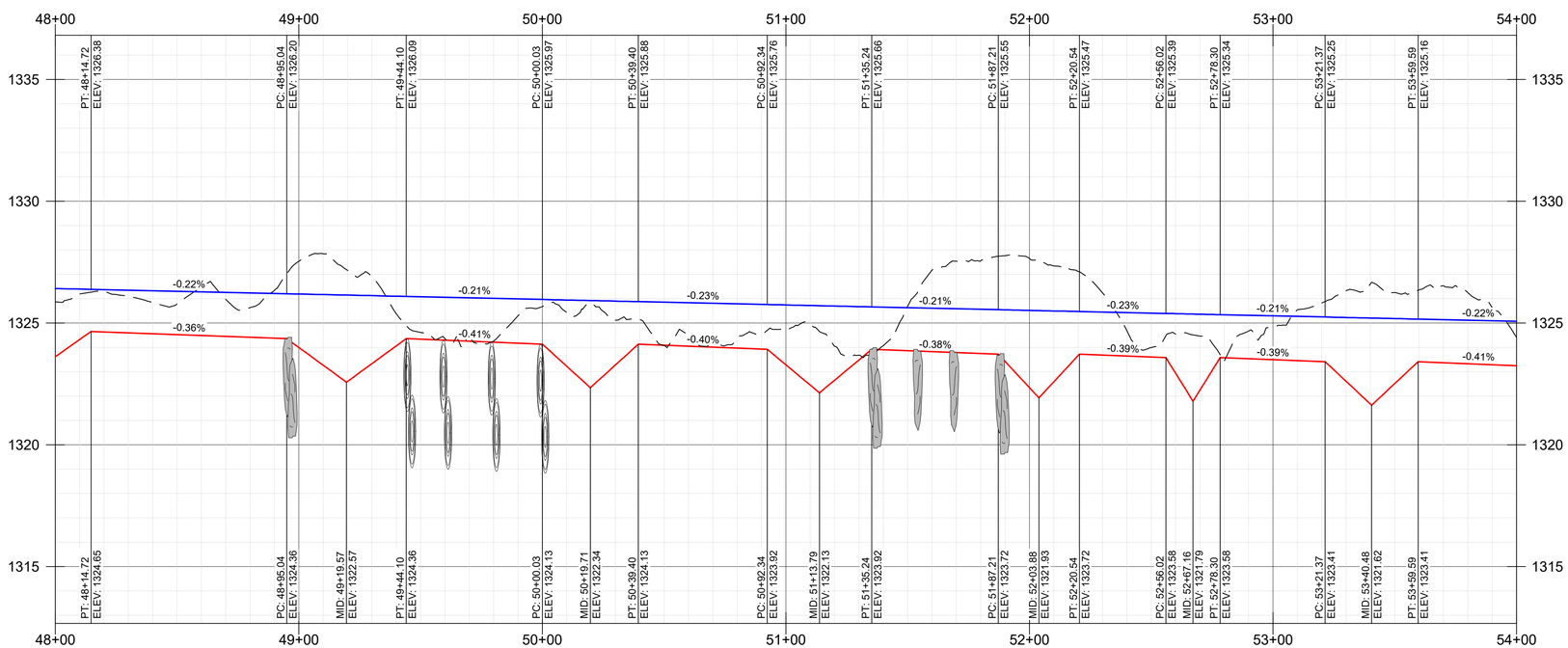

## PLAN LEGEND

- PROPOSED STREAM CENTER LINE
- PROPOSED INNER BERM
- PROPOSED GEOMORPHIC CHANNEL TOB
- PROPOSED FLOODPLAIN TOE
- LIMITS OF DISTURBANCE
- (483) PROPOSED MAJOR CONTOUR
- PROPOSED MINOR CONTOUR
- 479 EXISTING MAJOR CONTOUR
- EXISTING MINOR CONTOUR
- AUGMENTED RIFFLE
- LOG J-HOOK
- CONSTRUCTED LOG RIFFLE
- TOE WOOD
- NOT SURE?
- CONSTRUCTED RIFFLE
- BOULDER J-HOOK
- CONSTRUCTED BOULDER/LOG RIFFLE
- BOULDER TOE?
- LOG VANE
- TRANSPLANTS?

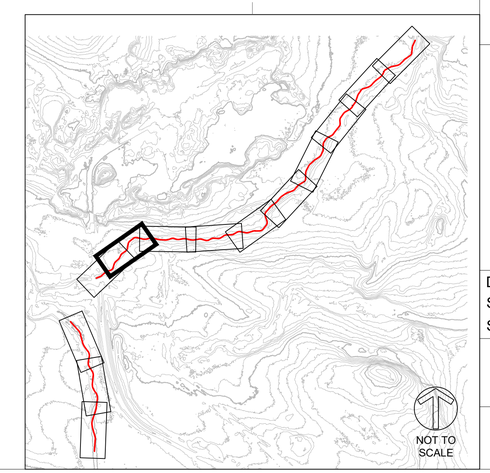
## PROFILE LEGEND

- PROPOSED STREAM CENTER LINE
- PROPOSED BANKFULL TOB
- EXISTING GROUND
- STRUCTURE BOULDER
- HEADER AND FOOTER BOULDER
- STRUCTURE LOG
- AUGMENTED RIFFLE




SCALE: HOR 1" =30'; VERT 1"= 3'




| REV | DESCRIPTION | APPROVED BY: KA | CHECKED BY: MJG | DRAWN BY: GET | APPRV |
|---|---|---|---|---|---|
| 1 | DRAFT 30% DESIGN | XX | XX | XX | XX |
| XX | XX | XX | XX | XX | XX |
| XX | XX | XX | XX | XX | XX |
| XX | XX | XX | XX | XX | XX |
| XX | XX | XX | XX | XX | XX |
| XX | XX | XX | XX | XX | XX |
| XX | XX | XX | XX | XX | XX |

# BIG AND LITTLE 39 STREAM RESTORATION NEAR SILVER BAY LAKE COUNTY, MN

## DRAFT 30% DESIGN - NOT FOR CONSTRUCTION LITTLE 39 PLAN AND PROFILE - (9) STA 48+00 TO 54+00


CLIFFS
NORTHSHORE MINING CO
10 OUTER DR
SILVER BAY, MN 55614
---
BEAVER RIVER CONSULTING
BEAVER RIVER CONSULTING, LLC.
5752 EAGLE VIEW DRIVE
DULUTH, MN 55803
---

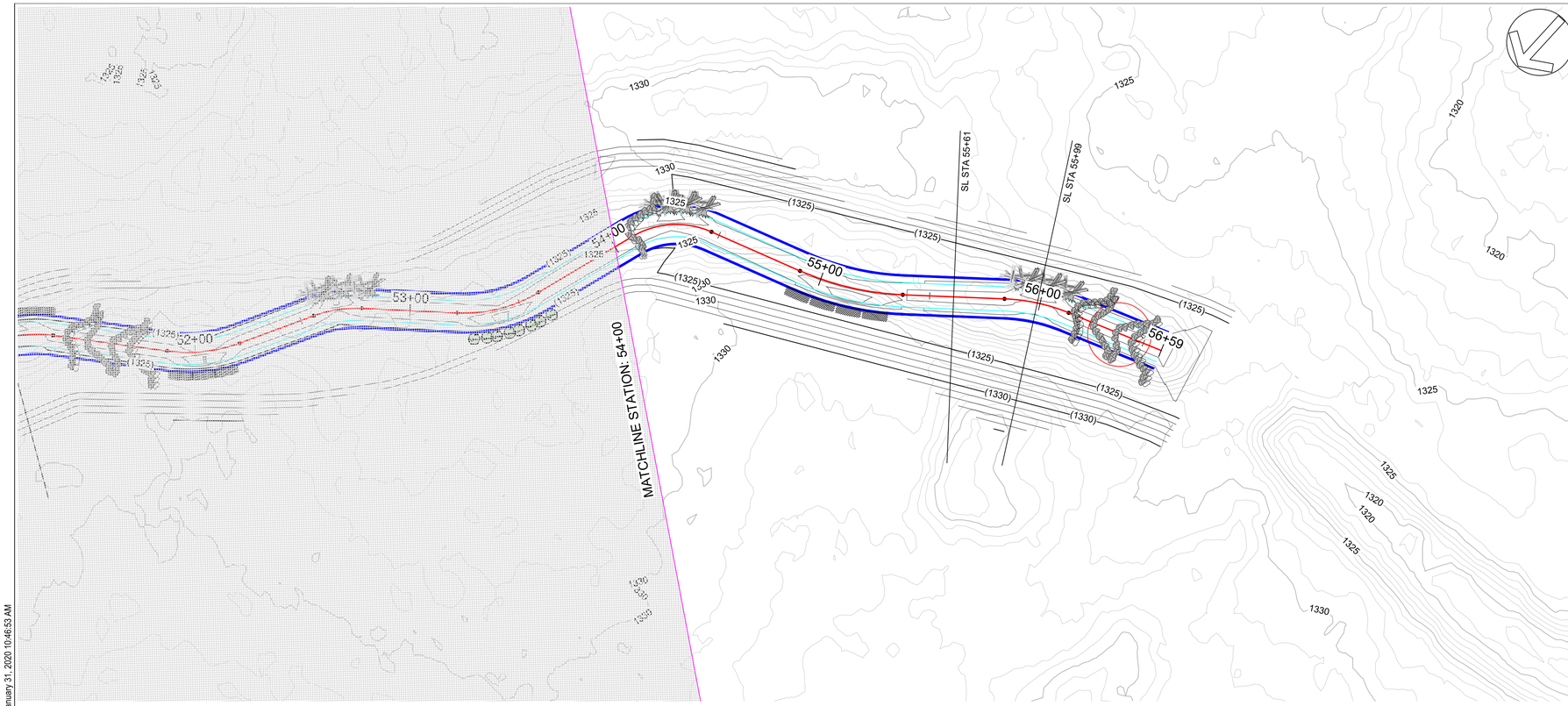

CONCEPT DESIGN
NOT FOR
CONSTRUCTION

DATE: 1/31/2020
SCALE (34"X22"): 1" = 30'
SCALE (17"X11"): 1" = 60'

0 30 60
SCALE IN FEET




E:\DROPBOX (SSR)\NORTHSHOREMINING\C3D\SHEETS\LITTLE39_PP.DWG | GREGTAILLACQ | SAVED: Monday, January 27, 2020 10:54:36 AM | ACAD.CTB | | PLOTTED: Friday, January 31, 2020 10:46:42 AM

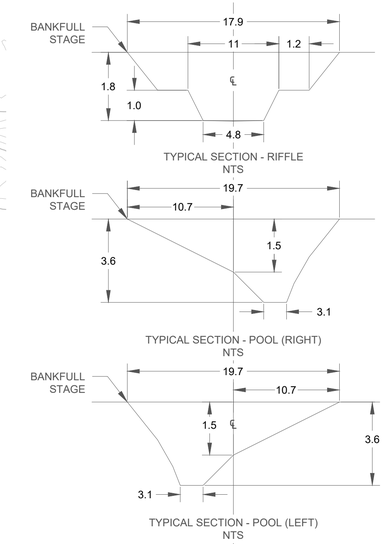


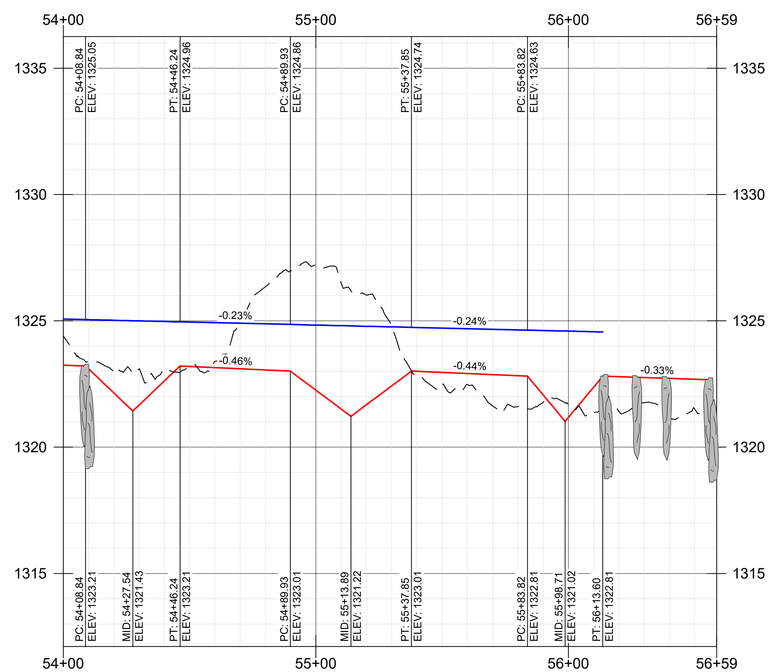

## PLAN LEGEND

- PROPOSED STREAM CENTER LINE
- PROPOSED INNER BERM
- PROPOSED GEOMORPHIC CHANNEL TOB
- PROPOSED FLOODPLAIN TOE
- LIMITS OF DISTURBANCE
- (483) PROPOSED MAJOR CONTOUR
- PROPOSED MINOR CONTOUR
- 479 EXISTING MAJOR CONTOUR
- EXISTING MINOR CONTOUR
- AUGMENTED RIFFLE
- LOG J-HOOK
- CONSTRUCTED LOG RIFFLE
- TOE WOOD
- NOT SURE?
- CONSTRUCTED RIFFLE
- BOULDER J-HOOK
- CONSTRUCTED BOULDER/LOG RIFFLE
- BOULDER TOE?
- LOG VANE
- TRANSPLANTS?

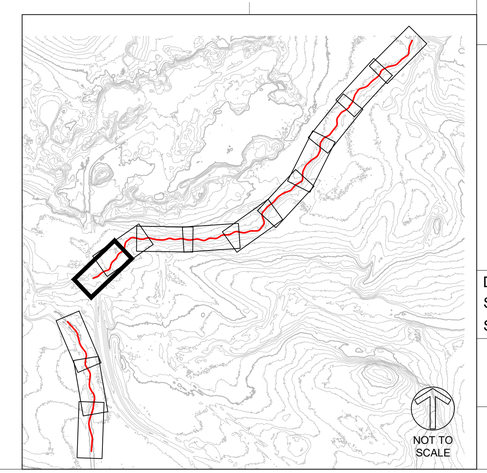
## PROFILE LEGEND

- PROPOSED STREAM CENTER LINE
- PROPOSED BANKFULL TOB
- EXISTING GROUND
- STRUCTURE BOULDER
- HEADER AND FOOTER BOULDER
- STRUCTURE LOG
- AUGMENTED RIFFLE




SCALE: HOR 1" =30'; VERT 1"= 3'




| REV | DESCRIPTION | APPROVED BY: KA | CHECKED BY: MJG | DRAWN BY: GET | APPRV |
|---|---|---|---|---|---|
| 1 | DRAFT 30% DESIGN | XX | XX | XX | XX |
| XX | XX | XX | XX | XX | XX |
| XX | XX | XX | XX | XX | XX |
| XX | XX | XX | XX | XX | XX |
| XX | XX | XX | XX | XX | XX |
| XX | XX | XX | XX | XX | XX |
| XX | XX | XX | XX | XX | XX |

# BIG AND LITTLE 39 STREAM RESTORATION NEAR SILVER BAY LAKE COUNTY, MN

## DRAFT 30% DESIGN - NOT FOR CONSTRUCTION
## LITTLE 39
## PLAN AND PROFILE - (10)
## STA 54+00 TO 56+59


CLIFFS
NORTHSHORE MINING CO
10 OUTER DR
SILVER BAY, MN 55614
---
BEAVER RIVER CONSULTING
BEAVER RIVER CONSULTING, LLC.
5752 EAGLE VIEW DRIVE
DULUTH, MN 55803
---


CONCEPT DESIGN
NOT FOR
CONSTRUCTION

DATE: 1/31/2020
SCALE (34"X22"): 1" = 30'
SCALE (17"X11"): 1" = 60'

0 30 60
SCALE IN FEET

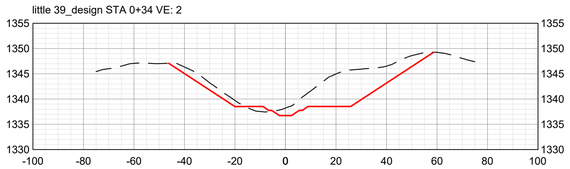
SHEET NUMBER
20 OF 33

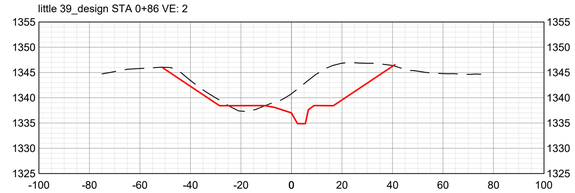

E:\DROPBOX (SSSR)\NORTHSHOREMINING\C3D\SHEETS\LITTLE39_PP.DWG | GREGTAILLACQ | SAVED: Monday, January 27, 2020 10:54:36 AM | ACAD.CTB | | PLOTTED: Friday, January 31, 2020 10:46:53 AM

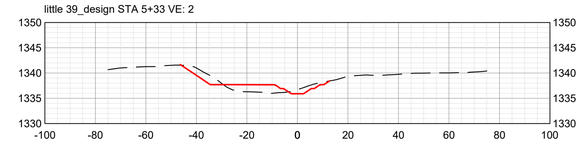
SECTION LEGEND

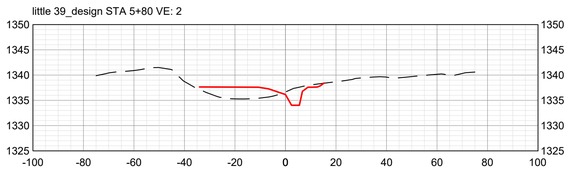
DESIGN SURFACE

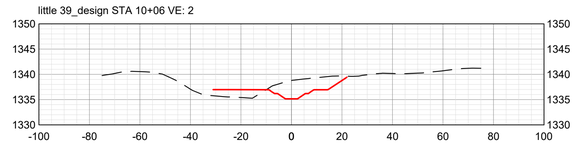
EXISTING GROUND

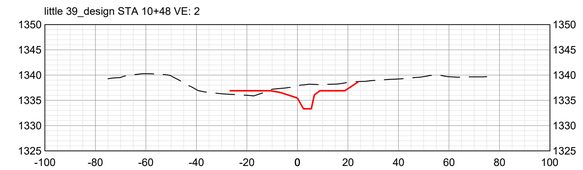


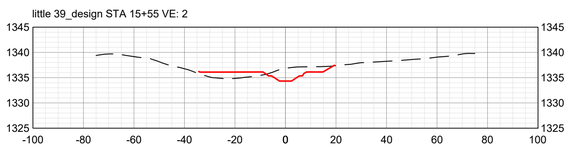



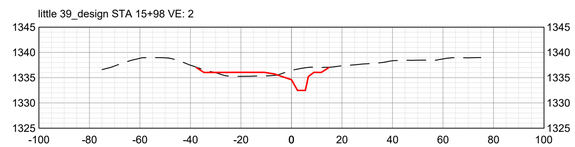



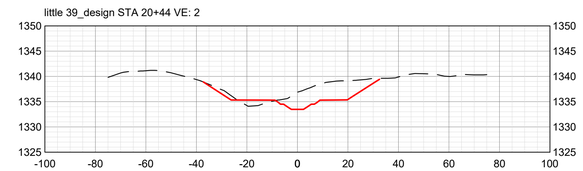



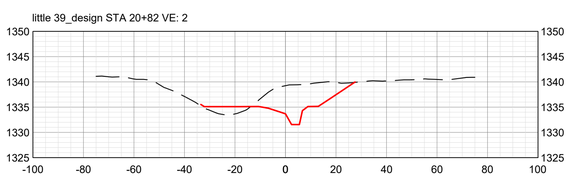



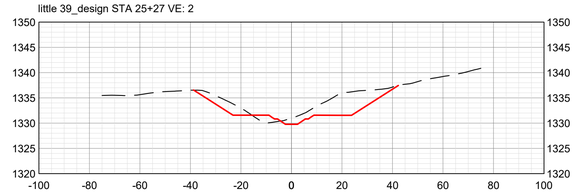



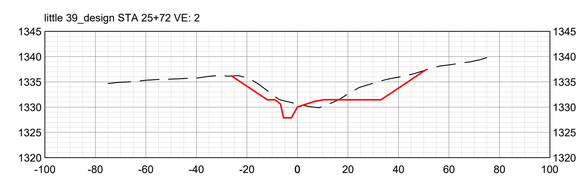



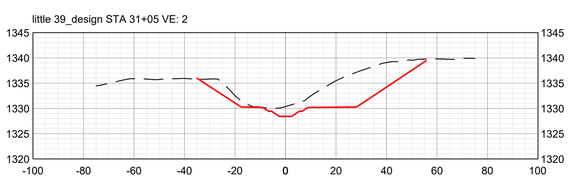



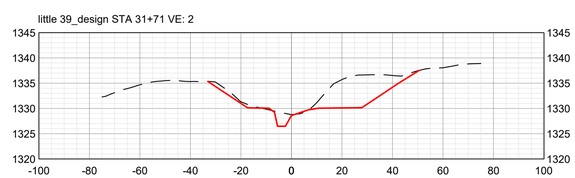



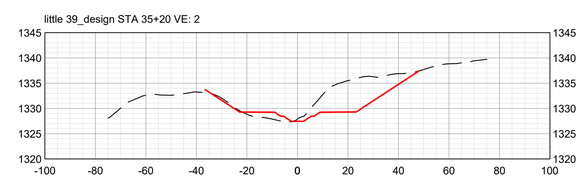



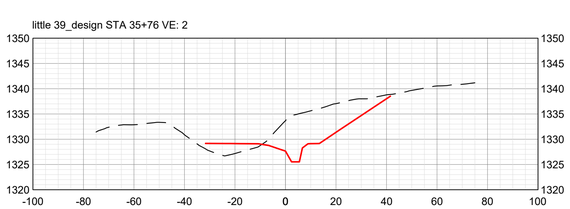



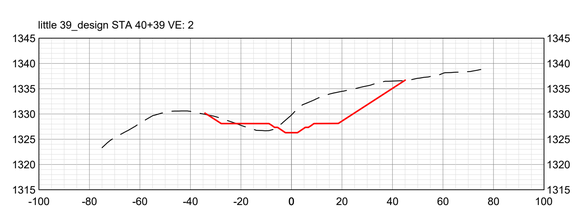



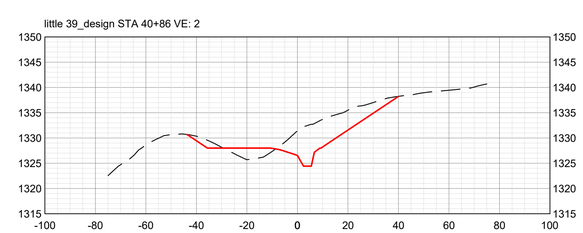




| APPROVED BY: KA | CHECKED BY: MJG | DRAWN BY: GET |
|---|---|---|
| REV | DESCRIPTION | APPRV |
| 1 | DRAFT 30% DESIGN | XX |
| XX | XX | XX |
| XX | XX | XX |
| XX | XX | XX |
| XX | XX | XX |
| XX | XX | XX |
| XX | XX | XX |
| XX | XX | XX |

BIG AND LITTLE 39
STREAM RESTORATION
NEAR SILVER BAY
LAKE COUNTY, MN

DRAFT 30% DESIGN - NOT FOR CONSTRUCTION
LITTLE 39
SECTIONS - (1)
STA 0+34 TO STA 40+86

CLIFFS

NORTHSHORE MINING CO
10 OUTER DR
SILVER BAY, MN 55614
---

BEAVER RIVER CONSULTING

BEAVER RIVER CONSULTING, LLC.
5752 EAGLE VIEW DRIVE
DULUTH, MN 55803
---

CONCEPT DESIGN
NOT FOR
CONSTRUCTION

DATE: 1/31/2020
SCALE (34"X22"): 1" = 30'
SCALE (17"X11"): 1" = 60'

0 30 60
SCALE IN FEET

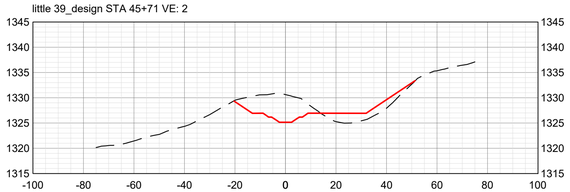
SHEET NUMBER
21 OF 33

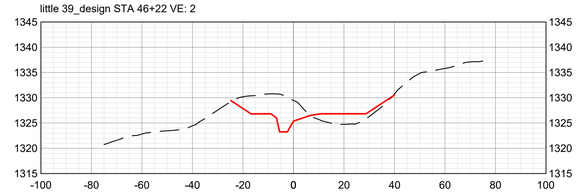
E:\DROPBOX (SSSR)\NORTHSHOREMINING\C3D\SHEETS\LITTLE39_SECTIONS.DWG | GREGTAILLACQ | SAVED: Friday, January 24, 2020 11:41:30 AM | ACAD.CTB | | PLOTTED: Friday, January 31, 2020 10:47:01 AM

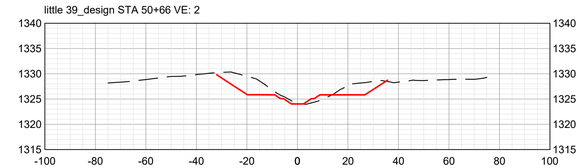
SECTION LEGEND

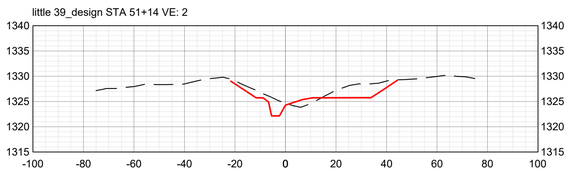
DESIGN SURFACE

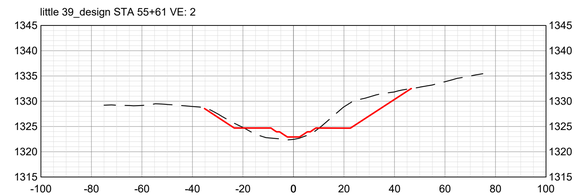
EXISTING GROUND

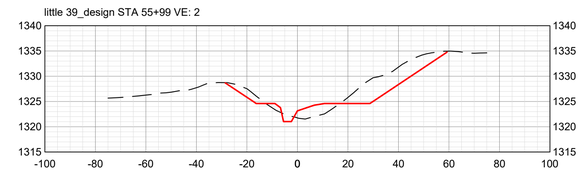



| REV | DESCRIPTION | APPROVED BY: KA | CHECKED BY: MJG | DRAWN BY: GET | APPRV |
|---|---|---|---|---|---|
| 1 | DRAFT 30% DESIGN | XX | XX | XX | XX |
| XX | | XX | XX | XX | XX |
| XX | | XX | XX | XX | XX |
| XX | | XX | XX | XX | XX |
| XX | | XX | XX | XX | XX |
| XX | | XX | XX | XX | XX |

BIG AND LITTLE 39
STREAM RESTORATION
NEAR SILVER BAY
LAKE COUNTY, MN

DRAFT 30% DESIGN - NOT FOR CONSTRUCTION

LITTLE 39
SECTIONS - (2)
STA 45+71 TO 55+99

CLIFFS

NORTHSHORE MINING CO
10 OUTER DR
SILVER BAY, MN 55614
----

BEAVER RIVER CONSULTING

BEAVER RIVER CONSULTING, LLC.
5752 EAGLE VIEW DRIVE
DULUTH, MN 55803
----

CONCEPT DESIGN
NOT FOR
CONSTRUCTION

DATE: 1/31/2020
SCALE (34"X22"): 1" = 30'
SCALE (17"X11"): 1" = 60'

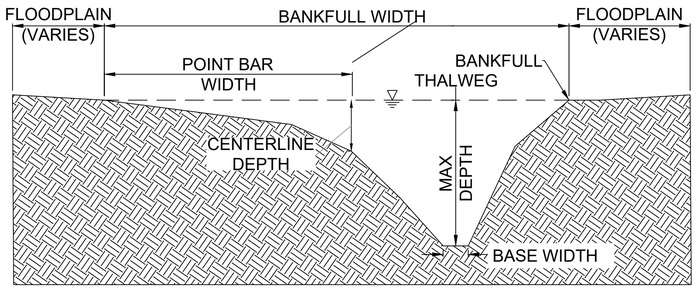
0 30 60
SCALE IN FEET

SHEET NUMBER
22 OF 33

E:\DROPBOX (SSSR)\NORTHSHOREMINING\C3D\SHEETS\LITTLE39_SECTIONS.DWG | GREGTAILLACQ | SAVED: Friday, January 24, 2020 11:41:30 AM | ACAD.CTB | | PLOTTED: Friday, January 31, 2020 10:47:03 AM

TYPICAL SECTION - POOL RIGHT (A)

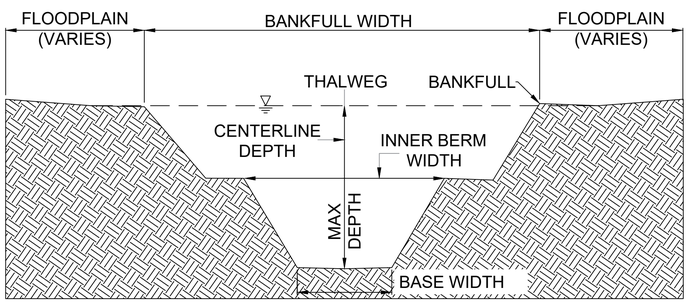
| DESIGN PARAMETERS | SIZE (FT) |
|---|---|
| BANKFULL WIDTH | 36 |
| POINT BAR WIDTH | 20 |
| MAX DEPTH | 6 |
| BASE WIDTH | 6 |
| CENTERLINE DEPTH | 2.8 |




NTS

TYPICAL SECTION -RIFFLE (B)

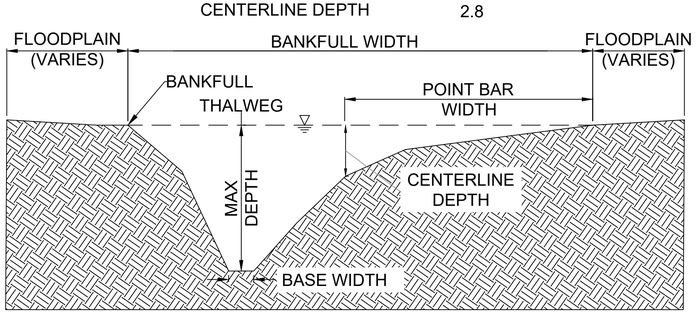
| DESIGN PARAMETERS | SIZE (FT) |
|---|---|
| BANKFULL WIDTH | 33 |
| MAX DEPTH | 2.9 |
| BASE WIDTH | 8 |
| INNER BERM DEPTH | 1.5 |
| INNER BERM WIDTH | 16 |




NTS

TYPICAL SECTION - POOL LEFT (C)

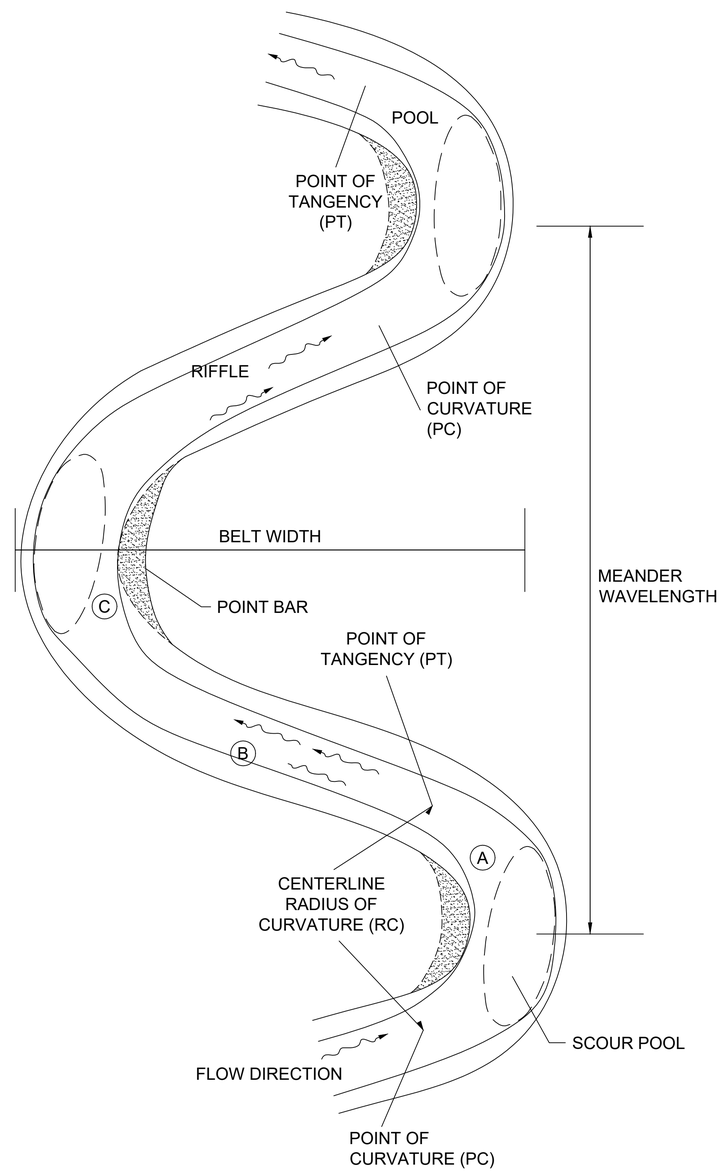
| DESIGN PARAMETERS | SIZE (FT) |
|---|---|
| BANKFULL WIDTH | 36 |
| POINT BAR WIDTH | 20 |
| MAX DEPTH | 6 |
| BASE WIDTH | 6 |
| CENTERLINE DEPTH | 2.8 |




NTS

STREAM MORPHOLOGY
STREAM NAME: BIG 39

STREAM LAYOUT TYPICALS
NTS




| STREAM NAME | BIG 39 | | |
|---|---|---|---|
| STREAM TYPE | B4c | | |
| DRAINAGE AREA, DA (SQ MI) | 23 | | |
| DESIGN PARAMETERS | MINIMUM | MEDIAN | MAXIMUM |
| MEAN RIFFLE DEPTH, $D_{BKF}$ (FT) | | 1.8 | |
| RIFFLE WIDTH, $W_{BKF}$ (FT) | | 33.0 | |
| WIDTH-TO-DEPTH RATIO, [$W_{BKF}/D_{BKF}$] | | 18.0 | |
| RIFFLE CROSS-SECTION AREA, $A_{BKF}$ (SQ FT) | | 60.0 | |
| MAX RIFFLE DEPTH, $D_{MAX}$ (FT) | | 2.9 | |
| POOL WIDTH, $W_{BKFP}$ (FT) | | 36.0 | |
| POOL CROSS-SECTION AREA, $A_{BKFP}$ (SQ FT) | | 80.0 | |
| MAX POOL DEPTH, $D_{MAXP}$ (FT) | | 6.0 | |
| RIFFLE LENGTH, $L_{RIF}$ (FT) | 1.4 | 3.0 | 4.3 |
| POOL LENGTH, $L_P$ (FT) | 1.5 | 1.9 | 2.8 |
| ENTRENCHMENT RATIO, ER [$W_{FPA}/W_{BKF}$] | | 2.2 | |
| BANKFULL DISCHARGE, $Q_{BKF}$ (CFS) | | | |
| MEANDER LENGTH, $L_M$ (FT) | | | |
| BELT WIDTH, $W_{BLT}$ (FT) | | 80.0 | |
| RADIUS OF CURVATURE, RC (FT) | 3.0 | 4.4 | 9.0 |
| POOL-TO-POOL SPACING, P-P (FT) | 3.5 | | 7.0 |
| VALLEY SLOPE, VS (FT/FT) | 0.0019 | | |
| WATER SURFACE SLOPE, WS (FT/FT) | 0.0020 | | |
| SINUOSITY, K = SL/VL (FT/FT) | 1.0300 | | |

| REV | DESCRIPTION | CHECKED BY: MJG | DRAWN BY: GET | APPROVED BY: KA | APPRV |
|---|---|---|---|---|---|
| 1 | DRAFT 30% DESIGN | XX | XX | XX | XX |
| XX | | XX | XX | XX | XX |
| XX | | XX | XX | XX | XX |
| XX | | XX | XX | XX | XX |
| XX | | XX | XX | XX | XX |
| XX | | XX | XX | XX | XX |
| XX | | XX | XX | XX | XX |

BIG AND LITTLE 39
STREAM RESTORATION
NEAR SILVER BAY
LAKE COUNTY, MN

DRAFT 30% DESIGN - NOT FOR CONSTRUCTION
---
DETAIL - TYPICAL SECTIONS - BIG 39


CLIFFS
NORTHSHORE MINING CO
10 OUTER DR
SILVER BAY, MN 55614
---
BEAVER RIVER CONSULTING
BEAVER RIVER CONSULTING, LLC.
5752 EAGLE VIEW DRIVE
DULUTH, MN 55803
---


CONCEPT DESIGN
NOT FOR
CONSTRUCTION

DATE: 1/31/2020

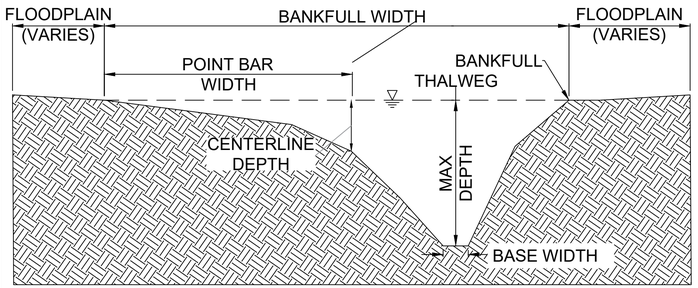
NTS

SHEET NUMBER
23 OF 33


E:\DROPBOX (SSSR)\NORTHSHOREMINING\C3D\SHEETS\NORTHSHORE39MASTERDETAIL.DWG | GREGTAILLACQ | SAVED: Friday, January 31, 2020 10:42:03 AM | ACAD.CTB | | PLOTTED: Friday, January 31, 2020 10:47:12 AM

TYPICAL SECTION - POOL RIGHT (A)

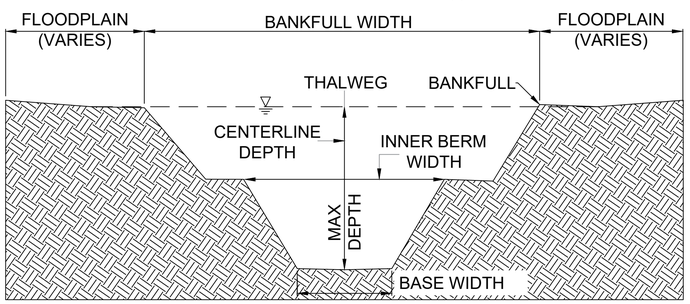
| DESIGN PARAMETERS | SIZE (FT) |
|---|---|
| BANKFULL WIDTH | 20 |
| POINT BAR WIDTH | 10 |
| MAX DEPTH | 3.5 |
| BASE WIDTH | 4 |
| CENTERLINE DEPTH | 1.5 |




NTS

TYPICAL SECTION -RIFFLE (B)

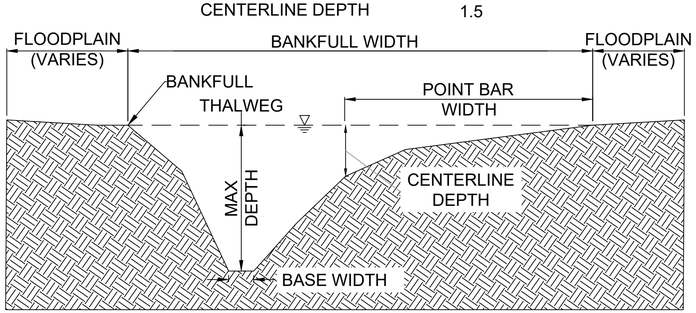
| DESIGN PARAMETERS | SIZE (FT) |
|---|---|
| BANKFULL WIDTH | 18 |
| MAX DEPTH | 1.8 |
| BASE WIDTH | 5.0 |
| INNER BERM DEPTH | 0.8 |
| INNER BERM WIDTH | 11 |




NTS

TYPICAL SECTION - POOL LEFT (C)

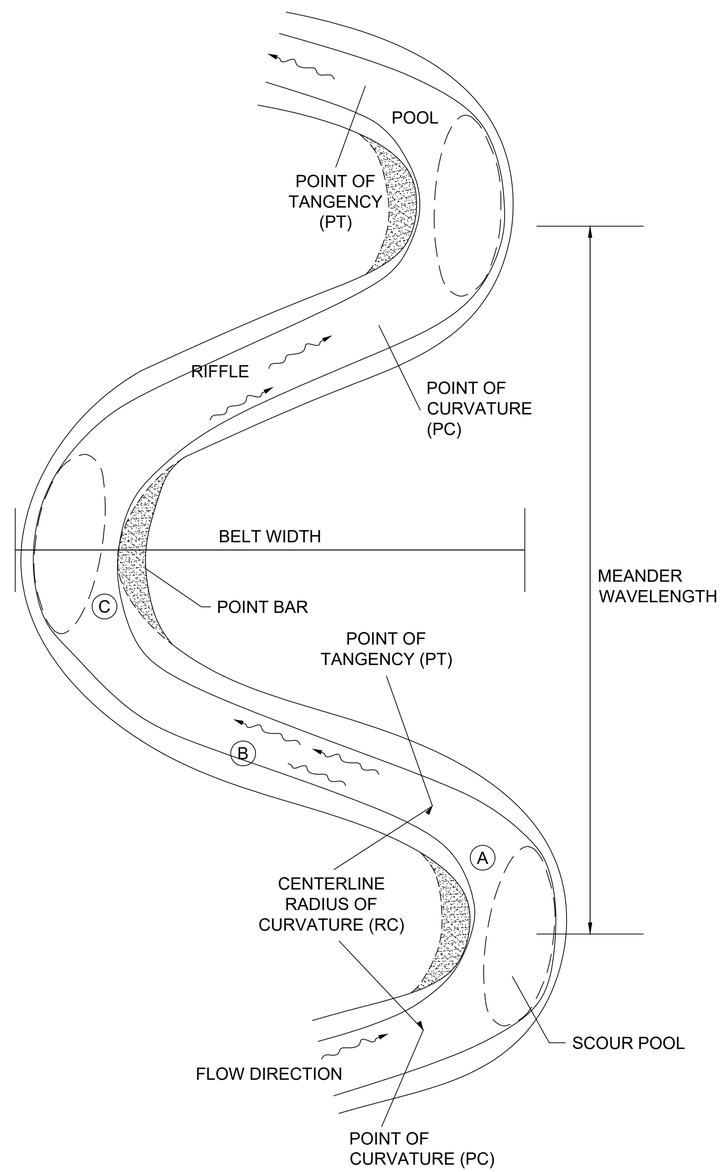
| DESIGN PARAMETERS | SIZE (FT) |
|---|---|
| BANKFULL WIDTH | 20 |
| POINT BAR WIDTH | 10 |
| MAX DEPTH | 3.5 |
| BASE WIDTH | 4 |
| CENTERLINE DEPTH | 1.5 |




NTS

STREAM MORPHOLOGY
STREAM NAME: LITTLE 39

STREAM LAYOUT TYPICALS
NTS




| STREAM NAME | LITTLE 39 | | |
|---|---|---|---|
| STREAM TYPE | B4c | | |
| DRAINAGE AREA, DA (SQ MI) | 2 | | |
| DESIGN PARAMETERS | MINIMUM | MEDIAN | MAXIMUM |
| MEAN RIFFLE DEPTH, $D_{BKF}$ (FT) | | 1.1 | |
| RIFFLE WIDTH, $W_{BKF}$ (FT) | | 18 | |
| WIDTH-TO-DEPTH RATIO, [$W_{BKF}/D_{BKF}$] | | 16 | |
| RIFFLE CROSS-SECTION AREA, $A_{BKF}$ (SQ FT) | | 20 | |
| MAX RIFFLE DEPTH, $D_{MAX}$ (FT) | | 1.8 | |
| POOL WIDTH, $W_{BKFP}$ (FT) | | 20 | |
| POOL CROSS-SECTION AREA, $A_{BKFP}$ (SQ FT) | | 27 | |
| MAX POOL DEPTH, $D_{MAXP}$ (FT) | | 3.6 | |
| RIFFLE LENGTH, $L_{RIF}$ (FT) | 1.7 | 3 | 4.7 |
| POOL LENGTH, $L_P$ (FT) | 1.3 | 2.4 | 3.4 |
| ENTRENCHMENT RATIO, ER [$W_{FPA}/W_{BKF}$] | | 2 | |
| BANKFULL DISCHARGE, $Q_{BKF}$ (CFS) | | | |
| MEANDER LENGTH, $L_M$ (FT) | | | |
| BELT WIDTH, $W_{BLT}$ (FT) | | 45 | |
| RADIUS OF CURVATURE, RC (FT) | | | |
| POOL-TO-POOL SPACING, P-P (FT) | 3.5 | 5.5 | 7.7 |
| VALLEY SLOPE, VS (FT/FT) | 0.12-093 | | |
| WATER SURFACE SLOPE, WS (FT/FT) | varies | | |
| SINUOSITY, K = SL/VL (FT/FT) | 1.02 | | |

| APPROVED BY: KA | CHECKED BY: MJG | DRAWN BY: GET |
|---|---|---|
| REV | DESCRIPTION | APPRV |
| 1 | DRAFT 30% DESIGN | XX |
| XX | XX | XX |
| XX | XX | XX |
| XX | XX | XX |
| XX | XX | XX |
| XX | XX | XX |
| XX | XX | XX |
| XX | XX | XX |
| XX | XX | XX |

BIG AND LITTLE 39
STREAM RESTORATION
NEAR SILVER BAY
LAKE COUNTY, MN

DRAFT 30% DESIGN - NOT FOR CONSTRUCTION
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DETAIL - TYPICAL SECTIONS - LITTLE 39


CLIFFS
NORTHSHORE MINING CO
10 OUTER DR
SILVER BAY, MN 55614
---
BEAVER RIVER CONSULTING
BEAVER RIVER CONSULTING, LLC.
5752 EAGLE VIEW DRIVE
DULUTH, MN 55803
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CONCEPT DESIGN
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CONSTRUCTION

DATE: 1/31/2020

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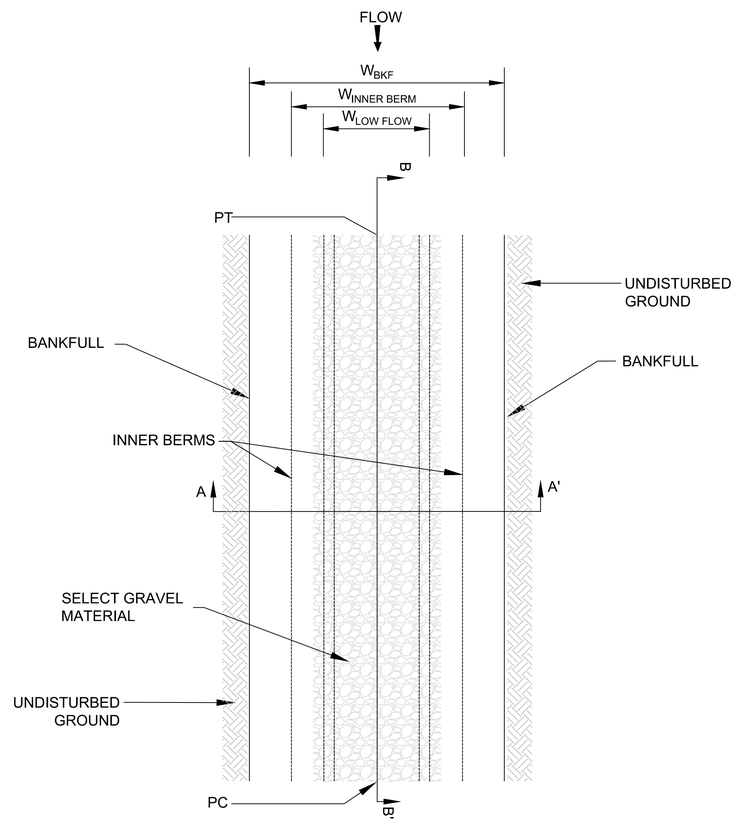
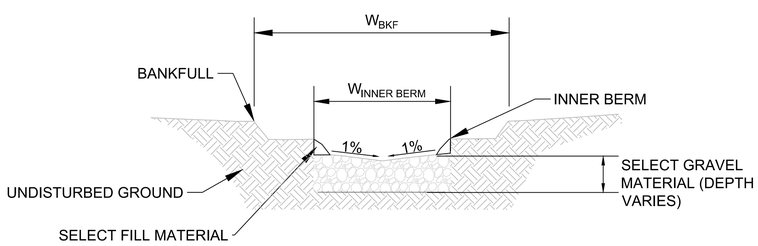
SHEET NUMBER
24 OF 33


E:\DROPBOX (SSR)\NORTHSHOREMINING\C3D\SHEETS\NORTHSHORE39\MASTERDETAIL.DWG | GREGTAILLACQ | SAVED: Friday, January 31, 2020 10:42:03 AM | ACAD.CTB | | PLOTTED: Friday, January 31, 2020 10:47:13 AM

PLAN SYMBOL




PLAN VIEW




CROSS-SECTION A-A'

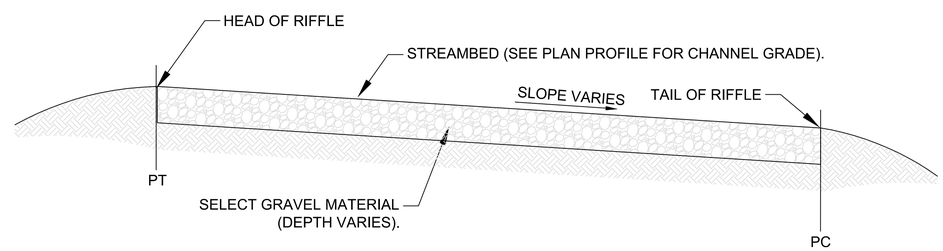
## DETAIL - AUGMENTED RIFFLE

NOT TO SCALE

CONSTRUCTED RIFFLE WITH IMPORTED MATERIAL

NOTES:

1. THE AUGMENTED RIFFLE IS GENERALLY INSTALLED IN A NEW CHANNEL TO PROVIDE GRADE CONTROL AND PREVENT DOWNCUTTING. MATERIAL IS IMPORTED TO THE SITE BECAUSE APPROPRIATELY SIZED MATERIAL IN NOT AVAILABLE ON-SITE.
2. THIS ENGINEER WILL SPECIFY THE SIZE OF THE MATERIAL TO BE USED IN THE RIFFLE AND MUST APPROVE IT BEFORE IT IS INSTALLED. THE CONTRACTOR MAY USE MATERIAL AVAILABLE ON-SITE IF APPROVED BY THE ENGINEER.
3. THE CONTRACTOR SHALL EXCAVATE A TRENCH THAT EXTENDS THE LENGTH OF THE RIFFLE (AS SHOWN ON THE PLANSHEETS) AND FROM INNER BERM TO INNER BERM. THE CONTRACTOR SHALL EXCAVATE TO A DEPTH OF 24" OR THREE TIMES THE D84 OF THE MATERIAL SPECIFIED BY THE ENGINEER, WHICHEVER IS GREATER. THE CONTRACTOR SHALL NOT DISTURB THE SURROUNDING GROUND.
4. THE CONTRACTOR SHALL FILL THE TRENCH WITH THE GRAVEL MATERIAL SPECIFIED AND APPROVED BY THE ENGINEER. THE GRAVEL MATERIAL SHALL BE COMPACTED USING EQUIPMENT SO THAT FUTURE SETTLEMENT OF THE MATERIAL WILL BE MINIMAL.
5. THE GRAVEL MATERIAL SHALL BE COMPACTED SUCH THAT, IN CROSS-SECTION, THERE IS A 1% SLOPE TO THE CENTER OF THE CHANNEL OR AS GENERATED BY THE 3D SURFACE.
6. SELECT FILL MATERIAL APPROVED BY THE ENGINEER SHALL BE PLACED ACCORDING TO THE TYPICAL CROSS-SECTIONS TO CREATE A SMOOTH SLOPED TRANSITION FROM THE INNER BERM TO THE GRAVEL MATERIAL COMPRISING THE RIFFLE.
7. THE SURFACE OF THE RIFFLE SHALL BE FINISHED TO THE FINAL GRADES AS SHOWN ON THE PLANSHEETS. THE DEGREE OF TOLERANCE FOR ALL ELEVATIONS SHALL BE WITHIN +/- 0.1' OF THE GRADES AND ELEVATIONS SPECIFIED ON THE PLANS.
8. FINAL GRADING AND TOP DRESSING OF THE INNER BERM AND BANKFULL BENCH TO THE FLOODPLAIN IS REQUIRED FOLLOWING THE INSTALLATION OF THE CONSTRUCTED RIFFLE AND SHALL BE CONSIDERED INCIDENTAL TO CONSTRUCTION.
9. BANK TREATMENTS SHALL BE INSTALLED AFTER FINAL GRADING AND TOP DRESSING. SEE THE PLANSHEETS FOR THE BANK TREATMENT TYPE.




PROFILE B-B'

| APPROVED BY: KA | CHECKED BY: MJG | DRAWN BY: GET | |
|---|---|---|---|
| REV | DESCRIPTION | | APPRV |
| 1 | DRAFT 30% DESIGN | | XX |
| XX | XX | | XX |
| XX | XX | | XX |
| XX | XX | | XX |
| XX | XX | | XX |
| XX | XX | | XX |
| XX | XX | | XX |
| XX | XX | | XX |

BIG AND LITTLE 39
STREAM RESTORATION
NEAR SILVER BAY
LAKE COUNTY, MN

DRAFT 30% DESIGN - NOT FOR CONSTRUCTION
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---
DETAIL - AUGMENTED RIFFLE

CLIFFS

NORTHSHORE MINING CO
10 OUTER DR
SILVER BAY, MN 55614
---

BEAVER RIVER CONSULTING

BEAVER RIVER CONSULTING, LLC.
5752 EAGLE VIEW DRIVE
DULUTH, MN 55803
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CONCEPT DESIGN
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CONSTRUCTION

DATE: 1/31/2020

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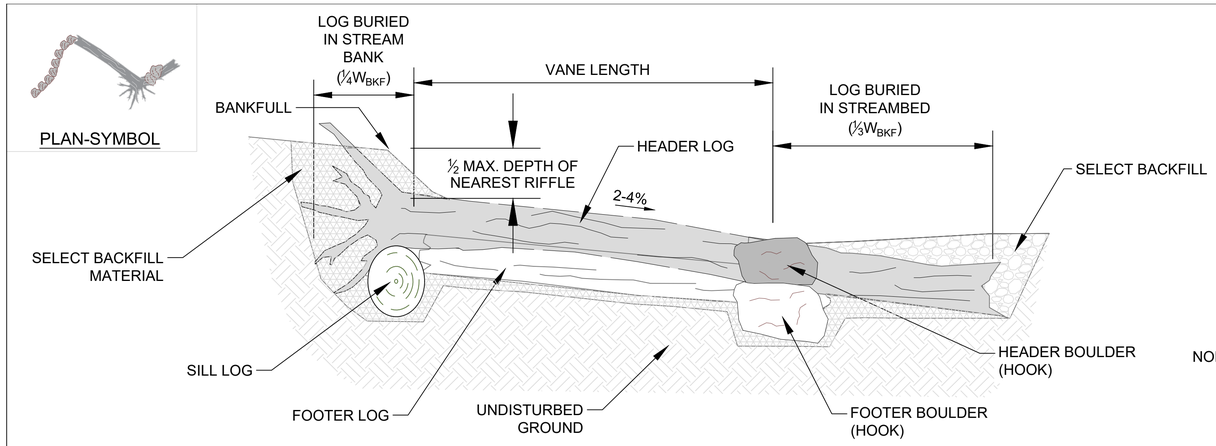
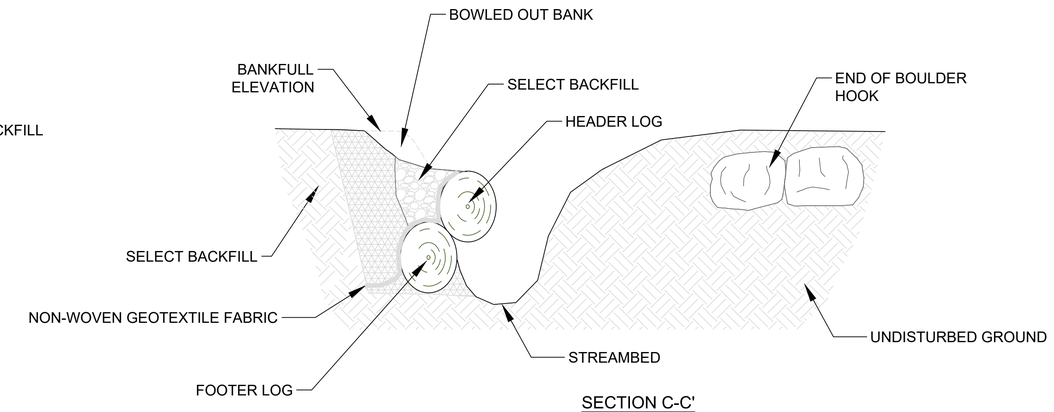
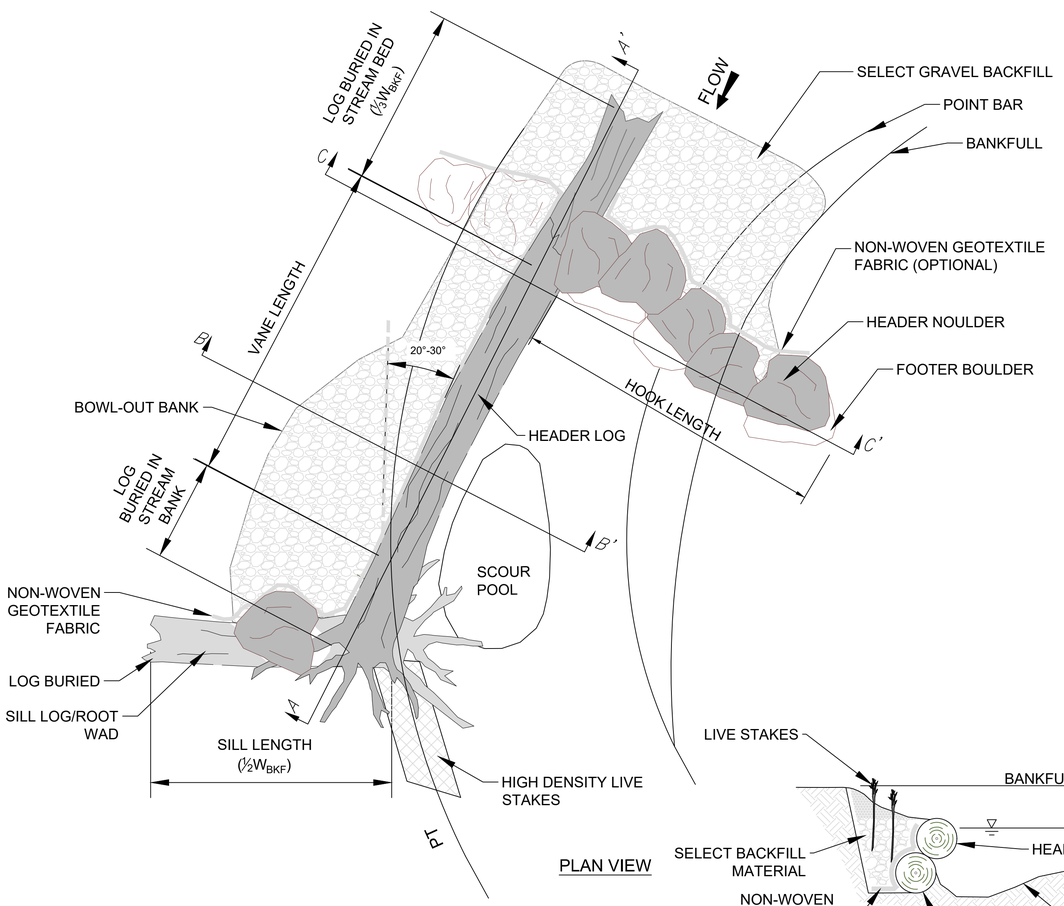


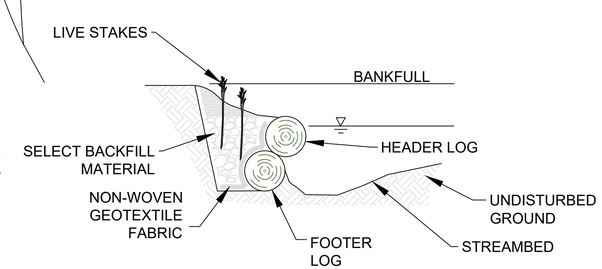

SECTION A-A'




SECTION C-C'




PLAN VIEW




SECTION B-B'

# DETAIL - LOG J-HOOK WITH ROOTWAD

NOT TO SCALE

NOTES:

1. THE LOG J-HOOK WITH ROOT WAD IS USED TO STABILIZE THE OUTSIDE BANK OF A STREAM CHANNEL IN A BEND BY PHYSICALLY PROTECTING THE BANK AND HELPING TURN THE WATER TOWARD THE CENTER OF THE CHANNEL. THE LOG J-HOOK WITH ROOT WAD CAN BE USED TO HELP STABILIZE AN EXISTING CHANNEL OR TO PROTECT THE BANK OF A NEWLY CONSTRUCTED CHANNEL.

2. THE STRUCTURE IS COMPRISED OF BOTH LOGS AND BOULDERS. LOGS SHALL HAVE A MINIMUM DIAMETER OF 18". THE LENGTH OF THE LOGS WILL BE DETRMINED BY THE SIZE AND SHAPE OF THE CHANNEL. ALL LOGS SHALL BE RELATIVELY STRAIGHT AND LIMBS SHALL BE TRIMMED FLUSH. THE SIZE OF THE BOULDERS VARIES WITH THE SIZE OF THE CHANNEL.

3. HEADER LOGS/BOULDERS SHALL BE UNDERLAIN BY FOOTER LOGS/BOULDERS UNLESS OTHERWISE DIRECTED BY THE ENGINEER. FOOTER LOGS PROVIDE SCOUR PROTECTION FOR HEADER LOGS. FOOTER BOULDERS PROVIDE SCOUR PROTECTION AND A FOUNDATION FOR THE HEADER BOULDERS.

4. THE SILL LOG WITH ROOT WAD IS GENERALLY INSTALLED FIRST. THE CONTRACTOR SHALL DIG A TRENCH PERPENDICULAR TO THE BANKFULL FLOW DIRECTION AND INSTALL THE SILL LOG. IT MAY BE NECESSARY TO CUT THE SILL LOG ROOTWAD TO PREVENT THE ROOTWAD FROM PROTRUDING ABOVE THE BANKFULL ELEVATION. A BOULDER OR HEADER SILL LOG SHALL BE PLACED ON THE SILL LOG TO EFFECTIVELY EXTEND THE SILL FURTHER INTO THE BANK.

5. THE HEADER LOG OF THE VANE ARM IS GENERALLY INSTALLED NEXT. THE CONTRACTOR SHALL DIG A TRENCH TO FACILIATE THE INSTALLATION OF THE VANE ARM. THE HEADER LOG SHALL TIE INTO THE STREAM BANK AT A MINIMUM ELEVATION OF 1/4 DMAX (MEASURED AT THE NEXT DOWNSTREAM RIFFLE) BELOW BANKFULL ELEVATION AND A MINIMUM ELEVATION OF 1/2 DMAX (MEASURED AT THE NEXT DOWNSTREAM RIFFLE) BELOW BANKFULL ELEVATION UNLESS OTHERWISE DIRECTED BY THE ENGINEER. THE HEADER LOG SHALL EXTEND FROM THE SILL LOG TO BEYOND THE HOOK PORTION OF THE STRUCTURE, GENERALLY AT A SLOPE OF 2 - 4%. THE VANE ARM FOOTER LOG SHALL BE CUT TO FIT BETWEEN SILL LOG AND THE BOULDER HOOK PORTION OF THE STRUCTURE. THE FOOTER LOG OF THE VANE ARM SHALL BE INSTALLED FROM UPSTREAM SIDE AND INSTALLED AGAINST THE LOWER HALF OF THE HEADER LOG RESULTING IN A STAGGER WITH THE HEADER LOG BEING SLIGHTLY MORE DOWNSTREAM THAN THE FOOTER LOG. ANY GAPS BETWEEN THE HEADER AND FOOTER LOGS WIDER THAN 1" SHALL BE CHINKED WITH BRANCHES AND/OR BRUSH FROM THE UPSTREAM SIDE. WHEN COMPLETE THE FOOTER LOG WILL NOT BE VISIBLE BUT THE HEADER LOG WILL BE VISIBLE DURING LOW FLOWS.

6. THE HOOK PORTION OF THE STRUCTURE CONSISTS OF BOULDERS. THE CONTRACTOR SHALL EXCAVATE A TRENCH TO FACILIATE THE INSTALLATION OF A ROW OF FOOTER BOULDERS THAT EXTEND FROM THE END OF THE FOOTER LOG OF THE VANE ARM ACROSS THE CHANNEL TO BEYOND BANKFULL ON THE OTHER SIDE OF THE CHANNEL CREATING A BURIED SILL. THE CONTRACTOR SHALL INSTALL HEADER BOULDERS ON TOP OF THE FOOTER BOULDERS. ALL BOULDERS SHALL BE FIT TIGHLTY TOGETHER AND ANY GAPS WIDER THAN 1" SHALL BE CHINKED WITH GRAVEL AND COBBLE FROM THE UPSTREAM SIDE WITH ROCKS. WHEN COMPLETE THE FOOTER BOULDERS WILL NOT BE VISIBLE BUT THE HEADER BOULDERS WILL BE VISIBLE DURING LOW FLOWS.

7. THE LOCATION AND ELEVATION OF THE SILL, VANE ARM AND THE BOULDER HOOK STRUCTURE MAY NOT VARY FROM THOSE SPECIFIED IN THE PLANSHEETS UNLESS DIRECTED OTHERWISE BY THE ENGINEER. THE FOOTER DEPTH ON ALL STRUCTURES REQUIRING FOOTERS SHALL BE 6 TIMES GREATER THAN THE DROP BETWEEN THE STRUCTURE AND THE FOOTERED STRUCTURE DIRECTLY DOWNSTREAM.

8. ON THE UPSTREAM SIDE OF THE LOGS AND BOULDERS NON-WOVEN GEOTEXTILE FABRIC SHALL BE PLACED AS SHOWN IN THE DETAIL PLANVIEW DRAWING. THE GEOTEXTILE FABRIC SHALL BE NAILED TO UPSTREAM SIDE OF THE HEADER LOGS USING 3" 10D GALVANZED COMMON NAILS ON 12" SPACING. THE GEOTEXTILE FABRIC SHALL BE CAREFULLY PLACED AGAINST THE UPSTREAM SIDE OF THE BOULDERS AND HELD IN PLACE BY BACKFILL MATERIAL.

9. THE EXCAVATED AREAS UPSTREAM OF THE SILL, VANE ARM AND BOULDER HOOK SHOULD BE FILLED WITH SELECT BACKFILL MATERIAL AS SPECIFIED AND APPROVED BY THE ENGINEER. THE SELECT BACKFILL AND SOIL BACKFILL MATERIAL SHALL BE OVER COMPACTED USING EQUIPMENT SO THAT FUTURE SETTLEMENT IS KEPT TO A MINIMUM. THE STEAMBANK SHOULD BE BOWLED OUT BEHIND THE VANE ARM AT THE DOWNSTREAM END OF THE VANE ARM.

10. THE SURFACE OF THIS STRUCTURE SHALL BE FINISHED TO A SMOOTH AND COMPACT SURFACE IN ACCORDANCE WITH THE LINES, GRADES, AND CROSS-SECTIONS OR ELEVATIONS SHOWN ON THE DRAWINGS . THE DEGREE OF FINISH FOR ELEVATIONS SHALL BE WITHIN 0.1' OF THE GRADES AND ELEVATIONS INDICATED. DRESSING OF THE CHANNEL, BANKFULL BENCH AND FLOODPLAIN WILL LIKELY BE REQUIRED FOLLOWING INSTALLATION OF THIS STRUCTURE AND SHALL BE CONSIDERED INCIDENTAL TO CONSTRUCTION.

11. DETAILS REGARDING PLANTING REQUIREMENTS. NO LIVE STAKES SHALL BE INSTALLED ON THE UPSTREAM SIDE OF THE LOG VANE AT OR BELOW THE TIE-IN ELEVATION OF THE HEADER LOG WITH THE STREAMBANK UNLESS OTHERWISE DIRECTED BY THE ENGINEER. INSTALL LIVE STAKES PER THE PLAN VIEW DRAWING AND THE LIVE STAKE DETAIL. LIVE STAKES SHOULD BE INSTALLED BEHIND THE VANE ARM ABOVE THE BANKFULL ELEVATION ON 12" CENTERS. LIVE STAKES SHOULD BE INSTALLED DOWNSTREAM OF THE ROOT WAD ALONG THE TOP OF BANK AT A HIGHER DENSITY (I.E. 10" CENTERS).

| APPROVED BY: KA | CHECKED BY: MJG | DRAWN BY: GET | |
|---|---|---|---|
| REV | DESCRIPTION | | APPRV |
| 1 | DRAFT 30% DESIGN | | XX |
| XX | XX | XX | XX |
| XX | XX | XX | XX |
| XX | XX | XX | XX |
| XX | XX | XX | XX |
| XX | XX | XX | XX |
| XX | XX | XX | XX |

BIG AND LITTLE 39
STREAM RESTORATION
NEAR SILVER BAY
LAKE COUNTY, MN

DRAFT 30% DESIGN - NOT FOR CONSTRUCTION

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DETAIL - LOG J-HOOK

CLIFFS
NORTHSHORE MINING CO
10 OUTER DR
SILVER BAY, MN 55614

BEAVER RIVER CONSULTING
BEAVER RIVER CONSULTING, LLC.
5752 EAGLE VIEW DRIVE
DULUTH, MN 55803

CONCEPT DESIGN
NOT FOR
CONSTRUCTION

DATE: 1/31/2020

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26 OF 33

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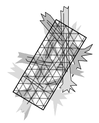

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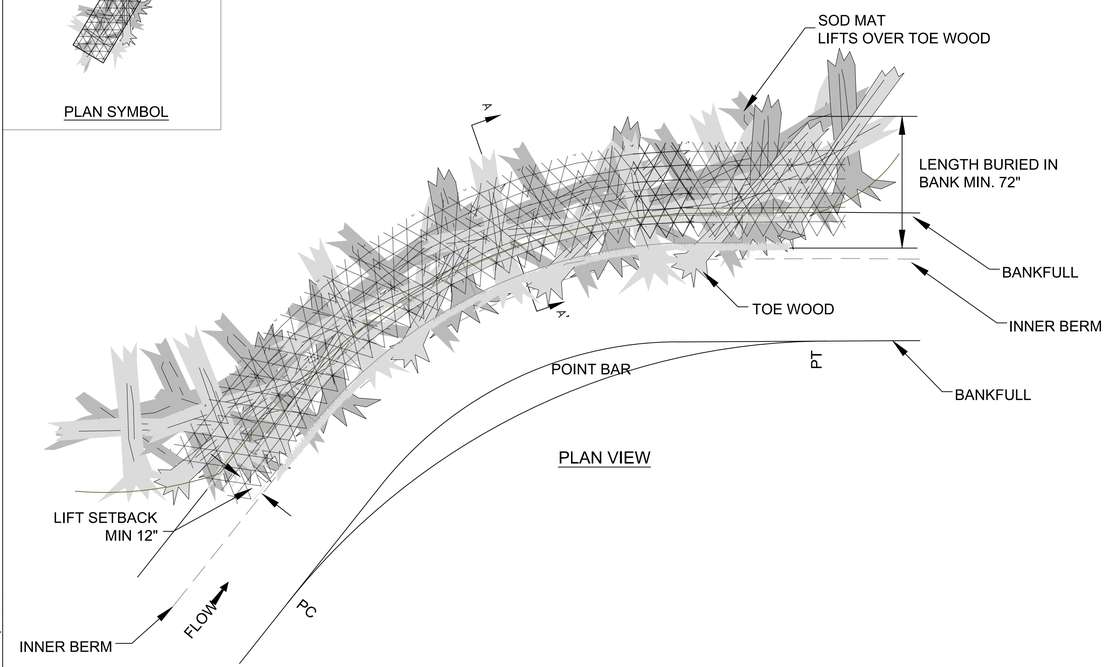
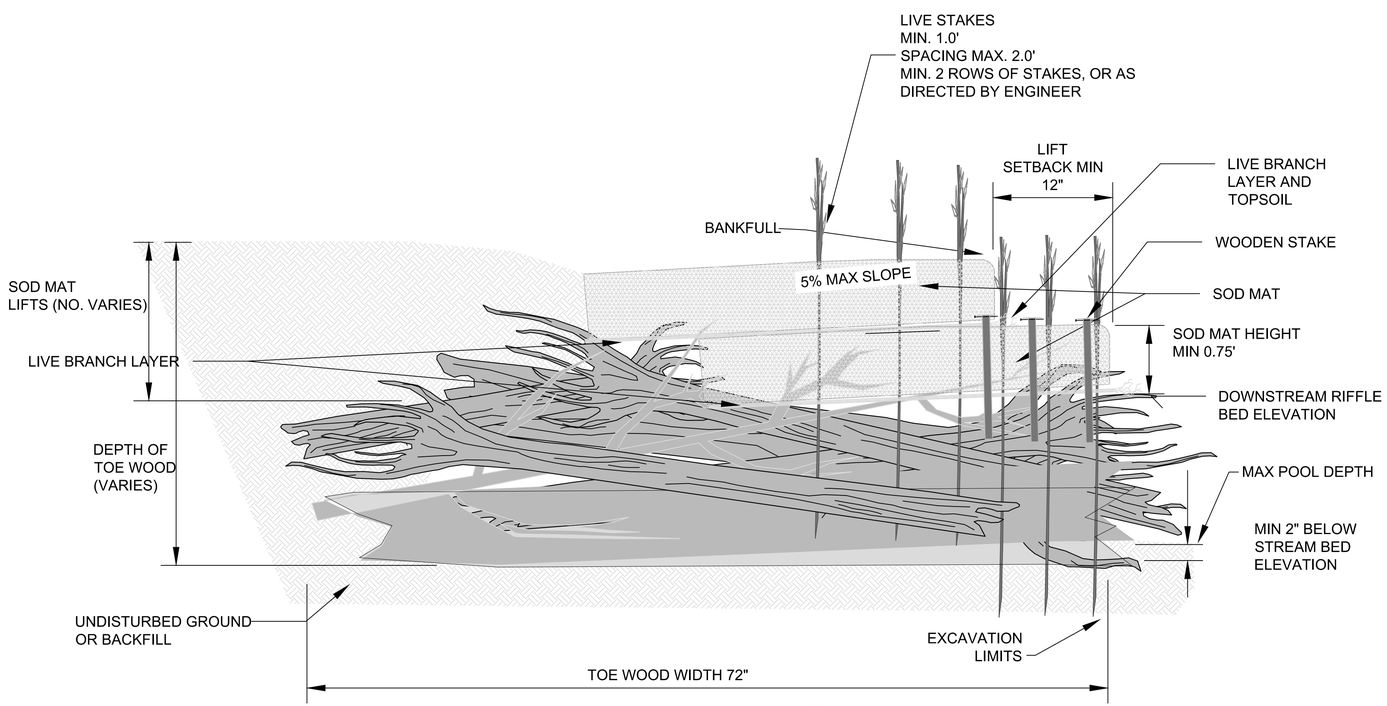



PLAN VIEW




SECTION A-A'

DETAIL - TOE WOOD WITH SOD MAT
NOT TO SCALE

TOE WOOD WITH SOD MAT
CONSTRUCTED NOVEMBER 2018

NOTES:

1. THIS STRUCTURE PROVIDES PROTECTION TO THE BANKS OF NEWLY CONSTRUCTED STREAM CHANNELS. WOODY DEBRIS OF ALL SIZES CAN BE USED IN THE CONSTRUCTION OF THIS STRUCTURE. THE STABILITY OF THE LOWER PORTION OF THE STREAMBANK IS CRITICAL TO THE SUCCESS OF THE PROJECT. THE INSTALLATION OF ALTERNATE BANK PROTECTION STRUCTURES (E.G., HAY/STRAW BALES) WILL ONLY BE CONSIDERED IF WOOD IS NOT AVAILABLE ONSITE.

2. COARSE/LARGE WOODY DEBRIS CONSISTS OF LOGS, ROOTWADS, AND LARGE BRANCHES WHICH ARE NOT SUITABLE FOR CONSTRUCTION OF LOG STRUCTURES. ALL MATERIALS ARE TO BE APPROVED BY THE ENGINEER.

3. A TRENCH SHALL BE EXCAVATED ALONG THE OUTER BANK OF THE POOL. THE BOTTOM ELEVATION OF THE TRENCH SHALL BE AT OR BELOW MAX. POOL DEPTH.

4. COARSE/LARGE WOODY DEBRIS SHALL BE INSTALLED IN THE TRENCH WITH THE LARGEST MATERIAL PLACED FIRST. THE LOGS OR WOOD MATERIAL SHALL BE PLACED PERPENDICULAR TO THE FLOW OF WATER. LOGS SHALL BE PLACED IN A CROSSING PATTERN OR WEAVE SUCH THAT EACH LOG/BRANCH IS ANCHORED BY ANOTHER LOG/BRANCH. THE COARSE/LARGE WOODY DEBRIS SHALL BE INSTALLED TO A HEIGHT OF 3/4 OF THE FINISHED HEIGHT OF THE WOODY DEBRIS WITH THE FINE/SMALL WOODY DEBRIS MAKING UP THE REMAINING 1/4 OF THE TOTAL HEIGHT.

5. FINE/SMALL WOODY DEBRIS CONSISTS OF MEDIUM TO SMALL LIMBS, BRANCHES, BUSHES, AND/OR SMALL LOGS. INVASIVE SPECIES SHALL NOT BE USED. ALL MATERIALS ARE TO BE APPROVED BY THE ENGINEER.

6. FINE/SMALL WOODY DEBRIS SHALL BE PLACED ON TOP OF THE COARSE/LARGE WOODY DEBRIS WITH THE LARGEST MATERIAL BEING PLACED FIRST AND THE SMALLEST MATERIAL PLACED LAST. THE FINE WOODY DEBRIS SHALL BE INSTALLED TO AN ELEVATION EQUAL TO THE INVERT OF THE DOWNTREAM RIFFLE.

7. ALL WOODY DEBRIS SHALL BE COMPACTED WITH THE EXCAVATOR BUCKET IN ORDER TO REDUCE THE PRESENCE OF VOIDS IN THE SMALL/FINE WOODY DEBRIS LAYER AND TO KEEP FUTURE SETTLING TO A MIN.

8. SELECT BACKFILL/TOPSOIL SHALL BE INSTALLED 1. ON TOP OF WOODY DEBRIS TO CREATE A LEVEL SUBSTRATE FOR THE SOD MATS.

9. A THIN LAYER OF LIVE BRANCHES (3-5' IN LENGTH) AND TOPSOIL SHALL BE PLACED ON TOP OF THE BALES. THE LIVE BRANCHES SHALL BE OF THE SPECIES SPECIFIED FOR LIVE STAKES OR APPROVED BY THE ENGINEER AND SHALL EXCLUDE INVASIVE SPECIES.

10. NATIVE SOD MATS SHALL BE HARVESTED ONSITE. THEY SHALL BE WEED FREE AND APPROXIMATELY 3' X 3' WITH A MINIMUM OF 8" OF INTACT SOIL AND ROOTMASS ATTACHED. THE SOD MATS ARE TO BE INSTALLED ON TOP OF THE LIVE BRANCH LAYER.

11. REPEAT NUMBERS 9 AND 10 UNTIL THE FINISHED ELEVATION EQUALS THE ELEVATION OF BANKFULL.

12. THE TOP OF THE SOD MAT SHALL BE FLAT WITHIN THE LIFT SETBACK DISTANCE SPECIFIED IN THE STRUCTURE TABLE. BEYOND THE LIFT SETBACK DISTANCE, THE SOIL BACKFILL SHALL BE SLOPED AT AN APPROXIMATE 5% SLOPE AWAY FROM THE STREAM.

13. THE SURFACE OF THIS STRUCTURE SHALL BE FINISHED TO A SMOOTH AND COMPACT SURFACE IN ACCORDANCE WITH THE LINES, GRADES, AND CROSS-SECTIONS OR ELEVATIONS SHOWN ON THE DRAWINGS. THE DEGREE OF FINISH FOR ELEVATIONS SHALL BE WITHIN +/- 0.1' OF THE GRADES AND ELEVATIONS INDICATED ON THE PLANS OR APPROVED BY THE ENGINEER.

14. DRESSING OF CHANNEL AND BANKFULL BENCH/FLOODPLAIN WILL LIKELY BE REQUIRED FOLLOWING INSTALLATION OF BANK STRUCTURES AND SHALL BE CONSIDERED INCIDENTAL TO CONSTRUCTION.

15. LIVE STAKES SHALL BE OF SPECIES APPROVED BY THE ENGINEER. LIVE STAKES SHALL BE 2-3' LONG AND A MIN. OF 1" IN DIAMETER AND INSTALLED WITH 2/3 OF THE LENGTH BELOW GROUND WITH A MINIMUM OF 2 BUD SCARS BELOW THE GROUND AND 2 ABOVE GROUND. SEE LIVE STAKE DETAIL.

16. LIVE STAKES SHALL BE PLACED ON THE SLOPE FROM THE INNER BERM TO HALF BANK FULL HEIGHT.

17. WOODEN STAKES SHALL BE 1 X 2" AND A MIN.. OF 18" LONG. WOODEN STAKES SHALL BE INSTALLED FROM THE INNER BERM TO BANKFULL ON 18-24" CENTERS PER THE ENGINEER'S INSTRUCTIONS.

APPROVED BY: KA | CHECKED BY: MJG | DRAWN BY: GET

| REV | DESCRIPTION | APPRV |
|---|---|---|
| 1 | DRAFT 30% DESIGN | XX |
| XX | XX | XX |
| XX | XX | XX |
| XX | XX | XX |
| XX | XX | XX |
| XX | XX | XX |
| XX | XX | XX |
| XX | XX | XX |

BIG AND LITTLE 39
STREAM RESTORATION
NEAR SILVER BAY
LAKE COUNTY, MN

DRAFT 30% DESIGN - NOT FOR CONSTRUCTION
---
---
DETAIL - TOE WOOD

CLIFFS

NORTHSHORE MINING CO
10 OUTER DR
SILVER BAY, MN 55614
---

BEAVER RIVER CONSULTING

BEAVER RIVER CONSULTING, LLC.
5752 EAGLE VIEW DRIVE
DULUTH, MN 55803
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CONCEPT DESIGN
NOT FOR
CONSTRUCTION

DATE: 1/31/2020

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SHEET NUMBER
27 OF 33

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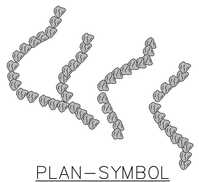
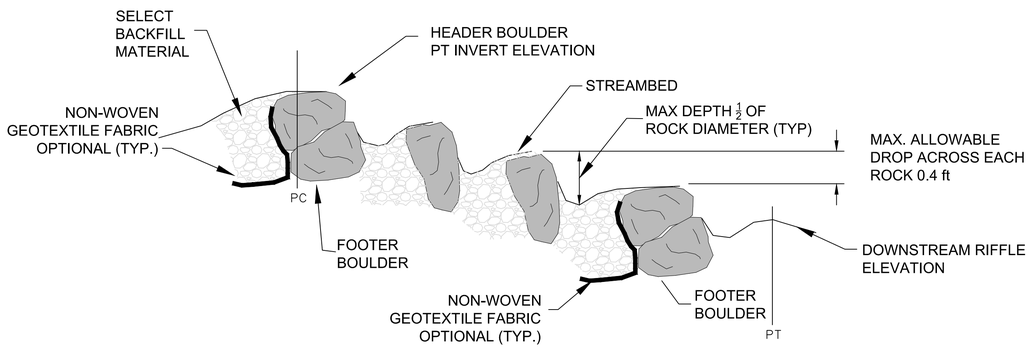
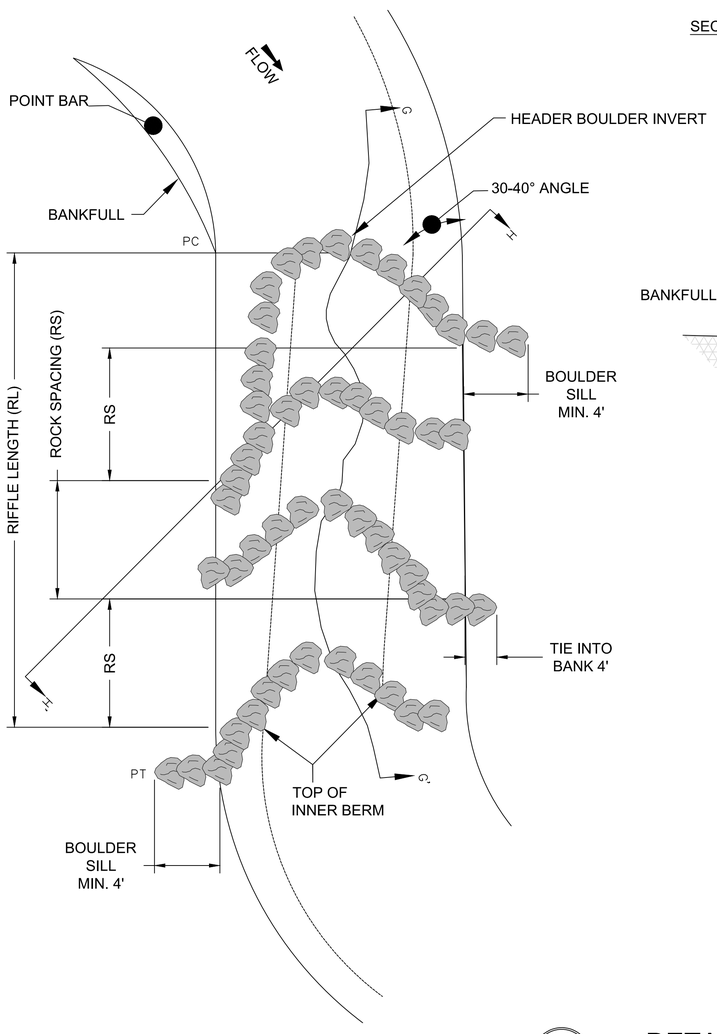
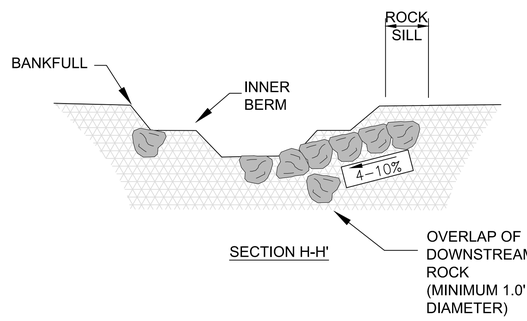



SECTION G-G'




PLAN VIEW




SECTION H-H'

# DETAIL - BOULDER CONSTRUCTED RIFFLE
NOT TO SCALE

BOULDER CONSTRUCTED RIFFLE
CONSTRUCTED MARCH 2019

NOTES:

1. BOULDERS FOR THE CONSTRUCTED RIFFLE MUST BE A MIN. OF 1-2 TON BOULDER WITH A MIN. DIAMETER OF 2-3'.
2. THE UPSTREAM AND DOWNSTREAM HEADER BOULDERS SHALL BE UNDERLAIN BY FOOTER BOULDERS UNLESS OTHERWISE DIRECTED BY THE ENGINEER.
3. HEADER BOULDERS ARE THE TOP MOST BOULDERS USED IN EACH STRUCTURE. HEADER BOULDERS FOR THIS STRUCTURE ARE ONLY VISIBLE BETWEEN THE INNER BERMS.
4. HEADER BOULDERS SHALL BE OFFSET SLIGHTLY UPSTREAM OF THE FOOTER BOULDERS. FOOTER BOULDERS SHALL BE INSTALLED BEFORE THE HEADER BOULDERS.
5. SET INVERTS AT ELEVATION SHOWN ON PLAN AND PROFILE SHEETS. INVERTS AND ELEVATIONS WILL BE PROVIDED TO THE CONTRACTOR AS A 2014 FORMAT DWG FILE. NO ELEVATIONS OF THE CONSTRUCTED RIFFLE ARMS MAY VARY FROM THE PLAN LOCATIONS WITHOUT DIRECTION FROM THE ENGINEER.
6. THE DROP IN ELEVATION ACROSS THE STRUCTURE SHALL NOT EXCEED 0.5FT UNLESS OTHERWISE DIRECTED BY THE ENGINEER.
7. MINI-VANES WILL BE SPACED IN THE RIFFLE AS A FUNCTION OF THE RIFFLE LENGTH.
8. THE MOST UPSTREAM RIFFLE MINI-VANE ARM SHALL BE PLACED SUCH THAT THE BANK TIE-IN IS ON THE SAME SIDE AS THE NEXT UPSTREAM OUTSIDE BEND IN ORDER TO SERVE AS A VANE AND HELP DIRECT STREAM FLOW AWAY FROM THE PREVIOUS OUTSIDE BEND. LOCATION OF ALL RIFFLE VANE ARMS ARE SHOWN ON THE PLAN AND PROFILE SHEETS.
9. THE MOST DOWNSTREAM MINI-VANE ARM SHALL BE PLACED SUCH THAT THE HIGH POINT IS ON THE SAME SIDE AS THE NEXT DOWNSTREAM OUTSIDE BEND IN ORDER TO HELP DIRECT STREAM FLOW FROM THE NEXT OUTSIDE BEND.
10. THE VERTICAL SLOPE OF EACH MINI-VANE ARM SHALL NOT EXCEED 10% UNLESS OTHERWISE DIRECTED BY THE ENGINEER. THE SLOPES WILL BE DICTATED BY THE WIDTH-TO-DEPTH RATIO OF THE REACH, TYPICAL RIFFLE INNER BERM CHANNEL, VERTICAL DROP OVER THE LOG, AND LOG DIAMETER.
11. ALL GAPS/VOIDS LARGER THAN 2" BETWEEN THE HEADER AND FOOTER BOULDERS SHALL BE HAND CHINKED WITH COBBLE AND GRAVEL ON THE UPSTREAM SIDE PRIOR TO PLACEMENT OF THE GEOTEXTILE. ALL CHINKING SHALL BE APPROVED BY THE ENGINEER BEFORE THE MINI-VANES ARE BACKFILLED.
12. THE UPSTREAM SIDE OF THE FIRST AND LAST MINI-VANE ARM REQUIRE A LAYER OF NON-WOVEN GEOTEXTILE FABRIC THAT SHALL BE PLACED AS SHOWN IN THE GEOTEXTILE PLACEMENT DETAIL THE ENTIRE LENGTH OF THE MINI-VANE.
13. BACKFILL VANES WITH SELECT BACKFILL MATERIAL AS SHOWN AND DEFINED IN THE CONSTRUCTED RIFFLE DETAIL. BACKFILL MATERIAL TO HAVE D100 OF 8" AND D50 OF 4".
14. SELECT BACKFILL AND SOIL BACKFILL MATERIAL SHALL BE COMPACTED SUCH THAT FUTURE SETTLEMENT OF THE MATERIAL IS KEPT TO A MINIMUM.
15. THE SURFACE OF THIS STRUCTURE SHALL BE FINISHED TO A SMOOTH AND COMPACT SURFACE IN ACCORDANCE WITH THE LINES, GRADES, AND CROSS-SECTIONS OR ELEVATIONS SHOWN ON THE DRAWINGS. THE DEGREE OF FINISH FOR INVERT ELEVATIONS SHALL BE WITHIN 0.1' OF THE GRADES AND ELEVATIONS INDICATED, PROVIDED ANY HEIGHT DOES NOT EXCEED MAX. ALLOWABLE DROP OF 0.5' FOR THIS STRUCTURE.
16. RE-DRESSING OF CHANNEL AND BANKFULL BENCH/FLOODPLAIN WILL LIKELY BE REQUIRED FOLLOWING INSTALLATION OF IN-STREAM STRUCTURES AND SHALL BE CONSIDERED INCIDENTAL TO CONSTRUCTION.
17. FOOTER DEPTH ON ALL STRUCTURES REQUIRING FOOTERS SHALL BE 6 TIMES GREATER THAN THE DROP BETWEEN THE STRUCTURE AND THE FOOTERED STRUCTURE DIRECTLY UPSTREAM.
18. THE DEPARTURE ANGLE SHOWN ABOVE IS DEPICTED IN SUCH A WAY TO EMPHASIZE DETAIL. ACTUAL DEPARTURE ANGLE SHALL BE AS SHOWN ON THE PLAN AND PROFILE SHEETS WILL BE PROVIDED TO THE CONTRACTOR AS A 2014 FORMAT DWG FILE AND LN3 FILE.

APPROVED BY: KA | CHECKED BY: MJG | DRAWN BY: GET

| REV | DESCRIPTION | APPRV |
|---|---|---|
| 1 | DRAFT 30% DESIGN | XX |
| XX | XX | XX |
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BIG AND LITTLE 39
STREAM RESTORATION
NEAR SILVER BAY
LAKE COUNTY, MN

DRAFT 30% DESIGN - NOT FOR CONSTRUCTION
---
DETAIL - BOULDER CONSTRUCTED RIFFLE

CLIFFS
NORTHSHORE MINING CO
10 OUTER DR
SILVER BAY, MN 55614
---
BEAVER RIVER CONSULTING
BEAVER RIVER CONSULTING, LLC.
5752 EAGLE VIEW DRIVE
DULUTH, MN 55803
---

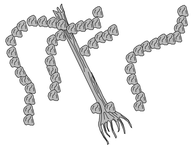
CONCEPT DESIGN
NOT FOR
CONSTRUCTION

DATE: 1/31/2020

NTS

SHEET NUMBER
28 OF 33

E:\DROPBOX (SSSR)\NORTHSHOREMINING\C3D\SHEETS\NORTHSHORE39MASTERDETAIL.DWG | GREGTAILLACQ | SAVED: Friday, January 31, 2020 10:42:03 AM | ACAD.CTB | | PLOTTED: Friday, January 31, 2020 10:47:20 AM



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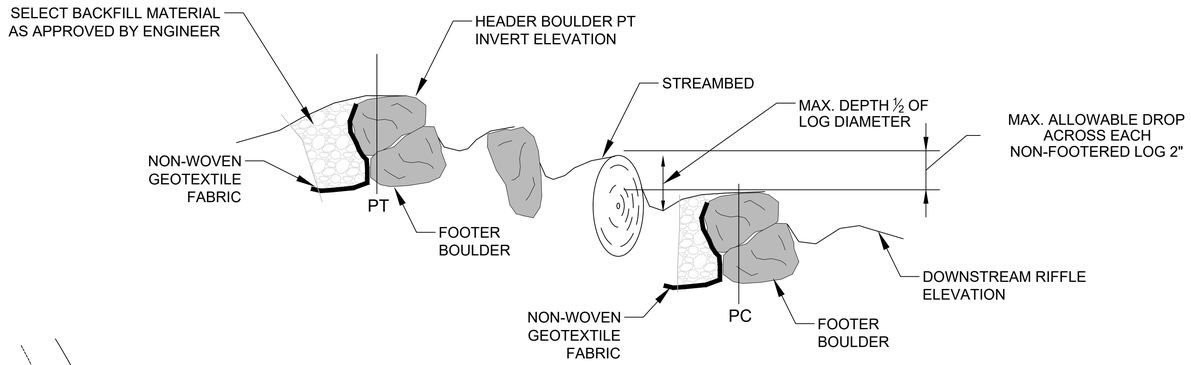
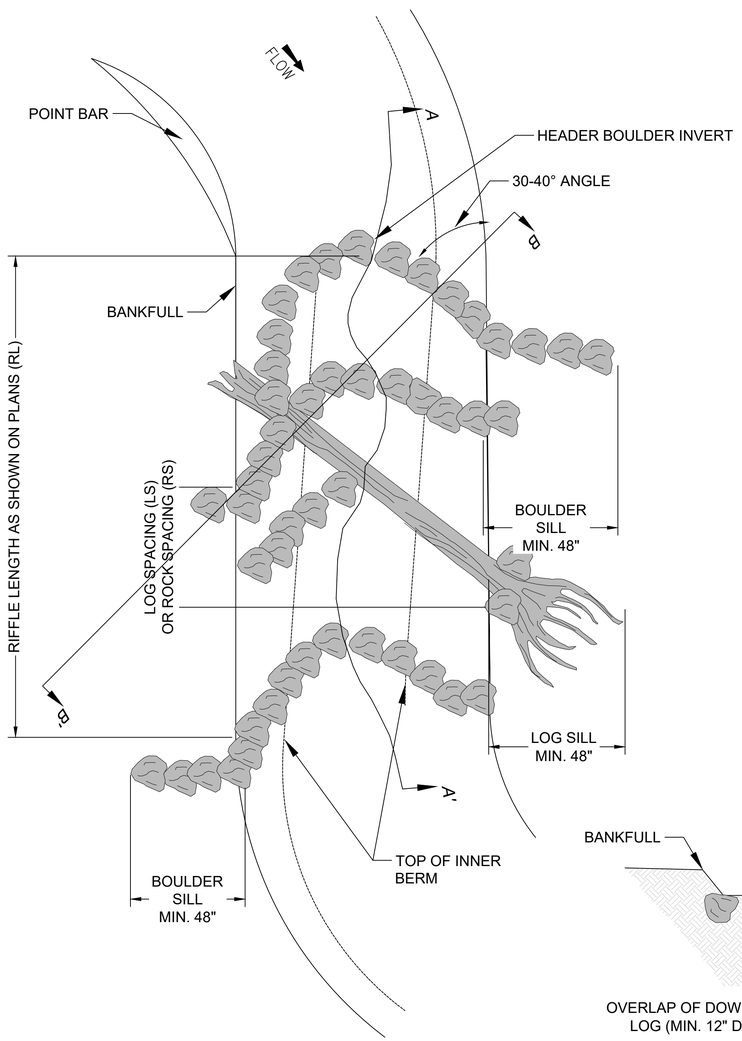
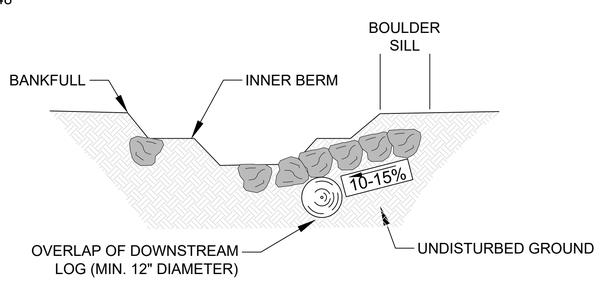



PROFILE A-A'

BOULDER AND LOG CONSTRUCTED RIFFLE
CONSTRUCTED MARCH 2019




PLANVIEW




SECTION B-B'

# DETAIL - BOULDER AND LOG CONSTRUCTED RIFFLE
NOT TO SCALE

NOTES:

1. THE BOULDER AND LOG CONSTRUCTED RIFFLE STRUCTURE IS USED TO PROVIDE GRADE CONTROL IN A DEGRADED CHANNEL OR A NEWLY CONSTRUCTED CHANNEL. THE BOULDER AND LOG CONSTRUCTED RIFFLE IS INSTALLED TO PREVENT ANY FURTHER DOWNCUTTING AND/OR HELP BRING THE CHANNEL UP TO AN APPROPRIATE GRADE.

2. THIS STRUCTURE CONSISTS OF AN UPSTREAM AND DOWNSTREAM BOULDER MINI-VANE. ONE OR MORE OF THE MINI-VANES WITHIN THE STRUCTURE CAN BE CONSTRUCTED USING A LOG(S) RATHER THAN BOULDERS AS A WAY OF SAVING MONEY BY USING MATERIAL AVAILABLE ON SITE. THE LOG(S) ALSO IMPROVE HABITAT WITHIN THE CHANNEL.

3. THE ACCEPTABILITY OF ALL BOULDERS AND LOGS WILL BE DETERMINED BY THE ENGINEER.

4. BOULDERS FOR THE ROCK MINI-VANES MUST BE A MIN. OF 1-2 TONS WITH A MIN. DIAMETER OF 2-3'.

5. THE MOST UPSTREAM AND DOWNSTREAM BOULDER MIN-VANES SHALL CONSIST OF ROWS OF BOULDERS STACKED TWO BOULDERS HIGH WITH A HEADER BOULDER RESTING ON A FOOTER BOULDER UNLESS OTHERWISE DIRECTED BY THE ENGINEER.

6. FOOTER BOULDERS SHALL BE INSTALLED BEFORE THE HEADER BOULDERS. HEADER BOULDERS SHALL BE OFFSET SLIGHTLY UPSTREAM OF THE FOOTER BOULDERS.

7. ALL GAPS/VOIDS LARGER THAN 2" BETWEEN THE HEADER AND FOOTER BOULDERS SHALL BE HANDED CHINKED WITH COBBLE AND GRAVEL ON THE UPSTREAM SIDE PRIOR TO PLACEMENT OF THE GEOTEXTILE. ALL CHINKING SHALL BE APPROVED BY THE ENGINEER BEFORE THE MINI-VANES ARE BACKFILLED.

8. ON THE UPSTREAM SIDE OF THE MOST UPSTREAM AND DOWNSTREAM MINI-VANE INSTALL A LAYER OF NON-WOVEN GEOTEXTILE FABRIC THAT SHALL BE PLACED ALONG THE ENTIRE LENGTH OF THE MINI-VANE AS SHOWN IN THE DRAWING.

9. THE MINI-VANES WITHIN THE STRUCTURE CAN BE CONSTRUCTED OF A SINGLE ROW OF BOULDERS (I.E., NOT STACKED) AS SPECIFIED IN 4. OR A SINGLE LOG (I.E., NOT STACKED). IF LOGS ARE USED TO CONSTRUCT MINI-VANES WITHIN STRUCURE, THE LOGS SHALL HAVE A MINIMUM DIAMETER OF 12", BE RELATIVELY STRAIGHT WITH LIMBS TRIMMED FLUSH AND HAVE A MINIMUM LENGTH OF 1.5 TIMES THE REACH BANKFULL WIDTH. THE MINIMUM LOG LENGTH WILL VARY BY REACH.

10. THE MINI-VANES WILL BE SPACED IN THE RIFFLE AS A FUNCTION OF THE RIFFLE LENGTH AND WILL BE DICATED BY THE ENGINEER.

11. THE MOST UPSTREAM MINI-VANE SHALL BE PLACED SUCH THAT THE BANK TIE IN IS ON THE SAME SIDE AS THE NEXT UPSTREAM OUTSIDE BEND IN ORDER TO SERVE AS A VANE AND HELP DIRECT STREAM FLOW AWAY FROM THE PREVIOUS OUTSIDE BEND.

12. THE MOST DOWNSTREAM MINI-VANE SHALL BE PLACED SUCH THAT THE HIGH POINT IS ON THE SAME SIDE AS THE NEXT DOWNSTREAM OUTSIDE BEND IN ORDER TO HELP DIRECT STREAM FLOW AWAY FROM THE NEXT OUTSIDE BEND.

13. THE VERTICAL SLOPE OF EACH MINI-VANE SHALL NOT EXCEED 10% UNLESS OTHERWISE DIRECTED BY THE ENGINEER.

14. SET INVERTS AT ELEVATIONS AS SHOWN ON THE PLAN AND PROFILE SHEETS. INVERTS AND ELEVATIONS WILL BE PROVIDED TO THE CONTRACTOR AS A 2004 FORMAT DWG FILE AND LN3 FILE. THE ELEVATIONS OF THE MIN-VANES SHALL NOT VARY FROM THOSE SPECIFIED IN THE PLANS UNLESS OTHERWISE DIRECTED BY THE ENGINEER.

15. THE DROP IN ELEVATION ACROSS THE ENTIRE STRUCTURE SHALL NOT EXCEED 1.0' UNLESS OTHERWISE DIRECTED BY THE ENGINEER.THE DROP ALONG A ROCK MINI-VANE WILL NOT EXCEED 0.2'. THE DROP ACROSS A LOG MINI-VANE SHALL NOT EXCEED 0.1'.

16. BACKFILL THE MINI-VANES WITH SELECT BACKFILL MATERIAL PER AUGMENTED RIFFLE DETAIL. WHEN THE STRUCTURE IS COMPLETE, THE HEADER BOULDERS/LOGS SHALL ONLY BE VISIBLE BETWEEN THE INNER BERMS.

17. SELECT BACKFILL MATERIAL SHALL BE COMPACTED SUCH THAT FUTURE SETTLEMENT OF THE MATERIAL WILL BE MINIMAL.

18. THE SURFACE OF THIS STRUCTURE SHALL BE FINISHED TO A SMOOTH AND COMPACT SURFACE IN ACCORDANCE WITH THE LINES, GRADES, AND CROSS-SECTIONS OR ELEVATIONS SHOWN ON THE DRAWINGS. THE FINISHED ELEVATIONS SHALL BE +/- 0.1' OF THE GRADES AND ELEVATIONS SPECIFIED IN THE PLANS.

19. DRESSING OF CHANNEL AND BANKFULL BENCH/FLOODPLAIN WILL LIKELY BE REQUIRED FOLLOWING INSTALLATION OF IN-STREAM STRUCTURES AND SHALL BE CONSIDERED INCIDENTAL TO CONSTRUCTION.

20. THE ANGLES SHOWN IN THE PLANVIEW IS DEPICTED IN SUCH A WAY TO EMPHASIZE DETAIL. ACTUAL DEPARTURE ANGLE SHALL BE AS SHOWN ON THE PLAN AND PROFILE SHEETS AND WILL BE PROVIDED TO THE CONTRACTOR AS A 2004 FORMAT DWG FILE AND LN3 FILE.

APPROVED BY: KA | CHECKED BY: MJG | DRAWN BY: GET

| REV | DESCRIPTION | APPRV |
|---|---|---|
| 1 | DRAFT 30% DESIGN | XX |
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BIG AND LITTLE 39
STREAM RESTORATION
NEAR SILVER BAY
LAKE COUNTY, MN

DRAFT 30% DESIGN - NOT FOR CONSTRUCTION
---
DETAIL - BOULDER LOG CONSTRUCTED RIFFLE


CLIFFS
NORTHSHORE MINING CO
10 OUTER DR
SILVER BAY, MN 55614
---
BEAVER RIVER CONSULTING
BEAVER RIVER CONSULTING, LLC.
5752 EAGLE VIEW DRIVE
DULUTH, MN 55803
---

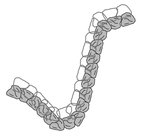

CONCEPT DESIGN
NOT FOR
CONSTRUCTION

DATE: 1/31/2020

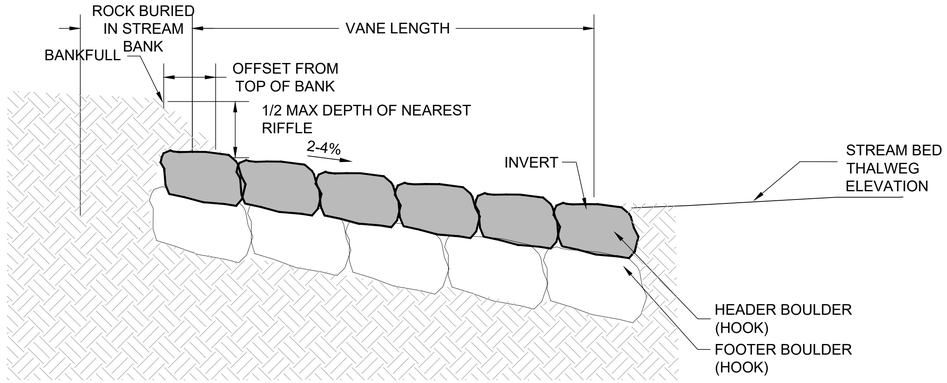
NTS

SHEET NUMBER
29 OF 33

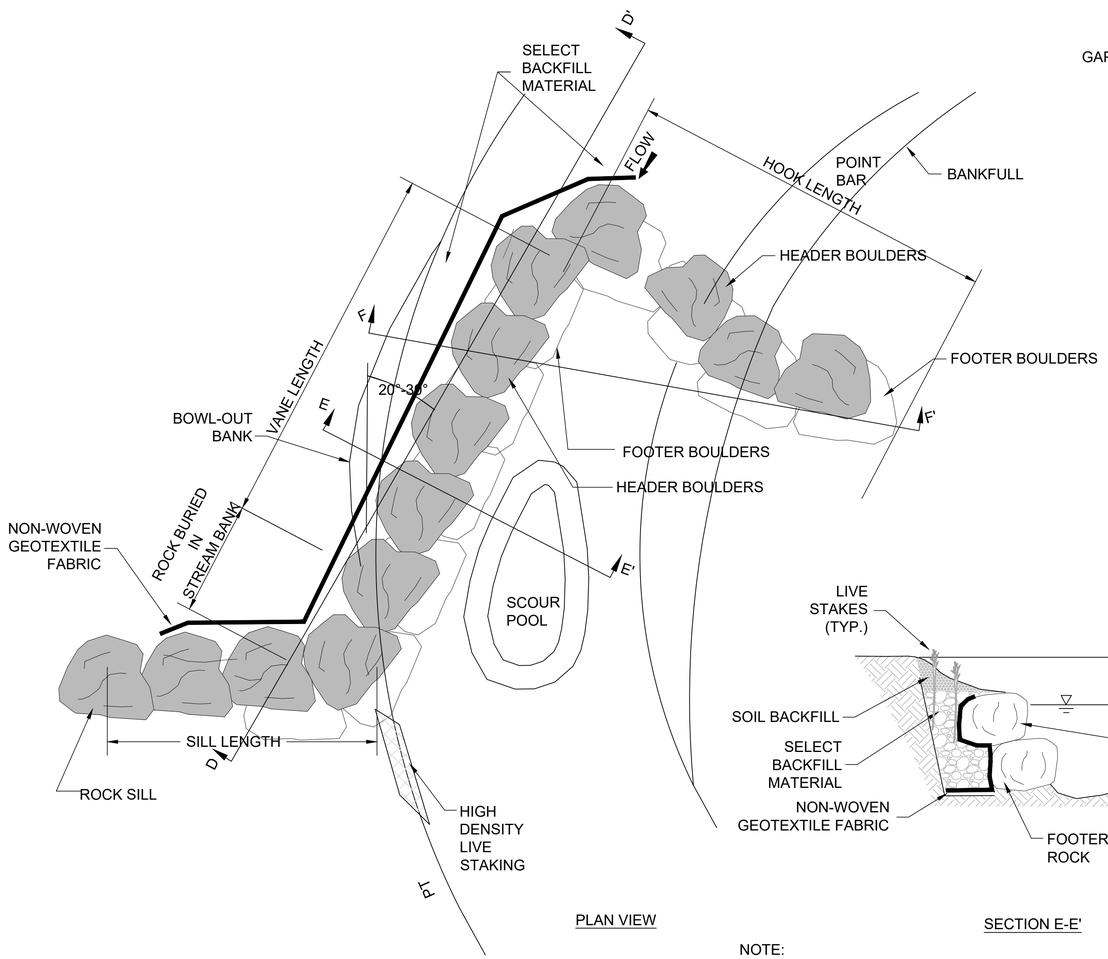
E:\DROPBOX (SSSR)\NORTHSHOREMINING\C3D\SHEETS\NORTHSHORE39MASTERDETAIL.DWG | GREGTAILLACQ | SAVED: Friday, January 31, 2020 10:42:03 AM | ACAD.CTB | | PLOTTED: Friday, January 31, 2020 10:47:21 AM



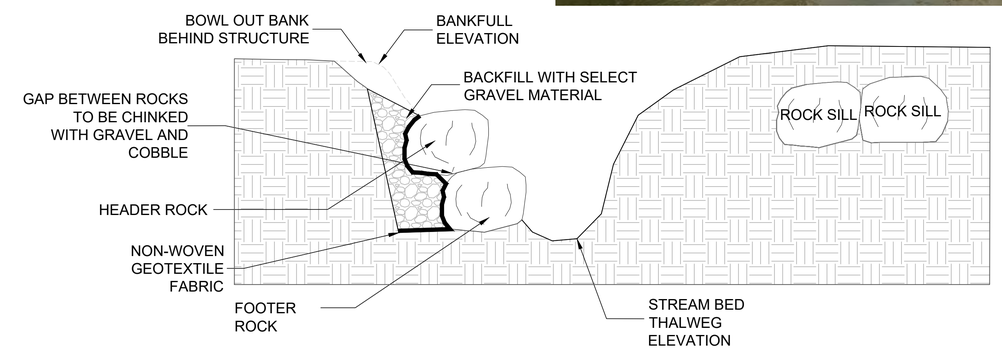
PLAN-SYMBOL



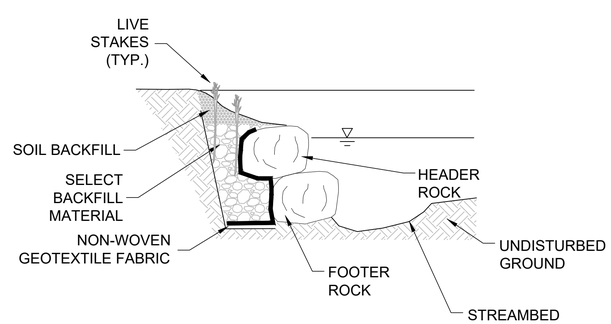
SECTION D-D'




PLAN VIEW




SECTION F-F'




SECTION E-E'

NOTE:

THE DEPARTURE ANGLE SHOWN ABOVE IS DEPICTED IN SUCH A WAY TO EMPHASIZE DETAIL. ACTUAL DEPARTURE ANGLE AND STRUCTURE LOCATION SHALL BE AS SHOWN ON THE PLAN AND PROFILE SHEETS AND WILL BE PROVIDED TO THE CONTRACTOR AS A 2004 FORMAT DWG FILE AND LN3 FILE.

DETAIL - BOULDER J-HOOK
NOT TO SCALE

NOTES:

1. BOULDERS FOR THE CONSTRUCTED RIFFLE MUST BE A MINIMUM OF 1-2 TN BOULDER WITH A MIN. DIAMETER OF 2-3FT.
2. FOOTER BOULDERS ARE BOULDERS PLACED TO PROVIDE A FOUNDATION AND SCOUR PROTECTION FOR THE HEADER BOULDERS.
3. HEADER BOULDERS SHALL BE UNDERLAIN BY FOOTER BOULDERS UNLESS OTHERWISE DIRECTED BY THE ENGINEER.
4. HEADER BOULDERS ARE THE TOP MOST BOULDER USED IN EACH STRUCTURE. ALL HEADER BULDERS CAN BE SEEN PARTIALLY PROTRUDING FROM THE WATER SURFACE DURING EXTREMELY LOW FLOWS.
5. HEADER BOULDERS SHALL BE OFFSET SLIGHTLY DOWNSTREAM OF THE FOOTING BOULDERS WHERE SCOUR POOLS ARE ANTICIPATED TO FORM AS SHOWN IN THE DETAIL.
6. SILL BOULDERS SHALL BE PLACED PERPENDICULAR TO THE BANKFULL FLOW DIRECTION.
7. THE FOOTER BOULDERS SHALL EXTEND FROM THE SILL BOULDER TO THE END OF THE HEADER BOULDER TOWARD THE BANK.
8. HOOK BOULDERS SHALL EXTEND FROM THE HEADER BOULDER TO BEYOND BANKFULL WIDTH.
9. SET INVERTS AT ELEVATION SHOWN ON THE PLAN AND PROFILE SHEETS. INVERTS AND ELEVATIONS WILL BE PROVIDED TO THE CONTRACTOR AS A 2004 FORMAT DWG FILE. NO ELEVATIONS OF THE BOULDER DROPS STRUCTURE MAY VARY FROM THE PLAN LOCATIONS WITHOUT DIRECTIONS FROM THE ENGINEER.
10. HEADER BOULDER SHALL TIE INTO THE STREAM BANK AT A MINIMUM ELEVATION OF 1/4 DMAX (MEASURED AT THE NEXT DOWNSTREAM RIFFLE) BELOW BANKFULL ELEVATION AND A MINIMUM ELEVATION OF 1/2 DMAX (MEASURED AT THE NEXT DOWNSTREAM RIFFLE) BELOW BANKFULL ELEVATION UNLESS OTHERWISE DIRECTED BY THE ENGINEER.
11. ALL GAPS/VOIDS LARGER THAN 1 INCH BETWEEN THE HEADER AND FOOTING BOULDERS SHALL BE CHINKED WITH GRAVEL AND COBBLES.
12. ON THE UPSTREAM SIDE OF THE BOULDERS NON-WOVEN GEOTEXTILE FABRIC SHALL BE PLACED AS SHOWN IN THE GEOTEXTILE PLACEMENT AND SELECT BACKFILL DETAIL FOR THE ENTIRE LENGTH OF THE BOULDER HOOK.
13. BACKFILL STRUCTURE WITH SELECT BACKFILL MATERIAL AS SHOWN AND DEFINED IN THE GEOTEXTILE PLACEMENT AND SELECT BACKFILL DETAIL.
14. SELECT BACKFILL AND SOIL BACKFILL MATERIAL SHALL BE COMPACTED SUCH THAT FUTURE SETTLEMENT OF THE MATERIAL IS KEPT TO A MINIMUM.
15. THE SURFACE OF THIS STRUCTURE SHALL BE FINISHED TO A SMOOTH AND COMPACT SURFACE IN ACCORDANCE WITH THE LINES, GRADES, AND CROSS-SECTIONS OR ELEVATIONS SHOWN ON THE DRAWINGS. THE DEGREE OF FINISH FOR INVERT ELEVATIONS SHALL BE WITHIN 0.1 FT OF THE GRADES AND ELEVATIONS INDICATED.
16. RE-DRESSING OF CHANNEL AND BANKFULL BENCH/FLOODPLAIN WILL LIKELY BE REQUIRED FOLLOWING INSTALLATION OF IN-STREAM STRUCTURES AND SHALL BE CONSIDERED INCIDENTAL TO CONSTRUCTION.
17. SEE THE PLANTING TABLE FOR DETAILS ON HIGH DENSITY LIVE STAKING.
18. NO LIVE STAKES SHALL BE INSTALLED ON THE UPSTREAM SIDE OF THE VANE AT OR BELOW THE TIE-IN ELEVATION OF THE HEADER LOG WITH THE STREAM BANK UNLESS OTHERWISE DIRECTED BY THE ENGINEER.
19. FOOTER DEPTH ON ALL STRUCTURES REQUIRING FOOTERS SHALL BE 6 TIMES GREATER THAN THE DROP BETWEEN THE STRUCTURE AND THE FOOTERED STRUCTURE DIRECTLY UPSTREAM.

APPROVED BY: KA | CHECKED BY: MJG | DRAWN BY: GET

| REV | DESCRIPTION | APPRV |
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| 1 | DRAFT 30% DESIGN | XX |
| XX | XX | XX |
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BIG AND LITTLE 39
STREAM RESTORATION
NEAR SILVER BAY
LAKE COUNTY, MN

DRAFT 30% DESIGN - NOT FOR CONSTRUCTION
---
DETAIL - BOULDER J-HOOK

CLIFFS

NORTHSHORE MINING CO
10 OUTER DR
SILVER BAY, MN 55614
---

BEAVER RIVER CONSULTING

BEAVER RIVER CONSULTING, LLC.
5752 EAGLE VIEW DRIVE
DULUTH, MN 55803
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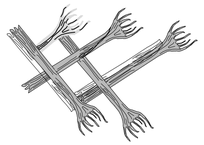
CONCEPT DESIGN
NOT FOR
CONSTRUCTION

DATE: 1/31/2020

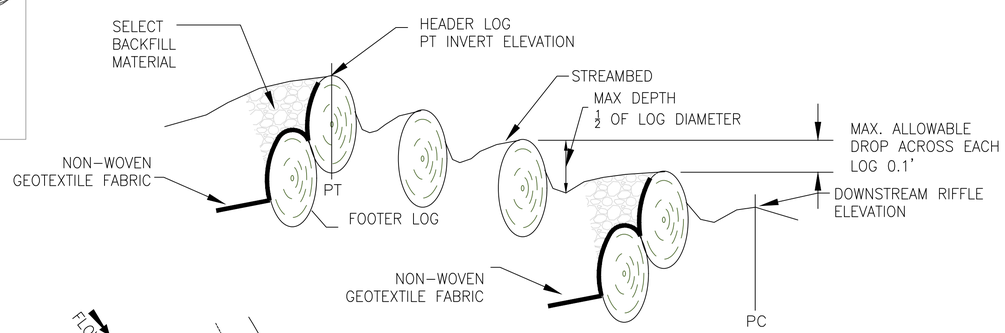
NTS

SHEET NUMBER
30 OF 33

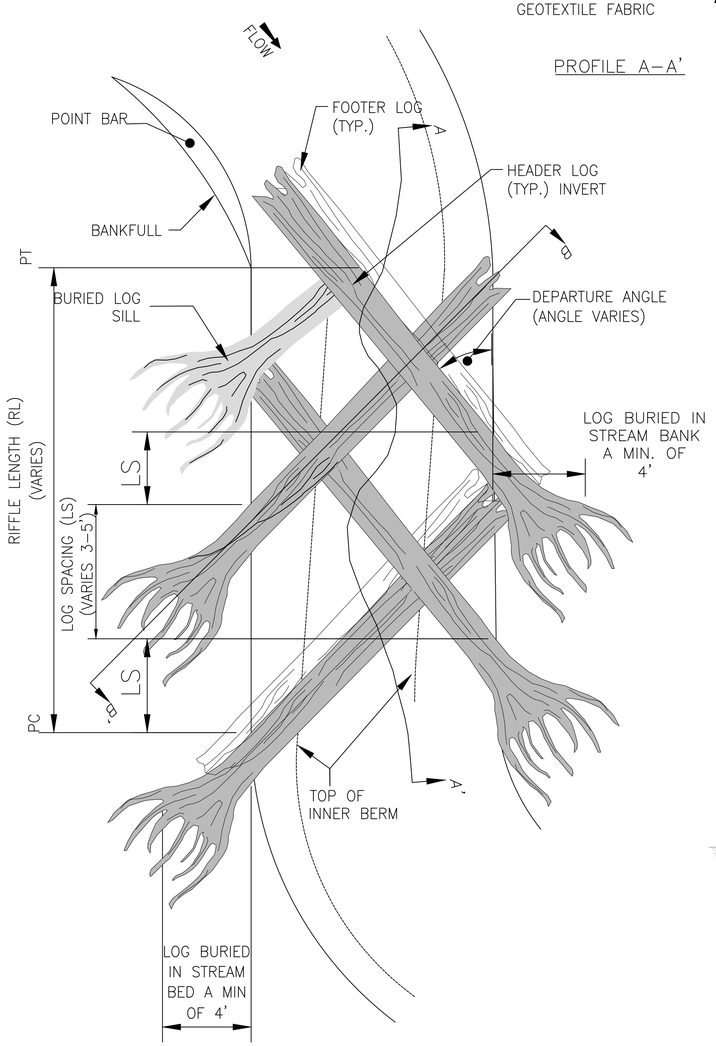
E:\DROPBOX (SSR)\NORTHSHOREMINING\C3D\SHEETS\NORTHSHORE39MASTERDETAIL.DWG | GREGTAILLACQ | SAVED: Friday, January 31, 2020 10:42:03 AM | ACAD.CTB | | PLOTTED: Friday, January 31, 2020 10:47:22 AM



PLAN–SYMBOL

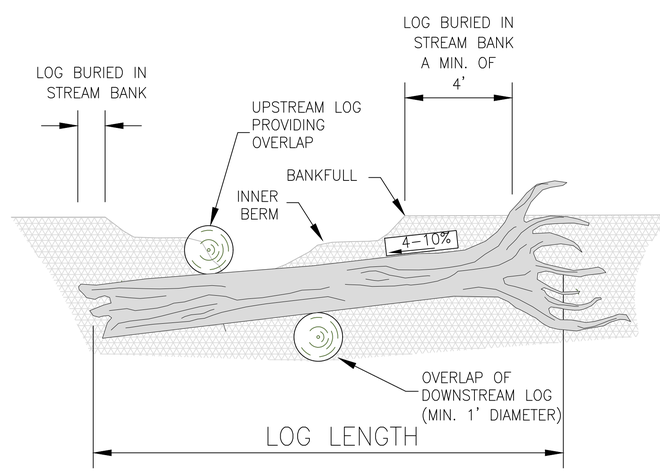



PROFILE A–A'




PLANVIEW

CONSTRUCTED LOG RIFFLE
CONSTRUCTED FEBRUARY 2019




SECTION B–B'

DETAIL – CONSTRUCTED LOG RIFFLE
NOT TO SCALE

NOTES:

1. THIS STRUCTURE HELPS MAINTAIN GRADE WITHIN A NEWLY CONSTRUCTED STREAM CHANNEL. IN GENERAL, IT IS USED IN LOCATIONS WHERE COARSE SUBSTRATE USED TO CONSTRUCT OTHER GRADE CONTROL STRUCTURES (E.G., AUGMENTED RIFFLE) IS NOT AVAILABLE. IF SUITABLE COARSE SUBSTRATE IS DISCOVERED ON SITE, THE CONTRACTOR MAY INSTALL A DIFFERENT GRADE CONTROL STRUCTURE WITH THE ENGINEER'S APPROVAL.

2. THE CONSTRUCTED LOG RIFFLE SHALL BE INSTALLED ON PERENNIAL REACHES THAT ARE REMOTE. BANKFULL WIDTHS OF THESE REACHES WILL BE BETWEEN 8-11', WITH SLOPES THAT RANGE FROM OF 1.5-2.5%. THE CONSTRUCTED LOG RIFFLE STRUCTURES ARE INTENDED FOR REACHES WITH LIMITED ACCESS AND WITH TREES AVAILABLE ONSITE.

3. LOGS SHALL HAVE MIN. DIAMETER OF 12". LOGS SHALL HAVE A MINIMUM LENGTH OF 10-50' DEPENDING ON THE REACH.

4. ALL LOGS SHALL BE RELATIVELY STRAIGHT AND LIMBS SHALL BE TRIMMED FLUSH.

5. THE LOGS AT THE UPSTREAM AND DOWNSTREAM END OF THE STRUCTURE WILL BE UNDERLAIN BY A FOOTER LOG (SOMETIMES CALLED A BACKER LOG) UNLESS OTHERWISE DIRECTED BY ENGINEER. THE HEADER LOG IS THE TOP LOG USED IN EACH PAIR. WHEN FINISHED, THE HEADER LOG IS VISIBLE ONLY BETWEEN THE INNER BERMS. THE HEADER LOG SHALL BE INSTALLED BEFORE THE FOOTER LOG. THE HEADER LOG DOES NOT REST ON THE TOP OF THE FOOTER LOG. THE FOOTER LOG IS INSTALLED FROM THE UPSTREAM SIDE AND INSTALLED AGAINST THE LOWER HALF OF THE HEADER LOG RESULTING IN A STAGGER WITH THE HEADER LOG BEING SLIGHTLY MORE DOWNSTREAM THAN THE FOOTER LOG.

6. THE OTHER LOGS IN THE STRUCTURE ARE SINGLE LOGS WITH NO FOOTER LOG.

7. SET INVERTS AT ELEVATIONS SHOWN ON THE PLAN AND PROFILE SHEETS. PLAN AND PROFILE SHEETS WILL BE PROVIDED TO THE CONTRACTOR AS A DWG FILE AND LN3 FILE. THE ELEVATIONS OF THE LOGS COMPRISING THE LOG CONSTRUCTED RIFFLE SHALL NOT VARY FROM THE PLAN UNLESS OTHERWISE DIRECTED BY THE ENGINEER.

8. THE MOST UPSTREAM LOG SHALL BE PLACED SUCH THAT THE BANK TIE-IN IS ON THE SAME SIDE AS THE NEXT UPSTREAM OUTSIDE BEND IN ORDER TO SERVE AS A VANE AND HELP DIRECT STREAM FLOW AWAY FROM THE PREVIOUS OUTSIDE BEND. LOCATION OF ALL RIFFLE LOG ARMS ARE SHOWN ON THE PLAN AND PROFILE SHEETS AND WILL BE PROVIDED TO THE CONTRACTOR AS A DWG FILE AND LN3 FILE. NO ELEVATIONS OF THE CONSTRUCTED RIFFLE ARMS MAY VARY FROM THE PLAN LOCATIONS WITHOUT DIRECTION FROM ENGINEER.

9. THE MOST DOWNSTREAM LOG SHALL BE PLACED SUCH THAT THE HIGH POINT IS ON THE SAME SIDE AS THE NEXT DOWNSTREAM OUTSIDE BEND IN ORDER TO HELP DIRECT STREAM FLOW AWAY FROM THE NEXT OUTSIDE BEND.

10. ALL LOGS ARE PLACED SUCH THAT THEY OVERLAP THE NEXT DOWNSTREAM LOG. THEREFORE, IT IS RECOMMENDED THAT THIS STRUCTURE BE CONSTRUCTED FROM DOWNSTREAM TO UPSTREAM.

11. THE VERTICAL SLOPE OF EACH LOG SHALL NOT EXCEED 10% WITH THE SPECIFIC VERTICAL SLOPE OF EACH LOG DETERMINED BY THE ENGINEER.

12. IT IS LIKELY THAT THE LOGS WILL REQUIRE NOTCHING WHERE THEY OVERLAP IN ORDER TO NOT EXCEED THE MAXIMUM VERTICAL SLOPE SPECIFICATION. THE CONTRACTOR SHOULD CHOOSE LOGS THAT CAN MEET THE SPECIFICATIONS OF THIS DETAIL

13. THE NOTCH DEPTH FOR ANY LOG SHALL NOT EXCEED HALF THE DIAMETER OF THE LOG UNLESS OTHERWISE DIRECTED BY THE ENGINEER. ANY NOTCHED LOGS SHALL BE APPROVED BY THE ENGINEER BEFORE THE LOGS ARE BACKFILLED.

14. ALL GAPS/VOIDS LARGER THAN 1" BETWEEN THE HEADER AND FOOTER LOGS SHALL BE CHINKED WITH LIMBS AND/OR BRUSH ON THE UPSTREAM SIDE PRIOR TO PLACEMENT OF THE GEOTEXTILE.

15. ON THE UPSTREAM SIDE OF THE LOGS A LAYER OF NON-WOVEN GEOTEXTILE FABRIC SHALL BE PLACED AS SHOWN IN THE DETAIL THE ENTIRE LENGTH OF THE LOG. SECURE THE GEOTEXTILE FABRIC TO THE UPSTREAM SIDE OF THE HEADER LOG USING 3" 10D GALVANIZED COMMON NAIL ON 12" SPACING.

16. SELECT BACKFILL MATERIAL SHALL BE PLACED UPSTREAM OF EACH LOG SUCH THAT FUTURE SETTLEMENT OF THE MATERIAL WILL BE MINIMAL. SELECT BACKFILL MATERIAL SHALL BE HAVE A MINIMUM D50 OF 60 MM. ANY DEVIATIONS IN THE GRADATION MUST BE APPROVED BY THE ENGINEER.

17. THE SURFACE OF THIS STRUCTURE SHALL BE FINISHED TO A SMOOTH AND COMPACT SURFACE IN ACCORDANCE WITH THE LINES, GRADES, AND CROSS-SECTIONS OR ELEVATIONS SHOWN ON THE DRAWINGS. THE DEGREE OF FINISH FOR INVERT ELEVATIONS SHALL BE WITHIN 0.1' OF THE GRADES AND ELEVATIONS INDICATED, PROVIDED ANY HEIGHT DOES NOT EXCEED MAX. ALLOWABLE DROP OF 0.1' OVER ANY ONE LOG AND 0.5' FOR THE ENTIRE STRUCTURE.

18. DRESSING OF CHANNEL AND BANKFULL BENCH/FLOODPLAIN WILL LIKELY BE REQUIRED FOLLOWING INSTALLATION OF IN-STREAM STRUCTURES.

19. THE DEPARTURE ANGLE SHOWN IN THE PLAN VIEW DRAWING IS DEPICTED IN SUCH A WAY TO EMPHASIZE DETAIL. ACTUAL DEPARTURE ANGLE SHALL BE AS SHOWN ON THE PLAN AND PROFILE SHEETS AND WILL BE PROVIDED TO THE CONTRACTOR AS A DWG FILE AND LN3 FILE.

1.

APPROVED BY: KA | CHECKED BY: MJG | DRAWN BY: GET

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BIG AND LITTLE 39
STREAM RESTORATION
NEAR SILVER BAY
LAKE COUNTY, MN

DRAFT 30% DESIGN - NOT FOR CONSTRUCTION

DETAIL - LOG CONSTRUCTED RIFFLE


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DATE: 1/31/2020

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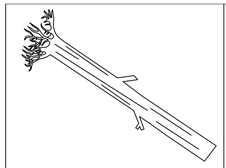
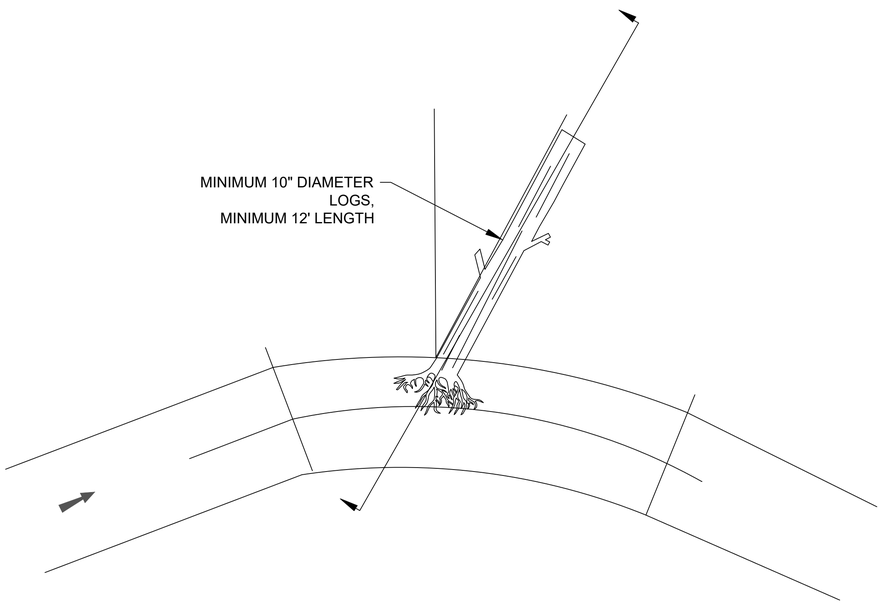
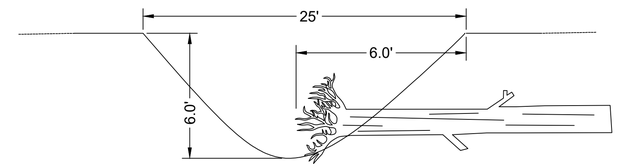
SHEET NUMBER
31 OF 33

E:\DROPBOX (SSR)\NORTHSHOREMINING\C3D\SHEETS\NORTHSHORE39MASTERDETAIL.DWG | GREGTAILLACQ | SAVED: Friday, January 31, 2020 10:42:03 AM | ACAD.CTB | | PLOTTED: Friday, January 31, 2020 10:47:22 AM

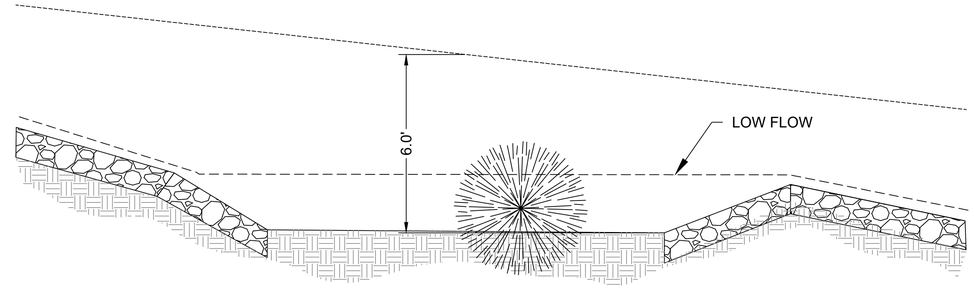


PLAN SYMBOL




LOG CROSS SECTION B-B'




HABITAT LOGS PROFILE C-C'

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BIG AND LITTLE 39
STREAM RESTORATION
NEAR SILVER BAY
LAKE COUNTY, MN

DRAFT 30% DESIGN - NOT FOR CONSTRUCTION
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---
DETAIL - HABITAT LOG

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32 OF 33

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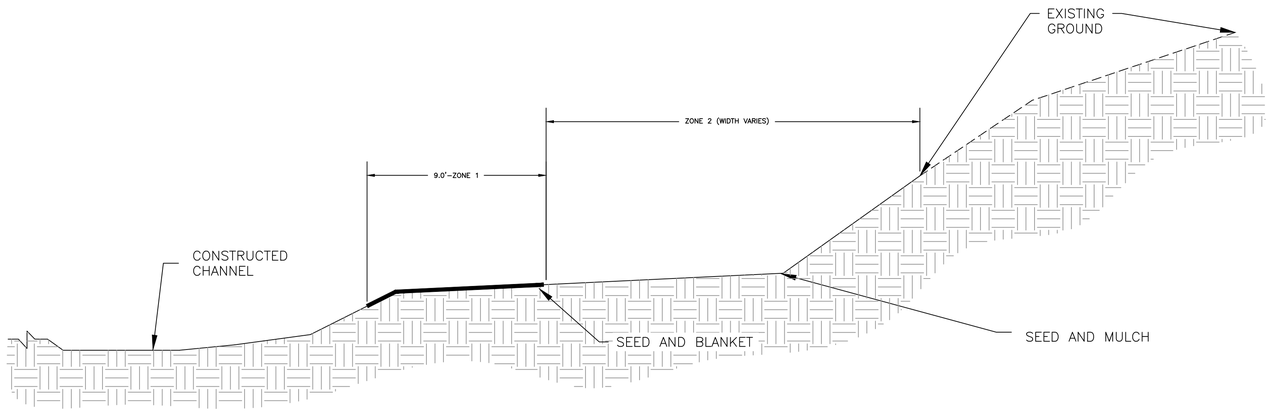


ZONE PLANTING
TYPICAL CROSS SECTION DETAIL

## ZONE 1

PLANTING AREA-

MIN. 8' WIDE BANKFULL BENCH, IN ADDITION TO 1' INTO CHANNEL.

CANOPY-

THE FOLLOWING CANOPY PLANTS SHALL BE 1.5' HEIGHT CONTAINERIZED STOCK. PLANT AT 12 FOOT SPACING ABOVE BANKFULL ELEVATION:

1. WHITE SPRUCE (PICEA GLAUCA)-90%
2. *WHITE CEDAR (*THUJA OCCIDENTALIS)-10%*

SUB-CANOPY-

THE FOLLOWING SUB-CANOPY PLANTS SHALL BE 1.5' HEIGHT CONTAINERIZED STOCK. PLANT THE FOLLOWING EVERY 8 FOOT SPACING, AT OR ABOVE BANKFULL ELEVATION.

1. BEAKED HAZEL (CORYLUS CORNUTA)-25%
2. MOUNTAIN MAPLE (ACER SPICATUM)-10%
3. SPECKLED ALDER (ALNUS INCANA)-25%
4. RED-OSIER DOGWOOD (CORNUS SERICEA)-40%

TRANSPLANTS:

- TRANSPLANT WILLOW AND DOGWOOD SHRUBS FROM THE EXCAVATED AREA. PLANT AT THE EDGE OF THE BLANKET ON THE STREAM SIDE EVERY 8 FEET IN THE RIFFLES. IF NOT IMMEDIATELY PLANTED, PLACE TEMPORARILY IN SOIL UNTIL PLANTING. SLICE COIR BLANKET TO PLANT TRANSPLANTS.

SEED AND COIR AND BACKER BLANKET

- BLANKET MAIN CHANNEL WITH 9.8' WIDE AND BACKED WITH MN DOT CATEGORY 3N, 2S, EROSION CONTROL BLANKET. INSTALL 2' LONG, 2"X2" WOOD STAKES WITH A ROOFING NAIL AT THE TOP TO SECURE THE BLANKET, INSTALL STAKES EVERY 5' ALONG BLANKET EDGES AND EVERY 5' DOWN THE CENTERLINE OF THE BLANKET.
  SEED WITH MIX NOTED ON THIS DETAIL SHEET WITH 25 LBS/ACRE OF COVER CROP AS APPROVED BY ENGINEER.

## ZONE 2

PLANTING AREA-

LIMITS OF RESTORATION OUTSIDE OF ZONE 1 FLOODPLAIN AREA.

CANOPY

THE FOLLOWING CANOPY PLANTS SHALL BE 1.5' HEIGHT CONTAINERIZED STOCK. PLANT AT 12 FOOT SPACING:

1. WHITE SPRUCE (PICEA GLAUCA) -40%
2. YELLOW BIRCH (BETULA ALLEGHANIENSIS)-10%
3. BUR OAK (*QUERCUS MACROCARPA*)- 10%
4. *WHITE PINE (PINUS STROBUS) -20%
5. PAPER BIRCH (BETULA PAPYRIFERA) -10%
6. SUGAR MAPLE (ACER SACCHARUM)-10%

SUB-CANOPY

THE FOLLOWING SUB-CANOPY PLANTS SHALL BE 1.5' HEIGHT CONTAINERIZED STOCK. PLANT THE FOLLOWING AT 12 FOOT SPACING,

1. CHOKE CHERRY (PRUNIS VIRGINIANA)-20%
2. NANNYBERRY (VIBURNUM LENTAGO)-20%
3. PAGODA DOGWOOD (CORNUS ALTERNIFOLIA)-20%
4. JUNEBERRIES (AMELANCHIER SPP.)-20%
5. BUSH HONEYSUCKLE (DIERVILLA LONICERA)-20%

SEED AND MULCH

- APPLY TYPE 3 MULCH, DISCED IN.
- SEED WITH MIX NOTED ON THIS DETAIL SHEET WITH 25 LBS/ACRE OF COVER CROP AS APPROVED BY ENGINEER.
- SCARIFY SOIL PRIOR TO SEEDING
- TOP DRESS GRAVEL AREAS (AREAS WITH OVER 30 PERCENT GRAVEL MATERIAL) WITH 0.3 FEET OF SOILS EXCAVATED FROM THE FLOODPLAIN AREA SUCH THAT FINE SOILS ARE PRESENT FOR SEED ESTABLISHMENT

## SEED MIX

| GRASS SEED | 15 LBS./ACRE |
|---|---|
| Big bluestem (*Andropogon gerardii*) | 20% |
| Fringed brome (*Bromus ciliatus*) | 8% |
| Blue-joint grass (*Calamagrostis canadensis*) | 2% |
| Caterpillar Sedge (Carex crinita) | 5% |
| Poverty oats (*Danthonia spicata*) | 10% |
| Slender Wheatgrass (*Elymus trachycalum*) | 12% |
| Virginia wild rye (*Elymus virginicus*) | 13% |
| American manna (Glyceria grandis) | 10% |
| Fowl bluegrass (Poa palustris) | 5% |
| Cord grass (*Spartina pectinata*) | 15% |

| **Wildflower Seed** | **32oz. /acre** |
|---|---|
| Yarrow (*Achillea millefolium*) | 2% |
| Fragrant giant hyssop (*Agastache foeniculum* | *10%* |
| Swamp milkweed (*Asclepias incarnata*) | 10% |
| Common milkweed (*Asclepias syriaca*) | 10% |
| Fireweed (*Epilobium angustifolium*) | 2% |
| Boneset (*Eupatorium perfoliatum*) | 8% |
| Joe-Pye weed (*Eutrochium maculatum*) | 5% |
| Common ox-eye (*Heliopsis helianthoides*) | 5% |
| Wild bergamot (*Monarda fistulosa*) | 10% |
| Black-eyed Susan (*Rudbeckia hirta*) | 5% |
| Stiff goldenrod (*Solidago rigida*) | 7% |
| Blue vervain (*Verbena hastata*) | 20% |
| Golden alexanders (*Zizia aurea*) | 6% |

## ZONE 3

SEED AND MULCH
SEED EXPOSED SOILS WITH SEED MIX NOTED ON THIS SHEET ALONG WITH 25 LBS/ACRE OF COVER CROP AS APPROVED BY ENGINEER.

TREE PROTECTION:

* SPECIES THAT REQUIRE 6' HIGH X 3.0' DIAMETER FENCING WITH 2 T-POSTS PLACED ON THE UPSTREAM SIDE OF THE TREE CAGE

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BIG AND LITTLE 39
STREAM RESTORATION
NEAR SILVER BAY
LAKE COUNTY, MN

DRAFT 30% DESIGN - NOT FOR CONSTRUCTION
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DETAIL - PLANTING

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SILVER BAY, MN 55614
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BEAVER RIVER CONSULTING, LLC.
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33 OF 33

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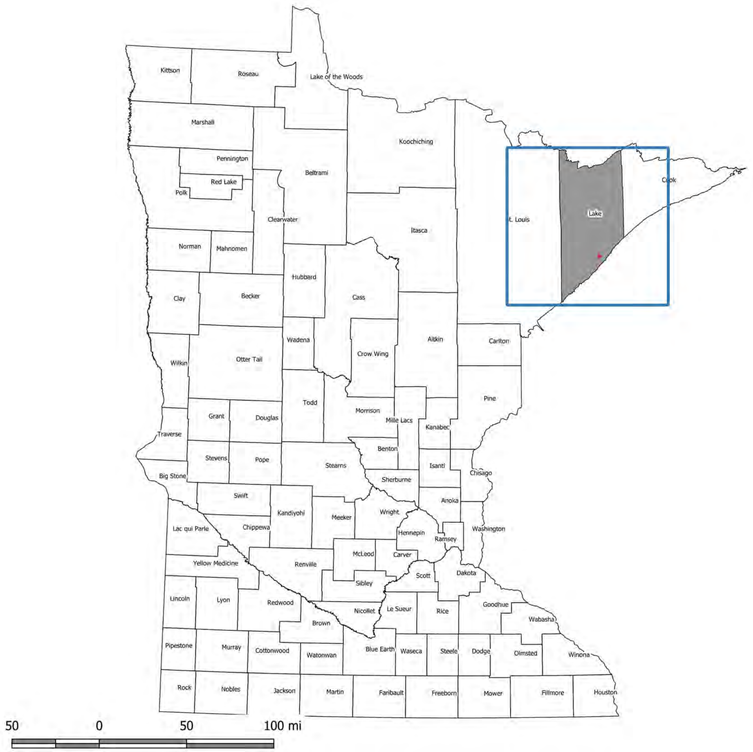
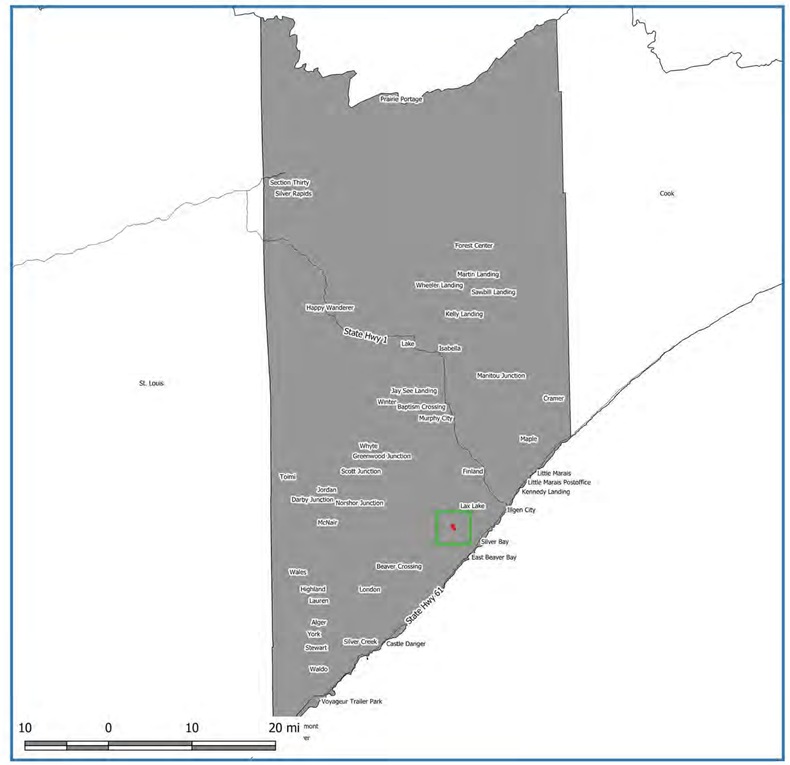
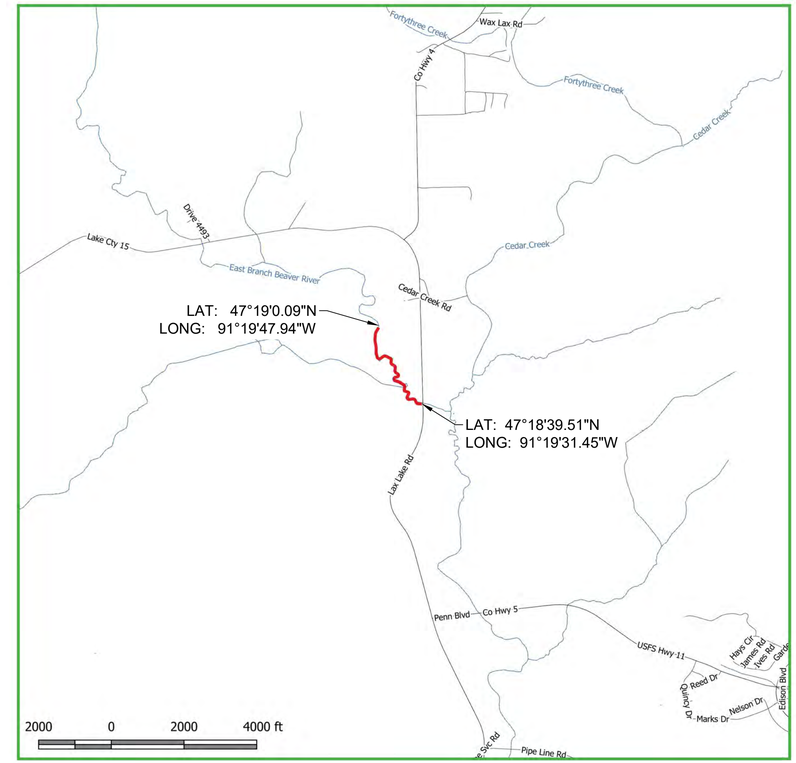
# DRAFT 30% DESIGN - NOT FOR CONSTRUCTION
# EAST BRANCH BEAVER RIVER
# STREAM RESTORATION

NEAR SILVER BAY
LAKE COUNTY, MN
2/07/2020

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| Sheet List Table | | | |
|---|---|---|---|
| SHEET # | SHEET TITLE | DRAWING TITLE | REVISION DATE |
| 1 | COVER | eastForkLightCoverNotes.dwg | Friday, February 7, 2020 2:03:11 PM |
| 2 | TABLE OF CONTENTS | eastForkLightCoverNotes.dwg | Friday, February 7, 2020 2:03:11 PM |
| 3 | NOTES | eastForkLightCoverNotes.dwg | Friday, February 7, 2020 2:03:11 PM |
| 4 | QUANTITIES | eastForkLightCoverNotes.dwg | Friday, February 7, 2020 2:03:11 PM |
| 5 | OVERVIEW | eastBranchLight_pp.dwg | Friday, February 7, 2020 2:03:05 PM |
| 6 | East Branch - Phase 1 PP - (1) | eastBranchLight_pp.dwg | Friday, February 7, 2020 2:03:05 PM |
| 7 | East Branch - Phase 1 PP - (2) | eastBranchLight_pp.dwg | Friday, February 7, 2020 2:03:05 PM |
| 8 | East Branch - Lower PP - (1) | eastBranchLight_pp.dwg | Friday, February 7, 2020 2:03:05 PM |
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| 10 | East Branch - Lower PP - (3) | eastBranchLight_pp.dwg | Friday, February 7, 2020 2:03:05 PM |
| 11 | East Branch - Lower PP - (4) | eastBranchLight_pp.dwg | Friday, February 7, 2020 2:03:05 PM |
| 12 | East Branch - Lower PP - (5) | eastBranchLight_pp.dwg | Friday, February 7, 2020 2:03:05 PM |
| 13 | East Branch - Lower SECTION - (1) | eastBranchLower_sections.dwg | Wednesday, January 29, 2020 11:52:39 AM |
| 14 | DTL - TYPICAL SECTIONS - EBL | northshoreEastBranchMasterDetail.dwg | Friday, February 7, 2020 1:57:35 PM |
| 15 | DTL - TOE WOOD | northshoreEastBranchMasterDetail.dwg | Friday, February 7, 2020 1:57:35 PM |
| 16 | DTL - AUGMENTED RIFFLE | northshoreEastBranchMasterDetail.dwg | Friday, February 7, 2020 1:57:35 PM |
| 17 | DTL - LOG J-HOOK | northshoreEastBranchMasterDetail.dwg | Friday, February 7, 2020 1:57:35 PM |
| 18 | DTL - BOULDER J-HOOK | northshoreEastBranchMasterDetail.dwg | Friday, February 7, 2020 1:57:35 PM |
| 19 | DTL - PLANTING | northshoreEastBranchMasterDetail.dwg | Friday, February 7, 2020 1:57:35 PM |

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EAST BRANCH BEAVER RIVER
STREAM RESTORATION
NEAR SILVER BAY
LAKE COUNTY, MN

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TABLE OF CONTENTS

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NOTES:

GENERAL CONSTRUCTION NOTES:

1. THE WORK ON THIS PROJECT SHALL ADHERE TO THE FOLLOWING SPECIFICATIONS, STANDARDS AND/OR REGULATIONS: MN DOT STANDARD SPECIFICATIONS FOR CONSTRUCTION, 2016 EDITION, THE FOLLOWING SPECIFICATIONS EITHER MODIFY OR REPLACE APPROPRIATE MN DOT SPECIFICATIONS.
2. INSTREAM STRUCTURES SHALL BE INSTALLED AS THE CHANNEL IS BEING CONSTRUCTED AND NOT POST CONSTRUCTION. FILTER FABRIC INSTALLED AS PART OF THE INSTREAM STRUCTURE SHALL BE MIRAFI 170N SERIES NONWOVEN GEOTEXTILE, OR ENGINEER'S APPROVED ALTERNATIVE, UNLESS OTHERWISE SPECIFIED IN STRUCTURE DETAILS OR SPECIFICATIONS.
3. WHERE PRACTICABLE, EXISTING TREES AND VEGETATION SHOULD BE LEFT IN PLACE TO FACILITATE NATURAL REGENERATION AND SOIL STABILIZATION.
4. DEFINITIONS:
   A. BANKFULL ELEVATION IS THE POINT OF INCIPIENT FLOODING IN AN ALLUVIAL CHANNEL. THIS ELEVATION IS THE REFERENCE FOR DEPTHS ON OR ALONG THE CHANNEL PROFILE AND STRUCTURES DESCRIBED IN THESE SHEETS.
   B. THE BANKFULL BENCH IS A CONSTRUCTED FLOODPLAIN ADJACENT TO THE CHANNEL. THE BANKFULL BENCH IS CONSTRUCTED AT THE BANKFULL ELEVATION.
   C. THE THALWEG IS THE LOWEST PORTION OF THE CHANNEL.
   D. THE VANE LENGTH IS THE STRAIGHT LINE DISTANCE BETWEEN THE VANE ARM AND A LINE TANGENT TO THE STREAMBANK AT THE POINT WHERE THE VANE ARM INTERSECTS THE STREAMBANK.
   E. THE VANE ANGLE IS THE ANGLE BETWEEN THE VANE ARM AND A LINE TANGENT TO THE STREAMBANK AT THE POINT WHERE THE VANE ARM INTERSECTS THE STREAMBANK.
   F. SOD MATS ARE GRASS AND WILLOW TRANSPLANTS THAT STILL CONTAIN ROOTING DEPTH. APPROXIMATELY 9-12IN OF DEPTH WILL BE NEEDED WHEN HARVESTING THE SOD MATS.
6. THE CONTRACTOR SHALL STAKE OUT THE PROPOSED STREAM CENTERLINE FOR REVIEW BY THE ENGINEER BEFORE INITIATING EXCAVATION. DEPENDING ON ENCOUNTERED CONDITIONS SOME SHIFTING OF THE STREAM CHANNEL MAY BE NECESSARY. ANY COST ASSOCIATED WITH CHANGING STRUCTURE LOCATIONS OR ALIGNMENT SHALL BE CONSIDERED INCIDENTAL TO CONSTRUCTION. STAKING MAY BE OMITTED FOR PORTIONS OF THE STREAM WHEN SURVEY-GRADE GPS IS USED TO CONSTRUCT THE CHANNEL. IF GPS IS USED IN LIEU OF STAKING THE CHANNEL IN THE FIELD, THE CONTRACTOR ASSUMES ALL RESPONSIBILITY FOR THE STREAM BEING CONSTRUCTED AS DESIGNED, INCLUDING ANY ISSUES RELATED TO PROJECTIONS, BASE POINTS OR CONVERSION OF DIGITAL TERRAIN MODELS.
7. PRIOR TO CLEARING AND GRUBBING, CONTRACTOR SHALL MARK THE LIMITS OF CLEARING NEAR TREES FOR VERIFICATION OF INTENT BY THE ENGINEER. SOME MINOR ADJUSTMENT OF CHANNEL ALIGNMENT MAY BE REQUIRED TO PRESERVE TREES OR MINIMIZE IMPACT TO TREES.
8. ANY HARVESTING OF WILLOWS AND SOD FROM ONSITE MUST BE APPROVED BY THE ENGINEER.
9. CONTRACTOR SHALL MINIMIZE, TO THE MAXIMUM EXTENT POSSIBLE, IMPACTS TO THE ADJACENT TREES. CONSTRUCTION EQUIPMENT TRACKS AND PATHWAYS SHALL BE GRADED AND RECONTOURED AFTER CONSTRUCTION TO PREVENT RILL AND GULLY EROSION.
10. THE PROPOSED GRADING IS SHOWN ON THESE PLAN SHEETS. THE CONTRACTOR MAY EXTEND THE LIMITS OF DISTURBANCE ONLY WITH THE APPROVAL OF THE ENGINEER.
11. CONTRACTOR SHALL USE AN EXCAVATOR WITH A HYDRAULIC THUMB TO INSTALL INSTREAM STRUCTURES.
12. CHANNEL RELOCATION WORK SHALL BE COMPLETED AND STABILIZED PRIOR TO ALLOWING FLOW TO ENTER INTO THE NEWLY CONSTRUCTED STREAM CHANNEL. THE CONTRACTOR SHALL NOT OPEN UP MORE THAN 200 FEET OF CHANNEL WITHOUT EROSION CONTROL BLANKET IN PLACE OR BY APPROVAL OF THE ENGINEER.
13. THE PROPOSED STREAM CHANNEL SHALL BE CONSTRUCTED BY FIRST GRADING THE FLOODPLAIN ADJACENT TO THE CHANNEL TO THE ELEVATION INDICATED ON THESE PLANS. THIS MAY BE DONE AS GENERAL EXCAVATION. THE PROPOSED STREAM CHANNEL SHALL THEN BE EXCAVATED TO THE PROPER DEPTHS INDICATED ON THE PROFILE AND PROPOSED CONTOURS. THIS SHALL BE DONE AS SPECIALIZED EXCAVATION AND IS TYPICALLY ACCOMPLISHED WITH A TRACK EXCAVATOR. THE PROFILES AND CONTOURS SHOWN PROVIDE WIDTHS AND SLOPES FOR AID IN CONSTRUCTING THE CHANNEL TO THE APPROPRIATE DIMENSIONS. THE THALWEG CAN FIRST BE EXCAVATED TO THE POINT INDICATED ON THE PROFILE. EXCAVATION AND FINE GRADING OF THE CROSS SECTIONS SHALL THEN BE PERFORMED AS SHOWN ON THE TYPICAL CROSS SECTIONS AND PROPOSED CONTOURS. ANY STOCKPILING OF MATERIALS OR “DOUBLE HANDLING” NECESSARY TO BUILD THE CHANNEL SHALL BE CONSIDERED INCIDENTAL TO CONSTRUCTION.
14. IF THE EXISTING GROUND IS LESS THAN 0.2 FEET HIGHER THAN THE PROPOSED BANKFULL ELEVATION, IT IS NOT NECESSARY TO EXCAVATE MATERIAL TO THE PROPOSED ELEVATION SHOWN ON THE PROFILE.
15. THE SURFACE OF ALL INSTREAM STRUCTURES SHALL BE FINISHED TO A SMOOTH LINE IN ACCORDANCE WITH THE LINES, GRADES, AND CROSS SECTIONS OR ELEVATIONS SHOWN ON THE DRAWINGS. THE DEGREE OF FINISH FOR THE VANE SLOPES AND INVERT ELEVATIONS SHALL BE WITHIN 0.1 VERTICAL FEET OF THE GRADES AND ELEVATIONS INDICATED. ALL GAPS OR VOIDS BETWEEN THE ROCKS SHALL BE PLUGGED WITH SMALL GRAVEL TO FORM A TIGHT-FITTING SEAL.
16. CONSTRUCTION SPECIFICATIONS FOR BANKFULL CHANNEL DIMENSIONS OR CROSS SECTIONS WILL BE HELD TO THE DIMENSIONS SHOWN ON THE TYPICAL CROSS SECTIONS. ELEVATIONS SHALL BE CONSTRUCTED WITHIN 0.1 VERTICAL FEET; WIDTHS AND MEAN DEPTHS MUST FALL WITHIN THE RANGES SHOWN IN THE DRAWINGS.
17. THE IN-STRUCTURE BID ITEMS SHALL INCLUDE ALL LABOR AND MATERIALS NECESSARY TO CONSTRUCT THE STRUCTURE. BID ITEMS INCLUDE SEEDING, PLANTING, AND MULCH AND EROSION CONTROL BLANKETS AND INCLUDE ALL LABOR AND MATERIALS NECESSARY TO STABILIZE AREAS DISTURBED DURING CONSTRUCTION OF STRUCTURES. AFTER THE STRUCTURE IS COMPLETE AND FLOW IS RESTORED TO THE CHANNEL, SOME ADJUSTMENT TO THE STRUCTURE OR ADDITIONAL STABILIZATION MEASURES MAY BE NECESSARY TO ACHIEVE DESIRED EFFECT. ANY COSTS ASSOCIATED WITH THESE ADJUSTMENTS SHALL BE CONSIDERED INCIDENTAL TO CONSTRUCTION.
18. THE CONSTRUCTED STREAM CHANNEL SHALL BE STABILIZED AS SOON AS POSSIBLE BY SEEDING IN ACCORDANCE WITH THE PLOT SCHEDULE, ADDING STRAW MULCH TO BARE SOIL, AND BY INSTALLING EROSION CONTROL BLANKET FROM THE INNER BERM TO BEYOND THE TOP OF THE BANKFULL CHANNEL. SEE EROSION CONTROL BLANKET DETAIL. PRIOR TO INSTALLING BLANKET, PREPARE THE BED BY LOOSENING THE SOIL 3 TO 6 INCHES, APPLY SEED AND THEN STRAW MULCH. SEED SHALL BE BROADCAST EVENLY OVER THE AREA USING A BROADCAST SPREADER PRIOR TO COVERING WITH THE EROSION CONTROL BLANKET. THE BLANKET SHALL BE ROLLED OUT IN THE DIRECTION OF THE ANTICIPATED RUN-OFF FLOW. INSTALL BLANKET IN ACCORDANCE WITH DETAIL SHOWN HEREIN. REWORKING OF AREAS THAT DO NOT ESTABLISH VEGETATION OR BECOME UNSTABLE SHALL BE NECESSARY IF THE EROSION CONTROL BLANKET SEPARATES FROM THE SOIL. SEE SEEDING AND PLANTING DETAIL FOR BLANKET SPECIFIATIONS. SEEDING OF THE BANKFULL BENCH SHALL BE IN ACCORDANCE WITH THE PLANTING TABLE. REFER TO CONTROL BLANKET DETAIL FOR PLACEMENT OF EROSION CONTROL BLANKET.
19. IF THE TIMING OF PROJECT IS SUCH THAT RIPARIAN SEED MIX CANNOT BE PLACED IN THE FALL, THEN THE CONTRACTOR SHALL SEED WITH TEMPORARY COVER ACCORDING TO THE EROSION AND SEDIMENT PLAN OR APPROVED BY THE ENGINEER UNTIL RIPARIAN MIX CAN BE SEEDED IN THE SPRING.
20. THE HARVESTING AND INSTALLATION OF LIVE STAKES SHALL BE PERFORMED ONLY DURING THE DORMANT SEASON TYPICALLY BETWEEN NOVEMBER 1 AND APRIL 15. CONTRACTOR SHALL NOTIFY ENGINEER 7 DAYS PRIOR TO HARVESTING TO REVIEW AND APPROVE ALL HARVESTING SITES. UPON APPROVAL BY ENGINEER, THE CONTRACTOR SHALL BE RESPONSIBLE FOR HARVESTING AND TRANSPORTING THE LIVE STAKE CUTTINGS TO THE JOB SITE.
21. LIVE STAKES SHALL BE INSTALLED ALONG THE OUTSIDE MEANDER BEND AND ALONG RIFFLES WHERE INDICATED ON THE DRAWINGS AND DETAILS. LIVE STAKES SHALL BE INSTALLED INTO THE EROSION CONTROL BLANKET IN ADDITION TO THE DEAD STAKES.
22. EXCESS SPOIL MATERIAL MAY BE SPREAD AND GRADED ONSITE OR IN THE ONSITE PIT AS APPROVED BY THE ENGINEER. PLACEMENT OF ANY ON-SITE OR OFF-SITE SPOIL MATERIAL SHALL BE CONSIDERED INCIDENTAL TO CONSTRUCTION.
23. TOPSOIL SHALL BE REMOVED FROM EXCAVATION AND SPOIL AREAS PRIOR TO CUT OR FILL AND RE-APPLIED TO AREAS AFTER ROUGH GRADING IS COMPLETE. SIX INCHES OF TOPSOIL SHALL BE PLACED ON DISTURBED AREAS TO MEET GRADE. STOCKPILING AND PLACEMENT OF TOPSOIL SHALL BE CONSIDERED INCIDENTAL TO CONSTRUCTION AND APPROVED BY THE ENGINEER.
24. SPOIL AREAS SHALL BE SEEDED WITH TEMPORARY VEGETATION WITHIN 7 DAYS FOLLOWING GRADING.
25. THE PLACEMENT OF STRAW MULCH SHALL OCCUR A MAXIMUM 48 HOURS AFTER SEEDING. MULCH WILL BE SPREAD TO COVER THE INSTALLED AREAS AT A MINIMUM RATE OF 1.5 TONS PER ACRE. MULCH SHALL BE KEPT OUT OF THE CROWNS OF SHRUBS AND GROUND COVER.
26. IF SOFT SOILS ARE ENCOUNTERED WHEN RECONSTRUCTING STREAM BANKS, RESTORE BANK WITH SOD MAT COVERING ALONG RIFFLES AND WOOD TOE SOD MAT ALONG BENDS.
27. CONTRACTOR SHALL CALL GOPHER STATE ONE CALL FOR UTILITY MARKING AT LEAST 48 HOURS PRIOR TO START OF CONSTRUCTION. THE LOCATIONS OF THE UTILITIES SHOWN ON THESE DRAWINGS ARE APPROXIMATE ONLY (UTILITY QUALITY LEVEL D) AND MAY NOT BE ACCURATE. LOCATING UTILITIES IS THE SOLE RESPONSIBILITY OF THE CONTRACTOR. THE ENGINEER AND PROJECT OWNER WILL NOT BE RESPONSIBLE FOR ANY DAMAGES TO UTILITIES.
28. CONTRACTOR SHALL UTILIZE NATIVE MATERIAL FROM THE SITE WHERE AVAILABLE AND ALLOWED BY THE ENGINEER. NATIVE MATERIAL THAT CAN BE FOUND ON SITE INCLUDE TREES THAT CAN PROVIDE LIVE STAKES AND TREES THAT CAN BE USED FOR LOG STRUCTURES AND WOOD DEBRIS.
29. AFTER CONSTRUCTION, THE ACCESS ROADS LEADING TO THE PROJECT SITE SHALL BE RESTORED TO AS GOOD OR BETTER CONDITION THAN BEFORE CONSTRUCTION AT THE ENGINEER'S DISCRETION.
30. FOOTER DEPTH ON ALL STRUCTURES REQUIRING FOOTERS SHALL BE AT LEAST 6 TIMES GREATER THAN THE DROP BETWEEN THE STRUCTURE AND THE FOOTERED STRUCTURE DIRECTLY UPSTREAM OR APPROVED BY THE ONSITE ENGINEER.

EROSION/SEDIMENTATION CONTROL NOTES:

1. ALL CONTROL MEASURES SHALL BE CHECKED, AND REPAIRED AS NECESSARY, MONTHLY IN DRY PERIODS, AND WITHIN 24 HOURS AFTER ANY RAINFALL AT THE SITE OF .75 INCHES OR GREATER WITHIN A 24 HOUR PERIOD. DAILY CHECKING AND, IF NECESSARY, REPAIRING SHALL BE DONE DURING PROLONGED RAINFALLS. THE PERMITTEE SHALL MAINTAIN WRITTEN RECORDS OF SUCH CHECKS AND REPAIRS ON-SITE AT ALL TIMES, AND RECORDS SHALL BE SUBJECT TO INSPECTION AT ANY REASONABLE TIME.
2. THE CONSTRUCTION ACCESS POINTS SHALL BE MAINTAINED AS REQUIRED TO PREVENT SILT/SEDIMENT FROM LEAVING THE SITE. THIS INCLUDES BUT IS NOT LIMITED TO WASH DOWN OF THE CONSTRUCTION ACCESS POINTS, INSTALLING AND UTILIZING A VEHICLE WASH DOWN AREA, INSTALLING ADDITIONAL STONE, ETC.
3. ANY AND ALL SILT/SEDIMENTATION SHALL BE FREQUENTLY REMOVED FROM THE SILT FENCE, DITCHES, CHECK DAMS AND RETENTION AREAS. AT THE END OF CONSTRUCTION, THESE AREAS SHALL BE COMPLETELY FREE OF SILT/SEDIMENTATION AND SHALL BE STABILIZED AS STATED IN THE PLANS AND SPECIFICATIONS.
4. ALL BMPS SHALL BE DESIGNED AND INSTALLED IN ACCORDANCE WITH THE MINNESOTA POLLUTION CONTROL AGENCY (MPCA) CONSTRUCTION OF GENERAL PERMITS FOR STORMWATER CONTROL. IF CONFLICTS ARISE BETWEEN THESE REQUIREMENTS, THE MORE STRINGENT SHALL APPLY.
5. BMPS SHOWN ALONG THE PERIMETER OF THE DISTURBED AREAS SHALL BE INSTALLED PRIOR TO DISTURBANCE ACTIVITY. OTHER BMPS SHALL BE INSTALLED AS SOON AS CONSTRUCTION SEQUENCES ALLOW.
6. TEMPORARY DIVERSION OF RUNOFF/RUNON WATER SHALL BE INSTALLED AS NEEDED TO FACILITATE CONSTRUCTION OR AS DIRECTED ON-SITE BY THE ENGINEER.
7. ALL DISTURBED AREAS SHALL BE PERMANENTLY STABILIZED IMMEDIATELY AFTER THE COMPLETION OF THE GRADING OPERATION. AREAS REQUIRING COCONUT COIR MATTING SHALL BE SEEDED AND MULCHED FOR STABILIZATION PRIOR TO THE INSTALLATION OF THE MATTING.
8. TEMPORARY STABILIZATION OF DISTURBED AREAS MUST BE INITIATED IMMEDIATELY WHENEVER WORK TOWARD PROJECT COMPLETION AND FINAL STABILIZATION OF ANY PORTION OF THE SITE HAS TEMPORARILY CEASED AND WILL NOT RESUME FOR A PERIOD EXCEEDING THIRTEEN (7) CALENDAR DAYS. THOSE AREAS SHALL BE SEEDED AND MULCHED IN ACCORDANCE WITH THE PLANS AND SPECIFICATIONS.
9. NECESSARY MEASURES SHALL BE TAKEN TO PRODUCE AND MAINTAIN AN ACCEPTABLE STAND OF GRASS. SAID MEASURES TO INCLUDE (BUT NOT LIMITED TO) WATERING, RE-SEEDING, REGRADING ERODED AREAS, RE-FERTILIZING, ETC.
10. CONTRACTOR IS RESPONSIBLE FOR KEEPING MUD AND DEBRIS OFF CITY/STATE STREETS AND ROW. CLEANUP IS REQUIRED DAILY.
11. CONTRACTOR SHALL KEEP A COPY OF THE NPDES CONSTRUCTION GENERAL PERMIT AND THE "CONSTRUCTION BEST MANAGEMENT PRACTICES PLAN" ON SITE AT ALL TIMES FOR THE LIFE OF THE PROJECT.
12. ALL HAZARDOUS SUBSTANCES USED FOR THIS PROJECT (PAINT, OIL, GREASE, AND OTHER PETROLEUM PRODUCTS) SHALL BE STORED IN ACCORDANCE WITH SPCC REGULATIONS. THESE SUBSTANCES SHALL BE STORED AWAY FROM DRAINS AND DITCHES IN WATERTIGHT CONTAINERS. DISPOSAL OF THESE SUBSTANCES SHALL BE IN ACCORDANCE WITH ADEM REGULATIONS. DAILY INSPECTIONS SHALL BE PERFORMED FOR LEAK DETECTION. IF LEAKS OCCUR, APPROPRIATE ACTION SHALL BE TAKEN TO CONTAIN AND REMEDIATE THE SPILL. ADEQUATE TRASH CONTAINERS SHALL BE KEPT ON SITE FOR THE DISPOSAL OF CONSTRUCTION MATERIALS WASTE. NECESSARY MEASURES SHALL BE TAKEN TO PREVENT ANY TRASH OR OTHER POLLUTANTS FROM ENTERING "WATERS OF THE UNITED STATES."
13. ALL TEMPORARY MEASURES SHALL BE REMOVED ONCE ACCEPTABLE PERMANENT STABILIZATION IS ACHIEVED. THE ENGINEER SHALL DETERMINE IF THE PERMANENT STABILIZATION IS ACCEPTABLE.

SPECIAL NOTES:

THE ELEVATIONS SHOWN HEREIN ARE BASED ON DATA SURVEY THAT ENCOMPASSES THE EXISTING GROUND SURFACE FROM WHICH ALL COMPUTATIONS FOR CUT/FILL ARE BASED. SLIGHT DISCREPANCIES BETWEEN THE EXISTING GROUND DIGITAL SURFACE AND FIELD CONDITIONS CAN RESULT IN SIGNIFICANT VARIATIONS IN TOTAL EXCAVATED QUANTITIES. THUS, THE CONTRACTOR SHALL COMPARE QUANTITIES OF MATERIAL EXCAVATED TO THOSE SHOWN ON THE DRAWINGS TO MANAGE THE MOVEMENT OF MATERIAL ACROSS THE SITE.

TOPOGRAPHIC INFORMATION:

EXISTING GROUND SURFACES ARE BASED ON A SURVEY COMPLETED XXXX BLENDED WITH STATE OF MN LIDAR. BENCHMARKS WERE SET THROUGHOUT THE SITE AND CAN BE PROVIDED AT ANY TIME. CHANGES IN EXISTING SURFACES SHALL BE INCIDENTAL TO CONSTRUCTION.

SPECIAL GRADING NOTE:

THE AGREED UPON INTENT OF THIS GRADING PLAN IS TO MAINTAIN A “LIVE” SURFACE SO THAT ANY CHANGES THAT ARISE DURING CONSTRUCTION CAN BE QUICKLY ENCOMPASSED INTO THE THREE-DIMENSIONAL SURFACE GENERATED DURING THIS DESIGN PROCESS. AS SUCH, FINE TUNING OF THE SURFACE THAT WOULD ELIMINATE THE APPEARANCE OF JAGGED CONTOUR LINES WHERE SLIGHT VARIATIONS BETWEEN THE EXISTING AND PROPOSED SURFACES WAS NOT COMPLETED.

APPROVED BY: KA | CHECKED BY: MJG | DRAWN BY: GET

| REV | DESCRIPTION | APPRV |
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| 1 | DRAFT 30% DESIGN | XX |
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EAST BRANCH BEAVER RIVER
STREAM RESTORATION
NEAR SILVER BAY
LAKE COUNTY, MN

DRAFT 30% DESIGN - NOT FOR CONSTRUCTION

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NOTES

CLIFFS
NORTHSHORE MINING CO
10 OUTER DR
SILVER BAY, MN 55614
---
BEAVER RIVER CONSULTING
BEAVER RIVER CONSULTING, LLC.
5752 EAGLE VIEW DRIVE
DULUTH, MN 55803
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CONCEPT DESIGN
NOT FOR
CONSTRUCTION

DATE: 2/07/2020

SHEET NUMBER
3 OF 19

E:\DROPBOX (SSSR)\NORTHSHOREMINING\C3D\SHEETS\EASTFORK\COVERNOTES.DWG | GREGTALLACQ | SAVED: Friday, February 7, 2020 2:03:22 PM | ACAD.CTB | | PLOTTED: Friday, February 7, 2020 2:07:05 PM

EAST BRANCH BEAVER RIVER

| ITEM DESCRIPTION | MNDOT SPEC. | ESTIMATED QUANTITY | UNIT |
|---|---|---|---|
| CONSTRUCTION SURVEYING | | *1* | *LS* |
| CONSTRUCTION OVERSIGHT | | *1* | *LS* |
| MOBILIZATION | 2021.501 | *1* | *LS* |
| TEMPORARY CONSTRUCTION ACCESS ROADS | 2021.600 | *1* | *LS* |
| GRADING CUT | 2105.511 | 2500 | CU YD |
| GRADING FILL | 2105.511 | 2500 | CU YD |
| CLEARING AND GRUBBING (AS DIRECTED) | 2105.511 | *5* | *ACRES* |
| LOG J-HOOK WITH ROOTWAD | 2577.601 | 10 | EACH |
| ROCK J-HOOK | 2577.601 | 0 | EACH |
| W VANE | 2577.601 | 1 | EACH |
| WOOD TOE | 2577.610 | 1253 | FT |
| ROCK TOE | 2577.610 | 0 | FT |
| SOIL LIFTS | 2577.610 | 89 | FT |
| TRANSPLANTS | 2577.610 | 0 | FT |
| CONSTRUCTED ROCK RIFFLE | 2577.611 | 1 | EACH |
| CONSTRUCTRED LOG RIFFLE | 2577.611 | 0 | EACH |
| CONSTRUCTRED ROCK/LOG RIFFLE (SHORT) | 2577.611 | 1 | EACH |
| CONSTRUCTRED ROCK/LOG RIFFLE (LONG) | 2577.611 | 0 | EACH |
| TEMPORARY CONSTRUCTION ENTRANCE | | *2* | *EACH* |
| TEMPORARY SILT FENCE | | *500* | *LN. FT.* |
| EROSION CONTROL MATTING (AND STAKES) | | 900 | SQ. YDS. |
| PUMP AROUND | | *0* | *EACH* |
| MULCH STRAW | | 4 | ACRES |
| TEMPORARY SEEDING | | 4 | ACRES |
| PERMANENT SEEDING | | 4 | ACRES |
| VEGETATION | | *2.5* | *ACRES* |

APPROVED BY: KA | CHECKED BY: MJG | DRAWN BY: GET

| REV | DESCRIPTION | APPRV |
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EAST BRANCH BEAVER RIVER
STREAM RESTORATION
NEAR SILVER BAY
LAKE COUNTY, MN

DRAFT 30% DESIGN - NOT FOR CONSTRUCTION
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---
QUANTITIES

CLIFFS

NORTHSHORE MINING CO
10 OUTER DR
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CONCEPT DESIGN
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DATE: 2/07/2020

SHEET NUMBER
4 OF 19

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| APPROVED BY: KA | CHECKED BY: MJG | DRAWN BY: GET |
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EAST BRANCH BEAVER RIVER
STREAM RESTORATION
NEAR SILVER BAY
LAKE COUNTY, MN

DRAFT 30% DESIGN - NOT FOR CONSTRUCTION
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OVERVIEW - EAST BRANCH

CLIFFS

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CONCEPT DESIGN
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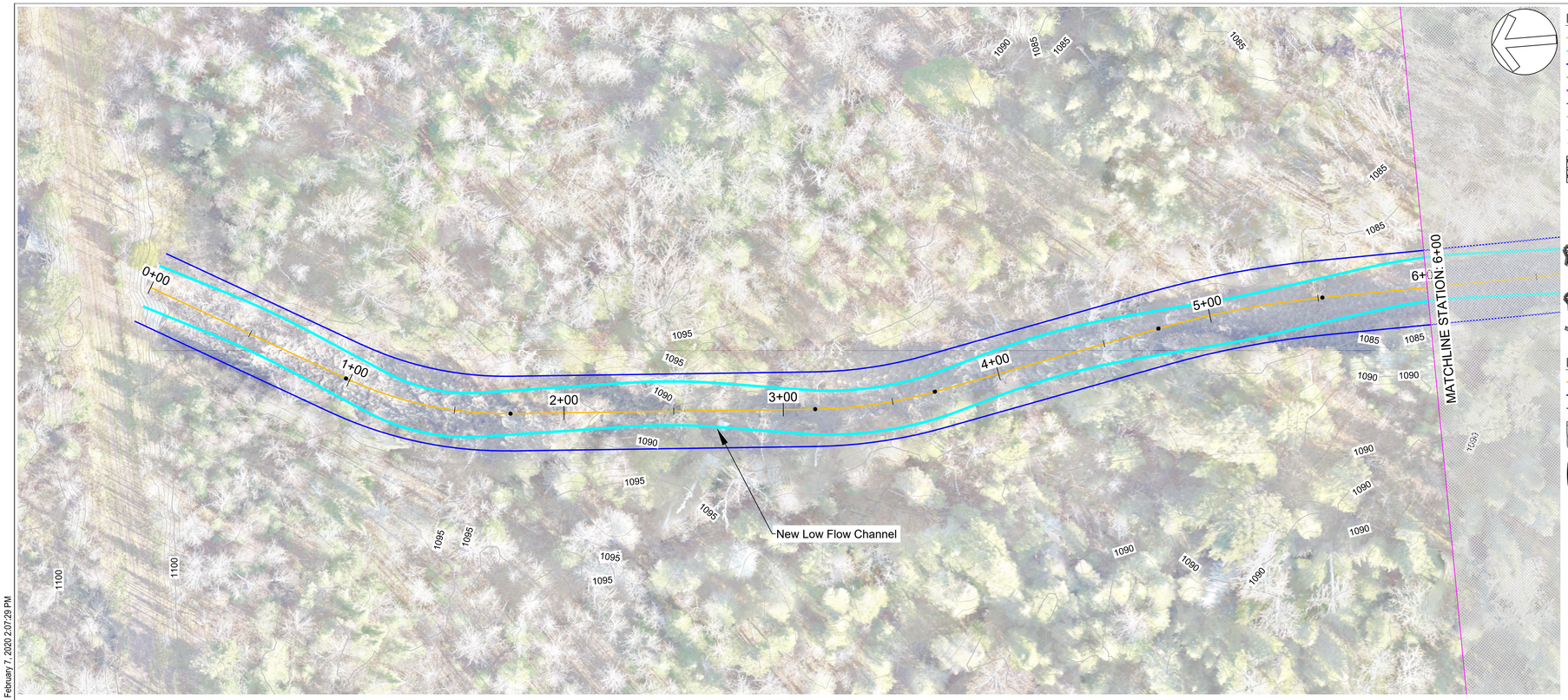
CONSTRUCTION

DATE: 2/07/2020
SCALE (34"X22"): 1" = 150'
SCALE (17"X11"): 1" = 300'

0 150 300
SCALE IN FEET

SHEET NUMBER
5 OF 19

E:\DROPBOX (SSSR)\NORTHSHOREMINING\C3D\SHEETS\EASTBRANCH_PP.DWG | GREGTALLACQ | SAVED: Friday, February 7, 2020 2:06:40 PM | ACAD.CTB | | PLOTTED: Friday, February 7, 2020 2:07:23 PM

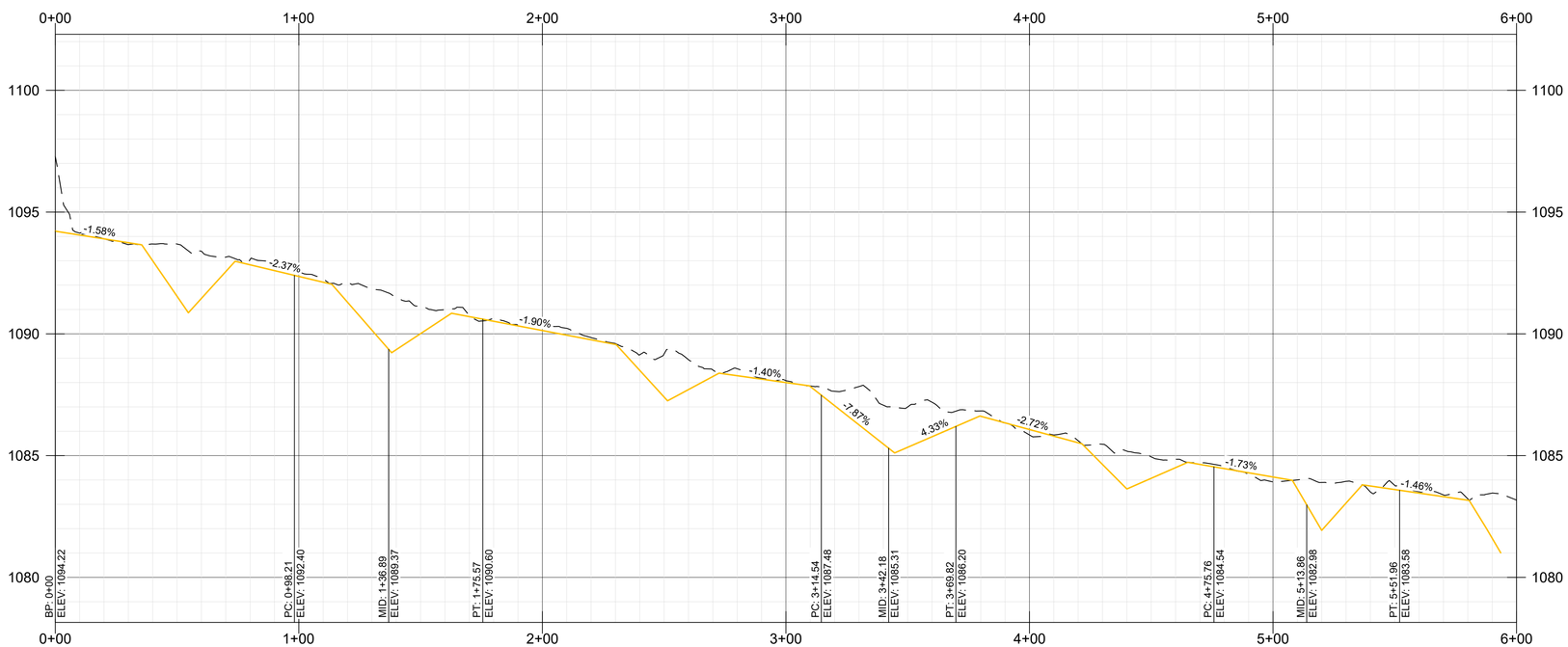



## PLAN LEGEND

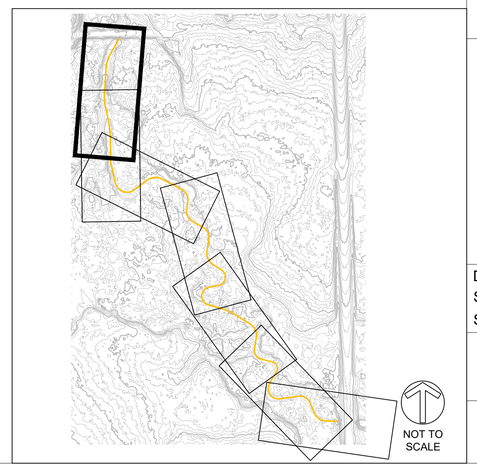
- PROPOSED STREAM CENTER LINE
- PROPOSED INNER BERM
- PROPOSED GEOMORPHIC CHANNEL TOB
- PROPOSED FLOODPLAIN TOE
- LIMITS OF DISTURBANCE
- (483) PROPOSED MAJOR CONTOUR
- PROPOSED MINOR CONTOUR
- 479 EXISTING MAJOR CONTOUR
- EXISTING MINOR CONTOUR
- AUGMENTED RIFFLE
- LOG J-HOOK
- CONSTRUCTED LOG RIFFLE
- TOE WOOD
- SOIL LIFT
- CONSTRUCTED RIFFLE
- BOULDER J-HOOK
- CONSTRUCTED BOULDER/LOG RIFFLE
- BOULDER TOE
- LOG VANE
- TRANSPLANTS

## PROFILE LEGEND

- PROPOSED STREAM CENTER LINE
- PROPOSED BANKFULL TOB
- EXISTING GROUND
- STRUCTURE BOULDER
- HEADER AND FOOTER BOULDER
- STRUCTURE LOG
- AUGMENTED RIFFLE




SCALE: HOR 1" =1'; VERT 1"= 0'




| REV | DESCRIPTION | APPROVED BY: KA | CHECKED BY: MJG | DRAWN BY: GET | APPRV |
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# EAST BRANCH BEAVER RIVER
## STREAM RESTORATION
## NEAR SILVER BAY
## LAKE COUNTY, MN

DRAFT 30% DESIGN - NOT FOR CONSTRUCTION
EAST BRANCH - PHASE 1
PLAN AND PROFILE - (1)
STA 0+00 TO 6+00


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CONCEPT DESIGN
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DATE: 2/07/2020
SCALE (34"X22"): 1" = 30'
SCALE (17"X11"): 1" = 60'

0 30 60
SCALE IN FEET

SHEET NUMBER
6 OF 19


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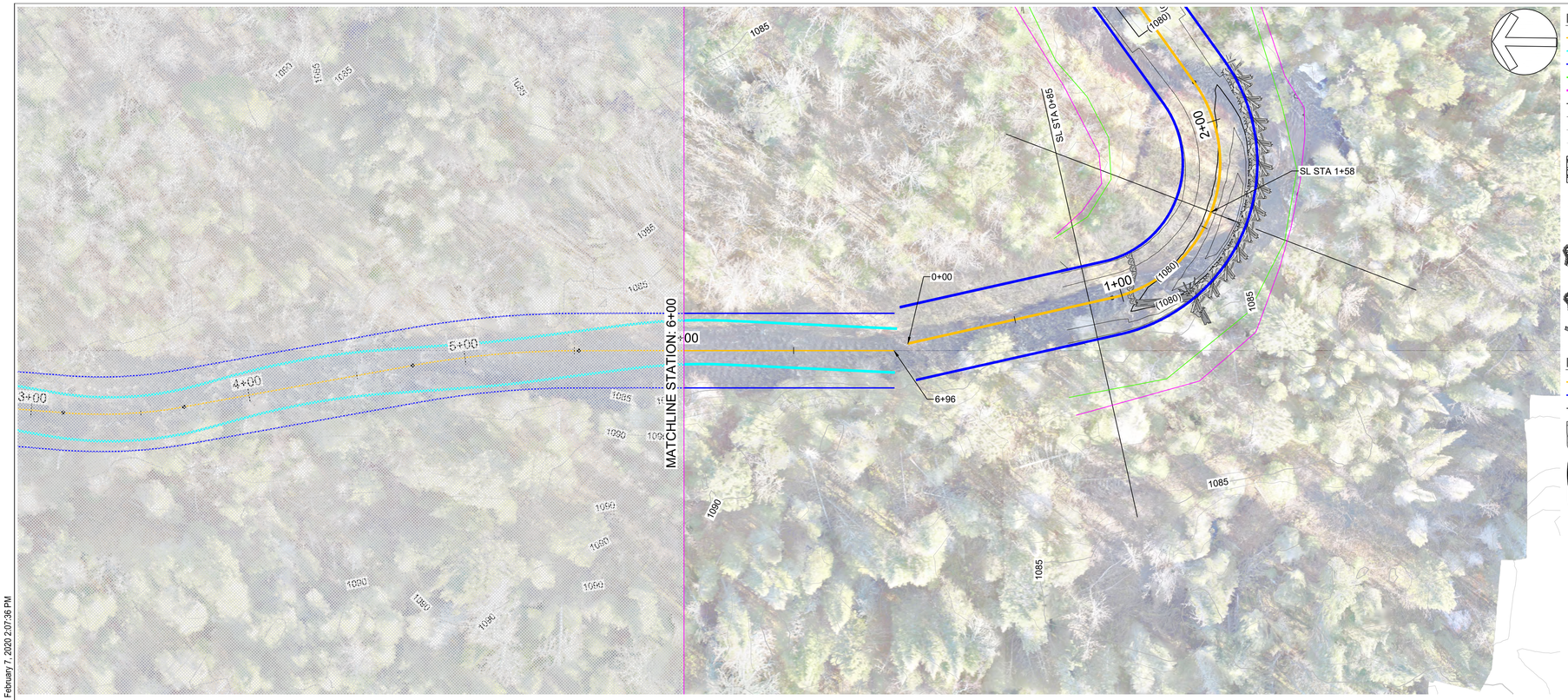


## PLAN LEGEND

- PROPOSED STREAM CENTER LINE
- PROPOSED INNER BERM
- PROPOSED GEOMORPHIC CHANNEL TOB
- PROPOSED FLOODPLAIN TOE
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- LOG VANE
- TRANSPLANTS

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- PROPOSED STREAM CENTER LINE
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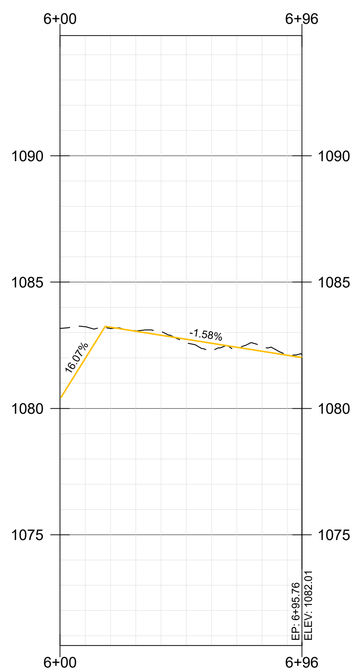
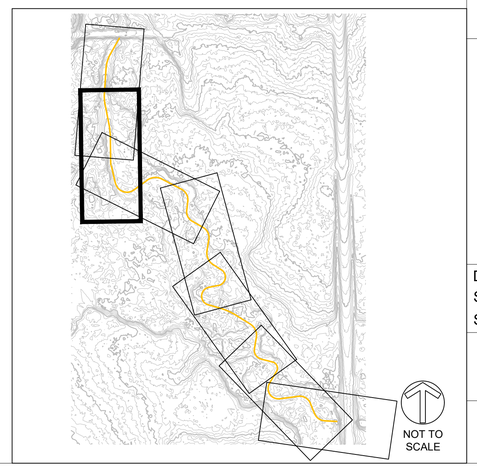



SCALE: HOR 1" =1'; VERT 1"= 0'




| REV | DESCRIPTION | APPROVED BY: KA | CHECKED BY: MJG | DRAWN BY: GET | APPRV |
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# EAST BRANCH BEAVER RIVER STREAM RESTORATION NEAR SILVER BAY LAKE COUNTY, MN

DRAFT 30% DESIGN - NOT FOR CONSTRUCTION
EAST BRANCH - PHASE 1
PLAN AND PROFILE - (2)
STA 6+00 TO 6+96

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SILVER BAY, MN 55614
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5752 EAGLE VIEW DRIVE
DULUTH, MN 55803
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CONCEPT DESIGN
NOT FOR
CONSTRUCTION

DATE: 2/07/2020
SCALE (34"X22"): 1" = 30'
SCALE (17"X11"): 1" = 60'

0 30 60
SCALE IN FEET



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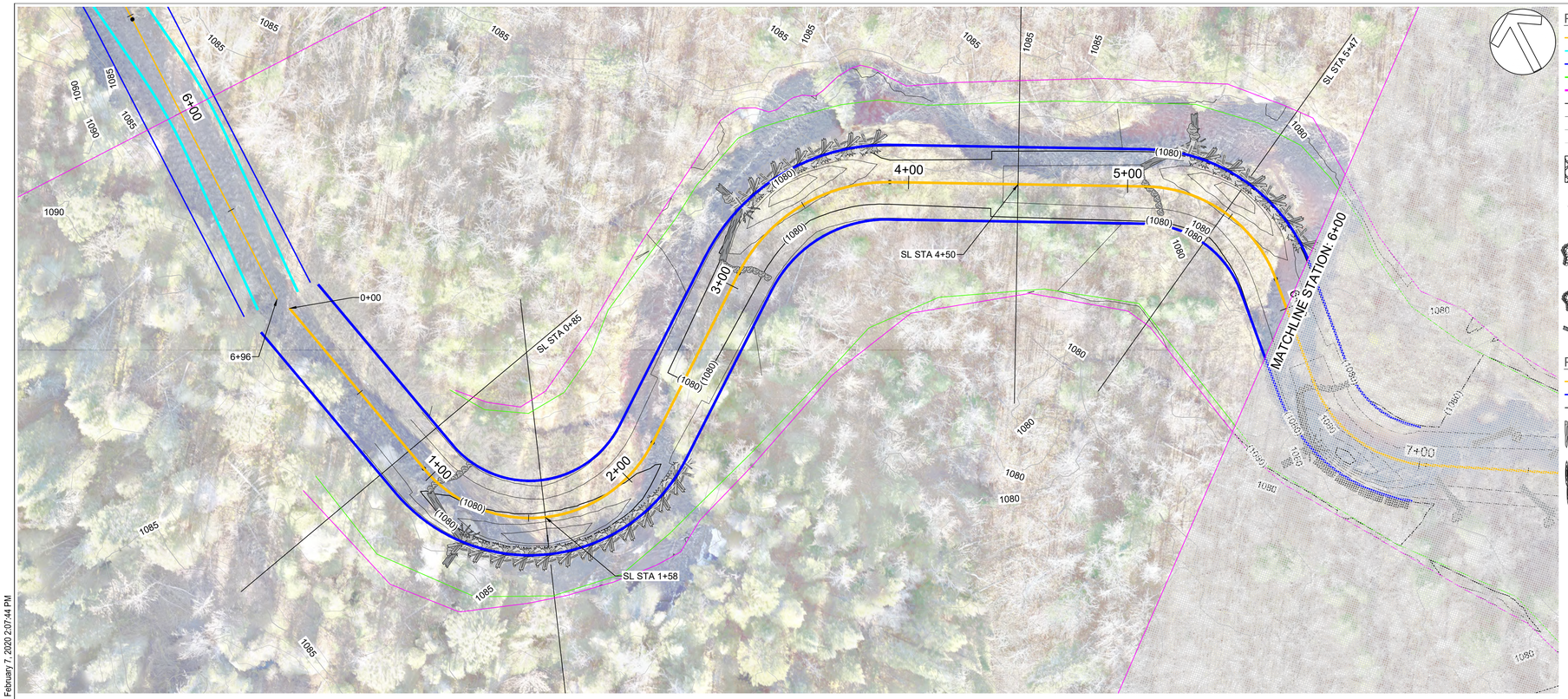


## PLAN LEGEND

- PROPOSED STREAM CENTER LINE
- PROPOSED INNER BERM
- PROPOSED GEOMORPHIC CHANNEL TOB
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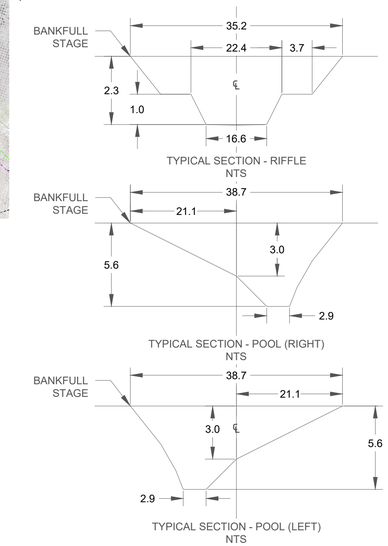
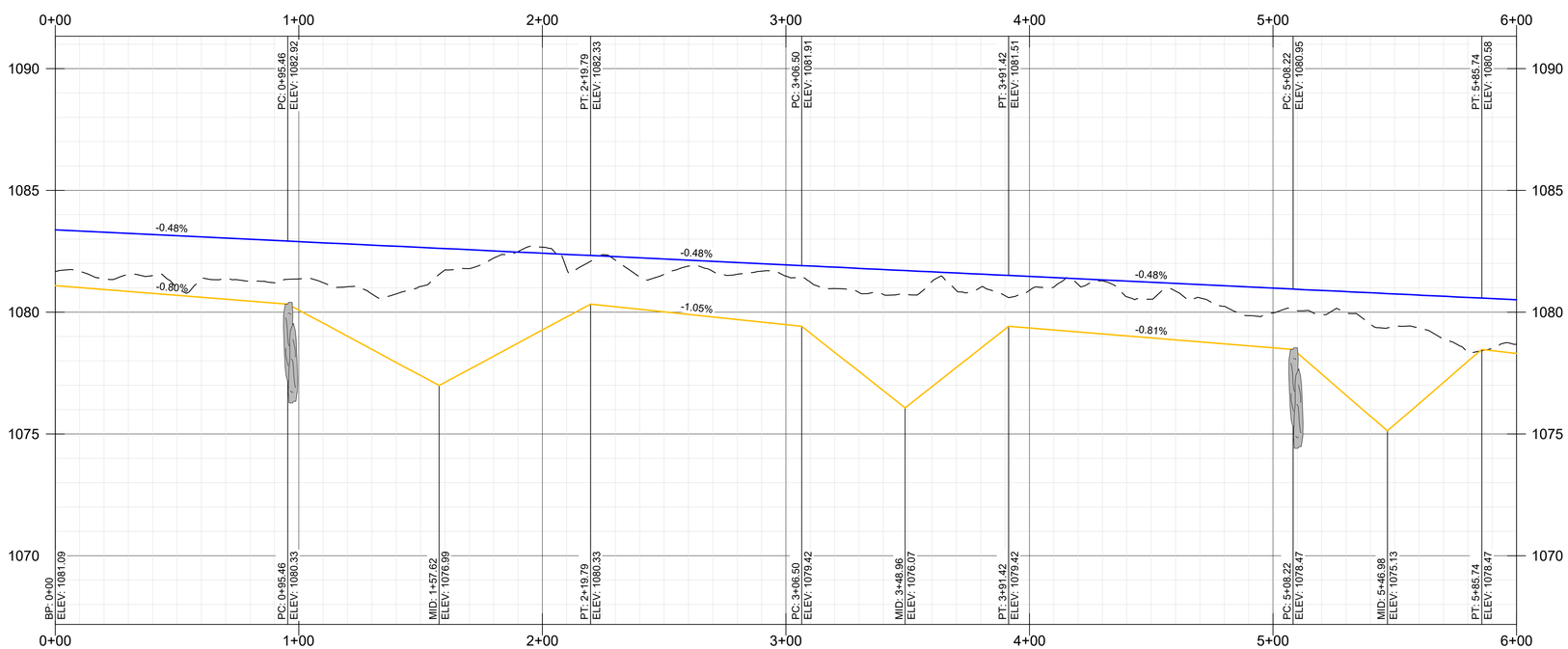
- SOIL LIFT
- CONSTRUCTED RIFFLE
- BOULDER J-HOOK
- CONSTRUCTED BOULDER/LOG RIFFLE
- BOULDER TOE
- LOG VANE
- TRANSPLANTS

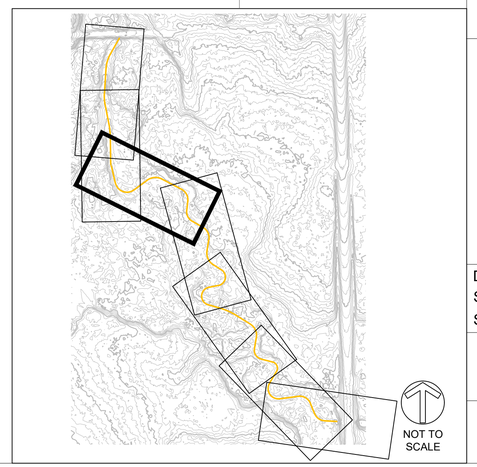
## PROFILE LEGEND

- PROPOSED STREAM CENTER LINE
- PROPOSED BANKFULL TOB
- EXISTING GROUND
- STRUCTURE BOULDER
- HEADER AND FOOTER BOULDER
- STRUCTURE LOG
- AUGMENTED RIFFLE




SCALE: HOR 1" =1'; VERT 1"= 0'




| APPROVED BY: KA | CHECKED BY: MJG | DRAWN BY: GET | |
|---|---|---|---|
| REV | DESCRIPTION | | APPRV |
| 1 | DRAFT 30% DESIGN | | XX |
| XX | XX | XX | XX |
| XX | XX | XX | XX |
| XX | XX | XX | XX |
| XX | XX | XX | XX |
| XX | XX | XX | XX |
| XX | XX | XX | XX |

# EAST BRANCH BEAVER RIVER STREAM RESTORATION NEAR SILVER BAY LAKE COUNTY, MN

## DRAFT 30% DESIGN - NOT FOR CONSTRUCTION EAST BRANCH - LOWER PLAN AND PROFILE - (1) STA 0+00 TO 6+00


CLIFFS

NORTHSHORE MINING CO
10 OUTER DR
SILVER BAY, MN 55614
---

BEAVER RIVER CONSULTING

BEAVER RIVER CONSULTING, LLC.
5752 EAGLE VIEW DRIVE
DULUTH, MN 55803
---

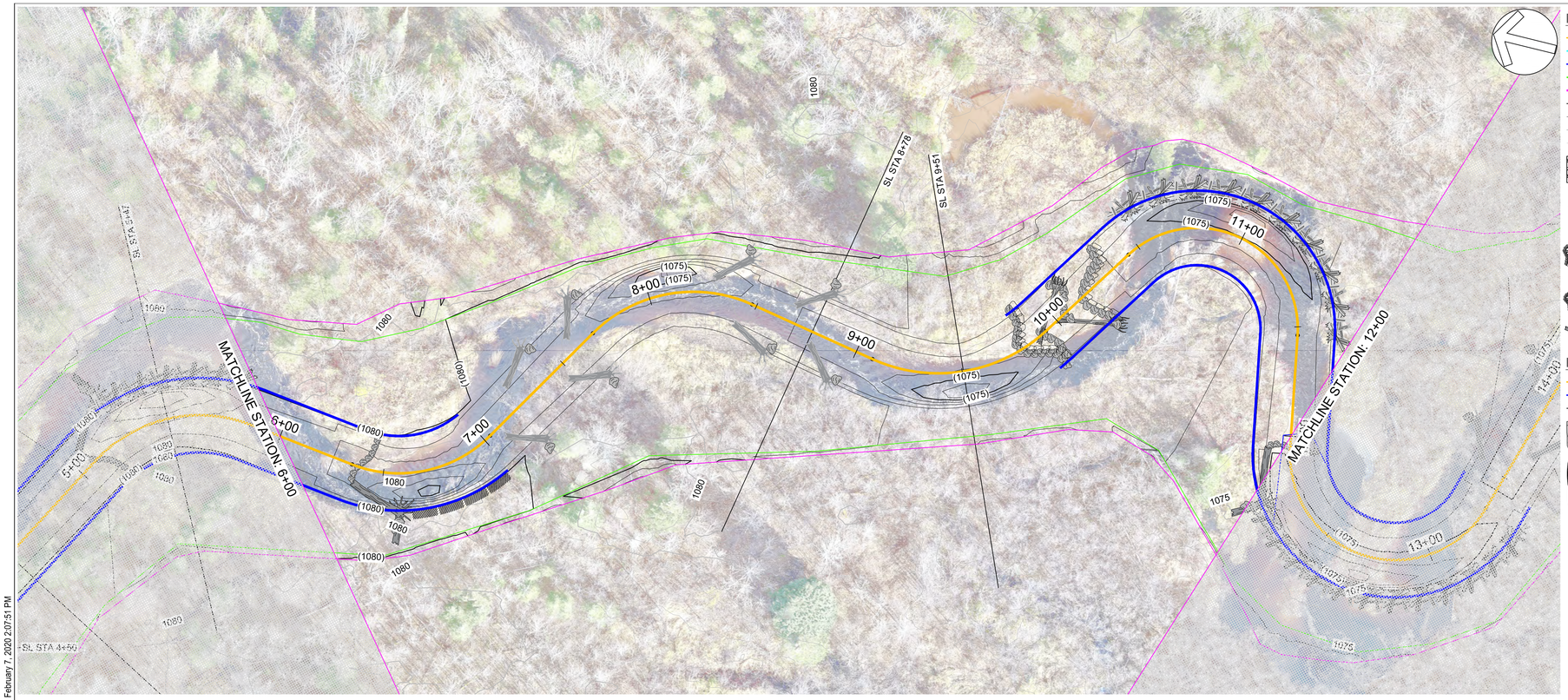

CONCEPT DESIGN
NOT FOR
CONSTRUCTION

DATE: 2/07/2020
SCALE (34"X22"): 1" = 30'
SCALE (17"X11"): 1" = 60'

0 30 60
SCALE IN FEET

SHEET NUMBER
8 OF 19


E:\DROPBOX (SSR)\NORTHSHOREMINING\C3D\SHEETS\EASTBRANCH_PP.DWG | GREGTAILLACQ | SAVED: Friday, February 7, 2020 2:06:40 PM | ACAD.CTB | | PLOTTED: Friday, February 7, 2020 2:07:44 PM

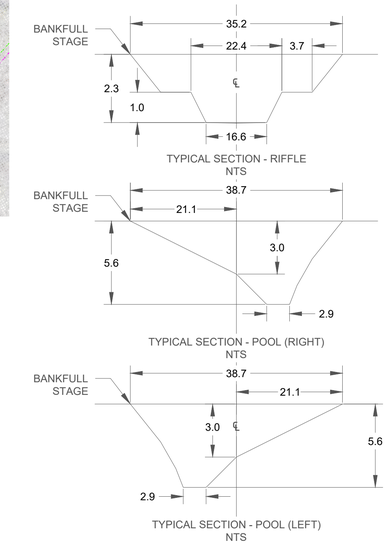


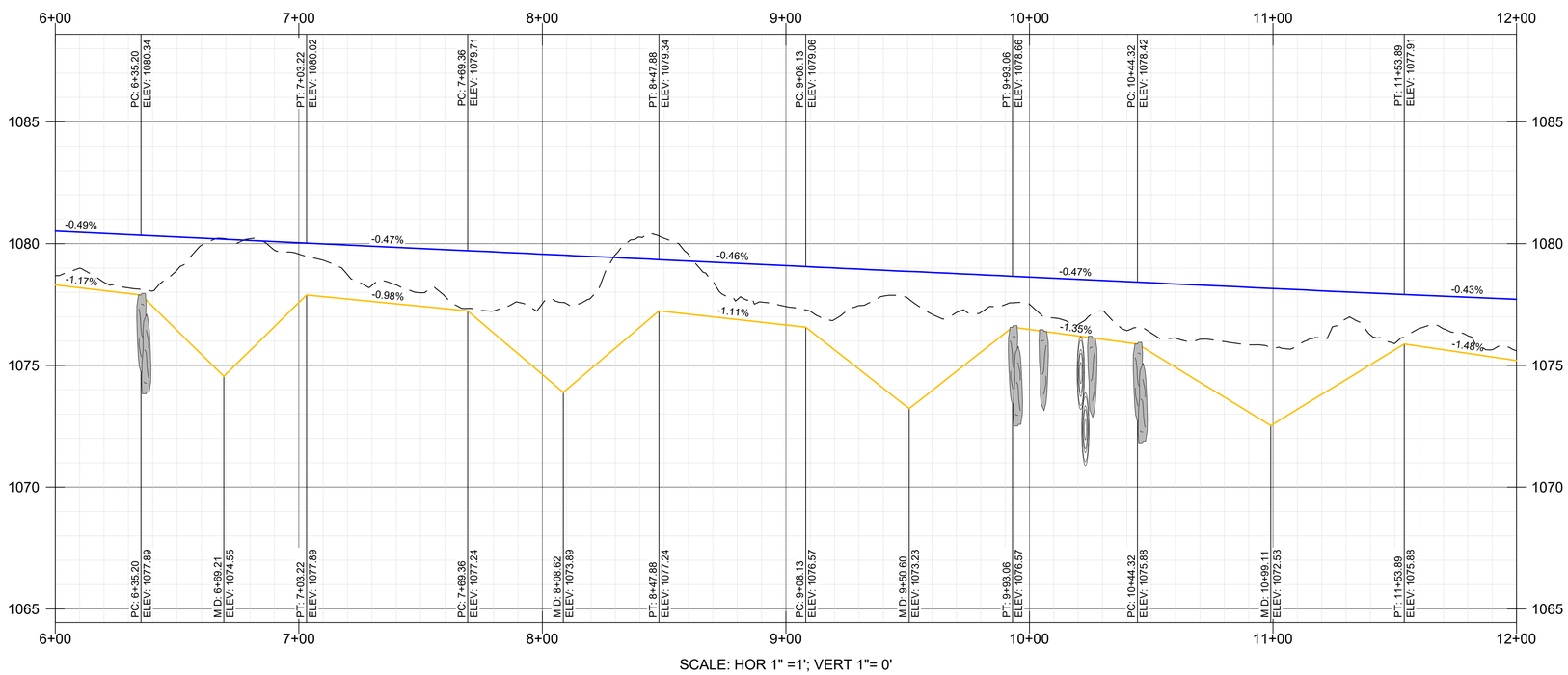

## PLAN LEGEND

- PROPOSED STREAM CENTER LINE
- PROPOSED INNER BERM
- PROPOSED GEOMORPHIC CHANNEL TOB
- PROPOSED FLOODPLAIN TOE
- LIMITS OF DISTURBANCE
- (483) PROPOSED MAJOR CONTOUR
- PROPOSED MINOR CONTOUR
- 479 EXISTING MAJOR CONTOUR
- EXISTING MINOR CONTOUR
- AUGMENTED RIFFLE
- LOG J-HOOK
- CONSTRUCTED LOG RIFFLE
- TOE WOOD
- SOIL LIFT
- CONSTRUCTED RIFFLE
- BOULDER J-HOOK
- CONSTRUCTED BOULDER/LOG RIFFLE
- BOULDER TOE
- LOG VANE
- TRANSPLANTS

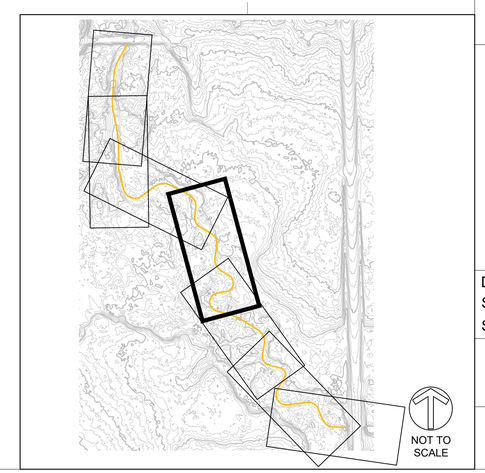
## PROFILE LEGEND

- PROPOSED STREAM CENTER LINE
- PROPOSED BANKFULL TOB
- EXISTING GROUND
- STRUCTURE BOULDER
- HEADER AND FOOTER BOULDER
- STRUCTURE LOG
- AUGMENTED RIFFLE




SCALE: HOR 1" =1'; VERT 1"= 0'




| REV | DESCRIPTION | APPROVED BY: KA | CHECKED BY: MJG | DRAWN BY: GET | APPRV |
|---|---|---|---|---|---|
| 1 | DRAFT 30% DESIGN | XX | XX | XX | XX |
| XX | XX | XX | XX | XX | XX |
| XX | XX | XX | XX | XX | XX |
| XX | XX | XX | XX | XX | XX |
| XX | XX | XX | XX | XX | XX |
| XX | XX | XX | XX | XX | XX |
| XX | XX | XX | XX | XX | XX |

# EAST BRANCH BEAVER RIVER
## STREAM RESTORATION
## NEAR SILVER BAY
## LAKE COUNTY, MN

## DRAFT 30% DESIGN - NOT FOR CONSTRUCTION
## EAST BRANCH - LOWER
## PLAN AND PROFILE - (2)
## STA 6+00 TO 12+00


CLIFFS
NORTHSHORE MINING CO
10 OUTER DR
SILVER BAY, MN 55614
---
BEAVER RIVER CONSULTING
BEAVER RIVER CONSULTING, LLC.
5752 EAGLE VIEW DRIVE
DULUTH, MN 55803
---

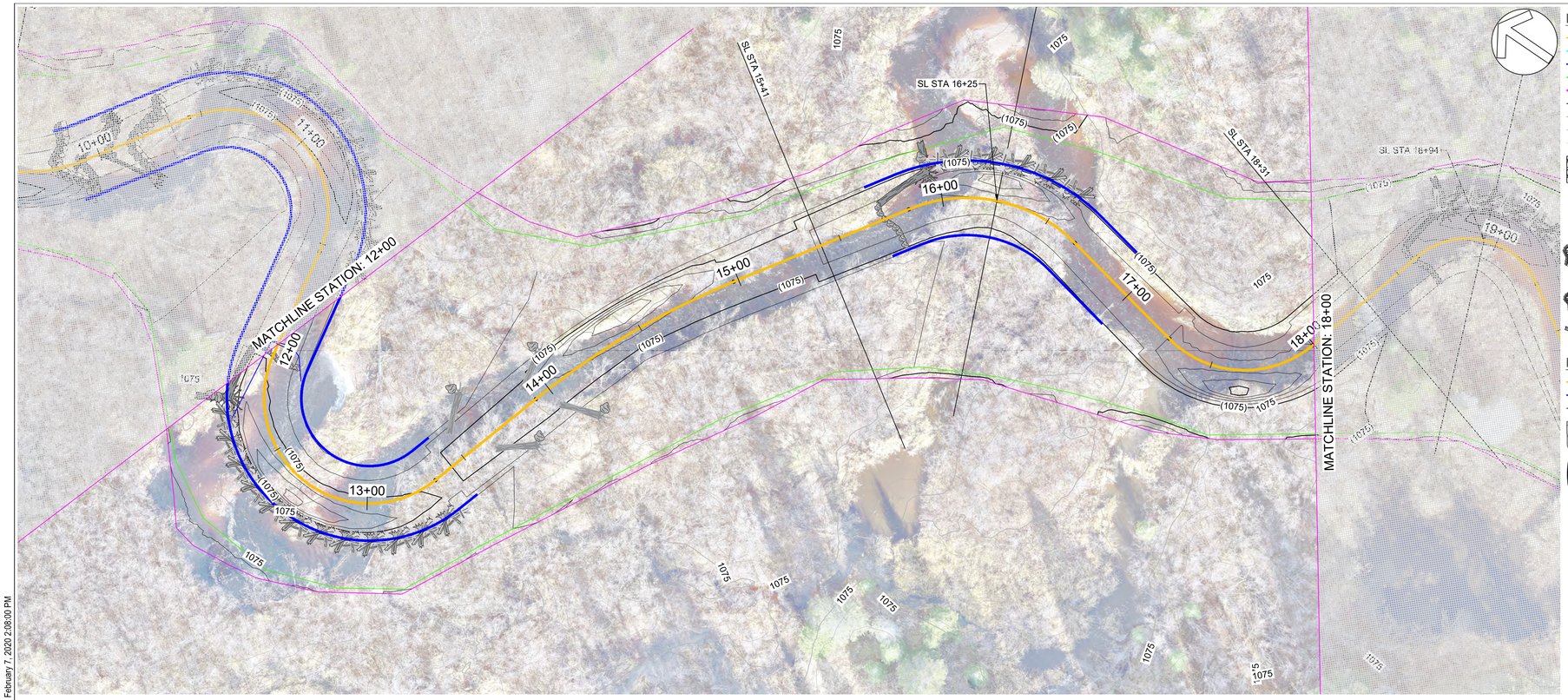

CONCEPT DESIGN
NOT FOR
CONSTRUCTION

DATE: 2/07/2020
SCALE (34"X22"): 1" = 30'
SCALE (17"X11"): 1" = 60'

0 30 60
SCALE IN FEET

SHEET NUMBER
9 OF 19


E:\DROPBOX (SSR)\NORTHSHOREMINING\C3D\SHEETS\EASTBRANCH_PP.DWG | GREGTAILLACQ | SAVED: Friday, February 7, 2020 2:06:40 PM | ACAD.CTB | | PLOTTED: Friday, February 7, 2020 2:07:51 PM

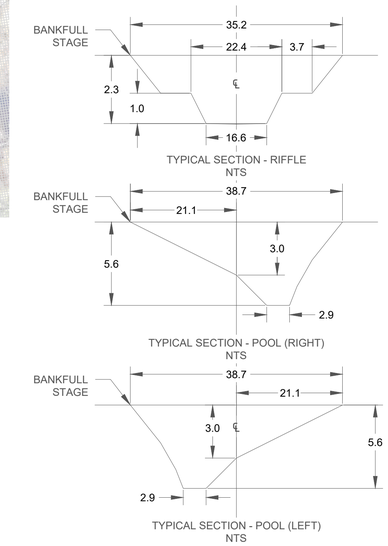


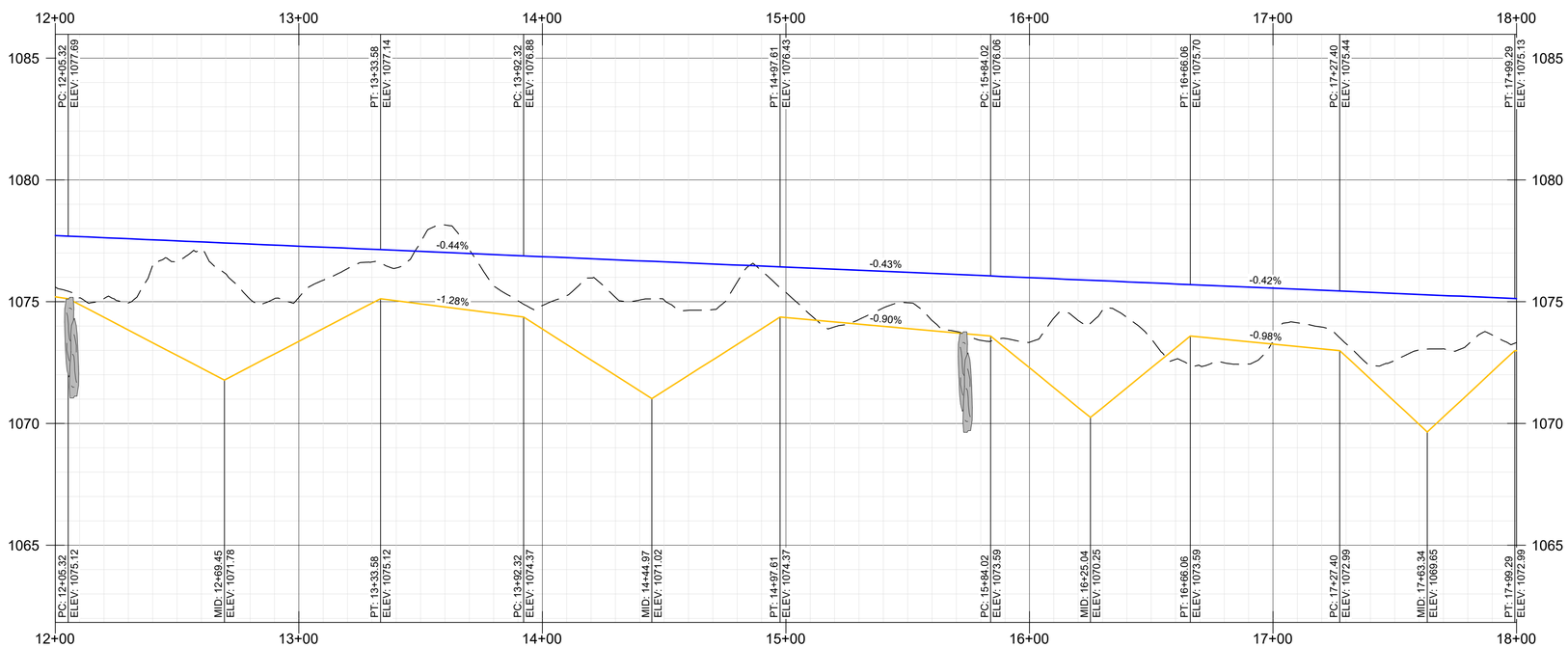

## PLAN LEGEND

- PROPOSED STREAM CENTER LINE
- PROPOSED INNER BERM
- PROPOSED GEOMORPHIC CHANNEL TOB
- PROPOSED FLOODPLAIN TOE
- LIMITS OF DISTURBANCE
- (483) PROPOSED MAJOR CONTOUR
- PROPOSED MINOR CONTOUR
- 479 EXISTING MAJOR CONTOUR
- EXISTING MINOR CONTOUR
- AUGMENTED RIFFLE
- LOG J-HOOK
- CONSTRUCTED LOG RIFFLE
- TOE WOOD
- SOIL LIFT
- CONSTRUCTED RIFFLE
- BOULDER J-HOOK
- CONSTRUCTED BOULDER/LOG RIFFLE
- BOULDER TOE
- LOG VANE
- TRANSPLANTS

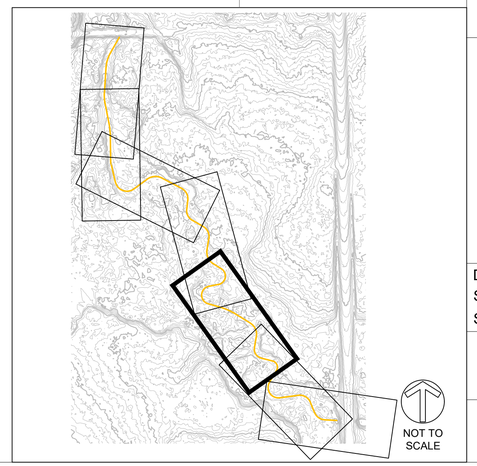
## PROFILE LEGEND

- PROPOSED STREAM CENTER LINE
- PROPOSED BANKFULL TOB
- EXISTING GROUND
- STRUCTURE BOULDER
- HEADER AND FOOTER BOULDER
- STRUCTURE LOG
- AUGMENTED RIFFLE




SCALE: HOR 1" =1'; VERT 1"= 0'




| REV | DESCRIPTION | APPROVED BY: KA | CHECKED BY: MJG | DRAWN BY: GET | APPRV |
|---|---|---|---|---|---|
| 1 | DRAFT 30% DESIGN | | | | |
| XX | | XX | XX | XX | XX |
| XX | | XX | XX | XX | XX |
| XX | | XX | XX | XX | XX |
| XX | | XX | XX | XX | XX |
| XX | | XX | XX | XX | XX |
| XX | | XX | XX | XX | XX |
| XX | | XX | XX | XX | XX |

# EAST BRANCH BEAVER RIVER STREAM RESTORATION NEAR SILVER BAY LAKE COUNTY, MN

## DRAFT 30% DESIGN - NOT FOR CONSTRUCTION EAST BRANCH - LOWER PLAN AND PROFILE - (3) STA 12+00 TO 18+00


CLIFFS

NORTHSHORE MINING CO
10 OUTER DR
SILVER BAY, MN 55614
---

BEAVER RIVER CONSULTING

BEAVER RIVER CONSULTING, LLC.
5752 EAGLE VIEW DRIVE
DULUTH, MN 55803
---

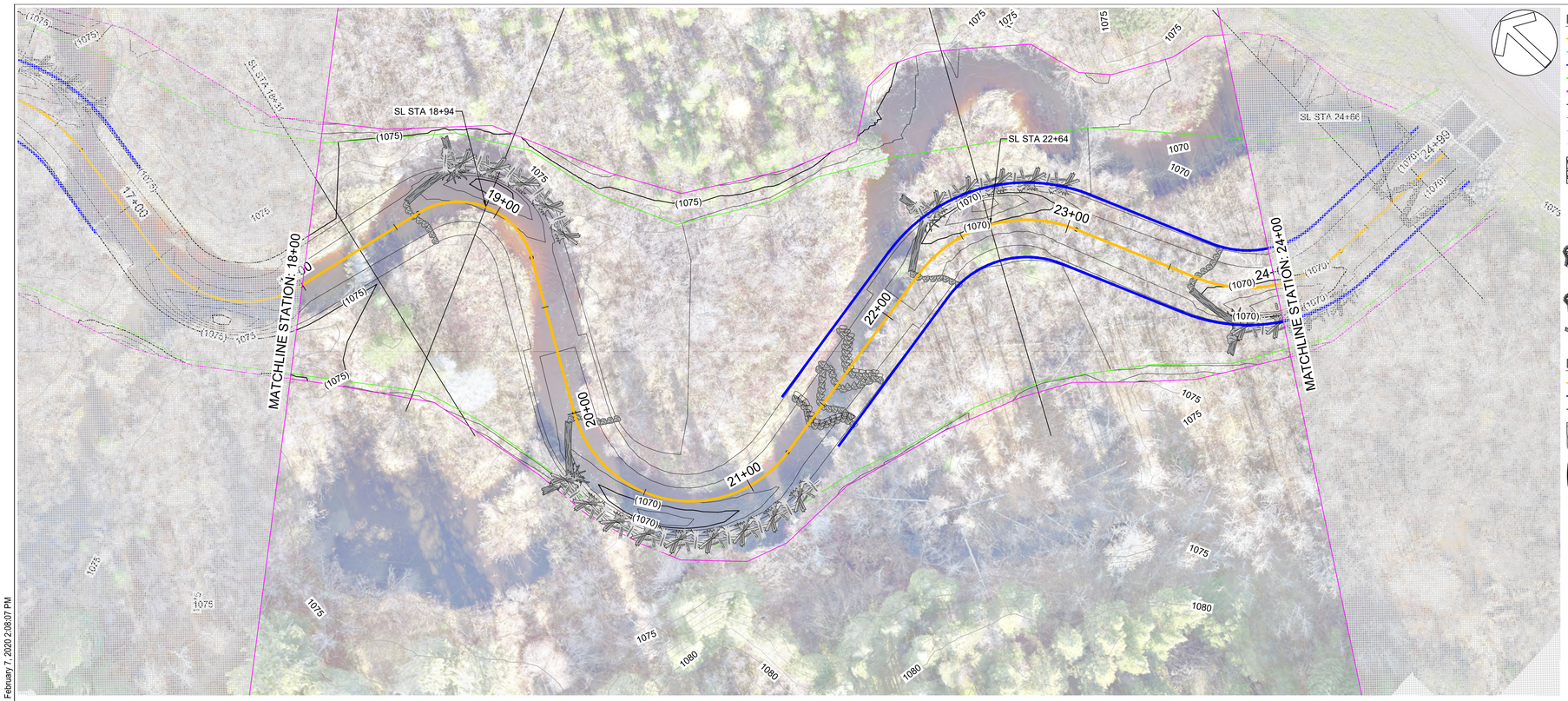

CONCEPT DESIGN
NOT FOR
CONSTRUCTION

DATE: 2/07/2020
SCALE (34"X22"): 1" = 30'
SCALE (17"X11"): 1" = 60'

0 30 60
SCALE IN FEET

SHEET NUMBER
10 OF 19


E:\DROPBOX (SSR)\NORTHSHOREMINING\C3D\SHEETS\EASTBRANCH_PP.DWG | GREGTAILLACQ | SAVED: Friday, February 7, 2020 2:06:40 PM | ACAD.CTB | | PLOTTED: Friday, February 7, 2020 2:08:00 PM

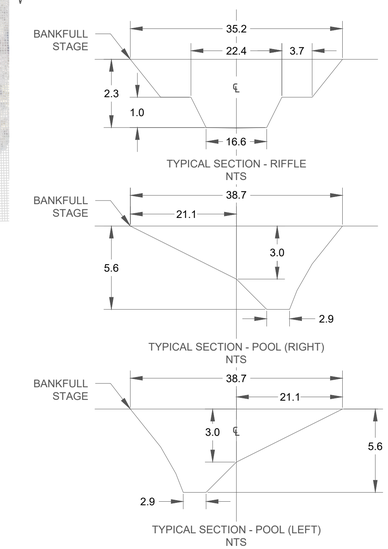


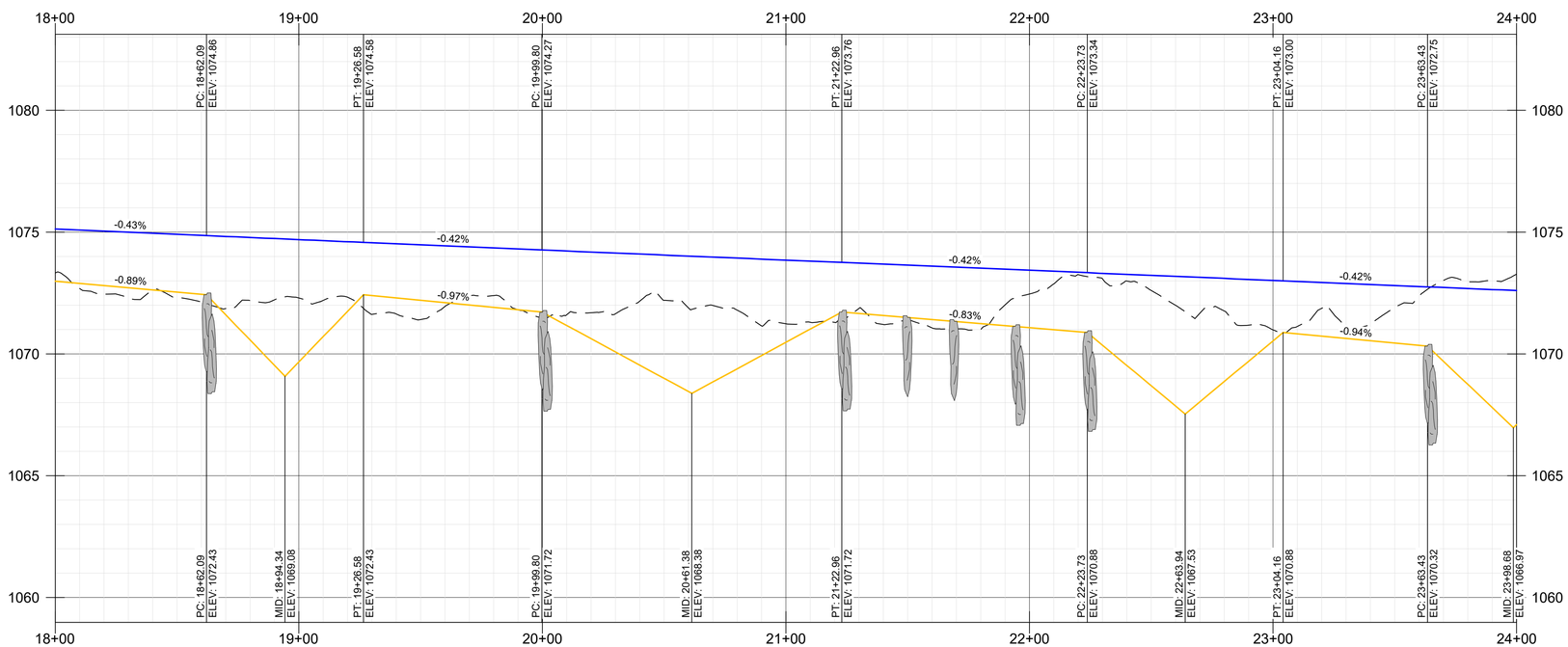

## PLAN LEGEND

- PROPOSED STREAM CENTER LINE
- PROPOSED INNER BERM
- PROPOSED GEOMORPHIC CHANNEL TOB
- PROPOSED FLOODPLAIN TOE
- LIMITS OF DISTURBANCE
- (483) PROPOSED MAJOR CONTOUR
- PROPOSED MINOR CONTOUR
- 479 EXISTING MAJOR CONTOUR
- EXISTING MINOR CONTOUR
- AUGMENTED RIFFLE
- LOG J-HOOK
- CONSTRUCTED LOG RIFFLE
- TOE WOOD
- SOIL LIFT
- CONSTRUCTED RIFFLE
- BOULDER J-HOOK
- CONSTRUCTED BOULDER/LOG RIFFLE
- BOULDER TOE
- LOG VANE
- TRANSPLANTS

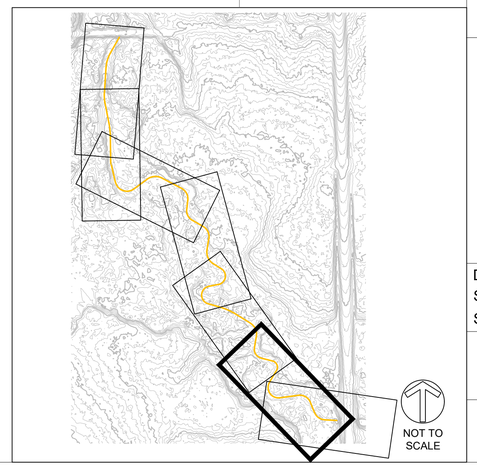
## PROFILE LEGEND

- PROPOSED STREAM CENTER LINE
- PROPOSED BANKFULL TOB
- EXISTING GROUND
- STRUCTURE BOULDER
- HEADER AND FOOTER BOULDER
- STRUCTURE LOG
- AUGMENTED RIFFLE




SCALE: HOR 1" =1'; VERT 1"= 0'




| REV | DESCRIPTION | APPROVED BY: KA | CHECKED BY: MJG | DRAWN BY: GET | APPRV |
|---|---|---|---|---|---|
| 1 | DRAFT 30% DESIGN | XX | XX | XX | XX |
| XX | | XX | XX | XX | XX |
| XX | | XX | XX | XX | XX |
| XX | | XX | XX | XX | XX |
| XX | | XX | XX | XX | XX |
| XX | | XX | XX | XX | XX |
| XX | | XX | XX | XX | XX |

# EAST BRANCH BEAVER RIVER STREAM RESTORATION NEAR SILVER BAY LAKE COUNTY, MN

## DRAFT 30% DESIGN - NOT FOR CONSTRUCTION EAST BRANCH - LOWER PLAN AND PROFILE - (4) STA 18+00 TO 24+00


CLIFFS

NORTHSHORE MINING CO
10 OUTER DR
SILVER BAY, MN 55614
---

BEAVER RIVER CONSULTING

BEAVER RIVER CONSULTING, LLC.
5752 EAGLE VIEW DRIVE
DULUTH, MN 55803
---

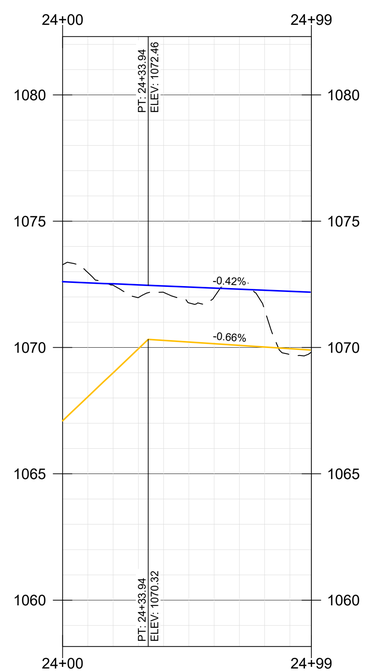

CONCEPT DESIGN
NOT FOR
CONSTRUCTION

DATE: 2/07/2020
SCALE (34"X22"): 1" = 30'
SCALE (17"X11"): 1" = 60'

0 30 60
SCALE IN FEET

SHEET NUMBER
11 OF 19


E:\DROPBOX (SSR)\NORTHSHOREMINING\C3D\SHEETS\EASTBRANCH_PP.DWG | GREGTAILLACQ | SAVED: Friday, February 7, 2020 2:08:40 PM | ACAD.CTB | | PLOTTED: Friday, February 7, 2020 2:08:07 PM




SCALE: HOR 1" =1'; VERT 1"= 0'

## PLAN LEGEND

- PROPOSED STREAM CENTER LINE
- PROPOSED INNER BERM
- PROPOSED GEOMORPHIC CHANNEL TOB
- PROPOSED FLOODPLAIN TOE
- LIMITS OF DISTURBANCE
- (483) PROPOSED MAJOR CONTOUR
- PROPOSED MINOR CONTOUR
- 479 EXISTING MAJOR CONTOUR
- EXISTING MINOR CONTOUR
- AUGMENTED RIFFLE
- LOG J-HOOK
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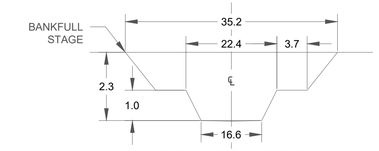
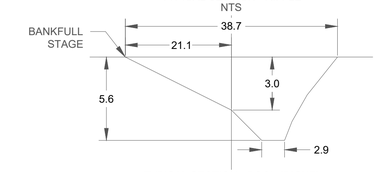
- CONSTRUCTED RIFFLE
- BOULDER J-HOOK
- CONSTRUCTED BOULDER/LOG RIFFLE
- BOULDER TOE
- LOG VANE
- TRANSPLANTS

## PROFILE LEGEND

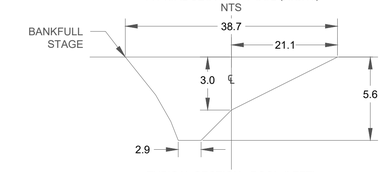
- PROPOSED STREAM CENTER LINE
- PROPOSED BANKFULL TOB
- EXISTING GROUND
- STRUCTURE BOULDER
- HEADER AND FOOTER BOULDER
- STRUCTURE LOG
- AUGMENTED RIFFLE



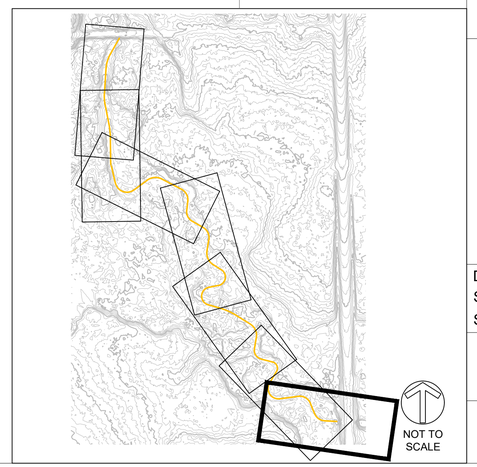

TYPICAL SECTION - RIFFLE
NTS




TYPICAL SECTION - POOL (RIGHT)
NTS




TYPICAL SECTION - POOL (LEFT)
NTS




| REV | DESCRIPTION | APPROVED BY: KA | CHECKED BY: MJG | DRAWN BY: GET | APPRV |
|---|---|---|---|---|---|
| 1 | DRAFT 30% DESIGN | XX | XX | XX | XX |
| XX | | XX | XX | XX | XX |
| XX | | XX | XX | XX | XX |
| XX | | XX | XX | XX | XX |
| XX | | XX | XX | XX | XX |
| XX | | XX | XX | XX | XX |
| XX | | XX | XX | XX | XX |

# EAST BRANCH BEAVER RIVER STREAM RESTORATION NEAR SILVER BAY LAKE COUNTY, MN

## DRAFT 30% DESIGN - NOT FOR CONSTRUCTION EAST BRANCH - LOWER PLAN AND PROFILE - (5) STA 24+00 TO 24+99


CLIFFS

NORTHSHORE MINING CO
10 OUTER DR
SILVER BAY, MN 55614
---

BEAVER RIVER CONSULTING

BEAVER RIVER CONSULTING, LLC.
5752 EAGLE VIEW DRIVE
DULUTH, MN 55803
---


CONCEPT DESIGN
NOT FOR
CONSTRUCTION

DATE: 2/07/2020
SCALE (34"X22"): 1" = 30'
SCALE (17"X11"): 1" = 60'

0 30 60
SCALE IN FEET

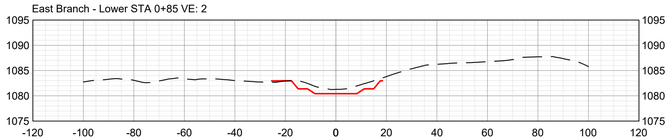


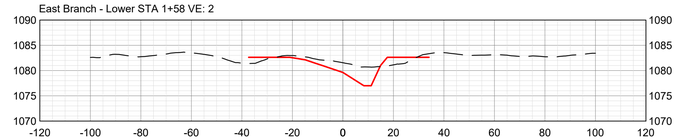

E:\DROPBOX (SSR)\NORTHSHOREMINING\C3D\SHEETS\EASTBRANCH_PP.DWG | GREGTAILLACQ | SAVED: Friday, February 7, 2020 2:08:40 PM | ACAD.CTB | | PLOTTED: Friday, February 7, 2020 2:08:16 PM

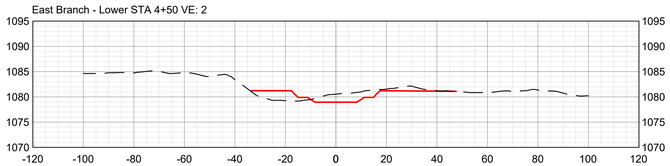
SECTION LEGEND

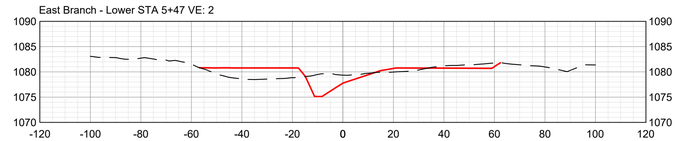
DESIGN SURFACE

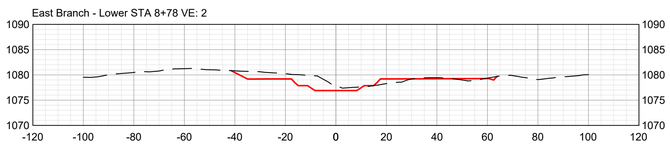
EXISTING GROUND

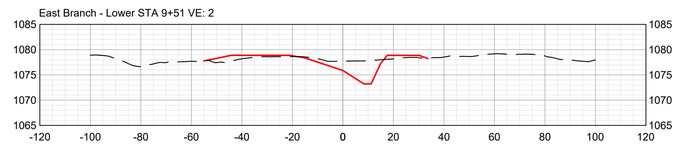


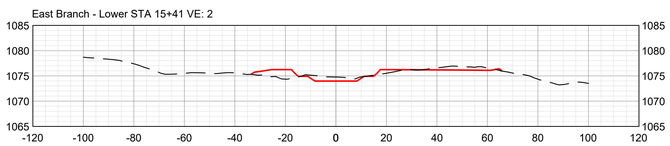



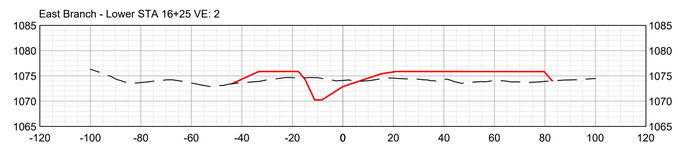



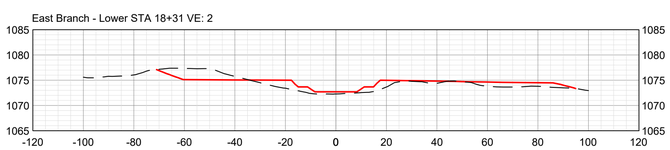



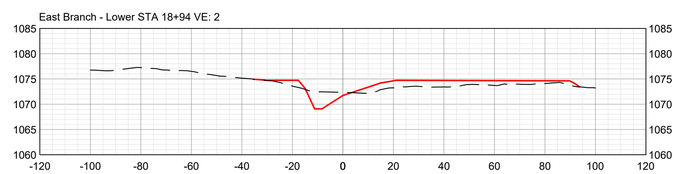



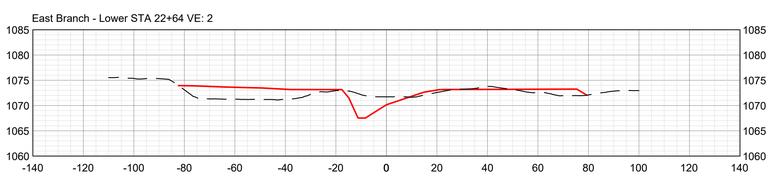



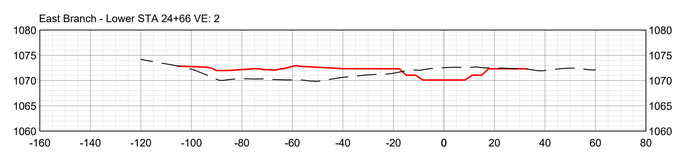




| REV | DESCRIPTION | APPROVED BY: KA | CHECKED BY: MJG | DRAWN BY: GET | APPRV |
|---|---|---|---|---|---|
| 1 | DRAFT 30% DESIGN | XX | XX | XX | XX |
| | | XX | XX | XX | XX |
| | | XX | XX | XX | XX |
| | | XX | XX | XX | XX |
| | | XX | XX | XX | XX |
| | | XX | XX | XX | XX |
| | | XX | XX | XX | XX |

EAST BRANCH BEAVER RIVER
STREAM RESTORATION
NEAR SILVER BAY
LAKE COUNTY, MN

DRAFT 30% DESIGN - NOT FOR CONSTRUCTION
---
---
Value

CLIFFS

NORTHSHORE MINING CO
10 OUTER DR
SILVER BAY, MN 55614
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BEAVER RIVER CONSULTING

BEAVER RIVER CONSULTING, LLC.
5752 EAGLE VIEW DRIVE
DULUTH, MN 55803
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CONCEPT DESIGN
NOT FOR
CONSTRUCTION

DATE: 2/07/2020
SCALE (34"X22"): 1" = 30'
SCALE (17"X11"): 1" = 60'

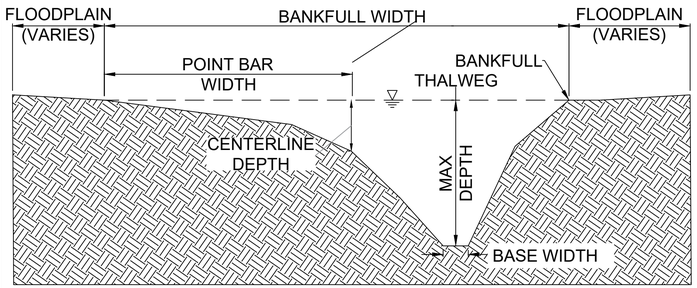
0 30 60
SCALE IN FEET

SHEET NUMBER
13 OF 19

E:\DROPBOX (SSSR)\NORTHSHOREMINING\C3D\SHEETS\EASTBRANCHLOWER_SECTIONS.DWG | GREGTAILLACQ | SAVED: Wednesday, January 29, 2020 11:52:39 AM | ACAD.CTB | | PLOTTED: Friday, February 7, 2020 2:08:23 PM

TYPICAL SECTION - POOL RIGHT (A)

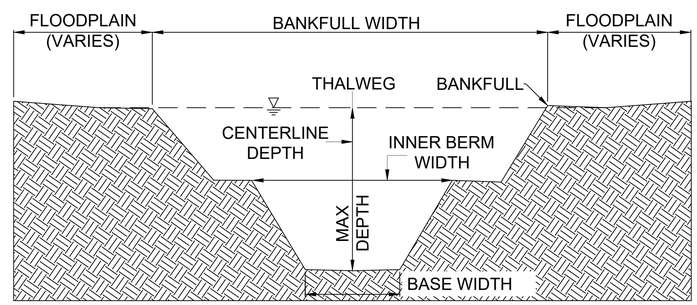
| DESIGN PARAMETERS | SIZE (FT) |
|---|---|
| BANKFULL WIDTH | 38.7 |
| POINT BAR WIDTH | 21.1 |
| MAX DEPTH | 5.6 |
| BASE WIDTH | 2.9 |
| CENTERLINE DEPTH | 3.0 |




NTS

TYPICAL SECTION -RIFFLE (B)

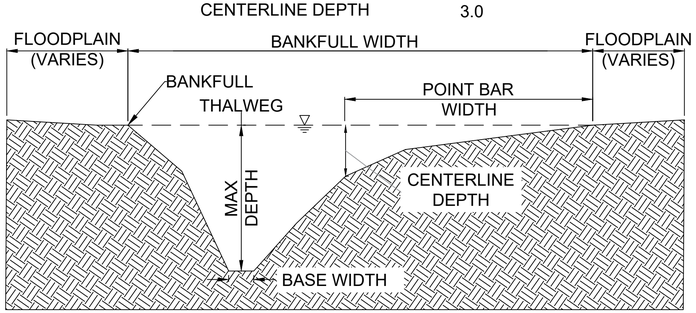
| DESIGN PARAMETERS | SIZE (FT) |
|---|---|
| BANKFULL WIDTH | 35.2 |
| MAX DEPTH | 2.3 |
| BASE WIDTH | 16.6 |
| INNER BERM DEPTH | 1.0 |
| INNER BERM WIDTH | 22.4 |




NTS

TYPICAL SECTION - POOL LEFT (C)

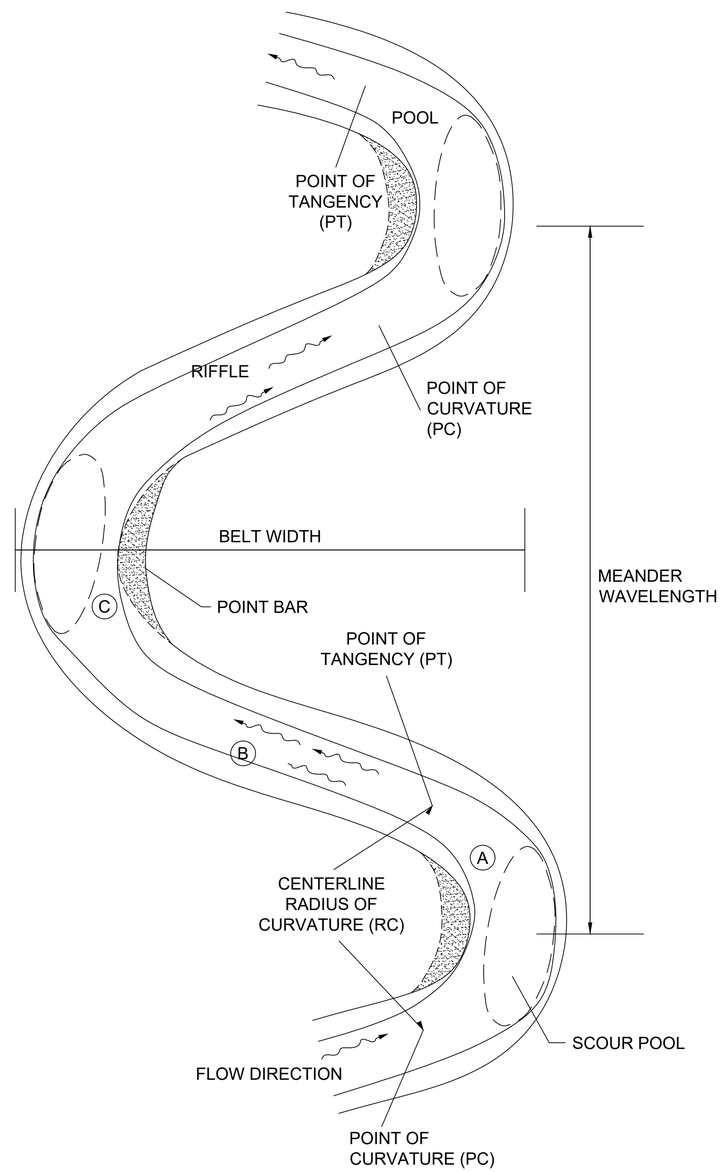
| DESIGN PARAMETERS | SIZE (FT) |
|---|---|
| BANKFULL WIDTH | 38.7 |
| POINT BAR WIDTH | 21.1 |
| MAX DEPTH | 5.6 |
| BASE WIDTH | 2.9 |
| CENTERLINE DEPTH | 3.0 |




NTS

STREAM MORPHOLOGY
STREAM NAME: EAST BRANCH LOWER

STREAM LAYOUT TYPICALS
NTS




| STREAM NAME | EAST BRANCH - LOWER | | |
|---|---|---|---|
| STREAM TYPE | | | |
| DRAINAGE AREA, DA (SQ MI) | | | |
| DESIGN PARAMETERS | MINIMUM | MEDIAN | MAXIMUM |
| MEAN RIFFLE DEPTH, $D_{BKF}$ (FT) | | | |
| RIFFLE WIDTH, $W_{BKF}$ (FT) | | | |
| WIDTH-TO-DEPTH RATIO, $[W_{BKF}/D_{BKF}]$ | | | |
| RIFFLE CROSS-SECTION AREA, $A_{BKF}$ (SQ FT) | | | |
| MAX RIFFLE DEPTH, $D_{MAX}$ (FT) | | | |
| POOL WIDTH, $W_{BKFP}$ (FT) | | | |
| POOL CROSS-SECTION AREA, $A_{BKFP}$ (SQ FT) | | | |
| MAX POOL DEPTH, $D_{MAXP}$ (FT) | | | |
| RIFFLE LENGTH, $L_{RIF}$ (FT) | | | |
| POOL LENGTH, $L_P$ (FT) | | | |
| ENTRENCHMENT RATIO, ER $[W_{FPA}/W_{BKF}]$ | | | |
| BANKFULL DISCHARGE, $Q_{BKF}$ (CFS) | | | |
| MEANDER LENGTH, $L_M$ (FT) | | | |
| BELT WIDTH, $W_{BLT}$ (FT) | | | |
| RADIUS OF CURVATURE, RC (FT) | | | |
| POOL-TO-POOL SPACING, P-P (FT) | | | |
| VALLEY SLOPE, VS (FT/FT) | | | |
| WATER SURFACE SLOPE, WS (FT/FT) | | | |
| SINUOSITY, K = SL/VL (FT/FT) | | | |

| APPROVED BY: KA | CHECKED BY: MJG | DRAWN BY: GET |
|---|---|---|
| REV | DESCRIPTION | APPRV |
| 1 | DRAFT 30% DESIGN | XX |
| XX | XX | XX |
| XX | XX | XX |
| XX | XX | XX |
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| XX | XX | XX |
| XX | XX | XX |
| XX | XX | XX |
| XX | XX | XX |

EAST BRANCH BEAVER RIVER
STREAM RESTORATION
NEAR SILVER BAY
LAKE COUNTY, MN

DRAFT 30% DESIGN - NOT FOR CONSTRUCTION
---
DETAIL - TYPICAL SECTIONS - EAST BRANCH LOWER


CLIFFS
NORTHSHORE MINING CO
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BEAVER RIVER CONSULTING
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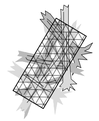
CONCEPT DESIGN
NOT FOR
CONSTRUCTION

DATE: 2/07/2020

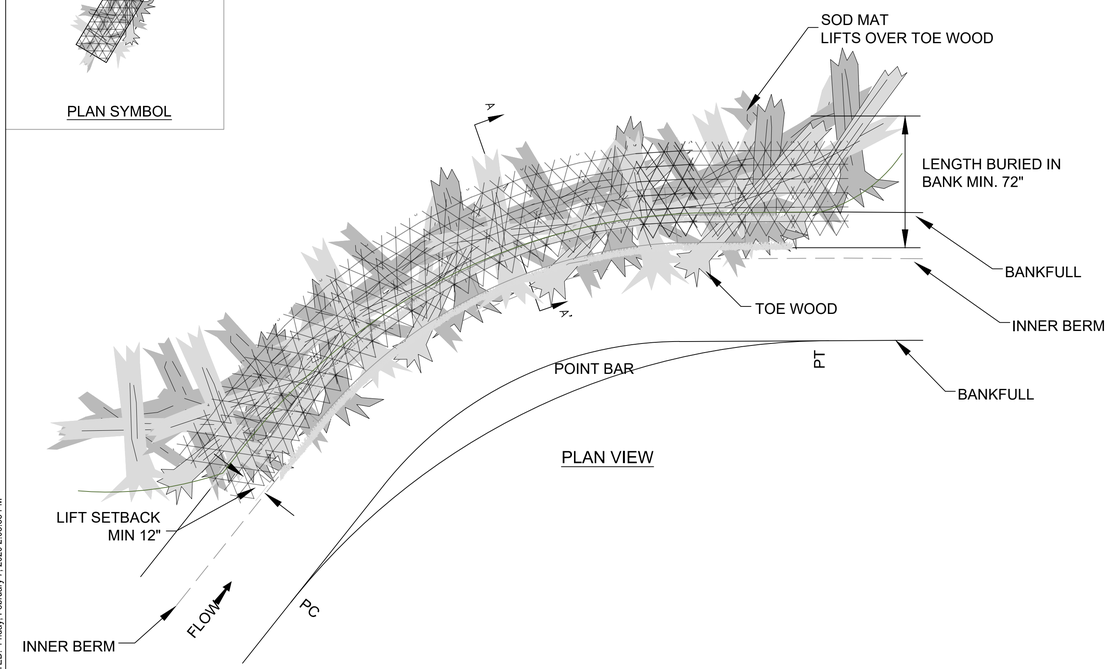
NTS

SHEET NUMBER
14 OF 19

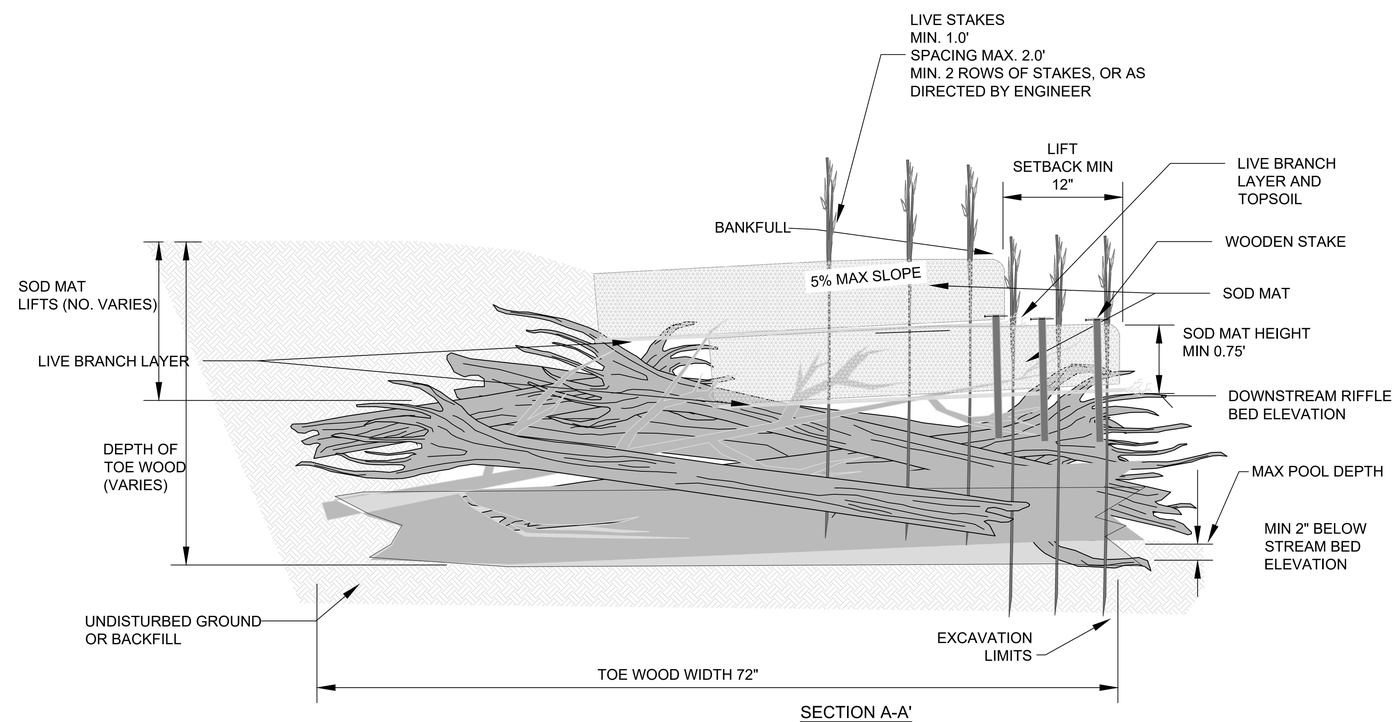
E:\DROPBOX (SSR)\NORTHSHOREMINING\C3D\SHEETS\NORTHSHOREEASTBRANCHMASTERDETAIL.DWG | GREGTAILLACQ | SAVED: Friday, February 7, 2020 1:57:35 PM | ACAD.CTB | | PLOTTED: Friday, February 7, 2020 2:08:32 PM



PLAN SYMBOL




PLAN VIEW




SECTION A-A'

DETAIL - TOE WOOD WITH SOD MAT

NOT TO SCALE

TOE WOOD WITH SOD MAT
CONSTRUCTED NOVEMBER 2018

NOTES:

1. THIS STRUCTURE PROVIDES PROTECTION TO THE BANKS OF NEWLY CONSTRUCTED STREAM CHANNELS. WOODY DEBRIS OF ALL SIZES CAN BE USED IN THE CONSTRUCTION OF THIS STRUCTURE. THE STABILITY OF THE LOWER PORTION OF THE STREAMBANK IS CRITICAL TO THE SUCCESS OF THE PROJECT. THE INSTALLATION OF ALTERNATE BANK PROTECTION STRUCTURES (E.G., HAY/STRAW BALES) WILL ONLY BE CONSIDERED IF WOOD IS NOT AVAILABLE ONSITE.

2. COARSE/LARGE WOODY DEBRIS CONSISTS OF LOGS, ROOTWADS, AND LARGE BRANCHES WHICH ARE NOT SUITABLE FOR CONSTRUCTION OF LOG STRUCTURES. ALL MATERIALS ARE TO BE APPROVED BY THE ENGINEER.

3. A TRENCH SHALL BE EXCAVATED ALONG THE OUTER BANK OF THE POOL. THE BOTTOM ELEVATION OF THE TRENCH SHALL BE AT OR BELOW MAX. POOL DEPTH.

4. COARSE/LARGE WOODY DEBRIS SHALL BE INSTALLED IN THE TRENCH WITH THE LARGEST MATERIAL PLACED FIRST. THE LOGS OR WOOD MATERIAL SHALL BE PLACED PERPENDICULAR TO THE FLOW OF WATER. LOGS SHALL BE PLACED IN A CROSSING PATTERN OR WEAVE SUCH THAT EACH LOG/BRANCH IS ANCHORED BY ANOTHER LOG/BRANCH. THE COARSE/LARGE WOODY DEBRIS SHALL BE INSTALLED TO A HEIGHT OF 3/4 OF THE FINISHED HEIGHT OF THE WOODY DEBRIS WITH THE FINE/SMALL WOODY DEBRIS MAKING UP THE REMAINING 1/4 OF THE TOTAL HEIGHT.

5. FINE/SMALL WOODY DEBRIS CONSISTS OF MEDIUM TO SMALL LIMBS, BRANCHES, BUSHES, AND/OR SMALL LOGS. INVASIVE SPECIES SHALL NOT BE USED. ALL MATERIALS ARE TO BE APPROVED BY THE ENGINEER.

6. FINE/SMALL WOODY DEBRIS SHALL BE PLACED ON TOP OF THE COARSE/LARGE WOODY DEBRIS WITH THE LARGEST MATERIAL BEING PLACED FIRST AND THE SMALLEST MATERIAL PLACED LAST. THE FINE WOODY DEBRIS SHALL BE INSTALLED TO AN ELEVATION EQUAL TO THE INVERT OF THE DOWNTREAM RIFFLE.

7. ALL WOODY DEBRIS SHALL BE COMPACTED WITH THE EXCAVATOR BUCKET IN ORDER TO REDUCE THE PRESENCE OF VOIDS IN THE SMALL/FINE WOODY DEBRIS LAYER AND TO KEEP FUTURE SETTLING TO A MIN.

8. SELECT BACKFILL/TOPSOIL SHALL BE INSTALLED ON TOP OF WOODY DEBRIS TO CREATE A LEVEL SUBSTRATE FOR THE SOD MATS.

9. A THIN LAYER OF LIVE BRANCHES (3-5' IN LENGTH) AND TOPSOIL SHALL BE PLACED ON TOP OF THE BALES. THE LIVE BRANCHES SHALL BE OF THE SPECIES SPECIFIED FOR LIVE STAKES OR APPROVED BY THE ENGINEER AND SHALL EXCLUDE INVASIVE SPECIES.

10. NATIVE SOD MATS SHALL BE HARVESTED ONSITE. THEY SHALL BE WEED FREE AND APPROXIMATELY 3' X 3' WITH A MINIMUM OF 8" OF INTACT SOIL AND ROOTMASS ATTACHED. THE SOD MATS ARE TO BE INSTALLED ON TOP OF THE LIVE BRANCH LAYER.

11. REPEAT NUMBERS 9 AND 10 UNTIL THE FINISHED ELEVATION EQUALS THE ELEVATION OF BANKFULL.

12. THE TOP OF THE SOD MAT SHALL BE FLAT WITHIN THE LIFT SETBACK DISTANCE SPECIFIED IN THE STRUCTURE TABLE. BEYOND THE LIFT SETBACK DISTANCE, THE SOIL BACKFILL SHALL BE SLOPED AT AN APPROXIMATE 5% SLOPE AWAY FROM THE STREAM.

13. THE SURFACE OF THIS STRUCTURE SHALL BE FINISHED TO A SMOOTH AND COMPACT SURFACE IN ACCORDANCE WITH THE LINES, GRADES, AND CROSS-SECTIONS OR ELEVATIONS SHOWN ON THE DRAWINGS. THE DEGREE OF FINISH FOR ELEVATIONS SHALL BE WITHIN +/- 0.1' OF THE GRADES AND ELEVATIONS INDICATED ON THE PLANS OR APPROVED BY THE ENGINEER.

14. DRESSING OF CHANNEL AND BANKFULL BENCH/FLOODPLAIN WILL LIKELY BE REQUIRED FOLLOWING INSTALLATION OF BANK STRUCTURES AND SHALL BE CONSIDERED INCIDENTAL TO CONSTRUCTION.

15. LIVE STAKES SHALL BE OF SPECIES APPROVED BY THE ENGINEER. LIVE STAKES SHALL BE 2-3' LONG AND A MIN. OF 1" IN DIAMETER AND INSTALLED WITH 2/3 OF THE LENGTH BELOW GROUND WITH A MINIMUM OF 2 BUD SCARS BELOW THE GROUND AND 2 ABOVE GROUND. SEE LIVE STAKE DETAIL.

16. LIVE STAKES SHALL BE PLACED ON THE SLOPE FROM THE INNER BERM TO HALF BANK FULL HEIGHT.

17. WOODEN STAKES SHALL BE 1 X 2" AND A MIN.. OF 18" LONG. WOODEN STAKES SHALL BE INSTALLED FROM THE INNER BERM TO BANKFULL ON 18-24" CENTERS PER THE ENGINEER'S INSTRUCTIONS.

APPROVED BY: KA | CHECKED BY: MJG | DRAWN BY: GET

| REV | DESCRIPTION | APPRV |
|---|---|---|
| 1 | DRAFT 30% DESIGN | XX |
| XX | XX | XX |
| XX | XX | XX |
| XX | XX | XX |
| XX | XX | XX |
| XX | XX | XX |
| XX | XX | XX |
| XX | XX | XX |

EAST BRANCH BEAVER RIVER
STREAM RESTORATION
NEAR SILVER BAY
LAKE COUNTY, MN

DRAFT 30% DESIGN - NOT FOR CONSTRUCTION
---
---
Value

CLIFFS

NORTHSHORE MINING CO
10 OUTER DR
SILVER BAY, MN 55614
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BEAVER RIVER CONSULTING

BEAVER RIVER CONSULTING, LLC.
5752 EAGLE VIEW DRIVE
DULUTH, MN 55803
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CONCEPT DESIGN
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DATE: 2/07/2020

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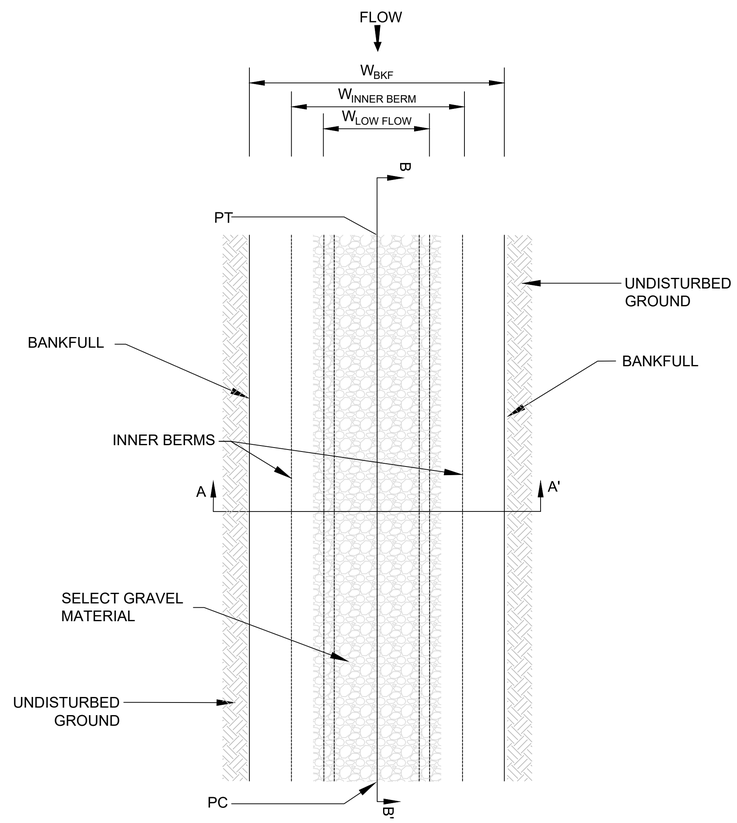
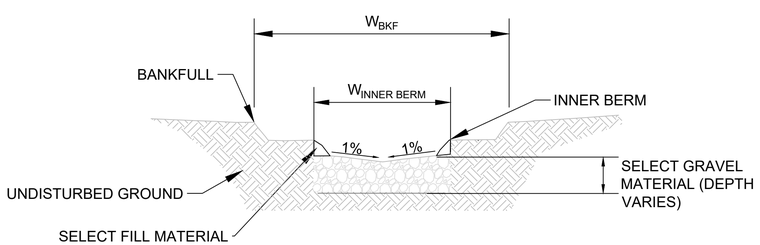
SHEET NUMBER
15 OF 19

E:\DROPBOX (SSSR)\NORTHSHOREMINING\C3D\SHEETS\NORTHSHOREEASTBRANCHMASTERDETAIL.DWG | GREGTAILLACQ | SAVED: Friday, February 7, 2020 1:57:35 PM | ACAD.CTB | | PLOTTED: Friday, February 7, 2020 2:08:35 PM

PLAN SYMBOL




PLAN VIEW




CROSS-SECTION A-A'

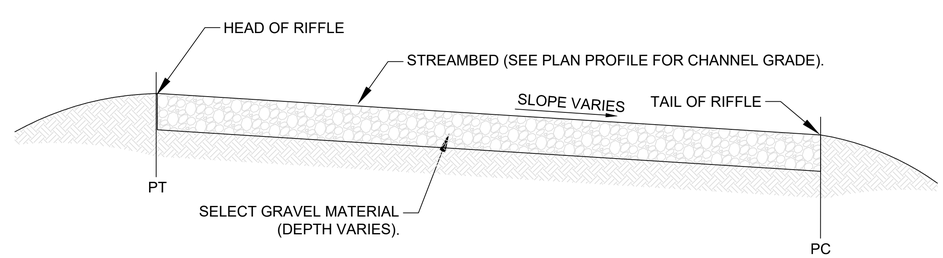
# DETAIL - AUGMENTED RIFFLE

NOT TO SCALE

CONSTRUCTED RIFFLE WITH IMPORTED MATERIAL

NOTES:

1. THE AUGMENTED RIFFLE IS GENERALLY INSTALLED IN A NEW CHANNEL TO PROVIDE GRADE CONTROL AND PREVENT DOWNCUTTING. MATERIAL IS IMPORTED TO THE SITE BECAUSE APPROPRIATELY SIZED MATERIAL IN NOT AVAILABLE ON-SITE.
2. THIS ENGINEER WILL SPECIFY THE SIZE OF THE MATERIAL TO BE USED IN THE RIFFLE AND MUST APPROVE IT BEFORE IT IS INSTALLED. THE CONTRACTOR MAY USE MATERIAL AVAILABLE ON-SITE IF APPROVED BY THE ENGINEER.
3. THE CONTRACTOR SHALL EXCAVATE A TRENCH THAT EXTENDS THE LENGTH OF THE RIFFLE (AS SHOWN ON THE PLANSHEETS) AND FROM INNER BERM TO INNER BERM. THE CONTRACTOR SHALL EXCAVATE TO A DEPTH OF 24" OR THREE TIMES THE D84 OF THE MATERIAL SPECIFIED BY THE ENGINEER, WHICHEVER IS GREATER. THE CONTRACTOR SHALL NOT DISTURB THE SURROUNDING GROUND.
4. THE CONTRACTOR SHALL FILL THE TRENCH WITH THE GRAVEL MATERIAL SPECIFIED AND APPROVED BY THE ENGINEER. THE GRAVEL MATERIAL SHALL BE COMPACTED USING EQUIPMENT SO THAT FUTURE SETTLEMENT OF THE MATERIAL WILL BE MINIMAL.
5. THE GRAVEL MATERIAL SHALL BE COMPACTED SUCH THAT, IN CROSS-SECTION, THERE IS A 1% SLOPE TO THE CENTER OF THE CHANNEL OR AS GENERATED BY THE 3D SURFACE.
6. SELECT FILL MATERIAL APPROVED BY THE ENGINEER SHALL BE PLACED ACCORDING TO THE TYPICAL CROSS-SECTIONS TO CREATE A SMOOTH SLOPED TRANSITION FROM THE INNER BERM TO THE GRAVEL MATERIAL COMPRISING THE RIFFLE.
7. THE SURFACE OF THE RIFFLE SHALL BE FINISHED TO THE FINAL GRADES AS SHOWN ON THE PLANSHEETS. THE DEGREE OF TOLERANCE FOR ALL ELEVATIONS SHALL BE WITHIN +/- 0.1' OF THE GRADES AND ELEVATIONS SPECIFIED ON THE PLANS.
8. FINAL GRADING AND TOP DRESSING OF THE INNER BERM AND BANKFULL BENCH TO THE FLOODPLAIN IS REQUIRED FOLLOWING THE INSTALLATION OF THE CONSTRUCTED RIFFLE AND SHALL BE CONSIDERED INCIDENTAL TO CONSTRUCTION.
9. BANK TREATMENTS SHALL BE INSTALLED AFTER FINAL GRADING AND TOP DRESSING. SEE THE PLANSHEETS FOR THE BANK TREATMENT TYPE.




PROFILE B-B'

| APPROVED BY: KA | CHECKED BY: MJG | DRAWN BY: GET | |
|---|---|---|---|
| REV | DESCRIPTION | | APPRV |
| 1 | DRAFT 30% DESIGN | | XX |
| XX | XX | | XX |
| XX | XX | | XX |
| XX | XX | | XX |
| XX | XX | | XX |
| XX | XX | | XX |
| XX | XX | | XX |
| XX | XX | | XX |

EAST BRANCH BEAVER RIVER
STREAM RESTORATION
NEAR SILVER BAY
LAKE COUNTY, MN

DRAFT 30% DESIGN - NOT FOR CONSTRUCTION
---
---
DETAIL - AUGMENTED RIFFLE


CLIFFS
NORTHSHORE MINING CO
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SILVER BAY, MN 55614
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BEAVER RIVER CONSULTING
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5752 EAGLE VIEW DRIVE
DULUTH, MN 55803
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CONCEPT DESIGN
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CONSTRUCTION

DATE: 2/07/2020

NTS

SHEET NUMBER
16 OF 19

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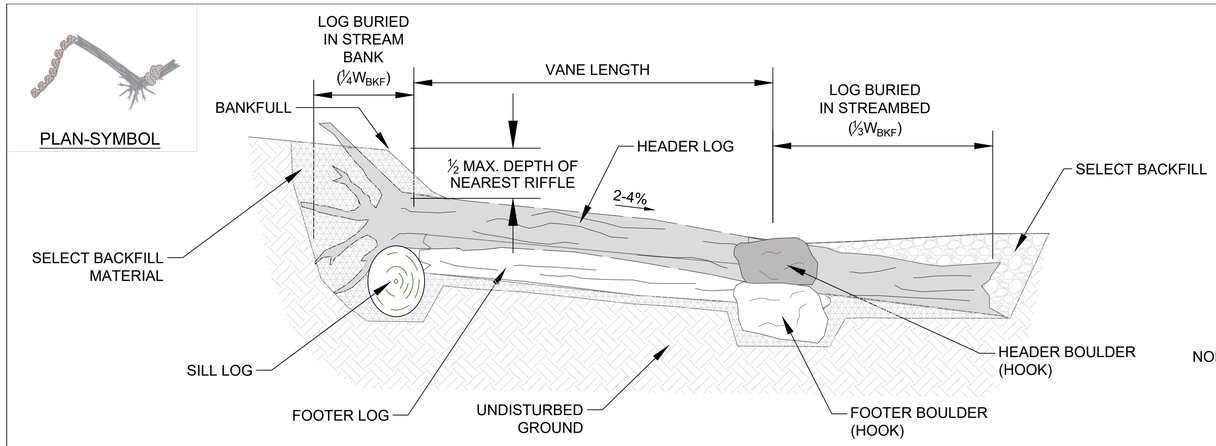
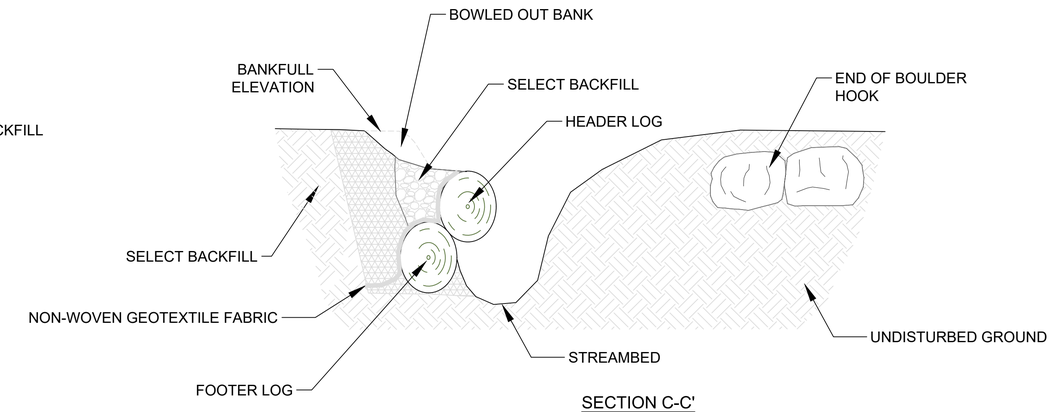
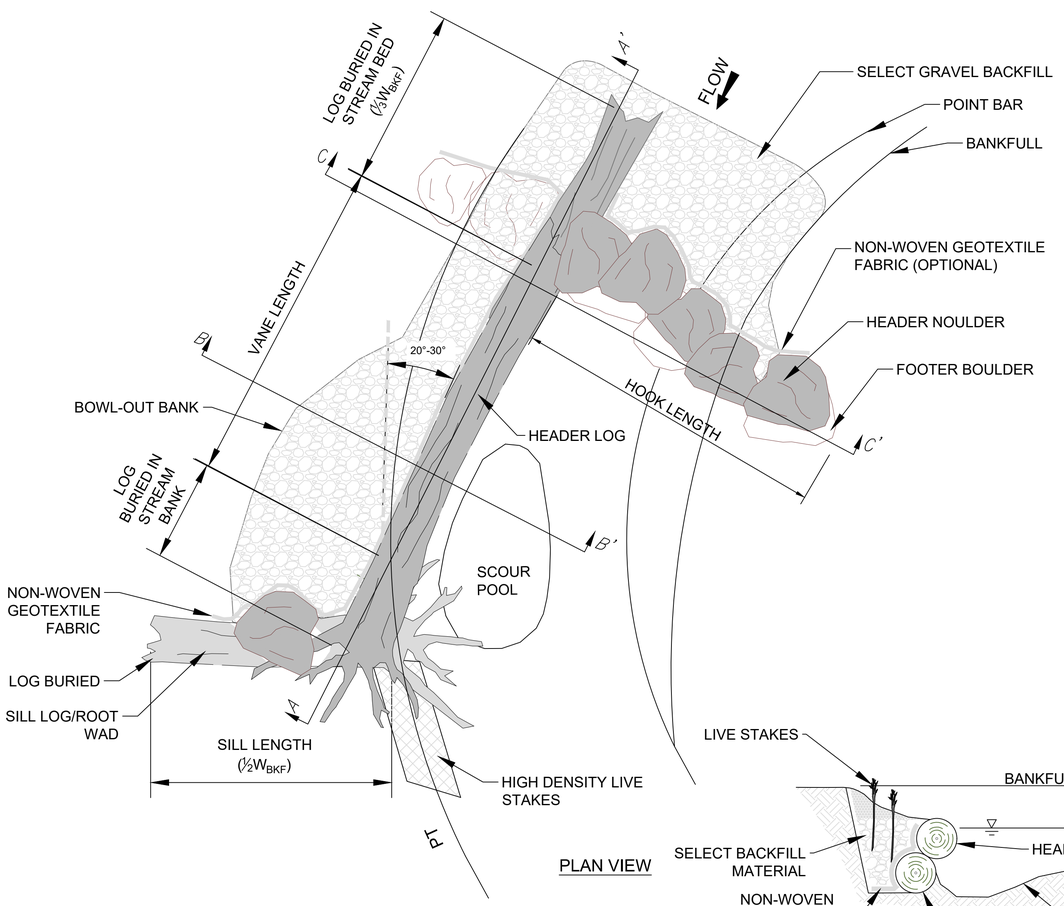


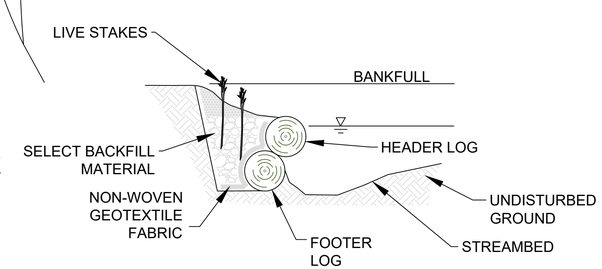

SECTION A-A'




SECTION C-C'




PLAN VIEW




SECTION B-B'

# DETAIL - LOG J-HOOK WITH ROOTWAD

NOT TO SCALE

NOTES:

1. THE LOG J-HOOK WITH ROOT WAD IS USED TO STABILIZE THE OUTSIDE BANK OF A STREAM CHANNEL IN A BEND BY PHYSICALLY PROTECTING THE BANK AND HELPING TURN THE WATER TOWARD THE CENTER OF THE CHANNEL. THE LOG J-HOOK WITH ROOT WAD CAN BE USED TO HELP STABILIZE AN EXISTING CHANNEL OR TO PROTECT THE BANK OF A NEWLY CONSTRUCTED CHANNEL.

2. THE STRUCTURE IS COMPRISED OF BOTH LOGS AND BOULDERS. LOGS SHALL HAVE A MINIMUM DIAMETER OF 18". THE LENGTH OF THE LOGS WILL BE DETRMINED BY THE SIZE AND SHAPE OF THE CHANNEL. ALL LOGS SHALL BE RELATIVELY STRAIGHT AND LIMBS SHALL BE TRIMMED FLUSH. THE SIZE OF THE BOULDERS VARIES WITH THE SIZE OF THE CHANNEL.

3. HEADER LOGS/BOULDERS SHALL BE UNDERLAIN BY FOOTER LOGS/BOULDERS UNLESS OTHERWISE DIRECTED BY THE ENGINEER. FOOTER LOGS PROVIDE SCOUR PROTECTION FOR HEADER LOGS. FOOTER BOULDERS PROVIDE SCOUR PROTECTION AND A FOUNDATION FOR THE HEADER BOULDERS.

4. THE SILL LOG WITH ROOT WAD IS GENERALLY INSTALLED FIRST. THE CONTRACTOR SHALL DIG A TRENCH PERPENDICULAR TO THE BANKFULL FLOW DIRECTION AND INSTALL THE SILL LOG. IT MAY BE NECESSARY TO CUT THE SILL LOG ROOTWAD TO PREVENT THE ROOTWAD FROM PROTRUDING ABOVE THE BANKFULL ELEVATION. A BOULDER OR HEADER SILL LOG SHALL BE PLACED ON THE SILL LOG TO EFFECTIVELY EXTEND THE SILL FURTHER INTO THE BANK.

5. THE HEADER LOG OF THE VANE ARM IS GENERALLY INSTALLED NEXT. THE CONTRACTOR SHALL DIG A TRENCH TO FACILIATE THE INSTALLATION OF THE VANE ARM. THE HEADER LOG SHALL TIE INTO THE STREAM BANK AT A MINIMUM ELEVATION OF 1/4 DMAX (MEASURED AT THE NEXT DOWNSTREAM RIFFLE) BELOW BANKFULL ELEVATION AND A MINIMUM ELEVATION OF 1/2 DMAX (MEASURED AT THE NEXT DOWNSTREAM RIFFLE) BELOW BANKFULL ELEVATION UNLESS OTHERWISE DIRECTED BY THE ENGINEER. THE HEADER LOG SHALL EXTEND FROM THE SILL LOG TO BEYOND THE HOOK PORTION OF THE STRUCTURE, GENERALLY AT A SLOPE OF 2 - 4%. THE VANE ARM FOOTER LOG SHALL BE CUT TO FIT BETWEEN SILL LOG AND THE BOULDER HOOK PORTION OF THE STRUCTURE. THE FOOTER LOG OF THE VANE ARM SHALL BE INSTALLED FROM UPSTREAM SIDE AND INSTALLED AGAINST THE LOWER HALF OF THE HEADER LOG RESULTING IN A STAGGER WITH THE HEADER LOG BEING SLIGHTLY MORE DOWNSTREAM THAN THE FOOTER LOG. ANY GAPS BETWEEN THE HEADER AND FOOTER LOGS WIDER THAN 1" SHALL BE CHINKED WITH BRANCHES AND/OR BRUSH FROM THE UPSTREAM SIDE. WHEN COMPLETE THE FOOTER LOG WILL NOT BE VISIBLE BUT THE HEADER LOG WILL BE VISIBLE DURING LOW FLOWS.

6. THE HOOK PORTION OF THE STRUCTURE CONSISTS OF BOULDERS. THE CONTRACTOR SHALL EXCAVATE A TRENCH TO FACILIATE THE INSTALLATION OF A ROW OF FOOTER BOULDERS THAT EXTEND FROM THE END OF THE FOOTER LOG OF THE VANE ARM ACROSS THE CHANNEL TO BEYOND BANKFULL ON THE OTHER SIDE OF THE CHANNEL CREATING A BURIED SILL. THE CONTRACTOR SHALL INSTALL HEADER BOULDERS ON TOP OF THE FOOTER BOULDERS. ALL BOULDERS SHALL BE FIT TIGHLTY TOGETHER AND ANY GAPS WIDER THAN 1" SHALL BE CHINKED WITH GRAVEL AND COBBLE FROM THE UPSTREAM SIDE WITH ROCKS. WHEN COMPLETE THE FOOTER BOULDERS WILL NOT BE VISIBLE BUT THE HEADER BOULDERS WILL BE VISIBLE DURING LOW FLOWS.

7. THE LOCATION AND ELEVATION OF THE SILL, VANE ARM AND THE BOULDER HOOK STRUCTURE MAY NOT VARY FROM THOSE SPECIFIED IN THE PLANSHEETS UNLESS DIRECTED OTHERWISE BY THE ENGINEER. THE FOOTER DEPTH ON ALL STRUCTURES REQUIRING FOOTERS SHALL BE 6 TIMES GREATER THAN THE DROP BETWEEN THE STRUCTURE AND THE FOOTERED STRUCTURE DIRECTLY DOWNSTREAM.

8. ON THE UPSTREAM SIDE OF THE LOGS AND BOULDERS NON-WOVEN GEOTEXTILE FABRIC SHALL BE PLACED AS SHOWN IN THE DETAIL PLANVIEW DRAWING. THE GEOTEXTILE FABRIC SHALL BE NAILED TO UPSTREAM SIDE OF THE HEADER LOGS USING 3" 10D GALVANZED COMMON NAILS ON 12" SPACING. THE GEOTEXTILE FABRIC SHALL BE CAREFULLY PLACED AGAINST THE UPSTREAM SIDE OF THE BOULDERS AND HELD IN PLACE BY BACKFILL MATERIAL.

9. THE EXCAVATED AREAS UPSTREAM OF THE SILL, VANE ARM AND BOULDER HOOK SHOULD BE FILLED WITH SELECT BACKFILL MATERIAL AS SPECIFIED AND APPROVED BY THE ENGINEER. THE SELECT BACKFILL AND SOIL BACKFILL MATERIAL SHALL BE OVER COMPACTED USING EQUIPMENT SO THAT FUTURE SETTLEMENT IS KEPT TO A MINIMUM. THE STEAMBANK SHOULD BE BOWLED OUT BEHIND THE VANE ARM AT THE DOWNSTREAM END OF THE VANE ARM.

10. THE SURFACE OF THIS STRUCTURE SHALL BE FINISHED TO A SMOOTH AND COMPACT SURFACE IN ACCORDANCE WITH THE LINES, GRADES, AND CROSS-SECTIONS OR ELEVATIONS SHOWN ON THE DRAWINGS . THE DEGREE OF FINISH FOR ELEVATIONS SHALL BE WITHIN 0.1' OF THE GRADES AND ELEVATIONS INDICATED. DRESSING OF THE CHANNEL, BANKFULL BENCH AND FLOODPLAIN WILL LIKELY BE REQUIRED FOLLOWING INSTALLATION OF THIS STRUCTURE AND SHALL BE CONSIDERED INCIDENTAL TO CONSTRUCTION.

11. DETAILS REGARDING PLANTING REQUIREMENTS. NO LIVE STAKES SHALL BE INSTALLED ON THE UPSTREAM SIDE OF THE LOG VANE AT OR BELOW THE TIE-IN ELEVATION OF THE HEADER LOG WITH THE STREAMBANK UNLESS OTHERWISE DIRECTED BY THE ENGINEER. INSTALL LIVE STAKES PER THE PLAN VIEW DRAWING AND THE LIVE STAKE DETAIL. LIVE STAKES SHOULD BE INSTALLED BEHIND THE VANE ARM ABOVE THE BANKFULL ELEVATION ON 12" CENTERS. LIVE STAKES SHOULD BE INSTALLED DOWNSTREAM OF THE ROOT WAD ALONG THE TOP OF BANK AT A HIGHER DENSITY (I.E. 10" CENTERS).

| APPROVED BY: KA | CHECKED BY: MJG | DRAWN BY: GET | |
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| 1 | DRAFT 30% DESIGN | | XX |
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EAST BRANCH BEAVER RIVER
STREAM RESTORATION
NEAR SILVER BAY
LAKE COUNTY, MN

DRAFT 30% DESIGN - NOT FOR CONSTRUCTION

DETAIL - LOG J-HOOK

CLIFFS
NORTHSHORE MINING CO
10 OUTER DR
SILVER BAY, MN 55614

BEAVER RIVER CONSULTING
BEAVER RIVER CONSULTING, LLC.
5752 EAGLE VIEW DRIVE
DULUTH, MN 55803

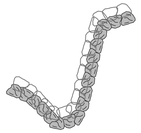
CONCEPT DESIGN
NOT FOR
CONSTRUCTION

DATE: 2/07/2020

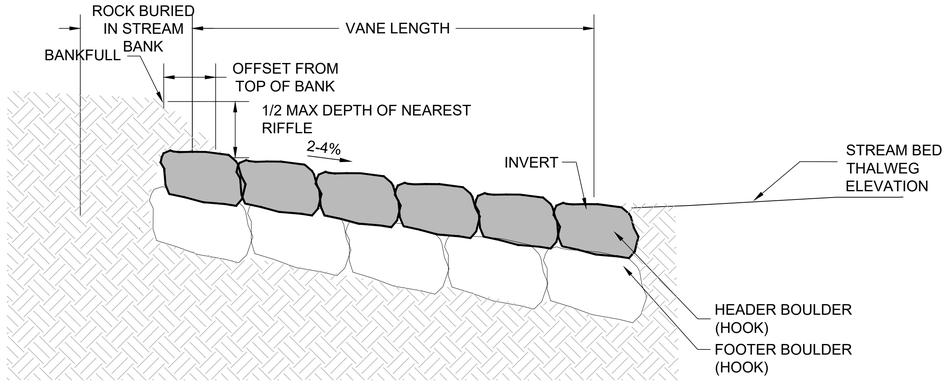
NTS

SHEET NUMBER
17 OF 19

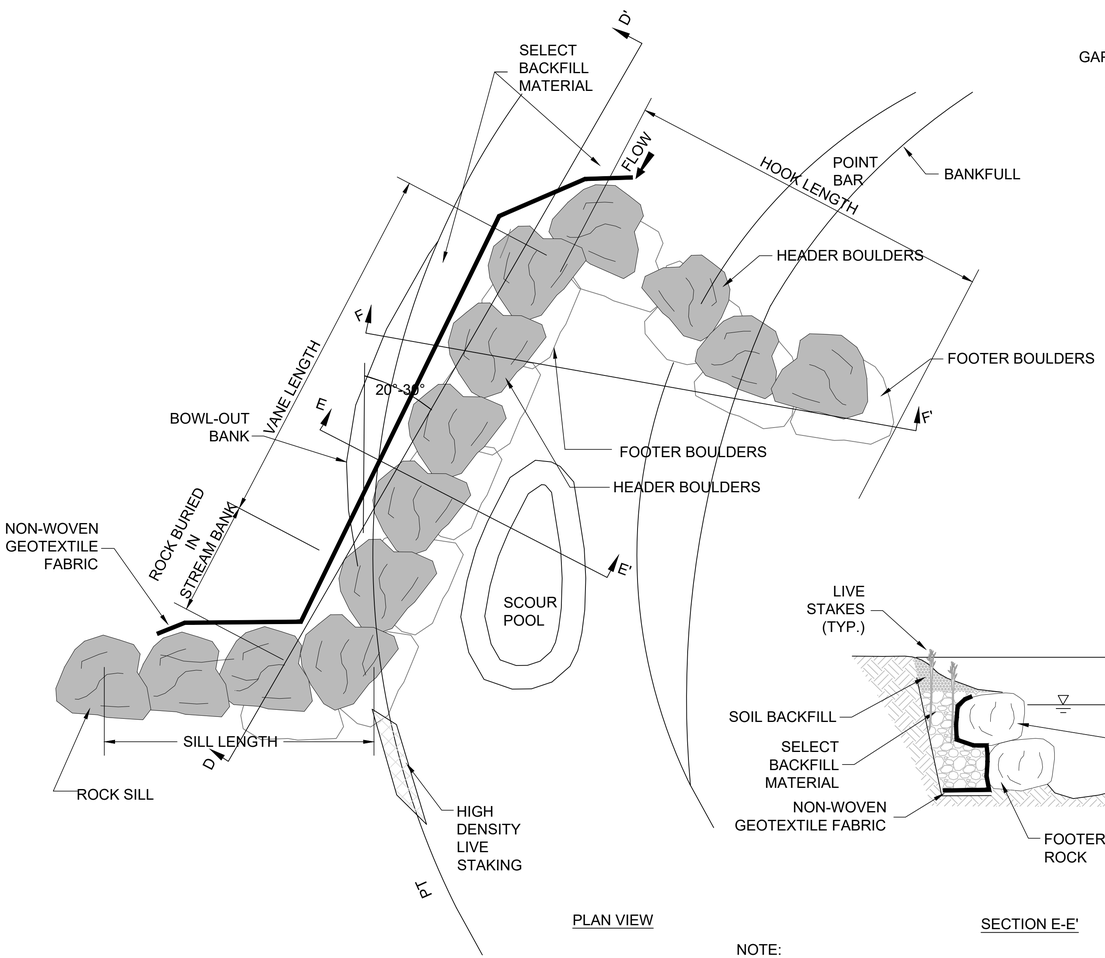
E:\DROPBOX (SSSR)\NORTHSHOREMINING\C3D\SHEETS\NORTHSHOREEASTBRANCHMASTERDETAIL.DWG | GREGTAILLACQ | SAVED: Friday, February 7, 2020 1:57:35 PM | ACAD.CTB | | PLOTTED: Friday, February 7, 2020 2:08:36 PM



PLAN-SYMBOL



SECTION D-D'

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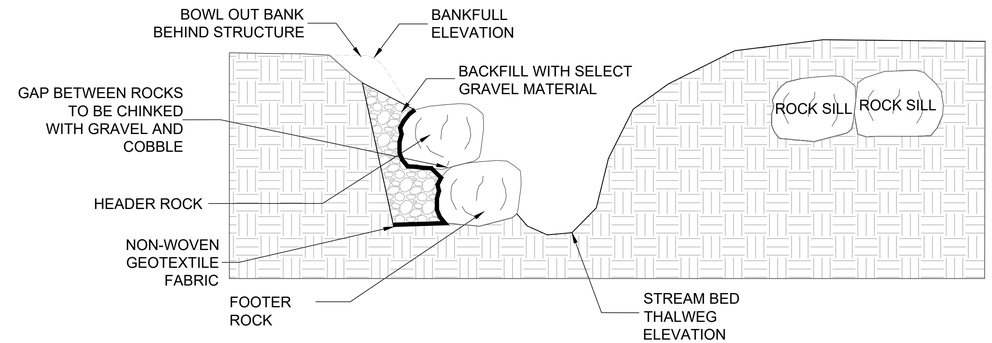
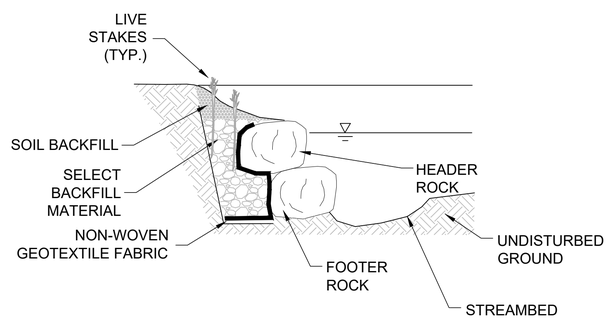



SECTION F-F'




SECTION E-E'

NOTE:

THE DEPARTURE ANGLE SHOWN ABOVE IS DEPICTED IN SUCH A WAY TO EMPHASIZE DETAIL. ACTUAL DEPARTURE ANGLE AND STRUCTURE LOCATION SHALL BE AS SHOWN ON THE PLAN AND PROFILE SHEETS AND WILL BE PROVIDED TO THE CONTRACTOR AS A 2004 FORMAT DWG FILE AND LN3 FILE.

NOTES:

1. BOULDERS FOR THE CONSTRUCTED RIFFLE MUST BE A MINIMUM OF 1-2 TN BOULDER WITH A MIN. DIAMETER OF 2-3FT.
2. FOOTER BOULDERS ARE BOULDERS PLACED TO PROVIDE A FOUNDATION AND SCOUR PROTECTION FOR THE HEADER BOULDERS.
3. HEADER BOULDERS SHALL BE UNDERLAIN BY FOOTER BOULDERS UNLESS OTHERWISE DIRECTED BY THE ENGINEER.
4. HEADER BOULDERS ARE THE TOP MOST BOULDER USED IN EACH STRUCTURE. ALL HEADER BULDERS CAN BE SEEN PARTIALLY PROTRUDING FROM THE WATER SURFACE DURING EXTREMELY LOW FLOWS.
5. HEADER BOULDERS SHALL BE OFFSET SLIGHTLY DOWNSTREAM OF THE FOOTING BOULDERS WHERE SCOUR POOLS ARE ANTICIPATED TO FORM AS SHOWN IN THE DETAIL.
6. SILL BOULDERS SHALL BE PLACED PERPENDICULAR TO THE BANKFULL FLOW DIRECTION.
7. THE FOOTER BOULDERS SHALL EXTEND FROM THE SILL BOULDER TO THE END OF THE HEADER BOULDER TOWARD THE BANK.
8. HOOK BOULDERS SHALL EXTEND FROM THE HEADER BOULDER TO BEYOND BANKFULL WIDTH.
9. SET INVERTS AT ELEVATION SHOWN ON THE PLAN AND PROFILE SHEETS. INVERTS AND ELEVATIONS WILL BE PROVIDED TO THE CONTRACTOR AS A 2004 FORMAT DWG FILE. NO ELEVATIONS OF THE BOULDER DROPS STRUCTURE MAY VARY FROM THE PLAN LOCATIONS WITHOUT DIRECTIONS FROM THE ENGINEER.
10. HEADER BOULDER SHALL TIE INTO THE STREAM BANK AT A MINIMUM ELEVATION OF 1/4 DMAX (MEASURED AT THE NEXT DOWNSTREAM RIFFLE) BELOW BANKFULL ELEVATION AND A MINIMUM ELEVATION OF 1/2 DMAX (MEASURED AT THE NEXT DOWNSTREAM RIFFLE) BELOW BANKFULL ELEVATION UNLESS OTHERWISE DIRECTED BY THE ENGINEER.
11. ALL GAPS/VOIDS LARGER THAN 1 INCH BETWEEN THE HEADER AND FOOTING BOULDERS SHALL BE CHINKED WITH GRAVEL AND COBBLES.
12. ON THE UPSTREAM SIDE OF THE BOULDERS NON-WOVEN GEOTEXTILE FABRIC SHALL BE PLACED AS SHOWN IN THE GEOTEXTILE PLACEMENT AND SELECT BACKFILL DETAIL FOR THE ENTIRE LENGTH OF THE BOULDER HOOK.
13. BACKFILL STRUCTURE WITH SELECT BACKFILL MATERIAL AS SHOWN AND DEFINED IN THE GEOTEXTILE PLACEMENT AND SELECT BACKFILL DETAIL.
14. SELECT BACKFILL AND SOIL BACKFILL MATERIAL SHALL BE COMPACTED SUCH THAT FUTURE SETTLEMENT OF THE MATERIAL IS KEPT TO A MINIMUM.
15. THE SURFACE OF THIS STRUCTURE SHALL BE FINISHED TO A SMOOTH AND COMPACT SURFACE IN ACCORDANCE WITH THE LINES, GRADES, AND CROSS-SECTIONS OR ELEVATIONS SHOWN ON THE DRAWINGS. THE DEGREE OF FINISH FOR INVERT ELEVATIONS SHALL BE WITHIN 0.1 FT OF THE GRADES AND ELEVATIONS INDICATED.
16. RE-DRESSING OF CHANNEL AND BANKFULL BENCH/FLOODPLAIN WILL LIKELY BE REQUIRED FOLLOWING INSTALLATION OF IN-STREAM STRUCTURES AND SHALL BE CONSIDERED INCIDENTAL TO CONSTRUCTION.
17. SEE THE PLANTING TABLE FOR DETAILS ON HIGH DENSITY LIVE STAKING.
18. NO LIVE STAKES SHALL BE INSTALLED ON THE UPSTREAM SIDE OF THE VANE AT OR BELOW THE TIE-IN ELEVATION OF THE HEADER LOG WITH THE STREAM BANK UNLESS OTHERWISE DIRECTED BY THE ENGINEER.
19. FOOTER DEPTH ON ALL STRUCTURES REQUIRING FOOTERS SHALL BE 6 TIMES GREATER THAN THE DROP BETWEEN THE STRUCTURE AND THE FOOTERED STRUCTURE DIRECTLY UPSTREAM.

DETAIL - BOULDER J-HOOK
NOT TO SCALE

APPROVED BY: KA | CHECKED BY: MJG | DRAWN BY: GET

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| 1 | DRAFT 30% DESIGN | XX |
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EAST BRANCH BEAVER RIVER
STREAM RESTORATION
NEAR SILVER BAY
LAKE COUNTY, MN

DRAFT 30% DESIGN - NOT FOR CONSTRUCTION
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DETAIL - BOULDER J-HOOK


CLIFFS
NORTHSHORE MINING CO
10 OUTER DR
SILVER BAY, MN 55614
---
BEAVER RIVER CONSULTING
BEAVER RIVER CONSULTING, LLC.
5752 EAGLE VIEW DRIVE
DULUTH, MN 55803
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CONCEPT DESIGN
NOT FOR
CONSTRUCTION

DATE: 2/07/2020

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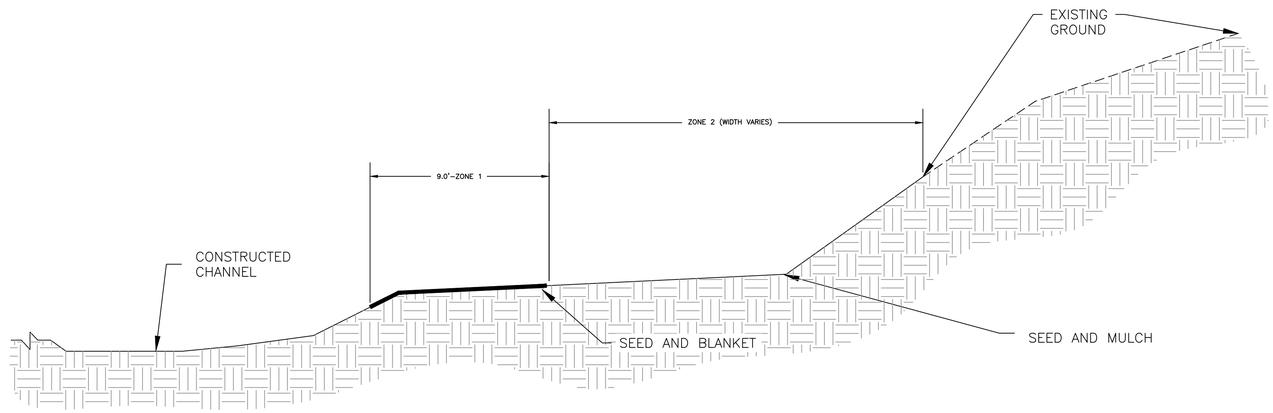
SHEET NUMBER
18 OF 19

E:\DROPBOX (SSSR)\NORTHSHOREMINING\C3D\SHEETS\NORTHSHOREEASTBRANCHMASTERDETAIL.DWG | GREGTAILLACQ | SAVED: Friday, February 7, 2020 1:57:35 PM | ACAD.CTB | | PLOTTED: Friday, February 7, 2020 2:08:37 PM




ZONE PLANTING
TYPICAL CROSS SECTION DETAIL

## ZONE 1

PLANTING AREA-

MIN. 8' WIDE BANKFULL BENCH, IN ADDITION TO 1' INTO CHANNEL.

CANOPY-

THE FOLLOWING CANOPY PLANTS SHALL BE 1.5' HEIGHT CONTAINERIZED STOCK. PLANT AT 12 FOOT SPACING ABOVE BANKFULL ELEVATION:

1. WHITE SPRUCE (PICEA GLAUCA)-90%
2. *WHITE CEDAR (*THUJA OCCIDENTALIS)-10%*

SUB-CANOPY-

THE FOLLOWING SUB-CANOPY PLANTS SHALL BE 1.5' HEIGHT CONTAINERIZED STOCK. PLANT THE FOLLOWING EVERY 8 FOOT SPACING, AT OR ABOVE BANKFULL ELEVATION.

1. BEAKED HAZEL (CORYLUS CORNUTA)-25%
2. MOUNTAIN MAPLE (ACER SPICATUM)-10%
3. SPECKLED ALDER (ALNUS INCANA)-25%
4. RED-OSIER DOGWOOD (CORNUS SERICEA)-40%

TRANSPLANTS:

- TRANSPLANT WILLOW AND DOGWOOD SHRUBS FROM THE EXCAVATED AREA. PLANT AT THE EDGE OF THE BLANKET ON THE STREAM SIDE EVERY 8 FEET IN THE RIFFLES. IF NOT IMMEDIATELY PLANTED, PLACE TEMPORARILY IN SOIL UNTIL PLANTING. SLICE COIR BLANKET TO PLANT TRANSPLANTS.

SEED AND COIR AND BACKER BLANKET

- BLANKET MAIN CHANNEL WITH 9.8' WIDE AND BACKED WITH MN DOT CATEGORY 3N, 2S, EROSION CONTROL BLANKET. INSTALL 2' LONG, 2"X2" WOOD STAKES WITH A ROOFING NAIL AT THE TOP TO SECURE THE BLANKET, INSTALL STAKES EVERY 5' ALONG BLANKET EDGES AND EVERY 5' DOWN THE CENTERLINE OF THE BLANKET.
  SEED WITH MIX NOTED ON THIS DETAIL SHEET WITH 25 LBS/ACRE OF COVER CROP AS APPROVED BY ENGINEER.

## ZONE 2

PLANTING AREA-

LIMITS OF RESTORATION OUTSIDE OF ZONE 1 FLOODPLAIN AREA.

CANOPY

THE FOLLOWING CANOPY PLANTS SHALL BE 1.5' HEIGHT CONTAINERIZED STOCK. PLANT AT 12 FOOT SPACING:

1. WHITE SPRUCE (PICEA GLAUCA) -40%
2. YELLOW BIRCH (BETULA ALLEGHANIENSIS)-10%
3. BUR OAK (*QUERCUS MACROCARPA*)- 10%
4. *WHITE PINE (PINUS STROBUS) -20%
5. PAPER BIRCH (BETULA PAPYRIFERA) -10%
6. SUGAR MAPLE (ACER SACCHARUM)-10%

SUB-CANOPY

THE FOLLOWING SUB-CANOPY PLANTS SHALL BE 1.5' HEIGHT CONTAINERIZED STOCK. PLANT THE FOLLOWING AT 12 FOOT SPACING,

1. CHOKE CHERRY (PRUNIS VIRGINIANA)-20%
2. NANNYBERRY (VIBURNUM LENTAGO)-20%
3. PAGODA DOGWOOD (CORNUS ALTERNIFOLIA)-20%
4. JUNEBERRIES (AMELANCHIER SPP.)-20%
5. BUSH HONEYSUCKLE (DIERVILLA LONICERA)-20%

SEED AND MULCH

- APPLY TYPE 3 MULCH, DISCED IN.
- SEED WITH MIX NOTED ON THIS DETAIL SHEET WITH 25 LBS/ACRE OF COVER CROP AS APPROVED BY ENGINEER.
- SCARIFY SOIL PRIOR TO SEEDING
- TOP DRESS GRAVEL AREAS (AREAS WITH OVER 30 PERCENT GRAVEL MATERIAL) WITH 0.3 FEET OF SOILS EXCAVATED FROM THE FLOODPLAIN AREA SUCH THAT FINE SOILS ARE PRESENT FOR SEED ESTABLISHMENT

## SEED MIX

| GRASS SEED | 15 LBS./ACRE |
|---|---|
| Big bluestem (*Andropogon gerardii*) | 20% |
| Fringed brome (*Bromus ciliatus*) | 8% |
| Blue-joint grass (*Calamagrostis canadensis*) | 2% |
| Caterpillar Sedge (Carex crinita) | 5% |
| Poverty oats (*Danthonia spicata*) | 10% |
| Slender Wheatgrass (*Elymus trachycalum*) | 12% |
| Virginia wild rye (*Elymus virginicus*) | 13% |
| American manna (Glyceria grandis) | 10% |
| Fowl bluegrass (Poa palustris) | 5% |
| Cord grass (*Spartina pectinata*) | 15% |

| **Wildflower Seed** | **32oz. /acre** |
|---|---|
| Yarrow (*Achillea millefolium*) | 2% |
| Fragrant giant hyssop (*Agastache foeniculum* | *10%* |
| Swamp milkweed (*Asclepias incarnata*) | 10% |
| Common milkweed (*Asclepias syriaca*) | 10% |
| Fireweed (*Epilobium angustifolium*) | 2% |
| Boneset (*Eupatorium perfoliatum*) | 8% |
| Joe-Pye weed (*Eutrochium maculatum*) | 5% |
| Common ox-eye (*Heliopsis helianthoides*) | 5% |
| Wild bergamot (*Monarda fistulosa*) | 10% |
| Black-eyed Susan (*Rudbeckia hirta*) | 5% |
| Stiff goldenrod (*Solidago rigida*) | 7% |
| Blue vervain (*Verbena hastata*) | 20% |
| Golden alexanders (*Zizia aurea*) | 6% |

## ZONE 3

SEED AND MULCH
SEED EXPOSED SOILS WITH SEED MIX NOTED ON THIS SHEET ALONG WITH 25 LBS/ACRE OF COVER CROP AS APPROVED BY ENGINEER.

TREE PROTECTION:

* SPECIES THAT REQUIRE 6' HIGH X 3.0' DIAMETER FENCING WITH 2 T-POSTS PLACED ON THE UPSTREAM SIDE OF THE TREE CAGE

APPROVED BY: KA | CHECKED BY: MJG | DRAWN BY: GET

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| 1 | DRAFT 30% DESIGN | XX |
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EAST BRANCH BEAVER RIVER
STREAM RESTORATION
NEAR SILVER BAY
LAKE COUNTY, MN

DRAFT 30% DESIGN - NOT FOR CONSTRUCTION
---
DETAIL - PLANTING

CLIFFS

NORTHSHORE MINING CO
10 OUTER DR
SILVER BAY, MN 55614
---

BEAVER RIVER CONSULTING

BEAVER RIVER CONSULTING, LLC.
5752 EAGLE VIEW DRIVE
DULUTH, MN 55803
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CONCEPT DESIGN
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DATE: 2/07/2020

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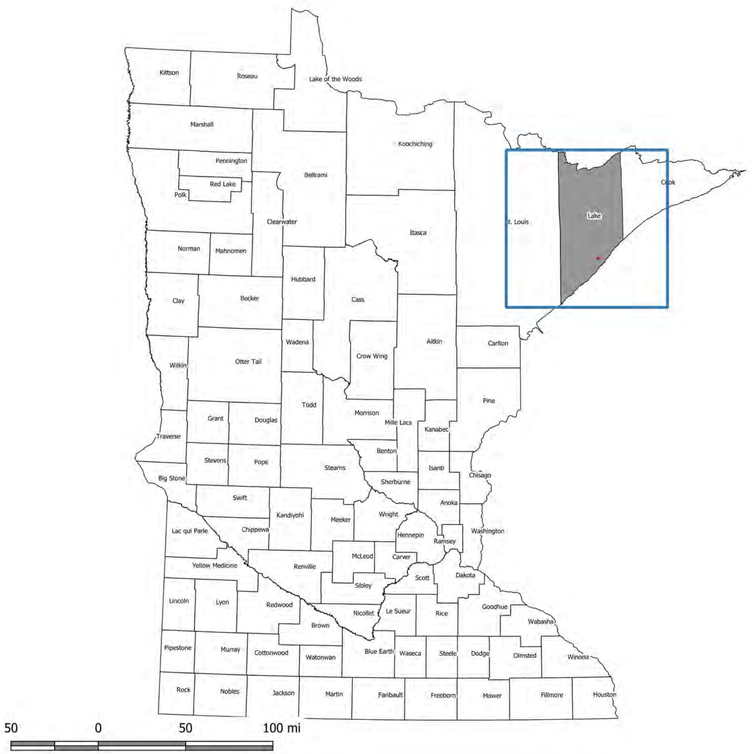
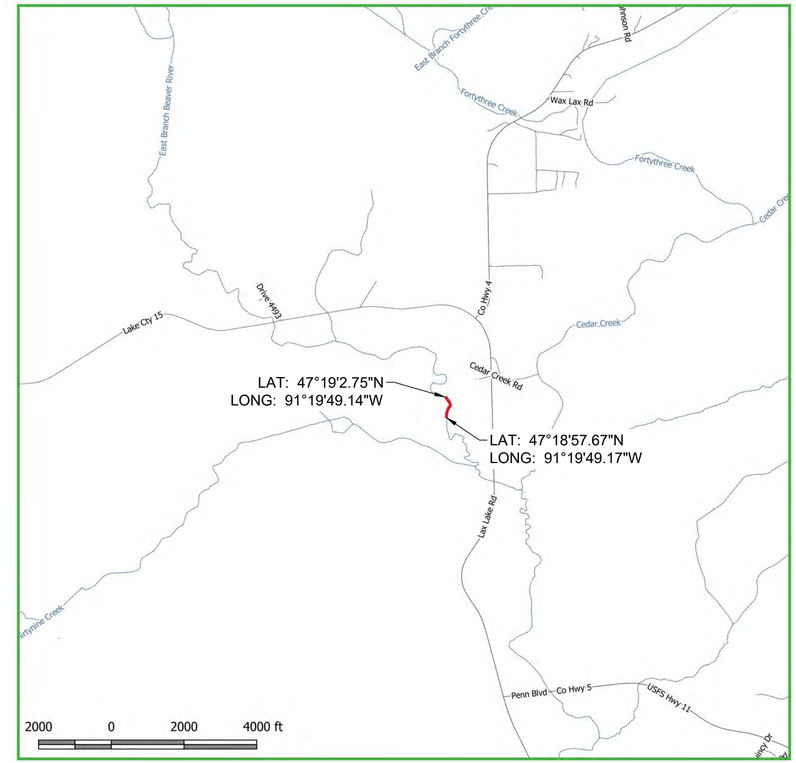
# DRAFT 30% DESIGN - NOT FOR CONSTRUCTION
# EAST BRANCH
# CULVERT INSTALLATION

NEAR SILVER BAY
LAKE COUNTY, MN
3/03/2020






| Sheet List Table | | | |
|---|---|---|---|
| SHEET # | SHEET TITLE | DRAWING TITLE | REVISION DATE |
| 1 | COVER | eastBranchCulvertCoverNotes.dwg | Tuesday, March 3, 2020 10:35:57 AM |
| 2 | NOTES | eastBranchCulvertCoverNotes.dwg | Tuesday, March 3, 2020 10:35:57 AM |
| 3 | EAST BRANCH CULVERT PP - (1) | eastBranchCulvert_pp.dwg | Wednesday, February 26, 2020 12:51:35 PM |
| 4 | DTL - BOULDER CONSTRUCTED RIFFLE | eastBranchCulvert_details.dwg | Monday, February 24, 2020 4:09:06 PM |
| 5 | DTL - EAST BRANCH CULVERT | eastBranchCulvert_details.dwg | Monday, February 24, 2020 4:09:06 PM |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BEAVER RIVER CONSULTING, LLC.
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DULUTH, MN 55803


FOR REVIEW ONLY
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CONSTRUCTION

NOTES:

GENERAL CONSTRUCTION NOTES:

1. THE WORK ON THIS PROJECT SHALL ADHERE TO THE FOLLOWING SPECIFICATIONS, STANDARDS AND/OR REGULATIONS: MN DOT STANDARD SPECIFICATIONS FOR CONSTRUCTION, 2016 EDITION, THE FOLLOWING SPECIFICATIONS EITHER MODIFY OR REPLACE APPROPRIATE MN DOT SPECIFICATIONS.
2. INSTREAM STRUCTURES SHALL BE INSTALLED AS THE CHANNEL IS BEING CONSTRUCTED AND NOT POST CONSTRUCTION. FILTER FABRIC INSTALLED AS PART OF THE INSTREAM STRUCTURE SHALL BE MIRAFI 170N SERIES NONWOVEN GEOTEXTILE, OR ENGINEER'S APPROVED ALTERNATIVE, UNLESS OTHERWISE SPECIFIED IN STRUCTURE DETAILS OR SPECIFICATIONS.
3. WHERE PRACTICABLE, EXISTING TREES AND VEGETATION SHOULD BE LEFT IN PLACE TO FACILITATE NATURAL REGENERATION AND SOIL STABILIZATION.
4. DEFINITIONS:
   A. BANKFULL ELEVATION IS THE POINT OF INCIPIENT FLOODING IN AN ALLUVIAL CHANNEL. THIS ELEVATION IS THE REFERENCE FOR DEPTHS ON OR ALONG THE CHANNEL PROFILE AND STRUCTURES DESCRIBED IN THESE SHEETS.
   B. THE BANKFULL BENCH IS A CONSTRUCTED FLOODPLAIN ADJACENT TO THE CHANNEL. THE BANKFULL BENCH IS CONSTRUCTED AT THE BANKFULL ELEVATION.
   C. THE THALWEG IS THE LOWEST PORTION OF THE CHANNEL.
   D. THE VANE LENGTH IS THE STRAIGHT LINE DISTANCE BETWEEN THE VANE ARM AND A LINE TANGENT TO THE STREAMBANK AT THE POINT WHERE THE VANE ARM INTERSECTS THE STREAMBANK.
   E. THE VANE ANGLE IS THE ANGLE BETWEEN THE VANE ARM AND A LINE TANGENT TO THE STREAMBANK AT THE POINT WHERE THE VANE ARM INTERSECTS THE STREAMBANK.
   F. SOD MATS ARE GRASS AND WILLOW TRANSPLANTS THAT STILL CONTAIN ROOTING DEPTH. APPROXIMATELY 9-12IN OF DEPTH WILL BE NEEDED WHEN HARVESTING THE SOD MATS.
6. THE CONTRACTOR SHALL STAKE OUT THE PROPOSED STREAM CENTERLINE FOR REVIEW BY THE ENGINEER BEFORE INITIATING EXCAVATION. DEPENDING ON ENCOUNTERED CONDITIONS SOME SHIFTING OF THE STREAM CHANNEL MAY BE NECESSARY. ANY COST ASSOCIATED WITH CHANGING STRUCTURE LOCATIONS OR ALIGNMENT SHALL BE CONSIDERED INCIDENTAL TO CONSTRUCTION. STAKING MAY BE OMITTED FOR PORTIONS OF THE STREAM WHEN SURVEY-GRADE GPS IS USED TO CONSTRUCT THE CHANNEL. IF GPS IS USED IN LIEU OF STAKING THE CHANNEL IN THE FIELD, THE CONTRACTOR ASSUMES ALL RESPONSIBILITY FOR THE STREAM BEING CONSTRUCTED AS DESIGNED, INCLUDING ANY ISSUES RELATED TO PROJECTIONS, BASE POINTS OR CONVERSION OF DIGITAL TERRAIN MODELS.
7. PRIOR TO CLEARING AND GRUBBING, CONTRACTOR SHALL MARK THE LIMITS OF CLEARING NEAR TREES FOR VERIFICATION OF INTENT BY THE ENGINEER. SOME MINOR ADJUSTMENT OF CHANNEL ALIGNMENT MAY BE REQUIRED TO PRESERVE TREES OR MINIMIZE IMPACT TO TREES.
8. ANY HARVESTING OF WILLOWS AND SOD FROM ONSITE MUST BE APPROVED BY THE ENGINEER.
9. CONTRACTOR SHALL MINIMIZE, TO THE MAXIMUM EXTENT POSSIBLE, IMPACTS TO THE ADJACENT TREES. CONSTRUCTION EQUIPMENT TRACKS AND PATHWAYS SHALL BE GRADED AND RECONTOURED AFTER CONSTRUCTION TO PREVENT RILL AND GULLY EROSION.
10. THE PROPOSED GRADING IS SHOWN ON THESE PLAN SHEETS. THE CONTRACTOR MAY EXTEND THE LIMITS OF DISTURBANCE ONLY WITH THE APPROVAL OF THE ENGINEER.
11. CONTRACTOR SHALL USE AN EXCAVATOR WITH A HYDRAULIC THUMB TO INSTALL INSTREAM STRUCTURES.
12. CHANNEL RELOCATION WORK SHALL BE COMPLETED AND STABILIZED PRIOR TO ALLOWING FLOW TO ENTER INTO THE NEWLY CONSTRUCTED STREAM CHANNEL. THE CONTRACTOR SHALL NOT OPEN UP MORE THAN 200 FEET OF CHANNEL WITHOUT EROSION CONTROL BLANKET IN PLACE OR BY APPROVAL OF THE ENGINEER.
13. THE PROPOSED STREAM CHANNEL SHALL BE CONSTRUCTED BY FIRST GRADING THE FLOODPLAIN ADJACENT TO THE CHANNEL TO THE ELEVATION INDICATED ON THESE PLANS. THIS MAY BE DONE AS GENERAL EXCAVATION. THE PROPOSED STREAM CHANNEL SHALL THEN BE EXCAVATED TO THE PROPER DEPTHS INDICATED ON THE PROFILE AND PROPOSED CONTOURS. THIS SHALL BE DONE AS SPECIALIZED EXCAVATION AND IS TYPICALLY ACCOMPLISHED WITH A TRACK EXCAVATOR. THE PROFILES AND CONTOURS SHOWN PROVIDE WIDTHS AND SLOPES FOR AID IN CONSTRUCTING THE CHANNEL TO THE APPROPRIATE DIMENSIONS. THE THALWEG CAN FIRST BE EXCAVATED TO THE POINT INDICATED ON THE PROFILE. EXCAVATION AND FINE GRADING OF THE CROSS SECTIONS SHALL THEN BE PERFORMED AS SHOWN ON THE TYPICAL CROSS SECTIONS AND PROPOSED CONTOURS. ANY STOCKPILING OF MATERIALS OR “DOUBLE HANDLING” NECESSARY TO BUILD THE CHANNEL SHALL BE CONSIDERED INCIDENTAL TO CONSTRUCTION.
14. IF THE EXISTING GROUND IS LESS THAN 0.2 FEET HIGHER THAN THE PROPOSED BANKFULL ELEVATION, IT IS NOT NECESSARY TO EXCAVATE MATERIAL TO THE PROPOSED ELEVATION SHOWN ON THE PROFILE.
15. THE SURFACE OF ALL INSTREAM STRUCTURES SHALL BE FINISHED TO A SMOOTH LINE IN ACCORDANCE WITH THE LINES, GRADES, AND CROSS SECTIONS OR ELEVATIONS SHOWN ON THE DRAWINGS. THE DEGREE OF FINISH FOR THE VANE SLOPES AND INVERT ELEVATIONS SHALL BE WITHIN 0.1 VERTICAL FEET OF THE GRADES AND ELEVATIONS INDICATED. ALL GAPS OR VOIDS BETWEEN THE ROCKS SHALL BE PLUGGED WITH SMALL GRAVEL TO FORM A TIGHT-FITTING SEAL.
16. CONSTRUCTION SPECIFICATIONS FOR BANKFULL CHANNEL DIMENSIONS OR CROSS SECTIONS WILL BE HELD TO THE DIMENSIONS SHOWN ON THE TYPICAL CROSS SECTIONS. ELEVATIONS SHALL BE CONSTRUCTED WITHIN 0.1 VERTICAL FEET; WIDTHS AND MEAN DEPTHS MUST FALL WITHIN THE RANGES SHOWN IN THE DRAWINGS.
17. THE IN-STRUCTURE BID ITEMS SHALL INCLUDE ALL LABOR AND MATERIALS NECESSARY TO CONSTRUCT THE STRUCTURE. BID ITEMS INCLUDE SEEDING, PLANTING, AND MULCH AND EROSION CONTROL BLANKETS AND INCLUDE ALL LABOR AND MATERIALS NECESSARY TO STABILIZE AREAS DISTURBED DURING CONSTRUCTION OF STRUCTURES. AFTER THE STRUCTURE IS COMPLETE AND FLOW IS RESTORED TO THE CHANNEL, SOME ADJUSTMENT TO THE STRUCTURE OR ADDITIONAL STABILIZATION MEASURES MAY BE NECESSARY TO ACHIEVE DESIRED EFFECT. ANY COSTS ASSOCIATED WITH THESE ADJUSTMENTS SHALL BE CONSIDERED INCIDENTAL TO CONSTRUCTION.
18. THE CONSTRUCTED STREAM CHANNEL SHALL BE STABILIZED AS SOON AS POSSIBLE BY SEEDING IN ACCORDANCE WITH THE PLOT SCHEDULE, ADDING STRAW MULCH TO BARE SOIL, AND BY INSTALLING EROSION CONTROL BLANKET FROM THE INNER BERM TO BEYOND THE TOP OF THE BANKFULL CHANNEL. SEE EROSION CONTROL BLANKET DETAIL. PRIOR TO INSTALLING BLANKET, PREPARE THE BED BY LOOSENING THE SOIL 3 TO 6 INCHES, APPLY SEED AND THEN STRAW MULCH. SEED SHALL BE BROADCAST EVENLY OVER THE AREA USING A BROADCAST SPREADER PRIOR TO COVERING WITH THE EROSION CONTROL BLANKET. THE BLANKET SHALL BE ROLLED OUT IN THE DIRECTION OF THE ANTICIPATED RUN-OFF FLOW. INSTALL BLANKET IN ACCORDANCE WITH DETAIL SHOWN HEREIN. REWORKING OF AREAS THAT DO NOT ESTABLISH VEGETATION OR BECOME UNSTABLE SHALL BE NECESSARY IF THE EROSION CONTROL BLANKET SEPARATES FROM THE SOIL. SEE SEEDING AND PLANTING DETAIL FOR BLANKET SPECIFIATIONS. SEEDING OF THE BANKFULL BENCH SHALL BE IN ACCORDANCE WITH THE PLANTING TABLE. REFER TO CONTROL BLANKET DETAIL FOR PLACEMENT OF EROSION CONTROL BLANKET.
19. IF THE TIMING OF PROJECT IS SUCH THAT RIPARIAN SEED MIX CANNOT BE PLACED IN THE FALL, THEN THE CONTRACTOR SHALL SEED WITH TEMPORARY COVER ACCORDING TO THE EROSION AND SEDIMENT PLAN OR APPROVED BY THE ENGINEER UNTIL RIPARIAN MIX CAN BE SEEDED IN THE SPRING.
20. THE HARVESTING AND INSTALLATION OF LIVE STAKES SHALL BE PERFORMED ONLY DURING THE DORMANT SEASON TYPICALLY BETWEEN NOVEMBER 1 AND APRIL 15. CONTRACTOR SHALL NOTIFY ENGINEER 7 DAYS PRIOR TO HARVESTING TO REVIEW AND APPROVE ALL HARVESTING SITES. UPON APPROVAL BY ENGINEER, THE CONTRACTOR SHALL BE RESPONSIBLE FOR HARVESTING AND TRANSPORTING THE LIVE STAKE CUTTINGS TO THE JOB SITE.
21. LIVE STAKES SHALL BE INSTALLED ALONG THE OUTSIDE MEANDER BEND AND ALONG RIFFLES WHERE INDICATED ON THE DRAWINGS AND DETAILS. LIVE STAKES SHALL BE INSTALLED INTO THE EROSION CONTROL BLANKET IN ADDITION TO THE DEAD STAKES.
22. EXCESS SPOIL MATERIAL MAY BE SPREAD AND GRADED ONSITE OR IN THE ONSITE PIT AS APPROVED BY THE ENGINEER. PLACEMENT OF ANY ON-SITE OR OFF-SITE SPOIL MATERIAL SHALL BE CONSIDERED INCIDENTAL TO CONSTRUCTION.
23. TOPSOIL SHALL BE REMOVED FROM EXCAVATION AND SPOIL AREAS PRIOR TO CUT OR FILL AND RE-APPLIED TO AREAS AFTER ROUGH GRADING IS COMPLETE. SIX INCHES OF TOPSOIL SHALL BE PLACED ON DISTURBED AREAS TO MEET GRADE. STOCKPILING AND PLACEMENT OF TOPSOIL SHALL BE CONSIDERED INCIDENTAL TO CONSTRUCTION AND APPROVED BY THE ENGINEER.
24. SPOIL AREAS SHALL BE SEEDED WITH TEMPORARY VEGETATION WITHIN 7 DAYS FOLLOWING GRADING.
25. THE PLACEMENT OF STRAW MULCH SHALL OCCUR A MAXIMUM 48 HOURS AFTER SEEDING. MULCH WILL BE SPREAD TO COVER THE INSTALLED AREAS AT A MINIMUM RATE OF 1.5 TONS PER ACRE. MULCH SHALL BE KEPT OUT OF THE CROWNS OF SHRUBS AND GROUND COVER.
26. IF SOFT SOILS ARE ENCOUNTERED WHEN RECONSTRUCTING STREAM BANKS, RESTORE BANK WITH SOD MAT COVERING ALONG RIFFLES AND WOOD TOE SOD MAT ALONG BENDS.
27. CONTRACTOR SHALL CALL GOPHER STATE ONE CALL FOR UTILITY MARKING AT LEAST 48 HOURS PRIOR TO START OF CONSTRUCTION. THE LOCATIONS OF THE UTILITIES SHOWN ON THESE DRAWINGS ARE APPROXIMATE ONLY (UTILITY QUALITY LEVEL D) AND MAY NOT BE ACCURATE. LOCATING UTILITIES IS THE SOLE RESPONSIBILITY OF THE CONTRACTOR. THE ENGINEER AND PROJECT OWNER WILL NOT BE RESPONSIBLE FOR ANY DAMAGES TO UTILITIES.
28. CONTRACTOR SHALL UTILIZE NATIVE MATERIAL FROM THE SITE WHERE AVAILABLE AND ALLOWED BY THE ENGINEER. NATIVE MATERIAL THAT CAN BE FOUND ON SITE INCLUDE TREES THAT CAN PROVIDE LIVE STAKES AND TREES THAT CAN BE USED FOR LOG STRUCTURES AND WOOD DEBRIS.
29. AFTER CONSTRUCTION, THE ACCESS ROADS LEADING TO THE PROJECT SITE SHALL BE RESTORED TO AS GOOD OR BETTER CONDITION THAN BEFORE CONSTRUCTION AT THE ENGINEER'S DISCRETION.
30. FOOTER DEPTH ON ALL STRUCTURES REQUIRING FOOTERS SHALL BE AT LEAST 6 TIMES GREATER THAN THE DROP BETWEEN THE STRUCTURE AND THE FOOTERED STRUCTURE DIRECTLY UPSTREAM OR APPROVED BY THE ONSITE ENGINEER.

EROSION/SEDIMENTATION CONTROL NOTES:

1. ALL CONTROL MEASURES SHALL BE CHECKED, AND REPAIRED AS NECESSARY, MONTHLY IN DRY PERIODS, AND WITHIN 24 HOURS AFTER ANY RAINFALL AT THE SITE OF .75 INCHES OR GREATER WITHIN A 24 HOUR PERIOD. DAILY CHECKING AND, IF NECESSARY, REPAIRING SHALL BE DONE DURING PROLONGED RAINFALLS. THE PERMITTEE SHALL MAINTAIN WRITTEN RECORDS OF SUCH CHECKS AND REPAIRS ON-SITE AT ALL TIMES, AND RECORDS SHALL BE SUBJECT TO INSPECTION AT ANY REASONABLE TIME.
2. THE CONSTRUCTION ACCESS POINTS SHALL BE MAINTAINED AS REQUIRED TO PREVENT SILT/SEDIMENT FROM LEAVING THE SITE. THIS INCLUDES BUT IS NOT LIMITED TO WASH DOWN OF THE CONSTRUCTION ACCESS POINTS, INSTALLING AND UTILIZING A VEHICLE WASH DOWN AREA, INSTALLING ADDITIONAL STONE, ETC.
3. ANY AND ALL SILT/SEDIMENTATION SHALL BE FREQUENTLY REMOVED FROM THE SILT FENCE, DITCHES, CHECK DAMS AND RETENTION AREAS. AT THE END OF CONSTRUCTION, THESE AREAS SHALL BE COMPLETELY FREE OF SILT/SEDIMENTATION AND SHALL BE STABILIZED AS STATED IN THE PLANS AND SPECIFICATIONS.
4. ALL BMPS SHALL BE DESIGNED AND INSTALLED IN ACCORDANCE WITH THE MINNESOTA POLLUTION CONTROL AGENCY (MPCA) CONSTRUCTION OF GENERAL PERMITS FOR STORMWATER CONTROL. IF CONFLICTS ARISE BETWEEN THESE REQUIREMENTS, THE MORE STRINGENT SHALL APPLY.
5. BMPS SHOWN ALONG THE PERIMETER OF THE DISTURBED AREAS SHALL BE INSTALLED PRIOR TO DISTURBANCE ACTIVITY. OTHER BMPS SHALL BE INSTALLED AS SOON AS CONSTRUCTION SEQUENCES ALLOW.
6. TEMPORARY DIVERSION OF RUNOFF/RUNON WATER SHALL BE INSTALLED AS NEEDED TO FACILITATE CONSTRUCTION OR AS DIRECTED ON-SITE BY THE ENGINEER.
7. ALL DISTURBED AREAS SHALL BE PERMANENTLY STABILIZED IMMEDIATELY AFTER THE COMPLETION OF THE GRADING OPERATION. AREAS REQUIRING COCONUT COIR MATTING SHALL BE SEEDED AND MULCHED FOR STABILIZATION PRIOR TO THE INSTALLATION OF THE MATTING.
8. TEMPORARY STABILIZATION OF DISTURBED AREAS MUST BE INITIATED IMMEDIATELY WHENEVER WORK TOWARD PROJECT COMPLETION AND FINAL STABILIZATION OF ANY PORTION OF THE SITE HAS TEMPORARILY CEASED AND WILL NOT RESUME FOR A PERIOD EXCEEDING THIRTEEN (7) CALENDAR DAYS. THOSE AREAS SHALL BE SEEDED AND MULCHED IN ACCORDANCE WITH THE PLANS AND SPECIFICATIONS.
9. NECESSARY MEASURES SHALL BE TAKEN TO PRODUCE AND MAINTAIN AN ACCEPTABLE STAND OF GRASS. SAID MEASURES TO INCLUDE (BUT NOT LIMITED TO) WATERING, RE-SEEDING, REGRADING ERODED AREAS, RE-FERTILIZING, ETC.
10. CONTRACTOR IS RESPONSIBLE FOR KEEPING MUD AND DEBRIS OFF CITY/STATE STREETS AND ROW. CLEANUP IS REQUIRED DAILY.
11. CONTRACTOR SHALL KEEP A COPY OF THE NPDES CONSTRUCTION GENERAL PERMIT AND THE "CONSTRUCTION BEST MANAGEMENT PRACTICES PLAN" ON SITE AT ALL TIMES FOR THE LIFE OF THE PROJECT.
12. ALL HAZARDOUS SUBSTANCES USED FOR THIS PROJECT (PAINT, OIL, GREASE, AND OTHER PETROLEUM PRODUCTS) SHALL BE STORED IN ACCORDANCE WITH SPCC REGULATIONS. THESE SUBSTANCES SHALL BE STORED AWAY FROM DRAINS AND DITCHES IN WATERTIGHT CONTAINERS. DISPOSAL OF THESE SUBSTANCES SHALL BE IN ACCORDANCE WITH ADEM REGULATIONS. DAILY INSPECTIONS SHALL BE PERFORMED FOR LEAK DETECTION. IF LEAKS OCCUR, APPROPRIATE ACTION SHALL BE TAKEN TO CONTAIN AND REMEDIATE THE SPILL. ADEQUATE TRASH CONTAINERS SHALL BE KEPT ON SITE FOR THE DISPOSAL OF CONSTRUCTION MATERIALS WASTE. NECESSARY MEASURES SHALL BE TAKEN TO PREVENT ANY TRASH OR OTHER POLLUTANTS FROM ENTERING "WATERS OF THE UNITED STATES."
13. ALL TEMPORARY MEASURES SHALL BE REMOVED ONCE ACCEPTABLE PERMANENT STABILIZATION IS ACHIEVED. THE ENGINEER SHALL DETERMINE IF THE PERMANENT STABILIZATION IS ACCEPTABLE.

SPECIAL NOTES:

THE ELEVATIONS SHOWN HEREIN ARE BASED ON DATA SURVEY THAT ENCOMPASSES THE EXISTING GROUND SURFACE FROM WHICH ALL COMPUTATIONS FOR CUT/FILL ARE BASED. SLIGHT DISCREPANCIES BETWEEN THE EXISTING GROUND DIGITAL SURFACE AND FIELD CONDITIONS CAN RESULT IN SIGNIFICANT VARIATIONS IN TOTAL EXCAVATED QUANTITIES. THUS, THE CONTRACTOR SHALL COMPARE QUANTITIES OF MATERIAL EXCAVATED TO THOSE SHOWN ON THE DRAWINGS TO MANAGE THE MOVEMENT OF MATERIAL ACROSS THE SITE.

TOPOGRAPHIC INFORMATION:

EXISTING GROUND SURFACES ARE BASED ON A SURVEY COMPLETED XXXX BLENDED WITH STATE OF MN LIDAR. BENCHMARKS WERE SET THROUGHOUT THE SITE AND CAN BE PROVIDED AT ANY TIME. CHANGES IN EXISTING SURFACES SHALL BE INCIDENTAL TO CONSTRUCTION.

SPECIAL GRADING NOTE:

THE AGREED UPON INTENT OF THIS GRADING PLAN IS TO MAINTAIN A “LIVE” SURFACE SO THAT ANY CHANGES THAT ARISE DURING CONSTRUCTION CAN BE QUICKLY ENCOMPASSED INTO THE THREE-DIMENSIONAL SURFACE GENERATED DURING THIS DESIGN PROCESS. AS SUCH, FINE TUNING OF THE SURFACE THAT WOULD ELIMINATE THE APPEARANCE OF JAGGED CONTOUR LINES WHERE SLIGHT VARIATIONS BETWEEN THE EXISTING AND PROPOSED SURFACES WAS NOT COMPLETED.

APPROVED BY: KA | CHECKED BY: MJG | DRAWN BY: GET

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EAST BRANCH
CULVERT INSTALLATION
NEAR SILVER BAY
LAKE COUNTY, MN

DRAFT 30% DESIGN - NOT FOR CONSTRUCTION

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GENERAL NOTES

CLIFFS
NORTHSHORE MINING CO
10 OUTER DR
SILVER BAY, MN 55614
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BEAVER RIVER CONSULTING
BEAVER RIVER CONSULTING, LLC.
5752 EAGLE VIEW DRIVE
DULUTH, MN 55803
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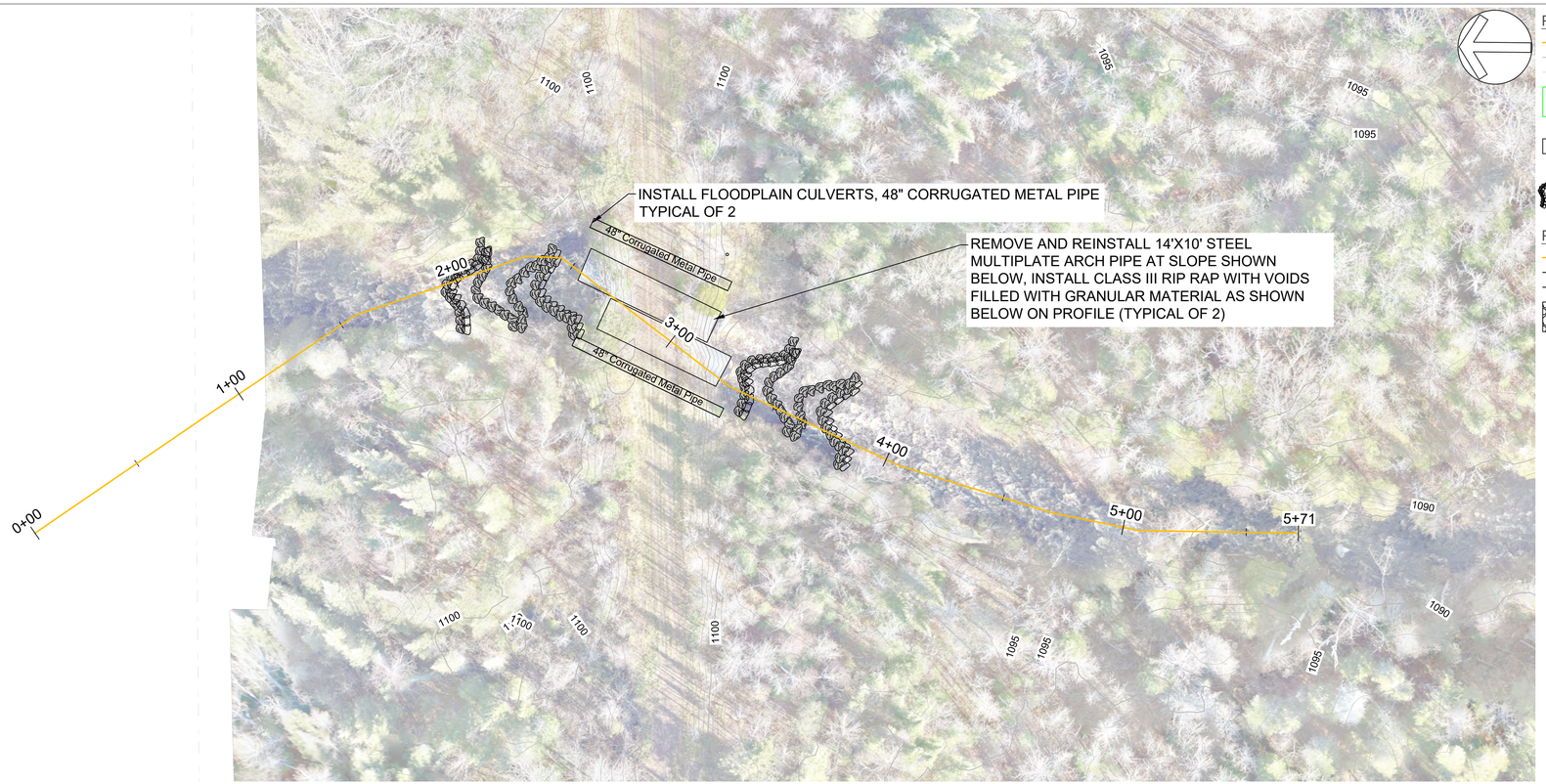
CONCEPT DESIGN
NOT FOR
CONSTRUCTION

DATE: 3/03/2020

SHEET NUMBER
2 OF 5

E:\DROPBOX (SSSR)\NORTHSHOREMINING\C3D\SHEETS\EASTBRANCHCULVERT_COVERNOTES.DWG | GREGTAILLACQ | SAVED: Tuesday, March 3, 2020 10:36:23 AM | ACAD.CTB | | PLOTTED: Tuesday, March 3, 2020 10:36:52 AM

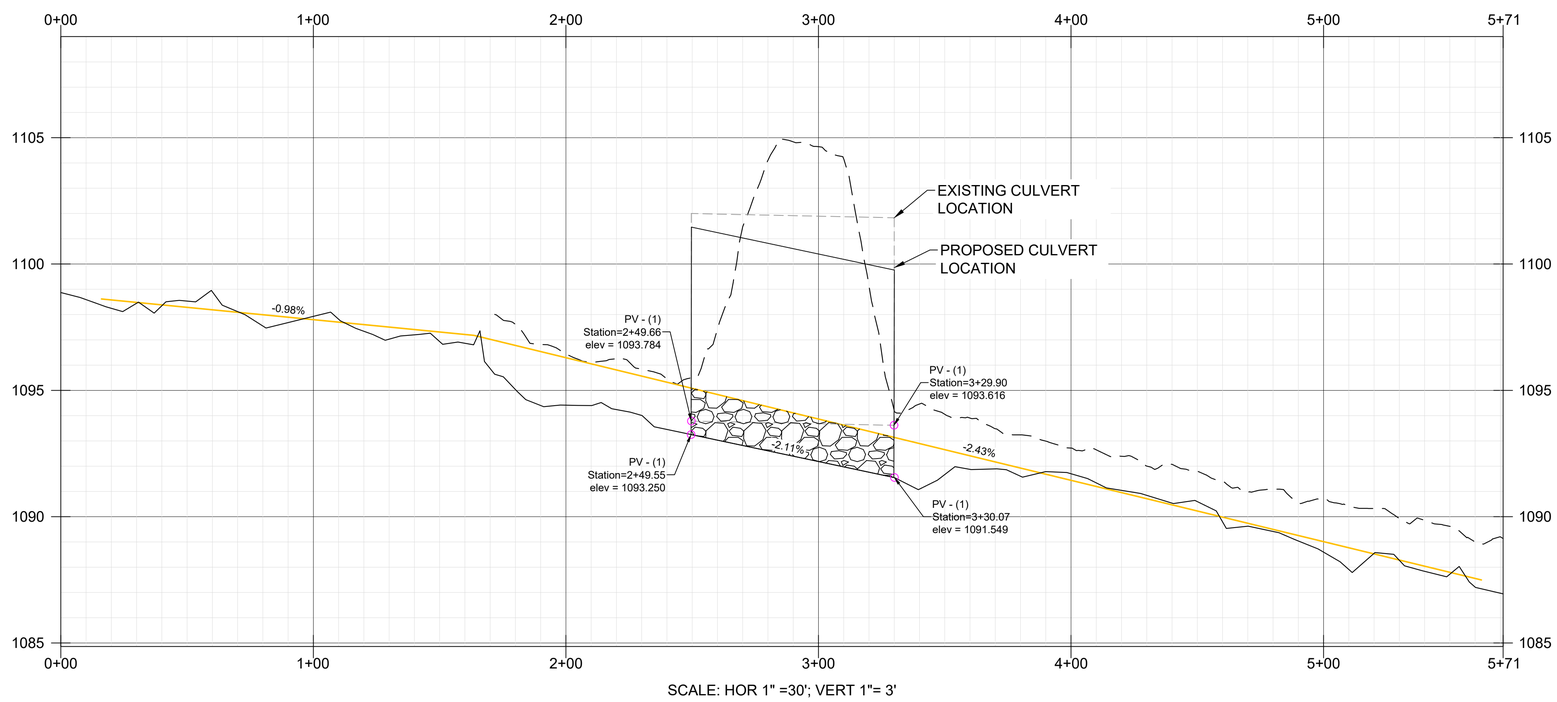



## PLAN LEGEND

- PROPOSED STREAM CENTER LINE
- 479 — EXISTING MAJOR CONTOUR
- EXISTING MINOR CONTOUR
- RELOCATE CULVERT
- FLOODPLAIN CULVERT
- CONSTRUCTED RIFFLE

## PROFILE LEGEND

- PROPOSED STREAM CENTER LINE
- EXISTING GROUND
- EXISTING GROUND - ASSESSMENT
- GRAVEL FILL




SCALE: HOR 1" =30'; VERT 1"= 3'

NOT TO SCALE

| REV | DESCRIPTION | APPROV. | CHECKED BY: MJG | DRAWN BY: GET | APPROVED BY: KA |
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# EAST BRANCH CULVERT INSTALLATION NEAR SILVER BAY LAKE COUNTY, MN

DRAFT 30% DESIGN - NOT FOR CONSTRUCTION

EAST BRANCH CULVERT PLAN AND PROFILE - (1) STA 0+00 TO 5+71

CLIFFS

NORTHSHORE MINING CO
10 OUTER DR
SILVER BAY, MN 55614

BEAVER RIVER CONSULTING

BEAVER RIVER CONSULTING, LLC.
5752 EAGLE VIEW DRIVE
DULUTH, MN 55803

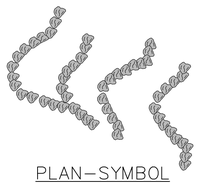
CONCEPT DESIGN NOT FOR CONSTRUCTION

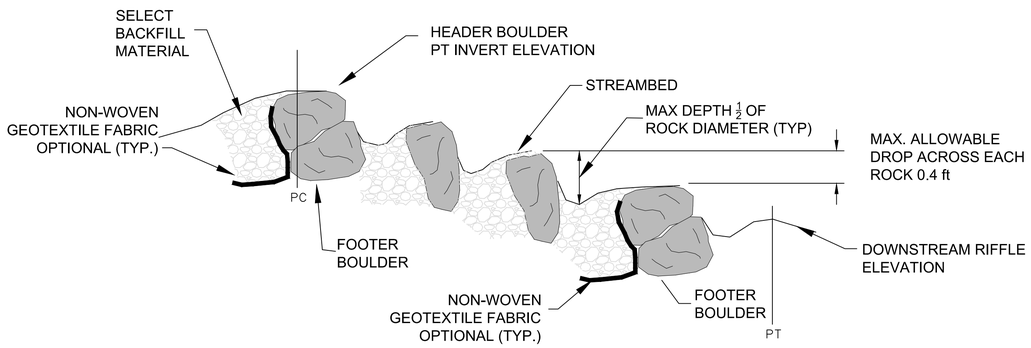
DATE: 3/03/2020
SCALE (34"X22"): 1" = 30'
SCALE (17"X11"): 1" = 60'

0 30 60
SCALE IN FEET

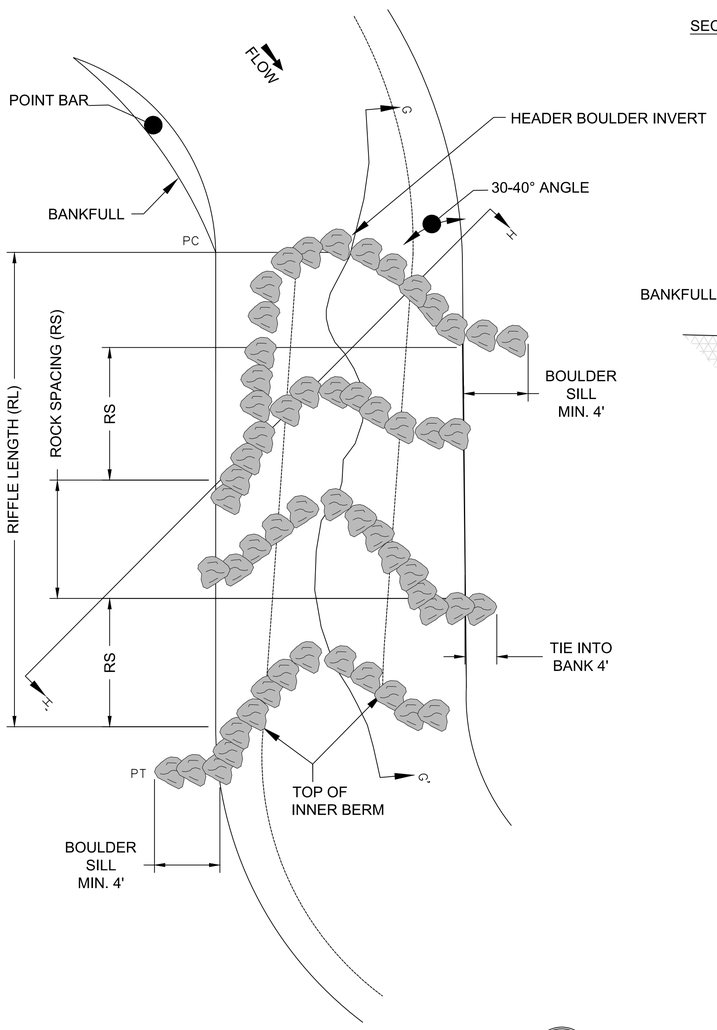
SHEET NUMBER
3 OF 5

E:\DROPBOX (SSSR)\NORTHSHOREMINING\C3D\SHEETS\EASTBRANCHCULVERT_PP.DWG | OWNER | SAVED: Wednesday, February 26, 2020 12:51:35 PM | ACAD.CTB | | PLOTTED: Tuesday, March 3, 2020 10:37:07 AM

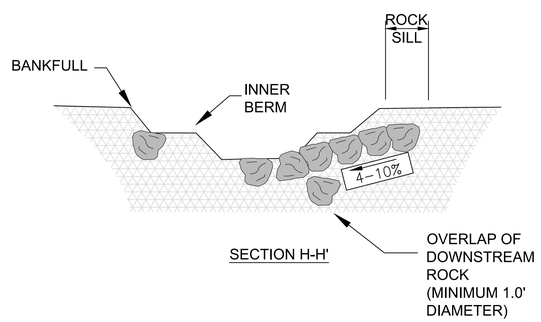



SECTION G-G'




PLAN VIEW




SECTION H-H'

# DETAIL - BOULDER CONSTRUCTED RIFFLE
NOT TO SCALE

BOULDER CONSTRUCTED RIFFLE
CONSTRUCTED MARCH 2019

NOTES:

1. BOULDERS FOR THE CONSTRUCTED RIFFLE MUST BE A MIN. OF 1-2 TON BOULDER WITH A MIN. DIAMETER OF 2-3'.
2. THE UPSTREAM AND DOWNSTREAM HEADER BOULDERS SHALL BE UNDERLAIN BY FOOTER BOULDERS UNLESS OTHERWISE DIRECTED BY THE ENGINEER.
3. HEADER BOULDERS ARE THE TOP MOST BOULDERS USED IN EACH STRUCTURE. HEADER BOULDERS FOR THIS STRUCTURE ARE ONLY VISIBLE BETWEEN THE INNER BERMS.
4. HEADER BOULDERS SHALL BE OFFSET SLIGHTLY UPSTREAM OF THE FOOTER BOULDERS. FOOTER BOULDERS SHALL BE INSTALLED BEFORE THE HEADER BOULDERS.
5. SET INVERTS AT ELEVATION SHOWN ON PLAN AND PROFILE SHEETS. INVERTS AND ELEVATIONS WILL BE PROVIDED TO THE CONTRACTOR AS A 2014 FORMAT DWG FILE. NO ELEVATIONS OF THE CONSTRUCTED RIFFLE ARMS MAY VARY FROM THE PLAN LOCATIONS WITHOUT DIRECTION FROM THE ENGINEER.
6. THE DROP IN ELEVATION ACROSS THE STRUCTURE SHALL NOT EXCEED 0.5FT UNLESS OTHERWISE DIRECTED BY THE ENGINEER.
7. MINI-VANES WILL BE SPACED IN THE RIFFLE AS A FUNCTION OF THE RIFFLE LENGTH.
8. THE MOST UPSTREAM RIFFLE MINI-VANE ARM SHALL BE PLACED SUCH THAT THE BANK TIE-IN IS ON THE SAME SIDE AS THE NEXT UPSTREAM OUTSIDE BEND IN ORDER TO SERVE AS A VANE AND HELP DIRECT STREAM FLOW AWAY FROM THE PREVIOUS OUTSIDE BEND. LOCATION OF ALL RIFFLE VANE ARMS ARE SHOWN ON THE PLAN AND PROFILE SHEETS.
9. THE MOST DOWNSTREAM MINI-VANE ARM SHALL BE PLACED SUCH THAT THE HIGH POINT IS ON THE SAME SIDE AS THE NEXT DOWNSTREAM OUTSIDE BEND IN ORDER TO HELP DIRECT STREAM FLOW FROM THE NEXT OUTSIDE BEND.
10. THE VERTICAL SLOPE OF EACH MINI-VANE ARM SHALL NOT EXCEED 10% UNLESS OTHERWISE DIRECTED BY THE ENGINEER. THE SLOPES WILL BE DICTATED BY THE WIDTH-TO-DEPTH RATIO OF THE REACH, TYPICAL RIFFLE INNER BERM CHANNEL, VERTICAL DROP OVER THE LOG, AND LOG DIAMETER.
11. ALL GAPS/VOIDS LARGER THAN 2" BETWEEN THE HEADER AND FOOTER BOULDERS SHALL BE HAND CHINKED WITH COBBLE AND GRAVEL ON THE UPSTREAM SIDE PRIOR TO PLACEMENT OF THE GEOTEXTILE. ALL CHINKING SHALL BE APPROVED BY THE ENGINEER BEFORE THE MINI-VANES ARE BACKFILLED.
12. THE UPSTREAM SIDE OF THE FIRST AND LAST MINI-VANE ARM REQUIRE A LAYER OF NON-WOVEN GEOTEXTILE FABRIC THAT SHALL BE PLACED AS SHOWN IN THE GEOTEXTILE PLACEMENT DETAIL THE ENTIRE LENGTH OF THE MINI-VANE.
13. BACKFILL VANES WITH SELECT BACKFILL MATERIAL AS SHOWN AND DEFINED IN THE CONSTRUCTED RIFFLE DETAIL. BACKFILL MATERIAL TO HAVE D100 OF 8" AND D50 OF 4".
14. SELECT BACKFILL AND SOIL BACKFILL MATERIAL SHALL BE COMPACTED SUCH THAT FUTURE SETTLEMENT OF THE MATERIAL IS KEPT TO A MINIMUM.
15. THE SURFACE OF THIS STRUCTURE SHALL BE FINISHED TO A SMOOTH AND COMPACT SURFACE IN ACCORDANCE WITH THE LINES, GRADES, AND CROSS-SECTIONS OR ELEVATIONS SHOWN ON THE DRAWINGS. THE DEGREE OF FINISH FOR INVERT ELEVATIONS SHALL BE WITHIN 0.1' OF THE GRADES AND ELEVATIONS INDICATED, PROVIDED ANY HEIGHT DOES NOT EXCEED MAX. ALLOWABLE DROP OF 0.5' FOR THIS STRUCTURE.
16. RE-DRESSING OF CHANNEL AND BANKFULL BENCH/FLOODPLAIN WILL LIKELY BE REQUIRED FOLLOWING INSTALLATION OF IN-STREAM STRUCTURES AND SHALL BE CONSIDERED INCIDENTAL TO CONSTRUCTION.
17. FOOTER DEPTH ON ALL STRUCTURES REQUIRING FOOTERS SHALL BE 6 TIMES GREATER THAN THE DROP BETWEEN THE STRUCTURE AND THE FOOTERED STRUCTURE DIRECTLY UPSTREAM.
18. THE DEPARTURE ANGLE SHOWN ABOVE IS DEPICTED IN SUCH A WAY TO EMPHASIZE DETAIL. ACTUAL DEPARTURE ANGLE SHALL BE AS SHOWN ON THE PLAN AND PROFILE SHEETS WILL BE PROVIDED TO THE CONTRACTOR AS A 2014 FORMAT DWG FILE AND LN3 FILE.

APPROVED BY: KA | CHECKED BY: MJG | DRAWN BY: GET

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EAST BRANCH
CULVERT INSTALLATION
NEAR SILVER BAY
LAKE COUNTY, MN

DRAFT 30% DESIGN - NOT FOR CONSTRUCTION
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DETAIL - BOULDER CONSTRUCTED RIFFLE

CLIFFS

NORTHSHORE MINING CO
10 OUTER DR
SILVER BAY, MN 55614
---

BEAVER RIVER CONSULTING

BEAVER RIVER CONSULTING, LLC.
5752 EAGLE VIEW DRIVE
DULUTH, MN 55803
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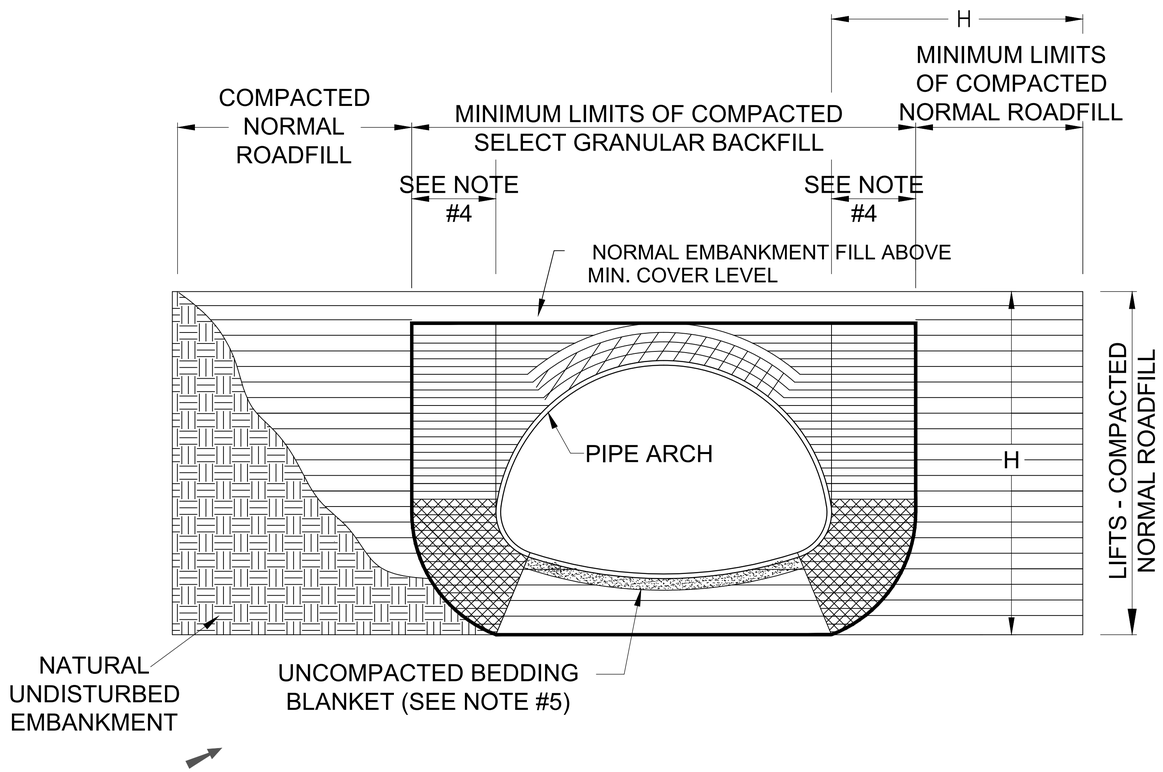
CONCEPT DESIGN
NOT FOR
CONSTRUCTION

DATE: 3/03/2020

NTS

SHEET NUMBER
4 OF 5

E:\DROPBOX (SSSR)\NORTHSHOREMINING\C3D\SHEETS\EASTBRANCHCULVERT_DETAILS.DWG | GREGTAILLACQ | SAVED: Monday, February 24, 2020 4:09:06 PM | ACAD.CTB | | PLOTTED: Tuesday, March 3, 2020 10:37:12 AM




SECTION

CRITICAL BACKFILL ZONE, PRESSURE ON SOIL GREATEST HERE.

INITIAL LIFTS OVER CROWN OF STRUCTURE AS INDICATED BY SHADED AREA TO BE COMPACTED TO REQUIRED DENSITY WITH HAND OPERATED EQUIPMENT OR WITH SMALL TRACTOR (D-4 OR SMALLER) DRAWN EQUIPMENT.

SELECT GRANULAR STRUCTURAL BACKFILL LIMITS.

BEDDING NOTES:

1. ALL SELECT GRANULAR BORROW TO BE PLACED IN A BALANCED FASHION IN THIN LIFTS (6"-8" LOOSE TYPICALLY) AND COMPACTED TO 90 PERCENT DENSITY PER AASHTO T-180.
2. COMPLETE AND REGULAR MONITORING OF THE CSP ARCH SHAPE IS NECESSARY DURING ALL BACKFILLING OF THE STRUCTURE.
3. PREVENT EXCESSIVE DISTORTION OF SHAPE AS NECESSARY BY VARYING COMPACTION METHODS AND EQUIPMENT.
4. THIS WIDTH SHOULD BE EQUAL TO 1/2 SPAN TO ONE SPAN WIDTH TYPICALLY. GREATER OR LESSER DISTANCE MAY BE REQUIRED. DISTANCE DEPENDS ON BEARING LOAD FOR ANY GIVEN LOADING, STRUCTURE SHAPE AND BACKFILL MATERIAL. THIS MUST BE EVALUATED BY THE PROJECT ENGINEER FOR EACH SPECIFIC SITUATION.
5. SHAPED BED FOR A MINIMUM WIDTH OF SPAN/2. MINIMUM BEDDING THICKNESS IS TWICE THE CORRUGATION DEPTH.
6. EMBANKMENT WIDTH H TO BE SUCH THAT A STABLE EMBANKMENT CAPABLE OF RESISTING SIDE PRESSURES FROM CSP PIPE-ARCH SHAPE WILL BE MAINTAINED THROUGHOUT THE LIFE OF INSTALLATION. THIS WIDTH TO BE DETERMINED BY THE PROJECT ENGINEER.

APPROVED BY: KA | CHECKED BY: MJG | DRAWN BY: GET

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EAST BRANCH
CULVERT INSTALLATION
NEAR SILVER BAY
LAKE COUNTY, MN

DRAFT 30% DESIGN - NOT FOR CONSTRUCTION

DETAIL - EAST BRANCH CULVERT

CLIFFS
NORTHSHORE MINING CO
10 OUTER DR
SILVER BAY, MN 55614

BEAVER RIVER CONSULTING
BEAVER RIVER CONSULTING, LLC.
5752 EAGLE VIEW DRIVE
DULUTH, MN 55803

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DATE: 3/03/2020

NTS

SHEET NUMBER
5 OF 5

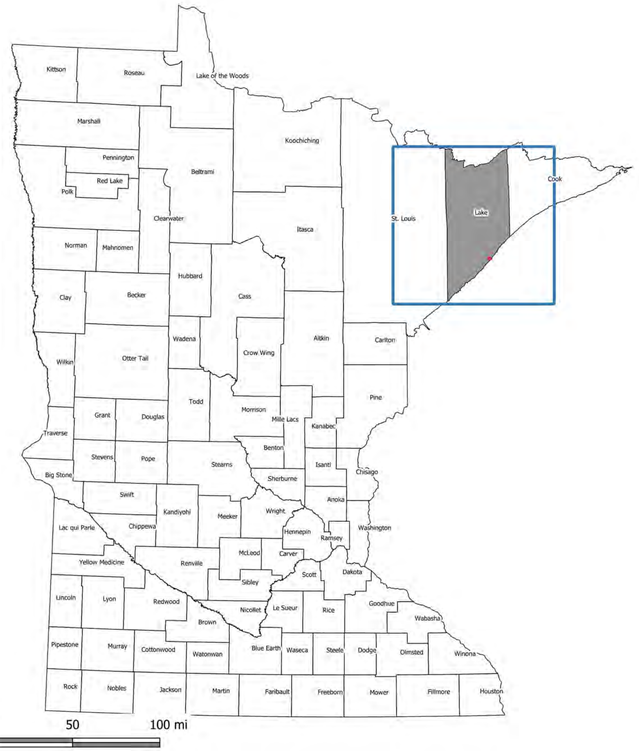
E:\DROPBOX (SSSR)\NORTHSHOREMINING\C3D\SHEETS\EASTBRANCHCULVERT_DETAILS.DWG | GREGTAILLACQ | SAVED: Monday, February 24, 2020 4:09:06 PM | ACAD.CTB | | PLOTTED: Tuesday, March 3, 2020 10:37:13 AM

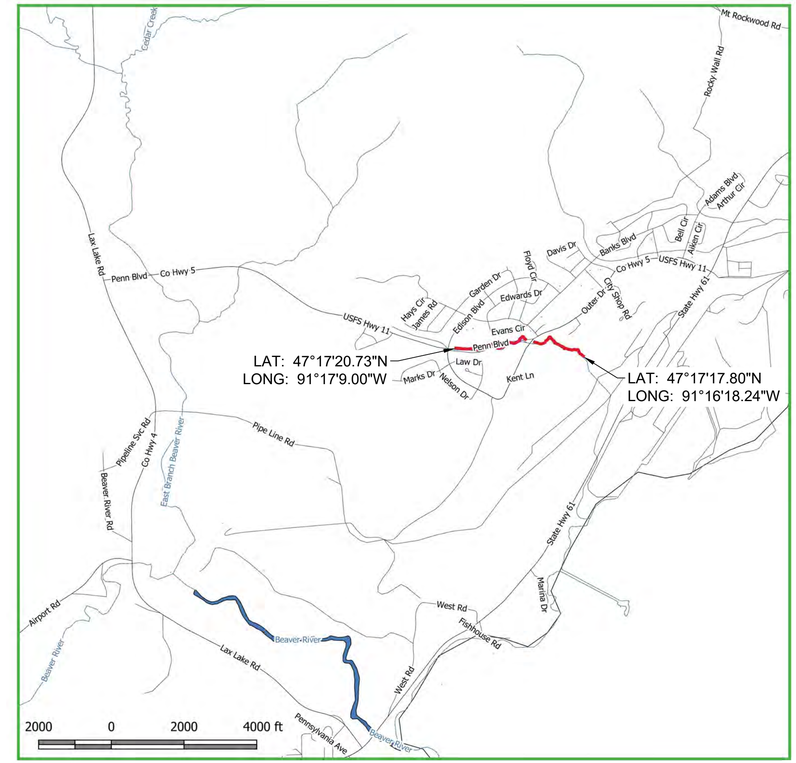
# DRAFT 30% DESIGN - NOT FOR CONSTRUCTION
# WHITE ROCK CREEK
# STREAM RESTORATION

NEAR SILVER BAY

LAKE COUNTY, MN

2/17/2020






CLIFFS

NORTHSHORE MINING CO
10 OUTER DR
SILVER BAY, MN 55614

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DULUTH, MN 55803

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| Sheet List Table | | | |
|---|---|---|---|
| SHEET # | SHEET TITLE | DRAWING TITLE | REVISION DATE |
| 1 | COVER | whiteRockCrCoverNotes.dwg | Monday, February 17, 2020 10:55:59 AM |
| 2 | TOC | whiteRockCrCoverNotes.dwg | Monday, February 17, 2020 10:55:59 AM |
| 3 | NOTES | whiteRockCrCoverNotes.dwg | Monday, February 17, 2020 10:55:59 AM |
| 4 | QUANTITIES | whiteRockCrCoverNotes.dwg | Monday, February 17, 2020 10:55:59 AM |
| 5 | OVERVIEW | whiteRockCr_pp.dwg | Monday, February 17, 2020 10:57:26 AM |
| 6 | White Rock Creek - Upper PP - (1) | whiteRockCr_pp.dwg | Monday, February 17, 2020 10:57:26 AM |
| 7 | White Rock Creek - Upper PP - (2) | whiteRockCr_pp.dwg | Monday, February 17, 2020 10:57:26 AM |
| 8 | White Rock Creek - Upper PP - (3) | whiteRockCr_pp.dwg | Monday, February 17, 2020 10:57:26 AM |
| 9 | White Rock Creek - Upper PP - (4) | whiteRockCr_pp.dwg | Monday, February 17, 2020 10:57:26 AM |
| 10 | White Rock Creek - Upper SECTION - (1) | whiteRockCr_sections.dwg | Friday, February 14, 2020 11:52:03 AM |
| 11 | White Rock Creek - Lower PP - (1) | whiteRockCr_pp.dwg | Monday, February 17, 2020 10:57:26 AM |
| 12 | White Rock Creek - Lower PP - (2) | whiteRockCr_pp.dwg | Monday, February 17, 2020 10:57:26 AM |
| 13 | White Rock Creek - Lower PP - (3) | whiteRockCr_pp.dwg | Monday, February 17, 2020 10:57:26 AM |
| 14 | White Rock Creek - Lower SECTION - (1) | whiteRockCr_sections.dwg | Friday, February 14, 2020 11:52:03 AM |
| 15 | DTL - TOE WOOD | northshoreWhiteRockCrMasterDetail.dwg | Friday, February 14, 2020 11:50:22 AM |
| 16 | DTL - AUGMENTED RIFFLE | northshoreWhiteRockCrMasterDetail.dwg | Friday, February 14, 2020 11:50:22 AM |
| 17 | DTL - BOULDER CONSTRUCTED RIFFLE | northshoreWhiteRockCrMasterDetail.dwg | Friday, February 14, 2020 11:50:22 AM |
| 18 | DTL - LOG CONSTRUCTED RIFFLE | northshoreWhiteRockCrMasterDetail.dwg | Friday, February 14, 2020 11:50:22 AM |
| 19 | DTL - ROCK STEP | northshoreWhiteRockCrMasterDetail.dwg | Friday, February 14, 2020 11:50:22 AM |
| 20 | DTL - PLANTING | northshoreWhiteRockCrMasterDetail.dwg | Friday, February 14, 2020 11:50:22 AM |

APPROVED BY: KA | CHECKED BY: MJG | DRAWN BY: GET

| REV | DESCRIPTION | APPRV |
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WHITE ROCK CREEK
STREAM RESTORATION
NEAR SILVER BAY
LAKE COUNTY, MN

DRAFT 30% DESIGN - NOT FOR CONSTRUCTION
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TABLE OF CONTENTS

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E:\DROPBOX (SSSR)\NORTHSHOREMINING\C3D\SHEETS\WHITEROCKCRCOVERNOTES.DWG | GREGTAILLACQ | SAVED: Monday, February 17, 2020 10:58:05 AM | ACAD.CTB | | PLOTTED: Monday, February 17, 2020 10:58:32 AM

NOTES:

GENERAL CONSTRUCTION NOTES:

1. THE WORK ON THIS PROJECT SHALL ADHERE TO THE FOLLOWING SPECIFICATIONS, STANDARDS AND/OR REGULATIONS: MN DOT STANDARD SPECIFICATIONS FOR CONSTRUCTION, 2016 EDITION, THE FOLLOWING SPECIFICATIONS EITHER MODIFY OR REPLACE APPROPRIATE MN DOT SPECIFICATIONS.
2. INSTREAM STRUCTURES SHALL BE INSTALLED AS THE CHANNEL IS BEING CONSTRUCTED AND NOT POST CONSTRUCTION. FILTER FABRIC INSTALLED AS PART OF THE INSTREAM STRUCTURE SHALL BE MIRAFI 170N SERIES NONWOVEN GEOTEXTILE, OR ENGINEER'S APPROVED ALTERNATIVE, UNLESS OTHERWISE SPECIFIED IN STRUCTURE DETAILS OR SPECIFICATIONS.
3. WHERE PRACTICABLE, EXISTING TREES AND VEGETATION SHOULD BE LEFT IN PLACE TO FACILITATE NATURAL REGENERATION AND SOIL STABILIZATION.
4. DEFINITIONS:
   A. BANKFULL ELEVATION IS THE POINT OF INCIPIENT FLOODING IN AN ALLUVIAL CHANNEL. THIS ELEVATION IS THE REFERENCE FOR DEPTHS ON OR ALONG THE CHANNEL PROFILE AND STRUCTURES DESCRIBED IN THESE SHEETS.
   B. THE BANKFULL BENCH IS A CONSTRUCTED FLOODPLAIN ADJACENT TO THE CHANNEL. THE BANKFULL BENCH IS CONSTRUCTED AT THE BANKFULL ELEVATION.
   C. THE THALWEG IS THE LOWEST PORTION OF THE CHANNEL.
   D. THE VANE LENGTH IS THE STRAIGHT LINE DISTANCE BETWEEN THE VANE ARM AND A LINE TANGENT TO THE STREAMBANK AT THE POINT WHERE THE VANE ARM INTERSECTS THE STREAMBANK.
   E. THE VANE ANGLE IS THE ANGLE BETWEEN THE VANE ARM AND A LINE TANGENT TO THE STREAMBANK AT THE POINT WHERE THE VANE ARM INTERSECTS THE STREAMBANK.
   F. SOD MATS ARE GRASS AND WILLOW TRANSPLANTS THAT STILL CONTAIN ROOTING DEPTH. APPROXIMATELY 9-12IN OF DEPTH WILL BE NEEDED WHEN HARVESTING THE SOD MATS.
6. THE CONTRACTOR SHALL STAKE OUT THE PROPOSED STREAM CENTERLINE FOR REVIEW BY THE ENGINEER BEFORE INITIATING EXCAVATION. DEPENDING ON ENCOUNTERED CONDITIONS SOME SHIFTING OF THE STREAM CHANNEL MAY BE NECESSARY. ANY COST ASSOCIATED WITH CHANGING STRUCTURE LOCATIONS OR ALIGNMENT SHALL BE CONSIDERED INCIDENTAL TO CONSTRUCTION. STAKING MAY BE OMITTED FOR PORTIONS OF THE STREAM WHEN SURVEY-GRADE GPS IS USED TO CONSTRUCT THE CHANNEL. IF GPS IS USED IN LIEU OF STAKING THE CHANNEL IN THE FIELD, THE CONTRACTOR ASSUMES ALL RESPONSIBILITY FOR THE STREAM BEING CONSTRUCTED AS DESIGNED, INCLUDING ANY ISSUES RELATED TO PROJECTIONS, BASE POINTS OR CONVERSION OF DIGITAL TERRAIN MODELS.
7. PRIOR TO CLEARING AND GRUBBING, CONTRACTOR SHALL MARK THE LIMITS OF CLEARING NEAR TREES FOR VERIFICATION OF INTENT BY THE ENGINEER. SOME MINOR ADJUSTMENT OF CHANNEL ALIGNMENT MAY BE REQUIRED TO PRESERVE TREES OR MINIMIZE IMPACT TO TREES.
8. ANY HARVESTING OF WILLOWS AND SOD FROM ONSITE MUST BE APPROVED BY THE ENGINEER.
9. CONTRACTOR SHALL MINIMIZE, TO THE MAXIMUM EXTENT POSSIBLE, IMPACTS TO THE ADJACENT TREES. CONSTRUCTION EQUIPMENT TRACKS AND PATHWAYS SHALL BE GRADED AND RECONTOURED AFTER CONSTRUCTION TO PREVENT RILL AND GULLY EROSION.
10. THE PROPOSED GRADING IS SHOWN ON THESE PLAN SHEETS. THE CONTRACTOR MAY EXTEND THE LIMITS OF DISTURBANCE ONLY WITH THE APPROVAL OF THE ENGINEER.
11. CONTRACTOR SHALL USE AN EXCAVATOR WITH A HYDRAULIC THUMB TO INSTALL INSTREAM STRUCTURES.
12. CHANNEL RELOCATION WORK SHALL BE COMPLETED AND STABILIZED PRIOR TO ALLOWING FLOW TO ENTER INTO THE NEWLY CONSTRUCTED STREAM CHANNEL. THE CONTRACTOR SHALL NOT OPEN UP MORE THAN 200 FEET OF CHANNEL WITHOUT EROSION CONTROL BLANKET IN PLACE OR BY APPROVAL OF THE ENGINEER.
13. THE PROPOSED STREAM CHANNEL SHALL BE CONSTRUCTED BY FIRST GRADING THE FLOODPLAIN ADJACENT TO THE CHANNEL TO THE ELEVATION INDICATED ON THESE PLANS. THIS MAY BE DONE AS GENERAL EXCAVATION. THE PROPOSED STREAM CHANNEL SHALL THEN BE EXCAVATED TO THE PROPER DEPTHS INDICATED ON THE PROFILE AND PROPOSED CONTOURS. THIS SHALL BE DONE AS SPECIALIZED EXCAVATION AND IS TYPICALLY ACCOMPLISHED WITH A TRACK EXCAVATOR. THE PROFILES AND CONTOURS SHOWN PROVIDE WIDTHS AND SLOPES FOR AID IN CONSTRUCTING THE CHANNEL TO THE APPROPRIATE DIMENSIONS. THE THALWEG CAN FIRST BE EXCAVATED TO THE POINT INDICATED ON THE PROFILE. EXCAVATION AND FINE GRADING OF THE CROSS SECTIONS SHALL THEN BE PERFORMED AS SHOWN ON THE TYPICAL CROSS SECTIONS AND PROPOSED CONTOURS. ANY STOCKPILING OF MATERIALS OR “DOUBLE HANDLING” NECESSARY TO BUILD THE CHANNEL SHALL BE CONSIDERED INCIDENTAL TO CONSTRUCTION.
14. IF THE EXISTING GROUND IS LESS THAN 0.2 FEET HIGHER THAN THE PROPOSED BANKFULL ELEVATION, IT IS NOT NECESSARY TO EXCAVATE MATERIAL TO THE PROPOSED ELEVATION SHOWN ON THE PROFILE.
15. THE SURFACE OF ALL INSTREAM STRUCTURES SHALL BE FINISHED TO A SMOOTH LINE IN ACCORDANCE WITH THE LINES, GRADES, AND CROSS SECTIONS OR ELEVATIONS SHOWN ON THE DRAWINGS. THE DEGREE OF FINISH FOR THE VANE SLOPES AND INVERT ELEVATIONS SHALL BE WITHIN 0.1 VERTICAL FEET OF THE GRADES AND ELEVATIONS INDICATED. ALL GAPS OR VOIDS BETWEEN THE ROCKS SHALL BE PLUGGED WITH SMALL GRAVEL TO FORM A TIGHT-FITTING SEAL.
16. CONSTRUCTION SPECIFICATIONS FOR BANKFULL CHANNEL DIMENSIONS OR CROSS SECTIONS WILL BE HELD TO THE DIMENSIONS SHOWN ON THE TYPICAL CROSS SECTIONS. ELEVATIONS SHALL BE CONSTRUCTED WITHIN 0.1 VERTICAL FEET; WIDTHS AND MEAN DEPTHS MUST FALL WITHIN THE RANGES SHOWN IN THE DRAWINGS.
17. THE IN-STRUCTURE BID ITEMS SHALL INCLUDE ALL LABOR AND MATERIALS NECESSARY TO CONSTRUCT THE STRUCTURE. BID ITEMS INCLUDE SEEDING, PLANTING, AND MULCH AND EROSION CONTROL BLANKETS AND INCLUDE ALL LABOR AND MATERIALS NECESSARY TO STABILIZE AREAS DISTURBED DURING CONSTRUCTION OF STRUCTURES. AFTER THE STRUCTURE IS COMPLETE AND FLOW IS RESTORED TO THE CHANNEL, SOME ADJUSTMENT TO THE STRUCTURE OR ADDITIONAL STABILIZATION MEASURES MAY BE NECESSARY TO ACHIEVE DESIRED EFFECT. ANY COSTS ASSOCIATED WITH THESE ADJUSTMENTS SHALL BE CONSIDERED INCIDENTAL TO CONSTRUCTION.
18. THE CONSTRUCTED STREAM CHANNEL SHALL BE STABILIZED AS SOON AS POSSIBLE BY SEEDING IN ACCORDANCE WITH THE PLOT SCHEDULE, ADDING STRAW MULCH TO BARE SOIL, AND BY INSTALLING EROSION CONTROL BLANKET FROM THE INNER BERM TO BEYOND THE TOP OF THE BANKFULL CHANNEL. SEE EROSION CONTROL BLANKET DETAIL. PRIOR TO INSTALLING BLANKET, PREPARE THE BED BY LOOSENING THE SOIL 3 TO 6 INCHES, APPLY SEED AND THEN STRAW MULCH. SEED SHALL BE BROADCAST EVENLY OVER THE AREA USING A BROADCAST SPREADER PRIOR TO COVERING WITH THE EROSION CONTROL BLANKET. THE BLANKET SHALL BE ROLLED OUT IN THE DIRECTION OF THE ANTICIPATED RUN-OFF FLOW. INSTALL BLANKET IN ACCORDANCE WITH DETAIL SHOWN HEREIN. REWORKING OF AREAS THAT DO NOT ESTABLISH VEGETATION OR BECOME UNSTABLE SHALL BE NECESSARY IF THE EROSION CONTROL BLANKET SEPARATES FROM THE SOIL. SEE SEEDING AND PLANTING DETAIL FOR BLANKET SPECIFIATIONS. SEEDING OF THE BANKFULL BENCH SHALL BE IN ACCORDANCE WITH THE PLANTING TABLE. REFER TO CONTROL BLANKET DETAIL FOR PLACEMENT OF EROSION CONTROL BLANKET.
19. IF THE TIMING OF PROJECT IS SUCH THAT RIPARIAN SEED MIX CANNOT BE PLACED IN THE FALL, THEN THE CONTRACTOR SHALL SEED WITH TEMPORARY COVER ACCORDING TO THE EROSION AND SEDIMENT PLAN OR APPROVED BY THE ENGINEER UNTIL RIPARIAN MIX CAN BE SEEDED IN THE SPRING.
20. THE HARVESTING AND INSTALLATION OF LIVE STAKES SHALL BE PERFORMED ONLY DURING THE DORMANT SEASON TYPICALLY BETWEEN NOVEMBER 1 AND APRIL 15. CONTRACTOR SHALL NOTIFY ENGINEER 7 DAYS PRIOR TO HARVESTING TO REVIEW AND APPROVE ALL HARVESTING SITES. UPON APPROVAL BY ENGINEER, THE CONTRACTOR SHALL BE RESPONSIBLE FOR HARVESTING AND TRANSPORTING THE LIVE STAKE CUTTINGS TO THE JOB SITE.
21. LIVE STAKES SHALL BE INSTALLED ALONG THE OUTSIDE MEANDER BEND AND ALONG RIFFLES WHERE INDICATED ON THE DRAWINGS AND DETAILS. LIVE STAKES SHALL BE INSTALLED INTO THE EROSION CONTROL BLANKET IN ADDITION TO THE DEAD STAKES.
22. EXCESS SPOIL MATERIAL MAY BE SPREAD AND GRADED ONSITE OR IN THE ONSITE PIT AS APPROVED BY THE ENGINEER. PLACEMENT OF ANY ON-SITE OR OFF-SITE SPOIL MATERIAL SHALL BE CONSIDERED INCIDENTAL TO CONSTRUCTION.
23. TOPSOIL SHALL BE REMOVED FROM EXCAVATION AND SPOIL AREAS PRIOR TO CUT OR FILL AND RE-APPLIED TO AREAS AFTER ROUGH GRADING IS COMPLETE. SIX INCHES OF TOPSOIL SHALL BE PLACED ON DISTURBED AREAS TO MEET GRADE. STOCKPILING AND PLACEMENT OF TOPSOIL SHALL BE CONSIDERED INCIDENTAL TO CONSTRUCTION AND APPROVED BY THE ENGINEER.
24. SPOIL AREAS SHALL BE SEEDED WITH TEMPORARY VEGETATION WITHIN 7 DAYS FOLLOWING GRADING.
25. THE PLACEMENT OF STRAW MULCH SHALL OCCUR A MAXIMUM 48 HOURS AFTER SEEDING. MULCH WILL BE SPREAD TO COVER THE INSTALLED AREAS AT A MINIMUM RATE OF 1.5 TONS PER ACRE. MULCH SHALL BE KEPT OUT OF THE CROWNS OF SHRUBS AND GROUND COVER.
26. IF SOFT SOILS ARE ENCOUNTERED WHEN RECONSTRUCTING STREAM BANKS, RESTORE BANK WITH SOD MAT COVERING ALONG RIFFLES AND WOOD TOE SOD MAT ALONG BENDS.
27. CONTRACTOR SHALL CALL GOPHER STATE ONE CALL FOR UTILITY MARKING AT LEAST 48 HOURS PRIOR TO START OF CONSTRUCTION. THE LOCATIONS OF THE UTILITIES SHOWN ON THESE DRAWINGS ARE APPROXIMATE ONLY (UTILITY QUALITY LEVEL D) AND MAY NOT BE ACCURATE. LOCATING UTILITIES IS THE SOLE RESPONSIBILITY OF THE CONTRACTOR. THE ENGINEER AND PROJECT OWNER WILL NOT BE RESPONSIBLE FOR ANY DAMAGES TO UTILITIES.
28. CONTRACTOR SHALL UTILIZE NATIVE MATERIAL FROM THE SITE WHERE AVAILABLE AND ALLOWED BY THE ENGINEER. NATIVE MATERIAL THAT CAN BE FOUND ON SITE INCLUDE TREES THAT CAN PROVIDE LIVE STAKES AND TREES THAT CAN BE USED FOR LOG STRUCTURES AND WOOD DEBRIS.
29. AFTER CONSTRUCTION, THE ACCESS ROADS LEADING TO THE PROJECT SITE SHALL BE RESTORED TO AS GOOD OR BETTER CONDITION THAN BEFORE CONSTRUCTION AT THE ENGINEER'S DISCRETION.
30. FOOTER DEPTH ON ALL STRUCTURES REQUIRING FOOTERS SHALL BE AT LEAST 6 TIMES GREATER THAN THE DROP BETWEEN THE STRUCTURE AND THE FOOTERED STRUCTURE DIRECTLY UPSTREAM OR APPROVED BY THE ONSITE ENGINEER.

EROSION/SEDIMENTATION CONTROL NOTES:

1. ALL CONTROL MEASURES SHALL BE CHECKED, AND REPAIRED AS NECESSARY, MONTHLY IN DRY PERIODS, AND WITHIN 24 HOURS AFTER ANY RAINFALL AT THE SITE OF .75 INCHES OR GREATER WITHIN A 24 HOUR PERIOD. DAILY CHECKING AND, IF NECESSARY, REPAIRING SHALL BE DONE DURING PROLONGED RAINFALLS. THE PERMITTEE SHALL MAINTAIN WRITTEN RECORDS OF SUCH CHECKS AND REPAIRS ON-SITE AT ALL TIMES, AND RECORDS SHALL BE SUBJECT TO INSPECTION AT ANY REASONABLE TIME.
2. THE CONSTRUCTION ACCESS POINTS SHALL BE MAINTAINED AS REQUIRED TO PREVENT SILT/SEDIMENT FROM LEAVING THE SITE. THIS INCLUDES BUT IS NOT LIMITED TO WASH DOWN OF THE CONSTRUCTION ACCESS POINTS, INSTALLING AND UTILIZING A VEHICLE WASH DOWN AREA, INSTALLING ADDITIONAL STONE, ETC.
3. ANY AND ALL SILT/SEDIMENTATION SHALL BE FREQUENTLY REMOVED FROM THE SILT FENCE, DITCHES, CHECK DAMS AND RETENTION AREAS. AT THE END OF CONSTRUCTION, THESE AREAS SHALL BE COMPLETELY FREE OF SILT/SEDIMENTATION AND SHALL BE STABILIZED AS STATED IN THE PLANS AND SPECIFICATIONS.
4. ALL BMPS SHALL BE DESIGNED AND INSTALLED IN ACCORDANCE WITH THE MINNESOTA POLLUTION CONTROL AGENCY (MPCA) CONSTRUCTION OF GENERAL PERMITS FOR STORMWATER CONTROL. IF CONFLICTS ARISE BETWEEN THESE REQUIREMENTS, THE MORE STRINGENT SHALL APPLY.
5. BMPS SHOWN ALONG THE PERIMETER OF THE DISTURBED AREAS SHALL BE INSTALLED PRIOR TO DISTURBANCE ACTIVITY. OTHER BMPS SHALL BE INSTALLED AS SOON AS CONSTRUCTION SEQUENCES ALLOW.
6. TEMPORARY DIVERSION OF RUNOFF/RUNON WATER SHALL BE INSTALLED AS NEEDED TO FACILITATE CONSTRUCTION OR AS DIRECTED ON-SITE BY THE ENGINEER.
7. ALL DISTURBED AREAS SHALL BE PERMANENTLY STABILIZED IMMEDIATELY AFTER THE COMPLETION OF THE GRADING OPERATION. AREAS REQUIRING COCONUT COIR MATTING SHALL BE SEEDED AND MULCHED FOR STABILIZATION PRIOR TO THE INSTALLATION OF THE MATTING.
8. TEMPORARY STABILIZATION OF DISTURBED AREAS MUST BE INITIATED IMMEDIATELY WHENEVER WORK TOWARD PROJECT COMPLETION AND FINAL STABILIZATION OF ANY PORTION OF THE SITE HAS TEMPORARILY CEASED AND WILL NOT RESUME FOR A PERIOD EXCEEDING THIRTEEN (7) CALENDAR DAYS. THOSE AREAS SHALL BE SEEDED AND MULCHED IN ACCORDANCE WITH THE PLANS AND SPECIFICATIONS.
9. NECESSARY MEASURES SHALL BE TAKEN TO PRODUCE AND MAINTAIN AN ACCEPTABLE STAND OF GRASS. SAID MEASURES TO INCLUDE (BUT NOT LIMITED TO) WATERING, RE-SEEDING, REGRADING ERODED AREAS, RE-FERTILIZING, ETC.
10. CONTRACTOR IS RESPONSIBLE FOR KEEPING MUD AND DEBRIS OFF CITY/STATE STREETS AND ROW. CLEANUP IS REQUIRED DAILY.
11. CONTRACTOR SHALL KEEP A COPY OF THE NPDES CONSTRUCTION GENERAL PERMIT AND THE "CONSTRUCTION BEST MANAGEMENT PRACTICES PLAN" ON SITE AT ALL TIMES FOR THE LIFE OF THE PROJECT.
12. ALL HAZARDOUS SUBSTANCES USED FOR THIS PROJECT (PAINT, OIL, GREASE, AND OTHER PETROLEUM PRODUCTS) SHALL BE STORED IN ACCORDANCE WITH SPCC REGULATIONS. THESE SUBSTANCES SHALL BE STORED AWAY FROM DRAINS AND DITCHES IN WATERTIGHT CONTAINERS. DISPOSAL OF THESE SUBSTANCES SHALL BE IN ACCORDANCE WITH ADEM REGULATIONS. DAILY INSPECTIONS SHALL BE PERFORMED FOR LEAK DETECTION. IF LEAKS OCCUR, APPROPRIATE ACTION SHALL BE TAKEN TO CONTAIN AND REMEDIATE THE SPILL. ADEQUATE TRASH CONTAINERS SHALL BE KEPT ON SITE FOR THE DISPOSAL OF CONSTRUCTION MATERIALS WASTE. NECESSARY MEASURES SHALL BE TAKEN TO PREVENT ANY TRASH OR OTHER POLLUTANTS FROM ENTERING "WATERS OF THE UNITED STATES."
13. ALL TEMPORARY MEASURES SHALL BE REMOVED ONCE ACCEPTABLE PERMANENT STABILIZATION IS ACHIEVED. THE ENGINEER SHALL DETERMINE IF THE PERMANENT STABILIZATION IS ACCEPTABLE.

SPECIAL NOTES:

THE ELEVATIONS SHOWN HEREIN ARE BASED ON DATA SURVEY THAT ENCOMPASSES THE EXISTING GROUND SURFACE FROM WHICH ALL COMPUTATIONS FOR CUT/FILL ARE BASED. SLIGHT DISCREPANCIES BETWEEN THE EXISTING GROUND DIGITAL SURFACE AND FIELD CONDITIONS CAN RESULT IN SIGNIFICANT VARIATIONS IN TOTAL EXCAVATED QUANTITIES. THUS, THE CONTRACTOR SHALL COMPARE QUANTITIES OF MATERIAL EXCAVATED TO THOSE SHOWN ON THE DRAWINGS TO MANAGE THE MOVEMENT OF MATERIAL ACROSS THE SITE.

TOPOGRAPHIC INFORMATION:

EXISTING GROUND SURFACES ARE BASED ON A SURVEY COMPLETED XXXX BLENDED WITH STATE OF MN LIDAR. BENCHMARKS WERE SET THROUGHOUT THE SITE AND CAN BE PROVIDED AT ANY TIME. CHANGES IN EXISTING SURFACES SHALL BE INCIDENTAL TO CONSTRUCTION.

SPECIAL GRADING NOTE:

THE AGREED UPON INTENT OF THIS GRADING PLAN IS TO MAINTAIN A “LIVE” SURFACE SO THAT ANY CHANGES THAT ARISE DURING CONSTRUCTION CAN BE QUICKLY ENCOMPASSED INTO THE THREE-DIMENSIONAL SURFACE GENERATED DURING THIS DESIGN PROCESS. AS SUCH, FINE TUNING OF THE SURFACE THAT WOULD ELIMINATE THE APPEARANCE OF JAGGED CONTOUR LINES WHERE SLIGHT VARIATIONS BETWEEN THE EXISTING AND PROPOSED SURFACES WAS NOT COMPLETED.

APPROVED BY: KA | CHECKED BY: MJG | DRAWN BY: GET

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| STATEMENT OF ESTIMATED QUANTITIES | | | | | |
|---|---|---|---|---|---|
| NOTE | NO. | ITEM | MNDOT SPEC. | QUANTITY | UNIT |
| | 1 | MOBILIZATION | 2021.501 | 1 | LS |
| | 2 | CUT COMMON CHANNEL EXCAVATION | 2105.511 | 4000 | CU YD |
| | 3 | FILL COMMON CHANNEL EXCAVATION | 2105.511 | 1000 | CU YD |
| | 4 | STREAM DIVERSION SYSTEM | 2105.601 | 1 | LS |
| | 5 | BOULDER CONSTRUCTED RIFFLE | 2577.604 | 7 | EACH |
| | 6 | TOE WOOD | 2577.610 | 440 | LIN FT |
| | 7 | AUGMENTED RIFFLE | 2577.611 | 229 | CY |
| | 8 | CONSTRUCTED LOG RIFFLE | 2577.612 | 43 | EACH |
| | 9 | ROCK STEP | 2577.613 | 34 | EACH |
| | 10 | MULCH MATERIAL TYPE 1 | 2575.511 | 2 | TON |
| | 11 | CONIFEROUS TREE, 1.5' HT CONT | 2571.501 | 474 | EACH |
| | 12 | DECIDUOUS TREE, 1.5' HT CONT | 2571.502 | 474 | EACH |
| | 13 | DECIDUOUS SHRUB, 1.5" HT CONT | 2571.505 | 1482 | EACH |
| | 14 | SEED MIXTURE FLOODPLAIN | 2575.502 | 131 | LBS |
| | 15 | EROSION CONTROL BLANKETS CATEGORY 4N | 2575.523 | 3000 | SQ YD |

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OVERVIEW

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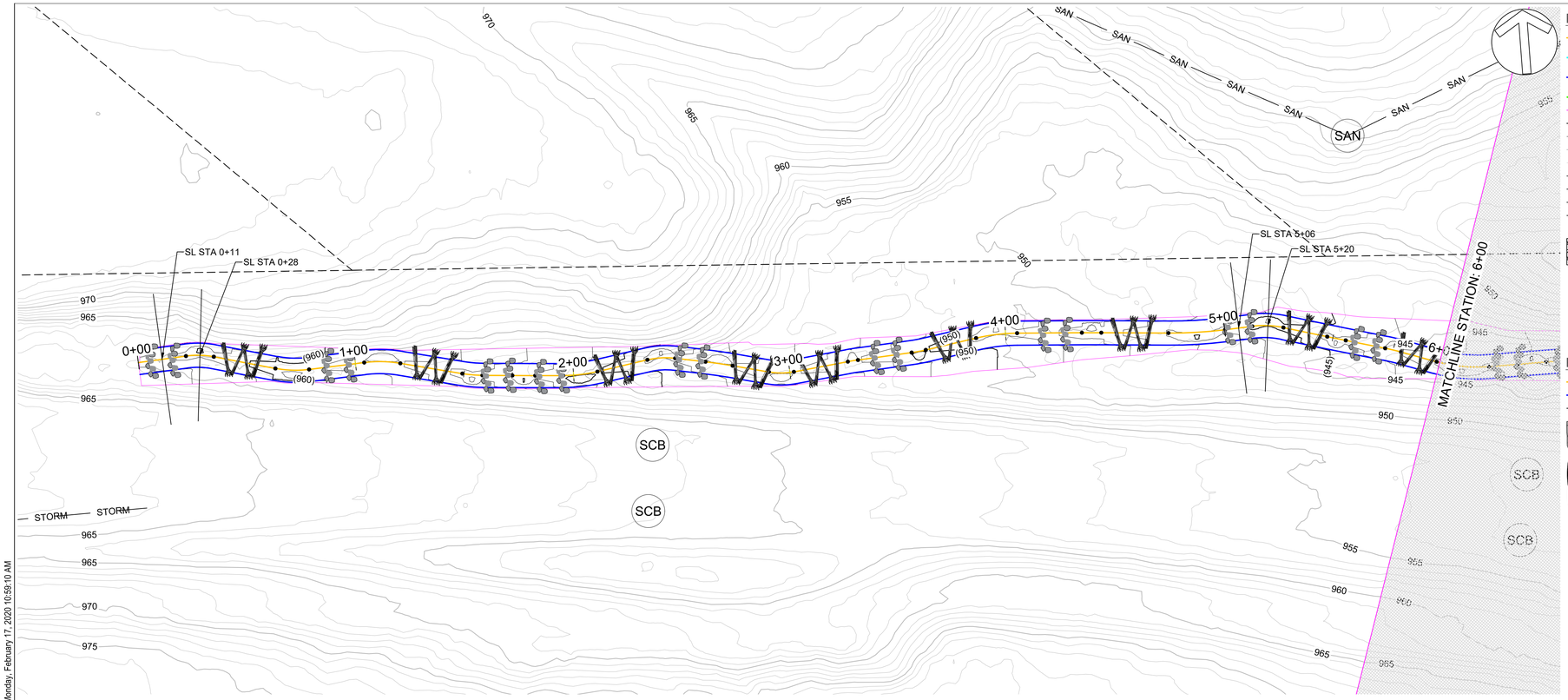
DATE: 2/17/2020
SCALE (34"X22"): 1" = 150'
SCALE (17"X11"): 1" = 300'

0 150 300
SCALE IN FEET

SHEET NUMBER
5 OF 20

E:\DROPBOX (SSSR)\NORTHSHOREMINING\C3D\SHEETS\WHITEROCKCR_PP.DWG | GREGTAILLACQ | SAVED: Monday, February 17, 2020 10:57:28 AM | ACAD.CTB | | PLOTTED: Monday, February 17, 2020 10:58:56 AM

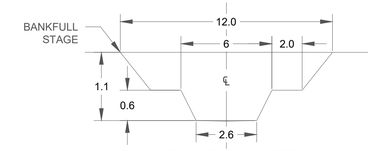



## PLAN LEGEND

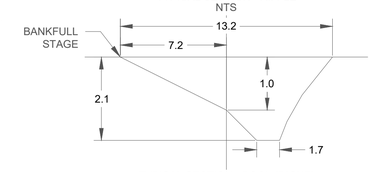
- PROPOSED STREAM CENTER LINE
- PROPOSED INNER BERM
- PROPOSED GEOMORPHIC CHANNEL TOB
- PROPOSED FLOODPLAIN TOE
- LIMITS OF DISTURBANCE
- (483) PROPOSED MAJOR CONTOUR
- PROPOSED MINOR CONTOUR
- 479 EXISTING MAJOR CONTOUR
- EXISTING MINOR CONTOUR
- STORM STORM PIPE
- SAN SANITARY PIPE
- WS WATER SERVICE PIPE
- W WATER PIPE
- HYD WATER HYDRANT
- SAN SANITARY MANHOLE
- ST STORM MANHOLE
- SCB STORM CATCH BASIN
- WV WATER VALVE
- AUGMENTED RIFFLE
- PARCEL
- TOE WOOD
- CONSTRUCTED LOG RIFFLE
- CONSTRUCTED RIFFLE
- ROCK STEP

## PROFILE LEGEND

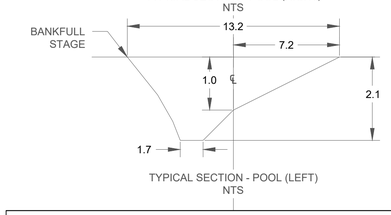
- PROPOSED STREAM CENTER LINE
- PROPOSED BANKFULL TOB
- EXISTING GROUND
- STRUCTURE BOULDER
- HEADER AND FOOTER BOULDER
- STRUCTURE LOG
- AUGMENTED RIFFLE



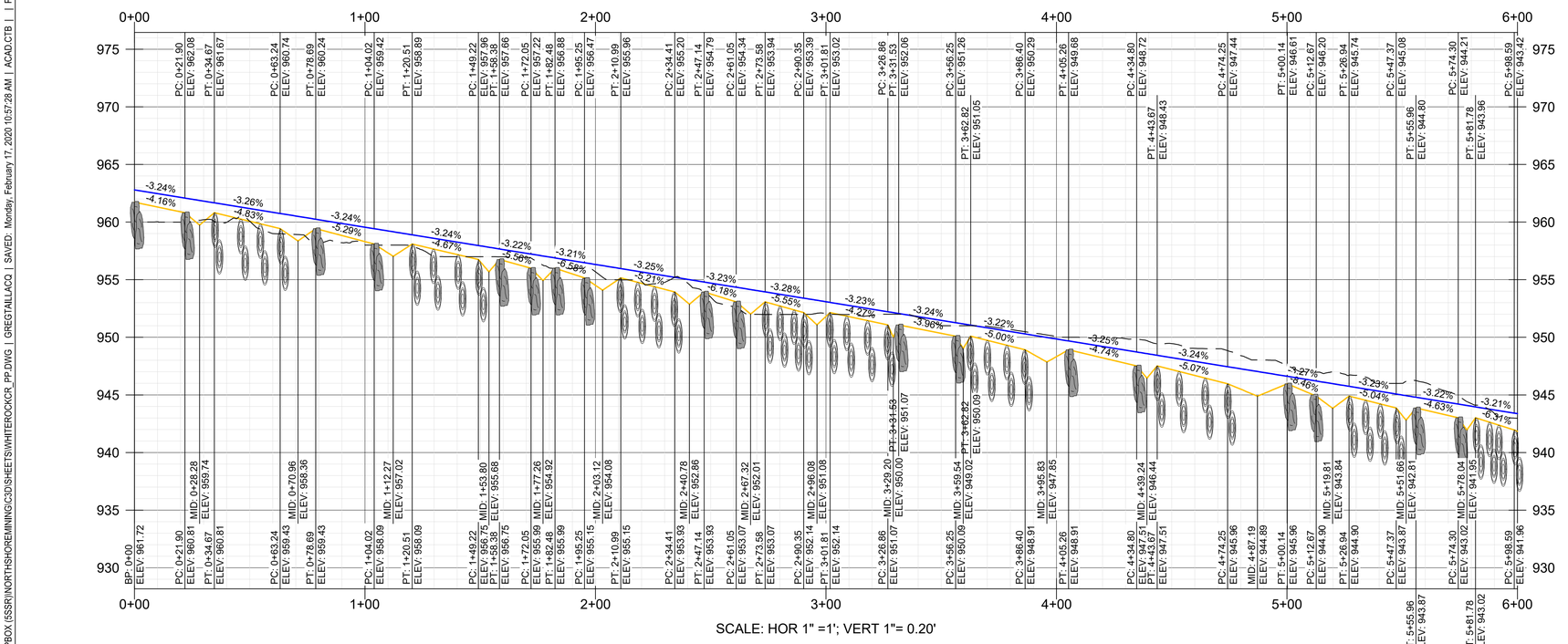

TYPICAL SECTION - RIFFLE
NTS




TYPICAL SECTION - POOL (RIGHT)
NTS




TYPICAL SECTION - POOL (LEFT)
NTS




SCALE: HOR 1" =1'; VERT 1"= 0.20'

NOT TO SCALE

| APPROVED BY: KA | CHECKED BY: MJG | DRAWN BY: GET |
|---|---|---|
| REV | DESCRIPTION | APPRV |
| 1 | DRAFT 30% DESIGN | XX |
| XX | XX | XX |
| XX | XX | XX |
| XX | XX | XX |
| XX | XX | XX |
| XX | XX | XX |
| XX | XX | XX |
| XX | XX | XX |

# WHITE ROCK CREEK STREAM RESTORATION NEAR SILVER BAY LAKE COUNTY, MN

## DRAFT 30% DESIGN - NOT FOR CONSTRUCTION
## WHITE ROCK CREEK - UPPER
## PLAN AND PROFILE - (1)
## STA 0+00 TO 6+00


CLIFFS
NORTHSHORE MINING CO
10 OUTER DR
SILVER BAY, MN 55614
---
BEAVER RIVER CONSULTING
BEAVER RIVER CONSULTING, LLC.
5752 EAGLE VIEW DRIVE
DULUTH, MN 55803
---

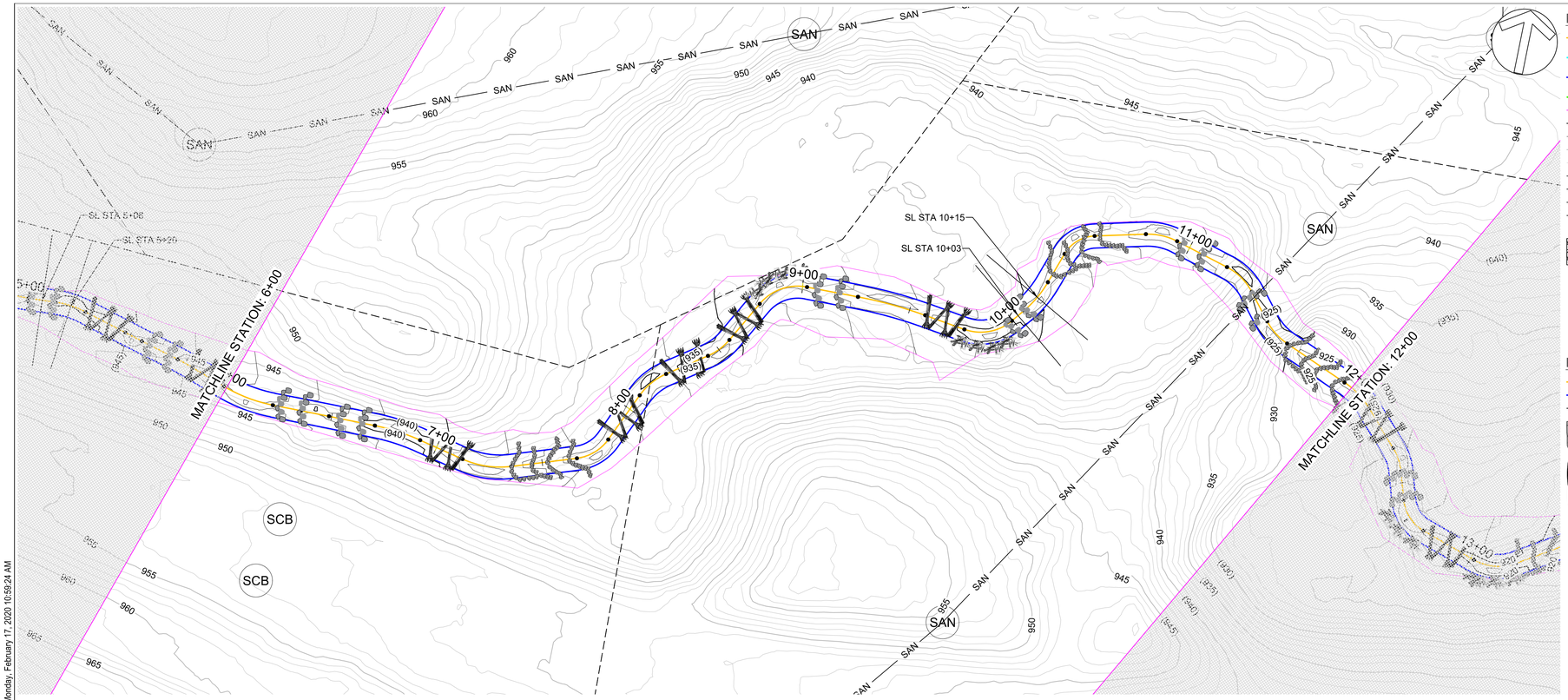

CONCEPT DESIGN
NOT FOR
CONSTRUCTION

DATE: 2/17/2020
SCALE (34"X22"): 1" = 30'
SCALE (17"X11"): 1" = 60'

0 30 60
SCALE IN FEET

SHEET NUMBER
6 OF 20


E:\DROPBOX (SSSR)\NORTHSHOREMINING\C3D\SHEETS\WHITEROCKCR_PP.DWG | GREGTAILLACQ | SAVED: Monday, February 17, 2020 10:57:28 AM | ACAD.CTB | | PLOTTED: Monday, February 17, 2020 10:59:10 AM

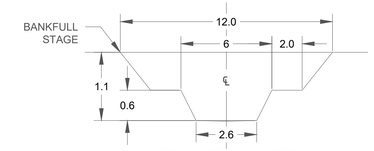



## PLAN LEGEND

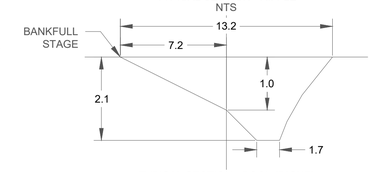
- PROPOSED STREAM CENTER LINE
- PROPOSED INNER BERM
- PROPOSED GEOMORPHIC CHANNEL TOB
- PROPOSED FLOODPLAIN TOE
- LIMITS OF DISTURBANCE
- (483) PROPOSED MAJOR CONTOUR
- PROPOSED MINOR CONTOUR
- 479 EXISTING MAJOR CONTOUR
- EXISTING MINOR CONTOUR
- STORM STORM PIPE
- SAN SANITARY PIPE
- WS WATER SERVICE PIPE
- W WATER PIPE
- HYD WATER HYDRANT
- SAN SANITARY MANHOLE
- ST STORM MANHOLE
- SCB STORM CATCH BASIN
- WV WATER VALVE
- AUGMENTED RIFFLE
- PARCEL
- TOE WOOD
- CONSTRUCTED LOG RIFFLE
- CONSTRUCTED RIFFLE
- ROCK STEP

## PROFILE LEGEND

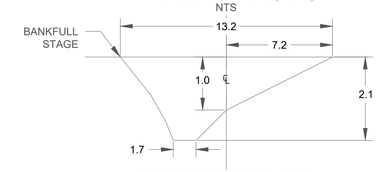
- PROPOSED STREAM CENTER LINE
- PROPOSED BANKFULL TOB
- EXISTING GROUND
- STRUCTURE BOULDER
- HEADER AND FOOTER BOULDER
- STRUCTURE LOG
- AUGMENTED RIFFLE



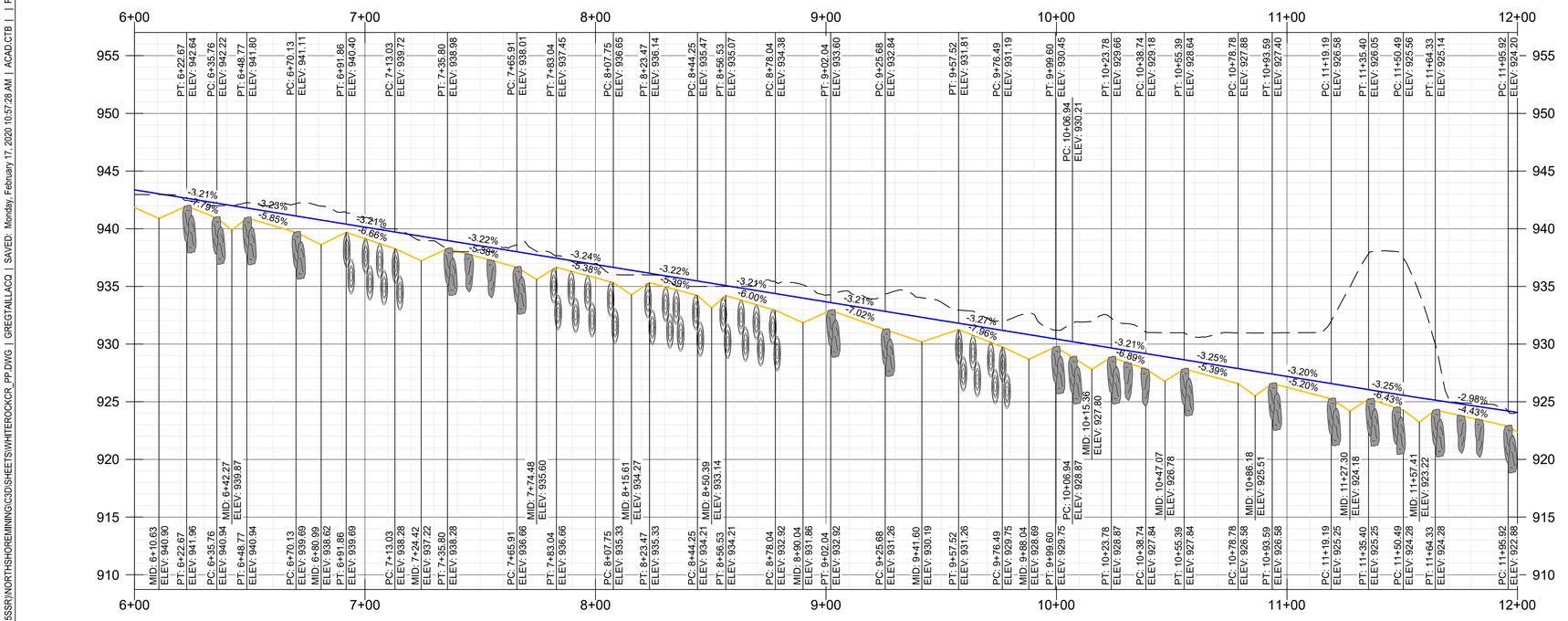

TYPICAL SECTION - RIFFLE
NTS




TYPICAL SECTION - POOL (RIGHT)
NTS




TYPICAL SECTION - POOL (LEFT)
NTS




SCALE: HOR 1" =1'; VERT 1"= 0.20'

NOT TO SCALE

| REV | DESCRIPTION | APPROVED BY: KA | CHECKED BY: MJG | DRAWN BY: GET | APPRV |
|---|---|---|---|---|---|
| 1 | DRAFT 30% DESIGN | | | | |
| XX | XX | XX | XX | XX | XX |
| XX | XX | XX | XX | XX | XX |
| XX | XX | XX | XX | XX | XX |
| XX | XX | XX | XX | XX | XX |
| XX | XX | XX | XX | XX | XX |
| XX | XX | XX | XX | XX | XX |
| XX | XX | XX | XX | XX | XX |

# WHITE ROCK CREEK STREAM RESTORATION NEAR SILVER BAY LAKE COUNTY, MN

## DRAFT 30% DESIGN - NOT FOR CONSTRUCTION
## WHITE ROCK CREEK - UPPER
## PLAN AND PROFILE - (2)
## STA 6+00 TO 12+00


CLIFFS
NORTHSHORE MINING CO
10 OUTER DR
SILVER BAY, MN 55614
---
BEAVER RIVER CONSULTING
BEAVER RIVER CONSULTING, LLC.
5752 EAGLE VIEW DRIVE
DULUTH, MN 55803
---

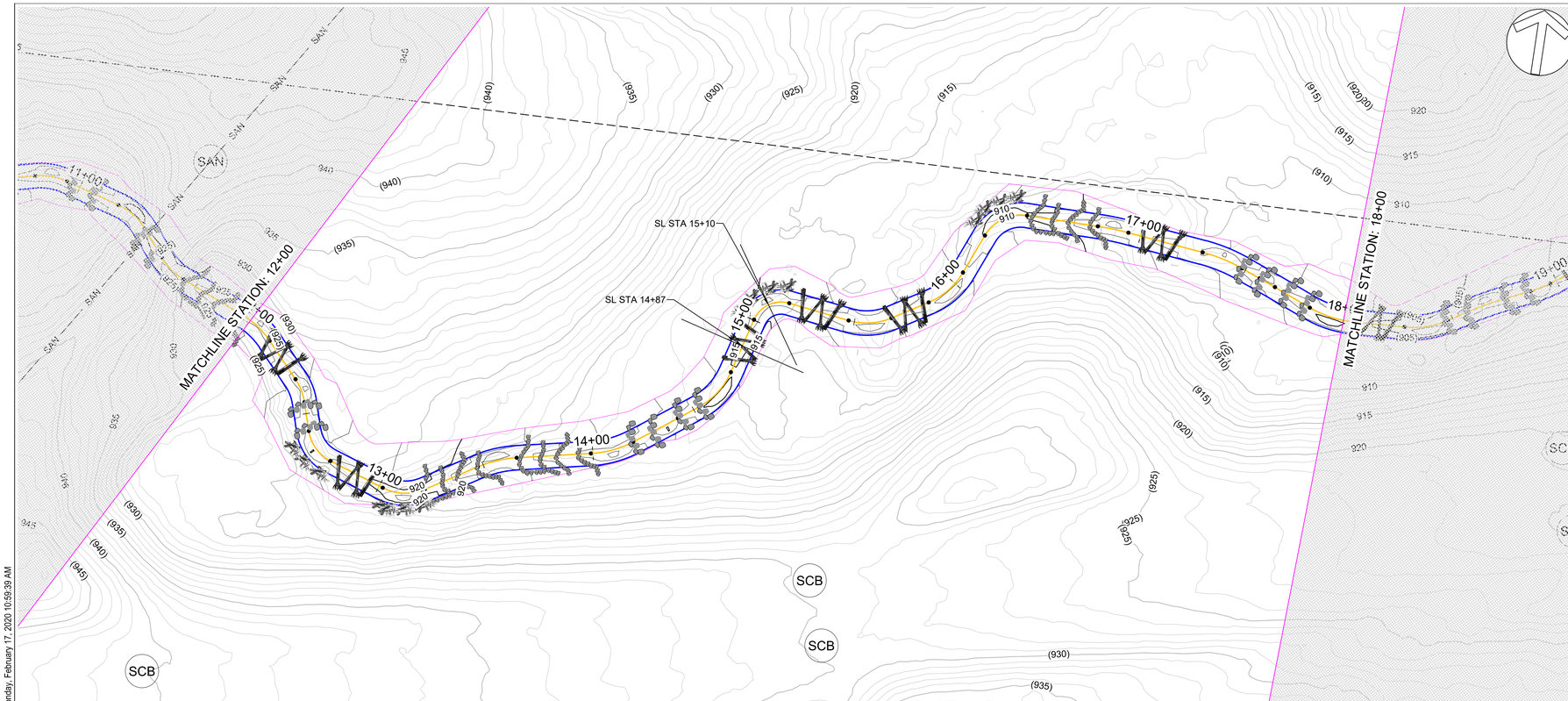

CONCEPT DESIGN
NOT FOR
CONSTRUCTION

DATE: 2/17/2020
SCALE (34"X22"): 1" = 30'
SCALE (17"X11"): 1" = 60'

0 30 60
SCALE IN FEET

SHEET NUMBER
7 OF 20


E:\DROPBOX (SSSR)\NORTHSHOREMINING\C3D\SHEETS\WHITEROCKCR_PP.DWG | GREGTAILLACQ | SAVED: Monday, February 17, 2020 10:57:28 AM | ACAD.CTB | | PLOTTED: Monday, February 17, 2020 10:59:24 AM




## PLAN LEGEND

- PROPOSED STREAM CENTER LINE
- PROPOSED INNER BERM
- PROPOSED GEOMORPHIC CHANNEL TOB
- PROPOSED FLOODPLAIN TOE
- LIMITS OF DISTURBANCE
- (483) PROPOSED MAJOR CONTOUR
- PROPOSED MINOR CONTOUR
- 479 EXISTING MAJOR CONTOUR
- EXISTING MINOR CONTOUR
- STORM STORM PIPE
- SAN SANITARY PIPE
- WS WATER SERVICE PIPE
- W WATER PIPE
- HYD WATER HYDRANT
- SAN SANITARY MANHOLE
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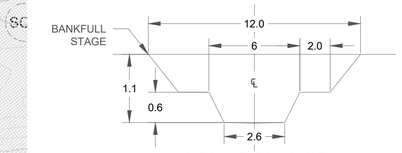
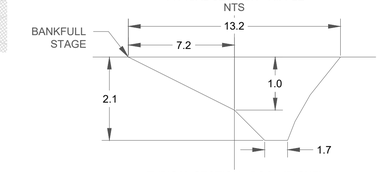
- SCB STORM CATCH BASIN
- WV WATER VALVE
- AUGMENTED RIFFLE
- PARCEL
- TOE WOOD
- CONSTRUCTED LOG RIFFLE
- CONSTRUCTED RIFFLE
- ROCK STEP

## PROFILE LEGEND

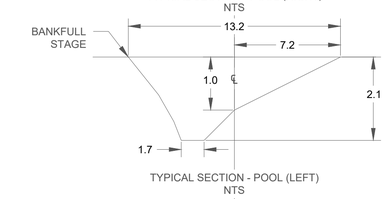
- PROPOSED STREAM CENTER LINE
- PROPOSED BANKFULL TOB
- EXISTING GROUND
- STRUCTURE BOULDER
- HEADER AND FOOTER BOULDER
- STRUCTURE LOG
- AUGMENTED RIFFLE



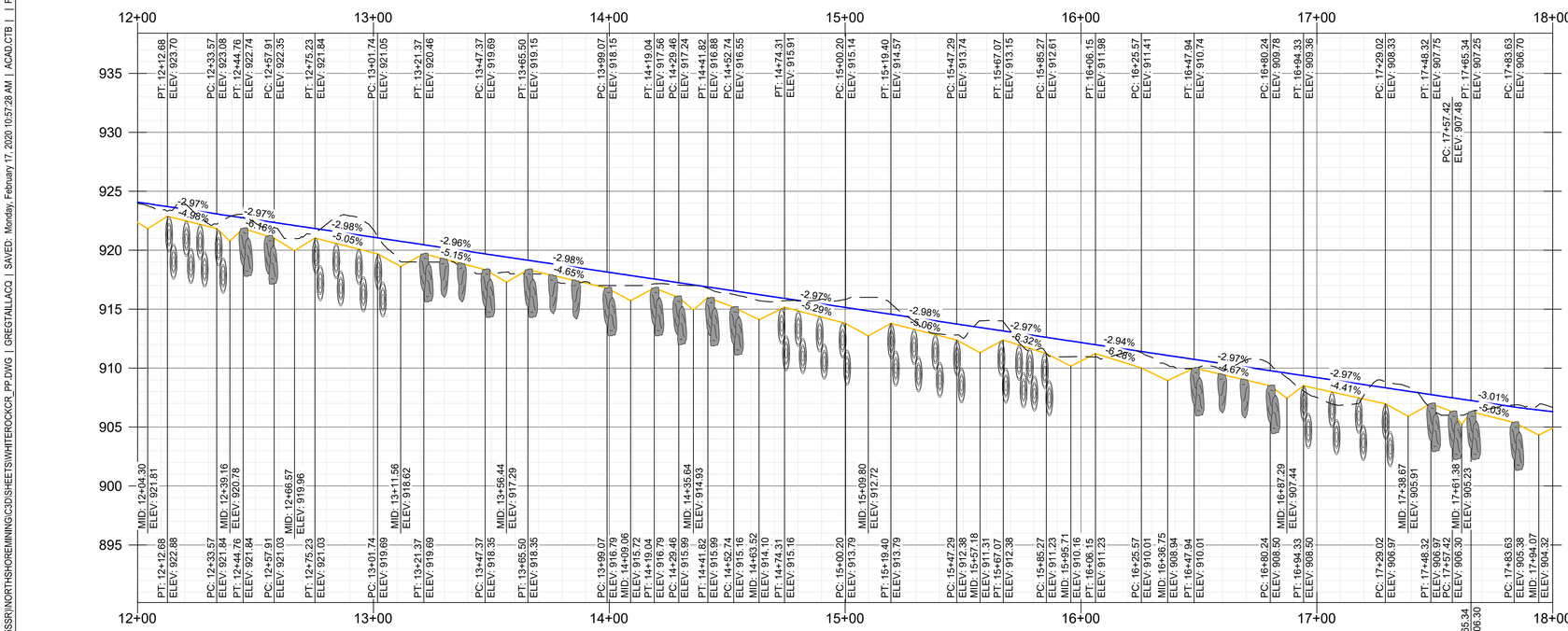

TYPICAL SECTION - RIFFLE
NTS



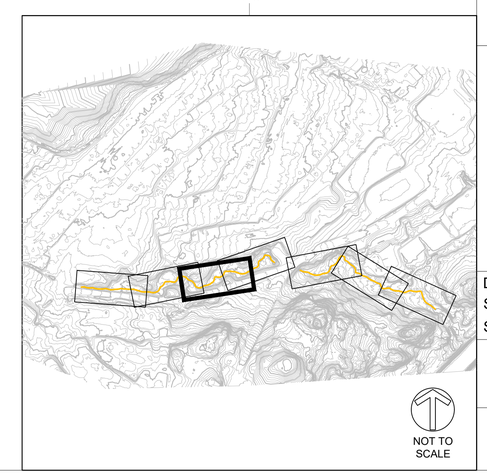

TYPICAL SECTION - POOL (RIGHT)
NTS




TYPICAL SECTION - POOL (LEFT)
NTS




SCALE: HOR 1" =1'; VERT 1"= 0.20'



NOT TO SCALE

| REV | DESCRIPTION | APPROVED BY: KA | CHECKED BY: MJG | DRAWN BY: GET | APPRV |
|---|---|---|---|---|---|
| 1 | DRAFT 30% DESIGN | XX | XX | XX | XX |
| XX | XX | XX | XX | XX | XX |
| XX | XX | XX | XX | XX | XX |
| XX | XX | XX | XX | XX | XX |
| XX | XX | XX | XX | XX | XX |
| XX | XX | XX | XX | XX | XX |
| XX | XX | XX | XX | XX | XX |

# WHITE ROCK CREEK STREAM RESTORATION NEAR SILVER BAY LAKE COUNTY, MN

## DRAFT 30% DESIGN - NOT FOR CONSTRUCTION WHITE ROCK CREEK - UPPER PLAN AND PROFILE - (3) STA 12+00 TO 18+00


CLIFFS
NORTHSHORE MINING CO
10 OUTER DR
SILVER BAY, MN 55614
---
BEAVER RIVER CONSULTING
BEAVER RIVER CONSULTING, LLC.
5752 EAGLE VIEW DRIVE
DULUTH, MN 55803
---

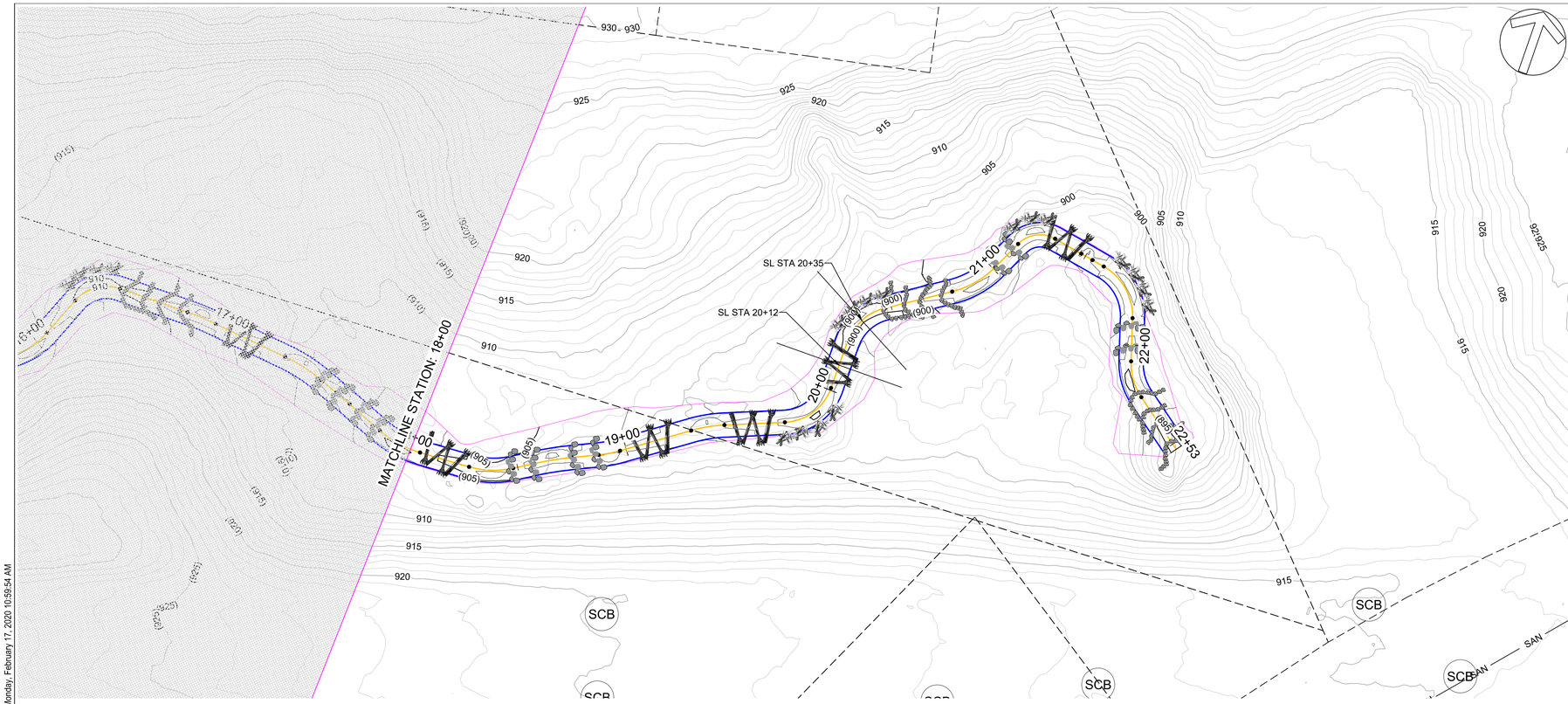

CONCEPT DESIGN
NOT FOR
CONSTRUCTION

DATE: 2/17/2020
SCALE (34"X22"): 1" = 30'
SCALE (17"X11"): 1" = 60'

0 30 60
SCALE IN FEET

SHEET NUMBER
8 OF 20


E:\DROPBOX (SSSR)\NORTHSHOREMINING\C3D\SHEETS\WHITEROCKCR_PP.DWG | GREGTAILLACQ | SAVED: Monday, February 17, 2020 10:57:28 AM | ACAD.CTB | | PLOTTED: Monday, February 17, 2020 10:59:39 AM




## PLAN LEGEND

- PROPOSED STREAM CENTER LINE
- PROPOSED INNER BERM
- PROPOSED GEOMORPHIC CHANNEL TOB
- PROPOSED FLOODPLAIN TOE
- LIMITS OF DISTURBANCE
- (483) PROPOSED MAJOR CONTOUR
- PROPOSED MINOR CONTOUR
- 479 EXISTING MAJOR CONTOUR
- EXISTING MINOR CONTOUR
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- WS WATER SERVICE PIPE
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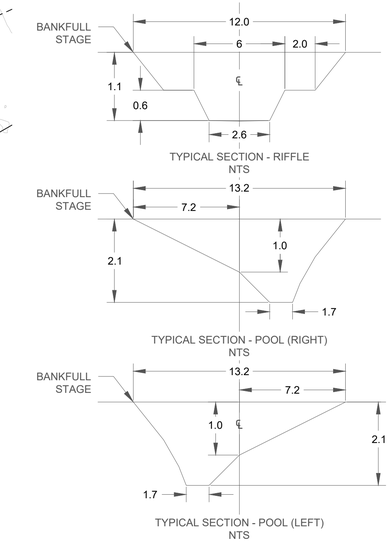
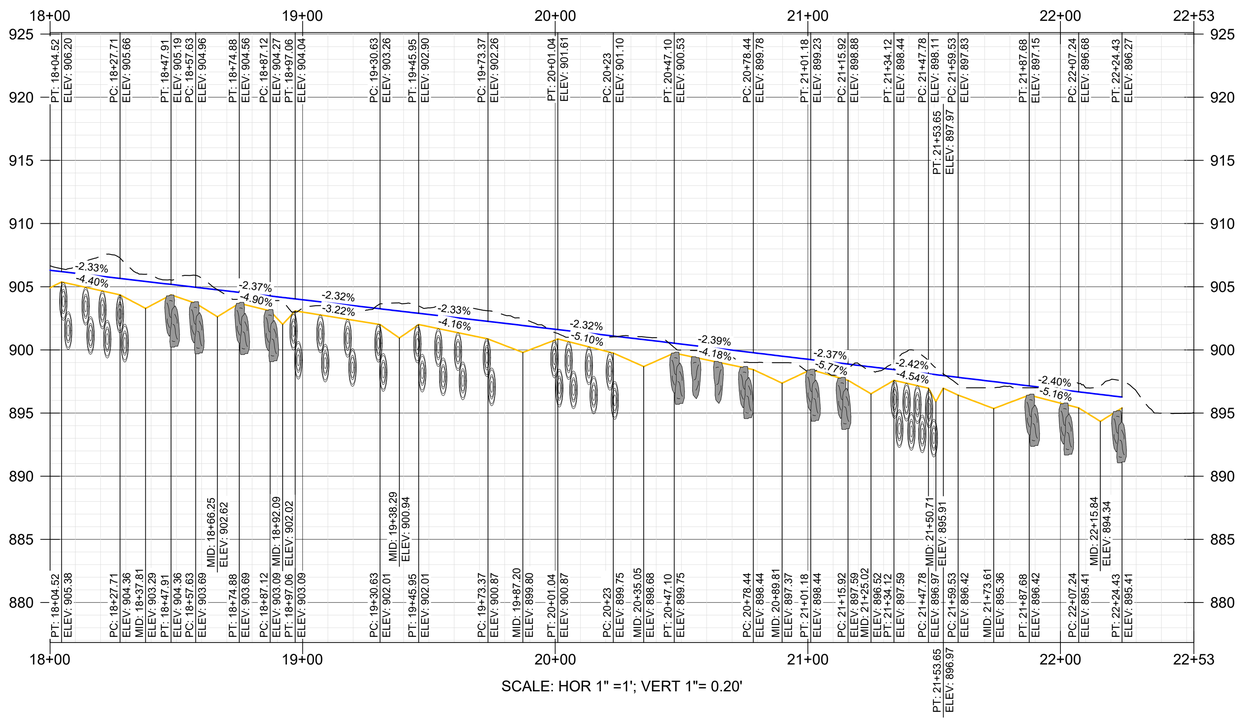
- SCB STORM CATCH BASIN
- WV WATER VALVE
- AUGMENTED RIFFLE
- PARCEL
- TOE WOOD
- CONSTRUCTED LOG RIFFLE
- CONSTRUCTED RIFFLE
- ROCK STEP

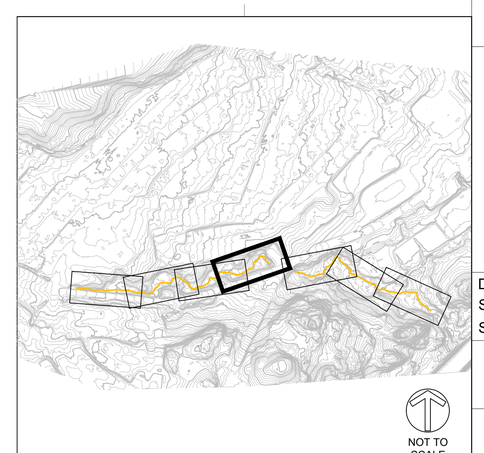
## PROFILE LEGEND

- PROPOSED STREAM CENTER LINE
- PROPOSED BANKFULL TOB
- EXISTING GROUND
- STRUCTURE BOULDER
- HEADER AND FOOTER BOULDER
- STRUCTURE LOG
- AUGMENTED RIFFLE




SCALE: HOR 1" =1'; VERT 1"= 0.20'



NOT TO SCALE

| APPROVED BY: KA | CHECKED BY: MJG | DRAWN BY: GET |
|---|---|---|
| REV | DESCRIPTION | APPRV |
| 1 | DRAFT 30% DESIGN | XX |
| XX | XX | XX |
| XX | XX | XX |
| XX | XX | XX |
| XX | XX | XX |
| XX | XX | XX |
| XX | XX | XX |
| XX | XX | XX |

# WHITE ROCK CREEK STREAM RESTORATION NEAR SILVER BAY LAKE COUNTY, MN

## DRAFT 30% DESIGN - NOT FOR CONSTRUCTION WHITE ROCK CREEK - UPPER PLAN AND PROFILE - (4) STA 18+00 TO 22+53


CLIFFS

NORTHSHORE MINING CO
10 OUTER DR
SILVER BAY, MN 55614
---

BEAVER RIVER CONSULTING

BEAVER RIVER CONSULTING, LLC.
5752 EAGLE VIEW DRIVE
DULUTH, MN 55803
---

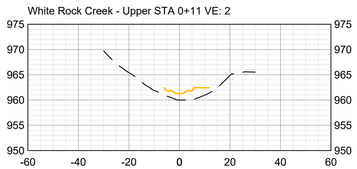

CONCEPT DESIGN
NOT FOR
CONSTRUCTION

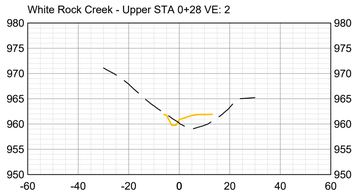
DATE: 2/17/2020
SCALE (34"X22"): 1" = 30'
SCALE (17"X11"): 1" = 60'

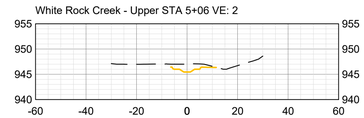
0 30 60
SCALE IN FEET

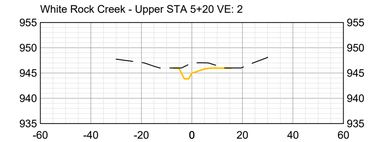
SHEET NUMBER
9 OF 20

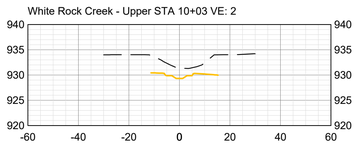

E:\DROPBOX (SSSR)\NORTHSHOREMINING\C3D\SHEETS\WHITEROCKCR_PP.DWG | GREGTAILLACQ | SAVED: Monday, February 17, 2020 10:57:28 AM | ACAD.CTB | | PLOTTED: Monday, February 17, 2020 10:59:54 AM

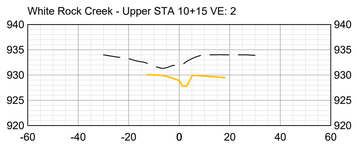


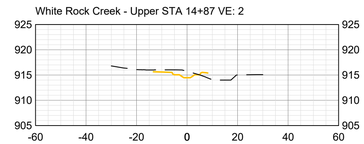



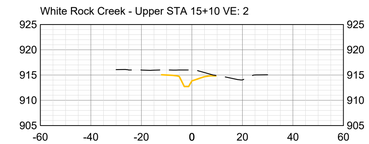



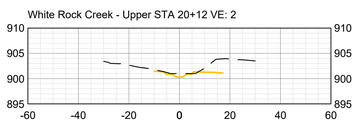



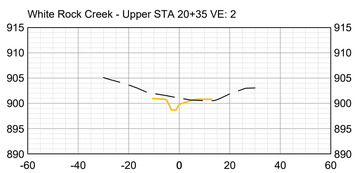




SECTION LEGEND

DESIGN SURFACE

EXISTING GROUND

| APPROVED BY: KA | CHECKED BY: MJG | DRAWN BY: GET |
|---|---|---|
| REV | DESCRIPTION | APPRV |
| 1 | DRAFT 30% DESIGN | XX |
| XX | XX | XX |
| XX | XX | XX |
| XX | XX | XX |
| XX | XX | XX |
| XX | XX | XX |
| XX | XX | XX |
| XX | XX | XX |

WHITE ROCK CREEK
STREAM RESTORATION
NEAR SILVER BAY
LAKE COUNTY, MN

DRAFT 30% DESIGN - NOT FOR CONSTRUCTION
WHITE ROCK CREEK - UPPER
SECTIONS - (1)
STA 0+11 TO 20+35

CLIFFS

NORTHSHORE MINING CO
10 OUTER DR
SILVER BAY, MN 55614
---

BEAVER RIVER CONSULTING

BEAVER RIVER CONSULTING, LLC.
5752 EAGLE VIEW DRIVE
DULUTH, MN 55803
---

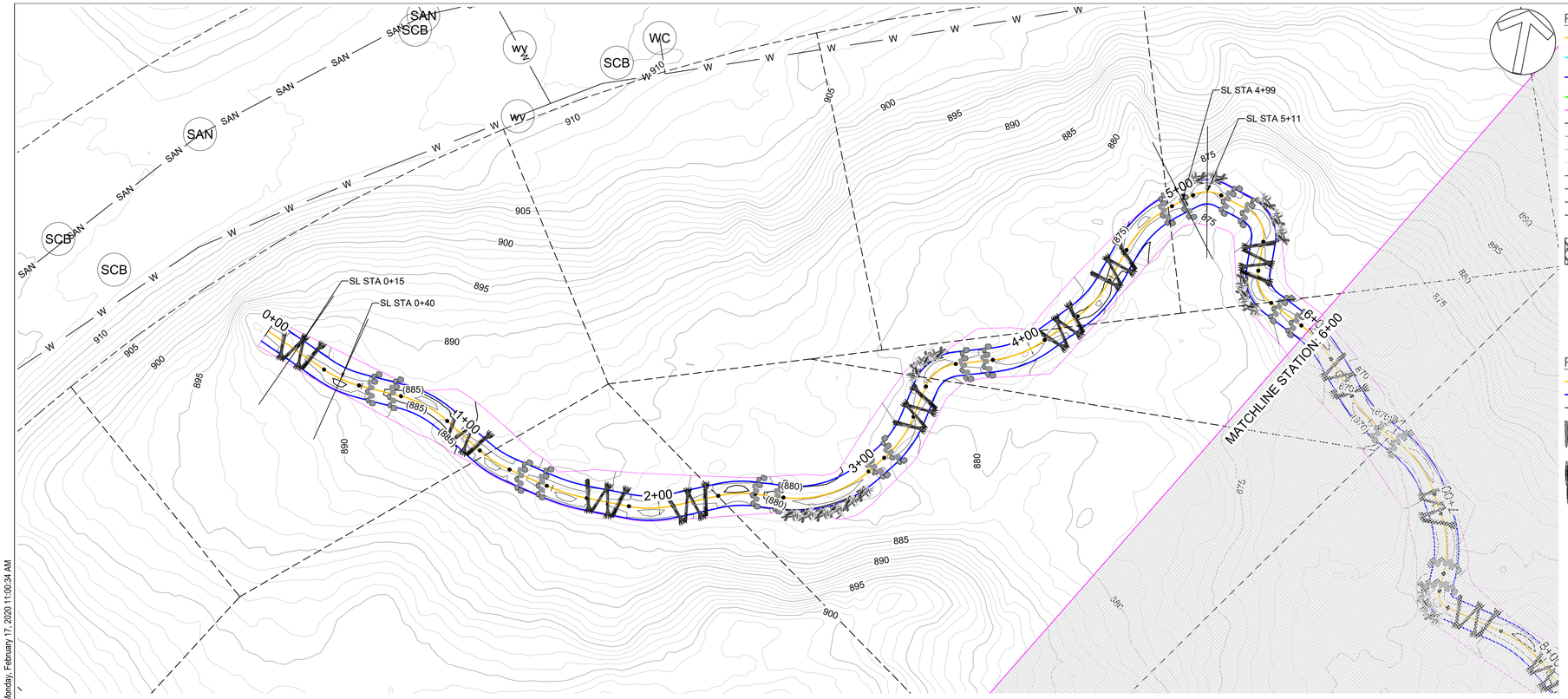
CONCEPT DESIGN
NOT FOR
CONSTRUCTION

DATE: 2/17/2020
SCALE (34"X22"): 1" = 30'
SCALE (17"X11"): 1" = 60'

0 30 60
SCALE IN FEET

SHEET NUMBER
10 OF 20

E:\DROPBOX (SSSR)\NORTHSHOREMINING\C3D\SHEETS\WHITEROCKCR_SECTIONS.DWG | GREGTALLACQ | SAVED: Friday, February 14, 2020 11:52:03 AM | ACAD.CTB | | PLOTTED: Monday, February 17, 2020 11:00:04 AM

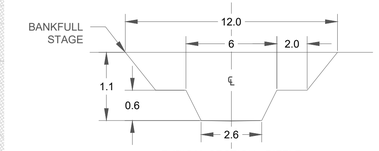



## PLAN LEGEND

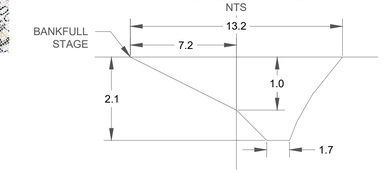
- PROPOSED STREAM CENTER LINE
- PROPOSED INNER BERM
- PROPOSED GEOMORPHIC CHANNEL TOB
- PROPOSED FLOODPLAIN TOE
- LIMITS OF DISTURBANCE
- (483) PROPOSED MAJOR CONTOUR
- PROPOSED MINOR CONTOUR
- 479 EXISTING MAJOR CONTOUR
- EXISTING MINOR CONTOUR
- STORM STORM PIPE
- SAN SANITARY PIPE
- WS WATER SERVICE PIPE
- W WATER PIPE
- HYD WATER HYDRANT
- SAN SANITARY MANHOLE
- ST STORM MANHOLE
- SCB STORM CATCH BASIN
- WV WATER VALVE
- AUGMENTED RIFFLE
- PARCEL
- TOE WOOD
- CONSTRUCTED LOG RIFFLE
- CONSTRUCTED RIFFLE
- ROCK STEP

## PROFILE LEGEND

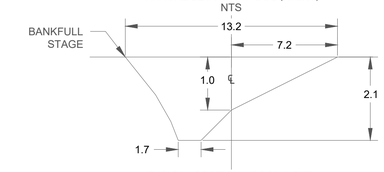
- PROPOSED STREAM CENTER LINE
- PROPOSED BANKFULL TOB
- EXISTING GROUND
- STRUCTURE BOULDER
- HEADER AND FOOTER BOULDER
- STRUCTURE LOG
- AUGMENTED RIFFLE




TYPICAL SECTION - RIFFLE
NTS




TYPICAL SECTION - POOL (RIGHT)
NTS




TYPICAL SECTION - POOL (LEFT)
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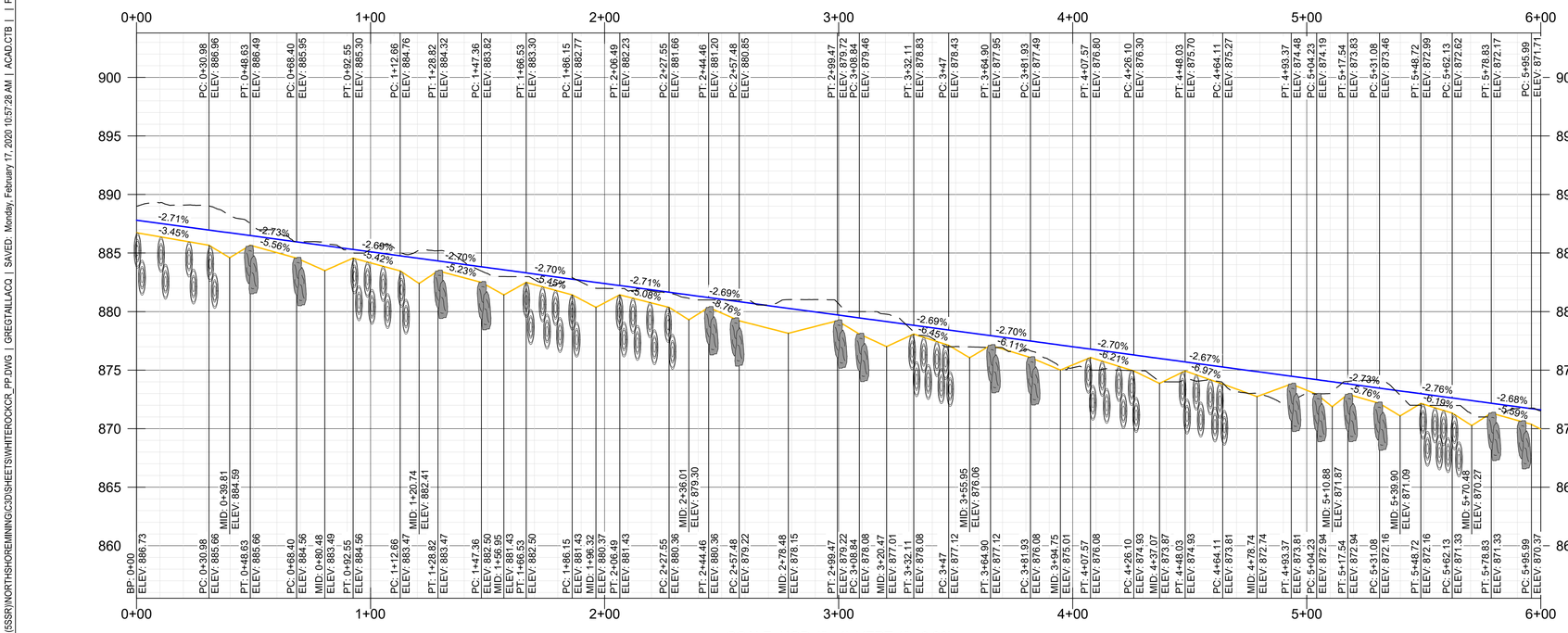



SCALE: HOR 1" =1'; VERT 1"= 0.20'

NOT TO SCALE

| REV | DESCRIPTION | APPROVED BY: KA | CHECKED BY: MJG | DRAWN BY: GET | APPRV |
|---|---|---|---|---|---|
| 1 | DRAFT 30% DESIGN | | | | XX |
| XX | | | XX | XX | XX |
| XX | | | XX | XX | XX |
| XX | | | XX | XX | XX |
| XX | | | XX | XX | XX |
| XX | | | XX | XX | XX |
| XX | | | XX | XX | XX |
| XX | | | XX | XX | XX |

# WHITE ROCK CREEK STREAM RESTORATION NEAR SILVER BAY LAKE COUNTY, MN

## DRAFT 30% DESIGN - NOT FOR CONSTRUCTION
## WHITE ROCK CREEK - LOWER
## PLAN AND PROFILE - (1)
## STA 0+00 TO 6+00


CLIFFS
NORTHSHORE MINING CO
10 OUTER DR
SILVER BAY, MN 55614
---
BEAVER RIVER CONSULTING
BEAVER RIVER CONSULTING, LLC.
5752 EAGLE VIEW DRIVE
DULUTH, MN 55803
---

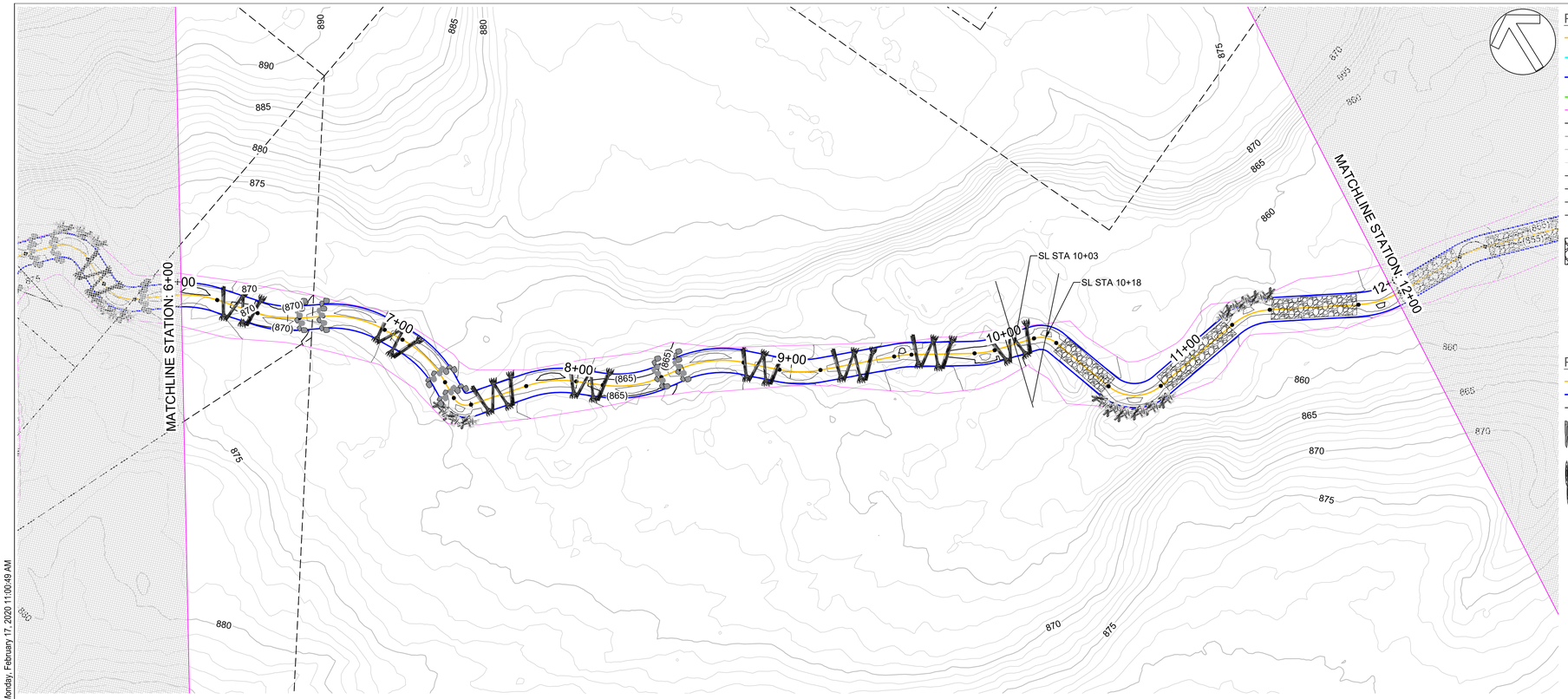

CONCEPT DESIGN
NOT FOR
CONSTRUCTION

DATE: 2/17/2020
SCALE (34"X22"): 1" = 30'
SCALE (17"X11"): 1" = 60'

0 30 60
SCALE IN FEET




E:\DROPBOX (SSSR)\NORTHSHOREMINING\C3D\SHEETS\WHITEROCKCR_PP.DWG | GREGTAILLACQ | SAVED: Monday, February 17, 2020 10:57:28 AM | ACAD.CTB | | PLOTTED: Monday, February 17, 2020 11:00:34 AM




## PLAN LEGEND

- PROPOSED STREAM CENTER LINE
- PROPOSED INNER BERM
- PROPOSED GEOMORPHIC CHANNEL TOB
- PROPOSED FLOODPLAIN TOE
- LIMITS OF DISTURBANCE
- (483) PROPOSED MAJOR CONTOUR
- PROPOSED MINOR CONTOUR
- 479 EXISTING MAJOR CONTOUR
- EXISTING MINOR CONTOUR
- STORM STORM PIPE
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- WS WATER SERVICE PIPE
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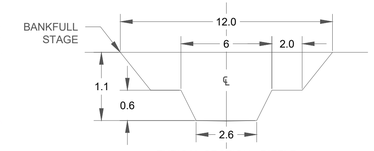
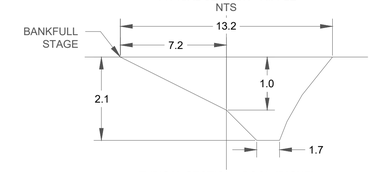
- TOE WOOD
- CONSTRUCTED LOG RIFFLE
- CONSTRUCTED RIFFLE
- ROCK STEP

## PROFILE LEGEND

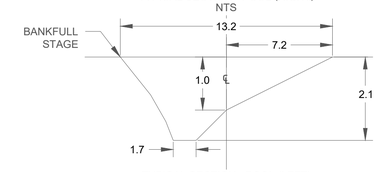
- PROPOSED STREAM CENTER LINE
- PROPOSED BANKFULL TOB
- EXISTING GROUND
- STRUCTURE BOULDER
- HEADER AND FOOTER BOULDER
- STRUCTURE LOG
- AUGMENTED RIFFLE



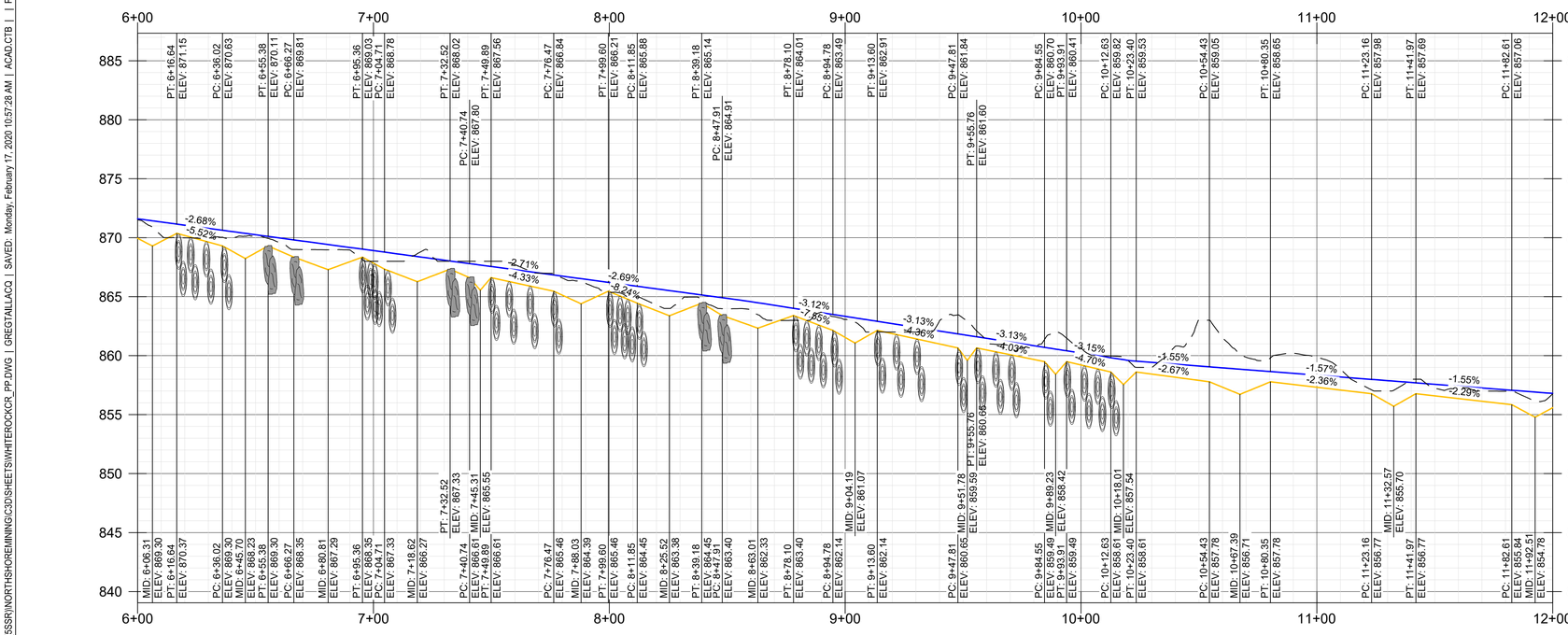

TYPICAL SECTION - RIFFLE
NTS




TYPICAL SECTION - POOL (RIGHT)
NTS




TYPICAL SECTION - POOL (LEFT)
NTS




SCALE: HOR 1" =1'; VERT 1"= 0.20'

NOT TO SCALE

| APPROVED BY: KA | CHECKED BY: MJG | DRAWN BY: GET |
|---|---|---|
| REV | DESCRIPTION | APPRV |
| 1 | DRAFT 30% DESIGN | XX |
| XX | XX | XX |
| XX | XX | XX |
| XX | XX | XX |
| XX | XX | XX |
| XX | XX | XX |
| XX | XX | XX |
| XX | XX | XX |

# WHITE ROCK CREEK STREAM RESTORATION NEAR SILVER BAY LAKE COUNTY, MN

## DRAFT 30% DESIGN - NOT FOR CONSTRUCTION WHITE ROCK CREEK - UPPER PLAN AND PROFILE - (2) STA 6+00 TO 12+00


CLIFFS
NORTHSHORE MINING CO
10 OUTER DR
SILVER BAY, MN 55614
---
BEAVER RIVER CONSULTING
BEAVER RIVER CONSULTING, LLC.
5752 EAGLE VIEW DRIVE
DULUTH, MN 55803
---

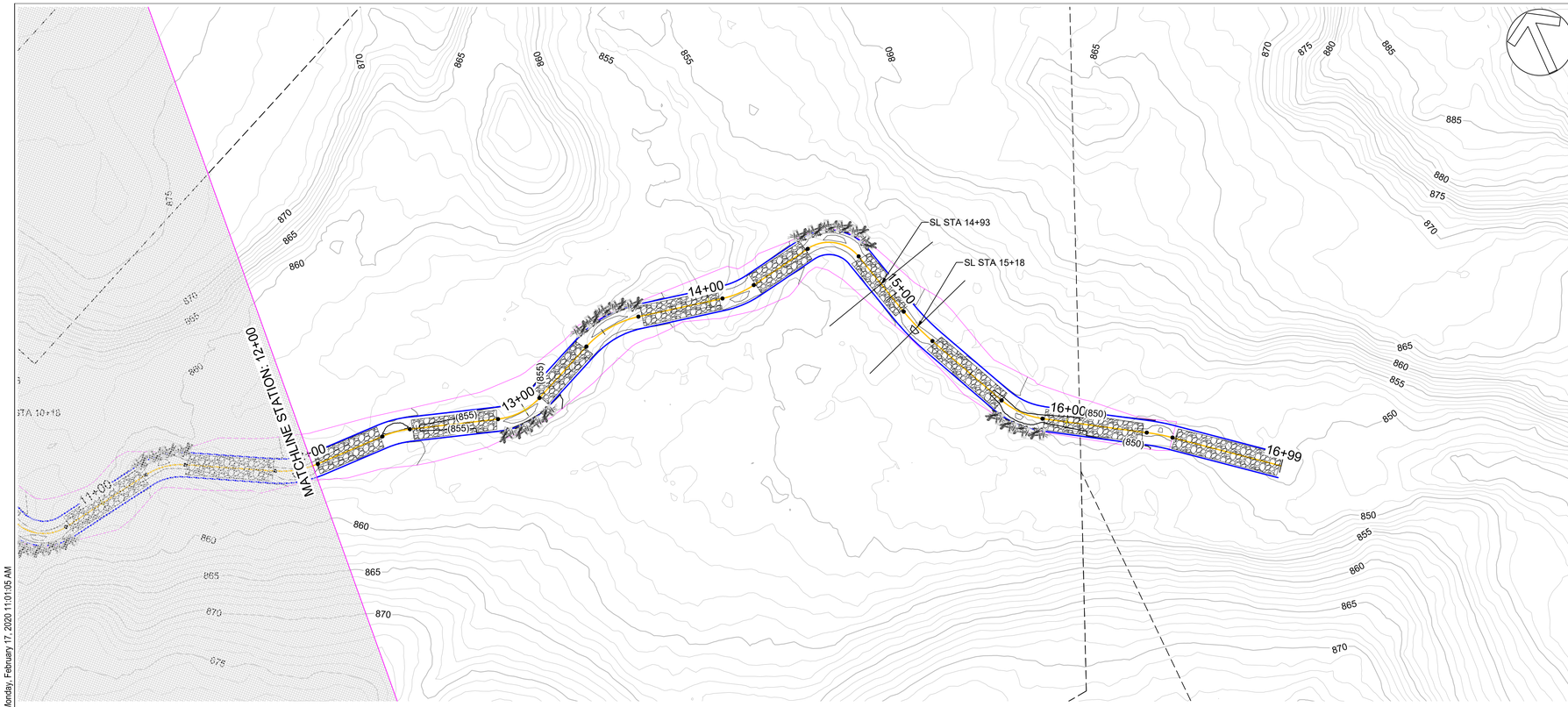

CONCEPT DESIGN
NOT FOR
CONSTRUCTION

DATE: 2/17/2020
SCALE (34"X22"): 1" = 30'
SCALE (17"X11"): 1" = 60'

0 30 60
SCALE IN FEET

SHEET NUMBER
12 OF 20


E:\DROPBOX (SSSR)\NORTHSHOREMINING\C3D\SHEETS\WHITEROCKCR_PP.DWG | GREGTALLACQ | SAVED: Monday, February 17, 2020 10:57:28 AM | ACAD.CTB | | PLOTTED: Monday, February 17, 2020 11:00:49 AM




## PLAN LEGEND

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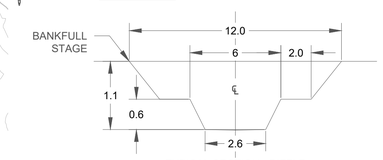
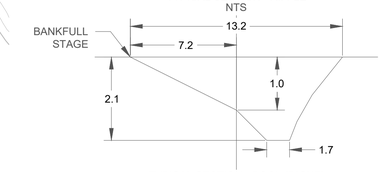
## PROFILE LEGEND

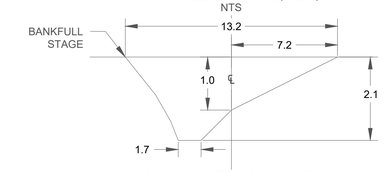
- PROPOSED STREAM CENTER LINE
- PROPOSED BANKFULL TOB
- EXISTING GROUND
- STRUCTURE BOULDER
- HEADER AND FOOTER BOULDER
- STRUCTURE LOG
- AUGMENTED RIFFLE



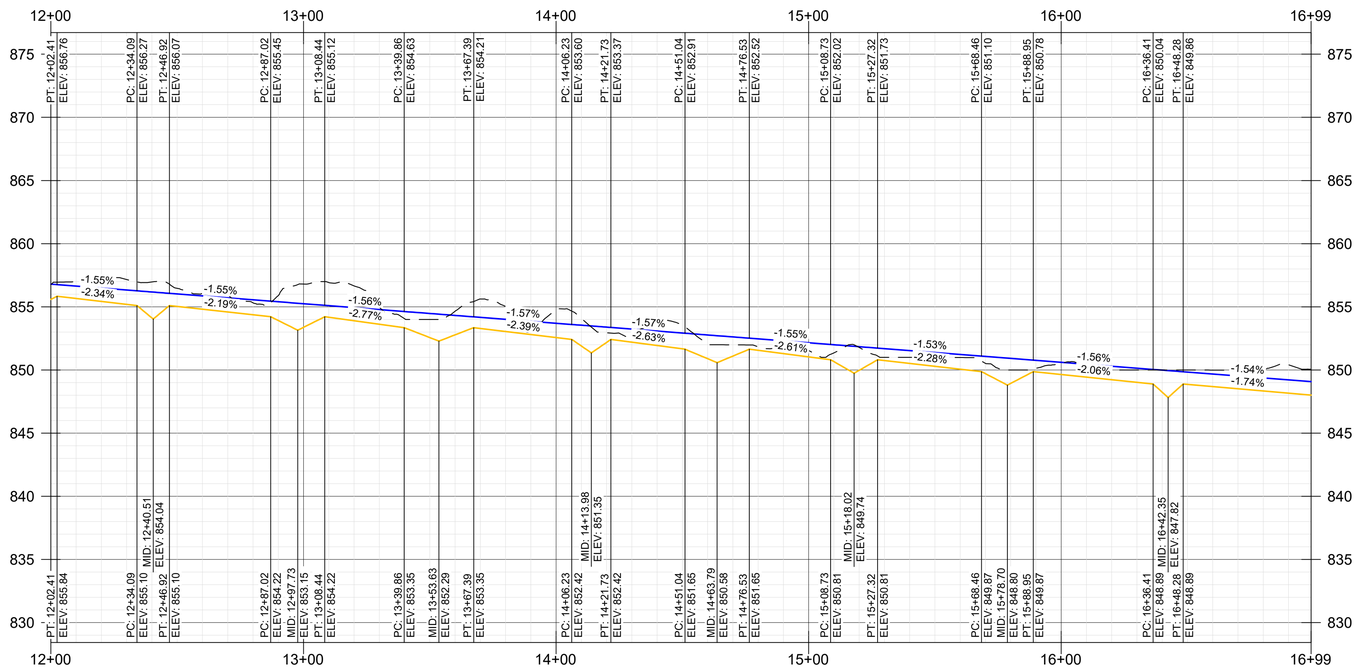

TYPICAL SECTION - RIFFLE
NTS




TYPICAL SECTION - POOL (RIGHT)
NTS




TYPICAL SECTION - POOL (LEFT)
NTS




SCALE: HOR 1" =1'; VERT 1"= 0.20'

NOT TO SCALE

| REV | DESCRIPTION | CHECKED BY: MJG | DRAWN BY: GET | APPRV |
|---|---|---|---|---|
| 1 | DRAFT 30% DESIGN | XX | XX | XX |
| XX | XX | XX | XX | XX |
| XX | XX | XX | XX | XX |
| XX | XX | XX | XX | XX |
| XX | XX | XX | XX | XX |
| XX | XX | XX | XX | XX |
| XX | XX | XX | XX | XX |
| XX | XX | XX | XX | XX |

APPROVED BY: KA

# WHITE ROCK CREEK STREAM RESTORATION NEAR SILVER BAY LAKE COUNTY, MN

## DRAFT 30% DESIGN - NOT FOR CONSTRUCTION
## WHITE ROCK CREEK - UPPER
## PLAN AND PROFILE - (3)
## STA 12+00 TO 16+99


CLIFFS
NORTHSHORE MINING CO
10 OUTER DR
SILVER BAY, MN 55614
---
BEAVER RIVER CONSULTING
BEAVER RIVER CONSULTING, LLC.
5752 EAGLE VIEW DRIVE
DULUTH, MN 55803
---


CONCEPT DESIGN
NOT FOR
CONSTRUCTION

DATE: 2/17/2020
SCALE (34"X22"): 1" = 30'
SCALE (17"X11"): 1" = 60'

0 30 60
SCALE IN FEET

SHEET NUMBER
13 OF 20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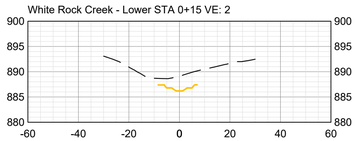
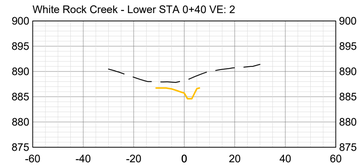
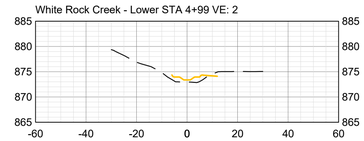
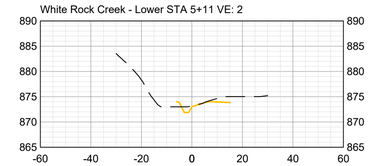
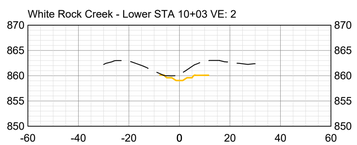
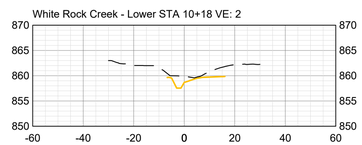


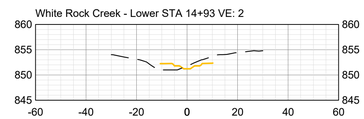



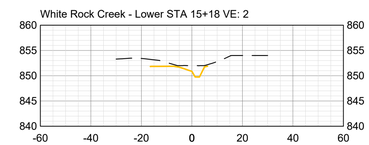




SECTION LEGEND

DESIGN SURFACE

EXISTING GROUND

| APPROVED BY: KA | CHECKED BY: MJG | DRAWN BY: GET |
|---|---|---|
| REV | DESCRIPTION | APPRV |
| 1 | DRAFT 30% DESIGN | XX |
| XX | XX | XX |
| XX | XX | XX |
| XX | XX | XX |
| XX | XX | XX |
| XX | XX | XX |
| XX | XX | XX |
| XX | XX | XX |

WHITE ROCK CREEK
STREAM RESTORATION
NEAR SILVER BAY
LAKE COUNTY, MN

DRAFT 30% DESIGN - NOT FOR CONSTRUCTION
WHITE ROCK CREEK - LOWER
SECTIONS - (1)
STA 0+15 TO 15+18

CLIFFS

NORTHSHORE MINING CO
10 OUTER DR
SILVER BAY, MN 55614
---

BEAVER RIVER CONSULTING

BEAVER RIVER CONSULTING, LLC.
5752 EAGLE VIEW DRIVE
DULUTH, MN 55803
---

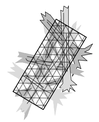
CONCEPT DESIGN
NOT FOR
CONSTRUCTION

DATE: 2/17/2020
SCALE (34"X22"): 1" = 30'
SCALE (17"X11"): 1" = 60'

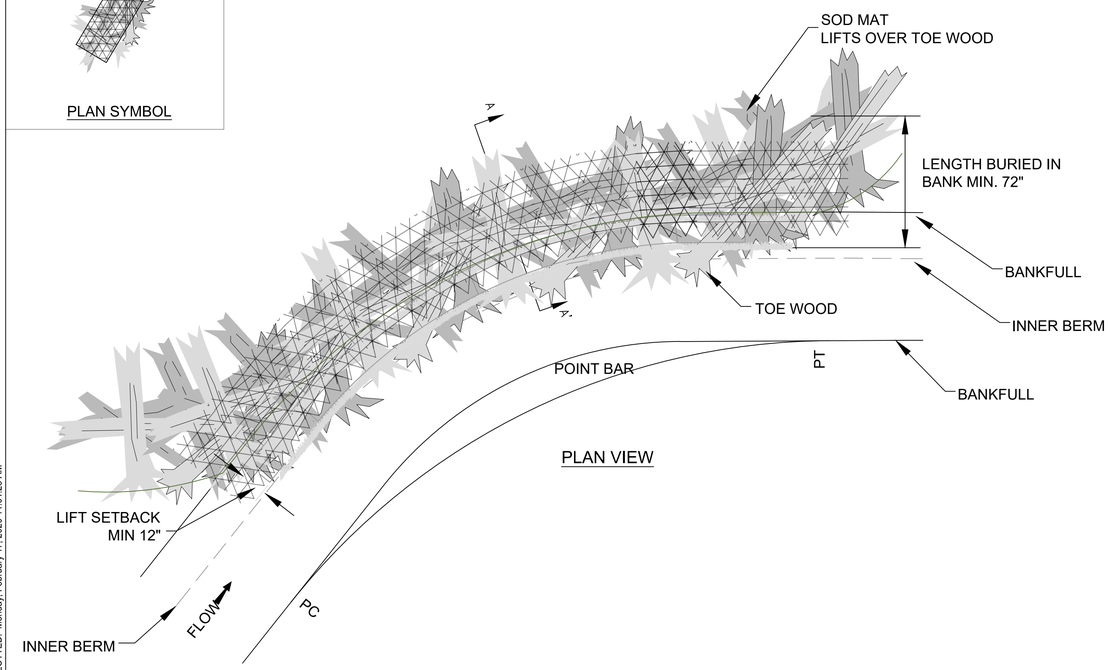
0 30 60
SCALE IN FEET

SHEET NUMBER
14 OF 20

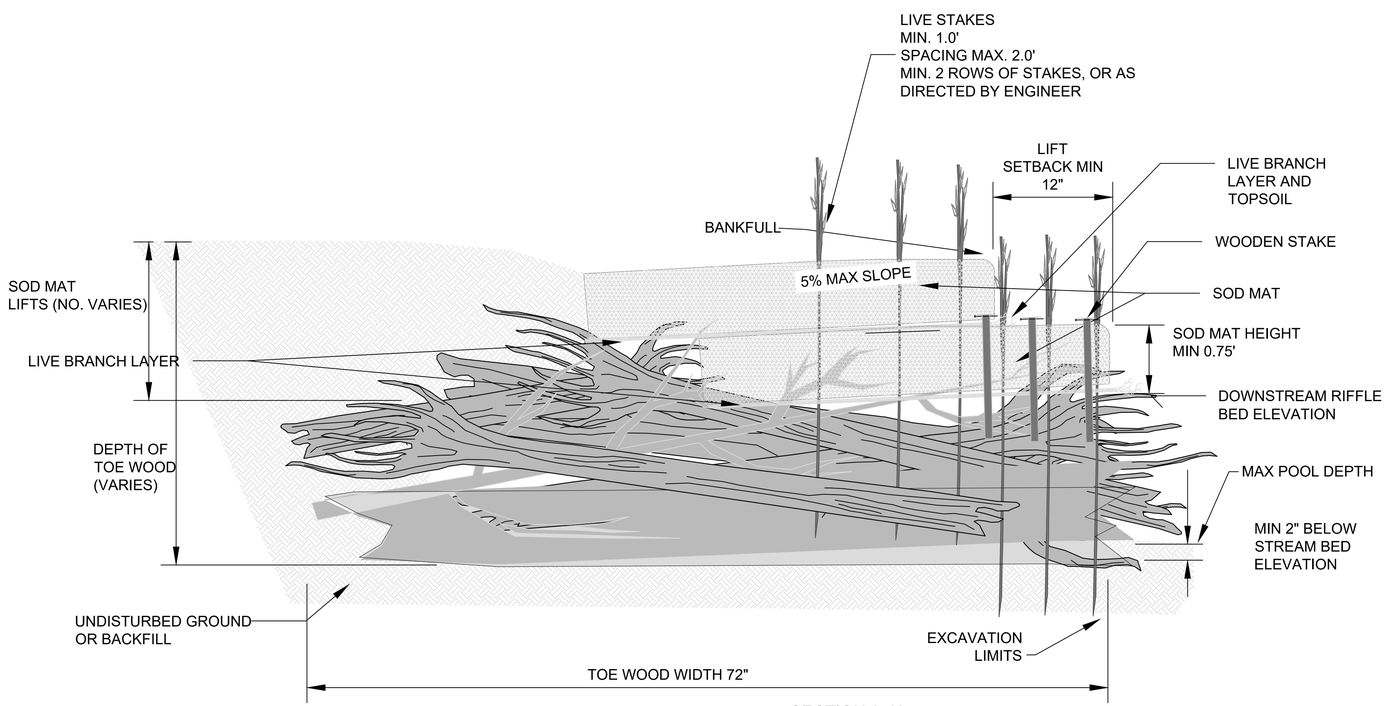
E:\DROPBOX (SSSR)\NORTHSHOREMINING\C3D\SHEETS\WHITEROCKCR_SECTIONS.DWG | GREGTALLACQ | SAVED: Friday, February 14, 2020 11:52:03 AM | ACAD.CTB | | PLOTTED: Monday, February 17, 2020 11:01:16 AM



PLAN SYMBOL




PLAN VIEW




SECTION A-A'

DETAIL - TOE WOOD WITH SOD MAT

NOT TO SCALE

TOE WOOD WITH SOD MAT
CONSTRUCTED NOVEMBER 2018

NOTES:

1. THIS STRUCTURE PROVIDES PROTECTION TO THE BANKS OF NEWLY CONSTRUCTED STREAM CHANNELS. WOODY DEBRIS OF ALL SIZES CAN BE USED IN THE CONSTRUCTION OF THIS STRUCTURE. THE STABILITY OF THE LOWER PORTION OF THE STREAMBANK IS CRITICAL TO THE SUCCESS OF THE PROJECT. THE INSTALLATION OF ALTERNATE BANK PROTECTION STRUCTURES (E.G., HAY/STRAW BALES) WILL ONLY BE CONSIDERED IF WOOD IS NOT AVAILABLE ONSITE.

2. COARSE/LARGE WOODY DEBRIS CONSISTS OF LOGS, ROOTWADS, AND LARGE BRANCHES WHICH ARE NOT SUITABLE FOR CONSTRUCTION OF LOG STRUCTURES. ALL MATERIALS ARE TO BE APPROVED BY THE ENGINEER.

3. A TRENCH SHALL BE EXCAVATED ALONG THE OUTER BANK OF THE POOL. THE BOTTOM ELEVATION OF THE TRENCH SHALL BE AT OR BELOW MAX. POOL DEPTH.

4. COARSE/LARGE WOODY DEBRIS SHALL BE INSTALLED IN THE TRENCH WITH THE LARGEST MATERIAL PLACED FIRST. THE LOGS OR WOOD MATERIAL SHALL BE PLACED PERPENDICULAR TO THE FLOW OF WATER. LOGS SHALL BE PLACED IN A CROSSING PATTERN OR WEAVE SUCH THAT EACH LOG/BRANCH IS ANCHORED BY ANOTHER LOG/BRANCH. THE COARSE/LARGE WOODY DEBRIS SHALL BE INSTALLED TO A HEIGHT OF 3/4 OF THE FINISHED HEIGHT OF THE WOODY DEBRIS WITH THE FINE/SMALL WOODY DEBRIS MAKING UP THE REMAINING 1/4 OF THE TOTAL HEIGHT.

5. FINE/SMALL WOODY DEBRIS CONSISTS OF MEDIUM TO SMALL LIMBS, BRANCHES, BUSHES, AND/OR SMALL LOGS. INVASIVE SPECIES SHALL NOT BE USED. ALL MATERIALS ARE TO BE APPROVED BY THE ENGINEER.

6. FINE/SMALL WOODY DEBRIS SHALL BE PLACED ON TOP OF THE COARSE/LARGE WOODY DEBRIS WITH THE LARGEST MATERIAL BEING PLACED FIRST AND THE SMALLEST MATERIAL PLACED LAST. THE FINE WOODY DEBRIS SHALL BE INSTALLED TO AN ELEVATION EQUAL TO THE INVERT OF THE DOWNTREAM RIFFLE.

7. ALL WOODY DEBRIS SHALL BE COMPACTED WITH THE EXCAVATOR BUCKET IN ORDER TO REDUCE THE PRESENCE OF VOIDS IN THE SMALL/FINE WOODY DEBRIS LAYER AND TO KEEP FUTURE SETTLING TO A MIN.

8. SELECT BACKFILL/TOPSOIL SHALL BE INSTALLED 1. ON TOP OF WOODY DEBRIS TO CREATE A LEVEL SUBSTRATE FOR THE SOD MATS.

9. A THIN LAYER OF LIVE BRANCHES (3-5' IN LENGTH) AND TOPSOIL SHALL BE PLACED ON TOP OF THE BALES. THE LIVE BRANCHES SHALL BE OF THE SPECIES SPECIFIED FOR LIVE STAKES OR APPROVED BY THE ENGINEER AND SHALL EXCLUDE INVASIVE SPECIES.

10. NATIVE SOD MATS SHALL BE HARVESTED ONSITE. THEY SHALL BE WEED FREE AND APPROXIMATELY 3' X 3' WITH A MINIMUM OF 8" OF INTACT SOIL AND ROOTMASS ATTACHED. THE SOD MATS ARE TO BE INSTALLED ON TOP OF THE LIVE BRANCH LAYER.

11. REPEAT NUMBERS 9 AND 10 UNTIL THE FINISHED ELEVATION EQUALS THE ELEVATION OF BANKFULL.

12. THE TOP OF THE SOD MAT SHALL BE FLAT WITHIN THE LIFT SETBACK DISTANCE SPECIFIED IN THE STRUCTURE TABLE. BEYOND THE LIFT SETBACK DISTANCE, THE SOIL BACKFILL SHALL BE SLOPED AT AN APPROXIMATE 5% SLOPE AWAY FROM THE STREAM.

13. THE SURFACE OF THIS STRUCTURE SHALL BE FINISHED TO A SMOOTH AND COMPACT SURFACE IN ACCORDANCE WITH THE LINES, GRADES, AND CROSS-SECTIONS OR ELEVATIONS SHOWN ON THE DRAWINGS. THE DEGREE OF FINISH FOR ELEVATIONS SHALL BE WITHIN +/- 0.1' OF THE GRADES AND ELEVATIONS INDICATED ON THE PLANS OR APPROVED BY THE ENGINEER.

14. DRESSING OF CHANNEL AND BANKFULL BENCH/FLOODPLAIN WILL LIKELY BE REQUIRED FOLLOWING INSTALLATION OF BANK STRUCTURES AND SHALL BE CONSIDERED INCIDENTAL TO CONSTRUCTION.

15. LIVE STAKES SHALL BE OF SPECIES APPROVED BY THE ENGINEER. LIVE STAKES SHALL BE 2-3' LONG AND A MIN. OF 1" IN DIAMETER AND INSTALLED WITH 2/3 OF THE LENGTH BELOW GROUND WITH A MINIMUM OF 2 BUD SCARS BELOW THE GROUND AND 2 ABOVE GROUND. SEE LIVE STAKE DETAIL.

16. LIVE STAKES SHALL BE PLACED ON THE SLOPE FROM THE INNER BERM TO HALF BANK FULL HEIGHT.

17. WOODEN STAKES SHALL BE 1 X 2" AND A MIN.. OF 18" LONG. WOODEN STAKES SHALL BE INSTALLED FROM THE INNER BERM TO BANKFULL ON 18-24" CENTERS PER THE ENGINEER'S INSTRUCTIONS.

APPROVED BY: KA | CHECKED BY: MJG | DRAWN BY: GET

| REV | DESCRIPTION | APPRV |
|---|---|---|
| 1 | DRAFT 30% DESIGN | XX |
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WHITE ROCK CREEK
STREAM RESTORATION
NEAR SILVER BAY
LAKE COUNTY, MN

DRAFT 30% DESIGN - NOT FOR CONSTRUCTION

DETAIL - TOE WOOD


CLIFFS

NORTHSHORE MINING CO
10 OUTER DR
SILVER BAY, MN 55614

BEAVER RIVER CONSULTING

BEAVER RIVER CONSULTING, LLC.
5752 EAGLE VIEW DRIVE
DULUTH, MN 55803


CONCEPT DESIGN
NOT FOR
CONSTRUCTION

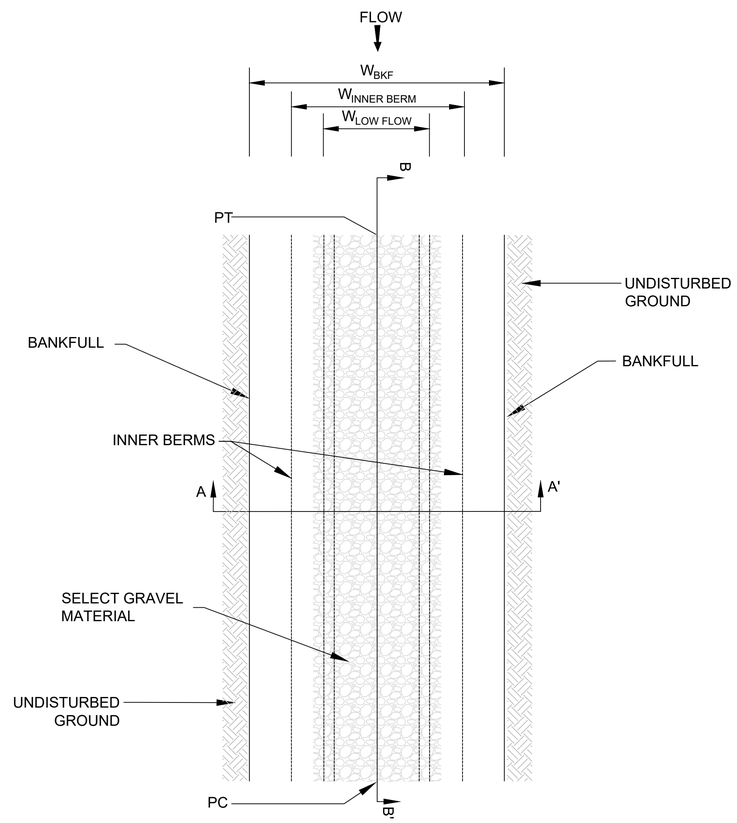
DATE: 2/17/2020

NTS

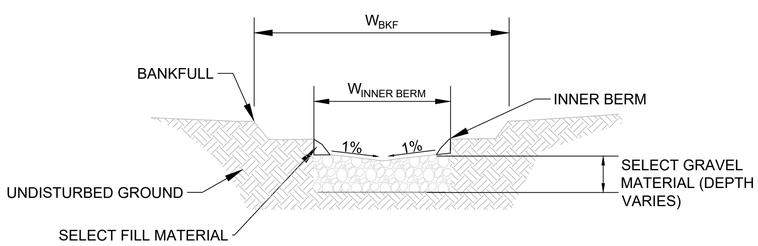
SHEET NUMBER
15 OF 20


E:\DROPBOX (SSSR)\NORTHSHOREMINING\C3D\SHEETS\NORTHSHORE\WHITEROCKCRMASTERDETAIL.DWG | GREGTALLACQ | SAVED: Friday, February 14, 2020 11:50:23 AM | ACAD.CTB | | PLOTTED: Monday, February 17, 2020 11:01:28 AM

PLAN SYMBOL




PLAN VIEW




CROSS-SECTION A-A'

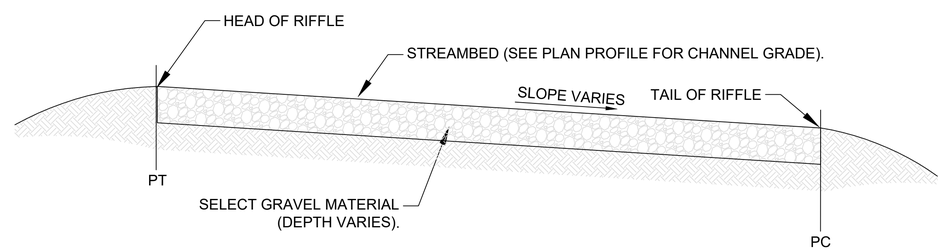
## DETAIL - AUGMENTED RIFFLE

NOT TO SCALE

CONSTRUCTED RIFFLE WITH IMPORTED MATERIAL

NOTES:

1. THE AUGMENTED RIFFLE IS GENERALLY INSTALLED IN A NEW CHANNEL TO PROVIDE GRADE CONTROL AND PREVENT DOWNCUTTING. MATERIAL IS IMPORTED TO THE SITE BECAUSE APPROPRIATELY SIZED MATERIAL IN NOT AVAILABLE ON-SITE.
2. THIS ENGINEER WILL SPECIFY THE SIZE OF THE MATERIAL TO BE USED IN THE RIFFLE AND MUST APPROVE IT BEFORE IT IS INSTALLED. THE CONTRACTOR MAY USE MATERIAL AVAILABLE ON-SITE IF APPROVED BY THE ENGINEER.
3. THE CONTRACTOR SHALL EXCAVATE A TRENCH THAT EXTENDS THE LENGTH OF THE RIFFLE (AS SHOWN ON THE PLANSHEETS) AND FROM INNER BERM TO INNER BERM. THE CONTRACTOR SHALL EXCAVATE TO A DEPTH OF 24" OR THREE TIMES THE D84 OF THE MATERIAL SPECIFIED BY THE ENGINEER, WHICHEVER IS GREATER. THE CONTRACTOR SHALL NOT DISTURB THE SURROUNDING GROUND.
4. THE CONTRACTOR SHALL FILL THE TRENCH WITH THE GRAVEL MATERIAL SPECIFIED AND APPROVED BY THE ENGINEER. THE GRAVEL MATERIAL SHALL BE COMPACTED USING EQUIPMENT SO THAT FUTURE SETTLEMENT OF THE MATERIAL WILL BE MINIMAL.
5. THE GRAVEL MATERIAL SHALL BE COMPACTED SUCH THAT, IN CROSS-SECTION, THERE IS A 1% SLOPE TO THE CENTER OF THE CHANNEL OR AS GENERATED BY THE 3D SURFACE.
6. SELECT FILL MATERIAL APPROVED BY THE ENGINEER SHALL BE PLACED ACCORDING TO THE TYPICAL CROSS-SECTIONS TO CREATE A SMOOTH SLOPED TRANSITION FROM THE INNER BERM TO THE GRAVEL MATERIAL COMPRISING THE RIFFLE.
7. THE SURFACE OF THE RIFFLE SHALL BE FINISHED TO THE FINAL GRADES AS SHOWN ON THE PLANSHEETS. THE DEGREE OF TOLERANCE FOR ALL ELEVATIONS SHALL BE WITHIN +/- 0.1' OF THE GRADES AND ELEVATIONS SPECIFIED ON THE PLANS.
8. FINAL GRADING AND TOP DRESSING OF THE INNER BERM AND BANKFULL BENCH TO THE FLOODPLAIN IS REQUIRED FOLLOWING THE INSTALLATION OF THE CONSTRUCTED RIFFLE AND SHALL BE CONSIDERED INCIDENTAL TO CONSTRUCTION.
9. BANK TREATMENTS SHALL BE INSTALLED AFTER FINAL GRADING AND TOP DRESSING. SEE THE PLANSHEETS FOR THE BANK TREATMENT TYPE.




PROFILE B-B'

| APPROVED BY: KA | CHECKED BY: MJG | DRAWN BY: GET | |
|---|---|---|---|
| REV | DESCRIPTION | | APPRV |
| 1 | DRAFT 30% DESIGN | | XX |
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WHITE ROCK CREEK
STREAM RESTORATION
NEAR SILVER BAY
LAKE COUNTY, MN

DRAFT 30% DESIGN - NOT FOR CONSTRUCTION

DETAIL - AUGMENTED RIFFLE

CLIFFS

NORTHSHORE MINING CO
10 OUTER DR
SILVER BAY, MN 55614

BEAVER RIVER CONSULTING

BEAVER RIVER CONSULTING, LLC.
5752 EAGLE VIEW DRIVE
DULUTH, MN 55803

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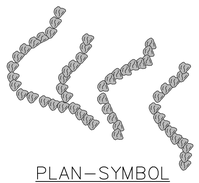
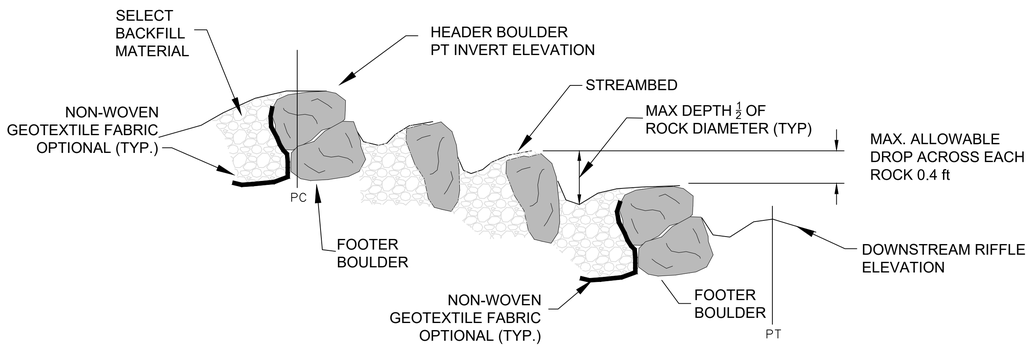
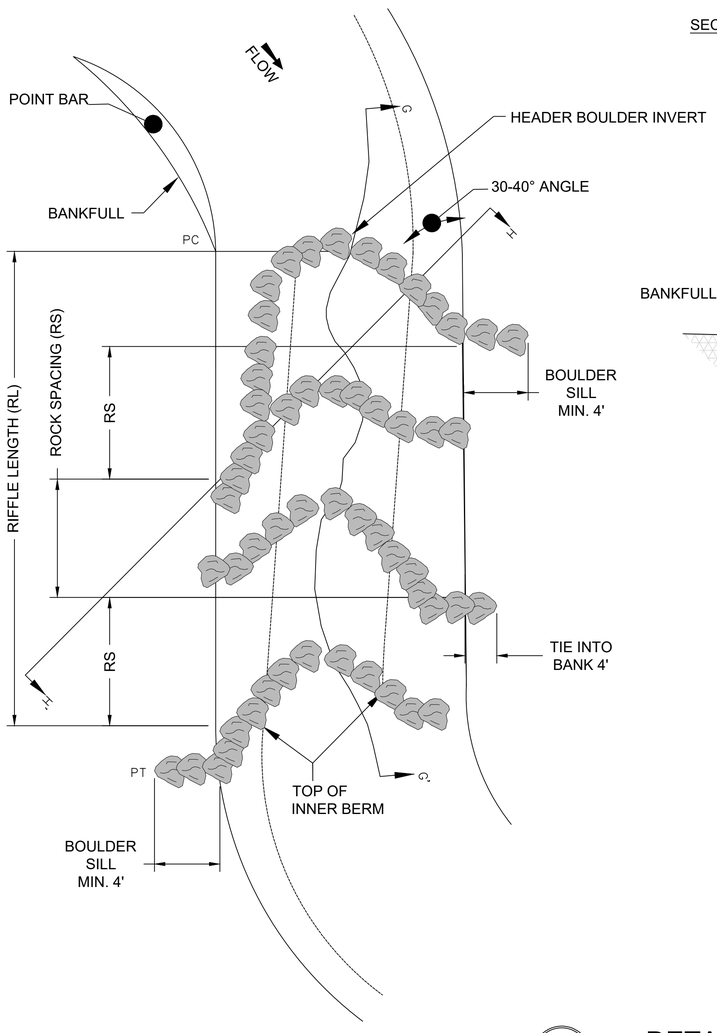
E:\DROPBOX (SSSR)\NORTHSHOREMINING\C3D\SHEETS\NORTHSHOREWHITEROCKCRMASTERDETAIL.DWG | GREGTAILLACQ | SAVED: Friday, February 14, 2020 11:50:23 AM | ACAD.CTB | | PLOTTED: Monday, February 17, 2020 11:01:28 AM

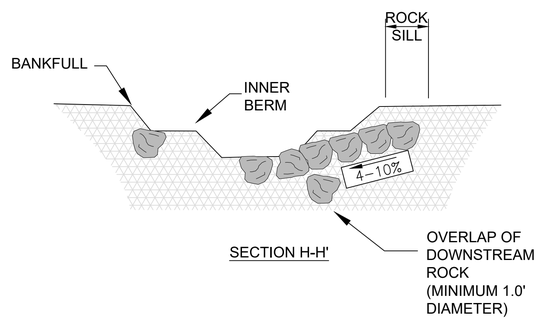



SECTION G-G'




PLAN VIEW




SECTION H-H'

# DETAIL - BOULDER CONSTRUCTED RIFFLE
NOT TO SCALE

BOULDER CONSTRUCTED RIFFLE
CONSTRUCTED MARCH 2019

NOTES:

1. BOULDERS FOR THE CONSTRUCTED RIFFLE MUST BE A MIN. OF 1-2 TON BOULDER WITH A MIN. DIAMETER OF 2-3'.
2. THE UPSTREAM AND DOWNSTREAM HEADER BOULDERS SHALL BE UNDERLAIN BY FOOTER BOULDERS UNLESS OTHERWISE DIRECTED BY THE ENGINEER.
3. HEADER BOULDERS ARE THE TOP MOST BOULDERS USED IN EACH STRUCTURE. HEADER BOULDERS FOR THIS STRUCTURE ARE ONLY VISIBLE BETWEEN THE INNER BERMS.
4. HEADER BOULDERS SHALL BE OFFSET SLIGHTLY UPSTREAM OF THE FOOTER BOULDERS. FOOTER BOULDERS SHALL BE INSTALLED BEFORE THE HEADER BOULDERS.
5. SET INVERTS AT ELEVATION SHOWN ON PLAN AND PROFILE SHEETS. INVERTS AND ELEVATIONS WILL BE PROVIDED TO THE CONTRACTOR AS A 2014 FORMAT DWG FILE. NO ELEVATIONS OF THE CONSTRUCTED RIFFLE ARMS MAY VARY FROM THE PLAN LOCATIONS WITHOUT DIRECTION FROM THE ENGINEER.
6. THE DROP IN ELEVATION ACROSS THE STRUCTURE SHALL NOT EXCEED 0.5FT UNLESS OTHERWISE DIRECTED BY THE ENGINEER.
7. MINI-VANES WILL BE SPACED IN THE RIFFLE AS A FUNCTION OF THE RIFFLE LENGTH.
8. THE MOST UPSTREAM RIFFLE MINI-VANE ARM SHALL BE PLACED SUCH THAT THE BANK TIE-IN IS ON THE SAME SIDE AS THE NEXT UPSTREAM OUTSIDE BEND IN ORDER TO SERVE AS A VANE AND HELP DIRECT STREAM FLOW AWAY FROM THE PREVIOUS OUTSIDE BEND. LOCATION OF ALL RIFFLE VANE ARMS ARE SHOWN ON THE PLAN AND PROFILE SHEETS.
9. THE MOST DOWNSTREAM MINI-VANE ARM SHALL BE PLACED SUCH THAT THE HIGH POINT IS ON THE SAME SIDE AS THE NEXT DOWNSTREAM OUTSIDE BEND IN ORDER TO HELP DIRECT STREAM FLOW FROM THE NEXT OUTSIDE BEND.
10. THE VERTICAL SLOPE OF EACH MINI-VANE ARM SHALL NOT EXCEED 10% UNLESS OTHERWISE DIRECTED BY THE ENGINEER. THE SLOPES WILL BE DICTATED BY THE WIDTH-TO-DEPTH RATIO OF THE REACH, TYPICAL RIFFLE INNER BERM CHANNEL, VERTICAL DROP OVER THE LOG, AND LOG DIAMETER.
11. ALL GAPS/VOIDS LARGER THAN 2" BETWEEN THE HEADER AND FOOTER BOULDERS SHALL BE HAND CHINKED WITH COBBLE AND GRAVEL ON THE UPSTREAM SIDE PRIOR TO PLACEMENT OF THE GEOTEXTILE. ALL CHINKING SHALL BE APPROVED BY THE ENGINEER BEFORE THE MINI-VANES ARE BACKFILLED.
12. THE UPSTREAM SIDE OF THE FIRST AND LAST MINI-VANE ARM REQUIRE A LAYER OF NON-WOVEN GEOTEXTILE FABRIC THAT SHALL BE PLACED AS SHOWN IN THE GEOTEXTILE PLACEMENT DETAIL THE ENTIRE LENGTH OF THE MINI-VANE.
13. BACKFILL VANES WITH SELECT BACKFILL MATERIAL AS SHOWN AND DEFINED IN THE CONSTRUCTED RIFFLE DETAIL. BACKFILL MATERIAL TO HAVE D100 OF 8" AND D50 OF 4".
14. SELECT BACKFILL AND SOIL BACKFILL MATERIAL SHALL BE COMPACTED SUCH THAT FUTURE SETTLEMENT OF THE MATERIAL IS KEPT TO A MINIMUM.
15. THE SURFACE OF THIS STRUCTURE SHALL BE FINISHED TO A SMOOTH AND COMPACT SURFACE IN ACCORDANCE WITH THE LINES, GRADES, AND CROSS-SECTIONS OR ELEVATIONS SHOWN ON THE DRAWINGS. THE DEGREE OF FINISH FOR INVERT ELEVATIONS SHALL BE WITHIN 0.1' OF THE GRADES AND ELEVATIONS INDICATED, PROVIDED ANY HEIGHT DOES NOT EXCEED MAX. ALLOWABLE DROP OF 0.5' FOR THIS STRUCTURE.
16. RE-DRESSING OF CHANNEL AND BANKFULL BENCH/FLOODPLAIN WILL LIKELY BE REQUIRED FOLLOWING INSTALLATION OF IN-STREAM STRUCTURES AND SHALL BE CONSIDERED INCIDENTAL TO CONSTRUCTION.
17. FOOTER DEPTH ON ALL STRUCTURES REQUIRING FOOTERS SHALL BE 6 TIMES GREATER THAN THE DROP BETWEEN THE STRUCTURE AND THE FOOTERED STRUCTURE DIRECTLY UPSTREAM.
18. THE DEPARTURE ANGLE SHOWN ABOVE IS DEPICTED IN SUCH A WAY TO EMPHASIZE DETAIL. ACTUAL DEPARTURE ANGLE SHALL BE AS SHOWN ON THE PLAN AND PROFILE SHEETS WILL BE PROVIDED TO THE CONTRACTOR AS A 2014 FORMAT DWG FILE AND LN3 FILE.

APPROVED BY: KA | CHECKED BY: MJG | DRAWN BY: GET

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| 1 | DRAFT 30% DESIGN | XX |
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WHITE ROCK CREEK
STREAM RESTORATION
NEAR SILVER BAY
LAKE COUNTY, MN

DRAFT 30% DESIGN - NOT FOR CONSTRUCTION
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DETAIL - BOULDER CONSTRUCTED RIFFLE

CLIFFS

NORTHSHORE MINING CO
10 OUTER DR
SILVER BAY, MN 55614
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BEAVER RIVER CONSULTING

BEAVER RIVER CONSULTING, LLC.
5752 EAGLE VIEW DRIVE
DULUTH, MN 55803
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CONCEPT DESIGN
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DATE: 2/17/2020

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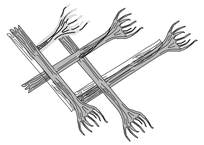
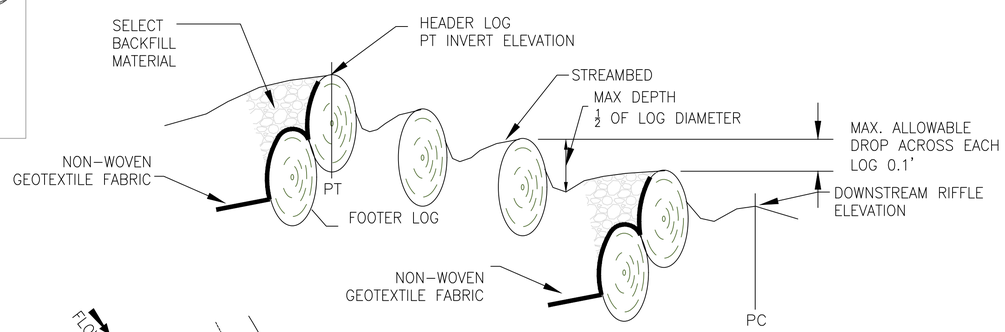
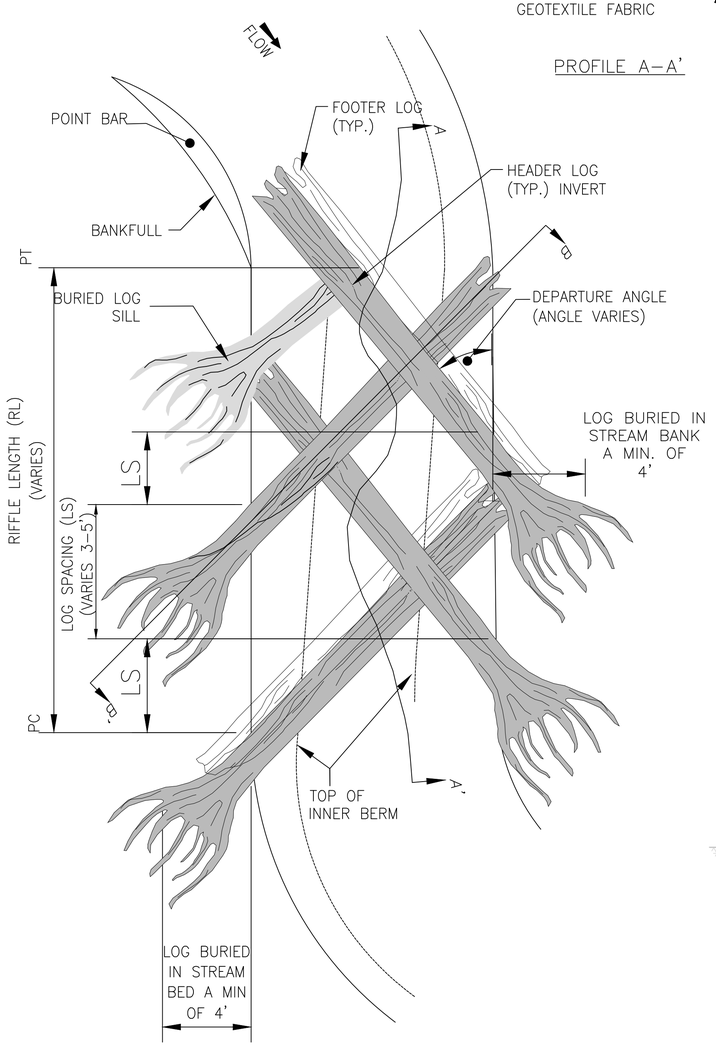


PLAN–SYMBOL

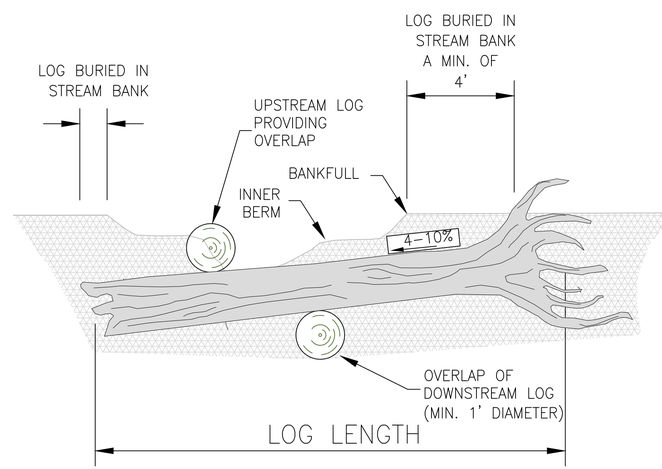



PROFILE A–A'




PLANVIEW

CONSTRUCTED LOG RIFFLE
CONSTRUCTED FEBRUARY 2019




SECTION B–B'

DETAIL – CONSTRUCTED LOG RIFFLE
NOT TO SCALE

NOTES:

1. THIS STRUCTURE HELPS MAINTAIN GRADE WITHIN A NEWLY CONSTRUCTED STREAM CHANNEL. IN GENERAL, IT IS USED IN LOCATIONS WHERE COARSE SUBSTRATE USED TO CONSTRUCT OTHER GRADE CONTROL STRUCTURES (E.G., AUGMENTED RIFFLE) IS NOT AVAILABLE. IF SUITABLE COARSE SUBSTRATE IS DISCOVERED ON SITE, THE CONTRACTOR MAY INSTALL A DIFFERENT GRADE CONTROL STRUCTURE WITH THE ENGINEER'S APPROVAL.

2. THE CONSTRUCTED LOG RIFFLE SHALL BE INSTALLED ON PERENNIAL REACHES THAT ARE REMOTE. BANKFULL WIDTHS OF THESE REACHES WILL BE BETWEEN 8-11', WITH SLOPES THAT RANGE FROM OF 1.5-2.5%. THE CONSTRUCTED LOG RIFFLE STRUCTURES ARE INTENDED FOR REACHES WITH LIMITED ACCESS AND WITH TREES AVAILABLE ONSITE.

3. LOGS SHALL HAVE MIN. DIAMETER OF 12". LOGS SHALL HAVE A MINIMUM LENGTH OF 10-50' DEPENDING ON THE REACH.

4. ALL LOGS SHALL BE RELATIVELY STRAIGHT AND LIMBS SHALL BE TRIMMED FLUSH.

5. THE LOGS AT THE UPSTREAM AND DOWNSTREAM END OF THE STRUCTURE WILL BE UNDERLAIN BY A FOOTER LOG (SOMETIMES CALLED A BACKER LOG) UNLESS OTHERWISE DIRECTED BY ENGINEER. THE HEADER LOG IS THE TOP LOG USED IN EACH PAIR. WHEN FINISHED, THE HEADER LOG IS VISIBLE ONLY BETWEEN THE INNER BERMS. THE HEADER LOG SHALL BE INSTALLED BEFORE THE FOOTER LOG. THE HEADER LOG DOES NOT REST ON THE TOP OF THE FOOTER LOG. THE FOOTER LOG IS INSTALLED FROM THE UPSTREAM SIDE AND INSTALLED AGAINST THE LOWER HALF OF THE HEADER LOG RESULTING IN A STAGGER WITH THE HEADER LOG BEING SLIGHTLY MORE DOWNSTREAM THAN THE FOOTER LOG.

6. THE OTHER LOGS IN THE STRUCTURE ARE SINGLE LOGS WITH NO FOOTER LOG.

7. SET INVERTS AT ELEVATIONS SHOWN ON THE PLAN AND PROFILE SHEETS. PLAN AND PROFILE SHEETS WILL BE PROVIDED TO THE CONTRACTOR AS A DWG FILE AND LN3 FILE. THE ELEVATIONS OF THE LOGS COMPRISING THE LOG CONSTRUCTED RIFFLE SHALL NOT VARY FROM THE PLAN UNLESS OTHERWISE DIRECTED BY THE ENGINEER.

8. THE MOST UPSTREAM LOG SHALL BE PLACED SUCH THAT THE BANK TIE-IN IS ON THE SAME SIDE AS THE NEXT UPSTREAM OUTSIDE BEND IN ORDER TO SERVE AS A VANE AND HELP DIRECT STREAM FLOW AWAY FROM THE PREVIOUS OUTSIDE BEND. LOCATION OF ALL RIFFLE LOG ARMS ARE SHOWN ON THE PLAN AND PROFILE SHEETS AND WILL BE PROVIDED TO THE CONTRACTOR AS A DWG FILE AND LN3 FILE. NO ELEVATIONS OF THE CONSTRUCTED RIFFLE ARMS MAY VARY FROM THE PLAN LOCATIONS WITHOUT DIRECTION FROM ENGINEER.

9. THE MOST DOWNSTREAM LOG SHALL BE PLACED SUCH THAT THE HIGH POINT IS ON THE SAME SIDE AS THE NEXT DOWNSTREAM OUTSIDE BEND IN ORDER TO HELP DIRECT STREAM FLOW AWAY FROM THE NEXT OUTSIDE BEND.

10. ALL LOGS ARE PLACED SUCH THAT THEY OVERLAP THE NEXT DOWNSTREAM LOG. THEREFORE, IT IS RECOMMENDED THAT THIS STRUCTURE BE CONSTRUCTED FROM DOWNSTREAM TO UPSTREAM.

11. THE VERTICAL SLOPE OF EACH LOG SHALL NOT EXCEED 10% WITH THE SPECIFIC VERTICAL SLOPE OF EACH LOG DETERMINED BY THE ENGINEER.

12. IT IS LIKELY THAT THE LOGS WILL REQUIRE NOTCHING WHERE THEY OVERLAP IN ORDER TO NOT EXCEED THE MAXIMUM VERTICAL SLOPE SPECIFICATION. THE CONTRACTOR SHOULD CHOOSE LOGS THAT CAN MEET THE SPECIFICATIONS OF THIS DETAIL

13. THE NOTCH DEPTH FOR ANY LOG SHALL NOT EXCEED HALF THE DIAMETER OF THE LOG UNLESS OTHERWISE DIRECTED BY THE ENGINEER. ANY NOTCHED LOGS SHALL BE APPROVED BY THE ENGINEER BEFORE THE LOGS ARE BACKFILLED.

14. ALL GAPS/VOIDS LARGER THAN 1" BETWEEN THE HEADER AND FOOTER LOGS SHALL BE CHINKED WITH LIMBS AND/OR BRUSH ON THE UPSTREAM SIDE PRIOR TO PLACEMENT OF THE GEOTEXTILE.

15. ON THE UPSTREAM SIDE OF THE LOGS A LAYER OF NON-WOVEN GEOTEXTILE FABRIC SHALL BE PLACED AS SHOWN IN THE DETAIL THE ENTIRE LENGTH OF THE LOG. SECURE THE GEOTEXTILE FABRIC TO THE UPSTREAM SIDE OF THE HEADER LOG USING 3" 10D GALVANIZED COMMON NAIL ON 12" SPACING.

16. SELECT BACKFILL MATERIAL SHALL BE PLACED UPSTREAM OF EACH LOG SUCH THAT FUTURE SETTLEMENT OF THE MATERIAL WILL BE MINIMAL. SELECT BACKFILL MATERIAL SHALL BE HAVE A MINIMUM D50 OF 60 MM. ANY DEVIATIONS IN THE GRADATION MUST BE APPROVED BY THE ENGINEER.

17. THE SURFACE OF THIS STRUCTURE SHALL BE FINISHED TO A SMOOTH AND COMPACT SURFACE IN ACCORDANCE WITH THE LINES, GRADES, AND CROSS-SECTIONS OR ELEVATIONS SHOWN ON THE DRAWINGS. THE DEGREE OF FINISH FOR INVERT ELEVATIONS SHALL BE WITHIN 0.1' OF THE GRADES AND ELEVATIONS INDICATED, PROVIDED ANY HEIGHT DOES NOT EXCEED MAX. ALLOWABLE DROP OF 0.1' OVER ANY ONE LOG AND 0.5' FOR THE ENTIRE STRUCTURE.

18. DRESSING OF CHANNEL AND BANKFULL BENCH/FLOODPLAIN WILL LIKELY BE REQUIRED FOLLOWING INSTALLATION OF IN-STREAM STRUCTURES.

19. THE DEPARTURE ANGLE SHOWN IN THE PLAN VIEW DRAWING IS DEPICTED IN SUCH A WAY TO EMPHASIZE DETAIL. ACTUAL DEPARTURE ANGLE SHALL BE AS SHOWN ON THE PLAN AND PROFILE SHEETS AND WILL BE PROVIDED TO THE CONTRACTOR AS A DWG FILE AND LN3 FILE.

1.

APPROVED BY: KA | CHECKED BY: MJG | DRAWN BY: GET

| REV | DESCRIPTION | APPRV |
|---|---|---|
| 1 | DRAFT 30% DESIGN | XX |
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WHITE ROCK CREEK
STREAM RESTORATION
NEAR SILVER BAY
LAKE COUNTY, MN

DRAFT 30% DESIGN - NOT FOR CONSTRUCTION
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DETAIL - LOG CONSTRUCTED RIFFLE


CLIFFS
NORTHSHORE MINING CO
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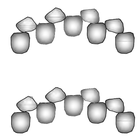


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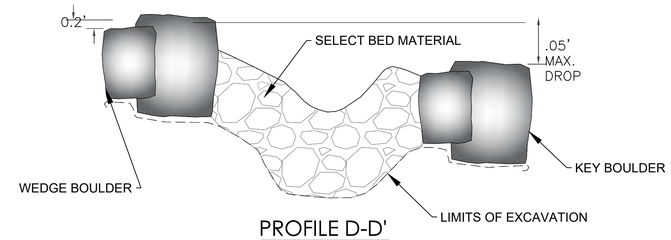
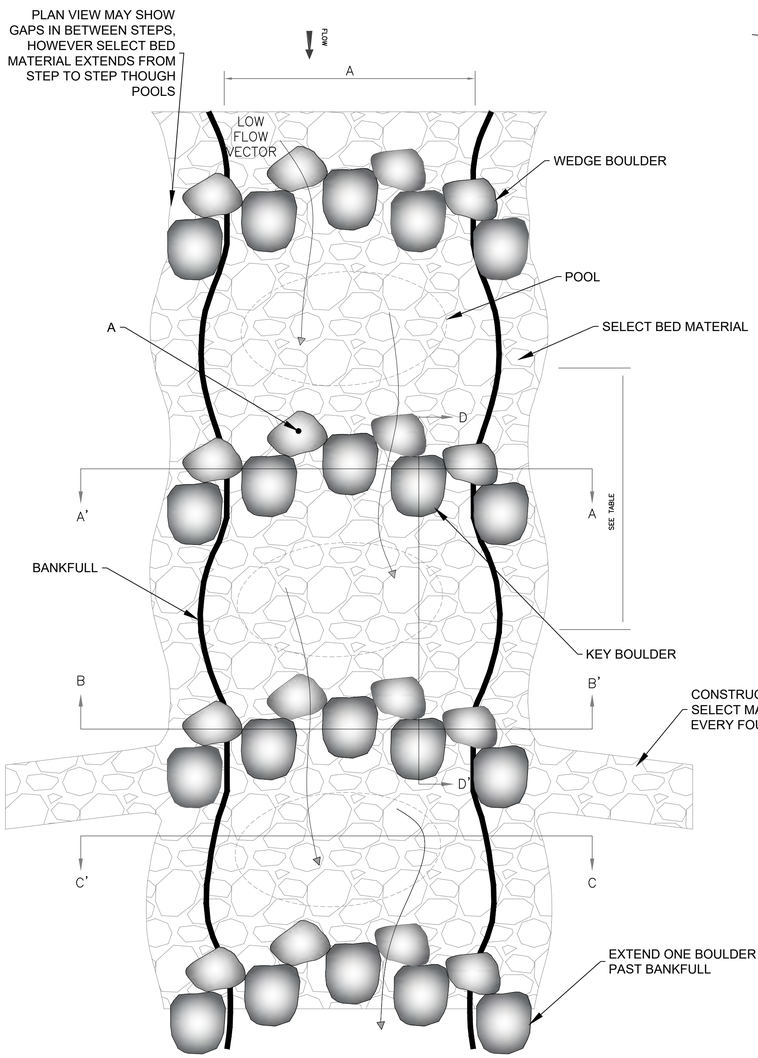
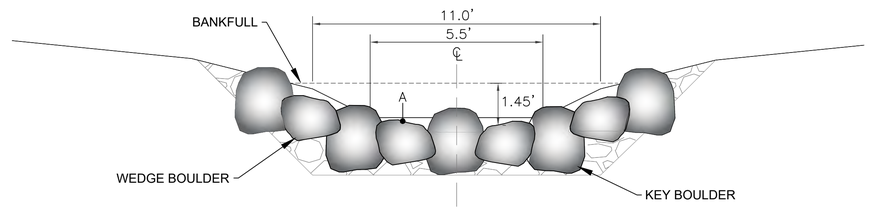


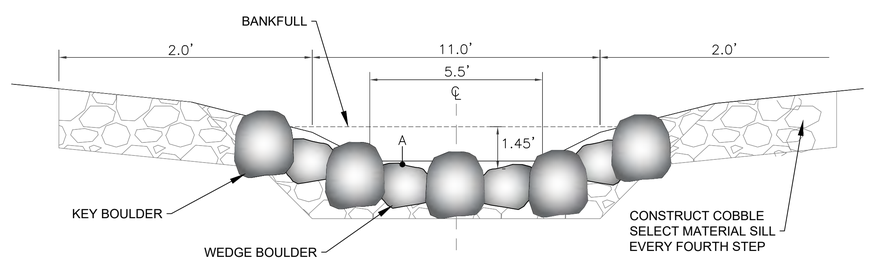

PROFILE D-D'



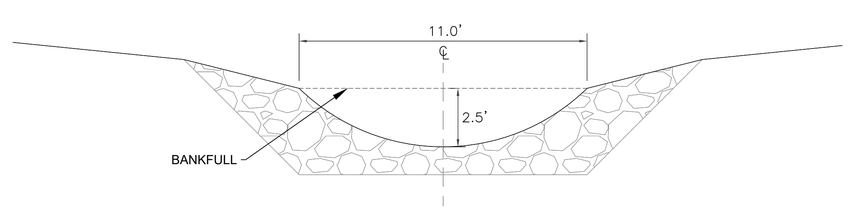

BOULDER STEP POOL




STEP SECTION A–A' (LOOKING DOWNSTREAM)




STEP SECTION B–B' (LOOKING UPSTREAM)




POOL SECTION C–C'

ROCK STEP POOL

NOTES:

1. SELECT BED MATERIAL SHALL BE SOURCED FROM ON–SITE EXISTING GRAVEL/COBBLE STREAM BED MATERIAL. REMOVE FROM CHANNEL, STOCKPILE, AND PLACE AS SHOWN ON DETAIL.
2. SELECT BED MATERIAL IS PLACED ALONG ENTIRE PROFILE.
3. KEY BOULDER DIMENSIONS ARE EQUAL TO 24" AND WEDGE BOULDERS ARE 18". BOULDERS SHALL BE SOURCED FROM ON–SITE MATERIAL AND MAY EXCEED DIMENSIONS NOTED.
4. BOULDER STEP POOL IS CONSTRUCTED BY FIRST PLACING KEY BOULDERS SUCH THAT THEY SPAN THE CHANNEL AS INDICATED IN THE DETAIL. WEDGE BOULDERS ARE PLACED IMMEDIATELY UPSTREAM OF THE KEY BOULDERS TO FILL GAPS BETWEEN KEY BOULDERS AND TO PROVIDE THE LOW–FLOW DROP. SELECT BED MATERIAL IS THEN PLACED TO CHINK THE GAPS BETWEEN ALL BOULDERS.
5. WEDGE BOULDERS SHOULD FIT TIGHTLY BETWEEN KEY BOULDERS SUCH THAT THEY CANNOT BE PUSHED THROUGH THE GAP BETWEEN THE KEY BOULDERS.
6. KEY BOULDERS ARE PLACED IN A SLIGHT ARCH ACROSS THE CHANNEL SUCH THAT THE APEX OF THE ARCH IS ORIENTED FACING UPSTREAM.
7. BOULDERS SHALL BE PLACED AS SHOWN IN THE DETAIL.
8. CHINKING THE GAPS BETWEEN THE BOULDERS WITH THE SELECT BED MATERIAL IS INCIDENTAL TO CONSTRUCTION AND SHALL BE ACCOUNTED FOR IN THE BID PRICE FOR THIS ITEM.
9. THE QUANTITY OF BOULDERS ILLUSTRATED IN THE DETAIL DOES NOT NECESSARILY EQUAL THE QUANTITY REQUIRED FOR THE STRUCTURE. SMALLER BOULDER STEP POOL WILL HAVE FEWER BOULDERS AND LARGER STEP POOL WILL HAVE MORE.
10. WEDGE BOULDER ELEVATIONS SHALL VARY VERTICALLY A SLIGHT AMOUNT IN CROSS–SECTION TO PROMOTE A LOW–FLOW PATH THAT ALTERNATES ACROSS THE CHANNEL.

APPROVED BY: KA | CHECKED BY: MJG | DRAWN BY: GET

| REV | DESCRIPTION | APPRV |
|---|---|---|
| 1 | DRAFT 30% DESIGN | XX |
| XX | XX | XX |
| XX | XX | XX |
| XX | XX | XX |
| XX | XX | XX |
| XX | XX | XX |
| XX | XX | XX |
| XX | XX | XX |

WHITE ROCK CREEK
STREAM RESTORATION
NEAR SILVER BAY
LAKE COUNTY, MN

DRAFT 30% DESIGN - NOT FOR CONSTRUCTION
---
DETAIL - ROCK STEP

CLIFFS
NORTHSHORE MINING CO
10 OUTER DR
SILVER BAY, MN 55614
---
BEAVER RIVER CONSULTING
BEAVER RIVER CONSULTING, LLC.
5752 EAGLE VIEW DRIVE
DULUTH, MN 55803
---

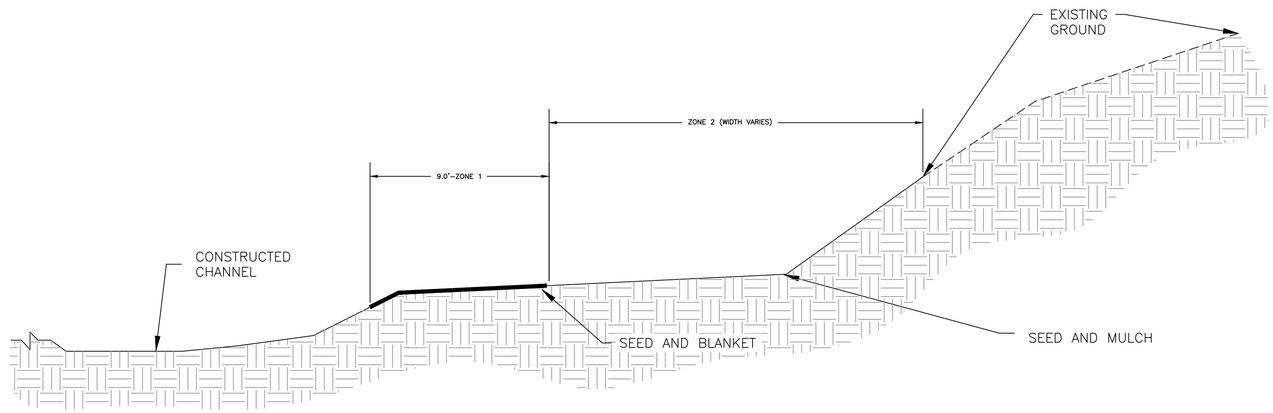
CONCEPT DESIGN
NOT FOR
CONSTRUCTION

DATE: 2/17/2020

NTS

SHEET NUMBER
19 OF 20

E:\DROPBOX (SSSR)\NORTHSHOREMINING\C3D\SHEETS\NORTHSHOREWHITEROCKCRMASTERDETAIL.DWG | GREGTALLACQ | SAVED: Friday, February 14, 2020 11:50:23 AM | ACAD.CTB | | PLOTTED: Monday, February 17, 2020 11:01:32 AM




ZONE PLANTING
TYPICAL CROSS SECTION DETAIL

## ZONE 1

PLANTING AREA-

MIN. 8' WIDE BANKFULL BENCH, IN ADDITION TO 1' INTO CHANNEL.

CANOPY-

THE FOLLOWING CANOPY PLANTS SHALL BE 1.5' HEIGHT CONTAINERIZED STOCK. PLANT AT 12 FOOT SPACING ABOVE BANKFULL ELEVATION:

1. WHITE SPRUCE (PICEA GLAUCA)-90%
2. *WHITE CEDAR (*THUJA OCCIDENTALIS)-10%*

SUB-CANOPY-

THE FOLLOWING SUB-CANOPY PLANTS SHALL BE 1.5' HEIGHT CONTAINERIZED STOCK. PLANT THE FOLLOWING EVERY 8 FOOT SPACING, AT OR ABOVE BANKFULL ELEVATION.

1. BEAKED HAZEL (CORYLUS CORNUTA)-25%
2. MOUNTAIN MAPLE (ACER SPICATUM)-10%
3. SPECKLED ALDER (ALNUS INCANA)-25%
4. RED-OSIER DOGWOOD (CORNUS SERICEA)-40%

TRANSPLANTS:

- TRANSPLANT WILLOW AND DOGWOOD SHRUBS FROM THE EXCAVATED AREA. PLANT AT THE EDGE OF THE BLANKET ON THE STREAM SIDE EVERY 8 FEET IN THE RIFFLES. IF NOT IMMEDIATELY PLANTED, PLACE TEMPORARILY IN SOIL UNTIL PLANTING. SLICE COIR BLANKET TO PLANT TRANSPLANTS.

SEED AND COIR AND BACKER BLANKET

- BLANKET MAIN CHANNEL WITH 9.8' WIDE AND BACKED WITH MN DOT CATEGORY 3N, 2S, EROSION CONTROL BLANKET. INSTALL 2' LONG, 2"X2" WOOD STAKES WITH A ROOFING NAIL AT THE TOP TO SECURE THE BLANKET, INSTALL STAKES EVERY 5' ALONG BLANKET EDGES AND EVERY 5' DOWN THE CENTERLINE OF THE BLANKET.
  SEED WITH MIX NOTED ON THIS DETAIL SHEET WITH 25 LBS/ACRE OF COVER CROP AS APPROVED BY ENGINEER.

## ZONE 2

PLANTING AREA-

LIMITS OF RESTORATION OUTSIDE OF ZONE 1 FLOODPLAIN AREA.

CANOPY

THE FOLLOWING CANOPY PLANTS SHALL BE 1.5' HEIGHT CONTAINERIZED STOCK. PLANT AT 12 FOOT SPACING:

1. WHITE SPRUCE (PICEA GLAUCA) -40%
2. YELLOW BIRCH (BETULA ALLEGHANIENSIS)-10%
3. BUR OAK (*QUERCUS MACROCARPA*)- 10%
4. *WHITE PINE (PINUS STROBUS) -20%
5. PAPER BIRCH (BETULA PAPYRIFERA) -10%
6. SUGAR MAPLE (ACER SACCHARUM)-10%

SUB-CANOPY

THE FOLLOWING SUB-CANOPY PLANTS SHALL BE 1.5' HEIGHT CONTAINERIZED STOCK. PLANT THE FOLLOWING AT 12 FOOT SPACING,

1. CHOKE CHERRY (PRUNIS VIRGINIANA)-20%
2. NANNYBERRY (VIBURNUM LENTAGO)-20%
3. PAGODA DOGWOOD (CORNUS ALTERNIFOLIA)-20%
4. JUNEBERRIES (AMELANCHIER SPP.)-20%
5. BUSH HONEYSUCKLE (DIERVILLA LONICERA)-20%

SEED AND MULCH

- APPLY TYPE 3 MULCH, DISCED IN.
- SEED WITH MIX NOTED ON THIS DETAIL SHEET WITH 25 LBS/ACRE OF COVER CROP AS APPROVED BY ENGINEER.
- SCARIFY SOIL PRIOR TO SEEDING
- TOP DRESS GRAVEL AREAS (AREAS WITH OVER 30 PERCENT GRAVEL MATERIAL) WITH 0.3 FEET OF SOILS EXCAVATED FROM THE FLOODPLAIN AREA SUCH THAT FINE SOILS ARE PRESENT FOR SEED ESTABLISHMENT

## SEED MIX

| GRASS SEED | 15 LBS./ACRE |
|---|---|
| Big bluestem (*Andropogon gerardii*) | 20% |
| Fringed brome (*Bromus ciliatus*) | 8% |
| Blue-joint grass (*Calamagrostis canadensis*) | 2% |
| Caterpillar Sedge (Carex crinita) | 5% |
| Poverty oats (*Danthonia spicata*) | 10% |
| Slender Wheatgrass (*Elymus trachycalum*) | 12% |
| Virginia wild rye (*Elymus virginicus*) | 13% |
| American manna (Glyceria grandis) | 10% |
| Fowl bluegrass (Poa palustris) | 5% |
| Cord grass (*Spartina pectinata*) | 15% |

| **Wildflower Seed** | **32oz. /acre** |
|---|---|
| Yarrow (*Achillea millefolium*) | 2% |
| Fragrant giant hyssop (*Agastache foeniculum* | *10%* |
| Swamp milkweed (*Asclepias incarnata*) | 10% |
| Common milkweed (*Asclepias syriaca*) | 10% |
| Fireweed (*Epilobium angustifolium*) | 2% |
| Boneset (*Eupatorium perfoliatum*) | 8% |
| Joe-Pye weed (*Eutrochium maculatum*) | 5% |
| Common ox-eye (*Heliopsis helianthoides*) | 5% |
| Wild bergamot (*Monarda fistulosa*) | 10% |
| Black-eyed Susan (*Rudbeckia hirta*) | 5% |
| Stiff goldenrod (*Solidago rigida*) | 7% |
| Blue vervain (*Verbena hastata*) | 20% |
| Golden alexanders (*Zizia aurea*) | 6% |

## ZONE 3

SEED AND MULCH
SEED EXPOSED SOILS WITH SEED MIX NOTED ON THIS SHEET ALONG WITH 25 LBS/ACRE OF COVER CROP AS APPROVED BY ENGINEER.

TREE PROTECTION:

* SPECIES THAT REQUIRE 6' HIGH X 3.0' DIAMETER FENCING WITH 2 T-POSTS PLACED ON THE UPSTREAM SIDE OF THE TREE CAGE

APPROVED BY: KA | CHECKED BY: MJG | DRAWN BY: GET

| REV | DESCRIPTION | APPRV |
|---|---|---|
| 1 | DRAFT 30% DESIGN | XX |
| XX | XX | XX |
| XX | XX | XX |
| XX | XX | XX |
| XX | XX | XX |
| XX | XX | XX |
| XX | XX | XX |
| XX | XX | XX |

WHITE ROCK CREEK
STREAM RESTORATION
NEAR SILVER BAY
LAKE COUNTY, MN

DRAFT 30% DESIGN - NOT FOR CONSTRUCTION
---
---
DETAIL - PLANTING

CLIFFS

NORTHSHORE MINING CO
10 OUTER DR
SILVER BAY, MN 55614
---

BEAVER RIVER CONSULTING

BEAVER RIVER CONSULTING, LLC.
5752 EAGLE VIEW DRIVE
DULUTH, MN 55803
---

CONCEPT DESIGN
NOT FOR
CONSTRUCTION

DATE: 2/17/2020

NTS

SHEET NUMBER
20 OF 20

E:\DROPBOX (SSSR)\NORTHSHOREMINING\C3D\SHEETS\NORTHSHOREWHITEROCKCRMASTERDETAIL.DWG | GREGTAILLACQ | SAVED: Friday, February 14, 2020 11:50:23 AM | ACAD.CTB | | PLOTTED: Monday, February 17, 2020 11:01:33 AM

# *Appendix D*

# *Debit Calculation Field Forms*

Project:
Reach ID:

**Minnesota Stream Quantification Tool**
**Parameter Selection Checklist**

| | Function-Based Parameter | Metric(s) | Datasheets for Field-based Metrics |
|---|---|---|---|
| ☑ | Reach Runoff* | ☑ Land Use Coefficient (D) **AND** Concentrated Flow Points (F) | Project Reach Form Section II(B)** |
| | | ***or*** | |
| | | ☐ BMP MIDS Rv Coefficient (D) | |
| ☑ | Floodplain Connectivity* | ☑ Bank Height Ratio* **AND** Entrenchment Ratio* (F) | Rapid Survey Form** **OR** Cross Section **AND** Longitudinal Survey Forms |
| ☑ | Large Woody Debris (LWD) | ☐ LWD Index (F) | LWDI Form |
| | | ***or*** | |
| | | ☑ No. of LWD Pieces/ 100 meters (F) | Project Reach Form Section VI** |
| ☑ | Lateral Migration* | ☑ Dominant BEHI/NBS* **AND** Percent Streambank Erosion* (F) | Lateral Migration Form** |
| | | ***or*** | |
| | | ☐ ***Optional:*** Percent Armoring (F) | Project Reach Form Section II(C)** |
| ☐ | Bed Material Characterization | ☐ ***Optional:*** Size Class Pebble Count Analyzer (F) | Pebble Count Form |
| ☑ | Bed Form Diversity* | ☑ Pool Spacing Ratio* **AND** Pool Depth Ratio* **AND** Percent Riffle* (F) | Longitudinal Survey **OR** Rapid Survey Form** |
| | | ☐ ***Optional:*** Aggradation Ratio (F) | Cross Section Form **OR** Rapid Survey Form** |
| ☐ | Riparian Vegetation* | ☐ Riparian Width* (D/F) **AND** Canopy Cover* (F) **AND** Herbaceous Vegetation Cover* (F) **AND** Woody Stem Basal Area[1] (F) | Riparian Width and Vegetation Forms** |
| | Riparian vegetation is assessed using the MPCA Stream Habitat Assessment Worksheets | | |
| ☑ | Temperature | ☑ ***Optional:*** Summer Average (F) | Temperature Logger SOP Form |
| ☑ | Dissolved Oxygen | ☑ ***Optional:*** Dissolved Oxygen Concentration (F) | Sensor Log |
| | Total Suspended Solids | ***Optional:*** Total Suspended Solids Concentration (F) | Sensor Log |
| ☑ | Macroinvertebrates | ☑ ***Optional:*** Macroinvertebrate IBI (F) | Macroinvertebrate Sample Sorting Bench Sheet **AND** Stream Invertebrate Visit Form |
| ☑ | Fish | ☑ ***Optional:*** Fish IBI (F) | Fish Survey Record Form **AND** Visit Summary Form |

* Include in all assessments
** Field values can be entered directly from field forms into MNSQT; all other metrics require additional post-processing or analysis to
(D) indicates metrics are calculated using desktop methods
(F) indicates metrics are calculated or verified using field methods
[1] Include Woody Stem Basal Area only if woody vegetation is determined to be a signification natural component of the riparian zone.

Date:
Investigators:

**Minnesota Stream Quantification Tool**
**Project Reach Form**

## I. Site Information

| | |
|---|---|
| Project Name: | West Ridge Railroad Relocation |
| Reach ID: | Big 39 Creek |
| Drainage Area (sq. mi.): | 0.46 |
| Use Class: | 2A |
| River Nutrient Region: | North |
| Valley Type: | Unconfined Alluvial |
| Stream Reach length (ft): | 5149 |
| Latitude: | 47°18'6.35"N |
| Longitude: | 91°23'7.57"W |

| Shading Key |
|---|
| Desktop Value |
| Field Value |
| Calculation |

## II. Reach Walk

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| A. | Difference between bankfull (BKF) stage and water surface (WS) (ft) | 0.26 | 0.1 | 0.4 | 0.2 | | |
| | | | | | | | |
| | Difference between BKF stage and WS (ft)<br>*Average or consensus value from reach walk.* | | 0.24 | | | | |
| B. | Number Concentrated Flow Points | | 0 | 0 | 0 | 0 | 0 |
| | Concentrated Flow Points/ 1,000 L.F. | | 0.0 | | | | |
| C. | Length of Armoring on banks (ft) | | 0 | | | | |
| | Total (ft) | 0.0 | | | | | |
| | Percent Armoring (%) | 0% | | | | | |

| | | |
|---|---|---|
| D. | Valley length (ft) | 4160 |
| | Stream Length (ft) | 5149 |
| | Sinuosity | 1.24 |

## III. Identification of Representative Sub-Reach

| | | | |
|---|---|---|---|
| Representative Sub-Reach Length<br>At least 20 x the Bankfull Width | 5149 | 20*Bankfull Width | 306.0 |
| Latitude of downstream extent: | 47°18'6.35"N | | |
| Longitude of downstream extent: | 91°23'7.57"W | | |

**Sub-Reach Survey Method**

x Longitudinal Profile & Cross Section

□ Rapid Survey

Date:
Investigators:

**Minnesota Stream Quantification Tool**
**Project Reach Form**

## IV. Bankfull Verification and Representative Riffle Cross Section

Is Cross Section located within Representative Sub-Reach? **x** Yes ☐ No

If no, explain why:

| | | XS1 | XS2 | XS3 |
|---|---|---|---|---|
| A. | Bankfull Width (ft) | 15.3 | 10.45 | 13.76 |
| B. | Bankfull Mean Depth (ft)<br>= Average of cross-section depths | 0.4 | 0.3 | 0.2 |
| C. | Bankfull Area (sq. ft.)<br>Width * Mean Depth | 3.0 | 3.2 | 3.2 |
| D. | Regional Curve Bankfull Width (ft) | 9.1 | 9.1 | 9.1 |
| E. | Regional Curve Bankfull Mean Depth (ft) | 0.7 | 0.7 | 0.7 |
| F. | Regional Curve Bankfull Area (sq. ft.) | 5.8 | 5.8 | 5.8 |
| G. | Curve Used | North Shore (B channel) | | |

*NOTE: Space is provided here to survey a cross section using rapid survey methods. A cross section form is also available for cross section surveys.*

## V. Stream Classification

| | | AVERAGE | XS1 | XS2 | XS3 |
|---|---|---|---|---|---|
| A. | Width Depth Ratio (ft/ft)<br>Bankfull Width / Bankfull Mean Depth | 45.8 | 43.71 | 33.71 | 59.83 |
| B. | Bankfull Max Riffle Depth | 0.49 | 0.56 | 0.48 | 0.44 |
| C. | Floodprone Area Width (ft) | 18.62 | 15.30 | 14.47 | 26.09 |
| D. | Entrenchment Ratio (ft/ft)<br>Floodprone Area Width /Bankfull Width | 1.7 | 1.82 | 1.38 | 1.90 |
| E. | Slope Estimate (%) | 1.3 | | | |
| F. | Channel Material Estimate | | | | |
| G. | Stream Type | **B** | | | |

*Average slope from the representative sub-reach will be Pebble count forms are available to aid in this determination.*

## VI. Large Woody Debris (100m (328 ft) assessment length within Sub-Reach)

| | | |
|---|---|---|
| A. | Number of Pieces | 40 |

*NOTE: Complete this section only if the LWDI is not being used. Otherwise complete the LWDI Field*

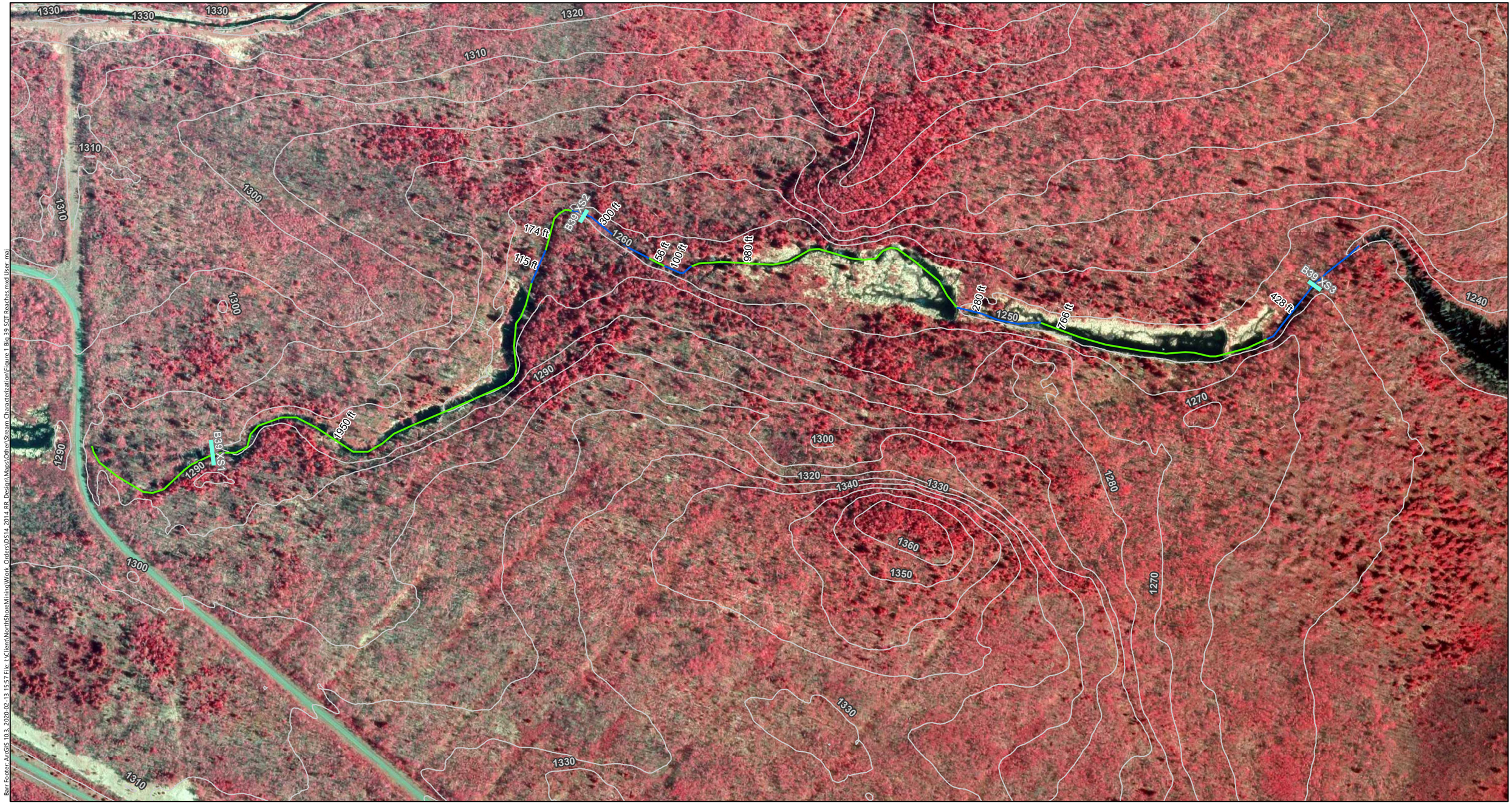
## VII. Representative Sub-Reach Sketch

SEE FIGURE 1
SQT ASSESSMENT REACHES
BIG 39 CREEK

## VIII. Notes

Cross section data was entered into RiverMorph; thus the following parameters were averaged for all cross sections collected for the Stream Classification Values

Width Depth Ratio
Bankfull Max Riffle Depth
Floodprone Area Width
Entrenchment Ratio




Barr Footer: ArcGIS 10.3, 2020-02-13 15:57 File: I:\Client\NorthShoreMining\Work_Orders\D514_2014 RR_Design\Maps\Other\Stream Characterization\Figure 1 Big 39 SQT Reaches.mxd User: maj

**Legend**

Survey Cross Sections

10-ft contours

**SQT Reaches**

**Reach Type**

Stream

Wetland

0 150 300 600

Feet

Aerial Imagery: Color Infrared (2009)

Figure 1

SQT ASSESSMENT
REACHES
Big 39 Creek
Northshore Mining Company
Lake County, Minnesota

**Minnesota Stream Quantification Tool**
**Longitudinal Profile Form**

| | | | |
|---|---|---|---|
| Date: | 9/15/2017 | Rod Team: | BARR |
| Stream Name: | Big 39 Creek | Instrument Team: | BARR |
| Reach I.D. | NA | Notes Team: | BARR |
| Team Number: | NA | | |

**Longitudinal Profile Field Form**

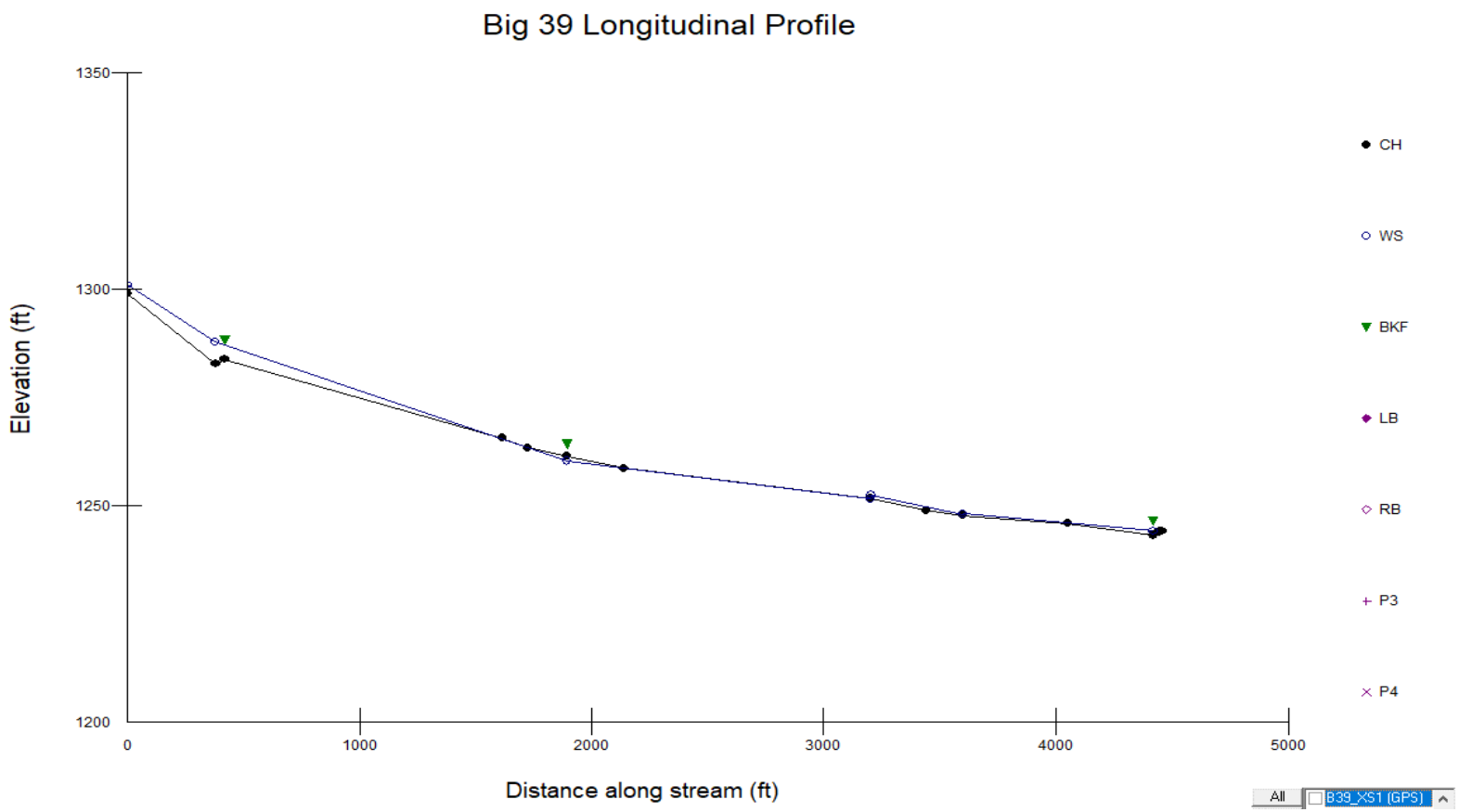
**Key Codes:** Exported from RiverMorph

| **Survey:** | | | | |
|---|---|---|---|---|
| **Station Loc** | **Channel Elevation** | **Water Surface Elevation** | **BKF Elevation** | **Comment** |
| 0.0 | | 1301.0 | | |
| 0.0 | 1299.0 | | | |
| 135.6 | | | | |
| 139.4 | | | | |
| 376.2 | | | | |
| 378.1 | | 1287.8 | | |
| 378.7 | | | | |
| 379.8 | 1282.8 | | | |
| 401.8 | | | | |
| 404.3 | | | | |
| 406.3 | | | | |
| 416.1 | | | | |
| 419.3 | | | | |
| 419.3 | | | | |
| 419.3 | | | 1288.3 | |
| 419.3 | 1283.9 | | | |
| 1613.6 | 1265.7 | | | |
| 1724.4 | 1263.4 | | | |
| 1864.1 | | | | |
| 1887.8 | | | | |
| 1894.4 | | | 1264.3 | |
| 1894.4 | 1261.5 | | | |
| 1894.4 | | 1260.4 | | |
| 2139.7 | 1258.6 | | | |
| 3200.3 | | 1251.5 | | |

**Minnesota Stream Quantification Tool**
**Longitudinal Profile Form**

| | | | | |
|---|---|---|---|---|
| 3201.8 | 1251.7 | | | |
| 3204.2 | | 1252.4 | | |
| 3439.0 | 1248.9 | | | |
| 3599.3 | 1247.8 | | | |
| 3600.2 | | 1248.0 | | |
| 3601.1 | | 1248.2 | | |
| 4050.7 | 1246.0 | | | |
| 4412.3 | | | | |
| 4416.6 | | | 1246.5 | |
| 4418.7 | | | | |
| 4418.7 | 1243.2 | | | |
| 4418.8 | | 1244.2 | | |
| 4430.0 | 1243.6 | | | |
| 4448.8 | 1244.0 | | | |
| 4457.6 | 1244.1 | | | |

## II. Longitudinal Profile



**Minnesota Stream Quantification Tool**
**Longitudinal Profile Form**

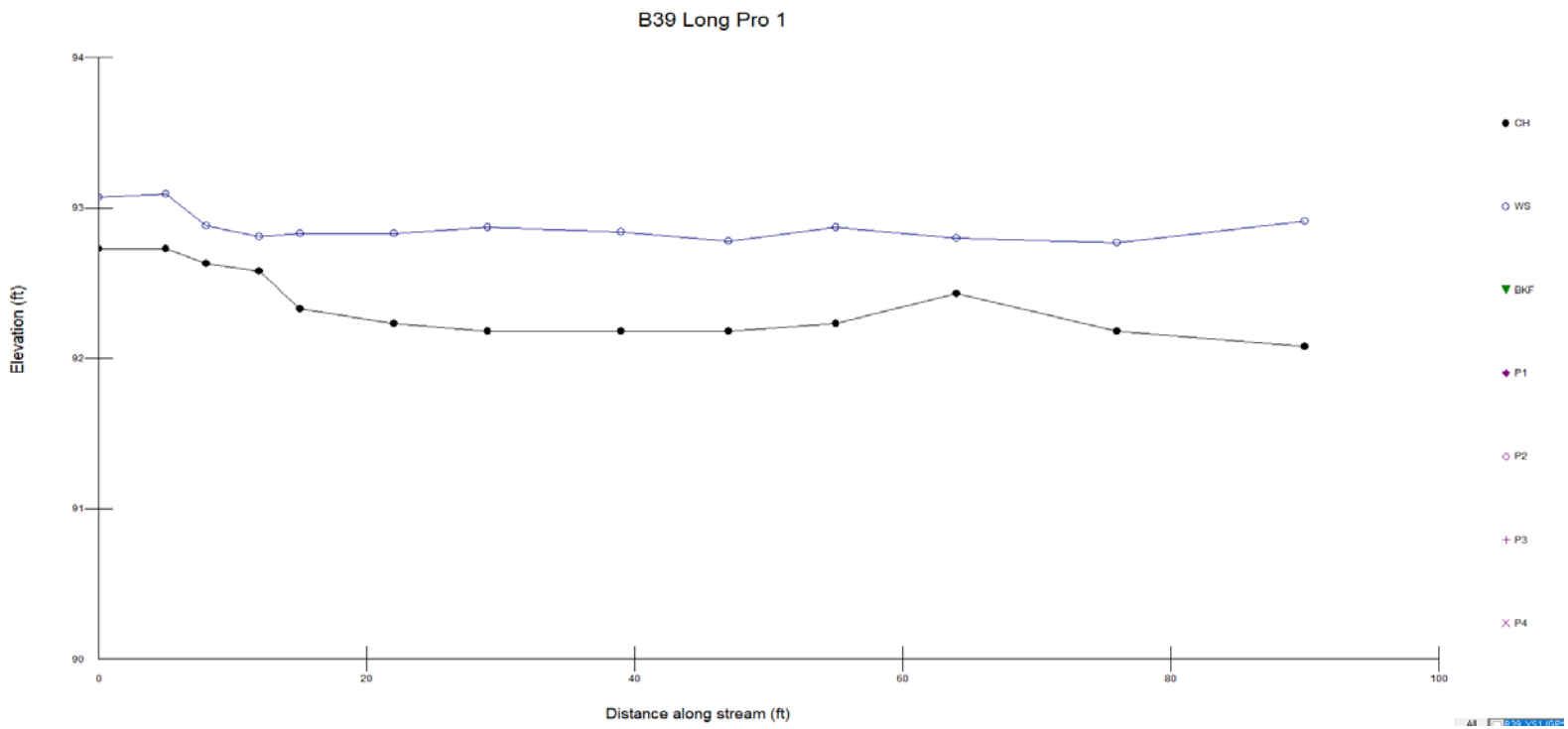
| | | | |
|---|---|---|---|
| Date: | 8/7/2019 | Rod Team: | BARR |
| Stream Name: | Big 39 Creek | Instrument Team: | BARR |
| Reach I.D. | **supplemental** | Notes Team: | BARR |
| Team Number: | NA | | |

**Longitudinal Profile Field Form**

**Key Codes:** Exported from RiverMorph

| **Survey:** | | |
|---|---|---|
| **Station Loc** | **Channel Elevation** | **Water Surface Elevation** |
| 0 | 92.73 | 93.07 |
| 5 | 92.73 | 93.09 |
| 8 | 92.63 | 92.88 |
| 12 | 92.58 | 92.81 |
| 15 | 92.33 | 92.83 |
| 22 | 92.23 | 92.83 |
| 29 | 92.18 | 92.87 |
| 39 | 92.18 | 92.84 |
| 47 | 92.18 | 92.78 |
| 55 | 92.23 | 92.87 |
| 64 | 92.43 | 92.8 |
| 76 | 92.18 | 92.77 |
| 90 | 92.08 | 92.91 |

## II. Longitudinal Profile



**Minnesota Stream Quantification Tool**
**Cross Section Form**

| | | | |
|---|---|---|---|
| Date: | 8/7/2019 | Rod Team: | BARR |
| Stream Name: | Big 39 | Instrument Team: | BARR |
| Reach I.D. | B39 XS1 | Notes Team: | BARR |
| Team Number: | NA | | |

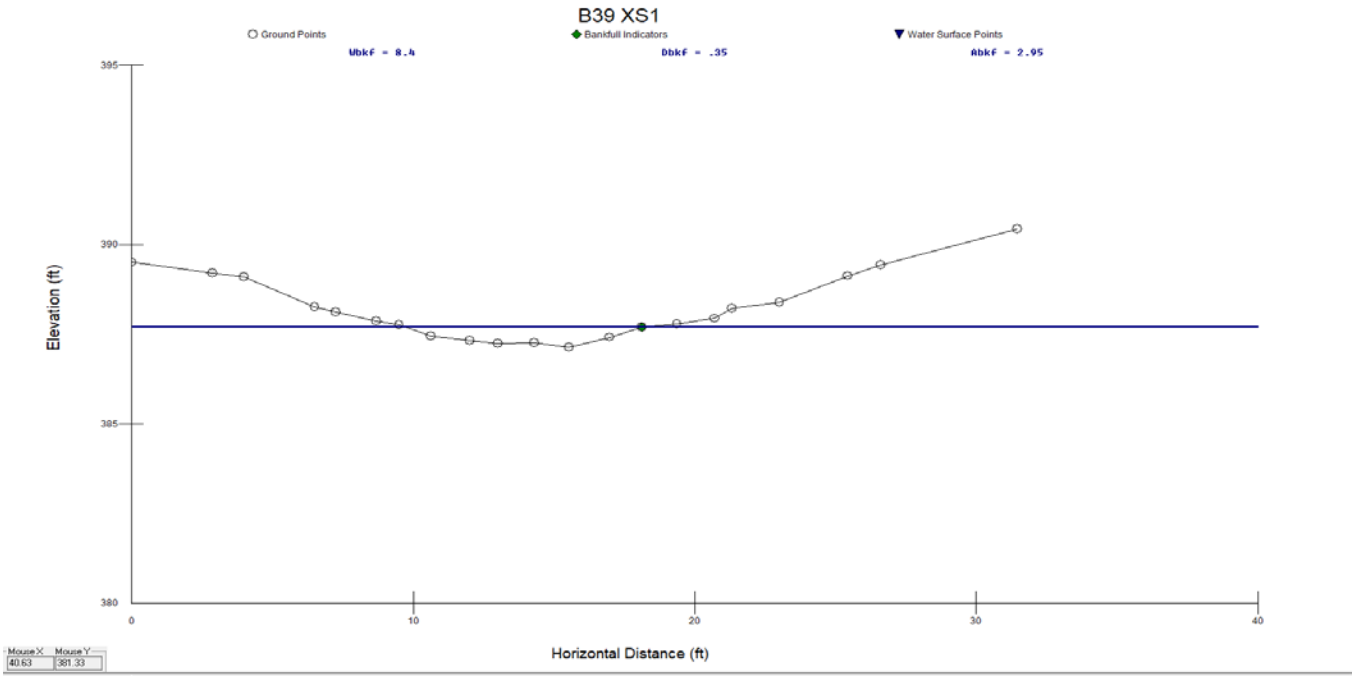
**Key Codes:**

| | | | | | |
|---|---|---|---|---|---|
| Head of Riffle | R | Bankfull | BKF | Benchmark | TBM |
| Head of Run | N | Top of Bank | TOB | Turning Point | TP |
| Head of Pool | P | Edge of Channel | EC | Backsight | BS |
| Head of Glide | G | Inner Berm | IB | Foresight | FS |
| Thalweg | TW | | | Height of Instrument | HI |

**Cross Section Field Form**

| Station | BS (+) | HI | FS (-) | Elevation | Notes |
|---|---|---|---|---|---|
| 0.0 | | | 0.0 | 389.5 | |
| 2.9 | | | 0.0 | 389.2 | |
| 4.0 | | | 0.0 | 389.1 | |
| 6.5 | | | 0.0 | 388.3 | |
| 7.3 | | | 0.0 | 388.1 | |
| 8.7 | | | 0.0 | 387.9 | |
| 9.5 | | | 0.0 | 387.8 | |
| 10.6 | | | 0.0 | 387.4 | |
| 12.0 | | | 0.0 | 387.3 | |
| 13.0 | | | 0.0 | 387.2 | |
| 14.3 | | | 0.0 | 387.3 | |
| 15.5 | | | 0.0 | 387.1 | |
| 17.0 | | | 0.0 | 387.4 | |
| 18.1 | | | 0.0 | 387.7 | |
| 19.4 | | | 0.0 | 387.8 | |
| 20.7 | | | 0.0 | 387.9 | BKF |
| 21.3 | | | 0.0 | 388.2 | |
| 23.0 | | | 0.0 | 388.4 | |
| 25.4 | | | 0.0 | 389.1 | |
| 26.6 | | | 0.0 | 389.4 | |
| 31.5 | | | 0.0 | 390.4 | |

## II. Cross Section



**Minnesota Stream Quantification Tool**
**Cross Section Form**

| | | | |
|---|---|---|---|
| Date: | 8/7/2019 | Rod Team: | BARR |
| Stream Name: | Big 39 | Instrument Team: | BARR |
| Reach I.D. | B39 XS2 | Notes Team: | BARR |
| Team Number: | NA | | |

**Key Codes:**

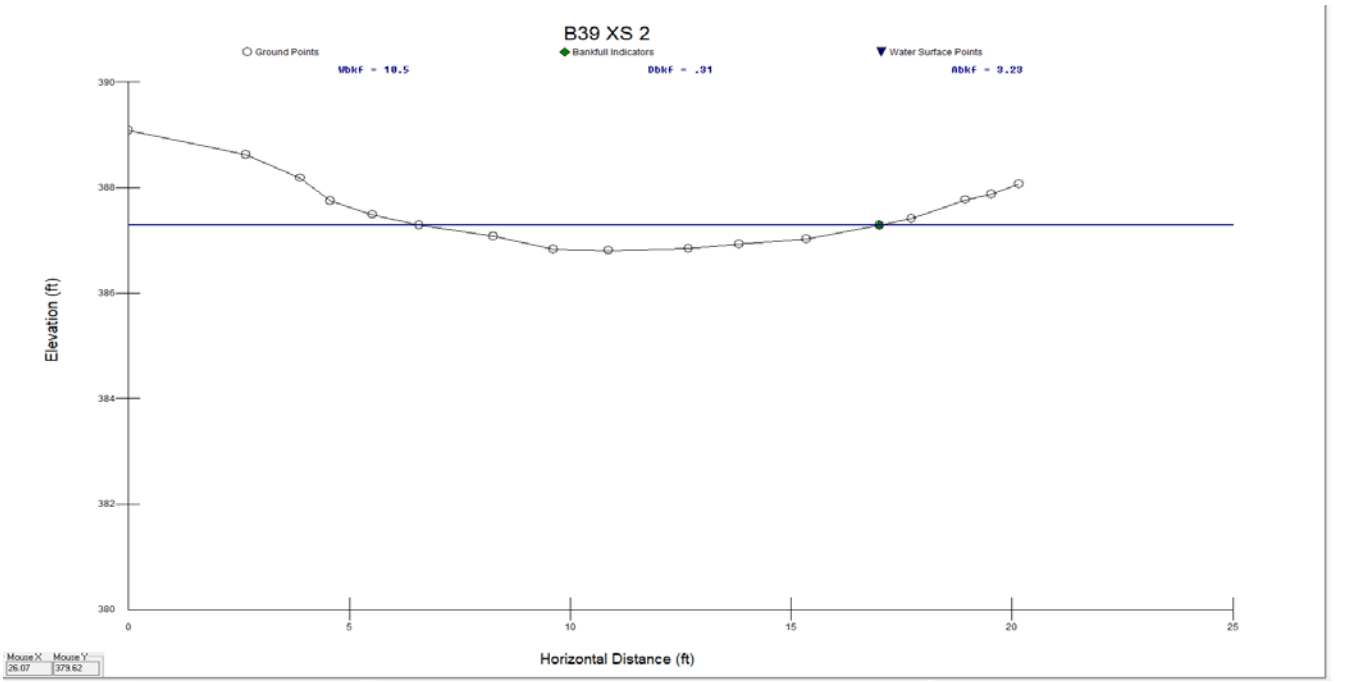
| | | | | | |
|---|---|---|---|---|---|
| Head of Riffle | R | Bankfull | BKF | Benchmark | TBM |
| Head of Run | N | Top of Bank | TOB | Turning Point | TP |
| Head of Pool | P | Edge of Channel | EC | Backsight | BS |
| Head of Glide | G | Inner Berm | IB | Foresight | FS |
| Thalweg | TW | | | Height of Instrument | HI |

**Cross Section Field Form**

| Station | BS (+) | HI | FS (-) | Elevation | Notes |
|---|---|---|---|---|---|
| 0.0 | | | 0.0 | 389.1 | |
| 2.7 | | | 0.0 | 388.6 | |
| 3.9 | | | 0.0 | 388.2 | |
| 4.6 | | | 0.0 | 387.7 | |
| 5.5 | | | 0.0 | 387.5 | |
| 6.6 | | | 0.0 | 387.3 | |
| 8.3 | | | 0.0 | 387.1 | |
| 9.6 | | | 0.0 | 386.8 | |
| 10.9 | | | 0.0 | 386.8 | |
| 12.7 | | | 0.0 | 386.8 | |
| 13.8 | | | 0.0 | 386.9 | |
| 15.3 | | | 0.0 | 387.0 | |
| 17.0 | | | 0.0 | 387.3 | BKF |
| 17.7 | | | 0.0 | 387.4 | |
| 19.0 | | | 0.0 | 387.8 | |
| 19.5 | | | 0.0 | 387.9 | |
| 20.2 | | | 0.0 | 388.1 | |

**Minnesota Stream Quantification Tool**
**Cross Section Form**

## II. Cross Section



**Minnesota Stream Quantification Tool**
**Cross Section Form**

| | | | |
|---|---|---|---|
| Date: | 8/7/2019 | Rod Team: | BARR |
| Stream Name: | Big 39 | Instrument Team: | BARR |
| Reach I.D. | B39 XS3 | Notes Team: | BARR |
| Team Number: | NA | | |

**Key Codes:**

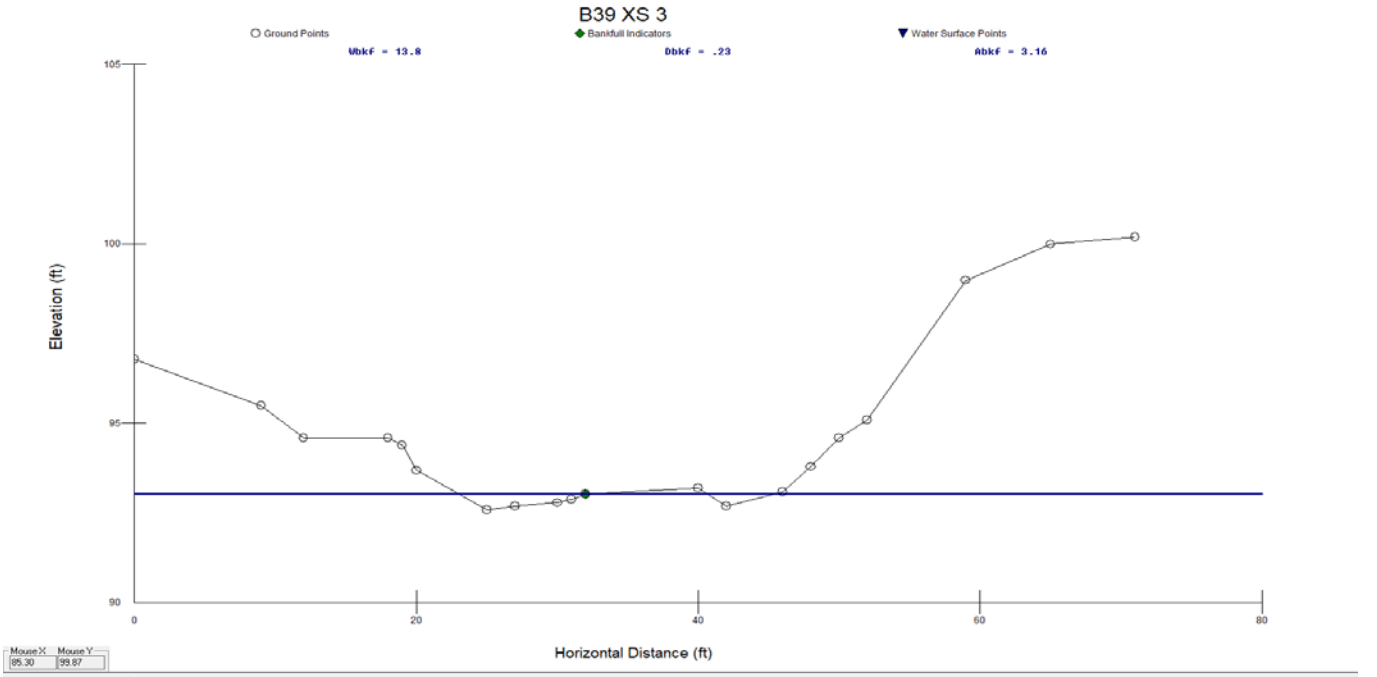
| | | | | | |
|---|---|---|---|---|---|
| Head of Riffle | R | Bankfull | BKF | Benchmark | TBM |
| Head of Run | N | Top of Bank | TOB | Turning Point | TP |
| Head of Pool | P | Edge of Channel | EC | Backsight | BS |
| Head of Glide | G | Inner Berm | IB | Foresight | FS |
| Thalweg | TW | | | Height of Instrument | HI |

**Cross Section Field Form**

| Station | BS (+) | HI | FS (-) | Elevation | Notes |
|---|---|---|---|---|---|
| 0.0 | | | 0.0 | 96.8 | |
| 9.0 | | | 0.0 | 95.5 | |
| 12.0 | | | 0.0 | 94.6 | |
| 18.0 | | | 0.0 | 94.6 | |
| 19.0 | | | 0.0 | 94.4 | |
| 20.0 | | | 0.0 | 93.7 | |
| 25.0 | | | 0.0 | 92.6 | |
| 27.0 | | | 0.0 | 92.7 | |
| 30.0 | | | 0.0 | 92.8 | |
| 31.0 | | | 0.0 | 92.9 | |
| 32.0 | | | 0.0 | 93.0 | BKF |
| 40.0 | | | 0.0 | 93.2 | |
| 42.0 | | | 0.0 | 92.7 | |
| 46.0 | | | 0.0 | 93.1 | |
| 48.0 | | | 0.0 | 93.8 | |
| 50.0 | | | 0.0 | 94.6 | |
| 52.0 | | | 0.0 | 95.1 | |
| 59.0 | | | 0.0 | 99.0 | |
| 65.0 | | | 0.0 | 100.0 | |
| 71.0 | | | 0.0 | 100.2 | |
| | | | | | |

**Minnesota Stream Quantification Tool**
**Cross Section Form**

## II. Cross Section



Date:
Investigators:

**Minnesota Stream Quantification Tool**
**Lateral Migration Form**

Reach ID: **Big 39**
Valley Type: **Unconfined Alluvial**
Bed Material: **Cobbles**

| | | | Bank Erosion Hazard Index | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Station ID** | **Bank Length (Ft)** | **Study Bank Height (ft)** | **BKF Height (ft)** | **Root Depth (ft)** | **Root Density (%)** | **Bank Angle (degrees)** | **Surface Protection (%)** | **Bank Material Adjustment** | **Stratification Adjustment** | **BEHI Total/ Category** | **NBS Ranking** |
| | | | | | | | | | | | |
| XS1-L | 8.6 | 2.52 | 0.35 | 1 | 25 | 7 | 90 | -10 | | 16 | Low |
| XS1-R | 10.75 | 3.38 | 0.35 | 1 | 25 | 10 | 90 | -10 | | 17 | Low |
| | | | | | | | | | | | |
| XS2-L | 6.6 | 2.33 | 0.31 | 1 | 25 | 20 | 90 | -10 | | 16 | Low |
| XS2-R | 3.2 | 1.32 | 0.31 | 1 | 25 | 14 | 90 | -10 | | 13 | Low |
| | | | | | | | | | | | |
| XS3-L | 12 | 7.56 | 0.23 | 1 | 25 | 18 | 90 | -10 | | 21 | Moderate |
| XS3-R | 7 | 4.15 | 0.23 | 1 | 25 | 35 | 90 | -10 | | 20 | Moderate |
| | | | | | | | | | | | |

**Summary Table**

| BEHI/NBS Ranking | Enter bank Length from all rows on p.1 with same ranking | | | | | | | | | Length (Feet) | Percent of Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Ex/Ex | | | | | | | | | | | |
| Ex/VH | | | | | | | | | | | |
| Ex/H | | | | | | | | | | | |
| Ex/M | | | | | | | | | | | |
| Ex/L | | | | | | | | | | | |
| Ex/VL | | | | | | | | | | | |
| VH/Ex | | | | | | | | | | | |
| Vh/VH | | | | | | | | | | | |
| VH/H | | | | | | | | | | | |
| VH/M | | | | | | | | | | | |
| VH/L | | | | | | | | | | | |
| VH/VL | | | | | | | | | | | |
| H/Ex | | | | | | | | | | | |
| H/VH | | | | | | | | | | | |
| H/H | | | | | | | | | | | |
| H/M | | | | | | | | | | | |
| H/L | | | | | | | | | | | |
| H/VL | | | | | | | | | | | |
| M/Ex | | | | | | | | | | | |
| M/VH | | | | | | | | | | | |
| M/H | | | | | | | | | | | |
| M/M | | | | | | | | | | | |
| M/L | 12 | 7 | | | | | | | | 19.0 | 39% |
| M/VL | | | | | | | | | | | |
| L/Ex | | | | | | | | | | | |
| L/VH | | | | | | | | | | | |
| L/H | | | | | | | | | | | |
| L/M | | | | | | | | | | | |
| L/L | 8.6 | 10.75 | 6.6 | 3.2 | | | | | | 29.2 | 61% |
| L/VL | | | | | | | | | | | |
| | | | | | | | | | Total Length: | 48.2 | 1.0 |
| | | | | | | | | | Eroding Length: | | |

# MPCA STREAM HABITAT ASSESSMENT '39

(revised 3-07)

**1. Stream Documentation**

Stream Big 39 Creek

County Lake Date 9/15/2017

Field Number _____ Person Scoring _____

Site Location Big 39 Creek, West of Northshore Mine Tailings Basin

**MSHA SCORE**

Max = 100 **76**

**2. Surrounding Land Use** (check the most predominant or check two and average scores) [L=left bank/R =right bank, facing downstream]

| L | R | | | L | R | | |
|---|---|---|---|---|---|---|---|
| ☒ | ☒ | Forest, Wetland, Prairie, Shrub | [5] | ☐ | ☐ | Residential/Park | [2] |
| ☐ | ☐ | Old Field/Hay Field | [3] | ☐ | ☐ | Urban/Industrial | [0] |
| ☐ | ☐ | Fenced Pasture | [2] | ☐ | ☐ | Open Pasture | [0] |
| ☐ | ☐ | Conservation Tillage, No Till | [2] | ☐ | ☐ | Row Crop | [0] |

**Land Use** Max=5 **5**

**3. Riparian Zone** (check the most predominant)

**A. Riparian Width**

| L | R | | | |
|---|---|---|---|---|
| ☒ | ☒ | Extensive | > 300' | [5] |
| ☐ | ☐ | Wide | 150'-300' | [4] |
| ☐ | ☐ | Moderate | 30'-150' | [3] |
| ☐ | ☐ | Narrow | 15'-30' | [2] |
| ☐ | ☐ | Very Narrow | 3'-15' | [1] |
| ☐ | ☐ | None | | [0] |

**B. Bank Erosion**

| L | R | | | |
|---|---|---|---|---|
| ☒ | ☒ | None | | [5] |
| ☐ | ☐ | Little | 5-25% | [4] |
| ☐ | ☐ | Moderate | 25-50% | [3] |
| ☐ | ☐ | Heavy | 50-75% | [1] |
| ☐ | ☐ | Severe | 75-100% | [0] |

**C. Shade**

| L | R | | | |
|---|---|---|---|---|
| ☐ | ☐ | Heavy | >75% | [5] |
| ☒ | ☒ | Substantial | 50-75% | [4] |
| ☐ | ☐ | Moderate | 25-50% | [2] |
| ☐ | ☐ | Light | 5-25% | [1] |
| ☐ | ☐ | None | | [0] |

**Riparian** Max=15 **14**

**4. Instream Zone**

**A. Substrate** (check two for each channel type)

| | [10] Boulder | [9] Cobble | [8] Gravel | [7] Sand | [5] Clay | [5] Bedrock | [2] Silt | [1] Muck | [1] Detritus | [0] Sludge | Channel Type % |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Pool | ☐ | ☐ | ☒ | ☐ | ☐ | ☐ | ☐ | ☒ | ☐ | ☐ | 50 |
| Riffle | ☒ | ☒ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | 50 |
| Run | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | |
| Glide | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | |

14

**B. Embeddedness**

- ☐ None [5]
- ☒ Light 25-50% [3]
- ☐ Moderate 50-75% [1]
- ☐ Severe 75-100% [-1]
- ☐ No coarse substrate [0]

**C. Substrate Types**

- ☒ >4 [2]
- ☐ <=4 [0]

**D. Water Color**

- ☐ Clear
- ☒ Stained

Turbid
- ☐ Brown
- ☐ Green
- ☐ Other

**Substrate** Max=27 **19**

**E. Cover Type** (check all that apply)

- ☐ Undercut Banks [1]
- ☒ Overhanging Vegetation [1]
- ☒ Deep Pools [1]
- ☒ Logs or Woody Debris [1]
- ☒ Boulders [1]
- ☒ Rootwads [1]
- ☒ Macrophytes: [1]
  - ☒ Emergent
  - ☒ Floating Leaf
  - ☒ Submergent

Pools due to impoundments

**F. Cover Amount** (check one)

- ☐ Extensive >50% [10]
- ☒ Moderate 25-50% [7]
- ☐ Sparse 5-25% [3]
- ☐ Nearly Absent [0]
- ☐ Choking Vegetation only [-1]

**Cover** Max=17 **13**

**5. Channel Morphology**

**A. Depth Variability**

- ☒ Greatest Depth >4X Shallow Depth [6]
- ☐ Greatest Depth 2-4X Shallow Depth [3]
- ☐ Greatest Depth <2X Shallow Depth [0]

**B. Channel Stability**

- ☒ High [9]
- ☐ Moderate/High [6]
- ☐ Moderate [3]
- ☐ Low [0]

**C. Velocity Types** (check all that apply)

- ☐ Torrential [-1]
- ☒ Fast [1]
- ☒ Moderate [1]
- ☐ Slow [1]
- ☐ Eddies [1]
- ☒ Intermittent [-2]
- ☐ Interstitial [-1]

**D. Sinuosity**

- ☐ Excellent [6]
- ☒ Good [4]
- ☐ Fair [2]
- ☐ Poor [0]

**E. Pool Width/Riffle Width**

- ☒ Pool Width > Riffle Width [2]
- ☐ Pool Width = Riffle Width [1]
- ☐ Pool Width < Riffle Width [0]
- ☐ No Riffle [0]

**F. Channel Development**

- ☐ Excellent [9]
- ☐ Good [6]
- ☒ Fair [3]
- ☐ Poor [0]

**G. Present Water Level**

- ☐ Flood
- ☐ High
- ☐ Normal
- ☒ Low
- ☐ Interstitial

**Channel Morphology** Max=36 **25**

Date: 8/16/2019
Investigators: Kevin Menken

**Minnesota Stream Quantification Tool**
**Sensor Log**

Stream Name: Big 39
Sub-reach Name:

---

**Dissolved Oxygen Logger Deployed?** ☒ **Yes** ☐ **No**

| | |
|---|---|
| Date Deployed: 8/7/2019 | Frequency of data: ☐ Daily ☒ Other: 2X |
| Date Retreived: 8/16/2019 | Timing of data: ☐ 1-3pm ☐ Other: _____ |

Describe sensor location within reach: at 50m mark within 90m reach

---

**Total Suspended Solids Sample Obtained?** Sample Type:

Date Obtained: 8/16/2019

Describe location within reach: at downstream end of 90m reach

**Other Sensor Deployed?** Sensor Type: YSI 556

Date Deployed:8/7/2019
Date Retreived: 8/16/2019

Frequency of data (if applicable): _____

Describe location within reach: at 50m mark within 90m reach

**ALSO IDENTIFY ALL SENSOR LOCATIONS ON SUB-REACH SKETCH ON PROJECT REACH FORM**

*-MPCA Biological Monitoring Program-*

# Macroinvertebrate Identification Lab Bench Sheet

| | |
|---|---|
| **Field Number** | **Sample Date** |
| **Site Name** | **Taxonomist:** |
| **Sample Type** QMH* QR HD other_____ | **Date of Sample ID:** _____/_____/_____ |

*A processed QMH sample consists of 2 parts, the subsample(ss) and large/rare (l/r), both parts must be identified

| Order/Family | Genus | Species/Notes | ss | l/r | Order/Family | Genus | Species/Notes | ss | l/r |
|---|---|---|---|---|---|---|---|---|---|
| **Ephemeroptera** | | | | | **Odonata** | | | | |
| Baetiscidae | Baetisca | | | | Calopterygidae | Calopteryx | | | |
| Caenidae | Bracycercus | | | | | Hetaerina | | | |
| | Caenis | | | | Coenagrionidae | Argia | | | |
| Ephemerellidae | Attenella | | | | | Enallagma | | | |
| | Ephemerella | | | | | Nehalennia | | | |
| | Serratella | | | | Lestidae | Lestes | | | |
| Ephemeridae | Ephemera | | | | Aeshnidae | Aeschna | | | |
| | Hexagenia | | | | | Anax | | | |
| Leptohyphidae | Tricorythodes | | | | | Basiaeschna | | | |
| Leptophlebiidae | Leptophlebia | | | | | Boyeria | | | |
| | Paraleptophlebia | | | | Cordulegastridae | Cordulegaster | | | |
| Polymitarcidae | Ephoron | | | | Corduliidae | Cordulia | | | |
| Potamanthidae | Anthopotamus | | | | | Dorocordulia | | | |
| Heptageniidae | Epeorus | | | | | Epitheca | | | |
| | Heptagenia | | | | | Somatochlora | | | |
| | Stenacron | | | | Gomphidae | Dromogomphus | | | |
| | Stenonema | | | | | Gomphurus | | | |
| Isonychiidae | Isonychia | | | | | Gomphus | | | |
| Ametropodidae | Ametropus | | | | | Hagenius | | | |
| Baetidae | Acerpenna | | | | | Ophiogomphus | | | |
| | Baetis | | | | | Phanogomphus | | | |
| | Callibaetis | | | | | Progomphus | | | |
| | Heterocloeon | | | | ***notes/additional taxa*** | | | | |
| ***notes/additional taxa*** | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | **Hemiptera** | | | | |
| **Plecoptera** | | | | | Belostomatidae | Belstoma | | | |
| Leuctridae | | | | | | Corixidae | | | |
| Taeniopterygidae | | | | | Corixidae | Hesperocorixa | | | |
| Perlidae | Acroneuria | | | | | Sigara | | | |
| | Agnetina | | | | | Trichocorixa | | | |
| | Attaneuria | | | | Nepidae | Ranatra | | | |
| | Neoperla | | | | Notonectidae | Buenoa | | | |
| | Paragnetina | | | | | Notonecta | | | |
| | Perlinella | | | | ***notes/additional taxa*** | | | | |
| Perlodidae | | | | | | | | | |
| Pteronarycyidae | Pteronarcys | | | | | | | | |
| ***notes/additional taxa*** | | | | | | | | | |
| | | | | | **Amphipoda** | | | | |
| | | | | | Talitridae | Hyallela | azteca | | |
| | | | | | Gammaridae | Gammarus | | | |
| **Lepidoptera** | | | | | ***notes/additional taxa*** | | | | |
| Pyralidae | Paraponyx | | | | | | | | |
| | Petrophila | | | | | | | | |
| ***notes/additional taxa*** | | | | | **Decapoda** | | | | |
| | | | | | Cambaridae | Cambarus | | | |
| **Megaloptera** | | | | | | Orconectes | | | |
| Corydalidae | Chauliodes | | | | | Procambarus | | | |
| | Corydalus | | | | ***notes/additional taxa*** | | | | |
| | Nigronia | | | | | | | | |
| Sialidae | Sialis | | | | | | | | |
| ***notes/additional taxa*** | | | | | **Pelecypoda** | | | | |
| | | | | | Sphaeriidae | | | | |
| | | | | | Corbiculidae | | | | |
| **Isopoda** | | | | | Unionidae | | | | |
| Asselidae | Asselus | | | | ***notes/additional taxa*** | | | | |
| ***notes/additional taxa*** | | | | | | | | | |

**entered into DataInverts by_____ --- (initials) date_____**

| Order/Family | Genus | Species/Notes | ss | l/r | Order/Family | Genus | Species/Notes | ss | l/r |
|---|---|---|---|---|---|---|---|---|---|
| **Trichoptera** | | | | | **Diptera** | | | | |
| Dipseudopsidae | Phylocentropus | | | | Ceratopogonidae | Alluaudomyia | | | |
| Hydropsycidae | Ceratopsyche | | | | | Atrichopogon | | | |
| | Cheumatopsyche | | | | | Bezzia | | | |
| | Diplectrona | | | | | Ceratopogon | | | |
| | Hydropsyche | | | | | Culicoides | | | |
| | Potamyia | | | | | Nilobezzia | | | |
| Philopotamidae | Chimarra | | | | | Palpomyia | | | |
| | Dolophilodes | | | | | Probezzia | | | |
| Polycentropodidae | Cernotina | | | | | Sphaeromias | | | |
| | Cyrnellus | | | | Chironomidae | G. | | | |
| | Neureclipsis | | | | Dixidae | Dixa | | | |
| | Paranyctiophylax | | | | | Dixella | | | |
| | Polycentropus | | | | Simuliidae | Simulium | | | |
| Psychomyiidae | Lype | | | | Tipulidae | Antocha | | | |
| | Psychomyia | | | | | Dicranota | | | |
| Glossosomatidae | Agapetus | | | | | Hexatoma | | | |
| | Glossosoma | | | | | Limnophila | | | |
| | Protoptila | | | | | Limonia | | | |
| Hydroptilidae | Hydroptila | | | | | Pilaria | | | |
| | Leucotrichia | | | | | Tipula | | | |
| | Mayatrichia | | | | Athericidae | Atherix | | | |
| | Oxyethira | | | | Empididae | Hemerodromia | | | |
| | Orthotrichia | | | | Tabanidae | Chrysops | | | |
| Rhyacophilidae | Rhyacophila | | | | | Tabanus | | | |
| Brachyecentridae | Brachycentrus | | | | ***notes/additional taxa*** | | | | |
| | Micrasema | | | | | | | | |
| Helicopsychidae | Helicopsyche | | | | | | | | |
| Lepidostomatidae | Lepidostoma | | | | | | | | |
| Leptoceridae | Ceraclea | | | | **Coleoptera** | | | | |
| | Leptocerus | | | | Dytiscidae | Agabus | | | |
| | Mystacides | | | | | Laccophilus | | | |
| | Nectopsyche | | | | | Liodessus | | | |
| | Oecetis | | | | Gyrinidae | Dineutus | | | |
| | Trianodes | | | | | Gyrinus | | | |
| Limnephilidae | Limnephilus | | | | Elmidae | Ancyronyx | | | |
| | Hydatophylax | | | | | Dubiraphia | | | |
| Molannidae | Molanna | | | | | Macronychus | | | |
| Phryganeidae | Phryganea | | | | | Optioservus | | | |
| | Ptilostomis | | | | | Stenelmis | | | |
| Sericostomatidae | Agarodes | | | | Hydrophilidae | Berosus | | | |
| ***notes/additional taxa*** | | | | | | Helocombus | | | |
| | | | | | | Laccobius | | | |
| | | | | | | Sperchopsis | | | |
| | | | | | | Tropisternus | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| **Gastropoda** | | | | | | | | | |
| Ancylidae | Ferrissia | | | | | | | | |
| Planorbidae | Helisoma | | | | **Annelida** | Oligochaeta | | | |
| | Promentus | | | | | Hirudinea | | | |
| | Planorbula | | | | ***notes/additional taxa*** | | | | |
| | Gyraulus | | | | | | | | |
| Vivaparidae | Campeloma | | | | | | | | |
| Lymnaeidae | Lymnaea | | | | | | | | |
| | Bulimnea | | | | | | | | |
| | Fossaria | | | | Hydracarina (trombidoformes, acarina) | | | | |
| Hydrobiidae | Amnicola | | | | Nematoda | | | | |
| Pleuroceridae | Pleurocera | | | | *notes/additional taxa* | | | | |
| Physidae | Physa | | | | | | | | |
| *notes/additional taxa* | | | | | | | | | |

**entered into DataInverts by_____ --- (initials) date_____**

*MPCA Stream Monitoring Program*

# STREAM INVERTEBRATE VISIT FORM

| | | |
|---|---|---|
| **Stream Name: Big 39** | | **Date: 8/7/2019** |
| **Field Number:** | **County: Lake** | **Crew:KDM, KMS2, JCO** |

**Water Chemistry** Tape Down: ___._____ (1/100ths ft) Location: _____

Time: (24 hr) 17:50 Air Temp: 24 (ºC) Water Temp: 20 (ºC) Sp.Conductivity: 240(umhos@25ºC)

DO: 7.39 (mg/L) DO % Saturation:_____ pH: 7.29 Secchi -Tube: _____ (cm)

Water Level: Normal Below _____ (m) Above _____ (m) Color _____ (pcu)

*****If Flagging is not found or if establishing a new site, fill out GPS info*****

| **Coordinates** | **LATITUDE** | **LONGITUTDE** | **Time: 2019-11-18 12:40:41** |
|---|---|---|---|
| **Field GPS:** | **47.30182_____** | **_____-91.38490_____** | **Name:** |

**Notes:** Boulder and cobble substrate where narrow, with muck and detritus in wide/slow reaches

## Stream Classification Information

| | | | | | |
|---|---|---|---|---|---|
| Flow | Flow over riffle(s) | High / Med / **Low** / NA | Channel | Excavated, trapezoidal channel | % |
| | Flow at reach constriction | High / Med / **Low** / NA | | Shallow excavation, channelized wetland | % |
| | Flow over run | High / Med / **Low** / NA | | Natural channel | 100% |
| | General flow pattern | High / Med / **Low** / NA | Vegetation | Emergent, aquatic vegetation in channel | Ext / Mod / **Sparse** / NA |
| | Intermittent sections | Yes / No | | Emergent, aquatic vegetation along bank | Ext / Mod / **Sparse** / NA |
| Habitat | Riffle (with flow) present in reach | Y | | Floating or submerged aquatic vegetation | Ext / Mod / **Sparse** / NA |
| | Riffle (with flow) present outside of reach (riffles do not include riprap associated with bridges or bank stabilization) | Y | | Loosely attached filamentous algae | Ext / Mod / **Sparse** / NA |
| | | | | Firmly attached algae or submerged veg | Ext / Mod / **Sparse** / NA |
| | Dominant invertebrate habitat (circle two) Riffle \| **Rocky Run-Pool** \| Aquatic Macrophyte \| Bank-Overhanging Veg \| **Wood** \| Leaf | | | | |
| Substrate | Dominant Run Substrate | bedrock / **boulder** / **cobble** / gravel / sand / silt | | | |
| | Dominant Pool Substrate | bedrock / boulder / cobble / gravel / sand / **silt** | | | |
| | Dominant Substrate receiving flow | bedrock / boulder / cobble / gravel / sand / silt | | | |
| | Dominant Substrate in reach | bedrock / boulder / cobble / gravel / sand / silt | | | |

| | |
|---|---|
| c | Stream displays a typical riffle-run pool morphology c adequate flow to maintain riffle organisms c inadequate flow to maintain riffle organisms |
| c | Stream has adquate flow to maintain riffle organism, but does not have suitable coarse substrate to support these assemblages (riffles, rock substrate in runs or pools) |
| c | Stream has adquate flow to maintain riffle dwelling organism, woody debris has replaced rocks as primary coarse substrate |
| c | Stream is low gradient, stream bed is predominately fine substrate, inadequate flow to maintain riffle organisms |

## Invertebrate Sample Information

### Qualitative Multi-Habitat Sample (QMH)

Divide 20 samples equally among habitat types present in the reach. If three habitat types are present take 7 samples in each of the three dominant habitats (for a total of 21). If a habitat is present, but not in abundance to sample in equal proportion to other habitats, sample as much as possible and divide the remaining samples between the dominant habitat types.

| a | Habitat | | | #Samples |
|---|---|---|---|---|
| X | rock riffle/run | Flow adequate to carry insects into net | | 8 |
| | rock substrate | Artificial flow needed to carry insect into net | | |
| c | aquatic macrophyte | | | |
| c | undercut bank, overhanging veg | | | |
| X | snag, woody debris, root wad | | | 8 |
| X | leaf pack | | | 4 |

**Number of multihabitat containers:** __1__

## Additional Biological Information

Presence of freshwater sponge ---------- yes / **no**

Presence of exotic species ---------- yes / **no**

Name of exotic(s) if present:

(voucher a specimen if not present in sample)

Presence of mussels ----------yes / **no**

Description of mussel density and/or mussel bed location:

## Notes

Pictures #: __ DD __ DU __ MD __ MU __ UD __ UU

# FISH SURVEY RECORD MPCA

| | |
|---|---|
| Field Number: Big 39 | Stream Name: Big 39 |
| Date: 09/03/2019 | Crew: DJM, CBJ, KDM |

Gear Type (circle one): **Backpack** **LR-24 Stream-electrofisher**
Volts: 155 Freq: 35 HZ Duty Cycle: 25%

Channel Position: Right Bank Mid-Channel Left Bank
(circle one if boom-electrofisher site)

| | | |
|---|---|---|
| Distance (m): 90m | Time Fished (sec): 1750 | Identified By:field identifications by-- DJM, voucher's and photo's sent to U of M for identification by Andrew Simon's, Ph. D., Dept. of Fisheries and Wildlife |

Visit Comments:

| Species (common name) | Length Range (mm) | Weight (g) | Number | Anomalies or YOY | Voucher Number | Voucher Pics |
|---|---|---|---|---|---|---|
| 1. Brook stickleback | 31-60 | 14 | 13 | --- | 1A | |
| 2. Blacknose Dace | 60-90 | 64 | 12 | --- | 1B, 2C | |
| 3. Fathead minnow | 39 | 1 | 1 | --- | 2C | |
| 4. | | | | | | |
| 5. Total Fish | | | 26 | | | |
| 6. | | | | | | |
| 7. | | | | | | |
| 8. | | | | | | |
| 9. | | | | | | |
| 10. | | | | | | |
| 11. | | | | | | |
| 12. | | | | | | |
| 13. | | | | | | |
| 14. | | | | | | |
| 15. | | | | | | |
| 16. | | | | | | |
| 17. | | | | | | |
| 18. | | | | | | |
| 19. | | | | | | |
| 20. | | | | | | |
| 21. | | | | | | |
| 22. | | | | | | |
| 23. | | | | | | |
| 24. | | | | | | |
| 25. | | | | | | |
| 26. | | | | | | |
| 27. | | | | | | |
| 28. | | | | | | |

Anomalies: **A**-anchor worm; **B**-black spot; **C**-leeches; **D**-deformities; **E**-eroded fins; **F**-fungus; **G**-yellow grub; **L**-lesions; **N**-blind; **P**=parasites; **PL**-parasite lesion; **Y**-popeye; **S**-emaciated; **W**-swirled scales; **T**-tumors; **Z**-other. (Heavy [**H**] or Light [**L**] code may be combined with above codes).

Project Area
Aquatic Biota Survey Segments
Streams

0 200 400 800
Feet

Aerial Imagery: FSA (2017)

Figure 1

AQUATIC BIOTA
SURVEY REACHES
Tailings Basin Progression
Northshore Mining Company
Lake County, Minnesota

Barr Footer: ArcGIS 10.6.1, 2019-08-19 16:19 File: K:\Client\NorthShore\Mining\Work Orders\DS14_2014 RR Design\Maps\Meetings\2019_08_19\Figure 1 Aquatic Biota Survey.mxd User: arm2

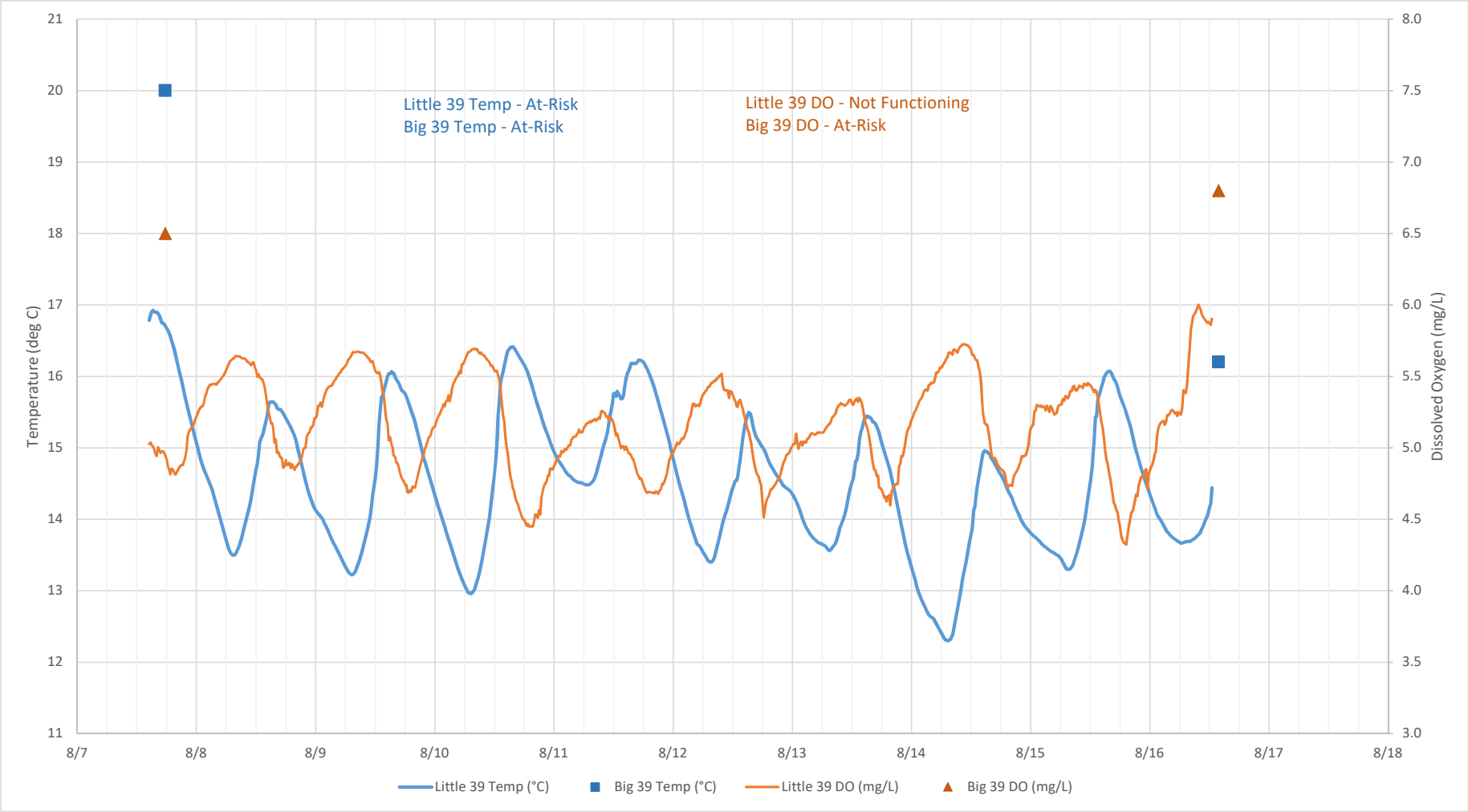



Figure 2
Temperature and Dissolved Oxygen
Big and Little 39 Creeks
Northshore Mining Company

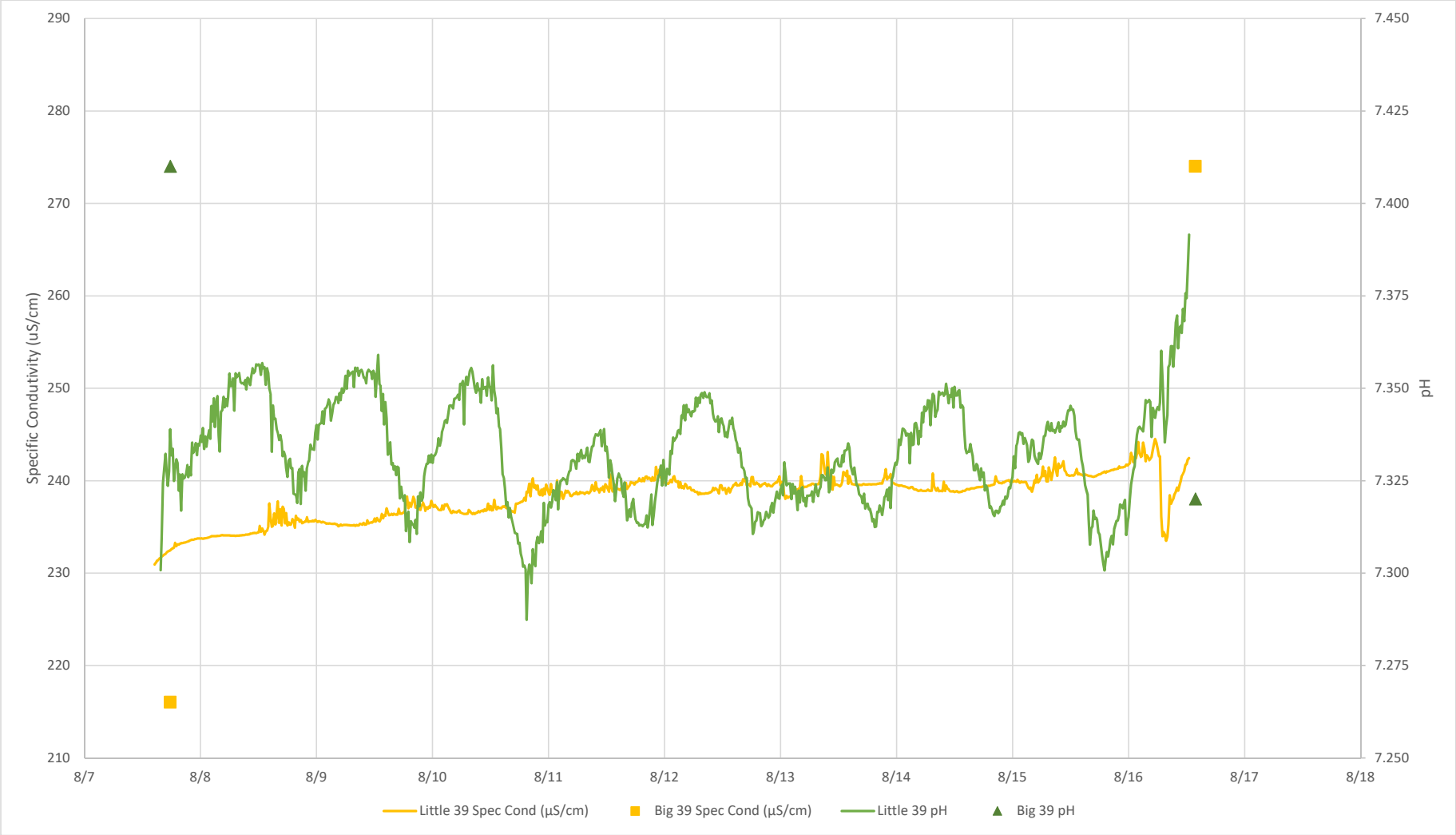



Figure 3
Specific Conductivity and pH
Big and Little 39 Creeks
Northshore Mining Company

Table 1
Physicochemical Data
Big and Little 39 Creeks
Northshore Mining Company

| Stream | Little 39 | | Big 39 | |
|---|---|---|---|---|
| Date Time | 8/7/2019 14:00 | 8/16/2019 12:30 | 8/7/2019 17:50 | 8/16/2019 13:50 |
| Temp (deg C) | 15.8 | 13.8 | 20.0 | 16.2 |
| Specific Conductivity (uS/cm) | 242 | 245 | 216 | 274 |
| Dissolved Oxygen (mg/L) | 5.9 | 6.6 | 6.5 | 6.8 |
| pH | 7.26 | 7.34 | 7.41 | 7.32 |
| Total Suspended Solids (mg/L) | < 1.1 | -- | 1.7 | -- |
| MN SQT Metrics | | | | |
| Temp (deg C) | At-Risk | | At-Risk | |
| Dissolved Oxygen (mg/L) | Not Functioning | | At-Risk | |
| Total Suspended Solids (mg/L) | Functioning | | Functioning | |

Project:
Reach ID:

**Minnesota Stream Quantification Tool**
**Parameter Selection Checklist**

| | Function-Based Parameter | Metric(s) | Datasheets for Field-based Metrics |
|---|---|---|---|
| ☑ | Reach Runoff* | ☑ Land Use Coefficient (D) **AND** Concentrated Flow Points (F) | Project Reach Form Section II(B)** |
| | | ***or*** | |
| | | ☐ BMP MIDS Rv Coefficient (D) | |
| ☑ | Floodplain Connectivity* | ☑ Bank Height Ratio* **AND** Entrenchment Ratio* (F) | Rapid Survey Form** **OR** Cross Section **AND** Longitudinal Survey Forms |
| ☑ | Large Woody Debris (LWD) | ☐ LWD Index (F) | LWDI Form |
| | | ***or*** | |
| | | ☑ No. of LWD Pieces/ 100 meters (F) | Project Reach Form Section VI** |
| ☑ | Lateral Migration* | ☑ Dominant BEHI/NBS* **AND** Percent Streambank Erosion* (F) | Lateral Migration Form** |
| | | ***or*** | |
| | | ☐ ***Optional:*** Percent Armoring (F) | Project Reach Form Section II(C)** |
| ☐ | Bed Material Characterization | ☐ ***Optional:*** Size Class Pebble Count Analyzer (F) | Pebble Count Form |
| ☑ | Bed Form Diversity* | ☑ Pool Spacing Ratio* **AND** Pool Depth Ratio* **AND** Percent Riffle* (F) | Longitudinal Survey **OR** Rapid Survey Form** |
| | | ☐ ***Optional:*** Aggradation Ratio (F) | Cross Section Form **OR** Rapid Survey Form** |
| ☐ | Riparian Vegetation* | ☐ Riparian Width* (D/F) **AND** Canopy Cover* (F) **AND** Herbaceous Vegetation Cover* (F) **AND** Woody Stem Basal Area[1] (F) | Riparian Width and Vegetation Forms** |
| | Riparian vegetation is assessed using the MPCA Stream Habitat Assessment Worksheets | | |
| ☑ | Temperature | ☑ ***Optional:*** Summer Average (F) | Temperature Logger SOP Form |
| ☑ | Dissolved Oxygen | ☑ ***Optional:*** Dissolved Oxygen Concentration (F) | Sensor Log |
| | Total Suspended Solids | ***Optional:*** Total Suspended Solids Concentration (F) | Sensor Log |
| ☑ | Macroinvertebrates | ☑ ***Optional:*** Macroinvertebrate IBI (F) | Macroinvertebrate Sample Sorting Bench Sheet **AND** Stream Invertebrate Visit Form |
| ☑ | Fish | ☑ ***Optional:*** Fish IBI (F) | Fish Survey Record Form **AND** Visit Summary Form |

* Include in all assessments
** Field values can be entered directly from field forms into MNSQT; all other metrics require additional post-processing or analysis to
(D) indicates metrics are calculated using desktop methods
(F) indicates metrics are calculated or verified using field methods
[1] Include Woody Stem Basal Area only if woody vegetation is determined to be a signification natural component of the riparian zone.

Date:
Investigators:

**Minnesota Stream Quantification Tool**
**Project Reach Form**

## I. Site Information

| | |
|---|---|
| Project Name: | West Ridge Railroad Relocation |
| Reach ID: | Little 39 Creek |
| Drainage Area (sq. mi.): | 0.17 |
| Use Class: | 2A |
| River Nutrient Region: | North |
| Valley Type: | Unconfined Alluvial |
| Stream Reach length (ft): | 3421 |
| Latitude: | 47°18'13.84"N |
| Longitude: | 91°22'49.57"W |

| Shading Key |
|---|
| Desktop Value |
| Field Value |
| Calculation |

## II. Reach Walk

A.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Difference between bankfull (BKF) stage and water surface (WS) (ft) | 0.26 | 0.1 | 0.4 | 0.2 | | | |
| | | | | | | | |
| Difference between BKF stage and WS (ft) *Average or consensus value from reach walk.* | | 0.24 | | | | | |

B.

| | |
|---|---|
| Number Concentrated Flow Points | 0 |
| Concentrated Flow Points/ 1,000 L.F. | 0.0 |

C.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Length of Armoring on banks (ft) | | 0 | | | | | |
| Total (ft) | 0.0 | | | | | | |
| Percent Armoring (%) | | | | | | | |

D.

| | |
|---|---|
| Valley length (ft) | 2764 |
| Stream Length (ft) | 3421 |
| Sinuosity | 1.24 |

## III. Identification of Representative Sub-Reach

| | | | |
|---|---|---|---|
| Representative Sub-Reach Length At least 20 x the Bankfull Width | 3421 | 20*Bankfull Width | 191.6 |
| Latitude of downstream extent: | 47°18'13.84"N | | |
| Longitude of downstream extent: | 91°22'49.57"W | | |

**Sub-Reach Survey Method**

x Longitudinal Profile & Cross Section

□ Rapid Survey

Date:
Investigators:

**Minnesota Stream Quantification Tool**
**Project Reach Form**

## IV. Bankfull Verification and Representative Riffle Cross Section

Is Cross Section located within Representative Sub-Reach? **x** Yes ☐ No

If no, explain why:

| | | XS1 | XS2 | XS3 | XS4 |
|---|---|---|---|---|---|
| A. | Bankfull Width (ft) | 9.58 | 10.24 | 9.5 | 9.71 |
| B. | Bankfull Mean Depth (ft)<br>= Average of cross-section depths | 0.3 | 0.3 | 0.3 | 0.3 |
| C. | Bankfull Area (sq. ft.)<br>Width * Mean Depth | 3.1 | 3.2 | 3.0 | 2.4 |
| D. | Regional Curve Bankfull Width (ft) | 6.6 | 6.6 | 6.6 | 6.6 |
| E. | Regional Curve Bankfull Mean Depth (ft) | 0.5 | 0.5 | 0.5 | 0.5 |
| F. | Regional Curve Bankfull Area (sq. ft.) | 3.3 | 3.3 | 3.3 | 3.3 |
| G. | Curve Used | Northshore (B channel) | | | |

*NOTE: Space is provided here to survey a cross section using rapid survey methods. A cross section form is also available for cross section surveys.*

| V. | Stream Classification | AVERAGE | XS1 | XS2 | XS3 | XS4 |
|---|---|---|---|---|---|---|
| A. | Width Depth Ratio (ft/ft)<br>Bankfull Width / Bankfull Mean Depth | 33.11 | 29.94 | 33.03 | 30.65 | 38.84 |
| B. | Bankfull Max Riffle Depth | 0.58 | 0.61 | 0.40 | 0.70 | 0.60 |
| C. | Floodprone Area Width (ft) | 19.11 | 20.08 | 15.80 | 20.89 | 19.65 |
| D. | Entrenchment Ratio (ft/ft)<br>Floodprone Area Width /Bankfull Width | 1.99 | 2.10 | 1.54 | 2.20 | 2.02 |
| E. | Slope Estimate (%) | 3.3 | *Average slope from the representative sub-reach will be measured and calculated. Pebble count forms are available to aid in this determination.* | | | |
| F. | Channel Material Estimate | | | | | |
| G. | Stream Type | B | | | | |

## VI. Large Woody Debris (100m (328 ft) assessment length within Sub-Reach)

| | | | |
|---|---|---|---|
| A. | Number of Pieces | | *NOTE: Complete this section only if the LWDI is not being used. Otherwise complete the LWDI Field Form.* |

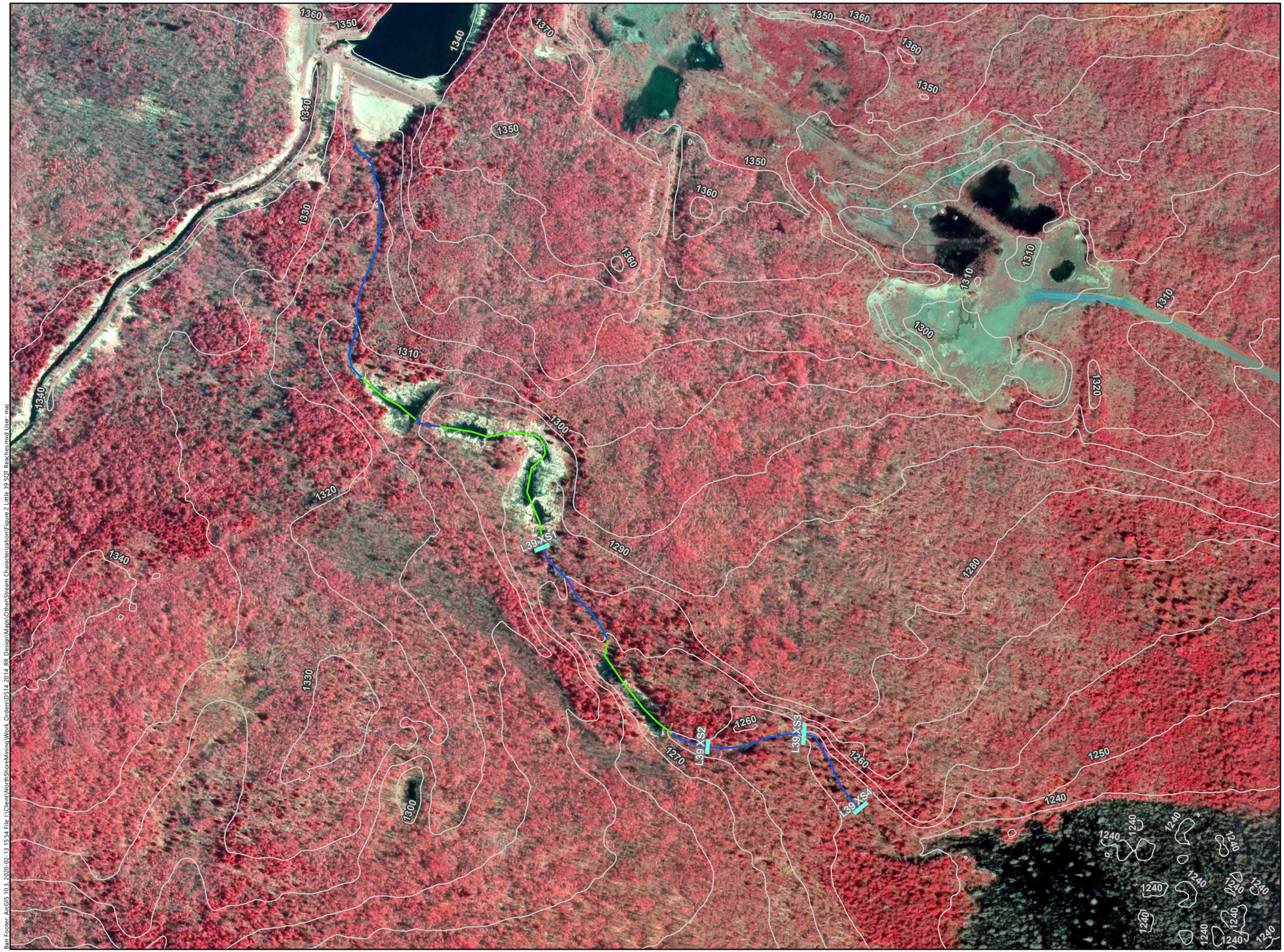
## VII. Representative Sub-Reach Sketch

SEE FIGURE 2
SQT ASSESSMENT REACHES
LITTLE 39 CREEK

## VIII. Notes

Cross section data was entered into RiverMorph; thus the following parameters were averaged for all cross sections collected for the Stream Classification Values

Width Depth Ratio
Bankfull Max Riffle Depth
Floodprone Area Width
Entrenchment Ratio




## Legend

Survey Cross Sections

10-ft contours

**SQT Reaches**

**Reach Type**

Stream

Wetland

0 150 300 600

Feet

Aerial Imagery: Color Infrared (2009)

Figure 2

SQT ASSESSMENT
REACHES
Little 39 Creek
Northshore Mining Company
Lake County, Minnesota

Barr Footer: ArcGIS 10.3, 2020-02-13 15:54 File: I:\Client\NorthShoreMining\Work_Orders\DS14 2014 RR Design\Maps\Other\Stream Characterization\Figure 2 Little 39 SQT Reaches.mxd User: maj

**Minnesota Stream Quantification Tool**
**Longitudinal Profile Form**

| | | | |
|---|---|---|---|
| Date: | 9/14/2017 | Rod Team: | BARR |
| Stream Name: | Little 39 Creek | Instrument Team: | BARR |
| Reach I.D. | NA | Notes Team: | BARR |
| Team Number: | NA | | |

**Longitudinal Profile Field Form**

**Key Codes:** RiverMorph Export

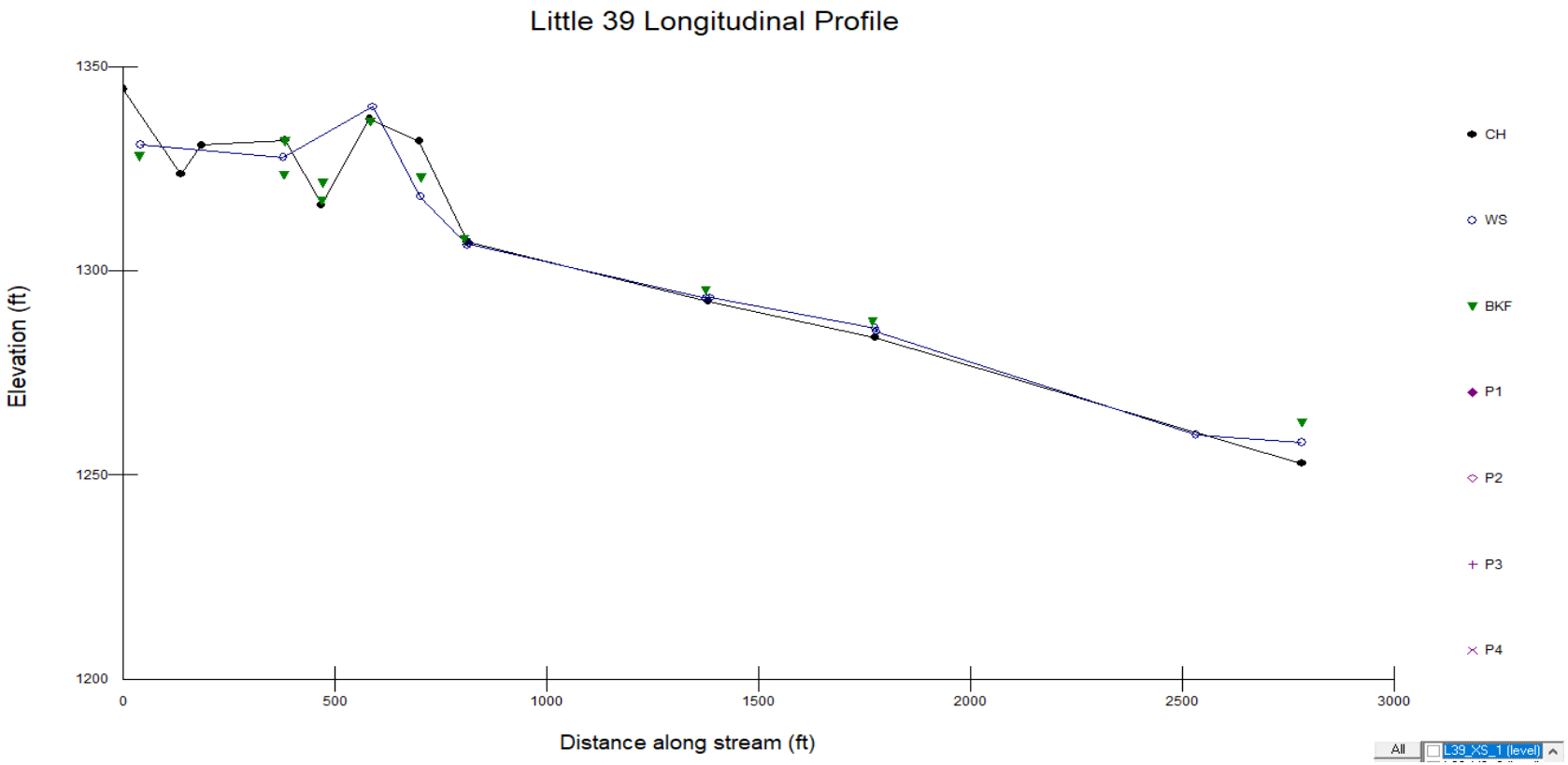
| **Survey:** | | | | |
|---|---|---|---|---|
| **Station Location** | **Channel Elevation** | **Water Surface Elevation** | **BKF Elevation** | **Comment** |
| 0.0 | 1344.4 | | | |
| 38.3 | | | 1327.9 | |
| 40.8 | | 1330.8 | | |
| 135.5 | 1323.6 | | | |
| 183.7 | 1330.8 | | | |
| 198.4 | | | | |
| 274.3 | | | | |
| 377.0 | | 1327.7 | | |
| 379.5 | | | 1323.3 | |
| 381.2 | 1331.9 | | | |
| 382.4 | | | 1331.6 | |
| 386.4 | | | | |
| 467.5 | 1316.1 | | | |
| 469.3 | | | 1317.0 | |
| 469.5 | | | | |
| 471.6 | | | 1321.4 | |
| 472.7 | | | | |
| 580.9 | 1337.0 | | | |
| 582.9 | | | 1336.4 | **Beaver Dam** |
| 583.3 | | | | |
| 584.5 | | | | |
| 588.0 | | 1340.1 | | |
| 688.1 | | | | |
| 698.3 | 1331.8 | | | |
| 699.9 | | | | |

**Minnesota Stream Quantification Tool**
**Longitudinal Profile Form**

| | | | | |
|---|---|---|---|---|
| 701.9 | | 1318.1 | | |
| 703.5 | | | 1322.7 | |
| 804.9 | | | 1307.8 | |
| 812.0 | | 1306.3 | | |
| 812.0 | | | | |
| 812.0 | 1307.1 | | | |
| 815.0 | | 1306.6 | | |
| 1374.7 | | | 1295.2 | |
| 1377.6 | | 1293.2 | | |
| 1382.1 | 1292.5 | | | |
| 1385.3 | | 1293.4 | | |
| 1390.4 | | | | |
| 1769.1 | | | 1287.5 | |
| 1775.1 | | 1285.9 | | |
| 1775.7 | | | | |
| 1775.7 | 1283.6 | | | |
| 1778.2 | | 1285.1 | | |
| 2527.7 | | | | |
| 2534.3 | | 1259.8 | | |
| 2539.7 | | | | |
| 2539.7 | | | | |
| 2758.0 | | | | |
| 2777.9 | | | | |
| 2783.6 | 1252.8 | | | |
| 2783.6 | | | | |
| 2783.6 | | 1258.0 | | |
| 2783.6 | | | | |
| 2783.6 | | | | |
| 2783.6 | | | 1262.7 | |

**Minnesota Stream Quantification Tool**
**Longitudinal Profile Form**

## II. Longitudinal Profile



**Minnesota Stream Quantification Tool**
**Longitudinal Profile Form**

| | | | |
|---|---|---|---|
| Date: | 8/7/2019 | Rod Team: | BARR |
| Stream Name: | Little 39 Creek | Instrument Team: | BARR |
| Reach I.D. | **Supplemental** | Notes Team: | BARR |
| Team Number: | NA | | |

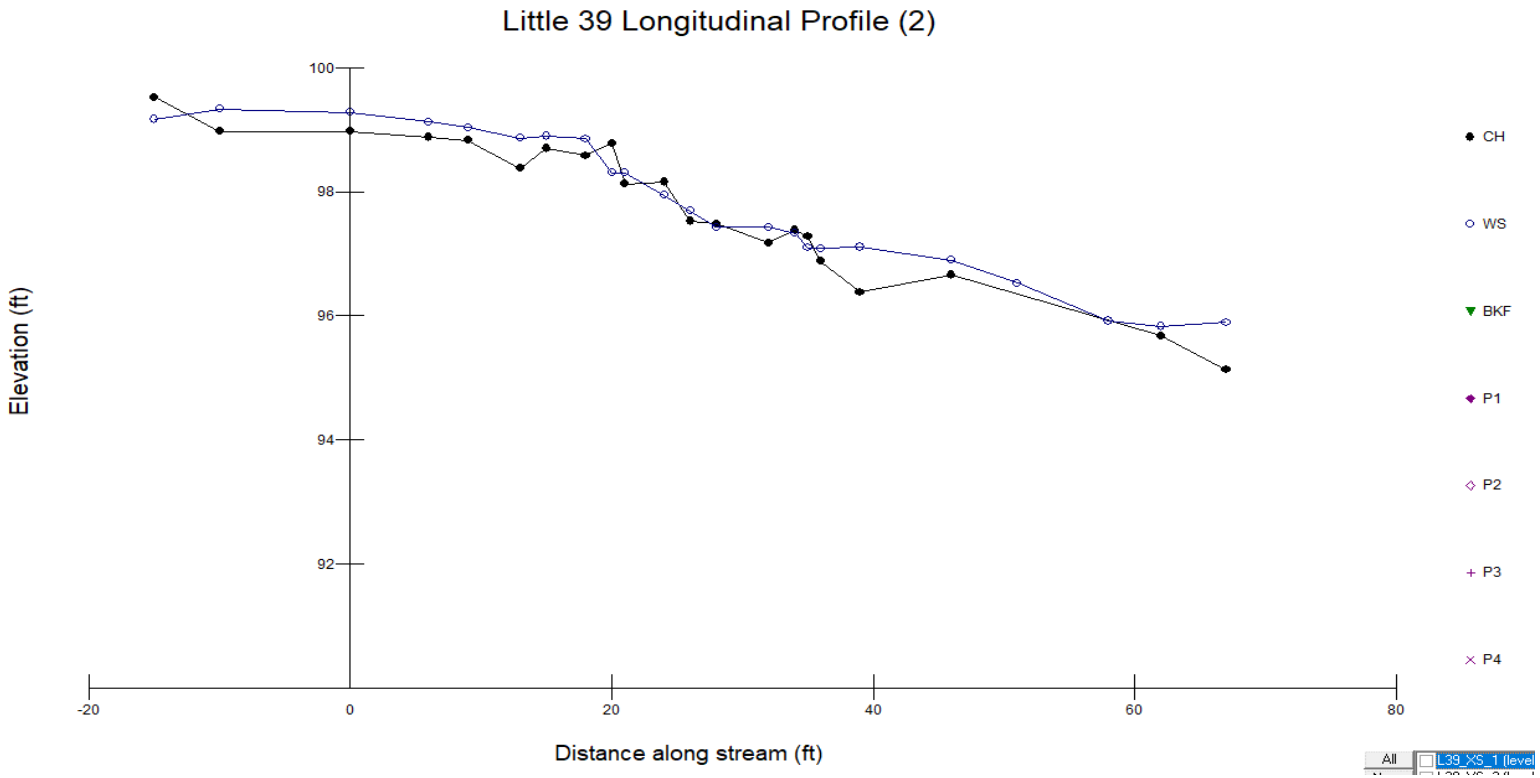
**Longitudinal Profile Field Form**

**Key Codes:** Exported from RiverMorph

| **Survey:** | | | | |
|---|---|---|---|---|
| **Station Loc** | **Channel Elevation** | **Water Surface Elevation** | **BKF Elevation** | **Comment** |
| -15 | 99.5 | 99.2 | | |
| -10 | 99.0 | 99.3 | | |
| 0 | 99.0 | 99.3 | | |
| 6 | 98.9 | 99.1 | | |
| 9 | 98.8 | 99.0 | | |
| 13 | 98.4 | 98.9 | | |
| 15 | 98.7 | 98.9 | | |
| 18 | 98.6 | 98.9 | | |
| 20 | 98.8 | 98.3 | | |
| 21 | 98.1 | 98.3 | | |
| 24 | 98.2 | 98.0 | | |
| 26 | 97.5 | 97.7 | | |
| 28 | 97.5 | 97.4 | | |
| 32 | 97.2 | 97.4 | | |
| 34 | 97.4 | 97.3 | | |
| 35 | 97.3 | 97.1 | | |
| 36 | 96.9 | 97.1 | | |
| 39 | 96.4 | 97.1 | | |
| 46 | 96.7 | 96.9 | | |
| 51 | | 96.5 | | |
| 58 | | 95.9 | | |
| 62 | 95.7 | 95.8 | | |
| 67 | 95.1 | 95.9 | | |

**Minnesota Stream Quantification Tool**
**Longitudinal Profile Form**

## II. Longitudinal Profile



**Minnesota Stream Quantification Tool**
**Cross Section Form**

| | | | |
|---|---|---|---|
| Date: | 8/7/2019 | Rod Team: | BARR |
| Stream Name: | Little 39 | Instrument Team: | BARR |
| Reach I.D. | L39 XS1 | Notes Team: | BARR |
| Team Number: | NA | | |

**Key Codes:**

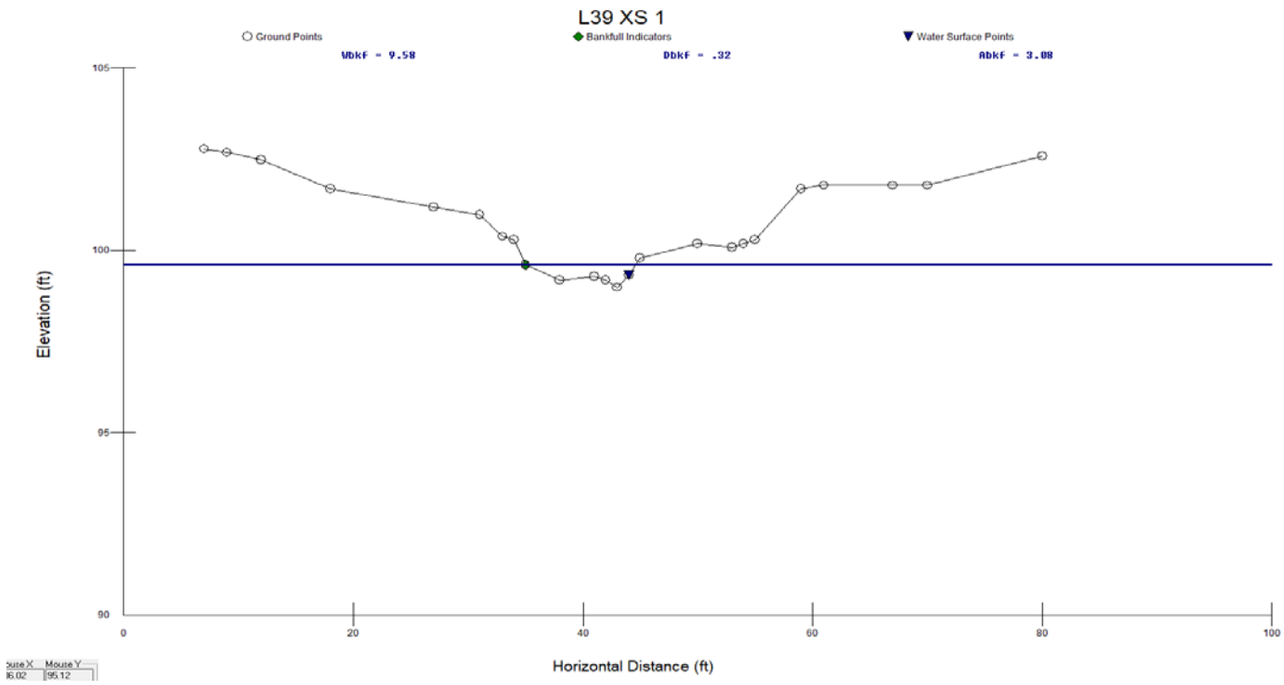
| | | | | | |
|---|---|---|---|---|---|
| Head of Riffle | R | Bankfull | BKF | Benchmark | TBM |
| Head of Run | N | Top of Bank | TOB | Turning Point | TP |
| Head of Pool | P | Edge of Channel | EC | Backsight | BS |
| Head of Glide | G | Inner Berm | IB | Foresight | FS |
| Thalweg | TW | | | Height of Instrument | HI |

**Cross Section Field Form**

| Station | BS (+) | HI | FS (-) | Elevation | Notes |
|---|---|---|---|---|---|
| 0 | | | | 102.8 | |
| 7 | | | | 102.7 | |
| 9 | | | | 102.5 | |
| 12 | | | | 101.7 | |
| 18 | | | | 101.2 | |
| 27 | | | | 101.0 | Historic bankfull? |
| 31 | | | | 100.4 | |
| 33 | | | | 100.3 | |
| 34 | | | | 99.6 | BKF |
| 35 | | | | 99.2 | |
| 38 | | | | 99.3 | |
| 41 | | | | 99.2 | |
| 42 | | | | 99.0 | |
| 43 | | | | 99.3 | |
| 44 | | | | 99.8 | |
| 45 | | | | 100.2 | |
| 50 | | | | 100.1 | BKF |
| 53 | | | | 100.2 | |
| 54 | | | | 100.3 | |
| 55 | | | | 101.7 | |
| 59 | | | | 101.8 | |
| 61 | | | | 101.8 | |
| 67 | | | | 101.8 | |
| 70 | | | | 102.6 | |
| | | | | | |
| | | | | | |

**Minnesota Stream Quantification Tool**
**Cross Section Form**

## II. Cross Section



**Minnesota Stream Quantification Tool**
**Cross Section Form**

| | | | |
|---|---|---|---|
| Date: | 8/7/2019 | Rod Team: | BARR |
| Stream Name: | Little 39 | Instrument Team: | BARR |
| Reach I.D. | L39 XS2 | Notes Team: | BARR |
| Team Number: | NA | | |

**Key Codes:**

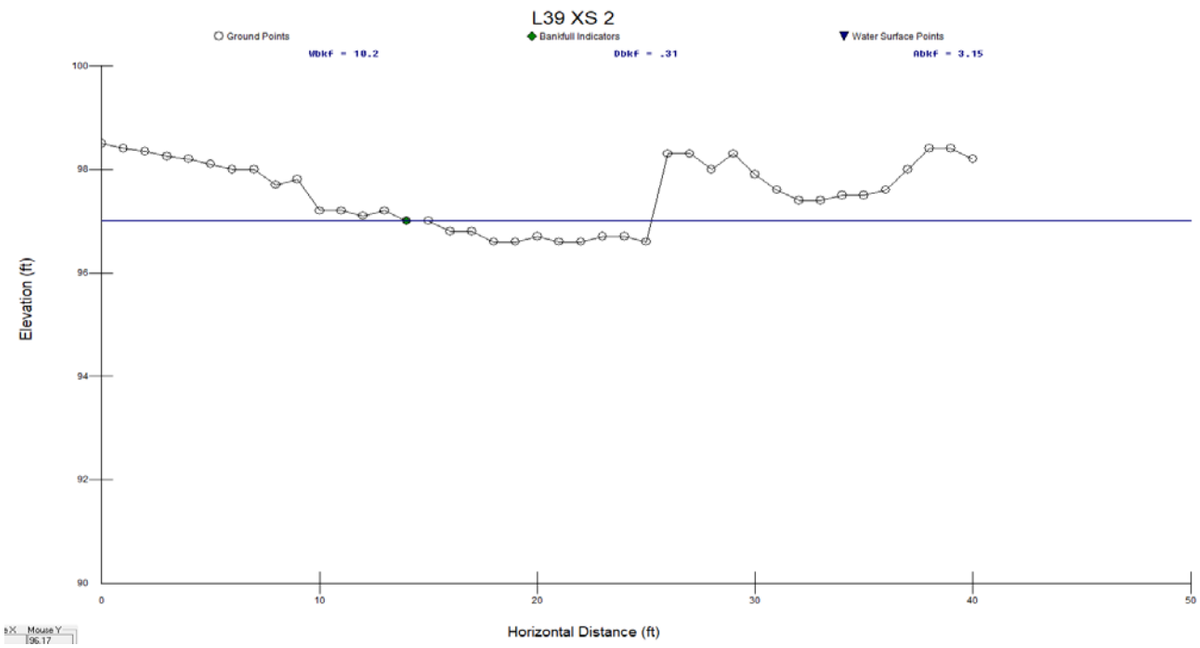
| | | | | | |
|---|---|---|---|---|---|
| Head of Riffle | R | Bankfull | BKF | Benchmark | TBM |
| Head of Run | N | Top of Bank | TOB | Turning Point | TP |
| Head of Pool | P | Edge of Channel | EC | Backsight | BS |
| Head of Glide | G | Inner Berm | IB | Foresight | FS |
| Thalweg | TW | | | Height of Instrument | HI |

**Cross Section Field Form**

| Station | BS (+) | HI | FS (-) | Elevation | Notes |
|---|---|---|---|---|---|
| 0 | | | | 98.5 | |
| 1 | | | | 98.4 | |
| 2 | | | | 98.35 | |
| 3 | | | | 98.25 | |
| 4 | | | | 98.2 | |
| 5 | | | | 98.1 | |
| 6 | | | | 98 | |
| 7 | | | | 98 | |
| 8 | | | | 97.7 | |
| 9 | | | | 97.8 | |
| 10 | | | | 97.2 | |
| 11 | | | | 97.2 | |
| 12 | | | | 97.1 | |
| 13 | | | | 97.2 | |
| 14 | | | | 97 | BKF |
| 15 | | | | 97 | |
| 16 | | | | 96.8 | |
| 17 | | | | 96.8 | |
| 18 | | | | 96.6 | |
| 19 | | | | 96.6 | |
| 20 | | | | 96.7 | |
| 21 | | | | 96.6 | |
| 22 | | | | 96.6 | |
| 23 | | | | 96.7 | |
| 24 | | | | 96.7 | |
| 25 | | | | 96.6 | |
| 26 | | | | 98.3 | |
| 27 | | | | 98.3 | |
| 28 | | | | 98 | |
| 29 | | | | 98.3 | |
| 30 | | | | 97.9 | |
| 31 | | | | 97.6 | |
| 32 | | | | 97.4 | |
| 33 | | | | 97.4 | |
| 34 | | | | 97.5 | |
| 35 | | | | 97.5 | |
| 36 | | | | 97.6 | |
| 37 | | | | 98 | |

| | | | | | |
|---|---|---|---|---|---|
| 38 | | | | 98.4 | |
| 39 | | | | 98.4 | |
| 40 | | | | 98.2 | |

## II. Cross Section



**Minnesota Stream Quantification Tool**
**Cross Section Form**

| | | | |
|---|---|---|---|
| Date: | 8/7/2019 | Rod Team: | BARR |
| Stream Name: | Little 39 | Instrument Team: | BARR |
| Reach I.D. | L39 XS3 | Notes Team: | BARR |
| Team Number: | NA | | |

**Key Codes:**

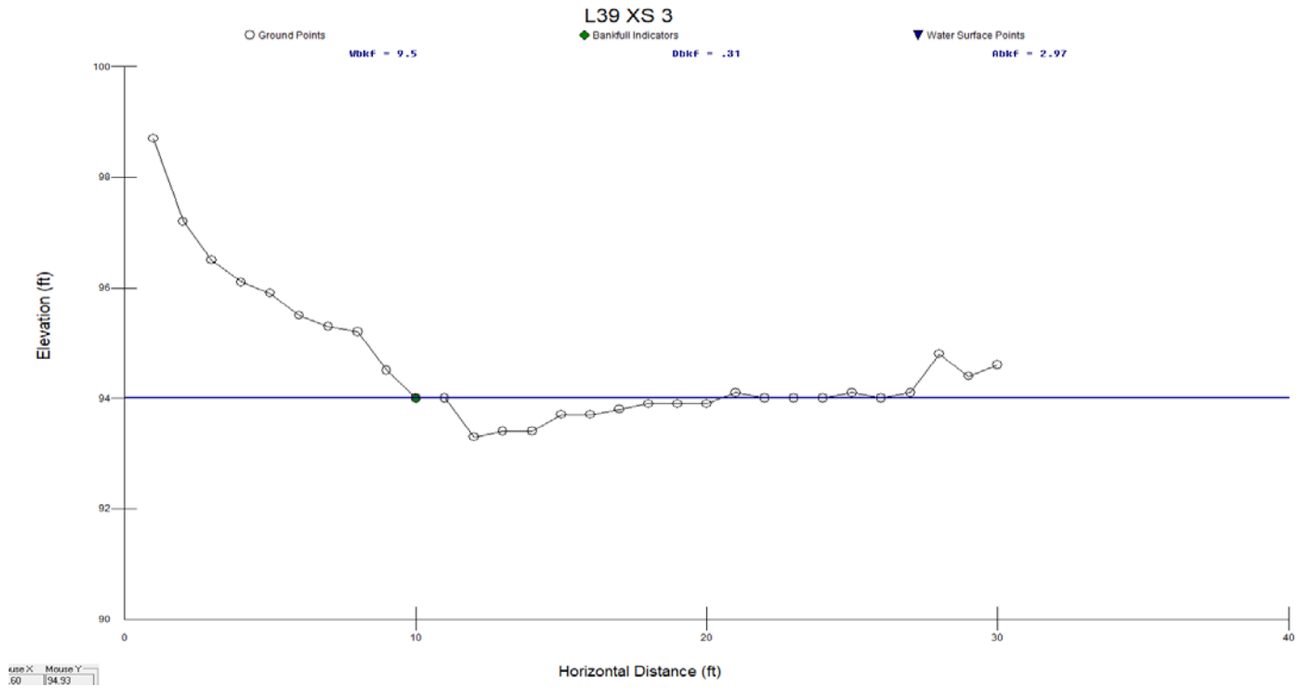
| | | | | | |
|---|---|---|---|---|---|
| Head of Riffle | R | Bankfull | BKF | Benchmark | TBM |
| Head of Run | N | Top of Bank | TOB | Turning Point | TP |
| Head of Pool | P | Edge of Channel | EC | Backsight | BS |
| Head of Glide | G | Inner Berm | IB | Foresight | FS |
| Thalweg | TW | | | Height of Instrument | HI |

**Cross Section Field Form**

| Station | BS (+) | HI | FS (-) | Elevation | Notes |
|---|---|---|---|---|---|
| 1 | | | | 98.7 | |
| 2 | | | | 97.2 | |
| 3 | | | | 96.5 | |
| 4 | | | | 96.1 | |
| 5 | | | | 95.9 | |
| 6 | | | | 95.5 | |
| 7 | | | | 95.3 | |
| 8 | | | | 95.2 | |
| 9 | | | | 94.5 | |
| 10 | | | | 94 | BKF |
| 11 | | | | 94 | |
| 12 | | | | 93.3 | |
| 13 | | | | 93.4 | |
| 14 | | | | 93.4 | |
| 15 | | | | 93.7 | |
| 16 | | | | 93.7 | |
| 17 | | | | 93.8 | |
| 18 | | | | 93.9 | |
| 19 | | | | 93.9 | |
| 20 | | | | 93.9 | |
| 21 | | | | 94.1 | |
| 22 | | | | 94 | |
| 23 | | | | 94 | |
| 24 | | | | 94 | |
| 25 | | | | 94.1 | |
| 26 | | | | 94 | |
| 27 | | | | 94.1 | |
| 28 | | | | 94.8 | |
| 29 | | | | 94.4 | |
| 30 | | | | 94.6 | |
| | | | | | |
| | | | | | |
| | | | | | |

**Minnesota Stream Quantification Tool**
**Cross Section Form**

## II. Cross Section



**Minnesota Stream Quantification Tool**
**Cross Section Form**

| | | | |
|---|---|---|---|
| Date: | 8/7/2019 | Rod Team: | BARR |
| Stream Name: | Little 39 | Instrument Team: | BARR |
| Reach I.D. | L39 XS4 | Notes Team: | BARR |
| Team Number: | NA | | |

**Key Codes:**

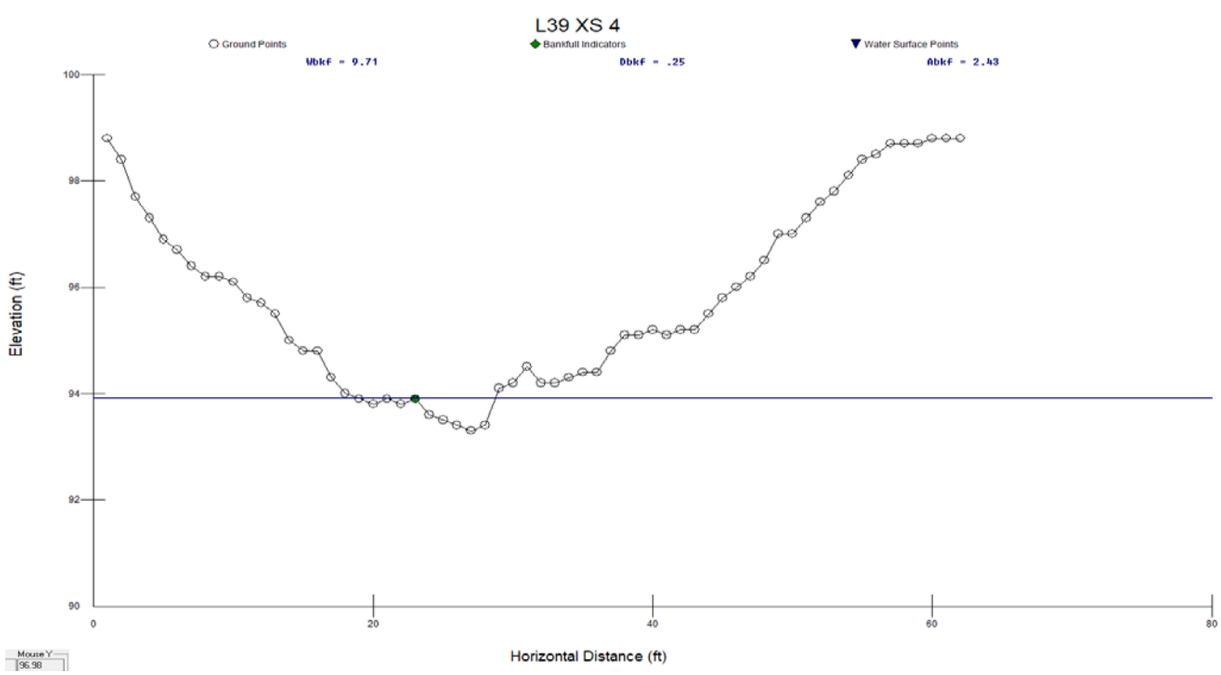
| | | | | | |
|---|---|---|---|---|---|
| Head of Riffle | R | Bankfull | BKF | Benchmark | TBM |
| Head of Run | N | Top of Bank | TOB | Turning Point | TP |
| Head of Pool | P | Edge of Channel | EC | Backsight | BS |
| Head of Glide | G | Inner Berm | IB | Foresight | FS |
| Thalweg | TW | | | Height of Instrument | HI |

**Cross Section Field Form**

| Station | BS (+) | HI | FS (-) | Elevation | Notes |
|---|---|---|---|---|---|
| 1 | | | | 98.8 | |
| 2 | | | | 98.4 | |
| 3 | | | | 97.7 | |
| 4 | | | | 97.3 | |
| 5 | | | | 96.9 | |
| 6 | | | | 96.7 | |
| 7 | | | | 96.4 | |
| 8 | | | | 96.2 | |
| 9 | | | | 96.2 | |
| 10 | | | | 96.1 | |
| 11 | | | | 95.8 | |
| 12 | | | | 95.7 | |
| 13 | | | | 95.5 | |
| 14 | | | | 95 | |
| 15 | | | | 94.8 | |
| 16 | | | | 94.8 | |
| 17 | | | | 94.3 | |
| 18 | | | | 94 | |
| 19 | | | | 93.9 | BKF |
| 20 | | | | 93.8 | |
| 21 | | | | 93.9 | |
| 22 | | | | 93.8 | |
| 23 | | | | 93.9 | |
| 24 | | | | 93.6 | |
| 25 | | | | 93.5 | |
| 26 | | | | 93.4 | |
| 27 | | | | 93.3 | |
| 28 | | | | 93.4 | |
| 29 | | | | 94.1 | |
| 30 | | | | 94.2 | |
| 31 | | | | 94.5 | |
| 32 | | | | 94.2 | |
| 33 | | | | 94.2 | |
| 34 | | | | 94.3 | |
| 35 | | | | 94.4 | |
| 36 | | | | 94.4 | |
| 37 | | | | 94.8 | |
| 38 | | | | 95.1 | |

| | | | | | |
|---|---|---|---|---|---|
| 39 | | | | 95.1 | |
| 40 | | | | 95.2 | |
| 41 | | | | 95.1 | |
| 42 | | | | 95.2 | |
| 43 | | | | 95.2 | |
| 44 | | | | 95.5 | |
| 45 | | | | 95.8 | |
| 46 | | | | 96 | |
| 47 | | | | 96.2 | |
| 48 | | | | 96.5 | |
| 49 | | | | 97 | |
| 50 | | | | 97 | |
| 51 | | | | 97.3 | |
| 52 | | | | 97.6 | |
| 53 | | | | 97.8 | |
| 54 | | | | 98.1 | |
| 55 | | | | 98.4 | |
| 56 | | | | 98.5 | |
| 57 | | | | 98.7 | |
| 58 | | | | 98.7 | |
| 59 | | | | 98.7 | |
| 60 | | | | 98.8 | |
| 61 | | | | 98.8 | |
| 62 | | | | 98.8 | |

## II. Cross Section



Reach ID: **Little 39**
Valley Type: **Unconfined Alluvial**
Bed Material: **cobbles**

| | | | Bank Erosion Hazard Index | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Station ID** | **Bank Length (Ft)** | **Study Bank Height (ft)** | **BKF Height (ft)** | **Root Depth (ft)** | **Root Density (%)** | **Bank Angle (degrees)** | **Surface Protection (%)** | **Bank Material Adjustment** | **Stratification Adjustment** | **BEHI Total/ Category** | **NBS Ranking** |
| | | | | | | | | | | | |
| XS1-L | 34 | 2.2 | 0.32 | 1 | 25 | 28 | 90 | -10 | | 16.5 | Low |
| XS1-R | 30 | 1.27 | 0.32 | 1 | 25 | 30 | 90 | -10 | | 13.5 | Low |
| | | | | | | | | | | | |
| XS2-L | 20 | 1.25 | 0.31 | 1 | 30 | 25 | 90 | -10 | | 13 | Low |
| XS2-R | 15 | 1.79 | 0.31 | 1 | 30 | 90 | 90 | -10 | | 20 | Moderate |
| | | | | | | | | | | | |
| XS3-L | 20 | 5.16 | 0.31 | 1 | 25 | 55 | 90 | -10 | | 20 | Moderate |
| XS3-R | 20 | 1.32 | 0.31 | 1 | 25 | 65 | 90 | -10 | | 16.2 | Low |
| | | | | | | | | | | | |
| XS4-L | 20 | 5.6 | 0.25 | 1 | 25 | 60 | 90 | -10 | | 21 | Moderate |
| XS4-R | 20 | 5.6 | 0.25 | 1 | 25 | 45 | 90 | -10 | | 20 | Moderate |
| | | | | | | | | | | | |

**Summary Table**

| BEHI/NBS Ranking | Enter bank Length from all rows on p.1 with same ranking | | | | | | | | | Length (Feet) | Percent of Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Ex/Ex | | | | | | | | | | | |
| Ex/VH | | | | | | | | | | | |
| Ex/H | | | | | | | | | | | |
| Ex/M | | | | | | | | | | | |
| Ex/L | | | | | | | | | | | |
| Ex/VL | | | | | | | | | | | |
| VH/Ex | | | | | | | | | | | |
| Vh/VH | | | | | | | | | | | |
| VH/H | | | | | | | | | | | |
| VH/M | | | | | | | | | | | |
| VH/L | | | | | | | | | | | |
| VH/VL | | | | | | | | | | | |
| H/Ex | | | | | | | | | | | |
| H/VH | | | | | | | | | | | |
| H/H | | | | | | | | | | | |
| H/M | | | | | | | | | | | |
| H/L | | | | | | | | | | | |
| H/VL | | | | | | | | | | | |
| M/Ex | | | | | | | | | | | |
| M/VH | | | | | | | | | | | |
| M/H | | | | | | | | | | | |
| M/M | | | | | | | | | | | |
| M/L | 15 | 20 | 20 | 20 | | | | | | 75.0 | 47% |
| M/VL | | | | | | | | | | | |
| L/Ex | | | | | | | | | | | |
| L/VH | | | | | | | | | | | |
| L/H | | | | | | | | | | | |
| L/M | | | | | | | | | | | |
| L/L | 34 | 30 | 20 | | | | | | | 84.0 | 53% |
| L/VL | | | | | | | | | | | |
| | | | | | | | | | Total Length: | 159.0 | 1.0 |
| | | | | | | | | | Eroding Length: | | |

# MPCA STREAM HABITAT ASSESSMENT

(revised 3-07)

**1. Stream Documentation**

Stream: Little 39 Creek

County: Lake  Date: 9/14/2017

Field Number:  Person Scoring: Kate Sinner

Site Location: Little 39 Creek, West of Northshore Mine Tailings Basin

**MSHA SCORE**

Max = 100: 61

**2. Surrounding Land Use** (check the most predominant or check two and average scores) [L=left bank/R=right bank, facing downstream]

| L | R | | | L | R | | |
|---|---|---|---|---|---|---|---|
| ☒ | ☒ | Forest, Wetland, Prairie, Shrub | [5] | ☐ | ☐ | Residential/Park | [2] |
| ☐ | ☐ | Old Field/Hay Field | [3] | ☐ | ☐ | Urban/Industrial | [0] |
| ☐ | ☐ | Fenced Pasture | [2] | ☐ | ☐ | Open Pasture | [0] |
| ☐ | ☐ | Conservation Tillage, No Till | [2] | ☐ | ☐ | Row Crop | [0] |

**Land Use** Max=5: 5

**3. Riparian Zone** (check the most predominant)

**A. Riparian Width**

| L | R | | | |
|---|---|---|---|---|
| ☒ | ☒ | Extensive | > 300' | [5] |
| ☐ | ☐ | Wide | 150'-300' | [4] |
| ☐ | ☐ | Moderate | 30'-150' | [3] |
| ☐ | ☐ | Narrow | 15'-30' | [2] |
| ☐ | ☐ | Very Narrow | 3'-15' | [1] |
| ☐ | ☐ | None | | [0] |

**B. Bank Erosion**

| L | R | | | |
|---|---|---|---|---|
| ☒ | ☒ | None | | [5] |
| ☐ | ☐ | Little | 5-25% | [4] |
| ☐ | ☐ | Moderate | 25-50% | [3] |
| ☐ | ☐ | Heavy | 50-75% | [1] |
| ☐ | ☐ | Severe | 75-100% | [0] |

**C. Shade**

| L | R | | | |
|---|---|---|---|---|
| ☒ | ☒ | Heavy | >75% | [5] |
| ☐ | ☐ | Substantial | 50-75% | [4] |
| ☐ | ☐ | Moderate | 25-50% | [2] |
| ☐ | ☐ | Light | 5-25% | [1] |
| ☐ | ☐ | None | | [0] |

**Riparian** Max=15: 15

**4. Instream Zone**

**A. Substrate** (check two for each channel type)

| | Boulder [10] | Cobble [9] | Gravel [8] | Sand [7] | Clay [5] | Bedrock [5] | Silt [2] | Muck [1] | Detritus [1] | Sludge [0] | Channel Type % |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Pool | ☒ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☒ | ☐ | ☐ | 50 |
| Riffle | ☒ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☒ | ☐ | ☐ | 50 |
| Run | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | |
| Glide | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | |

*both very shallow w/ Large boulders

**B. Embeddedness**

- ☐ None [5]
- ☐ Light 25-50% [3]
- ☒ Moderate 50-75% [1]
- ☐ Severe 75-100% [-1]
- ☐ No coarse substrate [0]

**C. Substrate Types**

- ☐ >4 [2]
- ☒ <=4 [0]

**D. Water Color**

- ☐ Clear
- ☒ Stained
- Turbid: ☐ Brown ☐ Green ☐ Other

**Substrate** Max=27: 12

**E. Cover Type** (check all that apply)

- ☐ Undercut Banks [1]
- ☒ Overhanging Vegetation [1]
- ☐ Deep Pools [1]
- ☒ Logs or Woody Debris [1]
- ☒ Boulders [1]
- ☐ Rootwads [1]
- ☒ Macrophytes: [1]
  - ☒ Emergent
  - ☒ Floating Leaf
  - ☒ Submergent

**F. Cover Amount** (check one)

- ☐ Extensive >50% [10]
- ☒ Moderate 25-50% [7]
- ☐ Sparse 5-25% [3]
- ☐ Nearly Absent [0]
- ☐ Choking Vegetation only [-1]

only on "stream-like" reaches

**Cover** Max=17: 11

**5. Channel Morphology**

**A. Depth Variability**

- ☐ Greatest Depth >4X Shallow Depth [6]
- ☒ Greatest Depth 2-4X Shallow Depth [3]
- ☐ Greatest Depth <2X Shallow Depth [0]

**B. Channel Stability**

- ☒ High [9]
- ☐ Moderate/High [6]
- ☐ Moderate [3]
- ☐ Low [0]

**C. Velocity Types** (check all that apply)

- ☐ Torrential [-1]
- ☐ Fast [1]
- ☒ Moderate [1]
- ☒ Slow [1]
- ☐ Eddies [1]
- ☒ Intermittent [-2]
- ☐ Interstitial [-1]

**D. Sinuosity**

- ☐ Excellent [6]
- ☒ Good [4]
- ☐ Fair [2]
- ☐ Poor [0]

**E. Pool Width/Riffle Width**

- ☒ Pool Width > Riffle Width [2]
- ☐ Pool Width = Riffle Width [1]
- ☐ Pool Width < Riffle Width [0]
- ☐ No Riffle [0]

**F. Channel Development**

- ☐ Excellent [9]
- ☐ Good [6]
- ☐ Fair [3]
- ☒ Poor [0]

*only seemed to pool due to impoundments

**G. Present Water Level**

- ☐ Flood
- ☐ High
- ☐ Normal
- ☒ Low
- ☐ Interstitial

**Channel Morphology** Max=36: 18

Date: 8/7/2019 Investigators:
KDM, KMS2, JCO

**Minnesota Stream Quantification Tool**
**Sensor Log**

Stream Name: Little 39
Sub-reach Name:

---

**Dissolved Oxygen Logger Deployed?** ☒ **Yes** ☐ **No**

| | |
|---|---|
| Date Deployed: 8/7/2019 | Frequency of data: ☐ Daily ☒ Other: 15 min. |
| Date Retreived: 8/16/2019 | Timing of data: ☐ 1-3pm ☐ Other: _____ |

Describe sensor location within reach: Installed at downstream end of 75m reach

---

**Total Suspended Solids Sample Obtained?** Sample Type:

Date Obtained:

Describe location within reach:

**Other Sensor Deployed?** Yes Sensor Type: In-Situ datalogger

Date Deployed: 8/7/2019
Date Retreived: 8/16/2019
Frequency of data (if applicable): 15 min.

Describe location within reach: Installed at downstream end of 75m reach

**ALSO IDENTIFY ALL SENSOR LOCATIONS ON SUB-REACH SKETCH ON PROJECT REACH FORM**

*-MPCA Biological Monitoring Program-*

# Macroinvertebrate Identification Lab Bench Sheet

| | |
|---|---|
| **Field Number** | **Sample Date** |
| **Site Name** | **Taxonomist:** |
| **Sample Type** QMH* QR HD other_____ | **Date of Sample ID:** _____/_____/_____ |

*A processed QMH sample consists of 2 parts, the subsample(ss) and large/rare (l/r), both parts must be identified

| Order/Family | Genus | Species/Notes | ss | l/r | Order/Family | Genus | Species/Notes | ss | l/r |
|---|---|---|---|---|---|---|---|---|---|
| **Ephemeroptera** | | | | | **Odonata** | | | | |
| Baetiscidae | Baetisca | | | | Calopterygidae | Calopteryx | | | |
| Caenidae | Bracycercus | | | | | Hetaerina | | | |
| | Caenis | | | | Coenagrionidae | Argia | | | |
| Ephemerellidae | Attenella | | | | | Enallagma | | | |
| | Ephemerella | | | | | Nehalennia | | | |
| | Serratella | | | | Lestidae | Lestes | | | |
| Ephemeridae | Ephemera | | | | Aeshnidae | Aeschna | | | |
| | Hexagenia | | | | | Anax | | | |
| Leptohyphidae | Tricorythodes | | | | | Basiaeschna | | | |
| Leptophlebiidae | Leptophlebia | | | | | Boyeria | | | |
| | Paraleptophlebia | | | | Cordulegastridae | Cordulegaster | | | |
| Polymitarcidae | Ephoron | | | | Corduliidae | Cordulia | | | |
| Potamanthidae | Anthopotamus | | | | | Dorocordulia | | | |
| Heptageniidae | Epeorus | | | | | Epitheca | | | |
| | Heptagenia | | | | | Somatochlora | | | |
| | Stenacron | | | | Gomphidae | Dromogomphus | | | |
| | Stenonema | | | | | Gomphurus | | | |
| Isonychiidae | Isonychia | | | | | Gomphus | | | |
| Ametropodidae | Ametropus | | | | | Hagenius | | | |
| Baetidae | Acerpenna | | | | | Ophiogomphus | | | |
| | Baetis | | | | | Phanogomphus | | | |
| | Callibaetis | | | | | Progomphus | | | |
| | Heterocloeon | | | | ***notes/additional taxa*** | | | | |
| ***notes/additional taxa*** | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | **Hemiptera** | | | | |
| **Plecoptera** | | | | | Belostomatidae | Belstoma | | | |
| Leuctridae | | | | | | Corixidae | | | |
| Taeniopterygidae | | | | | Corixidae | Hesperocorixa | | | |
| Perlidae | Acroneuria | | | | | Sigara | | | |
| | Agnetina | | | | | Trichocorixa | | | |
| | Attaneuria | | | | Nepidae | Ranatra | | | |
| | Neoperla | | | | Notonectidae | Buenoa | | | |
| | Paragnetina | | | | | Notonecta | | | |
| | Perlinella | | | | ***notes/additional taxa*** | | | | |
| Perlodidae | | | | | | | | | |
| Pteronarycyidae | Pteronarcys | | | | | | | | |
| ***notes/additional taxa*** | | | | | | | | | |
| | | | | | **Amphipoda** | | | | |
| | | | | | Talitridae | Hyallela | azteca | | |
| | | | | | Gammaridae | Gammarus | | | |
| **Lepidoptera** | | | | | ***notes/additional taxa*** | | | | |
| Pyralidae | Paraponyx | | | | | | | | |
| | Petrophila | | | | | | | | |
| ***notes/additional taxa*** | | | | | **Decapoda** | | | | |
| | | | | | Cambaridae | Cambarus | | | |
| **Megaloptera** | | | | | | Orconectes | | | |
| Corydalidae | Chauliodes | | | | | Procambarus | | | |
| | Corydalus | | | | ***notes/additional taxa*** | | | | |
| | Nigronia | | | | | | | | |
| Sialidae | Sialis | | | | | | | | |
| ***notes/additional taxa*** | | | | | **Pelecypoda** | | | | |
| | | | | | Sphaeriidae | | | | |
| | | | | | Corbiculidae | | | | |
| **Isopoda** | | | | | Unionidae | | | | |
| Asselidae | Asselus | | | | ***notes/additional taxa*** | | | | |
| ***notes/additional taxa*** | | | | | | | | | |

**entered into DataInverts by_____ --- (initials) date_____**

| Order/Family | Genus | Species/Notes | ss | l/r | Order/Family | Genus | Species/Notes | ss | l/r |
|---|---|---|---|---|---|---|---|---|---|
| **Trichoptera** | | | | | **Diptera** | | | | |
| Dipseudopsidae | Phylocentropus | | | | Ceratopogonidae | Alluaudomyia | | | |
| Hydropsycidae | Ceratopsyche | | | | | Atrichopogon | | | |
| | Cheumatopsyche | | | | | Bezzia | | | |
| | Diplectrona | | | | | Ceratopogon | | | |
| | Hydropsyche | | | | | Culicoides | | | |
| | Potamyia | | | | | Nilobezzia | | | |
| Philopotamidae | Chimarra | | | | | Palpomyia | | | |
| | Dolophilodes | | | | | Probezzia | | | |
| Polycentropodidae | Cernotina | | | | | Sphaeromias | | | |
| | Cyrnellus | | | | Chironomidae | G. | | | |
| | Neureclipsis | | | | Dixidae | Dixa | | | |
| | Paranyctiophylax | | | | | Dixella | | | |
| | Polycentropus | | | | Simuliidae | Simulium | | | |
| Psychomyiidae | Lype | | | | Tipulidae | Antocha | | | |
| | Psychomyia | | | | | Dicranota | | | |
| Glossosomatidae | Agapetus | | | | | Hexatoma | | | |
| | Glossosoma | | | | | Limnophila | | | |
| | Protoptila | | | | | Limonia | | | |
| Hydroptilidae | Hydroptila | | | | | Pilaria | | | |
| | Leucotrichia | | | | | Tipula | | | |
| | Mayatrichia | | | | Athericidae | Atherix | | | |
| | Oxyethira | | | | Empididae | Hemerodromia | | | |
| | Orthotrichia | | | | Tabanidae | Chrysops | | | |
| Rhyacophilidae | Rhyacophila | | | | | Tabanus | | | |
| Brachyecentridae | Brachycentrus | | | | ***notes/additional taxa*** | | | | |
| | Micrasema | | | | | | | | |
| Helicopsychidae | Helicopsyche | | | | | | | | |
| Lepidostomatidae | Lepidostoma | | | | | | | | |
| Leptoceridae | Ceraclea | | | | **Coleoptera** | | | | |
| | Leptocerus | | | | Dytiscidae | Agabus | | | |
| | Mystacides | | | | | Laccophilus | | | |
| | Nectopsyche | | | | | Liodessus | | | |
| | Oecetis | | | | Gyrinidae | Dineutus | | | |
| | Trianodes | | | | | Gyrinus | | | |
| Limnephilidae | Limnephilus | | | | Elmidae | Ancyronyx | | | |
| | Hydatophylax | | | | | Dubiraphia | | | |
| Molannidae | Molanna | | | | | Macronychus | | | |
| Phryganeidae | Phryganea | | | | | Optioservus | | | |
| | Ptilostomis | | | | | Stenelmis | | | |
| Sericostomatidae | Agarodes | | | | Hydrophilidae | Berosus | | | |
| ***notes/additional taxa*** | | | | | | Helocombus | | | |
| | | | | | | Laccobius | | | |
| | | | | | | Sperchopsis | | | |
| | | | | | | Tropisternus | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| **Gastropoda** | | | | | | | | | |
| Ancylidae | Ferrissia | | | | | | | | |
| Planorbidae | Helisoma | | | | **Annelida** | Oligochaeta | | | |
| | Promentus | | | | | Hirudinea | | | |
| | Planorbula | | | | ***notes/additional taxa*** | | | | |
| | Gyraulus | | | | | | | | |
| Vivaparidae | Campeloma | | | | | | | | |
| Lymnaeidae | Lymnaea | | | | | | | | |
| | Bulimnea | | | | | | | | |
| | Fossaria | | | | Hydracarina (trombidoformes, acarina) | | | | |
| Hydrobiidae | Amnicola | | | | Nematoda | | | | |
| Pleuroceridae | Pleurocera | | | | *notes/additional taxa* | | | | |
| Physidae | Physa | | | | | | | | |
| *notes/additional taxa* | | | | | | | | | |

**entered into DataInverts by_____ --- (initials) date_____**

*MPCA Stream Monitoring Program*

# STREAM INVERTEBRATE VISIT FORM

| | | |
|---|---|---|
| **Stream Name:** Little 39 | | **Date:** 8/7/2019 |
| **Field Number:** | **County: Lake** | **Crew:** KDM, KMS2, JCO |

**Water Chemistry** Tape Down: ___._____ (1/100ths ft) Location: _____

Time: (24 hr) 13:50 Air Temp: 24 (ºC) Water Temp: 15 (ºC) Sp. Cond.: 240 (umhos@25ºC)

DO: 7.39 (mg/L) DO % Saturation:_____ pH: 7.29 Secchi -Tube: _____ (cm)

Water Level: Normal Below _____ (m) Above _____ (m) Color _____ (pcu)

*****If Flagging is not found or if establishing a new site, fill out GPS info*****

| **Coordinates** | **LATITUDE** | **LONGITUTDE** | **Time: 2019-11-18 12:33:17** |
|---|---|---|---|
| **Field GPS:** | **47.30384** | **-91.38154** | **Name:** |

**Notes:** Reach is boulders with muck and detritus in between. Lots of woody debris.

## Stream Classification Information

| | | |
|---|---|---|
| Flow | Flow over riffle(s) | High / Med / **Low** / NA |
| Flow | Flow at reach constriction | High / Med / **Low** / NA |
| Flow | Flow over run | High / Med / **Low** / NA |
| Flow | General flow pattern | High / Med / **Low** / NA |
| Flow | Intermittent sections | Yes / No |
| Habitat | Riffle (with flow) present in reach | N |
| Habitat | Riffle (with flow) present outside of reach (riffles do not include riprap associated with bridges or bank stabilization) | Y |

| | | |
|---|---|---|
| Channel | Excavated, trapezoidal channel | % |
| Channel | Shallow excavation, channelized wetland | % |
| Channel | Natural channel | 100% |
| Vegetation | Emergent, aquatic vegetation in channel | Ext / Mod / **Sparse** / NA |
| Vegetation | Emergent, aquatic vegetation along bank | Ext / Mod / **Sparse** / NA |
| Vegetation | Floating or submerged aquatic vegetation | Ext / Mod / Sparse / **NA** |
| Vegetation | Loosely attached filamentous algae | Ext / Mod / Sparse / **NA** |
| Vegetation | Firmly attached algae or submerged veg | Ext / Mod / **Sparse** / NA |

Dominant invertebrate habitat (circle two) Riffle | Rocky Run-Pool | Aquatic Macrophyte | Bank-Overhanging Veg | **Wood** | Leaf

| | | |
|---|---|---|
| Substrate | Dominant Run Substrate | bedrock / **boulder** / cobble / gravel / sand / silt |
| Substrate | Dominant Pool Substrate | bedrock / boulder / cobble / gravel / sand / **silt** |
| Substrate | Dominant Substrate receiving flow | bedrock / boulder / cobble / gravel / sand / **silt** |
| Substrate | Dominant Substrate in reach | bedrock / boulder / cobble / gravel / sand / silt |

| | |
|---|---|
| c | Stream displays a typical riffle-run pool morphology c adequate flow to maintain riffle organisms c inadequate flow to maintain riffle organisms |
| c | Stream has adquate flow to maintain riffle organism, but does not have suitable coarse substrate to support these assemblages (riffles, rock substrate in runs or pools) |
| c | Stream has adquate flow to maintain riffle dwelling organism, woody debris has replaced rocks as primary coarse substrate |
| c | Stream is low gradient, stream bed is predominately fine substrate, inadequate flow to maintain riffle organisms |

## Invertebrate Sample Information

### Qualitative Multi-Habitat Sample (QMH)

Divide 20 samples equally among habitat types present in the reach. If three habitat types are present take 7 samples in each of the three dominant habitats (for a total of 21). If a habitat is present, but not in abundance to sample in equal proportion to other habitats, sample as much as possible and divide the remaining samples between the dominant habitat types.

| a | Habitat | | | #Samples |
|---|---|---|---|---|
| ✔ | rock riffle/run | Flow adequate to carry insects into net | | 8 |
| | rock substrate | Artificial flow needed to carry insect into net | | |
| c | aquatic macrophyte | | | |
| c | undercut bank, overhanging veg | | | |
| ✔ | snag, woody debris, root wad | | | 12 |
| c | leaf pack | | | |

**Number of multihabitat containers:** _____ 1

## Additional Biological Information

Presence of freshwater sponge ---------- yes / **no**

Presence of exotic species ---------- yes / **no**

Name of exotic(s) if present:

(voucher a specimen if not present in sample)

Presence of mussels ----------yes / **no**

Description of mussel density and/or mussel bed location:

## Notes

Pictures #: __ DD __ DU __ MD __ MU __ UD __ UU

## FISH SURVEY RECORD MPCA

| | |
|---|---|
| Field Number: Little 39 | Stream Name: Little 39 |
| Date 9/4/2019 | Crew: DJM, CJB, KDM |

Gear Type (circle one): Backpack, LR-24 Smith-Root Electrofisher

VOlts: 155 Freq: 35HZ Duty Cycle: 25%

Channel Position: Right Bank Mid-Channel Left Bank
(circle one if boom-electrofisher site)

| | | |
|---|---|---|
| Distance (m): 90m | Time Fished (sec): 1883 | Identified by: field identifications by--DJM, voucher's and photo's sent to U of M for identification by Andrew Simon's, Ph. D., Dept. of Fisheries and Wildlife |
| Visit Comments: | | |

| Species (common name) | Length Range (mm) | Weight (g) | Number | Anomalies or YOY | Voucher Number | Voucher Pics |
|---|---|---|---|---|---|---|
| 1. Brook stickleback | 30-70 | 31 | 19 | --- | --- | |
| 2. Pearl dace | 95-105 | 19 | 2 | --- | 1A | |
| 3. Fathead minnow | 42-65 | 17 | 8 | --- | 1C, 1D | |
| 4. Central mudminnow | 56-90 | 64 | 17 | 1E | 1B | |
| 5. | | | | | | |
| 6. Total Fish: | | | 46 | | | |
| 7. | | | | | | |
| 8. | | | | | | |
| 9. | | | | | | |
| 10. | | | | | | |
| 11. | | | | | | |
| 12. | | | | | | |
| 13. | | | | | | |
| 14. | | | | | | |
| 15. | | | | | | |
| 16. | | | | | | |
| 17. | | | | | | |
| 18. | | | | | | |
| 19. | | | | | | |
| 20. | | | | | | |
| 21. | | | | | | |
| 22. | | | | | | |
| 23. | | | | | | |
| 24. | | | | | | |
| 25. | | | | | | |
| 26. | | | | | | |
| 27. | | | | | | |
| 28. | | | | | | |

Anomalies: **A**-anchor worm; **B**-black spot; **C**-leeches; **D**-deformities; **E**-eroded fins; **F**-fungus; **G**-yellow grub; **L**-lesions; **N**-blind; **P**=parasites; **PL**-parasite lesion; **Y**-popeye; **S**-emaciated; **W**-swirled scales; **T**-tumors; **Z**-other. (Heavy [**H**] or Light [**L**] code may be combined with above codes).

Project Area
Aquatic Biota Survey Segments
Streams

0 200 400 800
Feet

Aerial Imagery: FSA (2017)

Figure 1

AQUATIC BIOTA
SURVEY REACHES
Tailings Basin Progression
Northshore Mining Company
Lake County, Minnesota

Barr Footer: ArcGIS 10.6.1, 2019-08-19 16:19 File: K:\Client\NorthShore\Mining\Work Orders\DS14_2014 RR Design\Maps\Meetings\2019_08_19\Figure 1 Aquatic Biota Survey.mxd User: arm2

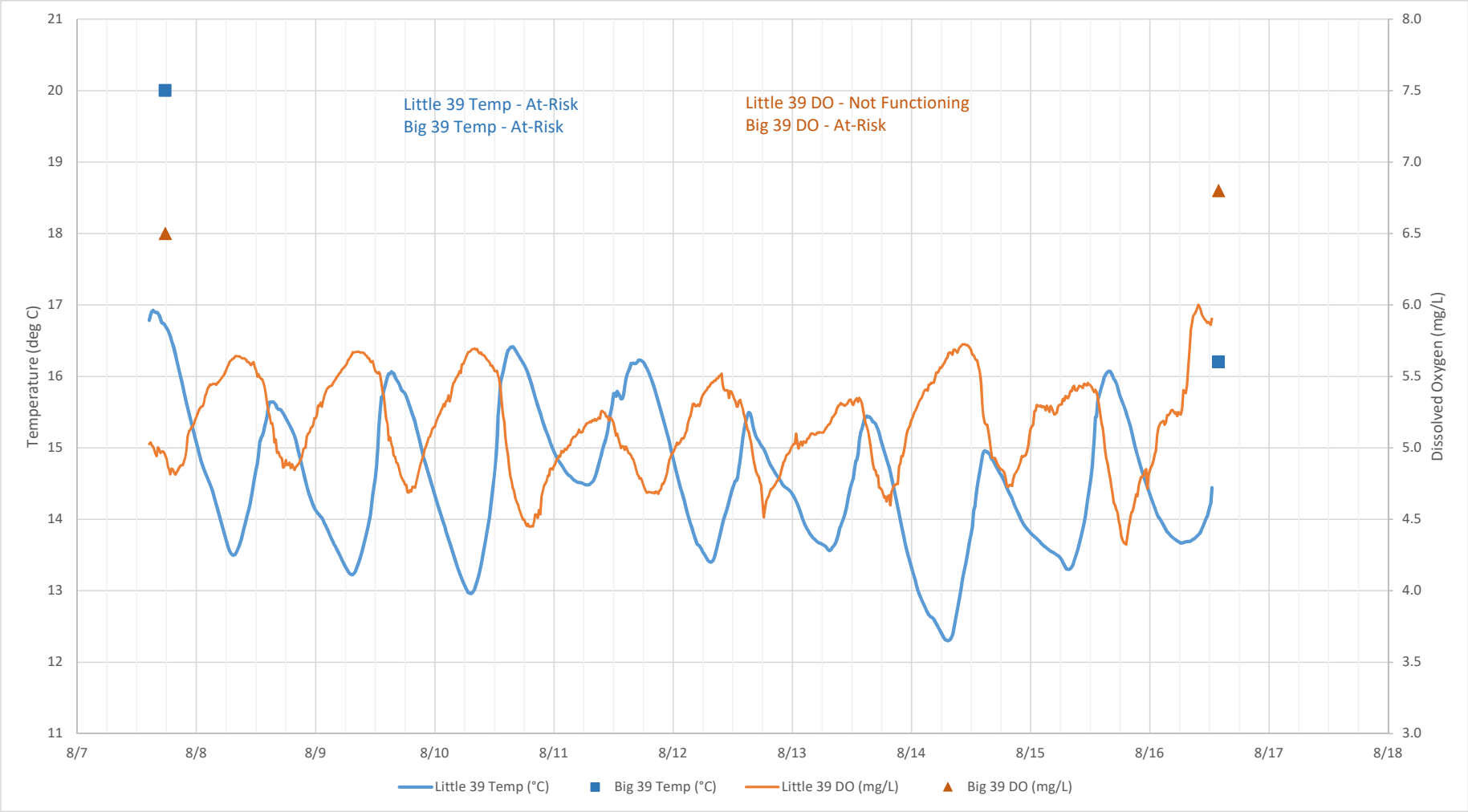



Figure 2
Temperature and Dissolved Oxygen
Big and Little 39 Creeks
Northshore Mining Company

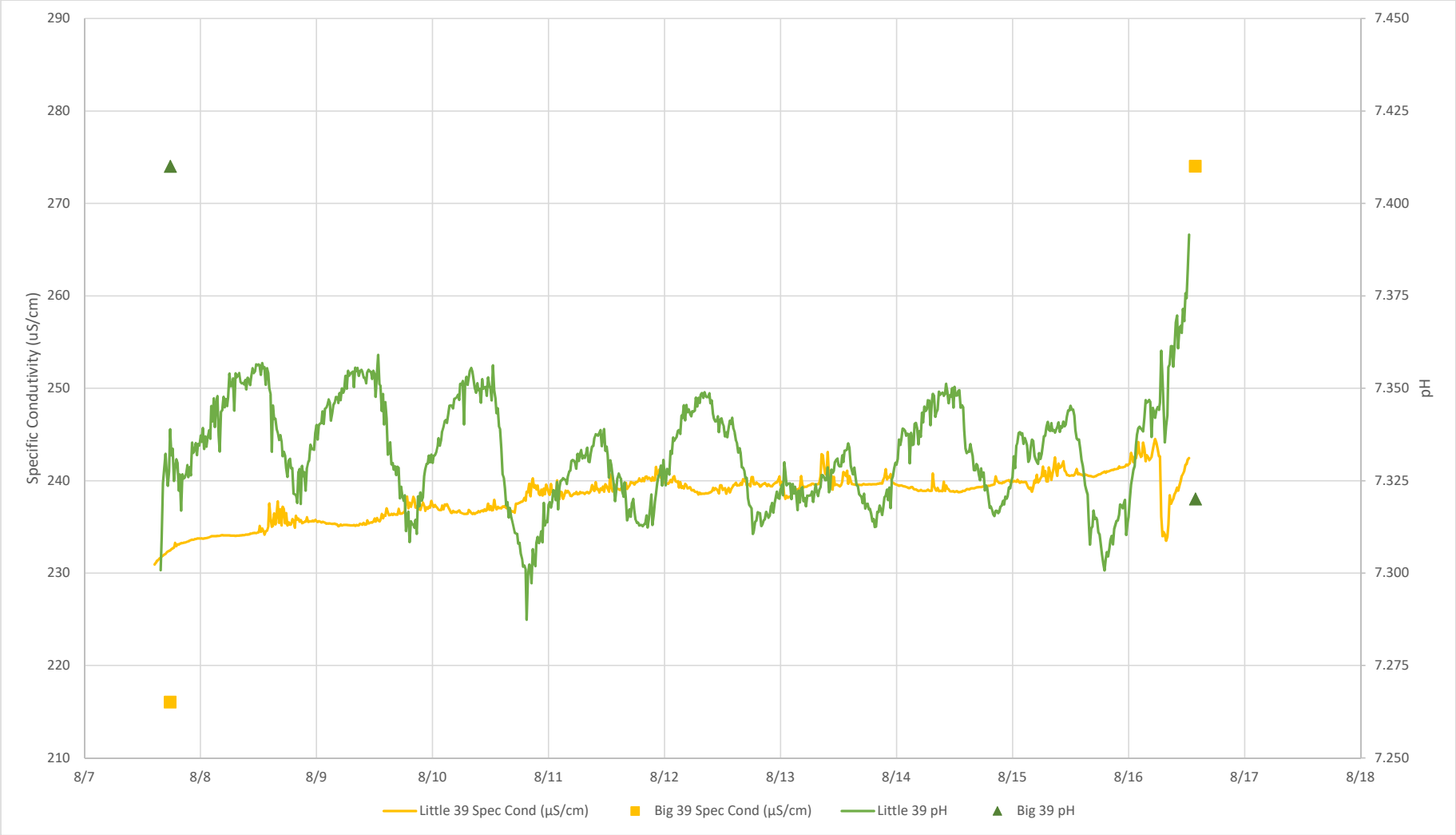



Figure 3
Specific Conductivity and pH
Big and Little 39 Creeks
Northshore Mining Company

Table 1
Physicochemical Data
Big and Little 39 Creeks
Northshore Mining Company

| Stream | Little 39 | | Big 39 | |
|---|---|---|---|---|
| Date Time | 8/7/2019 14:00 | 8/16/2019 12:30 | 8/7/2019 17:50 | 8/16/2019 13:50 |
| Temp (deg C) | 15.8 | 13.8 | 20.0 | 16.2 |
| Specific Conductivity (uS/cm) | 242 | 245 | 216 | 274 |
| Dissolved Oxygen (mg/L) | 5.9 | 6.6 | 6.5 | 6.8 |
| pH | 7.26 | 7.34 | 7.41 | 7.32 |
| Total Suspended Solids (mg/L) | < 1.1 | -- | 1.7 | -- |
| MN SQT Metrics | | | | |
| Temp (deg C) | At-Risk | | At-Risk | |
| Dissolved Oxygen (mg/L) | Not Functioning | | At-Risk | |
| Total Suspended Solids (mg/L) | Functioning | | Functioning | |

# *Appendix E*

# *Watershed Assessment*

# Watershed Assessment

## *Tailings Basin Progression and West Ridge Railroad*

Prepared for
Northshore Mining Company

April 2020

# Watershed Assessment

## *Tailings Basin Progression and West Ridge Railroad*

Prepared for
Northshore Mining Company

April 2020

4300 MarketPointe Drive, Suite 200
Minneapolis, MN 55435
952.832.2600
www.barr.com

# Watershed Assessment

## Tailings Basin Progression and West Ridge Railroad

## April 2020

# Contents


1 Introduction/Summary ..... 1
1.1 Approach Summary ..... 1
2 Project Description ..... 3
3 Study Area ..... 4
3.1 Land Cover and Land Use ..... 4
3.2 Topography, Geology, Soils ..... 5
3.3 Tailings Basin Operations ..... 5
3.3.1 General Description of Current Water Management System ..... 5
3.3.2 Projected Conditions ..... 6
3.3.3 Water Balance Model ..... 6
4 Subwatershed and Drainage Patterns ..... 8
4.1 Pre-Settlement Conditions ..... 8
4.2 Existing Conditions ..... 8
4.3 Proposed Conditions ..... 9
4.3.1 Direct Impacts ..... 9
4.3.2 Indirect Impacts ..... 10
4.3.3 Cumulative Effects ..... 10
5 Streams, Rivers, Ditches, Streamflow, and Floodplains ..... 11
5.1 Streamflow Modeling Methods ..... 11
5.2 Beaver River Subwatershed ..... 13
5.2.1 Beaver River Modeled Streamflow ..... 13
5.2.2 Beaver River Observed Streamflow ..... 14
5.2.3 Direct Impacts ..... 14
5.2.4 Indirect Impacts ..... 15
5.3 East Branch Beaver River Subwatershed ..... 15
5.3.1 West Unnamed Creek (Subwatershed 4) Modeled Streamflow ..... 16
5.3.2 East Branch Beaver River Headwaters (Subwatershed 1) Modeled Streamflow ..... 17

5.3.3 East Branch Beaver River Observed Streamflow ..... 18
5.3.4 Direct Impacts ..... 19
5.3.5 Indirect Impacts ..... 21
5.4 Cumulative Effects ..... 21
5.4.1 Beaver River Subwatershed ..... 21
5.4.2 East Branch Beaver River Subwatershed ..... 22
6 Wetland Resources ..... 24
6.1 Beaver River Subwatershed ..... 24
6.1.1 Direct Impacts ..... 24
6.1.2 Indirect Impacts ..... 24
6.2 East Branch Beaver River Subwatershed ..... 25
6.2.1 Direct Impacts ..... 25
6.2.2 Indirect Impacts ..... 26
6.2.2.1 Impoundment and Fragmentation ..... 26
6.2.2.2 Watershed Alterations ..... 26
6.2.3 Downstream Wetland Resources ..... 27
6.2.3.1 Beaver River Subwatershed ..... 27
6.2.3.2 West Unnamed Creek (Subwatershed 4) ..... 27
6.2.3.3 Lower East Branch Beaver River (Subwatershed 7) ..... 28
6.3 Cumulative Effects ..... 28
6.3.1 Beaver River Subwatershed ..... 28
6.3.2 East Branch Beaver River Subwatershed ..... 29
7 Lakes and Deepwater Habitat ..... 30
7.1 Beaver River Subwatershed ..... 30
7.1.1 Direct Impacts ..... 30
7.1.2 Indirect Impacts ..... 30
7.2 East Branch Beaver River Subwatershed ..... 30
7.2.1 Direct Impacts ..... 30
7.2.2 Indirect Impacts ..... 30
7.3 Thirtynine Creek Subwatershed ..... 30
7.3.1 Direct Impacts ..... 30
7.3.2 Indirect Impacts ..... 30
7.4 Cumulative Effects ..... 30
8 Biological Resources ..... 32

8.1 Fish Biological Monitoring ..... 32
8.1.1 Fishes Bioassessments Stressor Identification ..... 34
8.1.2 Fish Biological Monitoring Summary ..... 36
8.2 Macroinvertebrates Biological Monitoring ..... 36
8.2.1 Hilsenhoff Biotic Index (HBI) ..... 37
8.2.2 Macroinvertebrate Biological Monitoring Summary ..... 37
8.3 Habitat and Stream Stability ..... 38
8.3.1 Minnesota Stream Habitat Assessment ..... 38
8.3.2 Channel Condition and Stability Index ..... 39
8.4 Direct Impacts ..... 39
8.5 Indirect Impacts ..... 40
8.6 Cumulative Effects ..... 40
8.6.1 Beaver River ..... 40
8.6.2 East Branch Beaver River ..... 42
9 Water Quality ..... 44
9.1 Water Temperature ..... 44
9.2 Dissolved Oxygen ..... 46
9.3 pH ..... 47
9.4 Total Suspended Solids ..... 48
9.5 Nutrients ..... 49
9.6 Cumulative Effects ..... 50
10 Forest Resources ..... 52
10.1.1 Direct Impacts ..... 52
10.1.2 Indirect Impacts ..... 52
10.1.3 Cumulative Effects ..... 52
11 References ..... 53

## List of Tables


Table 1 Watershed Summary
Table 2 Aquatic Resources Watershed Summary
Table 3 Beaver River Monitoring Station Locations
Table 4 East Branch Beaver River Monitoring Station Locations
Table 5 Beaver River Flow Data Summary – Station 2006003
Table 6 Monthly Average and Minimum Flow – Beaver River Station 2006003
Table 7 Fish Survey Data – Beaver River and East Branch Beaver River
Table 8 Biological Monitoring Data – Beaver River and East Branch Beaver River
Table 9 Water Quality Data Narrative Summary – 2009-2019 - Beaver River
Table 10 Water Quality Data Narrative Summary - 2009-2019 - East Branch Beaver River
Table 11 Key Water Balance Components and Anticipated Changes with Basin Progression
Table 12 Monthly WTP Discharge Rates – 2000-2019
Table 13 Watershed Modeling Details
Table 14 Streamflow Discharge and Water Depth Modeling Results
Table 15 MnRAM Assessment Results
Table 16 Wetland Impact Functional Summary
Table 17 Summary of Wetland and Watershed Modifications – Wetlands 34 and 35


## List of Figures


Figure 1 Study Area
Figure 2 Pre-Settlement Resources
Figure 3 Land Slopes
Figure 4 Hydrologic Soil Groups
Figure 5 Tailings Basin Operation
Figure 6 Existing Resources
Figure 7 Foreseeable Future Resources
Figure 8 Pre-Settlement Project Area Resources
Figure 9 Monitoring Stations
Figure 10 Foreseeable Future Project Resources
Figure 11 Diversion Channel Discharge
Figure 12 Project Subwatershed 4 Flow to East Branch Beaver River
Figure 13 Seasonal Subwatershed 4 Flow Contributions to the East Branch Beaver River
Figure 14 Beaver River Hydrograph 2011-19
Figure 15 Beaver River Discharge Components 2011-19
Figure 16 WTP Discharge Contribution to Beaver River Streamflow – 2001-2019
Figure 17 F-IBI Survey Results
Figure 18 M-IBI Survey Results
Figure 19 Total Suspended Solids – Beaver River and MP7 WTP 1973-2015

Figure 20 pH – Beaver River and MP7 WTP 1973-2015
Figure 21 Beaver River and MP7 WTP Temperature – 1973-2015
Figure 22 Phosphorus - Beaver River 1973-2011
Figure 23 Dissolved Oxygen - Beaver River 1973-2015
Figure 24 Predicted Basin Volume – Recent History and Proposed Basin Progression Operation
Figure 25 Existing Watersheds – Wetlands 34 and 35
Figure 26 Future Watersheds – Wetlands 34 and 35
Figure 27 Habitat Survey Results
Figure 28 East Branch Beaver River Wetlands
Figure 29 Beaver River Wetlands

## List of Appendices

Appendix A Water Quality Dataset
Appendix B Cumulative Effects Analysis – Aquatic and Forest Resources – Tailings Basin Progression
Appendix C Streamflow and Stream Water Level Modeling Results – Beaver River
Appendix D Streamflow and Stream Water Level Modeling Results – West Unnamed Creek
Appendix E Streamflow and Stream Water Level Modeling Results – East Branch Beaver River
Appendix F Streamflow and Stream Water Level Modeling Results – Other
Appendix G Wetland Monitoring Plan
Appendix H MNRAM Wetland Assessments
Appendix I Big and Little 39 Creeks MNSQT Assessment Data

# 1 Introduction/Summary

Northshore Mining Company (Northshore) is undergoing environmental permitting for the proposed railroad relocation and tailings basin progression project (project). As part of the project, Northshore is pursuing a permit from the U.S. Army Corps of Engineers (Corps), consistent with the basin projection plans outlined in the 1977 Corps Environmental Impact Statement (EIS).

As part of the Section 404 permit review process, the Corps has requested a watershed assessment to evaluate how the project would impact the HUC 10 Beaver River - Lake Superior Frontal watershed (watershed). The Corps detailed various components of its request in a May 22, 2019 letter to Northshore. This assessment will be used to inform the Corps' determination of the significance of the impacts and whether an Environmental Assessment or a Supplemental EIS will be needed to demonstrate compliance with the National Environmental Policy Act. Northshore offered preliminary information responsive to the May 22 request in its July 23, 2019, letter to the Corps. This report complements that response and contains the requested complete watershed assessment.

The purpose of the watershed assessment is to evaluate the potential effects of the proposed tailings basin progression project on the watershed. More specifically, potential effects of the project on hydrology, water quality, and aquatic biota within the watershed have been assessed, including looking at possible cumulative effects related to historic activities within the watershed.

## 1.1 Approach Summary

Northshore has proposed impacts to parts of the Beaver River watershed in its June 18, 2018 Joint Permit Application and Wetland Replacement Plan. The proposed project seeks to impact certain aquatic features to support the railroad relocation and tailings basin progression necessary to continue Northshore's mining and pelletizing operations. The impacts are proposed only after consideration of avoidance and minimization opportunities.

This Watershed Assessment supports the Joint Permit Application by providing an in-depth evaluation of the potential effects of the proposed tailings basin progression project on the watershed. More specifically, potential effects of the project on hydrology, water quality, and aquatic biota within the watershed are assessed, including consideration of cumulative effects related to historic and known future activities within the subwatersheds directly associated with the project as well as more broadly within the Beaver River – Lake Superior Frontal HUC 10 watershed (Appendix B).

The Beaver River – Lake Superior Frontal watershed covers approximately 150 square miles. The project is located in three specific subwatersheds; East Branch Beaver River, Lower Beaver River and Thirtynine Creek, which together comprise 123 square miles. The respective subwatershed drainage areas, wetland areas, lineal feet of stream and projected impacts of the project on wetlands and streams are summarized here.

Summary of Current Conditions

| Subwatershed Name | Drainage Area (See Table 1) square miles (acres) | Wetland Area (See Table 2) square miles (acres) | Proposed Wetland Impact (See Table 16) square miles (acres) | Stream Length (See Table 2) miles | Proposed Stream Impact (See Section 5.0) feet |
|---|---|---|---|---|---|
| East Branch Beaver River | 50.5 (32,296) | 13.1 (8,391) | 0.4 (253.9) | 60.9 | 8,750 |
| Beaver River | 48.7 (31,181) | 10.0 (8,328) | 0.02 (13.6) | 63.4 | 0 |
| Thirtynine Creek | 23.8 (15,251) | 9.1 (5,795) | 0 | 30.0 | 0 |

Information available from Northshore was coupled with information from MPCA - in particular MPCA's Lake Superior South Watershed Stressor Identification Report – to provide a basis for review of the biology, water quality and forest resources in the Beaver River watershed and projected potential impacts as a result of the project.

# 2 Project Description

The project area encompasses approximately 1,200 acres, made up of tailings storage area and supporting infrastructure, and is located about 6 miles west of Silver Bay, in Lake County, Minnesota (Figure 1). Some of the project area consists of lands disturbed by past activities, including depleted borrow pits and access roads. The project area takes advantage of the existing tailings storage facility footprint and land adjacent to it, progressing westerly as contemplated in the 1977 Corps EIS and original state and federal permits. Tailings would be stored over the existing, approximately 2,100 acre tailings storage area an additional 113 feet in height above the existing permitted basin to a total height of about 233 feet at its highest point. In addition, tailings would be stored within approximately 850 acres of adjacent tailings storage area to an elevation of 1365 feet as the natural topography allows storage to extend generally northwesterly, but excluding about 1,100 acres of the storage area evaluated in the EIS.

# 3 Study Area

The study area is defined as the HUC 10 Beaver River – Lake Superior Frontal watershed (0401010201) within which the project lies. The total study area watershed covers approximately 150 square miles (96,225 acres; Figure 1), of which 123 square miles drain to the Beaver River and two other subwatersheds comprising 27 square miles together, drain directly to Lake Superior. The project spans three existing HUC 12 subwatersheds including: Thirtynine Creek, East Branch Beaver River, and Lower Beaver River, all of which drain to the Beaver River (Figure 6). The two Lake Superior frontal subwatersheds have no hydrologic connection or hydrologic interaction with the Beaver River watershed, or any of the subwatersheds within which the project lies. Therefore, analysis of project effects is limited to the Beaver River watershed.

## 3.1 Land Cover and Land Use

Prior to human development in the region, the study area watershed was characterized by forested land cover with numerous streams draining to Lake Superior, predominantly through the Beaver River and its major tributaries, East Branch Beaver River, West Branch Beaver River, and Thirtynine Creek, along with other minor tributaries (Figure 2). The City of Beaver Bay, which is located southeast of the project area, was established in 1856 and remains the oldest continuously occupied community on the North Shore of Lake Superior in Minnesota (MPCA, 2017). The production of lumber was prevalent in the region during Duluth's population boom in the 1860s followed by more extensive clearcutting of forests along the North Shore in the 1890s (MPCA, 2017). The Reserve Mining Company obtained permits for the construction of the E.W. Davis taconite processing plant in 1947 (City of Silver Bay). Construction of the town of Silver Bay began in 1951 and was officially incorporated in 1956 (City of Silver Bay). Following construction, the E.W. Davis plant made its first shipment of pellets in April 1956 (City of Silver Bay). Taconite tailings produced at the plant were discharged into Lake Superior in accordance with state permits until 1980, when the discharge was required to cease by a federal order. The Milepost 7 tailings basin was constructed in the late 1970s and began operations in 1980. Other than the cities of Beaver Bay and Silver Bay, development in the watershed is primarily focused along Highway 61, adjacent to Lake Superior with homes, resorts, and small businesses. A few other major features are present within the watershed, including the Silver Bay municipal airport (located in the West Branch Beaver River subwatershed), which opened in 1965 and was closed in 2018; a golf course (located predominantly in the East Branch Beaver River subwatershed) that opened in 1959 (Wild North Golf, 2019); and wastewater treatment ponds (located in the Lower Beaver River subwatershed) that were built before the 1990s. There is minimal development in the remainder of the study area. The major highways connecting the cities within the study area include Minnesota Trunk Highway (MNTH) 61 and County State Aid Highways (CSAH) 3, 4, 5, 15, 31, and 32 (Figure 1).

The U.S. Department of Agriculture-U.S. Forest Service (USDA-USFS) Superior National Forest covers 42,714 acres in the northwestern portion of the study area, or approximately 44 percent of the study area (Figure 1). Finland State Forest is located within the USDA-USFS Superior National Forest and encompasses 15,395 acres in the northwestern portion of the study area, or approximately 16 percent of the study area (Figure 1). The United States Geological Survey (USGS) National Land Cover Data (NLCD;

2016) identifies primary land cover types in the study area as forests and wetlands. Other minor land cover types include developed areas, barren land, cultivated crops/hay/pasture land, and open water.

## 3.2 Topography, Geology, Soils

Generally, elevations in and around the study area decrease from the northwest to the southeast, sloping towards Lake Superior. Elevations range from approximately 2000 feet in the upper watershed to about 600 feet at Lake Superior. The majority of the watershed is steeply sloping with nearly 60 percent of the watershed containing slopes steeper than 3 percent and 17 percent of the watershed containing slopes steeper than 10 percent (Figure 3). Approximately the lower one-third of the watershed, predominantly within 3-4 miles of Lake Superior, is even more steeply sloped, typically over 5 percent. The study area geologically straddles the eastern edge of the Duluth Complex and the western edge of the Northshore Volcanic Group. The Duluth Complex makes up about 70 percent of the study area, including Beaver Bay Complex subvolcanic felsic and mafic rock, including gabbro. The Northshore Volcanic Group comprises about 30 percent of the study area, primarily within the lower half of the watershed and is predominantly composed of basalt (Morey and Meints, 2000). Surficial landforms include Superior Lobe moraine of the Nickerson and Mille Lacs - Highland associations, which contain drift over dense Superior till at depths of a few inches to more than 50 feet over bedrock. The Nickerson ground moraine makes up about the lower one-third of the watershed including clayey till along the North Shore. The Mille Lacs ground moraine comprises approximately the middle half of the watershed with drumlins and flutes common, thin drift, and sandy to stony till. The Mille Lacs end moraine is present in the upper part of the watershed with a very small portion of the watershed comprised of Rainy Lobe ground moraine from the St. Croix Association (Hobbs and Goebel, 1982).

The Natural Resources Conservation Service (NRCS) has established four basic hydrologic soil groups, which are used to classify soils within the soil survey to provide a standardized system that contributes to estimating runoff. Soil map unit components assigned to a specific hydrologic soil group have similar physical and runoff characteristics (NRCS, 2007). Hydrologic soil groups have been established for about 80 percent of the study area, with the exception of the watershed headwaters, the Milepost 7 tailings basin, lakes, cities, and a few other disturbed areas. Figure 4 shows hydrologic soil group classifications within the mapped areas of the watershed. Unmapped areas are shown with generalized soil textures as developed by Cummins and Grigal (1981). Over 75 percent of the characterized watershed is classified as Group D soils (Figure 4). Group D soils are described as having very slow infiltration rates resulting in high runoff potential when thoroughly wet, typically with more than 40 percent clay content, and predominantly clayey textures. For the portions of the watershed in which detailed soil mapping is not available, general soil textures are shown based on a landscape scale (Cummins and Grigal, 1981).

## 3.3 Tailings Basin Operations

### 3.3.1 General Description of Current Water Management System

Processing iron ore into pellets requires water. At Northshore's processing plant, most of the water is recycled, using the tailings basin as the primary source of process makeup water. Water evaporates as steam generated by the pollution control equipment and from the large area of the tailings basin surface. Water must be re-supplied from the tailings basin to the plant to account for these losses. It is beneficial

to maintain a consistent volume of water in the basin to ensure an adequate water supply, aid in clarification for reuse, manage water quality and minimize fugitive dust. Seepage collection ponds, located downstream of each of the dams, recover seepage back into the tailings basin. There is one surface seep leaving the basin, noted as SD005 (SD5 on Figure 9), which is administered by the facility NPDES/SDS permit. The average flow from SD005 is 0.006 cfs (<3 gpm). Fresh water is added to the system through precipitation/runoff and as needed through a permitted intake from Lake Superior to support these needs. The tailings basin has a permitted outfall (SD1-S010 on Figure 9) to manage the water level of the basin where excess water is discharged through a water treatment plant (WTP) (Figure 5), which consists of chemical flocculation, dual media filtration units and related equipment for the removal of suspended solids.

### 3.3.2 Projected Conditions

The following changes to the plant water balance are anticipated as a result of the project, as summarized in Table 11:

- The net watershed area contributing to the tailings basin will increase as a result of the hydrology alterations proposed as part of the basin progression. The watershed increase comes primarily from the removal of the existing 2005 Diversion Ditch (Figure 5) and recovering all of that watershed contribution into the basin. The recent completion of the Bear Lake diversion project, located due east of the Tailings Basin, results in a partially offsetting reduction of watershed area into the basin. Despite the Bear Lake watershed adjustment, the net change will be an increase to watershed run-on to the basin.
- The tailings basin will occupy a larger footprint than current operations, resulting in the spread of tailings over a larger area as the elevation of the tailings pond increases. That increase in pond area will result in an increase in overall evaporative losses from the basin surface.
- Future operations are projected at full production capacity (consistent with current operations).
- Future operation of the water treatment plant is projected at rates within current permitted capacities.
- Makeup water intake from Lake Superior is anticipated to be reduced, as necessary, to maintain the target basin volume.

### 3.3.3 Water Balance Model

Northshore has developed a water balance model that is based on environmental and process data collected on site including: precipitation, evaporation, and water treatment plant discharge rates along with other internal plant operating conditions (e.g. pipeline flow rates). One of the benefits of the water balance model is to make an estimate of the volume of the water in the tailings basin. These modeled estimates are compared against periodic field bathymetric surveys to calculate water volume. The water balance model has been shown to accurately predict water volumes in the basin (Figure 24). Because the comparisons show reasonable agreement, the model can be used to make future predictions of operating

scenarios and indicate possible responses by the larger water system, allowing Northshore to maintain an appropriate basin volume.

Considering the projected change, Northshore's model anticipates that the system will remain in balance after completion of the proposed basin progression hydrology adjustments. Northshore will continue to conduct periodic bathymetry surveys and plan adjustments to the water system as needed to maintain the desired operating targets.

# 4 Subwatershed and Drainage Patterns

## 4.1 Pre-Settlement Conditions

The proposed tailings basin progression and the existing tailings basin lie principally within the historic Thirtynine Creek subwatershed with perimeter areas extending into the Beaver River and East Branch Beaver River subwatersheds (Figure 8). The Thirtynine Creek subwatershed historically supported Big and Little Thirtynine Creeks combining to form Thirtynine Creek, which discharged into the Beaver River (Figure 2). The total watershed area for Thirtynine Creek subwatershed was 31.5 square miles, including 17.70 square miles for Big Thirtynine Creek, 6.94 square miles for Little Thirtynine Creek and 6.91 square miles draining to Thirtynine Creek (Table 1). The East Branch Beaver River subwatershed was historically comprised of 48.5 square miles, including runoff from Nicado Creek and Cedar Creek entering downstream of the tailings basin (Figure 2). Approximately 28.00 square miles of drainage area supported the headwaters portion of the East Branch Beaver River upstream of the tailings basin, at the confluence with West Unnamed Creek (Subwatersheds 1 and 4, Figure 8). The Beaver River subwatershed, without tributaries, had a historic drainage area of 24.63 square miles, including Subwatersheds 8, 11, 12, 15, and 16 (Figure 2). Several tributaries contributed flow to the Beaver River, including Kit Creek, Unnamed Creek, Thirtynine Creek, the West Branch Beaver River; and the East Branch Beaver River resulting in a total historic drainage area of 123.0 square miles (Table 1 and Figure 2).

## 4.2 Existing Conditions

Construction and operation of the tailings basin required diverting the upper portions of Big and Little Thirtynine Creeks into the Beaver River (Figure 5, "1976 Diversion Ditch"), diverting a lower portion of the Thirtynine Creek subwatersheds to the East Branch Beaver River (Figure 5, "2005 Diversion Ditch"), while Thirtynine Creek no longer exists due to the permitted placement of the existing tailings basin (Figures 8 and 9). The upper 97.6 percent of the Big Thirtynine Creek subwatershed and the upper 94.6 percent of the Little Thirtynine Creek subwatershed remain unchanged from historic conditions (a 2.4% and 5.4% change, respectively), but are now routed into the Beaver River approximately 3.2 river miles upstream from the natural confluence (Table 1, Figure 6). The diversion increased the cumulative watershed area to that reach of the Beaver River (Subwatershed 11) by 97.6 percent (Table 1 and Figure 9). However, at the confluence with the former Thirtynine Creek into Subwatershed 12, (Figure 9), the watershed area contributing to the Beaver River has been reduced by 12.9 percent from historic conditions. The lower 7.7 square miles of the Thirtynine Creek subwatershed has been split between the East Branch Beaver River subwatershed and the existing tailings basin (Subwatershed 14), which encompasses 5.0 square miles that discharges farther downstream through Northshore's wastewater treatment plant (WTP) (Table 1, Figure 9). Within the tailings basin watershed (Subwatershed 14), an outlet from Bear Lake was recently put into service diverting the 197 acre Bear Lake subwatershed away from the tailings basin and into Subwatershed 16 of the Beaver River as was envisioned during the project EIS (Figure 9). Therefore, there remains currently 5 square miles of drainage area to the tailings basin from which rainfall and runoff is either utilized in the operation or discharged to the Beaver River through the WTP. By the time the Beaver River meets the confluence with the WTP discharge out of Subwatershed 15 into Subwatershed 16 (Figure

9), there is a 3.2 percent reduction in drainage area contributing to the Beaver River from historic conditions (Table 1).

One other watershed diversion, that has since been abandoned and now lies within the existing basin footprint (Figure 5, "Murphy's Pond Diversion Ditch"), was put in place during construction of the tailings basin in the 1970s along the northwest side of the basin. This diversion ditch was relocated to its current location subsequent to the permit authorized by the USACE in 2005 (Figure 5, "2005 Diversion Ditch"). The Murphy's Pond Diversion Ditch and subsequently, the 2005 Diversion Ditch resulted in approximately 2 square miles of the Thirtynine Creek subwatersheds to be routed to Subwatershed 7 of the East Branch Beaver River (Figure 9). The Murphy's Pond diversion added 2 square miles (4.1 percent) to the East Branch Beaver River watershed (Table 1, Figure 9), which now has a total drainage area of 50.5 square miles (Table 1). Flow contributions from the additional drainage area are ameliorated by approximately 78 acres of storage capacity provided by the wetland/deepwater complex associated with Murphy's Pond, which intermittently discharges to the East Branch Beaver River (Figure 9).

## 4.3 Proposed Conditions

With the proposed project, there will be additional watershed changes. Approximately 2.13 square miles of drainage area that was previously diverted to the East Branch Beaver River at the onset of the tailings basin construction in the late-1970s (Murphy's Pond Diversion Ditch and the 2005 Diversion Ditch) will become part of the tailings basin subwatershed (Subwatershed 14), where its flow will ultimately be routed by way of the WTP to the Beaver River, the receiving water for this subwatershed in pre-settlement conditions (Figure 10). Rainfall and runoff within the 7.13 square mile tailings basin Subwatershed 14 will be utilized in the Northshore operations or will be discharged through the WTP, as is currently the case. The watershed area draining to the East Branch Beaver River will be reduced to 48.4 square miles, which is a 0.2 percent decrease from historic conditions and a 4.1 percent decrease from existing conditions (Table 1). The Big and Little Thirtynine Creek diversion channel will not be altered under proposed conditions.

### 4.3.1 Direct Impacts

The watershed area within the project area and including approximately 0.4 square miles outside of the project area will drain into the tailings basin and all rainfall will be managed as part of the tailings basin operation. Therefore, approximately 2.1 square miles of watershed that currently drains to the East Branch Beaver River will be utilized in the Northshore operation and any discharge to the Beaver River will occur through the WTP following the current operating procedures (Table 1). Included in that area are small drainage areas of the remnant Big and Little Thirtynine Creeks, including 0.46 square miles draining to Big Thirtynine Creek and 0.11 square miles draining to Little Thirtynine Creek, which drain to the constructed 2005 Diversion Ditch (Figure 9). None of those channels will remain as a result of the project. The loss of drainage area to the East Branch Beaver River represents 4.1 percent of the current watershed area and 0.2 percent of the historic watershed. Watershed changes to the Beaver River as a result of the project include a 3.0 percent increase in watershed area draining through Subwatershed 15 into Subwatershed 16 (Table 1). The WTP discharge will continue to operate within the current water quantity limits in the existing permit.

### 4.3.2 Indirect Impacts

Potential indirect impacts related to watershed changes resulting from the project are evaluated in Sections 5.2.4, 5.3.5, 6.1.2, 6.2.2, and 8.5 of this report.

### 4.3.3 Cumulative Effects

Within the Upper Middle Beaver River subwatershed (Subwatershed 11), there has been a cumulative increase in drainage area to-date by about 97.6 percent from pre-settlement to present conditions (Table 1), and will be a 97.4 percent increase with the project compared to pre-settlement conditions. Specific, potential cumulative effects of that Beaver River watershed alteration are evaluated in Sections 5.4, 6.3, 7.4, 8.6.2, and 9.6 of this report. Cumulatively, the project will reduce the East Branch Beaver River subwatershed (Subwatershed 7) area by 0.2 percent from its historic drainage area prior to development of the tailings basin (Table 1). Potential cumulative effects of East Branch Beaver River watershed alterations are evaluated in Sections 5.4, 6.3, 7.4, 8.6.1, and 9.6 of this report.

# 5 Streams, Rivers, Ditches, Streamflow, and Floodplains

Physical impacts to stream geomorphology, or function typically occur due to:

- Physical alteration (straightening, culverts and other direct changes)
- Changes in hydrology (concentrated flow from development, landscape changes, alteration of watershed and other activities that change the ability of the stream to transport substrate)
- Major runoff events

## 5.1 Streamflow Modeling Methods

The expected changes to streamflow as a result of the proposed project were modeled using the U.S. Geological Survey's (USGS) web-based GIS application, StreamStats v4.3.11 (USGS, 2020). The USGS developed regression equations for north shore streams based on gaged flow data to allow for predicting streamflow statistics for ungaged sites (Lorenz et al., 2009). The USGS regression analysis for north shore streams determined that the watershed information required to predict streamflow in ungaged sites for events ranging from the 1.5-year recurrence interval to the 500-year recurrence interval is watershed area and the percent of the watershed comprised of ponds and lakes. Therefore, ponds and lakes within the watershed were mapped for pre-settlement conditions based on historic USGS quadrangle maps and historic aerial photos and for existing conditions based on recent aerial photos and lake data. Future conditions were assumed to be the same as existing.

In mapping ponds and lakes within the watershed under pre-settlement conditions compared to existing conditions, it became apparent that the extent of ponds throughout the watershed has increased significantly in recent years. West Unnamed Creek subwatershed had an increase in the percent of watershed covered by ponds of over 4,000 percent, all of the remaining subwatersheds except two had pond percentage increases ranging from 125 to 770 percent, and Nicado Creek and Cedar Creek had increases of 20 percent and 43 percent, respectively (Table 13). An increase in the percentage of watershed covered by ponds reduces predicted streamflow. To show the difference in flow predictions resulting from this natural change in ponding conditions throughout the watershed, the East Branch Beaver River headwaters (Subwatershed 1) was modeled under pre-settlement and existing ponding conditions with no other changes. The percent of ponds within the 26.96 square mile watershed increased from 0.75 percent in pre-settlement conditions to 3.53 percent in existing conditions, a 372 percent increase (Table 13). The corresponding modeled 1.5-year streamflow was 526 cfs for pre-settlement conditions compared to 320 cfs for existing conditions (Table 14), a 40 percent reduction. The corresponding 100-year modeled streamflow was 3,270 cfs for pre-settlement conditions compared to 1,710 cfs for existing conditions (Table 14), a 48 percent reduction. Therefore, because there has been a natural increase in ponding conditions, fairly consistently across the entire Beaver River watershed; evaluating cumulative effects related to streamflow predictions comparing historic conditions to future conditions is difficult. All existing and future streamflow predictions are substantially less than historic streamflows, regardless of anthropogenic impacts and solely due to ponding conditions.

Modeled flows were evaluated for the 1.5-year recurrence interval, or channel forming flow, which most affects stream stability, and provides a measure of potential effects on riverine wetlands. The 100-year recurrence interval was also evaluated to consider potential effects due to extreme events that may affect floodplains.

The effect of streamflow changes on the stream channels located downstream was evaluated by computing water level/elevation changes within the receiving channel. To determine stream water level changes, the National Oceanic and Atmospheric Administration (NOAA) National Weather Service web-based application, Normal Depth Calculator (NOAA, 2016), was used in conjunction with surveyed stream cross-sections. The Normal Depth Calculator utilizes Manning's Equation for open channel flow to compute water surface elevations, water depths, and flow velocities when the channel cross-section, slope, and roughness are known (NOAA, 2016).

The effects of hydrologic changes on stream ecosystems has been of growing concern in recent years. Richter et al., (2011) evaluated several case studies from the United States and Europe to determine if a sustainability boundary approach could be placed around natural flow conditions to achieve relatively high levels of ecological protection in stream ecosystems. They found consistent recommendations from the expert case studies that suggest a range of allowable changes in flow levels. They concluded that a high level of ecological protection will be provided when daily flow alterations are no greater than 10 percent and a moderate level of protection is provided when flows are altered between 10 percent and 20 percent.

The MnDNR (2016) has further evaluated streamflow limits for protection of stream ecosystems in Minnesota. The MnDNR's (2016) goal was to determine guidelines to meet statutory language that calls for sufficient flows to maintain fish in good condition, which inherently addresses the primary riverine components as further described below. Their basis for drawing this conclusion is because a healthy fishery requires balance across the five components of river and stream health: biology, connectivity, geomorphology, hydrology, and water quality. To conservatively preserve stream health, MnDNR (2016) research indicates that less than a 10 percent change in hydrologic regime is not likely detectable and 10-15 percent change in hydrologic regime may be acceptable where water uses are less dependent on a consistent supply. The MnDNR (2016) suggest evaluating August median base flow as an appropriate measure for preserving seasonal variability of the natural hydrology and maintain geomorphology, water quality, connectivity, and biology of the system. The StreamStats flow modeling includes several measures for estimating low flow at ungaged sites (Ziegeweid et al, 2015). The 7-day low flow with a 10-year recurrence interval during the period June-September (referred herein as the 7Q10 flow) is a close approximation of August median base flow and is evaluated to determine potential stream ecosystem effects associated with the project. The USGS regression modeling for low flows (Ziegeweid et al., 2015) showed that the primary controlling factors for predicting low flows in north shore streams are the percent of the watershed comprised of wetlands and lakes and the percent of the watershed comprised of soils in the C Hydrologic Group. The MPCA (2008) uses the 7-day average low flow occurring once every 10 years for water quality effluent discharge limits, so this measure of change for stream protection is consistent across agencies.

## 5.2 Beaver River Subwatershed

Key Points for the Beaver River subwatershed streams, rivers, ditches, streamflow, and floodplains assessment:

- Approximately 85 acres of the project area currently lies within the Beaver River subwatershed which has a total drainage size of 78,727 acres.
- No streams or ditches are proposed to be impacted.
- Low flows downstream of the project are estimated to increase 0.5 percent.
- Bankfull and 100-year flows are estimated to stay the same as existing.
- Downstream stream resources are not expected to be negatively impacted from a physical perspective.

The Beaver River forms in the headwaters of the watershed and flows approximately 23 miles to Lake Superior, draining a total of about 123 square miles, including flow from four primary tributaries, Little Thirtynine Creek, Big Thirtynine Creek, East Branch Beaver River, and West Branch Beaver River. Within the 123 square mile Beaver River watershed, there are approximately 154.3 miles of streams, rivers, and ditches. The Beaver River subwatershed, not including the drainage areas from the four primary tributaries (includes Subwatersheds 8-12, and 14-16; excludes Subwatershed 13), has a watershed area of 39.5 square miles (Table 1), including about 49.8 miles of streams, rivers, and ditches. The Beaver River is a Class 2Ag water and is impaired for fish bioassessments, turbidity, pH, and mercury in the water column as part of the statewide mercury Total Maximum Daily Load (TMDL) (MPCA, 2017). The MPCA conducted a stressor identification study within the Beaver River watershed (MPCA, 2017) and determined that altered hydrology is one of several potential stressors for the Beaver River.

### 5.2.1 Beaver River Modeled Streamflow

The Milepost 7 tailings basin operation discharges into the Upper Lower Beaver River subwatershed (#15) (Figure 9). The cumulative drainage area at Subwatershed #15 will increase by 3.0 percent from existing to future conditions (Table 1), while cumulative wetlands within the subwatersheds upstream and including #15 will not change (Table 2), and ponds within the subwatershed will increase by 5 percent not including the tailings pond within the basin (Subwatersheds 8-15 and 17-18) (Table 13). For the Beaver River, the existing 7Q10 streamflow out of Subwatershed 15 (immediately downstream of the confluence with the WTP discharge Subwatershed 14) is estimated to be 8.84 cfs (Table 14). That flow value includes the 7Q10 flow of 2.71 cfs into the Lower Beaver River subwatershed (#16) (Table 14 and Appendix C) and the average August discharge from the WTP (from 2000-2019) of 6.1 cfs. With the project, the 7Q10 flow is estimated to be 8.89 cfs, a 0.5 percent increase, including a 0.05 cfs increase in Beaver River flow (Table 14) and the same WTP discharge as existing. The 1.5-year return period streamflows are estimated to be 643.2 cfs under both existing and future conditions, including a modeled discharge from Subwatershed 15 of 636 cfs and the average daily maximum discharge from the WTP of 7.2 cfs (Table 14 and Appendix C). The 100-year streamflow is also estimated to remain the same in existing and future conditions at 2977.2 cfs, including a modeled discharge from Subwatershed 15 of 2,970 cfs and the average daily maximum discharge from the WTP of 7.2 cfs (Table 14 and Appendix C).

### 5.2.2 Beaver River Observed Streamflow

Beaver River flow data are collected by the Minnesota Department of Natural Resources (MDNR) through the Cooperative Stream Gaging (CSG) system at gage 2006003 (MDNR, 2019) located in the Lower Beaver River subwatershed #16. The location of the gage station is shown in Figure 9 and described in Table 3. The data record generally includes daily measurements during non-frozen periods (mid-April to early-November) from April 11, 2011 to November 1, 2017, and 15-minute interval measurements from November 2, 2017, to July 31, 2019, including some winter measurements (Figure 14). The gage is located in the downstream reaches of the Beaver River, such that the gage captures the majority of the watershed area including the East Branch and West Branch of the Beaver River. Flow rates in the upper Beaver River watershed are typically much lower than those recorded at the Beaver River gage station.

Streamflow in the Beaver River is typically highest in the spring starting with snowmelt and continuing into spring and early summer rainfall events until full recession occurs, typically in June (Figure 14). There are often prolonged low-flow periods throughout the remainder of the year with the exception of individual storm events. Annual maximum flows typically range from about 1,500-2,500 cfs. The highest recorded streamflow in the Beaver River during the 9-year period of record was 4,890 cfs, resulting from a 4.79 inch rainfall over a period of 9 hours, which occurred in June 2012 (Figure 14). Based on Atlas 14 (NOAA, 2019), that equates to approximately a 50-year return interval. The recorded streamflow for the approximate 50-year return interval storm event is within reasonable agreement with the modeled 50 year flow into Subwatershed 16 (Appendix C), at approximately 12 percent less, given the uncertainties of precipitation distribution. Recorded summer low flows typically range from about 10-25 cfs and recorded winter flows (December-February) during 2017-18 and 2018-19 (the only available data) averaged 159 cfs. Table 5 summarizes the results of annual flow monitoring on the Beaver River from April 2011 through July 2019. Table 6 shows the monthly average flow rates for the Beaver River and the average minimum flow value for each month for the time period of 2011 through 2019, which shows that the highest flows typically occur in April and the lowest flows typically occur in August.

### 5.2.3 Direct Impacts

No direct impacts are proposed to streams, rivers, or ditches within the Beaver River subwatershed. With the project, the 7Q10 streamflow within the Beaver River downstream of the project at the confluence with the WTP discharge is estimated to increase by 0.5 percent while the 1.5-year and 100-year flows are estimated to remain the same as existing. Rainfall and runoff within the tailings basin progression area and on the railroad embankment and dams will be contained within the basin or routed to the seepage ponds for use in the operation or treatment in the WTP prior to discharge to the Beaver River. The WTP will continue to discharge water within the same character as under existing conditions. Over the last 20 years, the average WTP discharge has been 6.1 cfs with an average daily maximum rate of 7.2 cfs. The annual WTP discharge data from 2000-2019 are summarized in Table 12. The additional 1.8 square miles of tailings basin watershed area with the proposed project is expected to add slightly less than 1.4 cfs of water supply to the basin, which is approximately equivalent to the current make-up water pumped from Lake Superior.

The floodplain of the Beaver River has not been mapped by the Federal Emergency Management Agency (FEMA) and there are no known plans to map the area. The floodplain of the Beaver River appears to range from approximately 150 feet to over one-half mile wide west of the project area (based on a review of aerial imagery and topographic data). South of the existing tailings basin, the floodplain becomes narrower, typically ranging from less than 100 feet wide to about 500 feet wide. Wetland areas occupy much of the floodplain near the project area. Because the modeled 100-year recurrence interval flows within the Beaver River downstream of the project will not change (Table 14), the project is not expected to affect the Beaver River floodplain.

### 5.2.4 Indirect Impacts

The project is not expected to result in indirect impacts to streams, streamflow, or floodplains. The largest change to watershed area within the Beaver River watershed is into Subwatershed 16 (Figure 10), to which the cumulative drainage area will increase by 3.0 percent (Table 1). However, the additional drainage area is within the tailings basin operating area from which discharge is controlled by the WTP and discharge from the WTP will follow the current operating plan with no need to increase the discharge capacity above the current permitted limits. Modeled future 7Q10 flows in the Beaver River into Subwatershed 16 will increase by 0.5 percent and the bankfull and 100-year flows will not change. Therefore, with no measurable changes to streamflow, no indirect impacts are predicted to streams or floodplains downstream of the project. With no material effect expected to streamflow or floodplain storage in the Beaver River subwatershed, there are no direct or indirect effects anticipated for terrestrial or animal populations.

## 5.3 East Branch Beaver River Subwatershed

Key Points for the East Branch Beaver River subwatershed streams, rivers, ditches, streamflow, and floodplains assessment:

- Approximately 997 acres of the project area currently lies within the East Branch Beaver River subwatershed which has a total drainage area of 32,320 acres.
- Approximately 5,040 linear feet of streams and 5,780 linear feet of ditch are proposed to be directly impacted and approximately 3,530 linear feet of indirect stream impacts are anticipated.
- Low flows in the East Branch Beaver River are estimated to be 12 percent lower than existing, corresponding to a 0.25 inch decrease in stream water level.
- Bankfull flows are estimated to be reduced by 3 percent, corresponding to a 0.25 inch water level reduction.
- Flows for the 100-year recurrence interval are estimated to decrease 1 percent, corresponding to a 0.1 inch stream water level reduction.
- Downstream stream resources are not expected to be negatively impacted from a physical perspective.

The East Branch Beaver River forms in the headwaters of the watershed and flows approximately 21 miles to where it discharges to the Beaver River, draining a total of about 50.5 square miles, including flow from two primary tributaries, Cedar Creek, and Nicado Creek. Within the 50.5 square mile East Branch Beaver

River watershed, there are approximately 61 miles of streams, rivers, and ditches. The East Branch Beaver River subwatershed, not including the drainage areas from the two primary tributaries (Subwatersheds 1-4 and 7), has a watershed area of 34.6 square miles, including about 42.5 miles of streams, rivers, and ditches. The East Branch Beaver River is a Class 2Ag water. The MPCA (2017, pg 86) has identified the East Branch Beaver River from about 1.5 miles upstream of West Unnamed Creek (through which the project area discharges) downstream to the confluence with Beaver River as a significant sediment source from undercutting banks and channel instability.

West Unnamed Creek (subwatershed 4) has a drainage area of 2.45 square miles, including most of the project area, is the receiving water for Northshore's 2005 Diversion Ditch, and flows into the East Branch Beaver River upstream of Lax Lake Road (Figure 9). Within the West Unnamed Creek watershed, there are approximately 4.2 miles of streams and ditches, including remnants of Big and Little Thirtynine Creeks.

### 5.3.1 West Unnamed Creek (Subwatershed 4) Modeled Streamflow

The watershed area contributing to the West Unnamed Creek (Subwatershed 4) will decrease by 68.5 percent from existing to future conditions (Table 1); wetlands as a percent of the West Unnamed Creek subwatershed will decrease by 26 percent, and ponds as a percent of the subwatershed will decrease by 42 percent (Table 13). For West Unnamed Creek, the modeled existing 7Q10 streamflow is 0.175 cfs, which would be reduced to 0.07 cfs (Table 14 and Appendix D) with the project, which represents a 60 percent reduction. The corresponding change in flow depth is 0.5 inch. It should be noted that the existing low flows are 108 percent higher than the estimated 0.084 cfs historic 7Q10 streamflow due to the watershed diversion established with the construction of the tailings basin (Murphy's Pond Diversion Ditch and subsequently the 2005 Diversion Ditch, Figure 5). Modeled 7Q10 flow in West Unnamed Creek with the proposed project represents a 17 percent reduction from historic conditions. At such a low flow rate, the water depth in the channel does not show a change to an accuracy of 0.01 foot.

The channel forming flow (1.5-year return period) is the flow that most affects stream stability. For West Unnamed Creek, the 1.5-year return period streamflows are estimated to be 38.3 cfs under existing conditions, and 17.9 cfs with the proposed project (Table 14 and Appendix D). The estimated future streamflow in West Unnamed Creek represents a 53 percent reduction from existing. The reduction in West Unnamed Creek channel forming flow would reduce water levels in the channel by 4 inches. Under both existing conditions and future conditions, water levels will not overtop the channel banks (Appendix D). The flow predicted for the 1.5-year return interval channel forming flow in West Unnamed Creek under pre-settlement condition is 41.1 cfs. The existing channel forming flow in West Unnamed Creek is estimated to be 47 percent of the estimated pre-settlement conditions, predominantly due to the increase in area of ponds within the watershed since construction of Milepost 7 compared to historic conditions. The measured streamflows in the East Branch Beaver River indicate intermittent flows from the project area, which also supports the conclusion that the diversion constructed with the tailings basin does not appear to have contributed to downstream instability in the East Branch Beaver River.

For West Unnamed Creek, the 100-year return period streamflows are estimated to be 265 cfs under existing conditions, and 156 cfs with the proposed project (Table 14 and Appendix D). The estimated

future 100-year streamflow in West Unnamed Creek represents a 41 percent reduction from existing with a corresponding reduction in water depth of 8.5 inches.

There are no biological survey data available for the West Unnamed Creek downstream of the project area. Much of the West Unnamed Creek has been evaluated by Northshore for potential mitigation opportunities, including conducting a LiDAR topographic survey and a field topographic survey of one lower reach. The upper reach of West Unnamed Creek, immediately downstream of the project area, is a constructed ditch. Figure 6 shows approximately where the ditch ends and an unaltered stream bed begins. An MNSQT analysis was performed on the ditch reach. A biological survey has not been completed, but the lack of habitat associated with the ditch reach, which is devoid of woody debris (see MNSQT parameters), would limit fish and macroinvertebrate establishment. The ditch reach is "functioning at risk" for hydraulics and on the low end of "functioning at risk" for geomorphology. There was no documented large woody debris, low bedform diversity and poor quality riparian vegetation. The same MNSQT analysis was completed on the lower, unaltered portion. This reach is "not functioning" in hydraulics, primarily due to metrics that indicate the stream is not connected to its floodplain. It is "functioning at risk" for geomorphology, due to lack of large woody debris, low bedform diversity, and lateral migration (bank erosion). It would have scored lower, but the riparian vegetation scored high. These metrics indicate poor fish and macroinvertebrate habitat. Large woody debris is a habitat for fish and macroinvertebrates, low bedform diversity indicates a more uniform substrate and lateral migration generates excess sediment. The pre-settlement drainage area to West Unnamed Creek was 1.04 square miles and with the project, will be 0.95 square miles, an 8.4 percent reduction from pre-settlement conditions (Table 1).

### 5.3.2 East Branch Beaver River Headwaters (Subwatershed 1) Modeled Streamflow

The watershed area contributing flow into the Lower East Branch Beaver River subwatershed (#7) at the confluence with West Unnamed Creek includes Subwatersheds 1-4, which will decrease by 6.9% percent from existing to future conditions (Table 1). Wetlands within those subwatersheds will decrease by 4 percent (Table 2), but wetlands and lakes as a percent of the watershed will increase by 3 percent with the project. Ponds as a percent of those subwatersheds will decrease by 7 percent from existing to future conditions (Table 13).

For East Branch Beaver River immediately downstream of the confluence with West Unnamed Creek, the existing 7Q10 streamflow is estimated to be 0.90 cfs, which would be reduced to 0.79 cfs with the project (Table 14), a 12 percent decrease. The decrease in low flow represents a 0.25 inch reduction in water level, which is at the limit of capability for instruments to accurately measure in a small stream environment. The 1.5-year return period streamflows are estimated to be 341 cfs under existing conditions, and 330 cfs with the proposed project (Table 14 and Appendix E), a 3 percent reduction. The reduction in East Branch Beaver River streamflow for the 1.5-year return period would also reduce water levels in the channel by 0.25 inch (Table 14 and Appendix E). The 100-year streamflow is estimated to be reduced from 1780 cfs in existing conditions to 1760 cfs with the project (Table 14), a 1 percent change, and to have a water level reduction of 0.1 inch, which does not represent a measurable change to the floodplain.

Modeling watershed flows based on the USGS regression models also indicate that historically, flows ranging from the 1.5-year recurrence interval through the 100-year recurrence interval may have been substantially higher than current flows. In the 1960s and early 1970s, aerial photos show that beaver impoundments and ponds were not nearly as prevalent within the East Branch Beaver River headwaters and West Unnamed Creek subwatersheds (Subwatersheds 1-4), covering about 0.2 square miles of the watershed compared to recent times when 1.13 square miles of the watershed is covered by ponds (Table 13), more than a five-fold increase. This landscape change indicates that historic flows were 1.6 to 1.9 times greater, which may have contributed to establishing channel instability within the East Branch Beaver River. Modeled flows indicate an estimated 3 percent reduction in the channel forming flow (1.5-year recurrence interval) from current conditions to future conditions, which slightly reduces the stream's ability to transport sediment. Modeling also indicates a slight decrease in 100-year flows (Table 14), indicating that the project is not expected to contribute to channel instability.

There is one culvert on the East Branch Beaver River upstream of West Unnamed Creek and three culverts downstream that may contribute to the instability. In addition, historical logging was noted by the MPCA (2017, pg 86) as contributing to higher runoff rates and peak flows due to reduced transpiration rates, which may have contributed to channel instability.

### 5.3.3 East Branch Beaver River Observed Streamflow

There are no continuous stream gaging stations located on the East Branch Beaver River to measure flow. As an obligation under its NPDES Permit, Northshore has been periodically measuring instantaneous streamflows within the East Branch Beaver River both immediately upstream (Station S101) and downstream (Station S102) of the confluence with West Unnamed Creek, which currently carries the 2005 Diversion Ditch flow (Table 4 and Figures 9 and 11). Ongoing instantaneous flow measurements are collected four times per year; typically, in April, July, September, and November and have been since 2001. The documented streamflows in the East Branch Beaver River are shown on Figure 12, including the estimated contribution from Subwatershed 4 (Figure 9), which includes most of the project area. Instantaneous streamflow measured by Northshore in the East Branch Beaver River is typically highest in the spring with an average flow of 88 cfs and lowest in the summer with an average flow of 17 cfs. The highest streamflow recorded by Northshore is 272 cfs from April 2011, which is lower than the modeled 1.5-year recurrence interval flow of 341 cfs (Table 14 and Appendix E) and the lowest flow recorded is 0.1 cfs from September 2012 (Figure 12), which is lower than any modeled flow (Appendix E). However, measured flows in the East Branch Beaver River have generally been within the range of modeled flows, lending confidence to the modeled flows.

For 56 percent of the available flow measurements, Subwatershed 4 did not contribute any flow to the East Branch Beaver River. Four of the five notable flow contributions from Subwatershed 4 of greater than 15 cfs, occurred during the spring, likely during snowmelt runoff and the other occurred November 4, 2009, with an estimated 140 cfs contribution following 5.4 inches of precipitation at the basin in October 2009, a time when evapotranspiration is typically low (Figure 13). Therefore, the reduction of Subwatershed 4 from 3.02 square miles to 0.95 square miles with the project will reduce snowmelt and

other peak flows to the East Branch Beaver River, but is not expected to adversely affect streamflows the remainder of the year when no or low flows have been observed.

### 5.3.4 Direct Impacts

The project will directly impact 5,040 linear feet of remnant streams, including 2,450 linear feet of Big Thirtynine Creek and 2,590 linear feet of Little Thirtynine Creek within the East Branch Beaver River subwatershed.

The remnant reaches of Big and Little Thirtynine Creeks that will be impacted by the project have been characterized using the Minnesota Stream Quantification Tool and Debit Calculator (MNSQT) (EPA, 2019) in which detailed information regarding the functional status of the streams has been compiled as presented in Appendix I. That information will be utilized to assist in determining appropriate stream mitigation. Both remnant Big and Little Thirtynine Creeks are diminished in flow from historic conditions as a result of the diversion channel that was constructed during the initial Milepost 7 tailings basin construction. Cutting off the lower reaches of Big and Little Thirtynine Creeks from their historic watershed was evaluated in the 1977 Corps EIS, recognizing that those remnant channels were within the footprint of the projected basin plan. Remnant Big Thirtynine Creek has 0.46 square miles of drainage area compared to its historic 17.7 square miles, a 97 percent reduction (Table 14). Modeled bankfull flows in the lower Big Thirtynine Creek are 399 cfs historically compared to 12.2 cfs under existing conditions and modeled 100-year flows have decreased from 2,640 cfs historically to 126 cfs under existing conditions (Table 14 and Appendix F). The remnant Little Thirtynine Creek is supported by a 0.11 square mile drainage area compared to 6.94 square miles historically, a 98 percent reduction (Table 14). Modeled bankfull flows in the lower Little Thirtynine Creek are 164 cfs historically compared to 2.6 cfs under existing conditions and modeled 100-year flows have decreased from 1,200 cfs historically to 30.6 cfs under existing conditions (Table 14 and Appendix F). Therefore, low flows approach zero and bankfull and flood flows are greatly diminished, so normal channel forming processes and flooding regimes no longer exist.

Fish and macroinvertebrate surveys were completed on remnant Big and Little Thirtynine Creeks in 2019 and index of biological diversity (IBI) scores were derived. The fish IBI scores are 19 for Big Thirtynine Creek and 16 for Little Thirtynine Creek (Appendix I), lower than for any stream documented in the watershed (Table 8). Both streams are low in diversity and fish quantity with three species documented in Big Thirtynine Creek and four species documented in Little Thirtynine Creek and 26 to 46 fish documented (Table 7). Evaluating the condition of the fishery in the streams using the MNSQT (EPA, 2019) indicates that both streams are "not functioning." The macroinvertebrate IBI scores are 30.6 for the remnant Big Thirtynine Creek and 25 for the remnant Little Thirtynine Creek (Appendix I), lower than all but two stream stations documented in the watershed (Table 8). Macroinvertebrates in the remnant Big Thirtynine Creek were predominantly species that are tolerant to very tolerant of pollution or anthropogenic disturbances while few long-lived species were present. The remnant Little Thirtynine Creek also had an abundance of tolerant to very tolerant species and percentages, but had no long-lived species. In addition, the remnant Little Thirtynine Creek had no macroinvertebrates present of the families; *Plectoptera*, *Odonata*, *Ephemeroptera*, and *Trichoptera* along with a high number of "very intolerant species." Evaluating the

condition of macroinvertebrates in the streams using the Minnesota Stream Quantification Tool and Debit Calculator (EPA, 2019) indicates that both streams are "not functioning."

Of the 2,450 linear feet of direct impacts to Big Thirtynine Creek, approximately 1,745 linear feet is functioning as ponds while the remaining 710 linear feet contain riffle and run flow reaches. Because of the reduction in drainage area, the bankfull elevation within the present channel areas in Big Thirtynine Creek is lower than the historic bankfull elevation. Therefore, the bank height ratio and the entrenchment ratio for Big Thirtynine Creek, which characterize floodplain connectivity, are determined to be "functioning at risk" based on the MNSQT (EPA, 2019). The measured water chemistry parameters in Big Thirtynine Creek are also "functioning at risk" based on the MNSQT (EPA, 2019). The hydrology and geomorphology parameters within the channel areas in Big Thirtynine Creek are determined to be "functioning" based on the MNSQT (EPA, 2019). Within the impounded beaver dam areas of Big Thirtynine Creek, the geomorphology parameters are "functioning at risk", primarily due to the lack of bed form diversity. The hydrology and hydraulics parameters, including floodplain connectivity within the impounded reach of Big Thirtynine Creek are "functioning" according to the MNSQT (EPA, 2019).

Of the 2,590 linear feet of direct impacts to Little Thirtynine Creek, approximately 1,340 linear feet is functioning as ponds while the remaining 1,250 linear feet contain riffle and run flow reaches. Because of the reduction in drainage area, the bankfull elevation within the present channel areas in Little Thirtynine Creek is lower than the historic bankfull elevation. Therefore, the bank height ratio and the entrenchment ratio for Little Thirtynine Creek, which characterize floodplain connectivity, are determined to be "functioning at risk" based on the MNSQT (EPA, 2019). The measured water chemistry parameters in Little Thirtynine Creek are also "functioning at risk" based on the MNSQT (EPA, 2019). The hydrology and geomorphology parameters within the channel areas in Big Thirtynine Creek are determined to be "functioning" based on the MNSQT (EPA, 2019). Within the impounded beaver dam areas of Little Thirtynine Creek, the geomorphology parameters are "functioning at risk", primarily due to the lack of bed form diversity. The hydrology and hydraulics parameters, including floodplain connectivity within the impounded reach of Little Thirtynine Creek are "functioning" according to the MNSQT (EPA, 2019).

Approximately, 5,780 linear feet of the 2005 Diversion Ditch will be directly impacted. Wetland functions in MnRAM 3.4 (BWSR, 2010) were evaluated within the diversion ditch, which is Wetland 17b (Table 15). Vegetative diversity is rated moderate due to a predominance of cattails. All of the hydrologic and water quality functions; hydrologic regime, flood storage, downstream water quality, and wetland water quality are rated moderate. Shoreline protection and wildlife habitat within the diversion ditch are both rated moderate while fish habitat is rated high. Amphibian habitat within the diversion channel is rated low along with aesthetics/recreation.

About 6,200 feet of new ditch will be constructed with the project to provide an outlet to Wetland 20 near the north corner of the proposed basin, which will drain to the East Branch Beaver River in near proximity to the historic intermittent channel in that watershed (Figure 11). The watersheds that Big and Little Thirtynine Creeks currently drain will become part of the proposed tailings basin, so no channels will be needed in the future for drainage of those areas.

The floodplain of the East Branch Beaver River has not been mapped by the Federal Emergency Management Agency (FEMA) and there are no known plans to map the area. The floodplain of the East Branch Beaver River near the proposed tailings basin progression ranges from approximately 125 feet to 300 feet wide based on a review of aerial imagery and topographic data. Near the confluence with West Unnamed Creek (Subwatershed 4), the floodplain widens, ranging from approximately 350 feet wide to about 800 feet wide. Wetland areas occupy much of the floodplain in that area. The modeled 100-year recurrence interval flows within the East Branch Beaver River downstream of the project will be reduced by one percent, which equates to less than 0.1 inch of water level reduction (Table 14), and for that reason, the project is not anticipated to affect the East Branch Beaver River floodplain.

### 5.3.5 Indirect Impacts

The project will indirectly impact 3,530 linear feet of remnant streams, including 2,700 linear feet of the remnant Big Thirtynine Creek and 830 linear feet of the remnant Little Thirtynine Creek. Of the 2,700 linear feet of indirect impacts to Big Thirtynine Creek, approximately 2,180 linear feet is functioning as ponds while the remaining 515 linear feet contain riffle and run flow reaches based on field survey of the creek. All of the 830 linear feet of indirect impacts to Little Thirtynine Creek are currently functioning as ponds with no riffle and run flow reaches based on field survey of the creek. Those stream reaches will either be utilized for seepage collection or will be flooded by water over time due to the impoundment of two valleys by the proposed railroad embankment and tailings dam. With annual net precipitation of about 10 inches in this part of the state (Vandegrift and Stefan, 2010), the stream valleys will fill with water over time, resulting in creation of up to 80 acres of impounded water with peripheral wetlands. The existing stream habitat will be replaced by open water habitat.

## 5.4 Cumulative Effects

### 5.4.1 Beaver River Subwatershed

The Beaver River watershed (including all contributing subwatersheds) is expected to have a cumulative loss of 4.8 miles of streams and ditches from 158.7 miles in pre-settlement conditions to 153.9 miles in future conditions (Table 2), a 3.1 percent loss, considering all reasonably foreseeable projects. The majority of the area where streams have been lost has been replaced by the tailings basin. While some aquatic stream habitat has been lost, the flood storage capacity of those streams and associated floodplains and wetlands has been replaced to some degree by the tailings basin operation. The tailings basin flood storage functions will be maintained through the capture of all runoff and controlled discharge at the WTP with peak flow rates of <11 cfs compared to modeled 100-year flow rates from Subwatershed 14 of 614 cfs if there were no tailings basin operation and the watershed was in a natural condition (Table 14).

Within the Beaver River watershed, there are no water appropriations permits issued for water withdrawals from the Beaver River or any other river, and there haven't been any such permits since 1975 (Barr, 2019b). There is one groundwater appropriation permit within the watershed for the Silver Bay golf course. There is one discharge permit within the watershed in addition to Northshore, for the Beaver Bay wastewater treatment plant. The Beaver Bay wastewater treatment plant is located downstream of the project in Subwatershed 16 (Figure 9) and only discharges intermittently. Records for 2019 indicate that

the Beaver Bay wastewater treatment plant discharged an average of 23 cfs during May and 0.3 cfs during August, with no other reported discharges. Northshore has two permitted discharge points, one for seepage from north of the seepage collection facilities named SD005/SRD2 (SD5 on Figure 9) and the other from the WTP in the south corner of the basin at SD1-S010 (Figure 9). Seepage from SD005/SRD2 is measured four times per year; typically, in April, July, September, and November, which has been in place since 2000. The average seepage from SD5/SRD2 is 0.006 cfs (2.6 gpm) with a range of 0-0.05 cfs. Discharge from SD1-S010 has been measured since 2000, including daily average flow and daily maximum flow. During the past 19 years, SD1-S010 discharge has averaged 6.1 cfs with a range from 0-11.0 cfs (Table 12).

Northshore measures streamflow four times per year on the Beaver River just upstream of the confluence with the West Branch Beaver River (Station S105) and downstream of the WTP discharge location (Station S106) (Figure 9). Flow measurements have been collected since 2001 and typically occur in April, July, September, and November. A breakdown of the flow components to the continuous Beaver River flow (Station 2006003) is shown for the period 2011-2019 on Figure 15, including the Beaver River upstream of the confluence with the West Branch Beaver River (S105), the Northshore WTP discharge (SD1-S010 WTP), the Beaver River downstream of the WTP discharge (S106), and the East Branch Beaver River at CSAH 4 (S102) (see Figure 9 for monitoring locations). No flow data is available for the West Branch Beaver River. A more detailed breakdown of the Northshore WTP contribution to Beaver River flows is shown on Figure 16. On Figure 16, streamflow measurements taken upstream and downstream of the Northshore WTP discharge are shown in conjunction with the WTP discharge from 2001-2019. Approximately once per year, the WTP discharge equals or slightly exceeds the Beaver River streamflow, always during baseflow conditions and typically in the latter part of the year. Habitat availability during prolonged low flows can be scarce due to decreased wetted width, cross-sectional area, and water depth, which decreases living space and increased competition for resources (MPCA, 2017). Prolonged low flows can lead to macroinvertebrate and fish communities comprised of generalists and those with a preference for standing water, as opposed to diverse, non-tolerant species (MPCA, 2017). Given the detrimental biological effect of low baseflows, maintaining a baseflow by way of the WTP discharge late in the summer and early fall is expected to result in modest biological benefits within the Beaver River.

### 5.4.2 East Branch Beaver River Subwatershed

While the construction and operation of the Milepost 7 Tailings Basin added about 2 square miles of drainage area to the East Branch Beaver River subwatershed through West Unnamed Creek, the discharge from that area has been documented as intermittent, with 56 percent of measured flows showing no contribution from the diverted watershed. Based on measured streamflow in the East Branch Beaver River, it is apparent that the diverted watershed has added flow to the East Branch Beaver River occasionally, but not of a magnitude or frequency to drastically alter flow regimes within the river. The project will remove the diverted watershed from the East Branch Beaver River, returning the watershed area to within 0.2 percent of historic watershed conditions (Table 1). The water level changes in the East Branch Beaver River downstream of the 2005 Diversion Ditch are estimated to be small; 1.3 inches for the 7Q10 flow, 0.25 inch for the 1.5-year return period channel forming flow, and 0.1 inch for the 100-year return period (Table 14). The West Unnamed Creek subwatershed (Subwatershed 4) will be reduced by 8.4 percent from historic

conditions and water levels within the creek to be reduced from existing conditions by 0.5 inch for the 7Q10 flow, 4 inches for the 1.5-year channel forming flow, and 8.5 inches for the 100-year flow (Table 14).

The proposed project will result in the cumulative loss of 10,227 linear feet of streams and ditches in the West Unnamed Creek subwatershed (including Subwatersheds 2, 3, and 4). In the existing condition there are 22,126 linear feet of stream/ditch in that watershed, which includes 8,570 feet that were added to the watershed during initial basin construction. The future condition of the West Unnamed Creek watershed includes 11,899 feet of stream which represents a 108 percent increase from pre-settlement conditions (Table 2). This added length is primarily due to the addition of diverted watershed and ditch construction by Northshore.

# 6 Wetland Resources

Barr (2020) evaluated wetland functions on a subset of wetlands within the project area using the Minnesota Routine Assessment Method for Evaluating Wetland Functions, Version 3.4 (MnRAM 3.4) based on field data collected utilizing the Barr Mine MnRAM methodology (Barr, 2020). Because the field data was shown to accurately evaluate full MnRAM functions, and the Corps approved the methodology via a letter dated April 9, 2020; those methods were applied to all project wetland impacts to determine ratings for all MnRAM 3.4 wetland functions and values (Table 15), which were used to present wetland functional losses.

## 6.1 Beaver River Subwatershed

Key Points for the Beaver River subwatershed wetlands resource assessment:

- Approximately 85 acres of the project area currently lie within the East Branch Beaver River subwatershed.
- Approximately 9.6 acres of direct wetland impacts are proposed and approximately 4.0 acres of indirect impacts (Table 16) are anticipated out of the approximate 22,513 acres of wetlands within the subwatershed (Table 2).
- There are approximately 71 acres of downstream wetland resources along the Beaver River.

### 6.1.1 Direct Impacts

A total of 9.6 acres of wetlands within the Beaver River subwatershed would be directly impacted by construction of the railroad and the rail switchback (Table 16), comprised predominantly of alder thicket wetlands with some hardwood swamp and sedge meadow. There would be a loss of 1.4 acres of wetlands with exceptional vegetative diversity (due to the presence of habitat for rare plant species), and 8.2 acres of wetlands rated high for vegetative diversity based on the Minnesota Routine Assessment Method for Evaluating Wetland Functions (MnRAM) Version 3.4 (BWSR, 2010) (Table 16). The 9.6 acres of direct wetland loss include moderate ratings for hydrologic regime, flood storage, and protection of downstream water quality, while the wetland water quality is rated high. There would be a loss of 1.4 acres of wetland rated high for wildlife habitat and 8.2 acres rated moderate. No wetland with suitable fish or amphibian habitat will be lost and none of the wetlands provide shoreline protection. All direct wetland impacts in the Beaver River subwatershed are rated low for aesthetics/recreational value.

### 6.1.2 Indirect Impacts

A total of 4 acres of indirect wetland impacts are anticipated within the Beaver River subwatershed, resulting from fragmentation. The majority of the fragmentation impacts for which wetland mitigation is proposed, occur where less than 0.2 acre of wetland would remain, and being isolated from other wetland habitats are not expected to be sustainable. The other wetland fragments range in size from 0.4 acre to 1.5 acres, and while larger in size, each wetland fragment will be subject to additional factors that are determined to be detrimental to their sustainability. All but one of the larger wetland fragments will be sandwiched between the railroad embankment and Dam 1 railroad switchback with less than 200 feet

between the project features (See Figure 25). Due to proximity of the railroad and switchback embankments, these wetland fragments will become isolated from other natural habitats and watershed area, so are not likely to maintain similar function. All wetlands impacted by fragmentation are comprised of alder thicket wetlands with high-rated vegetative diversity and wetland water quality and moderate-rated hydrologic regime, flood storage, downstream water quality protection, and wildlife habitat. The wetlands impacted by fragmentation provide no fish or amphibian habitat and no shoreline protection, but low aesthetics/recreational value.

## 6.2 East Branch Beaver River Subwatershed

Key Points for the East Branch Beaver River subwatershed wetlands resource assessment:

- Approximately 997 acres of the project area currently lie within the East Branch Beaver River subwatershed which has a total drainage area of 32,320 acres.
- Approximately 212 acres of direct wetland impacts are proposed and approximately 41.5 acres of indirect impacts (Table 16) are anticipated out of the approximate 8,391 acres of wetlands within the subwatershed (Table 2).
- There are approximately 71 acres of downstream wetland resources along the East Branch Beaver River.

### 6.2.1 Direct Impacts

A total of 212 acres of direct wetland impacts are proposed within the East Branch Beaver River subwatershed. The predominant wetland communities affected include hardwood swamp, coniferous swamp, shallow marsh, and alder thicket. A total of 2.7 acres of wetlands with exceptional vegetative diversity (due to the presence of rare plant species) will be directly impacted along with 127 acres rated high for vegetative diversity, and 82.7 acres rated moderate (Table 16). The vegetative diversity ratings are based on the Minnesota Routine Assessment Method for Evaluating Wetland Functions (MnRAM) Version 3.4 (BWSR, 2010). Approximately, 151 acres of direct wetland loss include high ratings for hydrologic regime, flood storage, and protection of downstream water quality, while 58.2 acres are rated moderate for those functions and 3.5 acres are rated low. Wetland water quality is rated high for 149.1 acres of direct wetland impacts and moderate for 63.3 acres of impact. There would be a loss of 167.1 acres of wetland rated high for wildlife habitat and 45.3 acres rated moderate. A total of 62.5 acres of direct wetland impacts provide moderate shoreline protection. There is suitable fish and amphibian habitat within 62.5 acres of the wetlands that will be directly impacted, all of which are rated high for fish habitat, 62 acres are rated moderate for amphibian habitat, and 0.5 acre is rated low for amphibian habitat. All direct wetland impacts in the East Branch Beaver River subwatershed are rated low for aesthetics/recreational value. Of the 212 acres of direct wetland impacts, approximately 187 acres historically drained to Thirtynine Creek while the remaining 25 acres drained to the East Branch Beaver River (Figure 8).

### 6.2.2 Indirect Impacts

#### 6.2.2.1 Impoundment and Fragmentation

Along the northwest side of the project, the railroad embankment will cross two valleys, thereby impounding wetlands upslope from the railroad. The southwest valley (Figure 10) will eventually be utilized for seepage collection, similar to existing seepage collection facilities. While the seepage collection facility has not yet been designed, approximately 35.0 acres of wetlands will eventually either be utilized for seepage collection or will be impounded by the project, resulting in a conversion to deepwater habitat with wetland perimeter. The northeast valley (Figure 10) will be impounded by the railroad embankment resulting in an expected 14 acre deepwater/wetland complex of similar character to Murphy's Pond, affecting 5.7 acres of existing wetland (Wetland 23). The northeast impoundment will overflow to the southwest valley after reaching elevation 1330 feet with a depth of about 26 feet. With only a 45-acre watershed area, the deepwater habitat in the northeast valley is not expected to fully develop until many years after construction of the railroad embankment. In addition, 0.8 acre of fragmentation impacts are expected within the East Branch Beaver River subwatershed along the outside of the railroad embankment in Wetlands 20 and 26. The fragmentation impacts include wetland fragments ranging in size from 0.02 acre and 0.5 acre, and will be isolated from other wetland habitats; so, they are not expected to be sustainable.

There would be a loss of 41.5 acres of wetlands rated high for vegetative diversity (Table 16). The indirect wetland loss includes 41.4 acres of wetlands rated high for hydrologic regime, flood storage, and protection of downstream water quality, with the remaining 0.1 acre rated low for those functions. Wetland water quality in all of the wetlands for which indirect impacts will occur are rated high for wetland water quality and wildlife habitat. For the indirect wetland impacts, 33.7 acres provide moderate shoreline protection and amphibian habitat along with 33.7 acres of high quality fish habitat. All indirect wetland impacts in the East Branch Beaver River subwatershed are rated low for aesthetics/recreational value.

#### 6.2.2.2 Watershed Alterations

***Wetland 34***

Wetland 34 is an 18.24 acre hardwood swamp that currently spans a watershed divide (Watersheds 2B and 3B, Figure 25) with 7.66 acres in the northwest Watershed 2B and 10.58 acres in the southeast Watershed 3B, discharging towards the tailings basin. The railroad and Dam 1 extension embankments will directly impact 3.59 acres of Wetland 34. Approximately 9.0 acres of Wetland 34 will remain between the two embankments within the landfill isolation area, of which 1.47 acres is on the north side of the watershed divide and will be impounded by the railroad embankment (Figure 26). The remaining 7.53 acres of unimpacted Wetland 34 lies in Watershed 1B (Figure 26), draining to the south.

Under existing conditions, the south part of Wetland 34 is 10.59 acres in size and has a 52.3 acre watershed, resulting in a watershed to wetland ratio of 4.9:1 (Table 17, Figure 25). With the project, 7.53 acres of Wetland 34 will remain with an immediate watershed area of 32.9 acres and a watershed to wetland ratio of 4.4:1 (Table 17, Figure 26). While the watershed ratio is reduced by 10 percent, the

effective drainage area to the remaining portion of the wetland is virtually the same as in existing conditions (compare Watershed 3B in Figure 25 to Watershed 1B in Figure 26) and the wetland will be allowed to discharge to the south at the wetland boundary elevation, preventing potential impoundment impacts. Since a portion of the wetland will be filled by the project, the original wetland watershed will be altered slightly with a 10 percent reduction in watershed ratio for the south part of the wetland overall; there is some potential for indirect impacts and monitoring is proposed.

#### *Wetland 35*

Wetland 35 is a 4.27 acre hardwood swamp wetland, which also crosses a watershed divide (Watersheds 2A and 3C, Figure 25) with 1.71 acres in the northern Watershed 2A and discharging to the south, while 2.56 acres is located in the southern Watershed 3C discharging to the east. The railroad and Dam 1 extension embankments will directly impact 1.54 acres of Wetland 35. Approximately 2.73 acres of Wetland 35 will remain between the two embankments within the landfill isolation area. Of the unimpacted 2.73 acres of wetland, 1.53 acres will remain on the north side of the watershed divide (Watershed 2A, Figure 26) and will continue to drain freely to Wetland 34. The other 1.2 acres of unimpacted Wetland 35 lies in Watershed 1A, draining to the southeast (Figure 26).

Under existing conditions, the north part of Wetland 35 is 1.71 acres in size and has a 5.1 acre watershed, resulting in a watershed to wetland ratio of 3.0:1 (Table 17, Figure 25). With the Project, 1.53 acres of Wetland 35 will remain in the northern part with a watershed area of 14.7 acres and a watershed to wetland ratio of 9.6:1, an increase of 220 percent (Table 17, Figure 26). Because the outlet from the wetland will not be impacted, the additional watershed will provide sustainable hydrology. Under existing conditions, the south part of Wetland 35 is 2.56 acres in size and has a 13.4 acre watershed, resulting in a watershed to wetland ratio of 5.2:1 (Table 17, Figure 25). With the Project, 1.2 acres of Wetland 35 will remain with a watershed area of 8.5 acres and a watershed to wetland ratio of 7.1:1, an increase of 37 percent (Table 17, Figure 26). Because the wetland will be allowed to discharge to the south at the wetland boundary elevation the additional watershed will provide sustainable hydrology. Since a portion of Wetland 35 will be filled by the project, the original wetland watershed will be altered slightly, and additional watershed area will be added; there is some potential for indirect impacts and monitoring is proposed. A monitoring plan is included in Appendix G.

### 6.2.3 Downstream Wetland Resources

#### 6.2.3.1 Beaver River Subwatershed

The Milepost 7 tailings basin operation discharges at the confluence of the Upper Lower Beaver River subwatershed (#15) into the Lower Beaver River subwatershed (#16) (Figure 9). There are approximately 92 acres of wetlands located along the Beaver River downstream of the WTP discharge (Figure 29). With an estimated 0.5 percent increase in low flows and no estimated change to bankfull and 100-year flows (Table 14), no effects are predicted to downstream wetland habitat, quantity, or quality.

#### 6.2.3.2 West Unnamed Creek (Subwatershed 4)

There are approximately 13 acres of wetlands along West Unnamed Creek between the project area and the East Branch Beaver River, all located along the lower 0.5 mile of the channel and spreading laterally up

to more than 300 feet from the channel. While the watershed area draining to the West Unnamed Creek channel will be reduced by 68.5 percent with the project, the direct watershed area contributing to the wetlands along West Unnamed Creek is predominantly from local drainage areas that will not change. The wetlands along West Unnamed Creek are comprised of sloping wetlands in the upper part and floodplain wetlands near the confluence with East Branch Beaver River. Relief within the wetlands is approximately 45 feet overall with slopes up to 4 percent within the wetlands. Therefore, because the channel water levels for the 1.5-year return period under existing and future conditions will remain within the channel and the local drainage areas supporting the wetlands will not change, there are no expected effects to the wetlands.

#### 6.2.3.3 Lower East Branch Beaver River (Subwatershed 7)

There are approximately 71 acres of wetlands located along the East Branch Beaver River between the proposed project in Subwatershed 4 and the confluence with the Beaver River (Figure 28). With the estimated change in water levels within the East Branch Beaver River for both bankfull and 100-year events being 0.25 inch or less, no effects are predicted to downstream wetland habitat, quantity, or quality.

## 6.3 Cumulative Effects

### 6.3.1 Beaver River Subwatershed

Operation of the tailings basin will collect all runoff from the 7.13 square mile drainage area, will store and utilize that water in the operation, and discharge excess water at controlled rates after treatment in the WTP. The tailings basin operation contains an extensive seepage collection system and returns seepage into the basin for reuse or routes seepage water to the WTP prior to discharge. The tailings basin also has permit obligations to preserve freeboard storage space to manage excess precipitation and runoff events. Over the last 19 years, the maximum recorded discharge rate from the WTP was 11.0 cfs and the average flow has been 6.1 cfs. The average WTP discharge represents 7 percent of the estimated bankfull (1.5-year recurrence interval) flow, which is 86.6 cfs from Subwatershed 14 and one percent of estimated 100-year flow, which is 614 cfs (Table 14 and Appendix F), assuming that there was no tailings basin storage or WTP discharge control. Therefore, the tailings basin operation has demonstrated the function of eliminating peak flood flows by maintaining discharge from the WTP below flood flow rates in a controlled manner. The storage of water in the tailings basin has, and will continue to decrease peak flows and maintain baseflow. Therefore, no adverse cumulative effects are expected to downstream wetlands and waters related to wetland loss within the Beaver River HUC10 watershed and the wetland functions performed in controlling flooding.

There will be a cumulative loss of 1,289 acres of wetland wildlife habitat within the Beaver River watershed (Table 2), predominantly associated with forested, shrub, and non-natural shallow marsh wetlands. Forested and shrub wetlands continue to be the two dominant wetland types within the watershed and with over 87,000 acres of nearly contiguous forested habitat in the watershed, no adverse cumulative effects are expected to wildlife habitat.

### 6.3.2 East Branch Beaver River Subwatershed

Cumulatively, the East Branch Beaver River subwatershed is expected to have a loss of 0.8 percent, or approximately 64 acres of wetlands from pre-settlement conditions to future conditions with the project (Table 2). There is expected to be a 254-acre loss of wetlands within the current East Branch Beaver River subwatershed (Table 16). Approximately, 200 acres of that wetland loss did not historically drain to the East Branch Beaver River, but rather to Thirtynine Creek. The historic Thirtynine Creek subwatershed has been, and will be predominantly filled by the tailings basin operating area (Figure 8). Cumulatively, approximately 1,277 acres of wetland loss are expected within the Thirtynine Creek subwatershed compared to historic conditions, of which 1,274 acres have already been impacted.

# 7 Lakes and Deepwater Habitat

## 7.1 Beaver River Subwatershed

### 7.1.1 Direct Impacts

No lakes or deepwater habitats will be impacted within the Beaver River subwatershed.

### 7.1.2 Indirect Impacts

No indirect impacts to lakes or deepwater habitats are expected within the Beaver River subwatershed.

## 7.2 East Branch Beaver River Subwatershed

### 7.2.1 Direct Impacts

A total of 29.57 acres of impounded deepwater habitat will be directly impacted by the project within the current East Branch Beaver River subwatershed (Figure 9).

### 7.2.2 Indirect Impacts

Along the northwest side of the project, the railroad embankment will cross two valleys, thereby impounding wetlands upslope from the railroad. The southwest valley (Figure 10) will eventually be utilized for seepage collection, similar to existing seepage collection facilities. Approximately 66 acres of area will eventually be converted to deepwater habitat with a periphery of wetlands. The northeast valley (Figure 10) will be impounded resulting in an expected 14 acre deepwater/wetland complex of similar character to Murphy's Pond. The northeast impoundment will overflow to the southwest valley after reaching elevation 1330 feet with a depth of about 26 feet. With only a 45 acre watershed area, the deepwater habitat in the northeast valley is not expected to fully develop until many years after construction of the railroad embankment.

## 7.3 Thirtynine Creek Subwatershed

### 7.3.1 Direct Impacts

No lakes or deepwater habitats will be impacted within the Thirtynine Creek subwatershed.

### 7.3.2 Indirect Impacts

No indirect impacts to lakes or deepwater habitats are expected within the Thirtynine Creek subwatershed.

## 7.4 Cumulative Effects

Cumulatively, there has been no loss of lake habitat within the Beaver River watershed historically and no expected future impacts to lake habitat. There has been an increase in deepwater habitat from historic conditions of approximately 43 acres due to the establishment of Murphy's Pond at the Northshore

tailings basin and the wastewater treatment ponds constructed for the Beaver Bay wastewater treatment facility (Figure 6). With all foreseeable future projects, the extent of deepwater habitat is expected to increase by approximately 21 acres compared to historic conditions. All of the increase in deepwater habitats is due to artificial impoundments, which do not function at the same level as natural deepwater/lake habitats. The City of Beaver Bay wastewater treatment ponds are devoid of vegetation and inherently not biologically diverse because their function is to settle out municipal sewage. Murphy's Pond is a recently flooded, predominantly forested wetland and only recently started developing aquatic vegetation. Therefore, with an increase in deepwater habitat area from historic conditions, deepwater habitat functions are not expected to change.

# 8 Biological Resources

Biological monitoring data have been collected by the MPCA as part of an overall watershed monitoring assessment report (WMAR), stressor identification, and total maximum daily load (TMDL) development for the Lake Superior South Watershed (MPCA, 2017), including the Beaver River watershed. Biological monitoring surveys have been conducted various years on the Beaver River and East Branch Beaver River between 1997 and 2015 at the stations summarized in Tables 3 and 4 and as shown on Figures 17 and 18.

Publicly-available data for fish, macroinvertebrate, and habitat surveys conducted in the Beaver River watershed by the MPCA are summarized in this section. Data were collected by the MPCA as part of an overall watershed assessment and to identify the principal causes or stressors contributing to impaired fish and aquatic macroinvertebrate communities in the Beaver River. These data are described here to establish existing conditions as a basis for evaluating potential project and cumulative effects. Summaries of the biological data are included in Tables 7 and 8 and shown graphically on Figures 17 and 18.

Fish, macroinvertebrate, habitat assessments, and the corresponding indices for the Beaver River and East Branch Beaver River indicate varied biological conditions throughout the watershed.

- In general, the Beaver River either exceeds or meets Class 2Ag general coldwater aquatic life and habitat criteria in Minnesota Rules, part 7050.0222, subpart 2d with the exception of monitoring stations within the Lower Beaver River where land use changes are more prevalent, including roads and railroads in close proximity to and crossing the river along with a golf course and wastewater treatment ponds. The presence of coldwater fish species, habitat that supports a coldwater community, and fish and macroinvertebrate indices of biological integrity (F-IBI and M-IBI) scores that generally meet the corresponding biocriteria thresholds demonstrate that the Beaver River is achieving its target use as habitat for a coldwater fishery.
- The East Branch Beaver River meets or exceeds Class 2Ag general coldwater fisheries criteria throughout its length supporting coldwater species in all areas of the river (Table 7). Only two locations on the East Branch Beaver River have been evaluated for macroinvertebrate communities (Figure 18), both in 2011, including one location in the headwaters (Station 91LS029) and one location in a lower reach (Station 11LS026). Neither of the monitored locations meet macroinvertebrate criteria for northern coldwater streams even though the habitat at 91LS029 is rated as good and the stream is rated as stable to moderately stable (Table 8).

## 8.1 Fish Biological Monitoring

The MPCA surveyed fish communities during various years from 1997 to 2015 to identify fish communities and corresponding F-IBIs, including 11 locations on the Beaver River and five locations on the East Branch Beaver River. Reserve Mining surveyed the fish community in one location each on the Beaver River and East Branch Beaver River prior to the start of the Milepost 7 tailings basin project. Tables 7 and 8 present the results of the fish surveys. Throughout the surveys 19 different fish species were identified in the Beaver River and 15 species were identified in the East Branch Beaver River. Of the 11 stations surveyed in the Beaver River, coldwater (sensitive) species were found at 10 stations, all but the station farthest

downstream. These coldwater species include mottled sculpin (*Cottus bairdi*), brook trout (*Salvelinus fontinalis*), and rainbow trout (*Oncorhynchus mykiss*). Coldwater species were found in all five stations on the East Branch Beaver River, including both brook trout and mottled sculpin. Specific information about the presence of the coldwater fish community is described by MPCA (2017) and is summarized as follows:

- Mottled sculpin were present at monitoring stations throughout the Beaver River. More recently, higher populations have been identified at 94LS007 in the Upper Beaver River and 15LS060, downstream of the discharge from the Milepost 7 Tailings Basin, but not in the sampling reach upstream (Station 15LS061). Station 94LS007 provides a heavily forested area for the mottled sculpin. The relatively large population of sculpin documented at Station 15LS060 is likely related to the colder water discharge from the Milepost 7 Tailings Basin SD1-S010 (MPCA, 2017, pg 32).

- Rainbow Trout have been sampled in low numbers at several biological monitoring stations. The primary limitation for rainbow trout populations is due to natural geomorphology and the lack of quality spawning habitat available. There are several complete natural barriers to fish migration from Lake Superior on the Beaver River and East Branch Beaver River. The first such barrier is only 0.20 miles upstream of Lake Superior with additional barriers within the next several river miles on both the Beaver River and East Branch Beaver River (MPCA, 2017, pgs 32, 80-81). These barriers do not allow for upstream migration and the lack of sizeable tributary streams feeding the lower Beaver River and lower East Branch Beaver River limit potential refugia for coldwater fish during critical baseflow periods, further limiting conditions for spawning and rearing rainbow trout (MPCA, 2017, pgs 84. The MDNR stocks rainbow trout in the East Branch Beaver River (MPCA, 2017, pg 32), but none have been documented there.

- Brook trout populations due to natural reproduction are low relative to other North Shore streams (MPCA, 2017, pg 31).

- There is a noticeable shift in fish communities in the Beaver River in response to stream gradients and substrate conditions. Riffle-dwelling fish species such as mottled sculpin and longnose dace account for a higher percentage of the overall fish community at stations exceeding one percent slope compared to stations with gradients less than 0.2 percent (MPCA, 2017, pg 74) (Figure 17).

Each fish community survey was used to develop a F-IBI, which is a metric used to evaluate the health of the biological community. IBI scores are expressed as a numerical value between 0 (lowest quality) to 100 (highest quality) (MPCA, 2014b) and are compared to their respective biocriteria thresholds in Minnesota Rules, part 7050.0222. Scores that meet or exceed applicable benchmarks support healthy biological communities; however, waterbodies with scores that both meet and do not meet benchmarks may also support aquatic life uses and functional biological communities. IBI biocriteria vary by region, temperature regime, and stream class. IBIs evaluated for the Beaver River are compared to the general fish and macroinvertebrate biocriteria for northern coldwater streams in Minnesota Rules, part 7050.0222, subpart 2.d. Per personal communication with the MPCA, F-IBI scores retrieved from the MPCA's online surface water viewer database reflect the MPCA's latest F-IBI methods and algorithms (Personal communication, 2018), as such, data from the online surface water viewer database are used in lieu of data presented in the older published reports.

Table 8 includes a summary of F-IBI scores for the Beaver River from the MPCA's biological surveys between 1997 and 2015. Figure 17 shows the geographic locations of the surveys and resulting F-IBI scores. A summary of the results of F-IBI data collected by the MPCA between 1997 and 2015 is as follows:

- Of the 11 stations surveyed for fish communities on the Beaver River, ten of the stations have at least one survey that meets or exceeds the applicable biocriterion. Meeting or exceeding biocriteria demonstrate the presence of healthy biological communities.
    - Station 14LS001, which had only one survey in 2014, is the only station that does not have an F-IBI score that meets or exceeds the biocriterion (Table 8). This station's F-IBI score of 30 falls five points short of the applicable biocriterion threshold of 35. This station is the downstream-most biological monitoring station on the Beaver River and is impacted by land use development and related stressors, including roads and railroads in close proximity to and crossing the river along with a golf course and wastewater treatment ponds.
    - Of this subset of 10 stations, eight of the stations have F-IBI scores that all meet or exceed biocriteria (Table 8). The two stations that have both passing F-IBI scores and one or more F-IBI scores that do not meet biocriteria include 11LS022 and 91LS026, which are located in the lower Beaver River watershed. Station 11LS022 is located near the golf course and WWTP ponds and Station 91026 is located just downstream of where Highway 3 crosses the Beaver River.
- All five stations surveyed for fish communities on the East Branch Beaver River meet or exceed the applicable biocriterion (Table 8). Meeting or exceeding biocriteria demonstrate the presence of healthy biological communities.
    - Station 14LS006, which is located upstream of West Unnamed Creek, through which the Milepost 7 diversion ditch discharges, has the highest F-IBI score of 75. Station 14LS005, which is located just downstream of that tributary has the second highest F-IBI score of 60, even higher than the headwaters station (91LS029), which has a F-IBI score of 52 Table 8 and Figure 17).

### 8.1.1 Fishes Bioassessments Stressor Identification

Based on the F-IBI scores, the MPCA included the Beaver River as an impaired water on Minnesota's 303(d) list in 2014 for fishes bioassessment (MPCA, 2018). Following the impairment listing, in 2017 the MPCA evaluated stressors and potential stressors for the Beaver River (MPCA, 2017) as applicable to the fishes bioassessment impairment. The Beaver River is also listed as impaired for pH, turbidity, and mercury in the water column as part of the statewide mercury TMDL. Based on the stressors identification study, it is clear that the fishes bioassessment, pH, and turbidity impairments are primarily localized to the lower third of the Beaver River, where land use changes and geomorphology play a significant role as the stressors for these listings (MPCA, 2017, pg 86). The stressors confirmed by the MPCA include: elevated water temperature, elevated turbidity/total suspended solids, and poor habitat, which demonstrate that

some of these impairments are interrelated. The identified stressors and their relationships with the fishes bioassessment impairment as described by the MPCA (2017) are summarized as follows:

- Water temperatures in the lower third of the Beaver River (downstream of Highway 3) are the warmest in the waterbody and can be classified as marginal to poor for supporting coldwater taxa. Warmer water temperatures correspond with the lower F-IBI indices and are identified as a contributing cause for the fish bioassessments impairment. The Milepost 7 discharge channel was the only location that did not have documented water temperatures exceeding the lethal threshold for coldwater fish (MPCA, 2017, pg 35).

- Clay streambanks in the Lower Beaver River result in higher turbidity (another impairment for the watershed), which in turn may also promote higher stream temperature. Roads, stream crossings, trails, ditches, residential development, and bank erosion can all contribute to turbidity. Elevated TSS concentrations were documented during high to mid-range flows and mostly in the lower half of the Beaver River. The presence of sensitive fish in the lower Beaver River suggests that the magnitude and duration of exposure to TSS is not severe enough to completely shift the fish community to highly tolerant taxa. Therefore, while elevated TSS concentrations are spatially linked to lower F-IBI scores, the causal relationship is not extremely strong (MPCA, 2017, pgs 97-98).

- For dissolved oxygen (DO), some results have been below the 7.0 mg/L standard, but they are typically below the standard for short periods of time, so DO was determined to not be a stressor contributing to fish impairment in the Beaver River (MPCA, 2017, pgs 47-48).

- The Beaver River was listed as impaired for elevated pH during the 2002 water quality assessment process. Although the entire reach was listed as impaired, elevated pH levels were only observed in the lower third of the river. The discharge entering from the Milepost 7 tailings basin has a stabilizing effect on the pH levels in the Beaver River and was determined to not be directly responsible for elevated pH levels. Elevated pH could be related to an increase in primary production from abundant plant and algae growth, which removes carbon dioxide, resulting in elevated pH. No major changes in the fish community were linked to an altered pH regime, so there is not a definitive link between the fish bioassessment impairment and pH (MPCA, 2017, pgs 67-68).

- Habitat assessments and lack of connectivity in the Beaver River show that habitat influences fish bioassessments. There is a wide variation of habitat on the Beaver River. Several monitored locations show that the Beaver River has physical habitat that is a stressor for trout and other sensitive fish species.

    - The best habitat scores are in reaches with steeper gradients (0.5-2.2 percent), moderately entrenched valleys, and forested riparian corridors (MPCA, 2017, pg 71).

    - The lowest habitat scores occur in reaches with lower gradients (0.06-0.2 percent) and slightly entrenched valleys (MPCA, 2017, pg 71).

- In addition, the lack of connectivity also influences fish bioassessment impairment:
    - Natural barriers, including impassable waterfalls, are present in the watershed. Eight major waterfalls are identified on the Beaver River, with many other smaller waterfalls that serve as natural barriers to some species under certain flow regimes. Most notably, several large waterfalls are located just upstream from mouth of the Beaver River, which effectively ends the migration of lake-run fish 0.2 miles upstream from Lake Superior. The next 3.6 miles of the Beaver River upstream from that point is naturally isolated by Glenn Avon falls at River Mile 3.8, which naturally renders that reach fair to poor for coldwater fish habitat, which is a natural occurrence and cannot be improved through human intervention (MPCA, 2017, pgs 81-82).
    - Culverts, beaver dams, and other natural features also provide barriers for fish migration. The MPCA (2017, pgs 81-82) documented over 30 old and active beaver dams on the Beaver River, mostly in the middle to upper reaches, which can result in increased fine substrates, lower DO, and higher temperatures.

### 8.1.2 Fish Biological Monitoring Summary

Fish biological data from the Beaver River support the presence of healthy fish communities in the upper Beaver River watershed as evidenced by all stations in approximately the upper 17 miles of the river meeting fish biocriteria (Table 8 and Figure 17). Some locations in the lower Beaver River watershed have fish communities that result in lower F-IBI scores, which are partly attributed to naturally limiting factors, including geomorphology, and side-channel habitat (MPCA, 2017, pf 75), but are not attributable to water quality. Fish surveys indicate the river supports sensitive coldwater species such as the mottled sculpin, brook trout, and rainbow trout and habitat supportive of these communities. At least one F-IBI score at each station, with the exception of station 14LS001, meets or exceeds biocriteria. The impairment for fishes bioassessment, although listed for the entire Beaver River, is limited to the lower third. For the majority of the stream, healthy, coldwater fish communities are present. In the lower third of the Beaver River, natural conditions limit fish movement and refuge, including: impassable barriers and lack of tributaries. Fish biological data from the East Branch Beaver River support the presence of healthy fish communities throughout its length as evidenced by all stations meeting fish biocriteria (Table 8 and Figure 17).

## 8.2 Macroinvertebrates Biological Monitoring

The MPCA conducted macroinvertebrate surveys between 1997 and 2015 to develop M-IBI scores for each survey location (MPCA, 2014c). Table 8 includes a summary of M-IBI data for the Beaver River and East Branch Beaver River from the MPCA's biological surveys. Based on personal communication with the MPCA, M-IBI scores retrieved from the MPCA's online surface water viewer database reflect the MPCA's latest M-IBI methods and algorithms (Personal communication, 2018), as such data from the online surface water viewer database are used in lieu of data presented in the older published reports.

A summary of the results of M-IBI data collected by the MPCA (2017) between 1997 and 2015 is as follows:

- Of the nine stations surveyed for macroinvertebrates on the Beaver River, eight of the surveys meet or exceed the applicable biocriteria. Meeting or exceeding biocriteria demonstrates the presence of healthy biological communities.
    - Station 94LS001, located in a lower reach of the Beaver River (approximately 1.25 miles upstream of Hwy 61), is the only station that does not have an M-IBI score that meets or exceeds the applicable biocriterion, which includes one survey in 2011 and one in 2015. The M-IBI scores for station 94LS001 were both 20, which is 12 points short of the applicable biocriterion threshold of 32. Hilsenhoff Biotic Index (HBI) scores at Station 94LS001, derived from macroinvertebrate surveys, indicated "good" water quality while the channel slope is 0.2 percent.
    - All other stations sampled for macroinvertebrates meet applicable biocriteria, demonstrating healthy and above average macroinvertebrate communities (Table 8 and Figure 18).
- Of the two stations surveyed for macroinvertebrates on the East Branch Beaver River, neither meets the applicable biocriteria, including a survey in the relatively undisturbed headwaters (Station 91LS029) and a survey on the steep lower reach (Station 11LS026) (Table 8 and Figure 18). The habitat at Station 91LS029 was also evaluated and determined to be in good condition, but the channel stability was rated moderately stable. Station 91LS029 is located just upstream of a road crossing, which likely played a role in the lower scores. Station 11LS026 was also rated for channel stability with a rating of "stable."

### 8.2.1 Hilsenhoff Biotic Index (HBI)

The MPCA used macroinvertebrate surveys to calculate HBI scores for each survey location. HBI scores for each location are included in Table 8. The HBI is a standard metric for assessing water quality through benthic macroinvertebrates and indicates a pollution tolerance index used to evaluate water quality (Hilsenhoff, 1987). The rating system is used to evaluate water quality based on HBI scores, which ranges from zero (intolerant organisms and excellent water quality) to 10 (tolerant organisms and very poor water quality).

HBI scores at the sites surveyed for macroinvertebrates ranged from 3.0 ("excellent") to 5.8 ("fair"). All of the nine surveyed Beaver River sites had at least one score that fell within the "very good" to "good" score range. Only one survey on the Beaver River (91LS026 in 2015) received a score above 5.5; this survey received a score of 5.8 ("fair"). Station 91LS026 is located upstream of the WTP discharge and downstream of reach affected by historic watershed diversion, but in a location where the stream gradient is relatively flat at 0.1 percent. On the East Branch Beaver River, Station 11LS026 received a score of 4.7 ("good"), while the headwaters Station 91LS029 had a score of 6.0 ("fair").

### 8.2.2 Macroinvertebrate Biological Monitoring Summary

M-IBI scores, with the exception of station 94LS001, meet or exceed the applicable biocriteria. Station 94LS001 is in the Lower Beaver watershed, and thus may experience similar stressors to fish in this portion

of the watershed. HBI scores indicate good to excellent water quality, with the exception of one survey that indicated "fair" water quality. These data and metrics demonstrate that the Beaver River is biologically a functioning stream system. M-IBI scores in the East Branch Beaver River do not meet applicable criteria, indicating deficiencies that may be related to nearby roads and development.

## 8.3 Habitat and Stream Stability

In 2011 and 2014, the MPCA used the Minnesota Stream Habitat Assessment (MSHA) and Channel Condition and Stability Index (CCSI) tools to evaluate habitat health and stability of the Beaver River for the Lake Superior WMAR (MPCA, 2014a and MPCA, 2017). MSHA and CCSI scores, presented in Table 8, indicate the Beaver River and East Branch Beaver River provide a range of stream habitat and stability conditions with some diverse habitat suitable for aquatic communities.

### 8.3.1 Minnesota Stream Habitat Assessment

The MSHA tool includes a variety of scoring categories, including land use, riparian zone, instream zone (substrate, embeddedness, cover types and amounts) and channel morphology (depth variability, sinuosity, stability, channel development, velocity). Scores from each category are summed for a total maximum score of 100 points; lower scores indicate "poor" habitat, while higher scores indicate "good" habitat. In their 2014 WMAR, the MPCA (2014a) broke out the range of MSHA scores into three categories: good, fair, and poor with scores over 66 rated as good, scores less than 45 rated poor, and scores in-between rated fair. The "good" rating was established as scores above the median of the least-disturbed stations and the "poor" rating was established as below the median of the most-disturbed stations (MPCA, 2014a). As part of that study, the MPCA evaluated four sites on the Beaver River in 2011 and rated all as having "good" habitat, while one site was evaluated on the East Branch Beaver River, which was also rated "good" (Table 8). During the stressor identification study, the MPCA evaluated stream habitat characteristics at additional locations on the Beaver River, and reported results in a different manner. Instead of reporting MSHA scores in the previously established categories: good, fair, and poor; the MPCA (2017, pgs 22, 178) set-up grading categories based on splitting MSHA scores from over 1,000 streams throughout northeastern Minnesota into 10 equal groups and then arbitrarily combining those groups to establish 5 categories, assigning them to letter grades from A to F. The letter grade "A" was assigned the highest 10 percent of scores, the letter "B" was assigned the next lowest 20 percent of scores, the letter "C" was assigned the next 30 percent of scores while letters "D" and "F" were each assigned the next lowest 20 percent of scores (MPCA, 2017, pg 178). This grading system provides no direct indication of habitat quality like the previous ratings did, because the primary intent was to represent the range of scores in the region and to identify the top ten percent of sites as potential reference sites. Utilizing that 2014 rating system that was based on habitat quality, all stations on the Beaver River except Station 94LS005 (just upstream of Highway 3) had habitats rated good (Table 8 and Figure 27). In addition to Station 94LS005, two stations in the lower reaches (Stations 97LS055 to 11LS022) scored in the 60s and also have low stream gradients ranging from 0.1-0.2 percent, which are noted by MPCA (2017, pgs 71, 74, and 75) for correlating with lower habitat scores where sediment inputs, fine substrates, and embeddedness limit physical habitat.

### 8.3.2 Channel Condition and Stability Index

The CCSI tool evaluates the upper banks, lower banks, and channel bottom of the stream to evaluate the geomorphic stability of the stream reach. The CCSI tool is used to provide an indication of stream channel geomorphic changes and loss of habitat quality due to changes in watershed hydrology, stream gradient, sediment supply, or sediment transport capacity (MPCA, 2014a). The CCSI tool uses a score range of 13-137; lower scores indicate a "stable" stream channel, while higher scores indicate an "unstable" stream channel. Table 8 shows that three of the five sites surveyed on the Beaver River received "stable" CCSI scores (Stations 94LS001, 11LS022, and 94LS007) and the other two sites surveyed received "fairly stable" CCSI scores (Stations 91LS026 and 11LS027). The two sites evaluated on the East Branch Beaver River included Station 11LS026 in the lower reach, which was rated "stable" and the headwaters station (91LS029), which was rated "moderately stable" (Table 8). The "fairly stable" scores correspond to lower F-IBI scores. While station 11LS027 has a "fairly stable" CCSI score and has a passing F-IBI, it is one of the lower passing scores and is located in the undeveloped headwaters of the Beaver River, but just downstream of a road crossing. The other station 91LS026, which has a "fairly stable" CCSI score, has one F-IBI score that is lower than the biocriterion and the most recent F-IBI score that exceeds the upper confidence limit. This station also corresponds to the one location with an HBI rating of "Fair." Station 91LS026 is located upstream of the WTP discharge location and downstream of the historic watershed diversion alterations, but is also located just downstream of a road crossing.

The stressor identification studies (MPCA, 2017, pgs 85-86) attributed the fishes bioassessment stressors, in part, to channel instability resulting from historical land use changes in the watershed, including, but not limited to, increased impervious surfaces, changes in forest cover as a result of turn-of-the-century logging, and the rerouting of Big and Little Thirtynine Creeks to the Beaver River during the construction of the Milepost 7 Tailings Basin. The MPCA (2017, pg 75) noted that stream habitat degradation within the Beaver River watershed is generally localized to areas with low stream gradients and high sediment supply, typically resulting from bank erosion. They conclude that physical habitat degradation is a stressor within two reaches of the Beaver River, from Station 91LS026 to Station 97LS010 (upstream of the WTP discharge) and within the downstream reach, from Station 11LS022 downstream (MPCA, 2017, pg 76) (Figure 9). The remainder of the Beaver River is noted as having physical habitat supportive of a coldwater fishery (MPCA, 2017, pg 76). Potential channel instability remediation options provided by the MPCA (2017) include stream restoration efforts and/or infrastructure improvements, which could result in improved habitat.

## 8.4 Direct Impacts

While the project will directly impact 5,040 linear feet of remnant streams, effects to related fish and macroinvertebrates will be limited. The remnant reaches of Big and Little Thirtynine Creeks proposed to be impacted have fish and macroinvertebrate IBI scores that are well below applicable criteria. The F-IBI score for the remnant Big Thirtynine Creek is 19 and the F-IBI score for the remnant Little Thirtynine Creek is 16, both nearly 50 percent lower than any other documented fishery in the watershed (Table 8). Four species were documented within each reach and 26-46 individual fish were found, which is 6-10 percent of the average 472 specimens found in other common era fish surveys within the watershed (Table 7). The M-IBI scores also indicated communities below applicable biologic criteria with a score of 30.6 in Big

Thirtynine Creek and a score of 25 in Little Thirtynine Creek. Both remnant streams had an abundance of tolerant and very tolerant macroinvertebrate species with few to no long-lived species. No other direct impacts are expected to biological stream resources.

## 8.5 Indirect Impacts

The project will result in the impoundment or use for seepage collection of 3,530 linear feet of remnant Big and Little Thirtynine Creeks. The MNSQT assessments of Big and Little Thirtynine Creeks (Appendix I) show that both are rated as "not functioning" for fish and macroinvertebrate communities. Downstream of the project, the modeled flows in the East Branch Beaver River will be 12 percent lower than existing for the 7Q10 low flows, which results in a 0.25 inch reduction in stream water level. The 1.5-year recurrence interval channel forming flow in the East Branch Beaver River is estimated to be reduced by 3 percent while the 100-year flow is modeled to be reduced by 1 percent. MnDNR (2016) found that low flow changes of less than 10 percent are not detectible and will preserve the seasonal variability of the natural hydrology and maintain geomorphology, water quality, connectivity, and biology of the system. MnDNR (2016) also concluded that low flow changes up to 15 percent would preserve stream characteristics most of the time. Given that the low flow change in the East Branch Beaver River is estimated to result in a negligible change to water levels and is less than 15 percent of existing flow, no indirect impacts are predicted to biological resources in the East Branch Beaver River.

For the Beaver River immediately downstream of the confluence with the WTP discharge (Subwatershed 14), the existing 7Q10 streamflow is estimated to be 8.84 cfs, including the 7Q10 flow of 2.71 cfs out of the Lower Middle Beaver River subwatershed (#15) (Table 14 and Appendix C) and the average August discharge from the WTP (from 2000-2019) of 6.1 cfs. With the project, the 7Q10 flow is estimated to be 8.89 cfs, a 0.5 percent increase, including a 0.05 cfs increase in Beaver River flow (Table 14) and the same WTP discharge as existing. The 1.5-year return period streamflows are estimated to be 636 cfs under both existing and future conditions (Table 14 and Appendix C). The 100-year streamflow is also estimated to remain the same in existing and future conditions at 2970 cfs (Table 14 and Appendix C). With no measurable flow change predicted in the Beaver River downstream of the project, no indirect impacts are expected to downstream biological resources.

## 8.6 Cumulative Effects

### 8.6.1 Beaver River

Indices of biological integrity show that the upper Beaver River generally meets or exceeds the established fish and macroinvertebrate IBI biocriteria thresholds. The presence of a coldwater fish community and other indices summarized in Section 8.2 demonstrate that approximately the upper 16 miles of the Beaver River continue to support functioning fishery and macroinvertebrate communities. While the Beaver River is listed as impaired for fish bioassessments and related pH and turbidity; these impairments are largely localized to the lower Beaver River where there is a higher impact from land use development and naturally-occurring geomorphological limitations. Related to the Beaver River impairments, the MPCA (2017, pg 117) identified poor habitat, elevated water temperature, and elevated turbidity/total suspended solids as confirmed stressors. One fish survey was completed in 1975 on the

Beaver River prior to construction of the basin. The monitoring location (R-8) is shown on Figure 17 and is located between Stations 94LS003 and 15LS060 at approximately river mile 3.9. The F-IBI score was 45, right at the upper confidence limit and lower or comparable to scores at neighboring stations from recent surveys (Table 8 and Figure 17). No coldwater species were identified in the pre-project survey. Based on one pre-project survey, F-IBI scores are the same or higher within the Beaver River than before basin construction, so no adverse cumulative effects to the fishery are apparent.

The most significant cumulative effect within the Beaver River subwatershed was the diversion of 23.9 square miles of drainage area, encompassing the upper Big and Little Thirtynine Creeks, into a localized segment of the Beaver River (Subwatershed 11, Upper Middle Beaver River) approximately 3.2 miles upstream from the historic confluence. This diversion occurred in the late 1970s to early 1980s with the construction of the Milepost 7 Tailings Basin and approximately doubled the drainage area to that 3.2 mile reach (Subwatershed 11) of the Beaver River (Table 1). The MPCA (2017, pgs 85-86) suggests that higher flows have occurred in the Beaver River due to the watershed diversion as well as extensive turn-of-the-century logging, which reduced transpiration rates and increased snowmelt, runoff, and peak flows. The MPCA (2017, pg 86) suggests that increased flows have triggered an evolutionary process of channel forming to adjust to increased flow events. As the river adapts to increased flows, it incises, widens, aggrades, and overall stream bank and bed erosion occurs, resulting in a loss of fish cover as streambanks erode and logs are carried downstream on higher flows (MPCA, 2017, pg 86). The increase in sediment supply and aggradation results in burying of gravel and cobbles important for fish spawning (MPCA, 2017, pg 74). While fish and macroinvertebrate communities have thrived in this reach, the MPCA (2017, pgs 161-163) has identified three specific locations where stream restoration work may reduce cumulative biological effects.

Modeling streamflows under historic and current conditions using the USGS regression equations developed for this region of Minnesota (Lorenz et al., 2009; Ziegeweid et al., 2015) suggest potentially differing streamflow responses to historic activities within the watershed. Low flows (7Q10) within the Beaver River into Subwatershed 11 are estimated to have increased from 0.84 cfs under historic conditions to 1.85 cfs under existing conditions (Table 14 and Appendix C). This increase is predicted because low flows are predominantly driven by watershed area, the extent of wetlands and lakes within the watershed, and the extent of soils in the "C" Hydrologic Soil Group. Of those factors, watershed area is the primary component that has changed from historic to existing conditions. Channel forming flows (1.5-year recurrence interval) into Subwatershed 11 are estimated to have remained similar under existing conditions (473 cfs) compared to historic conditions (509 cfs). The USGS found that channel forming flows in this region are predominantly driven by watershed area and extent of ponds and lakes within the watershed. Review of current conditions compared to historic conditions in the watershed suggests that the prevalence of beaver impounded ponds has increased in recent times compared to historic, which accounts for the prediction that flows in the Beaver River at Subwatershed 11 have not increased significantly, despite the increase in watershed area.

The Milepost 7 WTP (SD1-S010) discharge promotes lower temperature, which is beneficial for the coldwater community, and of the stations sampled for temperature on the lower Beaver River by the MPCA, SD1-S010 was the only location that did not have temperature values exceeding the threshold for

coldwater taxa (MPCA, 2017, pg 35). As evidence of this, mottled sculpin, a coldwater indicator species, was documented to be more abundant downstream of the SD1-S010 discharge than upstream. With the SD1-S010 discharge's ameliorating effect on stream temperature, particularly during low flow periods, it is not a contributing factor to thermal loading (MPCA, 2017, pg 42). The discharge entering from the Milepost 7 WTP also has a stabilizing effect on the pH levels in the Beaver River (MPCA, 2017, pg 63). Discharges from the WTP have complied with pH standards for coldwater streams and at times are lower than that of the Beaver River upstream (MPCA, 2017, pg 64), so the continued WTP discharge is not expected to result in an adverse cumulative effect on stream pH, temperature and related biological effects.

The MPCA (2017, pg 67) concluded that the Milepost 7 WTP discharge does not appear to have a direct impact on fish taxa richness immediately below the discharge point, as taxa are very similar just above and below that point (Stations 15LS061 and 15LS060) (Tables 7 and 8 and Figure 17). They also concluded that the Milepost 7 WTP discharge does not appear to have a direct impact on the macroinvertebrate community as evidenced by the station below the discharge (15LS060) meeting the exceptional use standard with a score of 56 and the station above the discharge (15LS061) being slightly lower with a score of 47 (MPCA, 2017, pgs 59-60) (Table 8 and Figure 18). The Milepost 7 WTP discharge occasionally contributes approximately 50 percent of the baseflow to the lower Beaver River, minimizing critical habitat reductions and providing beneficial biological support. There is no apparent adverse cumulative effect on biological communities from the Milepost 7 WTP discharge.

### 8.6.2 East Branch Beaver River

Biological data has identified that coldwater biological communities are present in the East Branch Beaver River. The second highest F-IBI rating measured within the East Branch Beaver River since tailings basin operations started is at the outlet from the 2005 Diversion Ditch at monitoring Station 14LS005 with an F-IBI of 60 (Table 8 and Figure 17) at approximately river mile 3.8 (Table 4). This indicates that the discharge water quality and volume is conducive to supporting a coldwater fishery. One fish survey was completed in 1975 on the East Branch Beaver River prior to construction of the basin. The pre-project F-IBI score was 88, which is slightly higher than the score at Station 14LS006 just upstream of 75 (Table 8 and Figure 17). Two coldwater species were identified, including 10 brook trout and one mottled sculpin.

Macroinvertebrate communities within the East Branch Beaver River are functioning below applicable biocriteria, both in the relatively undisturbed headwaters as well as in the lower reaches. With only two data points, it is difficult to draw conclusions on the entire river. No specific causes for diminished macroinvertebrate communities within the East Branch Beaver River have been specifically suggested by MPCA (2017), but several factors could contribute including: improperly sized or placed culverts at road crossings, excessive sediment, and a lack of old growth timber that can provide valuable habitat (MPCA, 2017).

The project will reduce the drainage area to the East Branch Beaver River by about 2 square miles, resulting in a 0.25 inch change in water level for the 7Q10 flow, a 3 percent reduction in channel forming flow, and a 1 percent reduction in 100-year peak flow. Reduced peak flows reduce the likelihood of bank erosion and downstream sedimentation.  Sedimentation has been listed as a significant stressor on the

macroinvertebrate and fishery.  Reduced sedimentation should then have a positive or neutral impact on the availability of habitat for macroinvertebrates and fish.

# 9 Water Quality

Beaver River water quality has been monitored by the MPCA at 16 surface water monitoring stations with sample dates ranging from 1973 through 2019 as part of an overall watershed monitoring assessment report (WMAR), stressor identification, and total maximum daily load (TMDL) development for the Lake Superior South Watershed (MPCA, 2017), including the Beaver River watershed. Northshore collects water quality data in accordance with the National Pollutant Discharge Elimination System/State Disposal System (NPDES/SDS) Permit from two monitoring locations on the Beaver River (SW002 and SW003) and two locations on the East Branch Beaver River (SW001 and SW004) on a quarterly basis. In addition, Northshore collects water quality data from their WTP (SD1-S010) discharge at intervals that differ for each parameter based on their NPDES/SDS permit. The locations of the surface water quality monitoring stations are described in Tables 3 and 4 and shown on Figure 9, which includes pre-project monitoring conducted by Reserve Mining at stations that start with the letter "R".

The entire dataset from publicly available records is included as Appendix A. Water quality data are depicted graphically for the Beaver River continuous monitoring station downstream of the tailings basin (Station S000-252) on Figures 19-23, generally including data from 1973 through 2015. Water quality data from all monitoring locations as compared to current water quality standards are also included in Table 9 for the Beaver River and Table 10 for the East Branch Beaver River.

Data have been collected by the MPCA as part of an overall watershed assessment and to identify the principal causes or stressors contributing to impaired fish and aquatic macroinvertebrate communities in the Beaver River. Those principal water quality stressors identified were elevated water temperature and elevated total suspended solids/turbidity. Other parameters were evaluated but were either eliminated outright or did not have enough information to identify them as confirmed stressors.

Potential changes to water quality resulting from loss of wetland functions due to unavoidable impacts from the proposed project will be expressed either as a result of the watershed changes proposed to the East Branch Beaver River watershed, or expressed in the form of the discharges from the Northshore WTP as a controlled outflow from the wetland-impact regions incorporated into the tailings basin watershed. The estimated streamflow in the East Branch Beaver River downstream of the project (at the confluence with West Unnamed Creek) are projected to decrease from 341 cfs under existing conditions to 330 cfs with the project (3 percent reduction) for the 1.5-year recurrence interval, channel forming flow (Table 14) and to decrease from 1,780 cfs under existing conditions to 1,760 cfs with the project (1 percent reduction) for the 100-year recurrence interval. The estimated streamflow in the Beaver River downstream of the project (into Subwatershed 16) is estimated to stay the same as existing for both the 1.5-year and 100-year recurrence intervals (Table 14), because operation of the WTP will follow the same operating protocols as today.

## 9.1 Water Temperature

The Beaver River and East Branch Beaver River are both classified as Class 2A waters and are designated trout streams, with the ability to support coldwater fish species. The MPCA (2017) discussed commonly

accepted water temperature ranges for northeastern Minnesota streams that support the growth of coldwater fish species along with water temperature ranges that can induce stress in fish or be lethal to fish under prolonged exposure. The ideal temperature range for the growth of brook trout is 7.8-20 °C, the range where stress is induced is 20-25 °C, and temperatures over 25 °C for prolonged periods can be lethal (MPCA, 2017). Factors controlling stream water temperature are complex, but include: air temperature, geology, shading, and water inputs from tributaries and springs. Some of the human activities can affect stream temperatures include: altering riparian vegetation, urban runoff, agricultural runoff, reduced water storage and baseflow, and warm wastewater discharge (MPCA, 2017). Warmer stream water affects reproduction and growth in coldwater adapted species, resulting in a competitive advantage for non-coldwater species.

The MPCA (2017) completed detailed stream temperature monitoring in 2011 and 2013-15. They found that upstream of Highway 3 (Station S006-273), there was little temperature variation in the Beaver River with high quality physical habitat and no temperature values exceeding the lethal threshold. Figure 21 shows summer water temperatures in the Beaver River approximately 0.75 mile downstream of the Northshore WTP discharge (Station S000-252) from 1973 to 2015, including approximately 12 years before the tailings basin discharged water to the Beaver River (which started about 1985), along with several summer temperature readings from the Northshore WTP discharge in 2003 (the only available temperature data). Those data do not show a warming trend within the Beaver River and only sporadic exceedances of the upper threshold, including prior to the tailings basin construction in the late 1970s or initiation of the WTP discharge to the Beaver River in about 1985. Limited stream water temperature monitoring conducted by Reserve Mining in 1975, prior to constructing the tailings basin (Station R-8, Figure 8), showed one temperature reading exceeding the upper threshold. While the Northshore WTP discharge temperature data is limited, the available data indicate slightly lower temperatures than in the Beaver River during the same timeframe. The MPCA (2017) conducted continuous temperature monitoring within the Beaver River and the Northshore WTP discharge and concluded:

> *"During this monitoring period, the continuous discharge from the Milepost 7 tailings basin significantly reduced the daily temperature flux observed in the Beaver River downstream of the outfall. Daily maximum and minimum temperatures downstream of the discharge were often several degrees cooler during the daylight hours and warmer during nightfall than observations upstream of the discharge."*

The MPCA (2017) concluded that the WTP discharge is not a major source of thermal loading. Because the Northshore discharge regime will continue as in the past, no adverse biological effects are expected from the project.

In the East Branch Beaver River, water temperatures have been monitored on a limited basis (Table 10). Stream water temperatures at about 55 percent of monitoring stations on the East Branch Beaver River have had at least one occurrence within the stress range for coldwater fish species, including in the upper part of the watershed (Station 14LS006), with a slight temperature increase apparent in the downstream reach (Stations 11LS026 and 14LS004) (Table 10, Figure 9). The project will eliminate runoff to the East Branch Beaver River from approximately 2 square miles of project area watershed. The majority of that

runoff occurs as overflow from Murphy's Pond, which detains streamflow from Big and Little 39 Creeks as well as runoff from the watershed, before overflowing. Because Murphy's Pond is large, open water pond, it is exposed to solar radiation, and the intermittent overflow to the East Branch Beaver River has potential for elevated water temperatures. Given that the discharge from Murphy's Pond is intermittent, and flows from West Unnamed Creek will contribute only 5-9 percent of the East Branch Beaver River flows, any potential effects on stream temperature are expected to be minimal. With the reduction in drainage area and elimination of discharge from the detention pond to the East Branch Beaver River, it is not expected that stream water temperatures downstream of the basin will be substantially altered, so no effect is predicted to coldwater species.

## 9.2 Dissolved Oxygen

Dissolved oxygen (DO) is the concentration of oxygen gas within the water column, which is important for the growth and reproduction of aquatic life (MPCA, 2017). Oxygen enters the water column from the atmosphere through diffusion, which is enhanced by turbulent flows and also through photosynthesis (MPCA, 2017). Factors involved in DO concentrations include: climate, topography, hydrologic pathways, water chemistry, temperature, and biological productivity (MPCA, 2017). Typically, the critical period for DO in supporting aquatic organisms is in late summer when water temperatures are high and flow volumes are near base flow (MPCA, 2017). Low DO concentrations or highly fluctuating DO concentrations can have detrimental effects on many fish and macroinvertebrate species (Davis, 1975; Nebeker, 1991). The MPCA (2017) has established a DO daily flux stressor threshold value of 3 mg/L, which means that when DO levels fluctuate by more than 3 mg/L/day, sensitive aquatic organisms can be stressed. The DO standard for Class 2A (coldwater) streams is 7 mg/L as a daily minimum.

A total of 28 monitoring stations on the Beaver River have collected summer DO data (Table 9). None of that data included any average summer DO levels below the 7 mg/L standard and only one individual reading was below the standard, which occurred at Station S007-357, in the Beaver River headwaters. Low flows and the presence of extensive wetlands and beaver impoundments are the primary contributors to low DO levels in the headwaters. DO levels have been monitored approximately monthly from 1973 – 2015 (with a few gap years) at Station S000-252 (Figure 9), approximately 0.75 mile downstream of the Northshore WTP discharge. The recorded DO levels are shown on Figure 23, which appear to be consistent throughout the 42 year period with more consistent concentrations above about 8 mg/L since 1989 and no readings below the water quality standard since 1976, before the construction of the tailings basin. Through their stressor study, the MPCA (2017) concluded that DO is not a biological stressor within the Beaver River. The MPCA (2017) also found that the WTP discharge actually dampens daily DO flux by about 2 mg/L, which is beneficial to aquatic organisms. The WTP discharge also minimizes low flows within the Beaver River, which is one of the primary periods when low DO concentrations occur. Therefore, because the project will continue to operate similar to the current operation, including the WTP, it is expected to have beneficial biological effects in downstream waters related to DO and DO flux.

A total of 10 monitoring stations on the East Branch Beaver River have collected summer DO data (Table 10). None of that data included any average summer DO levels below the 7 mg/L standard and only two individual readings were below the standard, which occurred at Station R-4 (Figure 8) in 1975, prior to the

construction of the tailings basin. None of the data indicate any potential adverse effects from the current operation of the tailings basin.

## 9.3 pH

The acidity or alkalinity of water is measured on a logarithmic scale called pH, which ranges from 0 to 14 with 7 being neutral, less than 7 acidic, and greater than 7 basic (MPCA, 2017). Excessive vegetation growth in streams can result in higher pH levels due to the removal of carbon dioxide (MPCA, 2017), which can result in toxic concentrations of the unionized form of ammonia ($NH_3$), which is a common cause of fish kills (USEPA, 2019b). The pH standard for Class 2A (coldwater) streams is within a daily range from 6.5 to 8.5 (MPCA, 2017). Human effects on pH values can result from agricultural and urban runoff and industrial discharges (U.S. EPA, 2019b). Natural factors affecting pH include: geologic conditions and photosynthesis (MPCA, 2017). The Beaver River was listed as impaired for elevated pH in 2012 based on observations in the lower third of the river.

Stream pH data is available from 30 stations on the Beaver River from which annual summer averages are presented in Table 9. Summer annual average pH values have fallen outside the water quality standard range at two stations, 15LS061, which is located just upstream from the Northshore WTP discharge and S106/SW003, which is located approximately 0.75 mile downstream of the WTP discharge (Table 9 and Figure 9). Approximately monthly pH values have been recorded from 1973-2015 at Station S000-252, the same general location as S106/SW003 (Figure 9). Those pH values are shown graphically in comparison to the Northshore WTP discharge pH on Figure 20. Monitoring of the WTP discharge over the last 19 years has shown consistent pH levels in the discharge, with an average of 7.5, a minimum of 6.4 and a maximum of 8.4 (Figure 20). The MPCA (2017) concluded that the Milepost 7 basin complies with pH standards for coldwater streams. Continuous monitoring by the MPCA (2017) showed that the pH levels in the basin discharge was lower than the Beaver River at times. They further suggested that groundwater seepage from the Milepost 7 basin or other sources are possible explanations for the elevated pH levels in the Beaver River. However, the suggestion of the basin as a possible explanation does not align with the relative rates of seepage from the basin as compared to the rates of discharge from the basin WTP. Seepage is estimated to be <10 percent of the basin WTP discharge, which has an average pH of 7.5 S.U. During low-flow conditions, the discharge from the Northshore basin WTP makes up a substantial portion of the flow in the Beaver River and would not contribute to elevated pH conditions.

The MPCA (2017, pg 64) concluded that discharges from the WTP have complied with pH standards for coldwater streams and at times are lower than that of the Beaver River upstream, so the continued WTP discharge is not expected to result in an adverse cumulative effect on stream pH. The pH data collected in the Beaver River downstream of the basin at Station S000-252 by MPCA apparently ceased after 2015, but the last three years of data indicated that the river was within the water quality standards (Figure 20). With no changes expected to the WTP operation or seepage collection system with the project, no adverse water quality effects are expected in the Beaver River.

A review of the past 10 years of monitoring data for pH on the East Branch of the Beaver River (see Table 10) indicates pH values of the river consistently within the levels prescribed by the water use classifications

for this water body. In particular, the monitoring stations prescribed by Northshore's NPDES permit show similar pH values from upstream to downstream of the input from West Unnamed Creek where diversion water from the northwest of the basin is routed into the East Branch Beaver River (7.8 and 7.6, respectively as 10-year average values). With no substantial change in pH values within the East Branch Beaver River from upstream to downstream of the 2005 Diversion Ditch discharge, and a slight reduction in estimated streamflow, the project is not anticipated to affect pH values in the East Branch Beaver River.

## 9.4 Total Suspended Solids

Erosion and sedimentation is one of the leading water quality issues affecting stream biological impairment in the U.S. (USEPA, 2019b). Human activities have been shown to increase sediment entering rivers and streams since European settlement in about 1830 (Triplet, 2009; Engstrom 2009). Sediment can come from exposed soil or unstable streambanks, which can result from construction, mining, agriculture, or other activities (MPCA, 2017). Alteration of waterways through channelization, riparian vegetation alteration, and increased impervious surfaces can lead to stream bank instability and sediment input from bank erosion (MPCA, 2017). Excessive sediment in streams can harm aquatic life by two major pathways: 1) direct physical effects (i.e., abrasion of gills, suppression of photosynthesis, and avoidance behaviors), and 2) indirect effects such as loss of visibility and increased sediment oxygen demand (Waters, 1995). Sediment can also result in increased water temperatures, as the darker water can absorb more solar radiation (MPCA, 2017). The Beaver River was listed as impaired for turbidity, for which total suspended solids (TSS) is a surrogate. The TSS water quality standard for Class 2A coldwaters in Minnesota is 10 mg/L.

Stream TSS data is available from 28 stations on the Beaver River from which annual summer averages are presented in Table 9. Summer annual average TSS values have exceeded the water quality standard at five stations (S007-354, S004-955, S014-956, S007-355, and S000-252), all located downstream of the Northshore WTP discharge (Table 9 and Figure 9). Approximately monthly TSS values have been recorded from 1973-1994, 2002-2010, and a few times a year from 2013-2015 at Station S000-252, the same general location as S106_SW003 (Figure 9). Those TSS values are shown graphically in comparison to the monthly Northshore WTP discharge TSS on Figure 19. Comparing TSS concentrations from prior to construction of the tailings basin and prior to discharge from the WTP, which started in about 1985, through 2015, there have been fewer exceedances of water quality standards and no material increase in TSS concentrations. The Milepost 7 WTP discharge has had no permit exceedances for TSS during its operation.

Sources of sedimentation are difficult to pinpoint, particularly over long periods of time. The MPCA (2017) identified several land use changes that may contribute to the TSS impairment, including: clear-cut forest harvesting in the early 1900s; increased road density, ditching, and stream crossings; residential development; mining practices; and watershed alterations. In their detailed study of TSS within the Beaver River watershed from 2008-2015, MPCA (2017) found increasing TSS towards the mouth of the Beaver River with more than 10 percent exceedances, but also exceedances at all four stations on the West Branch Beaver River as a contributing factor. Analysis of a snowmelt event in May 2013 was used to determine stream reaches with the highest contribution rates (MPCA, 2017). What they found was that the

highest sediment contribution rate was from the Cedar Creek subwatershed (Subwatershed 5), followed by the West Branch Beaver River, with the East Branch Beaver River reach from Station S007-259 to Station S007-603 (Figure 9) at a slightly lower contribution rate. Sediment contribution rates on the Beaver River from the Big Thirtynine confluence (Station S007-356) to Station S006-273 were one-third or less of the West Branch Beaver River and East Branch Beaver River rates (MPCA, 2017). That reach of the middle Beaver River also has more sensitive fish taxa than upstream of the Big Thirtynine confluence (MPCA, 2017). The MPCA (2017) concluded, "The presence of several sensitive fish species in the lower Beaver River suggests that the magnitude and duration of TSS exposure is not severe enough to cause a complete shift in the fish community towards highly tolerant taxa" (MPCA, 2017). They also suggested that there is not an extremely strong causal relationship between TSS and impaired conditions, but that in combination with elevated water temperatures and habitat degradation; TSS could not be ruled out as a possible stressor.

Operation of the project adjacent to remaining wetlands will be conducted with best management practices that will be established in accordance with Minnesota's stormwater construction permitting program to prevent erosion and sedimentation to those remaining wetlands. Further, all watershed flows interior to the project area will be captured in the tailings basin and treated in the WTP prior to discharge to the Beaver River. The project will not increase discharge rates to the Beaver River, which is the primary trigger for elevated TSS loads. Considering the consistently low TSS concentration in the WTP discharge, and no planned increase to discharge rates above what is currently permitted, the project is not expected to result in adverse biological or water quality effects on the Beaver River due to TSS.

The project will reduce the watershed area of the East Branch Beaver River by 4.1 percent from current conditions (Table 1) and will reduce streamflows to the East Branch Beaver River by 1 percent for the 100-year event and 3 percent for the 1.5-year recurrence intervals (Table 14). The reduced flows are anticipated to have at least a neutral effect on TSS concentrations in the East Branch Beaver River by slightly reducing peak flow rates in the river.

## 9.5 Nutrients

Phosphorus (P) is the primary plant nutrient of concern for waterways, which is typically limited in the natural environment (MPCA, 2017). Use and export of P by humans can impact aquatic organisms. Nutrient sources may include: agriculture, animal waste, fertilizer, industrial or municipal wastewater discharges, septic systems, and urban stormwater runoff (MPCA, 2017). Elevated P levels can lead to excessive plant growth, which can affect habitat, food resources, and oxygen levels in streams. The Class 2A water quality standard for P is 50 µg/L.

Stream P data is available from 23 stations on the Beaver River from which annual summer averages are presented in Table 9. None of the summer annual average P values have exceeded the water quality standard (Table 9). Approximately monthly P values have been recorded from 1973-1994, 2002-2010, and a few times a year from 2013-2015 at Station S000-252, the same general location as S106 (Figure 9). Those P values are shown graphically in comparison to the water quality standard on Figure 22. Prior to construction of the tailings basin, during the monitored period 1973-1980, P concentrations in the Beaver

River at Station S000-252 averaged 59.9 µg/L with 20 samples that exceeded the water quality standard. After the tailings basin was in operation, reviewing a comparable period 1987-1994, P concentrations averaged 26.6 µg/L with 9 samples exceeding the water quality standard. During the most recent period in which monthly data is generally available, 2002-2010, P concentrations in the Beaver River at Station S000-252 averaged 21.3 µg/L with 3 samples exceeding the water quality standard. In general, P concentrations have decreased from the period of time before construction of the tailings basin to recent years, which may be partly due to improved land use practices and regulations since the 1970s. Summer annual average P concentrations in the Beaver River upstream of the Northshore WTP discharge generally range from 5 to 29 µg/L with the highest concentrations in the two headwater stations (11LS027 and S007-357). The lowest P concentration documented along the Beaver River was in 2014 within the Northshore WTP discharge channel (Station S008-005), at 3 µg/L, which is largely reflective of the WTP discharge (Table 9). While Northshore does not measure P concentrations in their WTP discharge, looking at P concentrations in the Beaver River immediately upstream and downstream of the discharge indicates that there is no influence as P concentrations were slightly reduced downstream when monitored in 2014 and 2015 (Table 9). The main location on the Beaver River with elevated P concentrations was just over one mile upstream from Hwy 61 in Station S014-956 with annual summer average concentrations from 2016-2018 ranging from 34-38. These elevated P concentrations are not present within any other station along the Beaver River and appear to be related to localized effects. With no observed elevated P concentrations within the Beaver River, some of the lowest concentrations in the vicinity of the tailings basin, and no major changes to flows or water chemistry anticipated; the project is not expected to have adverse biological effects related to P concentrations in the Beaver River.

A review of recent monitoring data for P on the East Branch Beaver River (Table 10) indicates P values in the river are consistently below the levels prescribed by the water quality standards for this water body. The project will reduce the watershed area of the East Branch Beaver River by 4.1 percent from current conditions and will reduce streamflows to the East Branch Beaver River by 1 percent for the 100-year event and 3 percent for the 1.5-year recurrence intervals (Table 14). Therefore, the project is expected to have no material effect on the phosphorus levels in the East Branch Beaver River.

## 9.6 Cumulative Effects

The construction of the Big Thirtynine diversion channel during development of the tailings basin nearly doubled the drainage area to the 3.2 mile reach of the middle Beaver River in Subwatershed 11, and therefore, had a potential to contribute cumulative effects to downstream water quality. The MPCA (2017) has suggested that this diversion may have contributed to channel widening, incision, stream bank and bed erosion, and habitat degradation downstream. Streamflow modeling suggests that Beaver River discharge rates may have decreased over time due to an increase in beaver impounded ponds within the watershed in recent years (see Section 8.6.2). Evaluation of stream water quality characteristics related to that 3.2 mile reach of the Beaver River do not indicate adverse cumulative effects. A detailed stream water temperature study conducted by MPCA (2017) found that reach of middle Beaver River to have stable water temperatures with no water quality-based temperature standard exceedances. DO concentrations within and adjacent to that reach have been consistently above water quality standards and comparable or better than undisturbed upstream reaches. Data within that reach of the middle Beaver River for pH

have shown no elevated measurements of pH, Northshore's WTP discharge has never exceeded water quality standards for pH, has only been below the standard one time, and the monitoring station just downstream of the WTP discharge has no documented water quality exceedances for pH. Only one exceedance of pH water quality standards was documented in the station just upstream of the WTP discharge (Station 15LS061). The TSS contribution rate for that reach of the middle Beaver River was determined by MPCA (2017, pgs 90-94) to be far less than for portions of the Cedar Creek subwatershed, the West Branch Beaver River, and the East Branch Beaver River, while supporting several sensitive macroinvertebrate and fish species indicative of a coldwater fishery. In an effort to reverse potential historical cumulative effects, Northshore is evaluating several stream restoration projects within the Beaver River watershed.

Construction and operation of the tailings basin has included construction and operation of the WTP, through which all discharge from the project is routed, which has the potential to introduce cumulative water quality effects.

Operation of the tailings basin and WTP has resulted in a relatively constant discharge to the Beaver River, which has maintained baseflow during periods of naturally low flows that has resulted in beneficial effects on stream temperature and DO. Beaver River water temperatures have been shown to fluctuate less and not exceed the lethal threshold immediately downstream of the WTP (MPCA, 2017, pgs 40-42). Because low DO concentrations typically occur during baseflow periods when stream temperatures are the highest, the presence of the WTP discharge helps minimize the potential for low DO in the Beaver River, resulting in a beneficial effect. Water quality data for TSS shows that there is no adverse effect from the WTP discharge because TSS concentrations in the discharge are typically lower than in the Beaver River. With no apparent increase in TSS concentrations in the watershed since before construction of the tailings basin, no cumulative effects are apparent. Data on Beaver River pH have shown an exceedance of water quality standards just above downstream of the WTP discharge, but pH in the WTP discharge has only been outside the water quality limits one time in the last 19 years. The source(s) of pH exceedances downstream have not been identified, but there is no evidence that connects the tailings basin operation.

# 10 Forest Resources

### 10.1.1 Direct Impacts

The project is expected to remove 235 acres of forest for rail and dam construction and 613 acres that will slowly be inundated by tailings storage over several decades for a total of 848 acres affected.

### 10.1.2 Indirect Impacts

No indirect impacts are expected to forest resources. Forests surrounding the existing tailings basin have shown no adverse effects from the nearly 40 years of operating the basin, so no indirect impacts are expected.

### 10.1.3 Cumulative Effects

Compared to pre-settlement conditions, the net decrease in forest resources under future conditions in the study area is approximately 9,013 acres of the original 95,518 acres of forests identified in the 96,000 acre watershed, which represents about 9 percent of the pre-settlement forests in the study area (Appendix B). Over 90 percent of the 9,013 acres is due to past actions in the study area. Compared to existing conditions, the net decrease in forest resources associated with all foreseeable future projects in the study area, would be approximately 848 acres. The net change of forests associated with all foreseeable future projects represents about 1 percent of the existing forest resources within the study area. With over 90 percent of the watershed covered by forest resources, the watershed is more heavily forested than most parts of the state and no cumulative effects area expected.

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# Tables

Table 1
Watershed Summary
Tailings Basin Progression

| Subwatershed/ Receiving Water | ID | Stream Name | Watershed Area (sq mi) | | | % Watershed Change from Pre-Settlement to: | | Cumulative Watershed (sq mi) | | | % Cumulative Watershed Change from Pre-Settlement to: | | % Cumulative Change from Existing to Future |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Pre-Settlement | Existing | Future | Existing | Future | Pre-Settlement | Existing | Future | Existing | Future | |
| East Branch Beaver River | 1 | East Branch Beaver River HW | 26.96 | 26.96 | 26.96 | 0% | 0% | 26.96 | 26.96 | 26.96 | 0.0% | 0.0% | 0.0% |
| | 2 | Big Thirtynine Creek (remnant) | (See #18) | 0.46 | 0 | NA | NA | 17.70 | 0.46 | NA | NA | NA | |
| | 3 | Little Thirtynine Creek (remnant) | (See #17) | 0.11 | 0 | NA | NA | 6.94 | 0.11 | NA | NA | NA | |
| | 4 | West Unnamed Creek | 1.04 | 2.45 | 0.95 | 136% | -8% | 1.04 | 3.01 | 0.95 | 190.6% | -8.4% | -68.5% |
| | | Into Lower East Branch Beaver R. #7 | | | | | | 28.00 | 29.98 | 27.91 | 7.1% | -0.3% | -6.9% |
| | 5 | Cedar Creek | 9.86 | 9.86 | 9.86 | 0% | 0% | 15.93 | 15.93 | 15.93 | 0% | 0% | 0.0% |
| | 6 | Nicado Creek | 6.07 | 6.07 | 6.07 | 0% | 0% | 6.07 | 6.07 | 6.07 | 0% | 0% | 0.0% |
| | 7 | Lower East Branch Beaver River | 4.56 | 4.56 | 4.56 | 0% | 0% | 48.5 | 50.5 | 48.4 | 4.1% | -0.2% | -4.1% |
| | | **Subtotal** | **48.5** | **50.5** | **48.4** | **4.1%** | **-0.2%** | | | | | | |
| Beaver River | 8 | Beaver River HW | 17.08 | 17.01 | 17.01 | 0% | 0% | 17.08 | 17.01 | 17.01 | -0.4% | -0.4% | 0.0% |
| | 9 | Kit Creek | 6.97 | 6.97 | 6.97 | 0% | 0% | 6.969 | 6.969 | 6.969 | 0% | 0% | 0.0% |
| | 10 | Unnamed Creek | 2.20 | 2.20 | 2.20 | 0% | 0% | 2.204 | 2.204 | 2.204 | 0% | 0% | 0.0% |
| | 11 | Upper Middle Beaver River | 0.83 | 1.35 | 1.35 | 63% | 63% | 24.88 | 49.16 | 49.10 | 97.6% | 97.4% | -0.1% |
| | | Into Lower Middle Beaver River #12 | | | | | | 56.4 | 49.16 | 49.10 | -12.9% | -13.0% | -0.1% |
| | 12 | Lower Middle Beaver River | 1.44 | 1.41 | 1.41 | -2% | -2% | 60.1 | 52.78 | 52.72 | -12.1% | -12.2% | -0.1% |
| | 13 | West Branch Beaver River | 9.19 | 9.19 | 9.19 | 0% | 0% | 9.19 | 9.19 | 9.19 | 0% | 0% | 0.0% |
| | 14 | MP7 WTP[1] | 0.00 | 5.00 | 7.13 | NA | NA | 0.00 | 5.00 | 7.13 | NA | NA | NA |
| | 15 | Upper Lower Beaver River (Into #16) | 1.31 | 1.31 | 1.31 | 0% | 0% | 70.56 | 68.27 | 70.34 | -3.2% | -0.3% | 3.0% |
| | 16 | Lower Beaver River | 3.97 | 4.28 | 4.28 | 7.8% | 7.8% | 123.0 | 123.0 | 123.0 | 0.0% | 0.0% | 0.0% |
| | | **Subtotal** | **43.0** | **48.7** | **50.8** | **13%** | **18%** | | | | | | |
| Thirtynine Creek | 17 | Little Thirtynine Creek | 6.94 | 6.57 | 6.51 | -5.4% | -6.2% | 6.94 | 6.57 | 6.51 | -5.4% | -6.2% | -0.9% |
| | 18 | Big Thirtynine Creek | 17.70 | 17.26 | 17.26 | -2.4% | -2.4% | 17.70 | 17.26 | 17.26 | -2.4% | -2.4% | 0.0% |
| | 19 | Thirtynine Creek | 6.91 | 0 | 0 | -100% | -100% | 31.54 | 0 | 0 | NA | NA | |
| | | **Subtotal** | **31.5** | **23.8** | **23.8** | **-24%** | **-25%** | | | | | | |
| **Total** | | | **123.0** | **123.0** | **123.0** | **0%** | **0%** | | | | | | |

[1]The MP7 WTP subwatershed does not act as a contributing watershed, because all rainfall and runoff is captured by the tailings basin and is used in the operation or discharged through the wastewater treatment plant (WTP).

Table 2
Aquatic Resource Watershed Summary
Tailings Basin Progression

| Subwatershed/ Receiving Water | ID | Stream Name | Streams/Ditches (mi) | | | % Change in Streams from Pre-Settlement to: | | % Change in Streams from Existing to Future | Wetlands (ac) | | | % Change in Wetlands from Pre-Settlement to: | | % Change in Wetlands from Existing to Future |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Pre-Settlement | Existing | Future | Existing | Future | | Pre-Settlement | Existing[1] | Future[1] | Existing | Future | |
| East Branch Beaver River | 1 | East Branch Beaver River HW | 32.1 | 32.1 | 32.1 | 0% | 0% | 0% | 6209.5 | 6179.1 | 6179.1 | 0% | 0% | 0% |
| | 2 | Big Thirtynine Creek (remnant) | 0 | 1.0 | 0 | NA | NA | NA | 0.00 | 51.2 | 0.00 | NA | NA | NA |
| | 3 | Little Thirtynine Creek (remnant) | 0 | 0.6 | 0 | NA | NA | NA | 0.00 | 19.9 | 0.00 | NA | NA | NA |
| | 4 | West Unnamed Creek | 1.1 | 2.6 | 2.3 | 137% | 108% | -12% | 88.2 | 292.8 | 84.1 | 232% | -5% | -71% |
| | 5 | Cedar Creek | 12.9 | 12.9 | 12.9 | 0% | 0% | 0% | 1131.7 | 1127.4 | 1127.3 | 0% | 0% | 0% |
| | 6 | Nicado Creek | 5.4 | 5.4 | 5.4 | 0% | 0% | 0% | 509.8 | 489.2 | 489.2 | -4% | -4% | 0% |
| | 7 | Lower East Branch Beaver River | 6.3 | 6.3 | 6.3 | 0% | 0% | 0% | 236.0 | 231.2 | 231.1 | -2% | -2% | 0% |
| | | **Subtotal** | **57.8** | **60.9** | **59.0** | **5%** | **2%** | **-3%** | **8,175** | **8,391** | **8,111** | **3%** | **-0.8%** | **-3%** |
| Beaver River | 8 | Beaver River HW | 21.0 | 21.0 | 21.0 | 0% | 0% | 0% | 4347.8 | 4426.5 | 4424.9 | 2% | 2% | 0% |
| | 9 | Kit Creek | 9.5 | 9.5 | 9.5 | 0% | 0% | 0% | 1487.3 | 1482.3 | 1482.3 | 0% | 0% | 0% |
| | 10 | Unnamed Creek | 5.42 | 5.37 | 5.37 | -1% | -1% | 0% | 446.5 | 439.8 | 439.8 | -2% | -2% | 0% |
| | 11 | Upper Middle Beaver River | 3.3 | 3.3 | 3.3 | 0% | 0% | 0% | 303.1 | 186.6 | 182.0 | -38% | -40% | -2% |
| | 12 | Lower Middle Beaver River | 4.1 | 4.2 | 4.2 | 2% | 2% | 0% | 133.4 | 129.8 | 129.8 | -3% | -3% | 0% |
| | 13 | West Branch Beaver River | 13.7 | 13.7 | 13.7 | 0% | 0% | 0% | 1361.4 | 1333.6 | 1333.6 | -2% | -2% | 0% |
| | 14 | MP7 WTP | NA | 0 | 1.5 | NA | NA | NA | NA | 137.5 | 146.8 | NA | NA | 7% |
| | 15 | Lower Middle Beaver River | 1.6 | 2.2 | 2.2 | 36% | 36% | 0% | 46.2 | 41.3 | 41.3 | -11% | -11% | 0% |
| | 16 | Lower Beaver River | 4.2 | 4.2 | 4.2 | 0% | 0% | 0% | 151.7 | 150.4 | 150.1 | -1% | -1% | 0% |
| | | **Subtotal** | **62.8** | **63.4** | **64.9** | **1%** | **3%** | **2%** | **8,277** | **8,328** | **8,330** | **1%** | **1%** | **0.0%** |
| Thirtynine Creek | 17 | Little Thirtynine Creek | 7.7 | 6.8 | 6.8 | -12% | -12% | 0% | 1531.4 | 1439.6 | 1436.6 | -6% | -6% | -0.2% |
| | 18 | Big Thirtynine Creek | 23.4 | 23.2 | 23.2 | -1% | -1% | 0% | 4388.1 | 4355.2 | 4355.2 | -1% | -1% | 0% |
| | 19 | Thirtynine Creek | 7.0 | 0 | 0 | -100% | -100% | NA | 1149.4 | NA | NA | NA | NA | NA |
| | | **Subtotal** | **38.1** | **30.0** | **30.0** | **-21%** | **-21%** | **0%** | **7,069** | **5,795** | **5,792** | **-18%** | **-18%** | **-0.1%** |
| Total | | | **158.7** | **154.3** | **153.9** | **-2.8%** | **-3.1%** | **-0.3%** | **23,522** | **22,513** | **22,233** | **-4%** | **-5%** | **-1.2%** |

[1]The difference between existing and future will not necessarily match impact values in Table 16, because non-jurisdictional wetlands are not included in Table 16, nor are riverine wetland impacts.

Table 3
Beaver River Monitoring Station Locations

| Location ID | Location Type | Location Description | River Mile |
|---|---|---|---|
| S006-234 | Surface water | MPCA monitoring location downstream of U.S. Highway 61 | 0.11 |
| S007-354 | Surface water | MPCA monitoring location at U.S. Highway 61 | 0.15 |
| S004-955 | Surface water | MPCA monitoring location just upstream of U.S. Highway 61 | 0.33 |
| 14LS001 | Biological monitoring | MPCA monitoring location ~3/4 mi upstream of U.S. Highway 61 | 0.95 |
| S007-971 | Surface water | MPCA monitoring location north of CSAH-4 | 1.16 |
| 94LS001 | Biological monitoring | MPCA monitoring location ~1 mi upstream of U.S. Highway 61 | 1.23 |
| S014-956 | Surface water | MPCA monitoring location ~1.25 mi upstream of U.S. Highway 61 | 1.39 |
| 2006003 | Flow monitoring | MDNR monitoring location | 1.39 |
| S007-970 | Surface water | MPCA monitoring location north of CSAH-4 | 1.56 |
| 11LS022 | Biological monitoring | Located near S007-970 | 1.56 |
| 97LS055 | Biological monitoring | MPCA monitoring location downstream of the confluence with the East Beaver River | 1.79 |
| S007-355 | Surface water | MPCA monitoring location at CSAH-4 | 2.05 |
| 94LS003 | Biological monitoring | MPCA monitoring location ~0.4 mi upstream of confluence with East Branch Beaver River | 2.21 |
| S106 (SW003) | Surface water | NSM monitoring location at Glenn Avon Falls | 3.79 |
| S000-252 | Surface water | MPCA monitoring location south of CSAH-3 | 3.8 |
| R-8 | Surface water and biological monitoring | Reserve Mining EIS fish, macroinvertebrate, and water quality data collected in 1975 | 3.81 |
| 15LS060 | Biological monitoring | MPCA monitoring location just downstream of NSM WTP discharge stream | 4.39 |
| S007-968 | Surface water | MPCA monitoring location at CSAH-3, downstream of S007-967 | 4.48 |
| S007-598 | Surface water | MPCA monitoring location within Northshore discharge channel at confluence with Beaver River | 4.55 |
| SD1-S010 | Surface water | Northshore WTP discharge (0.6 mi upstream of Beaver River) | 4.55 |
| S008-005 | Surface water | MPCA monitoring location at confluence with Northshore WTP discharge channel | 4.55 |
| S007-967 | Surface water | MPCA monitoring location at CSAH-3 | 4.57 |
| 15LS061 | Biological monitoring | MPCA monitoring location just upstream of NSM WTP discharge stream | 4.72 |
| 91LS026 | Biological monitoring | MPCA monitoring location ~0.25 mi upstream of confluence with West Branch Beaver River | 6.22 |
| S105 (SW002) | Surface water | NSM monitoring location at CSAH-3 | 6.32 |
| S006-273 | Surface water | MPCA monitoring location at CSAH-3 | 6.33 |
| 94LS005 | Biological monitoring | MPCA monitoring location ~0.5 mi upstream of confluence with West Branch Beaver River | 6.51 |
| 97LS010 | Biological monitoring | MPCA monitoring location ~0.25 mi upstream of confluence with historic Thirtynine Creek discharge | 8.49 |
| S007-356 | Surface water | MPCA monitoring location 1.8 mi south of CSAH-15 | 11.51 |
| S008-004 | Surface water | MPCA monitoring location upstream of the confluence with Big Thirtynine Creek | 11.55 |
| 94LS007 | Biological monitoring | MPCA monitoring location ~1.3 mi upstream of current confluence with Big Thirtynine Creek | 12.87 |
| 11LS027 | Biological monitoring | MPCA monitoring location ~3.2 mi downstream of Beaver River headwaters | 20.15 |
| S007-357 | Surface water | MPCA monitoring location at CSAH-15 | 20.19 |

Table 4
East Branch Beaver River Monitoring Station Locations

| Location ID | Location Type | Location Description | River Mile |
|---|---|---|---|
| S007-358 | Surface water | MPCA monitoring location 0.25 mi upstream of confluence with Beaver River | 0.25 |
| 14LS004 | Biological monitoring | MPCA monitoring location ~0.4 mi downstream of CSAH 5 | 1.65 |
| S007-359 | Surface water | MPCA monitoring location ~0.16 mi upstream of CSAH 5 | 2.05 |
| 11LS026 | Biological monitoring | MPCA monitoring location ~3/4 mi upstream of U.S. Highway 61 | 2.26 |
| S006-277 | Surface water | MPCA monitoring location ~0.2 mi downstream of Lax Lake Road | 3.49 |
| S102 (SW001) | Surface water | NSM monitoring location downstream side of Lax Lake Road | 3.64 |
| R-4 | Surface water and biological monitoring | Reserve Mining EIS fish, macroinvertebrate, and water quality data collected in 1975 | 3.64 |
| S007-360 | Surface water | MPCA monitoring location upstream side of Lax Lake Road | 3.71 |
| 14LS005 | Biological monitoring | MPCA monitoring location ~0.13 mi upstream of Lax Lake Road | 3.8 |
| S101 (SW004) | Surface water | NSM monitoring location ~0.5 mi upstream of Lax Lake Road | 4.21 |
| R-10 | Biological monitoring | Reserve Mining EIS fish snf macroinvertebrate data collected in 1975 | 5 |
| S007-603 | Surface water | MPCA monitoring location on downstream side of CSAH 15 | 5.47 |
| 14LS006 | Biological monitoring | MPCA monitoring location ~0.1 mi upstream of CSAH 15 | 5.61 |

Table 5

Beaver River Flow Data Summary - Station 2006003

| Year | Monitoring Timeframe | Number of Measurements | Measurement Frequency | Flow Rate (cfs) | | | |
|---|---|---|---|---|---|---|---|
| | | | | Minimum | Maximum | Average | Median |
| 2011 | April 11 - November 9 | 213 | Daily | 0.9 | 1840.0 | 165.6 | 39.0 |
| 2012 | March 19 - November 12 | 239 | Daily | 8.3 | 4890.0 | 160.7 | 43.0 |
| 2013 | May 1 - November 21 | 206 | Daily | 7.7 | 2160.0 | 212.4 | 78.0 |
| 2014 | April 22 - November 9 | 202 | Daily | 17.0 | 1820.0 | 226.8 | 47.5 |
| 2015 | April 7 - November 18 | 226 | Daily | 4.8 | 1610.0 | 158.8 | 99.0 |
| 2016 | March 17 - November 17 | 246 | Daily | 19.0 | 1480.0 | 206.0 | 108.0 |
| 2017 | April 2 - December 31 | 5838 | 1/1-11/1, daily; 11/2-12/31, 15-min | 3.6 | 1080.0 | 101.9 | 97.2 |
| 2018 | January 1 - December 31 | 28,369 | 15-min | 7.6 | 2536.4 | 161.8 | 126.5 |
| 2019 | January 1 - August 21 | 21,976 | 15-min | 8.9 | 2203.1 | 290.2 | 179.6 |

Table 6
Monthly Average and Minimum Flow
Beaver River Station 2006003

| Month (2011-2019) | Average Monthly Flow | | Average Minimum Monthly Flow | |
|---|---|---|---|---|
| | (cfs) | (n years) | (cfs) | (n years) |
| January | 170 | 2 | 69 | 2 |
| February | 166 | 2 | 73 | 2 |
| March | 338 | 4 | 115 | 4 |
| April | 511 | 8 | 205 | 8 |
| May | 411 | 9 | 98 | 9 |
| June | 231 | 9 | 51 | 9 |
| July | 76 | 9 | 23 | 9 |
| August | 45 | 9 | 16 | 9 |
| September | 76 | 8 | 16 | 8 |
| October | 118 | 8 | 39 | 8 |
| November | 94 | 6 | 39 | 6 |
| December | 114 | 2 | 33 | 2 |
| **Annual Average Flow** | **196** | | **Not applicable** | |

Table 7
Fish Survey Data
Beaver River and East Branch Beaver River

| Fish | Beaver River[1] | | | | | | | | | | | | | | | | | | East Branch Beaver River[1] | | | | | | Little 39 Creek | Big 39 Creek |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 14LS001 | 94LS001 | 11LS022 | | | 97LS055 | | 94LS003 | R-8 | 15LS060 | 15LS061 | 91LS026 | | 94LS005 | 97LS010 | | 94LS007 | 11LS027 | 14LS004 | 11LS026 | 14LS005 | R-10 | 14LS006 | 91LS029 | | |
| Survey Date | Jul-14 | No survey | Jun-11 | Jul-14 | Jul-15 | Jun-97 | Sep-97 | Jul-15 | Jul-75 | Jul-15 | Jul-15 | Jun-11 | Jun-15 | Jul-14 | Jul-97 | Aug-14 | Jul-11 | Jul-11 | Jul-14 | Jul-11 | Jul-14 | Jul-75 | Jul-14 | Jul-11 | Aug-19 | Aug-19 |
| IBI Score | 30 | | 35 | 33 | 29 | 45 | 41 | 44 | NA | 50 | 51 | 24 | 47 | 41 | 45 | 52 | 63 | 36 | 43 | 46 | 60 | NA | 75 | 52 | 16 | 19 |
| Total Species | 5 | -- | 12 | 11 | 10 | 14 | 13 | 8 | 7 | 9 | 9 | 11 | 10 | 13 | 8 | 9 | 10 | 13 | 12 | 7 | 11 | 6 | 6 | 11 | 4 | 3 |
| Blacknose dace | 16 | -- | 680 | 43 | 302 | 126 | 526 | 304 | 8 | 426 | 238 | 286 | 133 | 127 | 60 | 138 | 108 | 70 | 53 | 133 | 75 | 4 | 14 | 224 | 0 | 12 |
| Blacknose shiner | 0 | -- | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Bluegill | 0 | -- | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Brook stickleback | 0 | -- | 12 | 4 | 11 | 45 | 39 | 0 | 2 | 7 | 3 | 28 | 35 | 20 | 0 | 0 | 1 | 44 | 3 | 0 | 18 | 0 | 0 | 13 | 19 | 13 |
| Brook trout | 0 | -- | 0 | 0 | 3 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 15 | 1 | 3 | 0 | 19 | 10 | 5 | 0 | 0 | 0 |
| Central mudminnow | 0 | -- | 4 | 4 | 2 | 13 | 19 | 2 | 1 | 0 | 1 | 15 | 7 | 8 | 0 | 0 | 0 | 3 | 7 | 0 | 0 | 0 | 0 | 0 | 17 | 0 |
| Common shiner | 0 | -- | 159 | 43 | 35 | 146 | 720 | 4 | 5 | 11 | 5 | 103 | 22 | 19 | 16 | 1 | 12 | 77 | 52 | 1 | 121 | 4 | 1 | 97 | 0 | 0 |
| Creek chub | 14 | -- | 368 | 68 | 76 | 212 | 946 | 157 | 14 | 34 | 60 | 174 | 84 | 109 | 31 | 30 | 15 | 33 | 87 | 52 | 99 | 4 | 5 | 27 | 0 | 0 |
| Fathead minnow | 0 | -- | 78 | 2 | 20 | 12 | 6 | 0 | 0 | 0 | 0 | 2 | 0 | 1 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 8 | 1 |
| Finescale dace | 0 | -- | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 2 | 0 | 0 | 9 | 4 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| Iowa darter | 0 | -- | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Johnny darter | 2 | -- | 47 | 19 | 24 | 18 | 253 | 23 | 0 | 15 | 9 | 110 | 44 | 13 | 2 | 9 | 2 | 0 | 61 | 3 | 5 | 0 | 0 | 3 | 0 | 0 |
| Longnose dace | 14 | -- | 14 | 15 | 8 | 36 | 82 | 17 | 3 | 197 | 185 | 20 | 23 | 41 | 21 | 104 | 41 | 0 | 0 | 7 | 2 | 3 | 54 | 4 | 0 | 0 |
| Mottled sculpin | 0 | -- | 0 | 3 | 0 | 5 | 26 | 0 | 0 | 16 | 0 | 0 | 1 | 1 | 0 | 5 | 22 | 5 | 20 | 3 | 7 | 1 | 0 | 2 | 0 | 0 |
| Northern redbelly dace | 0 | -- | 16 | 0 | 0 | 32 | 25 | 0 | 0 | 1 | 0 | 146 | 1 | 16 | 0 | 2 | 0 | 18 | 27 | 0 | 25 | 0 | 1 | 5 | 0 | 0 |
| Rainbow trout | 0 | -- | 1 | 0 | 0 | 0 | 0 | 7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Pearl dace | 0 | -- | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 3 | 2 | 7 | 3 | 15 | 2 | 39 | 2 | 0 | 1 | 0 | 0 | 18 | 2 | 0 |
| Salmonid Yoy | 0 | -- | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| White sucker | 5 | -- | 33 | 12 | 8 | 48 | 46 | 5 | 0 | 4 | 1 | 1 | 0 | 18 | 1 | 1 | 13 | 21 | 14 | 5 | 12 | 0 | 0 | 34 | 0 | 0 |
| Total Fish | 51 | -- | 1417 | 214 | 489 | 696 | 2690 | 519 | 34 | 711 | 503 | 888 | 352 | 383 | 136 | 305 | 231 | 332 | 333 | 204 | 384 | 26 | 80 | 428 | 46 | 26 |
| Coldwater species present? (e.g., rainbow trout, brook trout, mottled sculpin) | No | -- | Yes | Yes | Yes | Yes | Yes | Yes | No | Yes | Yes | No | Yes | Yes | No | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |

[1]Stations are listed sequentially from downstream to upstream for each stream

Table 8
Biological Monitoring Data
Beaver River and East Branch Beaver River

| Monitoring Information | Stream Gradient | Fish Monitoring Data | | Macroinvertebrate Monitoring Data | | | Habitat Monitoring Data | Channel Stability Monitoring Data |
|---|---|---|---|---|---|---|---|---|
| MPCA Survey Location ID | (%) | Fish Survey Date | Measured F-IBI (1) | Macroinvertebrate Survey Date | Measured M-IBI (1) | HBI / Water Quality Evaluation Rating (1)(3) | MSHA Score / Grade/Rating (4) | CCSI Score / Rating (5) |
| Beaver River(2) | | | | | | | | |
| 14LS001 | 1.8% | 2014 | 30 | 2014 | No survey | | 84 / Good | No survey |
| 94LS001 | 0.2% | 2011 | No survey | 2011 | 20 | 4.6 / Good | No survey | 22 / Stable |
| | | 2015 | No survey | 2015 | 20 | 5 / Good | No survey | No survey |
| 11LS022 | 0.1% | 2011 | 35 | No survey | No survey | | 74.75 / Good | 22 / Stable |
| | | 2014 | 33 | No survey | No survey | | 67 / Good | No survey |
| | | 2015 | 29 | No survey | No survey | | No survey | No survey |
| 97LS055 | 0.1% | 1997 (Jun) | 45 | 1997 (Jun) | 78 | 4.6 / Good | 69 / Good | No survey |
| | | 1997 (Sep) | 41 | 1997 (Sep) | 75 | 4 / Very Good | | No survey |
| 94LS003 | 0.2% | 2015 | 44 | 2015 | 51 | 3.9 / Very Good | 87 / Good | No survey |
| R-8 | | 1975 | 45 | 1975 | Not Calculated | | No survey | No survey |
| 15LS060 | 0.6% | 2015 | 50 | 2015 | 56 | 4.0 / Very Good | 88 / Good | No survey |
| 15LS061 | 0.8% | 2015 | 51 | 2015 | 47 | 4.3 / Very Good | 88 / Good | No survey |
| 91LS026 | 0.1% | 2011 | 24 | 2011 | 39 | 5.5 / Good | 71.35 / Good | 34 / Fairly stable |
| | | 2015 | 47 | 2015 | 46 | 5.8 / Fair | 74 / Good | No survey |
| 94LS005 | 0.2% | 2014 | 41 | 2014 | No survey | | 64 / Fair | No survey |
| 97LS010 | 1.0% | 1997 | 45 | 1997 | 65 | 4.2 / Very Good | 72 / Good | No survey |
| | | 2014 | 52 | 2014 | 64 | 3.0 / Excellent | No survey | No survey |
| 94LS007 | 1.3% | 2011 | 63 | 2011 | 52 | 4.5 / Very Good | 84 / Good | 24 / Stable |
| | | 2014 | | No survey | No survey | | 90/ Good | No survey |
| 11LS027 | 0.8% | 2011 | 36 | 2011 | 62 | 4.4 / Very Good | 72.1 / Good | 32 / Fairly stable |
| | | 2014 | | No survey | No survey | | 72 / Good | No survey |
| East Branch Beaver River2 | | | | | | | | |
| 14LS004 | 0.1% | 2014 | 43 | No survey | No survey | | No survey | No survey |
| 11LS026 | 0.7% | 2011 | 46 | 2011 | 32 | 4.7 / Good | No survey | 22 / Stable |
| 14LS005 | 0.3% | 2014 | 60 | No survey | No survey | | No survey | No survey |
| R-10 | | 1975 | 88 | 1975 | Not Calculated | | No Survey | No survey |
| 14LS006 | 1.2% | 2014 | 75 | No survey | No survey | | No survey | No survey |
| 91LS029 | 0.7% | 2011 | 52 | 2011 | 24 | 6.0 / Fair | 84.6 / Good | 48 / Moderately Stable |
| Little 39 Creek | | 2019 | 16 | 2019 | 25 | Not Calculated | No survey | No survey |
| Big 39 Creek | | 2019 | 19 | 2019 | 30.6 | Not Calculated | No survey | No survey |

Notes:

(1) Data retrieved from the MPCA's online surface water data access (Reference: EDA Surface Water Data. Minnesota Pollution Control Agency. [Online] [Cited: November 19, 2019.] https://mpca.maps.arcgis.com/apps/webappviewer/index.html?id=c3ad23220f60416fadcc117f82ba05e3).

(2) The Beaver River and East Branch Beaver River are classified as Class 2Ag waters for biologic criteria (Northern cold water stream - General). Biological criteria for lotic cold water aquatic life and habitats is found in Minnesota Rules 7050.0222 subpart 2d.

(3) HBI score range: 0.00-3.50: Excellent, 3.51-4.50: Very good, 4.51-5.50: Good, 5.51-6.50: Fair, 6.51-7.50: Fairly poor, 7.51-8.50: Poor, 8.51-10.00: Very poor (Reference: Hilsenhoff, William L. An Improved Biotic Index of Organic Stream Pollution. The Great Lakes Entomologist. 1987, Vol. 20, 1, pp. 31-39).

(4) MSHA = Minnesota Stream Habitat Assessment; MSHA rating range: Good > 66, Fair 45-66, and Poor < 45 (Reference: Minnesota Pollution Control Agency. Lake Superior South Watershed Monitoring and Assessment Report. Document number: wq-ws3-04010102b. June 2014; Reference: EDA Surface Water Data. Minnesota Pollution Control Agency. [Online]

(5) CCSI = Channel Condition and Stability Index; CCSI score range: Stable < 27, Fairly stable 27< CCSI <45, Moderately unstable 45< CCSI <80, Severely unstable 80< CCSI <115, and Extremely unstable CCS >115 (Reference: Minnesota Pollution Control Agency. Lake Superior South Watershed Monitoring and Assessment Report. Document number: wq-ws3-04010102b. June 2014).

Table 9
Water Quality Data Narrative Summary - 2009-2019[3]
Beaver River

| Constituent | Units | Minnesota Surface Water Quality Standards [1] | MPCA Monitoring Location S006-234 | | | MPCA Monitoring Location S007-354 | | | MPCA Monitoring Location S004-955 | | | MPCA Monitoring Location 14LS001 | | | MPCA Monitoring Location S007-971 | | | MPCA Monitoring Location S014-956 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Class 2A [2] | Year | Summer Average (3) (4) (5) | Number of Samples | Year | Summer Average (3) (4) (5) | Number of Samples | Year | Summer Average (3) (4) (5) | Number of Samples | Year | Summer Average (3) (4) (5) | Number of Samples | Year | Summer Average (3) (4) (5) | Number of Samples | Year | Summer Average (3) (4) (5) | Number of Samples |
| Dissolved oxygen | mg/L | <7.0 | 2010 | 9.42 | 1 | 2013 | 10 | 3 | 2009 | 10.3 | 3 | 2014 | 9.3 | 1 | 2014 | 9.2 | 1 | 2015 | 9.9 | 1 |
| | | | | | | 2015 | 8.7 | 1 | 2015 | 9.8 | 2 | | | | | | | 2018 | 8.6 | 2 |
| pH | SU | 6.5 to 8.5 | 2010 | 8.2 | 9 | 2013 | 7.8 | 3 | 2009 | 7.5 | 3 | 2014 | 8.0 | 1 | 2014 | 7.8 | 1 | 2015 | 7.8 | 3 |
| | | | 2011 | 7.9 | 8 | 2015 | 8.2 | 1 | 2015 | 7.9 | 2 | | | | | | | 2018 | 8.1 | 2 |
| Total Phosphorus | µg/L | 50 | 2011 | 23 | 9 | No data | | | 2009 | 16 | 3 | 2014 | 21 | 1 | 2014 | 7 | 1 | 2014 | 14 | 15 |
| | | | | | | | | | | | | | | | | | | 2015 | 17 | 21 |
| | | | | | | | | | | | | | | | | | | 2016 | 34 | 8 |
| | | | | | | | | | 2015 | 10 | 1 | | | | | | | 2017 | 34 | 8 |
| | | | | | | | | | | | | | | | | | | 2018 | 38 | 12 |
| Total Nitrogen | mg/L | Narrative | No data | | | No data | | | 2009 | 0.50 | 3 | 2014 | 0.165 | 1 | No data | | | No data | | |
| Specific Conductance | µS/cm | No aquatic life standards | 2010 | 232 | 9 | 2013 | 334 | 3 | 2013 | 137 | 3 | 2014 | 198 | 1 | 2014 | 271 | 1 | 2015 | 145 | 3 |
| | | | | | | 2015 | 231 | 1 | 2015 | 377 | 2 | | | | | | | 2018 | 512 | 2 |
| Temperature | °C | Stress: >20 to 25 Lethal: >25 | 2010 | 18.8 | 9 | 2013 | 17 | 3 | 2013 | 15 | 3 | 2014 | 18.6 | 1 | 2014 | 16.9 | 1 | 2015 | 17.2 | 3 |
| | | | | | | | | | | | | | | | | | | 2017 | 16.4 | 7 |
| | | | 2011 | 18.8 | 8 | 2015 | 21.4 | 1 | 2015 | 16 | 5 | | | | | | | 2018 | 19.4 | 2 |
| Total Suspended Solids | mg/L | 10 | 2011 | 4.89 | 9 | 2013 | 3.6 | 1 | 2009 | 5 | 3 | 2014 | <4 | 1 | 2014 | 4.8 | 1 | 2014 | 5.3 | 11 |
| | | | | | | | | | | | | | | | | | | 2015 | 9.7 | 18 |
| | | | | | | 2014 | **14** | 1 | | | | | | | | | | 2016 | **11.00** | 7 |
| | | | | | | | | | 2015 | **11.5** | 5 | | | | | | | 2017 | 8.7 | 9 |
| | | | | | | 2015 | **15.5** | 2 | | | | | | | | | | 2018 | **11.8** | 11 |
| Turbidity | NTU | 10 | No data | | | 2014 | **15** | 1 | 2015 | 8.43 | 3 | No data | | | No data | | | 2014 | 7.3 | 11 |
| | | | | | | | | | | | | | | | | | | 2015 | **10.3** | 8 |

| Constituent | MPCA Monitoring Location S007-970 | | | MPCA Monitoring Location 11LS022 | | | MPCA Monitoring Location 97LS055 | | | MPCA Monitoring Location S007-355 | | | MPCA Monitoring Location 94LS003 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Year | Summer Average (3) (4) (5) | Number of Samples | Year | Summer Average (3) (4) (5) | Number of Samples | Year | Summer Average (3) (4) (5) | Number of Samples | Year | Summer Average (3) (4) (5) | Number of Samples | Year | Summer Average (3) (4) (5) | Number of Samples |
| Dissolved oxygen | 2014 | 9.5 | 1 | 2011 | 9.3 | 1 | 1997 | 9.15 | 2 | 2013 | 7.9 | 1 | 2015 | 8.1 | 1 |
| | | | | 2014 | 8.5 | 1 | | | | | | | | | |
| | 2015 | 8.8 | 1 | 2015 | 7.3 | 1 | | | | 2015 | 10.2 | 1 | | | |
| pH | 2014 | 8.1 | 1 | 2011 | 7.9 | 1 | 1997 | 7.6 | 2 | 2013 | 8 | 2 | 2015 | 8.2 | 1 |
| | | | | 2014 | 7.8 | 1 | | | | | | | | | |
| | 2015 | 8 | 1 | 2015 | 7.6 | 1 | | | | 2015 | 7.4 | 1 | | | |
| Total Phosphorus | 2014 | 6 | 1 | 2011 | 15 | 1 | 1997 | 15.5 | 2 | No data | | | 2015 | 14 | 1 |
| | 2015 | 12 | 1 | 2014 | 16 | 1 | | | | | | | | | |
| | | | | 2015 | 16 | 1 | | | | | | | | | |
| Total Nitrogen | No data | | | 2011 | 0.596 | 1 | 1997 | 0.025 | 2 | No data | | | 2015 | 0.230 | 1 |
| | | | | 2014 | 0.142 | 1 | | | | | | | | | |
| | | | | 2015 | 0.100 | 1 | | | | | | | | | |
| Specific Conductance | 2014 | 287 | 1 | 2011 | 391 | 1 | 1997 | 237 | 2 | 2013 | 368 | 2 | 2015 | 260 | 1 |
| | | | | 2014 | 188 | 1 | | | | | | | | | |
| | 2015 | 205 | 1 | 2015 | 98 | 1 | | | | 2015 | 147 | 1 | | | |
| Temperature | 2014 | 17.3 | 1 | 2011 | 16.3 | 1 | 1997 | 18.8 | 2 | 2013 | 17.3 | 3 | 2015 | 16.6 | 1 |
| | | | | 2014 | 18.7 | 1 | | | | | | | | | |
| | 2015 | 22 | 1 | 2015 | 18.8 | 1 | | | | 2015 | 12.3 | 1 | | | |
| Total Suspended Solids | 2015 | 5.2 | 1 | 2011 | 3.6 | 1 | 1997 | 3.25 | 2 | 2013 | 3.2 | 1 | 2015 | 5.2 | 1 |
| | | | | 2014 | 4.4 | 1 | | | | 2014 | **12.0** | 1 | | | |
| | | | | 2015 | 6.8 | 1 | | | | 2015 | **11.8** | 2 | | | |
| Turbidity | No data | | | No data | | | 1997 | 2.7 | 2 | 2014 | **16** | 1 | No data | | |

| Constituent | Cliffs Monitoring Location S106 (SW003) Glenn Avon Falls, Beaver River | | | MPCA Monitoring Location S000-252 | | | MPCA Monitoring Location R-8 | | | MPCA Monitoring Location 15LS060 | | | MPCA Monitoring Location S007-968 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Year | Summer Average (3) (4) (5) | Number of Samples | Year | Summer Average (3) (4) (5) | Number of Samples | Year | Summer Average (3) (4) (5) | Number of Samples | Year | Summer Average (3) (4) (5) | Number of Samples | Year | Summer Average (3) (4) (5) | Number of Samples |
| Dissolved oxygen | No data | | | 2010 | 10.5 | 4 | 1975 | 8.6 | 2 | 2015 | 7.76 | 1 | 2014 | 9.3 | 1 |
| | | | | 2013 | 10 | 2 | | | | | | | | | |
| | | | | 2014 | 9.5 | 1 | | | | | | | 2015 | 9.3 | 2 |
| | | | | 2015 | 9.7 | 2 | | | | | | | | | |
| pH | 2009 | **8.6** | 2 | 2010 | 8.3 | 4 | 1975 | 7.9 | 2 | 2015 | 8.1 | 1 | 2014 | 8.3 | 1 |
| | 2010 | 8.4 | 2 | | | | | | | | | | | | |
| | 2011 | **8.6** | 2 | | | | | | | | | | | | |
| | 2012 | 8.4 | 2 | 2013 | 7.9 | 2 | | | | | | | | | |
| | 2013 | 8.5 | 2 | | | | | | | | | | | | |
| | 2014 | 8.1 | 2 | | | | | | | | | | 2015 | 8.1 | 2 |
| | 2015 | 7.8 | 2 | | | | | | | | | | | | |
| | 2016 | 8.1 | 2 | 2014 | 8.4 | 1 | | | | | | | | | |
| | 2017 | 8.0 | 2 | | | | | | | | | | | | |
| | 2018 | 8.0 | 2 | 2015 | 7.5 | 1 | | | | | | | | | |
| | 2019 | 7.8 | 1 | | | | | | | | | | | | |
| Total Phosphorus | No data | | | 2010 | 13 | 4 | No data | | | 2015 | 10 | 1 | 2014 | 5 | 1 |
| | | | | | | | | | | | | | 2015 | 4 | 1 |
| Total Nitrogen | No data | | | No data | | | No data | | | 2015 | 0.340 | 1 | No data | | |
| Specific Conductance | 2009 | 624 | 2 | 2010 | 271.5 | 4 | No data | | | 2015 | 325 | 1 | 2014 | 340 | 1 |
| | 2010 | 492 | 2 | | | | | | | | | | | | |
| | 2011 | 418 | 2 | | | | | | | | | | | | |
| | 2012 | 478 | 2 | 2013 | 393 | 2 | | | | | | | | | |
| | 2013 | 369 | 2 | | | | | | | | | | | | |
| | 2014 | 239 | 2 | | | | | | | | | | | | |
| | 2015 | 172 | 2 | 2014 | 374 | 1 | | | | | | | | | |
| | 2016 | 210 | 2 | | | | | | | | | | | | |
| | 2017 | 273 | 2 | | | | | | | | | | 2015 | 466 | 2 |
| | 2018 | 271 | 2 | 2015 | 122.0 | 2 | | | | | | | | | |
| Temperature | No data | | | 2009 | 18.1 | 4 | 1975 | 20.5 | 2 | 2015 | 16 | 1 | 2014 | 17.6 | 1 |
| | | | | 2010 | 19.8 | 4 | | | | | | | | | |
| | | | | 2013 | 15.7 | 2 | | | | | | | | | |
| | | | | 2014 | 11.2 | 2 | | | | | | | 2015 | 19.1 | 2 |
| | | | | 2015 | 13.8 | 2 | | | | | | | | | |
| Total Suspended Solids | No data | | | 2010 | 3.0 | 5 | 1975 | 4.5 | 2 | 2015 | 2.4 | 1 | 2014 | 4.0 | 1 |
| | | | | 2013 | 2.0 | 1 | | | | | | | | | |
| | | | | 2014 | **11.0** | 1 | | | | | | | | | |
| | | | | 2015 | 8.9 | 2 | | | | | | | 2015 | 5.4 | 2 |
| Turbidity | 2009 | 1.6 | 2 | 2010 | 3.0 | 5 | No data | | | No data | | | No data | | |
| | 2010 | 1.8 | 2 | | | | | | | | | | | | |
| | 2011 | 1.9 | 2 | | | | | | | | | | | | |
| | 2012 | 2.5 | 2 | 2013 | 2.0 | 1 | | | | | | | | | |
| | 2013 | 2.2 | 2 | | | | | | | | | | | | |
| | 2014 | 8.8 | 2 | | | | | | | | | | | | |
| | 2015 | **16.1** | 2 | 2014 | **11** | 1 | | | | | | | | | |
| | 2016 | **13.4** | 2 | | | | | | | | | | | | |
| | 2017 | 5.1 | 2 | | | | | | | | | | | | |
| | 2018 | 6.4 | 2 | 2015 | 8.9 | 2 | | | | | | | | | |

Notes:
(1) Per Minnesota Rules, part 7050.0410 and part 7050.0470, subpart 1.A(2), Beaver River is designated as Class 1B, 2A, 3B, 3C, 4A, 4B, 5, and 6. Beaver River is also a designated trout stream per Minnesota Rules, part 6264.0050, subpart 4.X(7).
(2) Class 2A water quality standards are found in Minnesota Rules, part 7050.0222, subpart 2. Class 2 narrative standards are found in Minnesota Rules, part 7050.0150.
(3) Data provided includes annual summer averages for available data from 2009 through 2019, with a couple of exceptions for earlier data. Average calculated with non-detect samples at half the reporting limit.
(4) Summer-average is calculated consistent with Minnesota Rules, part 7050.0150, subpart 4.(II.), where a summer-average is "representative average of concentrations or measurements of nutrient enrichment factors, taken over one summer season." and summer season "means a period annually from June 1 through September 30."
(5) Bold results indicate an exceedance of the water quality standard.

Table 9
Water Quality Data Narrative Summary - 2009-2019[3]
Beaver River

| Constituent | Units | Minnesota Surface Water Quality Standards [1] | MPCA Monitoring Location S008-005 | | | MPCA Monitoring Location S007-598 | | | Cliffs Monitoring Location S010 Milepost 7 Pipe Outfall SD 001 | | | MPCA Monitoring Location S007-967 | | | MPCA Monitoring Location 15LS061 | | | MPCA Monitoring Location 91LS026 | | | Cliffs Monitoring Location S105 (SW002) County Road 3, Beaver River | | | MPCA Monitoring Location S006-273 | | | MPCA Monitoring Location 94LS005 | | | MPCA Monitoring Location 97LS010 | | | MPCA Monitoring Location S007-356 | | | MPCA Monitoring Location S008-004 | | | MPCA Monitoring Location 94LS007 | | | MPCA Monitoring Location 11LS027 | | | MPCA Monitoring Location S007-357 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Class 2A [2] | Year | Summer Average (3) (4) (5) | Number of Samples | Year | Summer Average (3) (4) (5) | Number of Samples | Year | Summer Average (3) (4) (5) | Number of Samples | Year | Summer Average (3) (4) (5) | Number of Samples | Year | Summer Average (3) (4) (5) | Number of Samples | Year | Summer Average (3) (4) (5) | Number of Samples | Year | Summer Average (3) (4) (5) | Number of Samples | Year | Summer Average (3) (4) (5) | Number of Samples | Year | Summer Average (3) (4) (5) | Number of Samples | Year | Summer Average (3) (4) (5) | Number of Samples | Year | Summer Average (3) (4) (5) | Number of Samples | Year | Summer Average (3) (4) (5) | Number of Samples | Year | Summer Average (3) (4) (5) | Number of Samples | Year | Summer Average (3) (4) (5) | Number of Samples | Year | Summer Average (3) (4) (5) | Number of Samples |
| Dissolved oxygen | mg/L | <7.0 | 2014 | 8.9 | 1 | 2013 | 8.9 | 1 | No data | | | 2014 | 9.5 | 1 | 2015 | 9.4 | 1 | 2011 | 8.3 | 1 | No data | | | 2013 | 9.5 | 3 | 2014 | 9.5 | 1 | 2014 | 8.8 | 1 | 2013 | 10.5 | 1 | 2014 | 9.3 | 1 | 2011 | 8.1 | 1 | 2011 | 7.5 | 1 | 2013 | 8.7 | 3 |
| | | | | | | 2014 | 9.5 | 1 | | | | 2015 | 9.4 | 1 | | | | 2015 | 7.1 | 1 | | | | 2014 | 9.4 | 1 | | | | | | | 2015 | 9.9 | 1 | 2015 | 10 | 1 | | | | | | | 2015 | 7.2 | 2 |
| | | | | | | | | | | | | | | | | | | | | | | | | 2015 | 8.9 | 9 | | | | | | | | | | | | | | | | | | | | | |
| pH | SU | 6.5 to 8.5 | 2014 | 8.4 | 1 | No data | | | 2009 | 7.6 | 4 | 2014 | 8 | 1 | 2015 | **8.6** | 1 | 2011 | 7.8 | 1 | 2009 | 8 | 2 | 2013 | 7.4 | 3 | 2014 | 8.1 | 1 | 2014 | 7.8 | 1 | 2013 | 7.1 | 2 | 2013 | 7.1 | 2 | 2011 | 7.7 | 1 | 2011 | 7.1 | 1 | 2013 | 7.0 | 3 |
| | | | | | | | | | 2010 | 7.6 | 4 | | | | | | | | | | 2010 | 7.8 | 2 | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | 2011 | 7.6 | 4 | | | | | | | | | | 2011 | 8.3 | 2 | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | 2012 | 7.7 | 4 | | | | | | | | | | 2012 | 7.9 | 2 | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | 2013 | 7.5 | 4 | | | | | | | | | | 2013 | 7.8 | 2 | 2014 | 7.9 | 1 | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | 2014 | 7.4 | 4 | 2015 | 8.4 | 1 | | | | 2015 | 7.4 | 1 | 2014 | 7.9 | 2 | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | 2015 | 7.2 | 3 | | | | | | | | | | 2015 | 7.8 | 2 | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | 2016 | 7.4 | 3 | | | | | | | | | | 2016 | 7.9 | 2 | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | 2017 | 7.4 | 4 | | | | | | | | | | 2017 | 7.8 | 2 | 2015 | 7.7 | 9 | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | 2018 | 7.4 | 4 | | | | | | | | | | 2018 | 7.7 | 2 | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | 2019 | 7.5 | 4 | | | | | | | | | | 2019 | 8.0 | 1 | | | | | | | | | | | | | | | | | | | | | | | | |
| Total Phosphorus | µg/L | 50 | 2014 | 3 | 1 | No data | | | No data | | | 2014 | 6 | 1 | 2015 | 12 | 1 | 2011 | 17 | 1 | No data | | | 2014 | 6 | 1 | 2014 | 21 | 1 | 2014 | 13 | 1 | No data | | | 2014 | 11 | 1 | 2011 | 18 | 1 | 2011 | 29 | 1 | 2015 | 24 | 2 |
| | | | | | | | | | | | | 2015 | 5 | 1 | | | | 2015 | 13 | 1 | | | | 2015 | 14 | 5 | | | | | | | | | | | | | | | | | | | | | |
| Total Nitrogen | mg/L | Narrative | No data | | | No data | | | No data | | | No data | | | 2015 | <0.050 | 1 | 2011 | 0.072 | 1 | No data | | | No data | | | 2014 | <0.10 | 1 | 2014 | <0.050 | 1 | No data | | | No data | | | 2011 | <0.050 | 1 | 2011 | 0.192 | 1 | No data | | |
| | | | | | | | | | | | | | | | | | | 2015 | 0.05 | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Specific Conductance | µS/cm | No aquatic life standards | 2014 | 821 | 1 | No data | | | 2009 | 798 | 7 | 2014 | 138 | 1 | 2015 | 91 | 1 | 2011 | 114 | 1 | 2009 | 136 | 2 | 2013 | 132 | 3 | 2014 | 86 | 1 | 2014 | 148 | 1 | 2013 | 73 | 1 | 2014 | 141 | 1 | 2011 | 142 | 1 | 2011 | 113 | 1 | 2013 | 86 | 3 |
| | | | | | | | | | 2010 | 768 | 6 | | | | | | | | | | 2010 | 164 | 2 | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | 2011 | 775 | 8 | | | | | | | | | | 2011 | 140 | 2 | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | 2012 | 775 | 7 | | | | | | | | | | 2012 | 144 | 2 | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | 2013 | 792 | 7 | | | | | | | | | | 2013 | 119 | 2 | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | 2014 | 781 | 8 | | | | | | | | | | 2014 | 109 | 2 | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | 2015 | 894 | 5 | | | | | | | | | | 2015 | 101 | 2 | 2014 | 130 | 1 | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | 2016 | 827 | 6 | | | | | | | | | | 2016 | 118 | 2 | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | 2017 | 822 | 7 | 2015 | 182 | 1 | | | | 2015 | 90 | 1 | 2017 | 109 | 2 | | | | | | | | | | 2015 | 142 | 1 | 2015 | 132 | 1 | | | | | | | 2015 | 115 | 2 |
| | | | | | | | | | 2018 | 838 | 6 | | | | | | | | | | 2018 | 111 | 2 | 2015 | 130 | 9 | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | 2019 | 793 | 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Temperature | °C | Stress: >20 to 25 Lethal: >25 | 2014 | 19.4 | 1 | 2013 | 19.3 | 1 | No data | | | 2014 | 16.8 | 1 | 2015 | 20.3 | 1 | 2011 | 21.4 | 1 | No data | | | 2013 | 16.8 | 3 | 2014 | 23.1 | 1 | 2014 | 22.9 | 1 | 2013 | 10.2 | 1 | 2014 | 16.1 | 1 | 2011 | 22.8 | 1 | 2011 | 15.1 | 1 | 2013 | 13.6 | 3 |
| | | | | | | 2014 | 19.4 | 1 | | | | 2015 | 24 | 1 | | | | 2015 | 17.4 | 1 | | | | 2014 | 16.8 | 1 | | | | | | | 2015 | 13.2 | 2 | 2015 | 12.6 | 2 | | | | | | | 2015 | 14.6 | 6 |
| | | | | | | | | | | | | | | | | | | | | | | | | 2015 | 19.7 | 9 | | | | | | | | | | | | | | | | | | | | | |
| Total Suspended Solids | mg/L | 10 | 2014 | 2.8 | 1 | No data | | | 2009 | 0.7 | 4 | 2014 | 2.4 | 1 | 2015 | 2.8 | 1 | 2011 | <4 | 1 | No data | | | 2013 | 1.6 | 1 | 2014 | <4 | 1 | 2014 | <4 | 1 | 2013 | 1.6 | 1 | 2014 | 3.6 | 2 | 2011 | 5.6 | 1 | 2011 | <4 | 1 | 2013 | 2.4 | 1 |
| | | | | | | | | | 2010 | 0.5 | 4 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | 2011 | 1.6 | 4 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | 2012 | 1.1 | 4 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | 2013 | 0.7 | 4 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | 2014 | 0.5 | 4 | | | | | | | | | | | | | 2014 | 2.8 | 1 | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | 2015 | 0.7 | 3 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | 2016 | 0.5 | 3 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | 2017 | 0.5 | 4 | 2015 | 2.0 | 1 | | | | 2015 | 3.2 | 1 | | | | | | | | | | | | 2015 | 6.4 | 1 | 2015 | 4.8 | 1 | | | | | | | | | |
| | | | | | | | | | 2018 | 0.7 | 4 | | | | | | | | | | | | | 2015 | 9 | 5 | | | | | | | | | | | | | | | | | | | 2015 | 8.8 | 1 |
| | | | | | | | | | 2019 | 1.2 | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Turbidity | NTU | 10 | No data | | | No data | | | 2009 | 0.7 | 4 | No data | | | No data | | | No data | | | 2009 | 1.0 | 2 | No data | | | No data | | | No data | | | No data | | | 2014 | 1.7 | 1 | No data | | | No data | | | No data | | |
| | | | | | | | | | 2010 | 0.5 | 4 | | | | | | | | | | 2010 | 1.0 | 2 | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | 2011 | 1.6 | 4 | | | | | | | | | | 2011 | 1.3 | 2 | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | 2012 | 1.1 | 4 | | | | | | | | | | 2012 | 2.9 | 2 | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | 2013 | 0.7 | 4 | | | | | | | | | | 2013 | 1.7 | 2 | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | 2014 | 0.5 | 4 | | | | | | | | | | 2014 | 4.9 | 2 | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | 2015 | 0.7 | 3 | | | | | | | | | | 2015 | 6.4 | 2 | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | 2016 | 0.5 | 3 | | | | | | | | | | 2016 | 6.1 | 2 | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | 2017 | 0.5 | 4 | | | | | | | | | | 2017 | 2.4 | 2 | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | 2018 | 0.7 | 4 | | | | | | | | | | 2018 | 2.8 | 2 | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | 2019 | 1.2 | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

Notes:
(1) Per Minnesota Rules, part 7050.0410 and part 7050.0470, subpart 1.A(2), Beaver River is designated as Class 1B, 2A, 3B, 3C, 4A, 4B, 5, and 6. Beaver River is also a designated trout stream per Minnesota Rules, part 6264.0050, subpart 4.X(7).
(2) Class 2A water quality standards are found in Minnesota Rules, part 7050.0222, subpart 2. Class 2 narrative standards are found in Minnesota Rules, part 7050.0150.
(3) Data provided includes annual summer averages for available data from 2009 through 2019, with a couple of exceptions for earlier data. Average calculated with non-detect samples at half the reporting limit.
(4) Summer-average is calculated consistent with Minnesota Rules, part 7050.0150, subpart 4.(II.), where a summer-average is "representative average of concentrations or measurements of nutrient enrichment factors, taken over one summer season." and summer season "means a period annually from June 1 through September 30."
(5) Bold results indicate an exceedance of the water quality standard.

Table 10

Water Quality Data Narrative Summary - 2000-2019[3]

East Branch Beaver River

| Constituent | Units | Minnesota Surface Water Quality Standards (1) | MPCA Monitoring Location S007-358 | | | MPCA Monitoring Location 14LS004 | | | MPCA Monitoring Location S007-359 | | | MPCA Monitoring Location 11LS026 | | | MPCA Monitoring Location S006-277 | | | Cliffs Monitoring Location S102 (SW001) East Branch Beaver River | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Class 2A (2) | Year | Summer Average (3) (4) (5) | Number of Samples | Year | Summer Average (3) (4) (5) | Number of Samples | Year | Summer Average (3) (4) (5) | Number of Samples | Year | Summer Average (3) (4) (5) | Number of Samples | Year | Summer Average (3) (4) (5) | Number of Samples | Year | Summer Average (3) (4) (5) | Number of Samples |
| Dissolved oxygen | mg/L | <7 | 2013 | 10.9 | 1 | 2014 | 8.8 | 1 | 2013 | 9.4 | 3 | 2011 | 8.8 | 1 | No data | | | No data | | |
| | | | 2015 | 10.3 | 1 | | | | 2015 | 9.4 | 1 | | | | | | | | | |
| pH | SU | 6.5 to 8.5 | 2013 | 7.2 | 1 | 2014 | 7.7 | 1 | 2013 | 7.3 | 3 | 2011 | 8.0 | 1 | No data | | | 2009 | 7.6 | 2 |
| | | | | | | | | | | | | | | | | | | 2010 | 7.5 | 2 |
| | | | | | | | | | | | | | | | | | | 2011 | 7.9 | 2 |
| | | | | | | | | | | | | | | | | | | 2012 | 7.5 | 2 |
| | | | | | | | | | | | | | | | | | | 2013 | 7.4 | 2 |
| | | | | | | | | | | | | | | | | | | 2014 | 7.6 | 2 |
| | | | 2015 | 7.4 | 1 | | | | 2015 | 7.2 | 1 | | | | | | | 2015 | 7.4 | 2 |
| | | | | | | | | | | | | | | | | | | 2016 | 7.6 | 2 |
| | | | | | | | | | | | | | | | | | | 2017 | 7.6 | 2 |
| | | | | | | | | | | | | | | | | | | 2018 | 7.5 | 2 |
| Total Phosphorus | µg/L | 50 | No data | | | 2014 | 20 | 1 | No data | | | 2011 | 21 | 1 | 1997 | 19 | 2 | No data | | |
| | | | | | | | | | | | | | | | 1998 | 11 | 2 | | | |
| Total Nitrogen | mg/L | Narrative | No data | | | 2014 | <0.1 | 1 | No data | | | 2011 | <0.05 | 1 | 1997 | 0.48 | 2 | No data | | |
| | | | | | | | | | | | | | | | 1998 | 0.48 | 2 | | | |
| Specific Conductance | µS/cm | No aquatic life standards | 2013 | 79 | 1 | 2014 | 80.4 | 1 | 2013 | 93 | 3 | 2011 | 241 | 1 | 1997 | 102 | 2 | 2009 | 138 | 2 |
| | | | | | | | | | | | | | | | | | | 2010 | 132 | 2 |
| | | | | | | | | | | | | | | | | | | 2011 | 121 | 2 |
| | | | | | | | | | | | | | | | | | | 2012 | 88 | 2 |
| | | | | | | | | | | | | | | | | | | 2013 | 73 | 2 |
| | | | | | | | | | | | | | | | | | | 2014 | 91 | 2 |
| | | | 2015 | 135 | 1 | | | | 2015 | 133 | 1 | | | | 1998 | 124 | 2 | 2015 | 70 | 2 |
| | | | | | | | | | | | | | | | | | | 2016 | 103 | 2 |
| | | | | | | | | | | | | | | | | | | 2017 | 72 | 2 |
| | | | | | | | | | | | | | | | | | | 2018 | 81 | 2 |
| Temperature | °C | 'Stress: >20 to 25 Lethal: >25 | 2013 | 9.4 | 1 | 2014 | 23.5 | 1 | 2013 | 17.6 | 3 | 2011 | 23.7 | 1 | 1998 | 9.2 | 1 | No data | | |
| | | | 2015 | 12.5 | 1 | | | | 2015 | 12.4 | 1 | | | | | | | | | |
| Total Suspended Solids | mg/L | 10 | 2013 | 2 | 1 | 2014 | <4 | 1 | 2013 | 2.4 | 1 | 2011 | <4 | 1 | 1997 | 4.4 | 1 | No data | | |
| | | | 2014 | 10 | 1 | | | | 2014 | 8.4 | 1 | | | | | | | | | |
| | | | 2015 | 9.2 | 1 | | | | 2015 | 6.4 | 1 | | | | 1998 | 3.1 | 2 | | | |
| Turbidity | NTU | 10 | 2014 | 7.1 | 1 | No data | | | 2014 | 6.5 | 1 | No data | | | 1997 | 2.1 | 2 | 2009 | 1.92 | 2 |
| | | | | | | | | | | | | | | | | | | 2010 | 2.48 | 2 |
| | | | | | | | | | | | | | | | | | | 2011 | 2.39 | 2 |
| | | | | | | | | | | | | | | | | | | 2012 | 2.03 | 2 |
| | | | | | | | | | | | | | | | | | | 2013 | 2.84 | 2 |
| | | | | | | | | | | | | | | | | | | 2014 | 3.69 | 2 |
| | | | | | | | | | | | | | | | | | | 2015 | 3.60 | 2 |
| | | | | | | | | | | | | | | | 1998 | 1.6 | 2 | 2016 | 9.94 | 2 |
| | | | | | | | | | | | | | | | | | | 2017 | 2.15 | 2 |
| | | | | | | | | | | | | | | | | | | 2018 | 2.06 | 2 |

Notes:

(1) Per Minnesota Rules, part 7050.0410 and part 7050.0470, subpart 1.A(2), East Branch Beaver River is designated as Class 1B, 2A, and 3B. East Branch Beaver River is also a designated trout stream per Minnesota Rules, part 6264.0050, subpart 4.X(7).

(2) Class 2A water quality standards are found in Minnesota Rules, part 7050.0222, subpart 2. Class 2 narrative standards are found in Minnesota Rules, part 7050.0150.

(3) Data provided includes annual summer averages for available data from 2009 through 2019, with a couple of exceptions for earlier data. Average calculated with non-detect samples at half the reporting limit.

(4) Summer-average is calculated consistent with Minnesota Rules, part 7050.0150, subpart 4.(II.), where a summer-average is "representative average of concentrations or measurements of nutrient enrichment factors, taken over one summer season." and summer season "means a period annually from June 1 through September 30."

(5) Bold results indicate an exceedance of the water quality standard.

Table 10

Water Quality Data Narrative Summary - 2000-2019[3]

East Branch Beaver River

| Constituent | Units | Minnesota Surface Water Quality Standards (1) | MPCA Monitoring Location R-4 | | | MPCA Monitoring Location S007-360 | | | MPCA Monitoring Location 14LS005 | | | Cliffs Monitoring Location S101 (SW004) East Branch Beaver River | | | MPCA Monitoring Location S007-603 | | | MPCA Monitoring Location 14LS006 | | | MPCA Monitoring Location 91LS029 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Class 2A (2) | Year | Summer Average (3) (4) (5) | Number of Samples | Year | Summer Average (3) (4) (5) | Number of Samples | Year | Summer Average (3) (4) (5) | Number of Samples | Year | Summer Average (3) (4) (5) | Number of Samples | Year | Summer Average (3) (4) (5) | Number of Samples | Year | Summer Average (3) (4) (5) | Number of Samples | Year | Summer Average (3) (4) (5) | Number of Samples |
| Dissolved oxygen | mg/L | <7 | 1975 | 7.65 | 4 | 2013 | 9.6 | 2 | 2014 | 8.75 | 2 | No data | | | 2013 | 10.2 | 1 | 2014 | 9.3 | 1 | 2011 | 8.1 | 1 |
| | | | | | | 2015 | 10 | 1 | | | | | | | | | | | | | | | |
| pH | SU | 6.5 to 8.5 | 1975 | 7.1 | 4 | 2013 | 7.4 | 2 | 2014 | 7.2 | 2 | 2009 | 7.9 | 2 | 2013 | 7.2 | 2 | 2014 | 7.5 | 1 | 2011 | 7.2 | 1 |
| | | | | | | | | | | | | 2010 | 8 | 2 | | | | | | | | | |
| | | | | | | | | | | | | 2011 | 8.1 | 2 | | | | | | | | | |
| | | | | | | | | | | | | 2012 | 7.9 | 2 | | | | | | | | | |
| | | | | | | | | | | | | 2013 | 7.7 | 2 | | | | | | | | | |
| | | | | | | | | | | | | 2014 | 7.7 | 2 | | | | | | | | | |
| | | | | | | 2015 | 7.1 | 1 | | | | 2015 | 7.7 | 2 | | | | | | | | | |
| | | | | | | | | | | | | 2016 | 7.9 | 2 | | | | | | | | | |
| | | | | | | | | | | | | 2017 | 7.6 | 2 | | | | | | | | | |
| | | | | | | | | | | | | 2018 | 7.7 | 2 | | | | | | | | | |
| Total Phosphorus | µg/L | 50 | No data | | | No data | | | 2014 | 13.5 | 2 | No data | | | No data | | | 2014 | 23 | 1 | 2011 | 22 | 1 |
| Total Nitrogen | mg/L | Narrative | No data | | | No data | | | 2014 | 0.075 | 2 | No data | | | No data | | | 2014 | <0.1 | 1 | 2011 | 0.072 | 1 |
| Specific Conductance | µS/cm | No aquatic life standards | No data | | | 2013 | 100 | 2 | 2014 | 97.5 | 2 | 2009 | 114 | 2 | 2013 | 79 | 2 | 2014 | 52 | 1 | 2011 | 175 | 1 |
| | | | | | | | | | | | | 2010 | 111 | 2 | | | | | | | | | |
| | | | | | | | | | | | | 2011 | 88 | 2 | | | | | | | | | |
| | | | | | | | | | | | | 2012 | 80 | 2 | | | | | | | | | |
| | | | | | | | | | | | | 2013 | 69 | 2 | | | | | | | | | |
| | | | | | | | | | | | | 2014 | 80 | 2 | | | | | | | | | |
| | | | | | | 2015 | 127 | 1 | | | | 2015 | 64 | 2 | | | | | | | | | |
| | | | | | | | | | | | | 2016 | 92 | 2 | | | | | | | | | |
| | | | | | | | | | | | | 2017 | 66 | 2 | | | | | | | | | |
| | | | | | | | | | | | | 2018 | 72 | 2 | | | | | | | | | |
| Temperature | °C | 'Stress: >20 to 25 Lethal: >25 | 1975 | 20.0 | 4 | 2013 | 12.8 | 2 | 2014 | 19.5 | 2 | No data | | | 2013 | 12.3 | 2 | 2014 | 20.4 | 1 | 2011 | 17.2 | 1 |
| | | | | | | 2015 | 12.3 | 1 | | | | | | | | | | | | | | | |
| Total Suspended Solids | mg/L | 10 | 1975 | 2.75 | 4 | 2013 | 1.2 | 1 | 2014 | <4 | 2 | No data | | | 2013 | 1.2 | 1 | 2014 | 4 | 1 | 2011 | <4 | 1 |
| | | | | | | 2014 | 8.8 | 1 | | | | | | | 2014 | 5.2 | 1 | | | | | | |
| | | | | | | 2015 | 5.6 | 1 | | | | | | | | | | | | | | | |
| Turbidity | NTU | 10 | No data | | | 2014 | 3.8 | 1 | No data | | | 2009 | 0.62 | 2 | 2014 | 1.9 | 1 | No data | | | No data | | |
| | | | | | | | | | | | | 2010 | 0.98 | 2 | | | | | | | | | |
| | | | | | | | | | | | | 2011 | 0.76 | 2 | | | | | | | | | |
| | | | | | | | | | | | | 2012 | 0.72 | 2 | | | | | | | | | |
| | | | | | | | | | | | | 2013 | 1.34 | 2 | | | | | | | | | |
| | | | | | | | | | | | | 2014 | 1.3 | 2 | | | | | | | | | |
| | | | | | | | | | | | | 2015 | 1.78 | 2 | | | | | | | | | |
| | | | | | | | | | | | | 2016 | 3.19 | 2 | | | | | | | | | |
| | | | | | | | | | | | | 2017 | 1.8 | 2 | | | | | | | | | |
| | | | | | | | | | | | | 2018 | 1.9 | 2 | | | | | | | | | |

Notes:

(1) Per Minnesota Rules, part 7050.0410 and part 7050.0470, subpart 1.A(2), East Branch Beaver River is designated as Class 1B, 2A, and 3B. East Branch Beaver River is also a designated trout stream per Minnesota Rules, part 6264.0050, subpart 4.X(7).

(2) Class 2A water quality standards are found in Minnesota Rules, part 7050.0222, subpart 2. Class 2 narrative standards are found in Minnesota Rules, part 7050.0150.

(3) Data provided includes annual summer averages for available data from 2009 through 2019, with a couple of exceptions for earlier data. Average calculated with non-detect samples at half the reporting limit.

(4) Summer-average is calculated consistent with Minnesota Rules, part 7050.0150, subpart 4.(II.), where a summer-average is "representative average of concentrations or measurements of nutrient enrichment factors, taken over one summer season." and summer season "means a period annually from June 1 through September 30."

(5) Bold results indicate an exceedance of the water quality standard.

**Table 11**
**Key Water Balance Components and Anticipated Changes with Basin Progression**

| Model Component | Anticipated Change as a Result of Basin Progression |
|---|---|
| Facility production at capacity (affects evaporative losses through the indurating furnaces) | No Change |
| Targeted basin volume | No Change |
| Use of makeup water from lake adjusted to target a constant water volume in the basin | Reduced |
| Discharge from basin water treatment plant | No Change |
| Watershed run-on | Net Increase (after considering removal of Bear Lake watershed) |
| Watershed evaporation | Increased |
| Tailings deposition area (affects rate of rise) | Increased |

Table 12
Monthly WTP Discharge Rates
2000-2019

| Year | Flow Rate (cfs) | | | |
|---|---|---|---|---|
| | Minimum | Maximum | Average | Median |
| 2000 | 4.2 | 6.4 | 5.3 | 6.2 |
| 2001 | 0.0 | 6.5 | 4.3 | 5.8 |
| 2002 | 2.9 | 6.2 | 4.9 | 5.8 |
| 2003 | 1.4 | 6.9 | 4.5 | 5.6 |
| 2004 | 1.9 | 6.8 | 5.0 | 6.1 |
| 2005 | 2.3 | 7.0 | 5.6 | 6.3 |
| 2006 | 5.2 | 7.1 | 5.8 | 6.3 |
| 2007 | 0.5 | 7.4 | 5.0 | 6.4 |
| 2008 | 5.1 | 9.0 | 6.9 | 8.6 |
| 2009 | 0.0 | 8.9 | 5.6 | 8.1 |
| 2010 | 0.0 | 9.1 | 4.4 | 7.0 |
| 2011 | 5.0 | 11.0 | 7.1 | 8.4 |
| 2012 | 0.0 | 9.4 | 6.3 | 8.1 |
| 2013 | 0.0 | 9.6 | 6.0 | 8.7 |
| 2014 | 7.0 | 9.4 | 8.3 | 8.9 |
| 2015 | 0.0 | 10.4 | 6.9 | 8.8 |
| 2016 | 0.0 | 9.1 | 7.3 | 8.7 |
| 2017 | 3.1 | 9.4 | 7.9 | 8.7 |
| 2018 | 0.0 | 9.7 | 7.5 | 9.1 |
| 2019 | 7.3 | 10.1 | 8.8 | 9.1 |

Table 13
Watershed Modeling Details
Tailings Basin Progression

| ID | Stream Name | Watershed Area (sq mi) | | | Cumulative Watershed (sq mi) | | | Cumulative Ponds (sq mi) | | | % Cumulative Watershed as Ponds | | | % Change in % Cumulative Watershed as Ponds from Pre-Settlement to: | | % Change in % Cumulative Watershed as Ponds from Existing to Future | Cumulative Wetlands and Lakes (sq mi) | | | % Cumulative Watershed as Wetlands and Lakes | | | % Drainage Basin in Hydrologic Soil Group C | | | Pre-Settle Cumulative Watersheds | Existing Cumulative Watersheds | Future Cumulative Watersheds |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Pre-Settlement | Existing | Future | Pre-Settlement | Existing | Future | Pre-Settlement | Existing | Future | Pre-Settlement | Existing | Future | Existing | Future | | Pre-Settlement | Existing | Future | Pre-Settlement | Existing | Future | Pre-Settlement | Existing | Future | | | |
| | **East Branch Beaver River** | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1 | East Branch Beaver River HW | 26.96 | 26.96 | 26.96 | 26.96 | 26.96 | 26.96 | 0.20 | 0.95 | 0.95 | 0.75% | 3.53% | 3.53% | 372% | 372% | 0% | 9.72 | 9.67 | 9.67 | 36.05% | 35.87% | 35.87% | 42.1% | 42.1% | 42.1% | 1 | 1 | 1 |
| 2 | Big Thirtynine Creek (remnant) | 0 | 0.46 | 0 | 17.70 | 0.46 | NA | NA | 0.009 | NA | NA | 1.87% | NA | NA | NA | NA | NA | 0.08 | NA | NA | 17.56% | NA | | | | NA | 2 | NA |
| 3 | Little Thirtynine Creek (remnant) | 0 | 0.11 | 0 | 6.94 | 0.11 | NA | NA | 0.005 | NA | NA | 4.06% | NA | NA | NA | NA | NA | 0.03 | NA | NA | 27.76% | NA | | | | NA | 3 | NA |
| 4 | West Unnamed Creek | 1.04 | 2.45 | 0.95 | 1.04 | 3.02 | 0.95 | 0.0013 | 0.18 | 0.033 | 0.12% | 6.00% | 3.47% | 4767% | 2713% | -42% | 0.14 | 0.57 | 0.13 | 13.26% | 18.84% | 13.83% | 14.0% | 18.4% | 15.2% | 4 | 2, 3, 4 | 4 |
| | Into Lower East Branch Beaver R. #7 | | | | 28.00 | 29.98 | 27.91 | 0.20 | 1.13 | 0.99 | 0.73% | 3.78% | 3.53% | 421% | 387% | -7% | 9.86 | 10.24 | 9.80 | 35.20% | 34.16% | 35.12% | 40.2% | 38.6% | 40.4% | 1,4 | 1-4 | 1,4 |
| 5 | Cedar Creek | 9.86 | 9.86 | 9.86 | 15.93 | 15.93 | 15.93 | 0.57 | 0.82 | 0.82 | 3.59% | 5.14% | 5.14% | 43% | 43% | 0% | 3.08 | 3.04 | 3.04 | 19.33% | 19.08% | 19.08% | | | | 5, 6 | 5, 6 | 5,6 |
| 6 | Nicado Creek | 6.07 | 6.07 | 6.07 | 6.07 | 6.07 | 6.07 | 0.52 | 0.62 | 0.62 | 8.49% | 10.21% | 10.21% | 20% | 20% | 0% | 1.29 | 1.26 | 1.26 | 21.24% | 20.70% | 20.70% | | | | 6 | 6 | 6 |
| 7 | Lower East Branch Beaver River | 4.56 | 4.56 | 4.56 | 48.5 | 50.5 | 48.4 | 0.89 | 2.1 | 1.9 | 1.83% | 4.12% | 3.99% | 125% | 118% | -3% | 13.39 | 13.7 | 13.3 | 27.61% | 27.19% | 27.45% | | | | 1,4-7 | 1-7 | 1,4-7 |
| | **Main Branch Beaver River** | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 8 | Beaver River HW | 17.08 | 17.01 | 17.01 | 17.08 | 17.01 | 17.01 | 0.10 | 0.80 | 0.80 | 0.61% | 4.72% | 4.72% | 675% | 675% | 0% | 6.79 | 6.68 | 6.68 | 39.77% | 39.25% | 39.25% | | | | 8 | 8 | 8 |
| 9 | Kit Creek | 6.97 | 6.97 | 6.97 | 6.97 | 6.97 | 6.97 | 0.04 | 0.36 | 0.36 | 0.59% | 5.14% | 5.14% | 770% | 770% | 0% | 2.34 | 2.33 | 2.33 | 33.58% | 33.47% | 33.46% | | | | 9 | 9 | 9 |
| 10 | Unnamed Creek | 2.2 | 2.20 | 2.2 | 2.2 | 2.2 | 2.2 | 0.04 | 0.13 | 0.13 | 1.83% | 6.13% | 6.13% | 235% | 235% | 0% | 0.70 | 0.69 | 0.69 | 31.71% | 31.23% | 31.23% | | | | 10 | 10 | 10 |
| | Into Upper Middle Beaver River #11 | 24.05 | 47.81 | 47.75 | 24.05 | 47.81 | 47.75 | 0.15 | 2.15 | 2.15 | 0.60% | 4.50% | 4.50% | 644% | 645% | 0% | 9.13 | 18.06 | 18.06 | 37.98% | 37.78% | 37.82% | 21.9% | 21.2% | 21.1% | 8,9 | 8,9,17,18 | 8,9,17,18 |
| 11 | Upper Middle Beaver River | 0.83 | 1.35 | 1.35 | 24.9 | 49.16 | 49.10 | 0.19 | 2.15 | 2.15 | 0.77% | 4.38% | 4.38% | 468% | 469% | 0% | 9.61 | 18.54 | 18.54 | 38.62% | 37.72% | 37.75% | 21.9% | 21.1% | 21.0% | 8,9,11 | 8,9,11,17,18 | 8,9,11,17,18 |
| | Into 12 Lower Middle Beaver River | | | | 56.43 | 49.16 | 49.10 | 0.43 | 2.15 | 2.15 | 0.76% | 4.38% | 4.38% | 476% | 477% | 0% | 20.73 | 18.54 | 18.54 | 36.73% | 37.72% | 37.75% | 20.1% | 21.1% | 21.0% | 8,9,11,17,18,19 | 8,9,11,17,18 | 8,9,11,17,18 |
| 12 | Lower Middle Beaver River | 1.44 | 1.41 | 1.41 | 60.1 | 52.77 | 52.71 | 0.48 | 2.29 | 2.29 | 0.80% | 4.34% | 4.35% | 445% | 445% | 0% | 21.63 | 19.48 | 19.47 | 36.02% | 36.92% | 36.94% | | | | 8-12,17-19 | 8-12, 17-18 | 8-12, 17-18 |
| 13 | West Branch Beaver River | 9.19 | 9.19 | 9.19 | 9.19 | 9.19 | 9.19 | 0.04 | 0.21 | 0.21 | 0.41% | 2.33% | 2.33% | 473% | 473% | 0% | 2.13 | 2.08 | 2.08 | 23.15% | 22.67% | 22.67% | | | | 13 | 13 | 13 |
| 14 | MP7 WTP[1] | 0.00 | 5.00 | 7.12 | 0.00 | 5.00 | 7.12 | NA | 0.12 | 0.25 | NA | 2.46% | 3.52% | NA | NA | 43% | NA | 0.27 | 0.35 | NA | 5.42% | 4.98% | | | | NA | 14 | 14 |
| 15 | Upper Lower Beaver River (Into 16) | 1.31 | 1.31 | 1.31 | 70.57 | 68.27 | 70.33 | 0.52 | 2.63 | 2.76 | 0.73% | 3.86% | 3.92% | 425% | 435% | 2% | 23.83 | 21.84 | 21.91 | 33.77% | 31.99% | 31.15% | 21.6% | 22.5% | 21.6% | 8-13,15,17-19 | 8-15, 17-18 | 8-15, 17-18 |
| 16 | Lower Beaver River | 3.97 | 4.28 | 4.28 | 123.03 | 123.01 | 123.01 | 1.40 | 4.80 | 4.78 | 1.14% | 3.90% | 3.88% | 242% | 240% | -0.4% | 38.07 | 36.72 | 36.42 | 30.95% | 29.85% | 29.61% | | | | 1,4-7,8-13,15-19 | 1-18 | 1,4-18 |
| | **Thirtynine Creek** | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 17 | Little Thirtynine Creek | 6.94 | 6.57 | 6.51 | 6.94 | 6.57 | 6.51 | 0.06 | 0.19 | 0.19 | 0.80% | 2.86% | 2.88% | 255% | 258% | 1% | 2.39 | 2.25 | 2.24 | 34.48% | 34.26% | 34.49% | | | | 17 | 17 | 17 |
| 18 | Big Thirtynine Creek | 17.70 | 17.26 | 17.26 | 17.70 | 17.26 | 17.26 | 0.09 | 0.80 | 0.80 | 0.54% | 4.64% | 4.64% | 765% | 765% | 0% | 6.86 | 6.80 | 6.80 | 38.75% | 39.41% | 39.41% | | | | 18 | 18 | 18 |
| 19 | Thirtynine Creek | 6.91 | 0 | 0 | 31.55 | 0 | 0 | 0.24 | NA | NA | 0.75% | NA | NA | NA | NA | NA | 11.12 | NA | NA | 35.25% | NA | NA | | | | 17,18,19 | NA | NA |

Table 14
Streamflow Discharge and Water Depth Modeling Results
Tailings Basin Progression

| | Modeling Parameters | | | | Results | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Time Period | Watershed Area (sq mi) | Ponds (% of wtshd) | Wetlands & Lakes (% of wtshd) | C Soils (% of wtshd) | 7Q10 Jun-Sept Flow (cfs) | 7Q10 Jun-Sept Depth (ft) | 7Q10 Jun-Sept Elev (ft) | 1.5-yr Flow (cfs) | 1.5-yr Depth (ft) | 1.5-yr Elevation (ft) | 100-yr Flow (cfs) | 100-yr Depth (ft) | 100-yr Elevation (ft) |
| West Unnamed Creek Outlet | | | | | | | | | | | | | |
| Pre-Settlement | 1.04 | 0.12% | 13.26% | 14.00% | 0.084 | 0.12 | 1136.56 | 41.1 | 1.31 | 1137.75 | 428 | 3.91 | 1140.35 |
| Existing | 3.02 | 6.00% | 18.84% | 18.40% | 0.175 | 0.16 | 1136.6 | 38.3 | 1.27 | 1137.71 | 265 | 3.09 | 1139.53 |
| Future | 0.95 | 3.47% | 13.83% | 15.20% | 0.07 | 0.12 | 1136.56 | 17.9 | 0.94 | 1137.38 | 156 | 2.38 | 1138.82 |
| East Branch Beaver River Headwaters (Subwatershed 1) - No Project Influence | | | | | | | | | | | | | |
| Pre-Settlement | 26.96 | 0.75% | 36.05% | 42.10% | 0.72 | 0.16 | 1077.54 | 536 | 3.61 | 1080.99 | 3270 | 5.98 | 1083.36 |
| Existing | 26.96 | 3.53% | 35.87% | 42.10% | 0.73 | 0.16 | 1077.54 | 320 | 3.04 | 1080.42 | 1710 | 5.14 | 1082.52 |
| Future | 26.96 | 3.53% | 35.87% | 42.10% | 0.73 | 0.16 | 1077.54 | 320 | 3.04 | 1080.42 | 1710 | 5.14 | 1082.52 |
| East Branch Beaver River Downstream of West Unnamed Creek | | | | | | | | | | | | | |
| Pre-Settlement | 28.00 | 0.73% | 35.20% | 40.20% | 0.79 | 0.16 | 1077.54 | 557 | 3.65 | 1081.03 | 3390 | 6.04 | 1083.42 |
| Existing | 29.98 | 3.78% | 34.16% | 38.63% | 0.90 | 0.18 | 1077.56 | 341 | 3.11 | 1080.49 | 1780 | 5.18 | 1082.56 |
| Future | 27.91 | 3.53% | 35.12% | 40.40% | 0.79 | 0.16 | 1077.54 | 330 | 3.09 | 1080.47 | 1760 | 5.17 | 1082.55 |
| Main Branch Beaver River Discharge into Upper Middle Subwatershed 11 | | | | | | | | | | | | | |
| Pre-Settlement | 24.05 | 0.60% | 37.98% | 21.90% | 0.84 | 0.38 | 1107.67 | 509 | 3.04 | 1110.33 | 3200 | 6.54 | 1113.83 |
| Existing | 47.81 | 4.50% | 37.78% | 21.16% | 1.85 | 0.50 | 1107.79 | 473 | 2.97 | 1110.26 | 2270 | 5.38 | 1112.68 |
| Future | 47.75 | 4.50% | 37.82% | 21.10% | 1.85 | 0.50 | 1107.79 | 473 | 2.97 | 1110.26 | 2260 | 5.36 | 1112.65 |
| Main Branch Beaver River Discharge into Lower Middle Subwatershed 12 | | | | | | | | | | | | | |
| Pre-Settlement | 58.66 | 0.77% | 36.73% | 20.10% | 2.34 | 0.55 | 1107.84 | 1030 | 3.95 | 1111.24 | 5610 | 7.70 | 1114.99 |
| Existing | 49.16 | 4.38% | 37.72% | 21.11% | 1.91 | 0.50 | 1107.79 | 490 | 3.01 | 1110.3 | 2350 | 5.47 | 1112.76 |
| Future | 49.10 | 4.38% | 37.75% | 21.00% | 1.91 | 0.50 | 1107.79 | 490 | 3.01 | 1110.3 | 2350 | 5.47 | 1112.76 |
| Main Branch Beaver River Discharge into Lower Beaver River Subwatershed 16 (without Subwatershed 14 for existing and future) | | | | | | | | | | | | | |
| Pre-Settlement | 70.57 | 0.73% | 33.77% | 21.60% | 3.15 | NA | NA | 1240 | NA | NA | 6580 | NA | NA |
| Existing | 63.27 | 3.97% | 34.09% | 22.50% | 2.71 | NA | NA | 636 | NA | NA | 2970 | NA | NA |
| Future | 63.21 | 3.97% | 34.10% | 21.60% | 2.76 | NA | NA | 636 | NA | NA | 2970 | NA | NA |
| Main Branch Beaver River Discharge into Lower Beaver River Subwatershed 16[1] | | | | | | | | | | | | | |
| Pre-Settlement | 70.57 | 0.73% | 33.77% | 21.60% | 3.15 | NA | NA | 1240 | NA | NA | 6580 | NA | NA |
| Existing | 68.27 | 3.97% | 34.09% | 22.50% | 8.84 | NA | NA | 643.2 | NA | NA | 2977.2 | NA | NA |
| Future | 70.33 | 3.97% | 34.10% | 21.60% | 8.89 | NA | NA | 643.2 | NA | NA | 2977.2 | NA | NA |
| Little 39 Creek Subwatershed (#17 Pre-Settlement, #3 Existing) | | | | | | | | | | | | | |
| Pre-Settlement | 6.94 | 0.80% | 34.26% | 21.90% | 0.23 | NA | NA | 164 | NA | NA | 1200 | NA | NA |
| Existing | 0.11 | 4.06% | 27.76% | 21.20% | 0.003 | NA | NA | 2.6 | NA | NA | 30.6 | NA | NA |
| Big 39 Creek Subwatershed (#18 Pre-Settlement, #2 Existing) | | | | | | | | | | | | | |
| Pre-Settlement | 17.7 | 0.54% | 39.41% | 21.90% | 0.58 | NA | NA | 399 | NA | NA | 2640 | NA | NA |
| Existing | 0.46 | 1.87% | 17.56% | 21.20% | 0.023 | NA | NA | 12.2 | NA | NA | 126 | NA | NA |
| MilePost 7 Subwatershed 14 | | | | | | | | | | | | | |
| Existing | 5 | 2.46% | 5.42% | 12.00% | 1.14 | NA | NA | 86.6 | NA | NA | 614 | NA | NA |

[1]Watershed area includes Subwatershed 14 and modeling parameters include Subwatershed 14 for pre-settlement conditions. Modeling paramters for existing and future conditions do not include Subwatershed 14, because that discharge is controlled by the Northshore water treatment plant (WTP). Modeled flows for 7Q10 include modeled flows for Subwatershed 15 plus the average August flow from the WTP. Flows for the 1.5-year and 100-year events included modeled flows for Subwatershed 15 plus the average daily maximum flow for the WTP.

Table 15
MnRAM Assessment Results
Tailings Basin Progression

| MnRAM 3.4 Functions and Values | Barr Mine MnRAM Functions/Values | Wetland 1a | Wetland 1b | Wetland 2 | Wetland 3a | Wetland 3b | Wetland 3c | Wetland 4 | Wetland 5 | Wetland 6 | Wetland 8 | Wetland 9 | Wetland 10 | Wetland 11a | Wetland 11b | Wetland 11c | Wetland 12 | Wetland 13 | Wetland 14 | Wetland 15 | Wetland 16b | Wetland 17a | Wetland 17b |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ***Vegetative Diversity/Integrity Score*** | | 1.0 | 1.0 | 0.5 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 2.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 2.0 | 0.5 | 0.5 | 1.0 | 0.5 |
| ***Vegetative Diversity/Integrity Rating*** | | High | High | Moderate | High | High | High | High | High | High | Exceptional | High | High | High | High | High | High | High | Exceptional | Moderate | Moderate | High | Moderate |
| *Maintenance of hydrologic regime* | **Outlet condition** | 1 | 1 | 1 | 0.1 | 1 | 1 | 1 | 1 | 0.1 | 0.1 | 0.1 | 1 | 1 | 1 | 1 | 0.5 | 0.5 | 0.5 | 0.1 | 0.1 | 0.1 | 0.1 |
| | **Upland condition** | 0.5 | 0.5 | 0.5 | 1 | 1 | 1 | 1 | 0.5 | 0.5 | 0.5 | 0.5 | 1 | 1 | 1 | 1 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| | **Human disturbance[3]** | 0.5 | 0.5 | 0.5 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 1 | 1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| ***Maintenance of Hydrologic Regime Score*** | | 0.67 | 0.67 | 0.67 | 0.40 | 0.70 | 0.70 | 0.70 | 0.53 | 0.53 | 0.53 | 0.23 | 0.70 | 0.70 | 0.70 | 0.70 | 0.37 | 0.50 | 0.50 | 0.37 | 0.37 | 0.37 | 0.37 |
| ***Maintenance of Hydrologic Regime Rating*** | | High | High | High | Moderate | High | High | High | Moderate | Moderate | Moderate | Low | High | High | High | High | Moderate | Moderate | Moderate | Moderate | Moderate | Moderate | Moderate |
| *Flood/stormwater/ attenuation* | **Outlet condition** | 1 | 1 | 1 | 0.1 | 1 | 1 | 1 | 1 | 0.1 | 0.1 | 0.1 | 1 | 1 | 1 | 1 | 0.5 | 0.5 | 0.5 | 0.1 | 0.1 | 0.1 | 0.1 |
| | **Upland condition[4]** | 0.5 | 0.5 | 0.5 | 1 | 1 | 1 | 1 | 0.5 | 0.5 | 0.5 | 0.5 | 1 | 1 | 1 | 1 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| | **Human disturbance** | 0.5 | 0.5 | 0.5 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 1 | 1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| ***Flood/Stormwater/Attenuation Score*** | | 0.67 | 0.67 | 0.67 | 0.40 | 0.70 | 0.70 | 0.70 | 0.53 | 0.53 | 0.53 | 0.23 | 0.70 | 0.70 | 0.70 | 0.70 | 0.37 | 0.50 | 0.50 | 0.37 | 0.37 | 0.37 | 0.37 |
| ***Flood/Stormwater/Attenuation Rating*** | | High | High | High | Moderate | High | High | High | Moderate | Moderate | Moderate | Low | High | High | High | High | Moderate | Moderate | Moderate | Moderate | Moderate | Moderate | Moderate |
| *Downstream water quality* | **Outlet condition** | 1 | 1 | 1 | 0.1 | 1 | 1 | 1 | 1 | 0.1 | 0.1 | 0.1 | 1 | 1 | 1 | 1 | 0.5 | 0.5 | 0.5 | 0.1 | 0.1 | 0.1 | 0.1 |
| | **Upland condition** | 0.5 | 0.5 | 0.5 | 1 | 1 | 1 | 1 | 0.5 | 0.5 | 0.5 | 0.5 | 1 | 1 | 1 | 1 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| | **Human disturbance** | 0.5 | 0.5 | 0.5 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 1 | 1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| ***Downstream Water Quality Score*** | | 0.67 | 0.67 | 0.67 | 0.40 | 0.70 | 0.70 | 0.70 | 0.53 | 0.53 | 0.53 | 0.23 | 0.70 | 0.70 | 0.70 | 0.70 | 0.37 | 0.50 | 0.50 | 0.37 | 0.37 | 0.37 | 0.37 |
| ***Downstream Water Quality Rating*** | | High | High | High | Moderate | High | High | High | Moderate | Moderate | Moderate | Low | High | High | High | High | Moderate | Moderate | Moderate | Moderate | Moderate | Moderate | Moderate |
| *Maintenance of wetland water quality* | **Vegetative diversity** | 1 | 1 | 0.5 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 0.5 | 0.5 | 1 | 0.5 |
| | **Upland condition** | 0.5 | 0.5 | 0.5 | 1 | 1 | 1 | 1 | 0.5 | 0.5 | 0.5 | 0.5 | 1 | 1 | 1 | 1 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| | **Human disturbance[3]** | 0.5 | 0.5 | 0.5 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 1 | 1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| ***Maintenance of Wetland Water Quality Score*** | | 0.67 | 0.67 | 0.50 | 0.70 | 0.70 | 0.70 | 0.70 | 0.53 | 0.83 | 1.17 | 0.53 | 0.70 | 0.70 | 0.70 | 0.70 | 0.53 | 0.67 | 1.00 | 0.50 | 0.50 | 0.67 | 0.50 |
| ***Maintenance of Wetland Water Quality Rating*** | | High | High | Moderate | High | High | High | High | Moderate | High | High | Moderate | High | High | High | High | Moderate | High | High | Moderate | Moderate | High | Moderate |
| ***Shoreline protection Score*** | | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | 0.62 |
| ***Shoreline protection Rating*** | | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | Moderate |
| *Maintenance of characteristic wildlife habitat structure* | **Wildlife habitat** | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0.5 | 1 | 1 | 1 | 0.1 | 0.1 |
| | **Outlet condition** | 1 | 1 | 1 | 0.1 | 1 | 1 | 1 | 1 | 0.1 | 0.1 | 0.1 | 1 | 1 | 1 | 1 | 0.5 | 0.5 | 0.5 | 0.1 | 0.1 | 0.1 | 0.1 |
| | **Upland condition** | 0.5 | 0.5 | 0.5 | 1 | 1 | 1 | 1 | 0.5 | 0.5 | 0.5 | 0.5 | 1 | 1 | 1 | 1 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| | **Human disturbance[3]** | 0.5 | 0.5 | 0.5 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 1 | 1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| | **Vegetative diversity** | 1 | 1 | 0.5 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 0.5 | 0.5 | 1 | 0.5 |
| ***Maintenance of Characteristic Wildlife Habitat Structure Score*** | | 0.80 | 0.80 | 0.70 | 0.64 | 0.82 | 0.82 | 0.82 | 0.72 | 0.72 | 0.92 | 0.54 | 0.82 | 0.82 | 0.82 | 0.82 | 0.62 | 0.60 | 0.90 | 0.52 | 0.52 | 0.44 | 0.34 |
| ***Maintenance of Characteristic Wildlife Habitat Structure Rating*** | | High | High | High | Moderate | High | High | High | High | High | High | Moderate | High | High | High | High | Moderate | Moderate | High | Moderate | Moderate | Moderate | Moderate |
| *Maintenance of characteristic fish habitat* | **Upland condition** | 0.5 | 0.5 | 0.5 | 1 | 1 | 1 | 1 | 0.5 | 0.5 | 0.5 | 0.5 | 1 | 1 | 1 | 1 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| | **Human disturbance[3]** | 0.5 | 0.5 | 0.5 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 1 | 1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| ***Maintenance of Characteristic Fish Habitat Score*** | | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | 0.83 |
| ***Maintenance of Characteristic Fish Habitat Rating*** | | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | High |
| *Maintenance of characteristic amphibian habitat* | **Wildlife habitat** | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0.5 | 1 | 1 | 1 | 0.1 | 0.1 |
| | **Upland condition** | 0.5 | 0.5 | 0.5 | 1 | 1 | 1 | 1 | 0.5 | 0.5 | 0.5 | 0.5 | 1 | 1 | 1 | 1 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| | **Human disturbance[3]** | 0.5 | 0.5 | 0.5 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 1 | 1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| ***Maintenance of Characteristic Amphibian Habitat Score*** | | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | 0.26 |
| ***Maintenance of Characteristic Amphibian Habitat Rating*** | | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | Low |
| ***Aesthetics/Recreational/Educational/Cultural Score*** | | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| ***Aesthetics/Recreational/Educational/Cultural Rating*** | | Low | Low | Low | Low | Low | Low | Low | Low | Low | Low | Low | Low | Low | Low | Low | Low | Low | Low | Low | Low | Low | Low |

Table 15
MnRAM Assessment Results
Tailings Basin Progression

| MnRAM 3.4 Functions and Values | Barr Mine MnRAM Functions/Values | Wetland 18 | Wetland 19 | Wetland 20 | Wetland 21 | Wetland 22 | Wetland 23 | Wetland 24 | Wetland 25 | Wetland 26 | Wetland 27 | Wetland 28 | Wetland 29 | Wetland 32 | Wetland 33 | Wetland 34 | Wetland 35 | Wetland 36 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ***Vegetative Diversity/Integrity Score*** | | 0.5 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| ***Vegetative Diversity/Integrity Rating*** | | Moderate | High | High | High | High | High | High | High | High | High | High | High | High | High | High | High | High |
| *Maintenance of hydrologic regime* | **Outlet condition** | 0.1 | 1 | 1 | 1 | 1 | 1 | 0.5 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0.5 |
| | **Upland condition** | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| | **Human disturbance[3]** | 1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| ***Maintenance of Hydrologic Regime Score*** | | 0.70 | 0.70 | 0.70 | 0.70 | 0.70 | 0.70 | 0.53 | 0.70 | 0.70 | 0.70 | 0.70 | 0.70 | 0.70 | 0.70 | 0.70 | 0.70 | 0.53 |
| ***Maintenance of Hydrologic Regime Rating*** | | High | High | High | High | High | High | Moderate | High | High | High | High | High | High | High | High | High | Moderate |
| *Flood/stormwater/ attenuation* | **Outlet condition** | 0.1 | 1 | 1 | 1 | 1 | 1 | 0.5 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0.5 |
| | **Upland condition[4]** | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| | **Human disturbance** | 1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| ***Flood/Stormwater/Attenuation Score*** | | 0.70 | 0.70 | 0.70 | 0.70 | 0.70 | 0.70 | 0.53 | 0.70 | 0.70 | 0.70 | 0.70 | 0.70 | 0.70 | 0.70 | 0.70 | 0.70 | 0.53 |
| ***Flood/Stormwater/Attenuation Rating*** | | High | High | High | High | High | High | Moderate | High | High | High | High | High | High | High | High | High | Moderate |
| *Downstream water quality* | **Outlet condition** | 0.1 | 1 | 1 | 1 | 1 | 1 | 0.5 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0.5 |
| | **Upland condition** | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| | **Human disturbance** | 1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| ***Downstream Water Quality Score*** | | 0.70 | 0.70 | 0.70 | 0.70 | 0.70 | 0.70 | 0.53 | 0.70 | 0.70 | 0.70 | 0.70 | 0.70 | 0.70 | 0.70 | 0.70 | 0.70 | 0.53 |
| ***Downstream Water Quality Rating*** | | High | High | High | High | High | High | Moderate | High | High | High | High | High | High | High | High | High | Moderate |
| *Maintenance of wetland water quality* | **Vegetative diversity** | 0.5 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| | **Upland condition** | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| | **Human disturbance[3]** | 1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| ***Maintenance of Wetland Water Quality Score*** | | 0.83 | 0.70 | 0.70 | 0.70 | 0.70 | 0.70 | 0.70 | 0.70 | 0.70 | 0.70 | 0.70 | 0.70 | 0.70 | 0.70 | 0.70 | 0.70 | 0.70 |
| ***Maintenance of Wetland Water Quality Rating*** | | High | High | High | High | High | High | High | High | High | High | High | High | High | High | High | High | High |
| ***Shoreline protection Score*** | | 0.34 | NA | NA | NA | NA | 0.36 | NA | NA | NA | 0.36 | NA | NA | NA | NA | NA | NA | NA |
| ***Shoreline protection Rating*** | | Moderate | NA | NA | NA | NA | Moderate | NA | NA | NA | Moderate | NA | NA | NA | NA | NA | NA | NA |
| *Maintenance of characteristic wildlife habitat structure* | **Wildlife habitat** | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| | **Outlet condition** | 0.1 | 1 | 1 | 1 | 1 | 1 | 0.5 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0.5 |
| | **Upland condition** | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| | **Human disturbance[3]** | 1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| | **Vegetative diversity** | 0.5 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| ***Maintenance of Characteristic Wildlife Habitat Structure Score*** | | 0.72 | 0.82 | 0.82 | 0.82 | 0.82 | 0.82 | 0.72 | 0.82 | 0.82 | 0.82 | 0.82 | 0.82 | 0.82 | 0.82 | 0.82 | 0.82 | 0.72 |
| ***Maintenance of Characteristic Wildlife Habitat Structure Rating*** | | High | High | High | High | High | High | High | High | High | High | High | High | High | High | High | High | High |
| *Maintenance of characteristic fish habitat* | **Upland condition** | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| | **Human disturbance[3]** | 1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| ***Maintenance of Characteristic Fish Habitat Score*** | | 0.69 | NA | NA | NA | NA | 0.89 | NA | NA | NA | 0.88 | NA | NA | NA | NA | NA | NA | NA |
| ***Maintenance of Characteristic Fish Habitat Rating*** | | High | NA | NA | NA | NA | High | NA | NA | NA | High | NA | NA | NA | NA | NA | NA | NA |
| *Maintenance of characteristic amphibian habitat* | **Wildlife habitat** | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| | **Upland condition** | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| | **Human disturbance[3]** | 1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| ***Maintenance of Characteristic Amphibian Habitat Score*** | | 0.42 | NA | NA | NA | NA | 0.34 | NA | NA | NA | 0.34 | NA | NA | NA | NA | NA | NA | NA |
| ***Maintenance of Characteristic Amphibian Habitat Rating*** | | Moderate | NA | NA | NA | NA | Moderate | NA | NA | NA | Moderate | NA | NA | NA | NA | NA | NA | NA |
| ***Aesthetics/Recreational/Educational/Cultural Score*** | | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| ***Aesthetics/Recreational/Educational/Cultural Rating*** | | Low | Low | Low | Low | Low | Low | Low | Low | Low | Low | Low | Low | Low | Low | Low | Low | Low |

Table 16
Wetland Impact Functional Summary
Tailings Basin Progression

| Functional Rating | Exceptional | High | Moderate | Low | NA | Total |
|---|---|---|---|---|---|---|
| | Impact Area (ac) | | | | | |
| **Beaver River Subwatershed Direct Impacts** | | | | | | |
| Vegetative Diversity | 1.4 | 8.2 | 0.0 | 0.0 | 0.0 | 9.6 |
| Hydrologic Regime | 0.0 | 0.0 | 9.6 | 0.0 | 0.0 | 9.6 |
| Flood Storage | 0.0 | 0.0 | 9.6 | 0.0 | 0.0 | 9.6 |
| Downstream Water Quality | 0.0 | 0.0 | 9.6 | 0.0 | 0.0 | 9.6 |
| Wetland Water Quality | 0.0 | 9.6 | 0.0 | 0.0 | 0.0 | 9.6 |
| Shoreline Protection | 0.0 | 0.0 | 0.0 | 0.0 | 9.6 | 9.6 |
| Wildlife Habitat | 0.0 | 1.4 | 8.2 | 0.0 | 0.0 | 9.6 |
| Fish Habitat | 0.0 | 0.0 | 0.0 | 0.0 | 9.6 | 9.6 |
| Amphibian Habitat | 0.0 | 0.0 | 0.0 | 0.0 | 9.6 | 9.6 |
| Aesthetics/Recreation/Education | 0.0 | 0.0 | 0.0 | 9.6 | 0.0 | 9.6 |
| **Beaver River Subwatershed Indirect Impacts** | | | | | | |
| Vegetative Diversity | 0.0 | 4.0 | 0.0 | 0.0 | 0.0 | 4.0 |
| Hydrologic Regime | 0.0 | 0.0 | 4.0 | 0.0 | 0.0 | 4.0 |
| Flood Storage | 0.0 | 0.0 | 4.0 | 0.0 | 0.0 | 4.0 |
| Downstream Water Quality | 0.0 | 0.0 | 4.0 | 0.0 | 0.0 | 4.0 |
| Wetland Water Quality | 0.0 | 4.0 | 0.0 | 0.0 | 0.0 | 4.0 |
| Shoreline Protection | 0.0 | 0.0 | 0.0 | 0.0 | 4.0 | 4.0 |
| Wildlife Habitat | 0.0 | 0.0 | 4.0 | 0.0 | 0.0 | 4.0 |
| Fish Habitat | 0.0 | 0.0 | 0.0 | 0.0 | 4.0 | 4.0 |
| Amphibian Habitat | 0.0 | 0.0 | 0.0 | 0.0 | 4.0 | 4.0 |
| Aesthetics/Recreation/Education | 0.0 | 0.0 | 0.0 | 4.0 | 0.0 | 4.0 |
| **East Branch Beaver River Watershed Direct Impacts** | | | | | | |
| Vegetative Diversity | 2.7 | 127.0 | 82.7 | 0.0 | 0.0 | 212.4 |
| Hydrologic Regime | 0.0 | 150.7 | 58.2 | 3.5 | 0.0 | 212.4 |
| Flood Storage | 0.0 | 150.7 | 58.2 | 3.5 | 0.0 | 212.4 |
| Downstream Water Quality | 0.0 | 150.7 | 58.2 | 3.5 | 0.0 | 212.4 |
| Wetland Water Quality | 0.0 | 149.1 | 63.3 | 0.0 | 0.0 | 212.4 |
| Shoreline Protection | 0.0 | 0.0 | 62.5 | 0.0 | 149.9 | 212.4 |
| Wildlife Habitat | 0.0 | 167.1 | 45.3 | 0.0 | 0.0 | 212.4 |
| Fish Habitat | 0.0 | 62.5 | 0.0 | 0.0 | 149.9 | 212.4 |
| Amphibian Habitat | 0.0 | 0.0 | 62.0 | 0.5 | 149.9 | 212.4 |
| Aesthetics/Recreation/Education | 0.0 | 0.0 | 0.0 | 212.4 | 0.0 | 212.4 |
| **East Branch Beaver River Watershed Indirect Impacts** | | | | | | |
| Vegetative Diversity | 0.0 | 41.5 | 0.0 | 0.0 | 0.0 | 41.5 |
| Hydrologic Regime | 0.0 | 41.4 | 0.1 | 0.0 | 0.0 | 41.5 |
| Flood Storage | 0.0 | 41.4 | 0.1 | 0.0 | 0.0 | 41.5 |
| Downstream Water Quality | 0.0 | 41.4 | 0.1 | 0.0 | 0.0 | 41.5 |
| Wetland Water Quality | 0.0 | 41.5 | 0.0 | 0.0 | 0.0 | 41.5 |
| Shoreline Protection | 0.0 | 0.0 | 33.7 | 0.0 | 7.8 | 41.5 |
| Wildlife Habitat | 0.0 | 41.5 | 0.0 | 0.0 | 0.0 | 41.5 |
| Fish Habitat | 0.0 | 33.7 | 0.0 | 0.0 | 7.8 | 41.5 |
| Amphibian Habitat | 0.0 | 0.0 | 33.7 | 0.0 | 7.8 | 41.5 |
| Aesthetics/Recreation/Education | 0.0 | 0.0 | 0.0 | 41.5 | 0.0 | 41.5 |

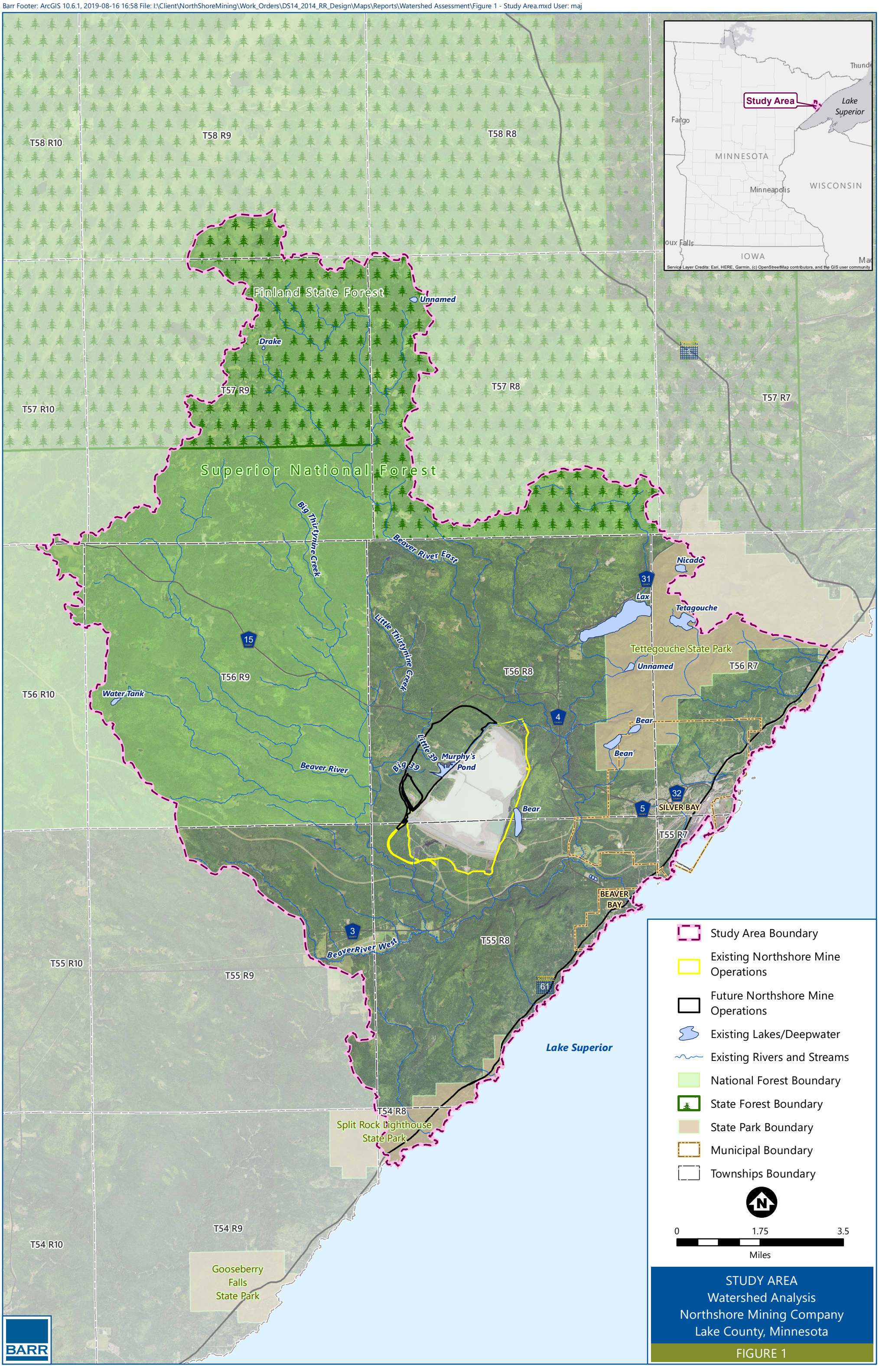
Table 17
Summary of Wetland and Watershed Modifications - Wetlands 34 and 35
Tailings Basin Progression

| Wetland ID | Existing Conditions | | | Future Conditions | | | Percent Watershed Change | Percent Change in Ratio |
|---|---|---|---|---|---|---|---|---|
| | Wetland (acres) | Watershed[1] (acres) | Ratio | Wetland (acres) | Watershed[1] (acres) | Ratio | | |
| Wetland 34 | 18.24 | 85.6 | 4.7 | NA | NA | NA | NA | NA |
| North Wetland 34 | 7.66 | 33.3 | 4.3 | 1.47 | 10.9 | 7.4 | -67% | 72% |
| South Wetland 34 | 10.58 | 52.3 | 4.9 | 7.53 | 32.9 | 4.4 | -37% | -10% |
| South Wetland 34 (including Wetland 35 Watershed) | NA | NA | NA | 7.53 | 41.4 | 5.5 | NA | NA |
| Wetland 35 | 4.27 | 18.5 | 4.3 | 2.73 | 23.0 | 8.4 | 24% | 94% |
| North Wetland 35 | 1.71 | 5.1 | 3.0 | 1.53 | 14.7 | 9.6 | 188% | 220% |
| South Wetland 35 | 2.56 | 13.4 | 5.2 | 1.2 | 8.5 | 7.1 | -37% | 37% |

[1] watershed area includes the wetland area (i.e., total watershed area)

# Figures

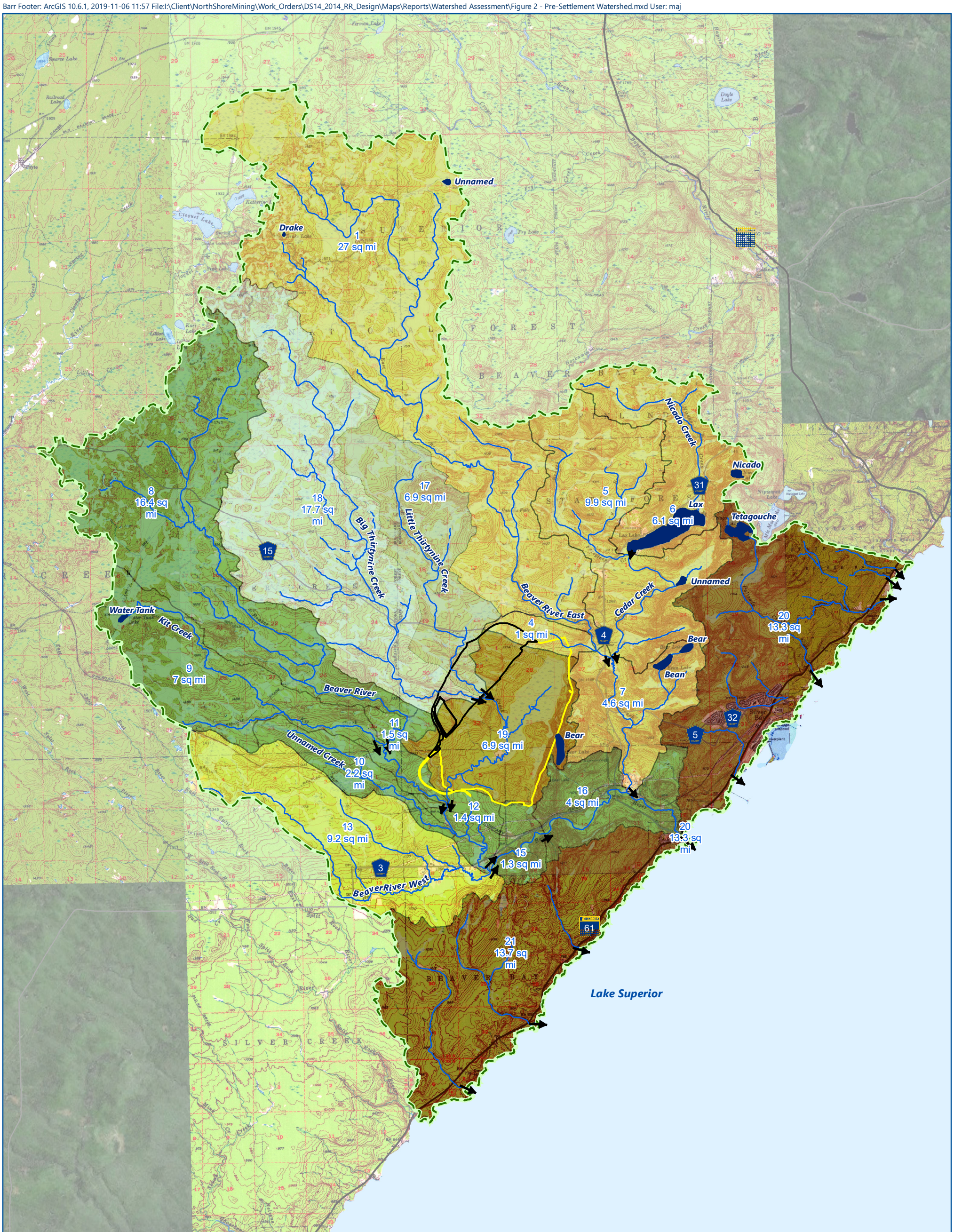
Barr Footer: ArcGIS 10.6.1, 2019-08-16 16:58 File: I:\Client\NorthShoreMining\Work_Orders\DS14_2014_RR_Design\Maps\Reports\Watershed Assessment\Figure 1 - Study Area.mxd User: maj




STUDY AREA
Watershed Analysis
Northshore Mining Company
Lake County, Minnesota

FIGURE 1

Barr Footer: ArcGIS 10.6.1, 2019-11-06 11:57 File:I:\Client\NorthShoreMining\Work_Orders\DS14_2014_RR_Design\Maps\Reports\Watershed Assessment\Figure 2 - Pre-Settlement Watershed.mxd User: maj




## Legend

- Pre-Settlement Flow Direction
- Pre-Settlement Watershed
- Pre-Settlement Streams
- Pre-Settlement Lakes
- Future Northshore Mine Operations
- Existing Northshore Mine Operations
- Pre-Settlement Wetlands

**Pre-Settlement Subwatersheds (6.3 = sq mi wtshd)**

- Big Thirtynine Creek
- Little Thirtynine Creek
- Thirtynine Creek
- East Branch Beaver River
- West Branch Beaver River
- Beaver River
- Lake Superior

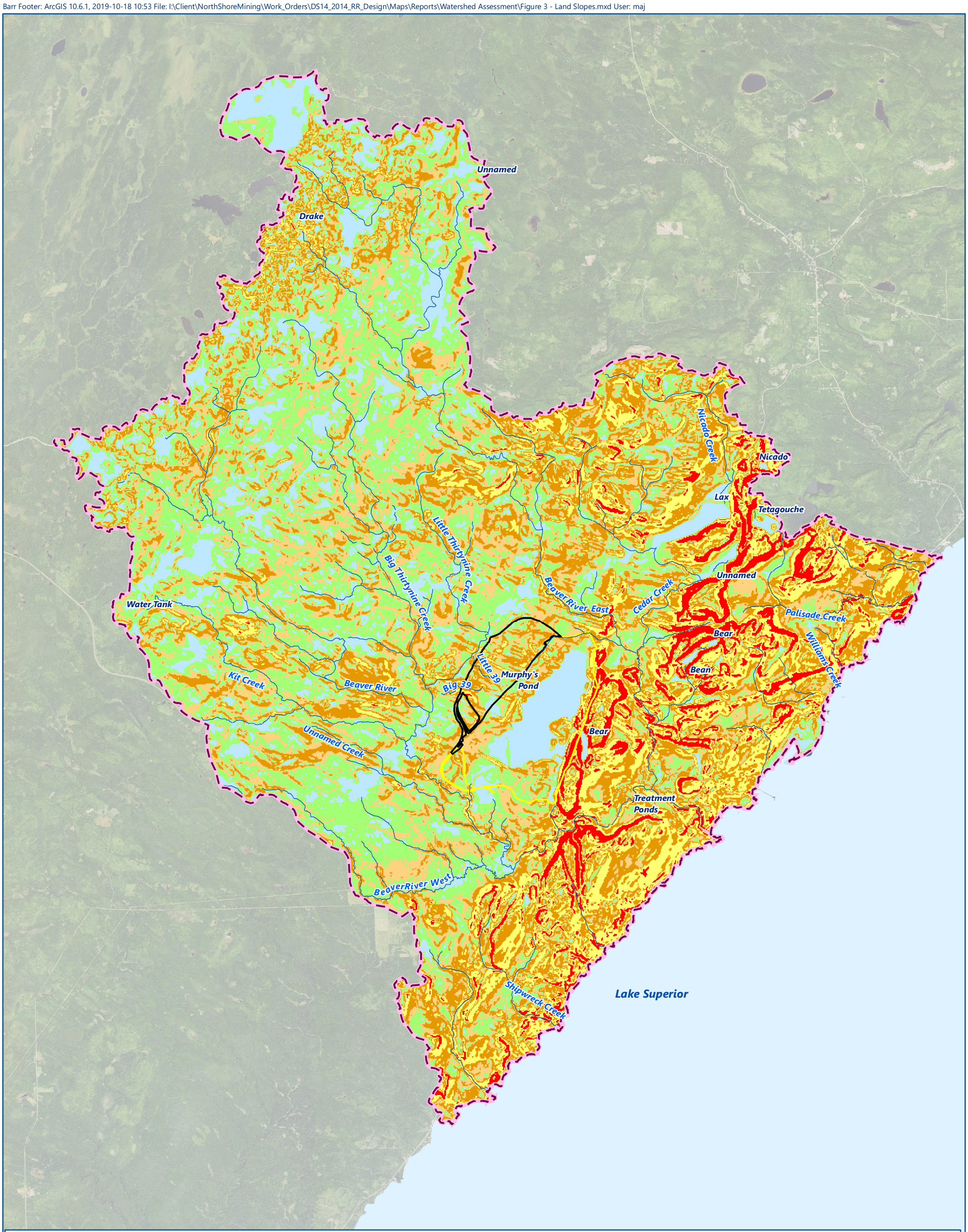
N

0 1.75 3.5
Miles

PRE-SETTLEMENT RESOURCES
Watershed Analysis
Northshore Mining Company
Lake County, Minnesota

FIGURE 2

BARR




**Legend**

- Study Area Boundary
- Existing Rivers and Streams
- Future Northshore Mine Operations
- Existing Northshore Mine Operations

**Land Slope**

- 0% - 1%
- 1% - 3%
- 10% -20%
- 3% - 5%
- 5% -10%
- >20%

N

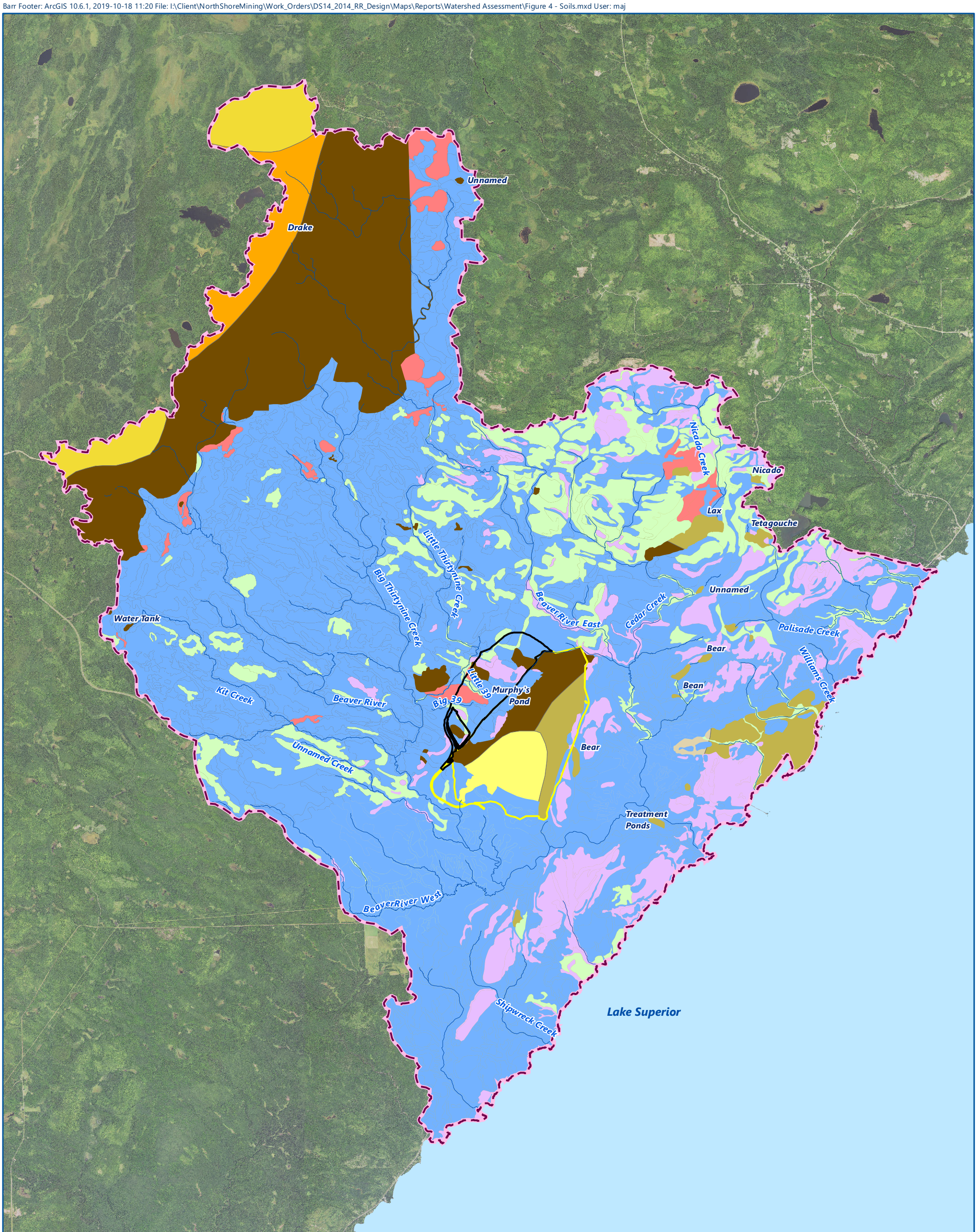
0 1.75 3.5
Miles

LAND SLOPES
Watershed Analysis
Northshore Mining Company
Lake County, Minnesota

FIGURE 3

BARR

Barr Footer: ArcGIS 10.6.1, 2019-10-18 11:20 File: I:\Client\NorthShoreMining\Work_Orders\DS14_2014_RR_Design\Maps\Reports\Watershed Assessment\Figure 4 - Soils.mxd User: maj




**Legend**

- Study Area Boundary
- Existing Rivers and Streams
- Future Northshore Mine Operations
- Existing Northshore Mine Operations

**Hydrologic Group - Dominant Conditions**

- A
- A/D
- B
- B/D
- C
- C/D
- D

**Soil and Land Surfaces (Cummins and Grigal, 1981)**

- Coarse-loamy
- Fine-loamy
- Hemic
- Loamy
- Sandy-skeletal
- Very-fine

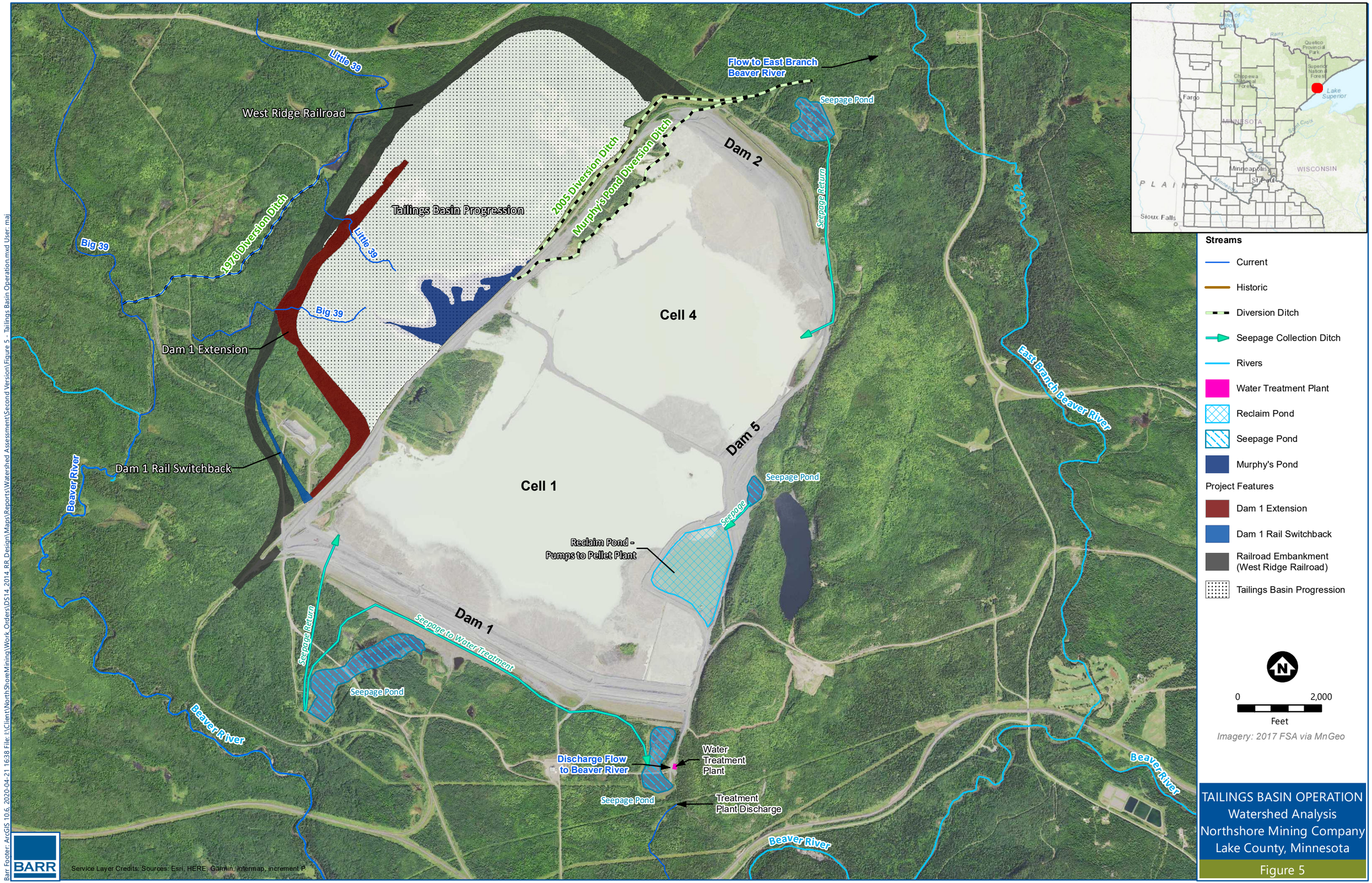
N

0 1.75 3.5
Miles

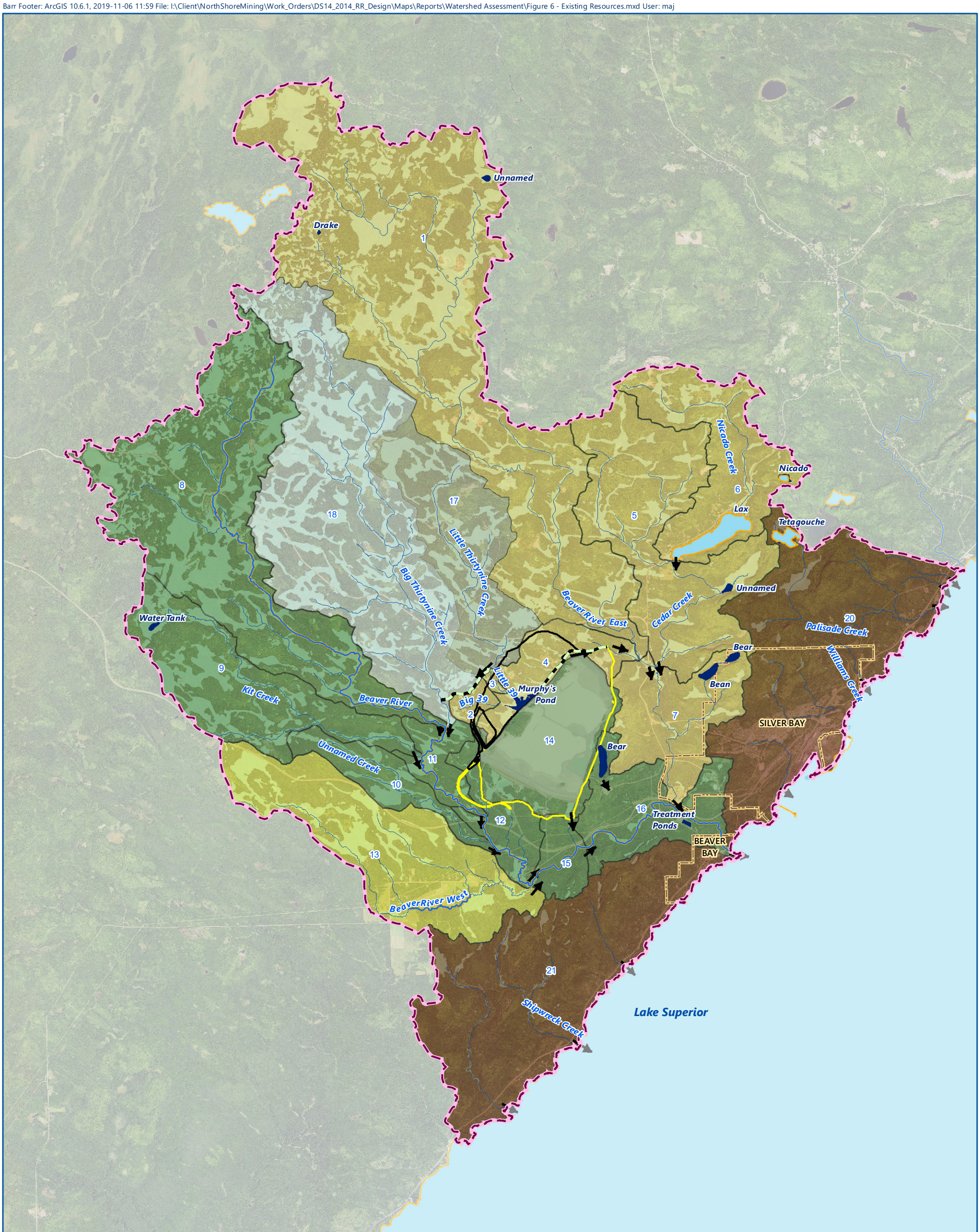
BARR

HYDROLOGIC SOIL GROUPS
Watershed Analysis
Northshore Mining Company
Lake County, Minnesota

FIGURE 4




Barr Footer: ArcGIS 10.6, 2020-04-21 16:38 File: I:\Client\NorthShoreMining\Work Orders\DS14_2014_RR Design\Maps\Reports\Watershed Assessment\Second Version\Figure 5 - Tailings Basin Operation.mxd User: maj




## Legend

- Diversion Ditch
- Study Area Boundary
- Impaired Streams
- Impaired Lakes
- Existing Rivers and Streams
- Existing Lakes/Deepwater
- Future Northshore Mine Operations
- Existing Wetlands
- Existing Northshore Mine Operations

**Existing Watershed (5.3 = sq mi wtshd)**

- Big Thirtynine Creek
- Little Thirtynine Creek
- East Branch Beaver River
- West Branch Beaver River
- Beaver River
- Lake Superior

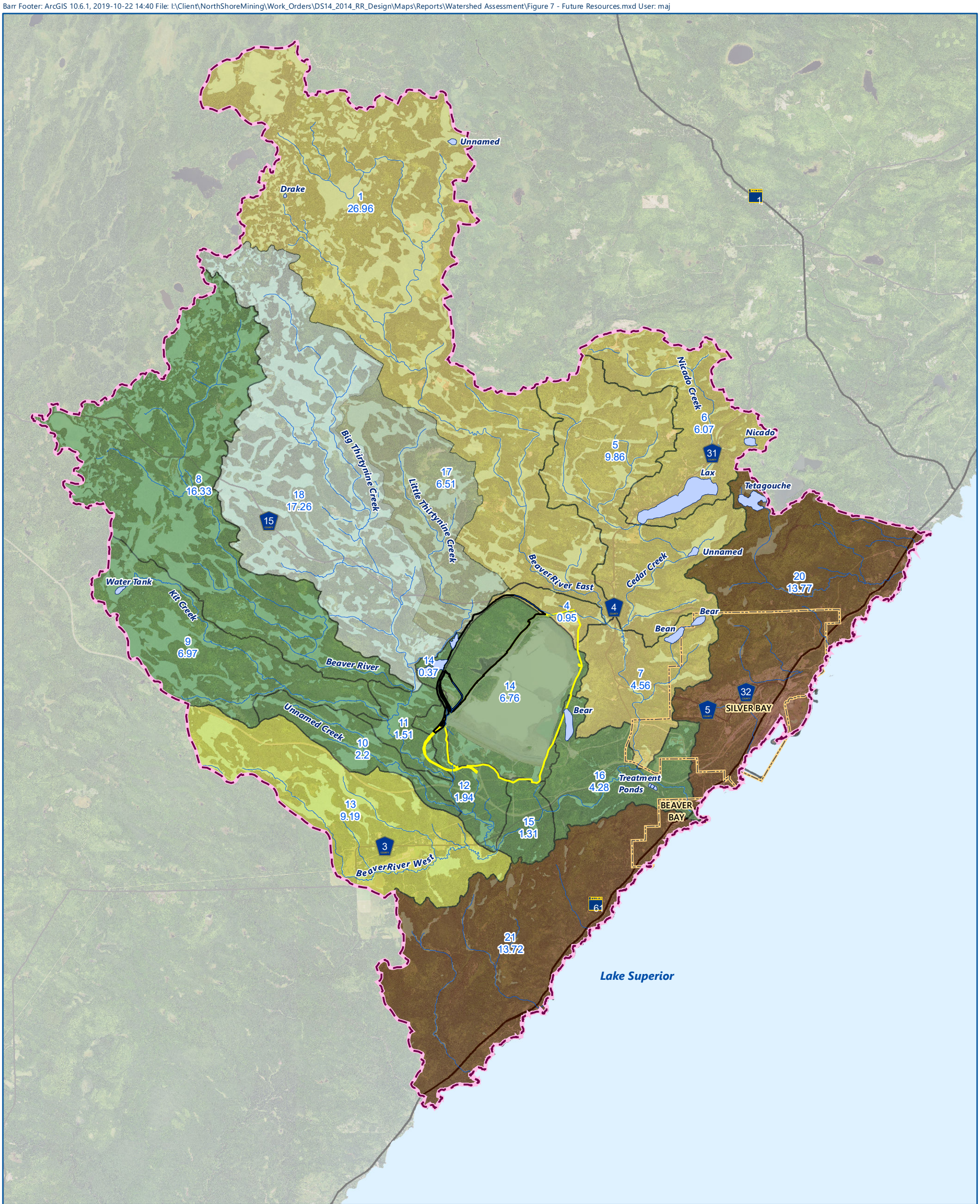
N

0 1.75 3.5
Miles

EXISTING RESOURCES
Watershed Analysis
Northshore Mining Company
Lake County, Minnesota

FIGURE 6

BARR




## Legend

- Study Area Boundary
- Future Rivers and Streams
- Future Lakes/Deepwater
- Municipal Boundary
- Future Northshore Mine Operations
- Existing Northshore Mine Operations
- Future Wetlands

**Future Watersheds (7.1 = sq mi wtshd)**

- Big Thirtynine Creek
- Little Thirtynine Creek
- East Branch Beaver River
- West Branch Beaver River
- Beaver River
- Lake Superior

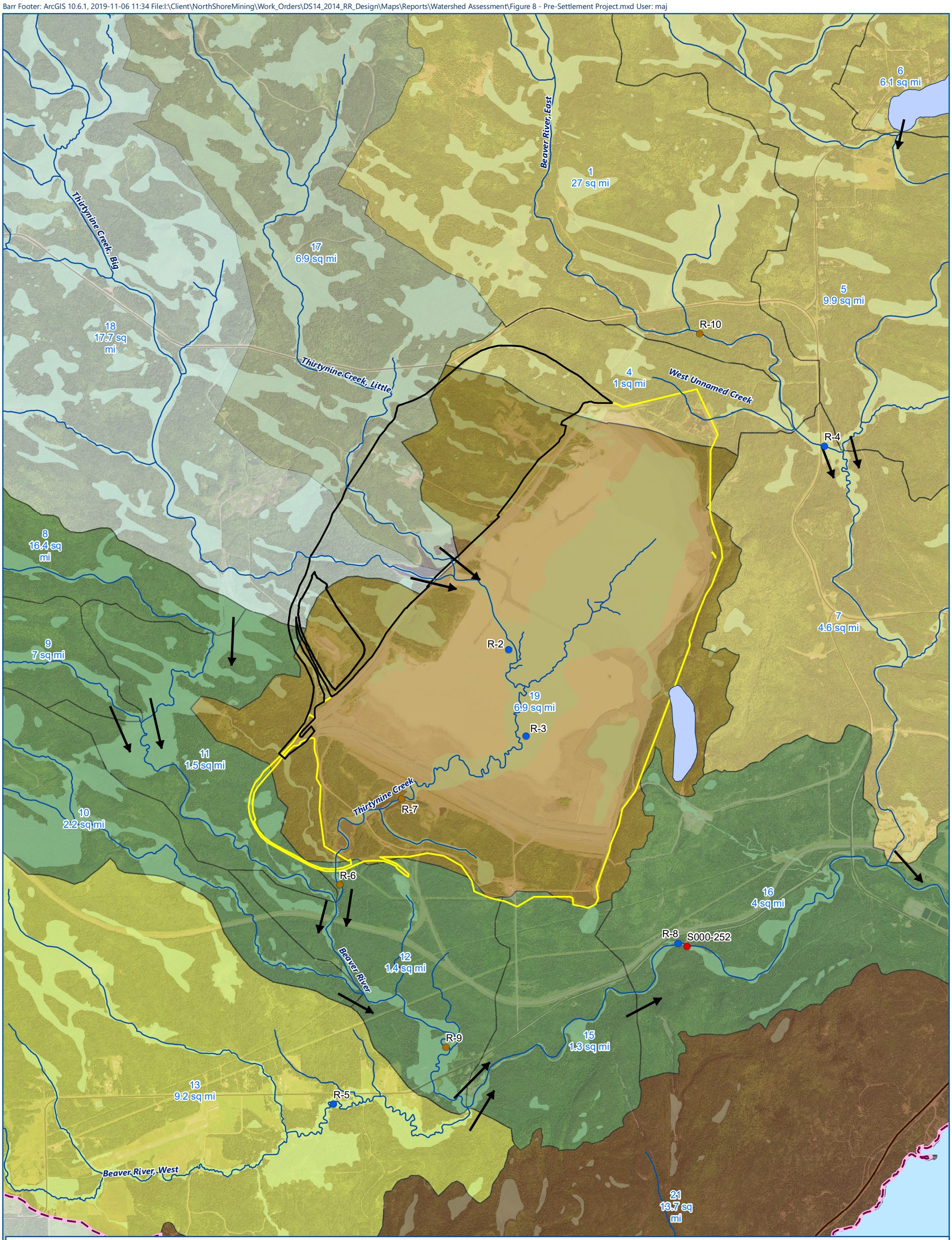
N

0 1.75 3.5
Miles

FORESEEABLE FUTURE RESOURCES
Watershed Analysis
Northshore Mining Company
Lake County, Minnesota

FIGURE 7

BARR




## Legend

**Pre-Settlement Data**

- Biological
- Discharge
- Flow/WQ
- WQ/Biological
- Pre-Settlement Flow Direction
- Pre-Settlement Streams
- Study Area Boundary
- Pre-Settlement Lakes
- Pre-Settlement Wetlands

- Future Northshore Mine Operations
- Existing Northshore Mine Operations

**Pre-Settlement Watersheds (6.3 = sq mi wtshd)**

- Big Thirtynine Creek
- Little Thirtynine Creek
- Thirtynine Creek
- East Branch Beaver River
- West Branch Beaver River
- Beaver River
- Lake Superior

N

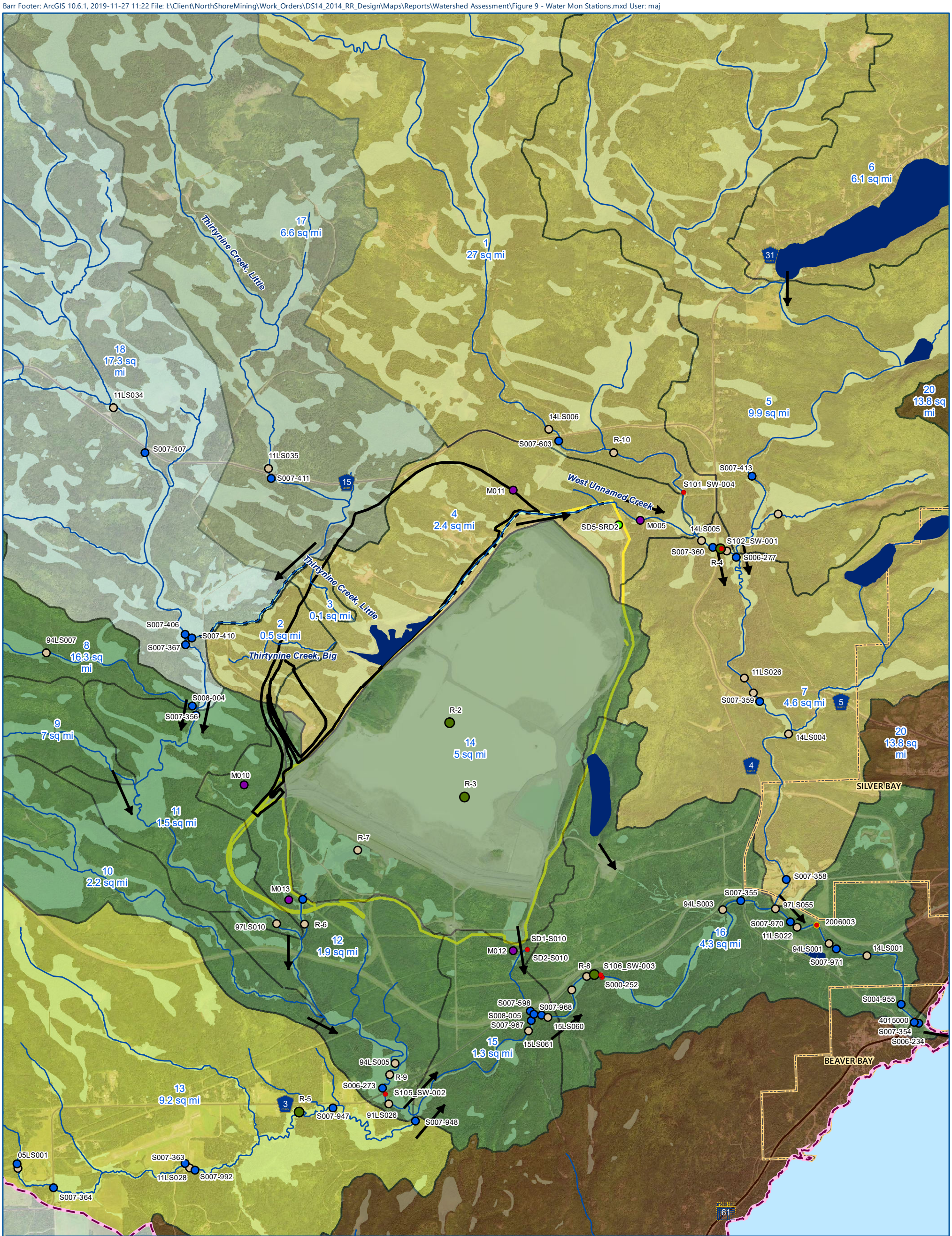
0 3,000 6,000
Feet

PRE-SETTLEMENT PROJECT
AREA RESOURCES
Watershed Analysis
Northshore Mining Company
Lake County, Minnesota

FIGURE 8

BARR

Barr Footer: ArcGIS 10.6.1, 2019-11-27 11:22 File: I:\Client\NorthShoreMining\Work_Orders\DS14_2014_RR_Design\Maps\Reports\Watershed Assessment\Figure 9 - Water Mon Stations.mxd User: maj




**Legend**

**Monitoring Data (see Tables 3 & 4)**

- Biological
- Flow
- Flow/WQ
- GW
- Seepage
- WQ
- WQ/Biological
- Existing Flow Direction
- Study Area Boundary
- Existing Rivers and Streams *Pre-Settlement Rivers and Streams*
- Existing Diversion Ditch
- Existing Lakes/Deepwater
- Future Northshore Mine Operations

**Existing Watershed (5.3 = sq mi wtshd)**

- Big Thirtynine Creek
- Little Thirtynine Creek
- East Branch Beaver River
- West Branch Beaver River
- Beaver River
- Lake Superior
- Existing Northshore Mine Operations
- Existing Wetlands

N

0 3,500 7,000

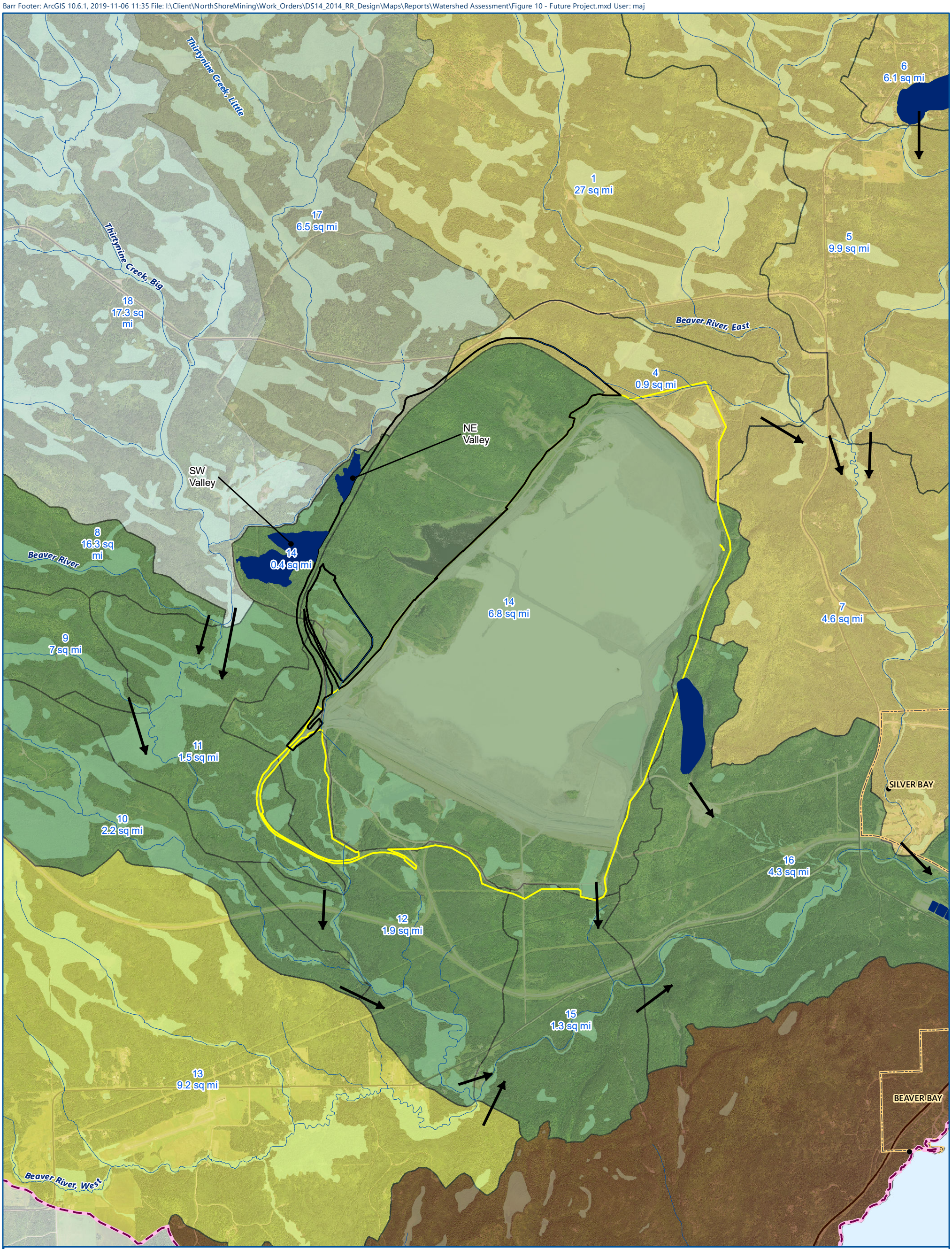
Feet

MONITORING STATIONS
Watershed Analysis
Northshore Mining Company
Lake County, Minnesota

FIGURE 9

BARR

Barr Footer: ArcGIS 10.6.1, 2019-11-06 11:35 File: I:\Client\NorthShoreMining\Work_Orders\DS14_2014_RR_Design\Maps\Reports\Watershed Assessment\Figure 10 - Future Project.mxd User: maj




## Legend

- Future Flow Direction
- Study Area Boundary
- Future Rivers and Streams
- Future Lakes/Deepwater
- Future Northshore Mine Operations
- Existing Northshore Mine Operations

**Future Watersheds (7.4 = sq mi wtshd)**

- Big Thirtynine Creek
- Little Thirtynine Creek
- East Branch Beaver River
- West Branch Beaver River
- Beaver River
- Lake Superior
- Future Wetlands

N

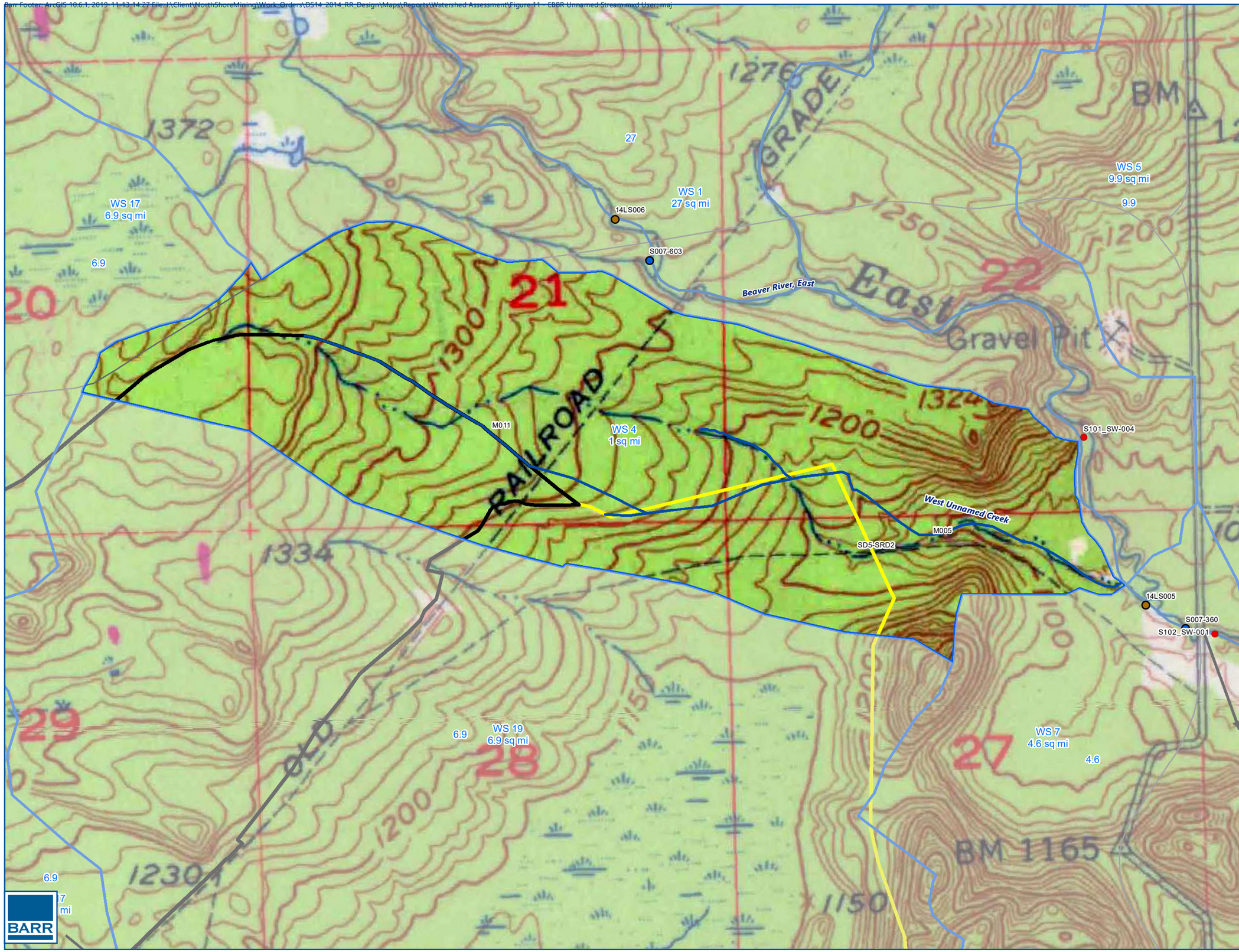
0 3,000 6,000
Feet

FORESEEABLE FUTURE
PROJECT RESOURCES
Watershed Analysis
Northshore Mining Company
Lake County, Minnesota

FIGURE 10

BARR

Barr Footer: ArcGIS 10.6.1, 2019-11-13 14:27 File: J:\Client\NorthShoreMining\Work_Orders\D514_2014_RR_Design\Maps\Reports\Watershed Assessment\Figure 11 - EBBR Unnamed Stream.mxd User: maj




## Legend

**Monitoring Data**

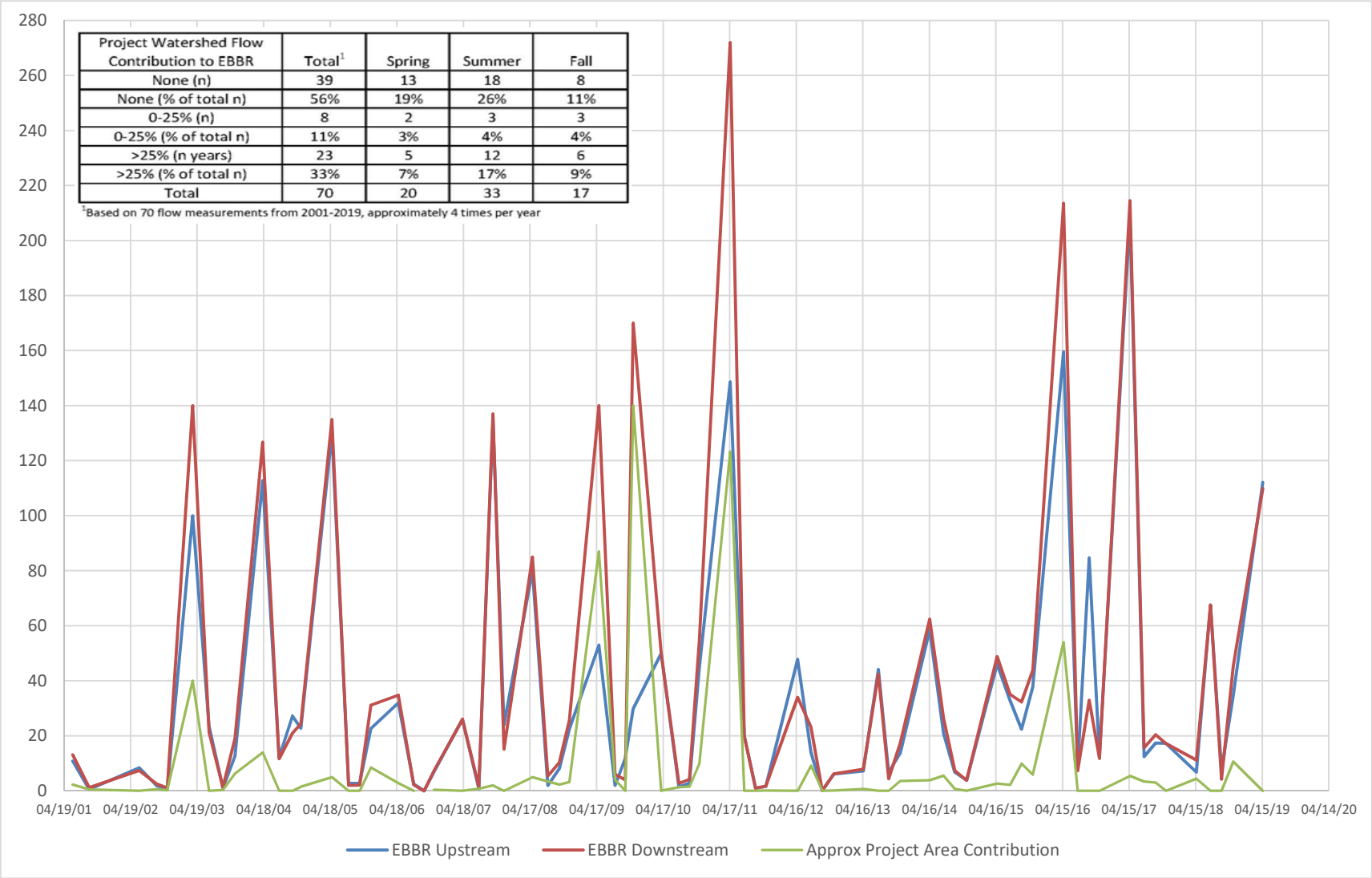
- Biological
- Flow
- Flow/WQ
- WQ
- Pre-Settlement Watersheds
- Future Rivers and Streams
- Future Northshore Mine Operations
- Existing Northshore Mine Operations

0 1,000 2,000
Feet

Source: 1954 USGS quad map

DIVERSION CHANNEL
DISCHARGE
Watershed Analysis
Northshore Mining Company
Lake County, Minnesota

FIGURE 11




| Project Watershed Flow Contribution to EBBR | Total[1] | Spring | Summer | Fall |
|---|---|---|---|---|
| None (n) | 39 | 13 | 18 | 8 |
| None (% of total n) | 56% | 19% | 26% | 11% |
| 0-25% (n) | 8 | 2 | 3 | 3 |
| 0-25% (% of total n) | 11% | 3% | 4% | 4% |
| >25% (n years) | 23 | 5 | 12 | 6 |
| >25% (% of total n) | 33% | 7% | 17% | 9% |
| Total | 70 | 20 | 33 | 17 |

[1]Based on 70 flow measurements from 2001-2019, approximately 4 times per year

Figure 12
Project Subwatershed 4 Flow
to East Branch Beaver River (EBBR)

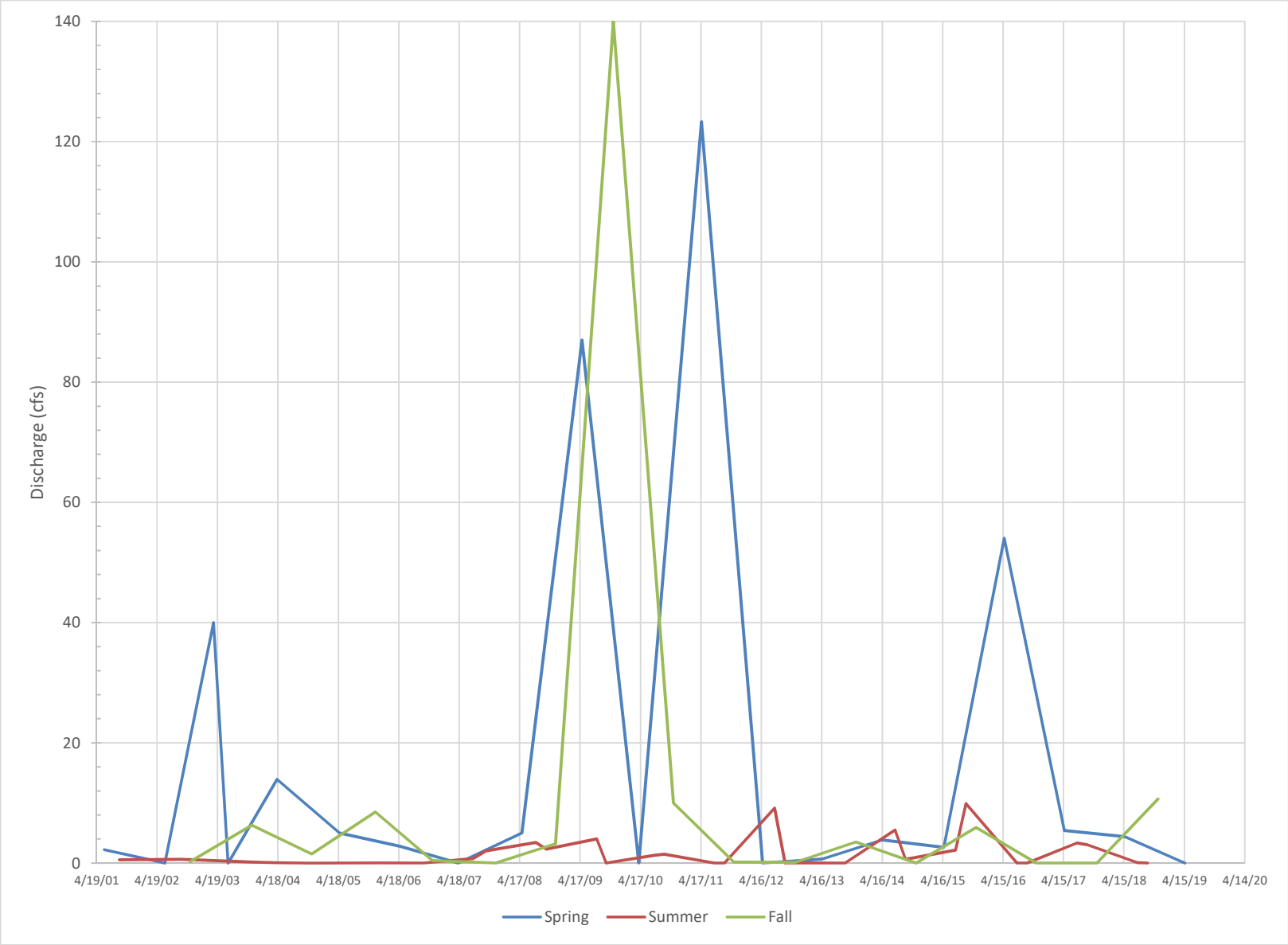



Figure 13
Seasonal Subwatershed 4 Flow Contibutions
to the East Branch Beaver River

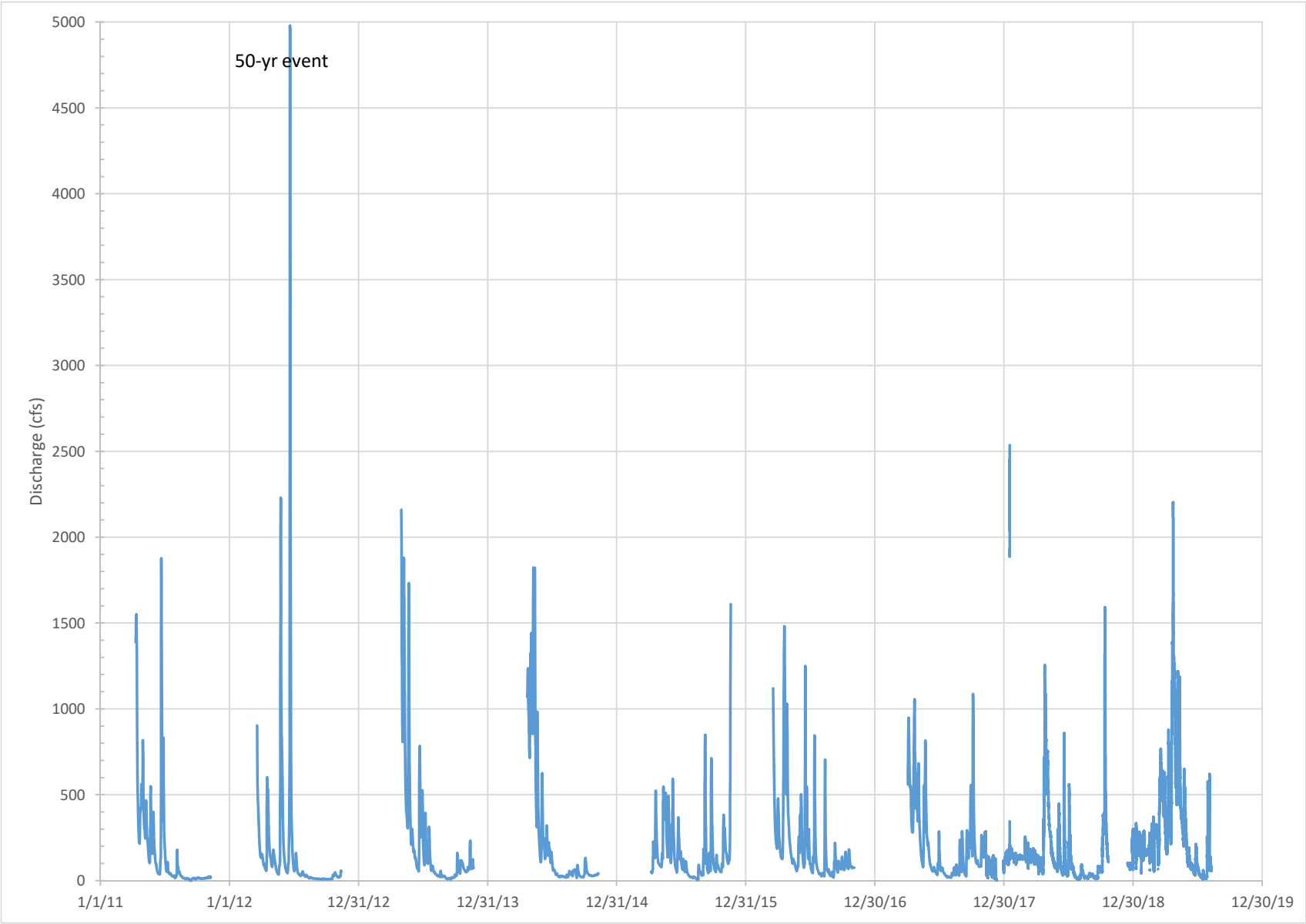
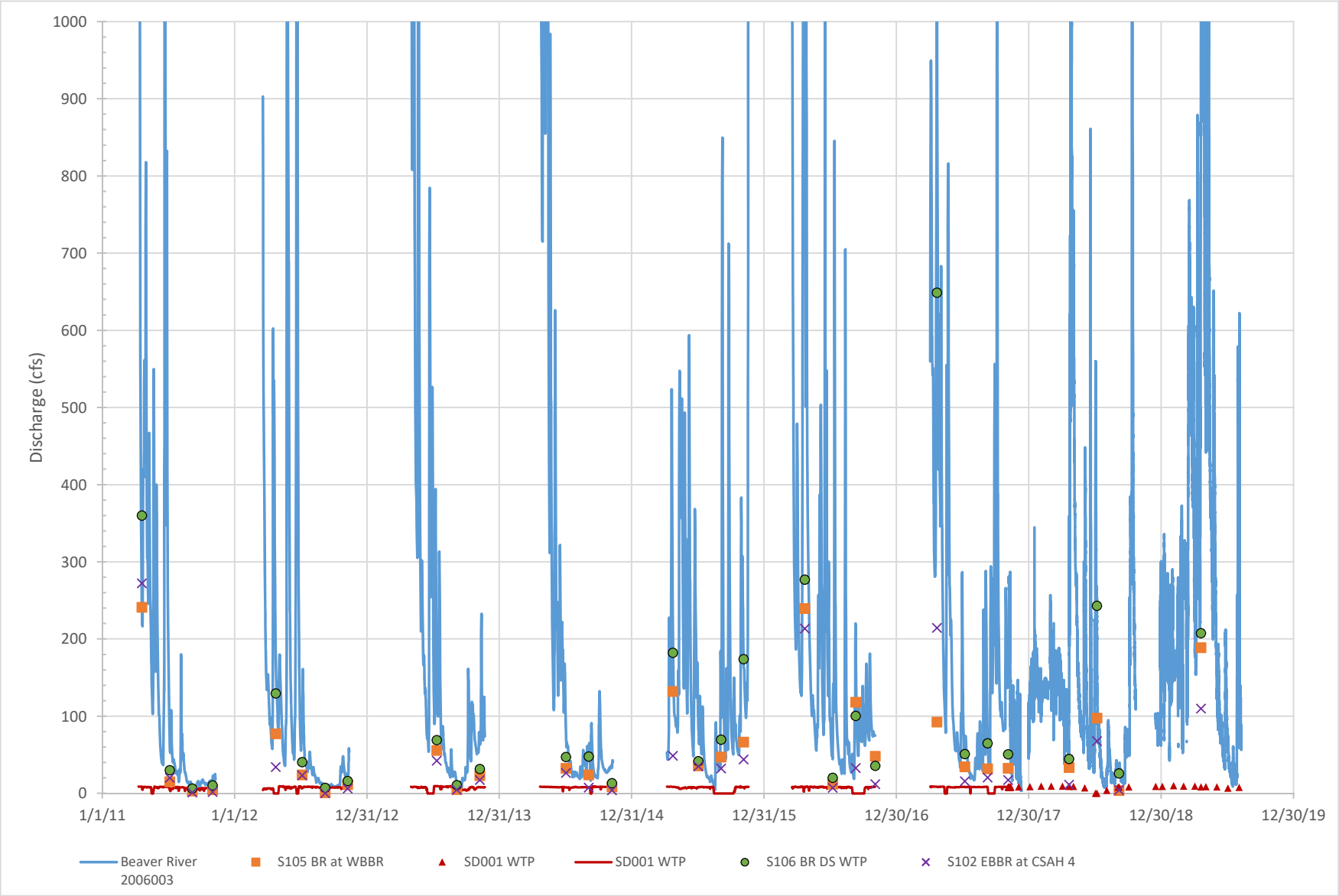



Figure 14
Beaver River Hydrograph 2011-19
DNR Station 2006003, 1.2 mi upstream of Hwy 61




*Flow peaks not shown, see Figure 14

Figure 15
Beaver River Discharge Components 2011-19

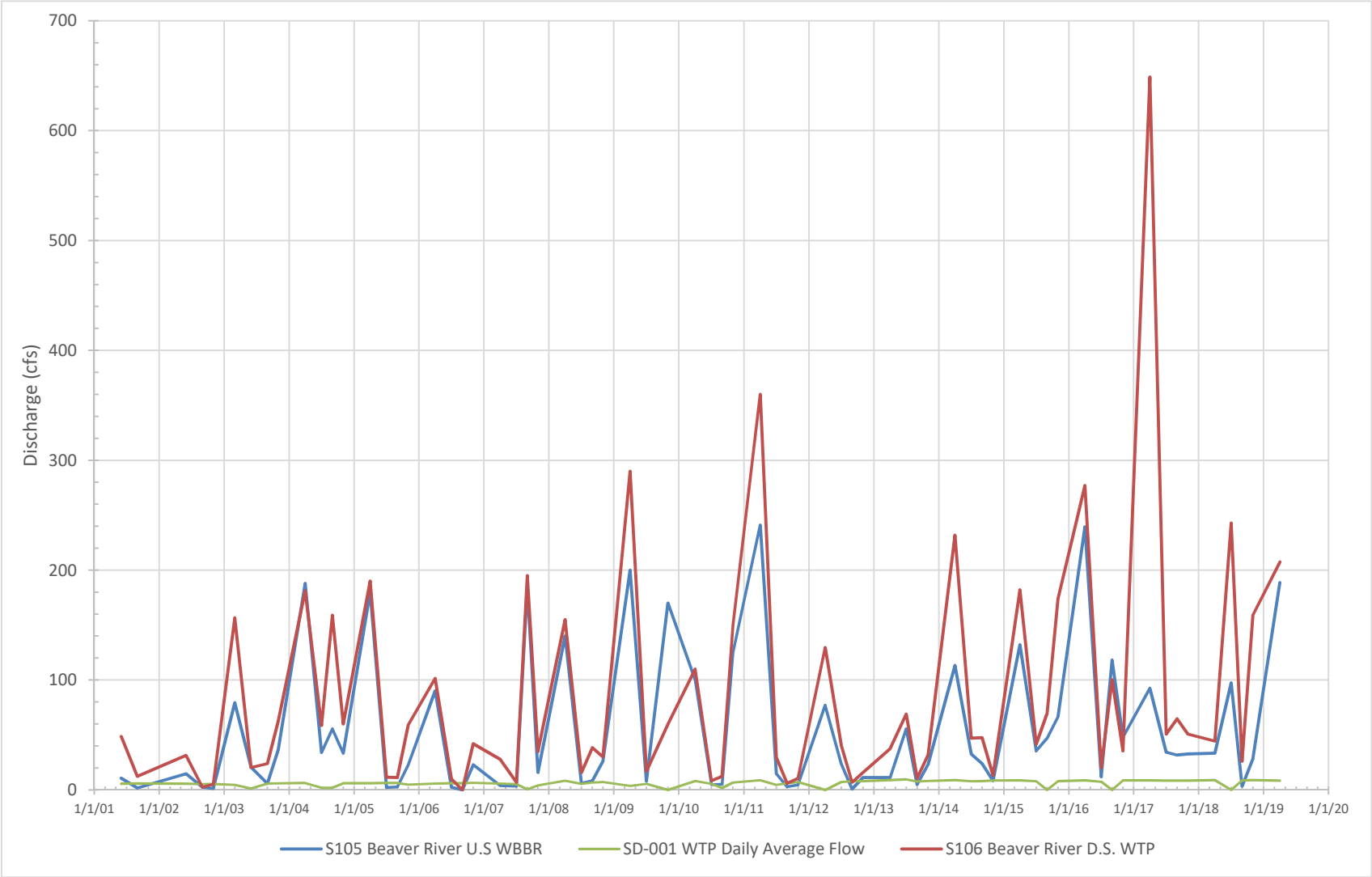
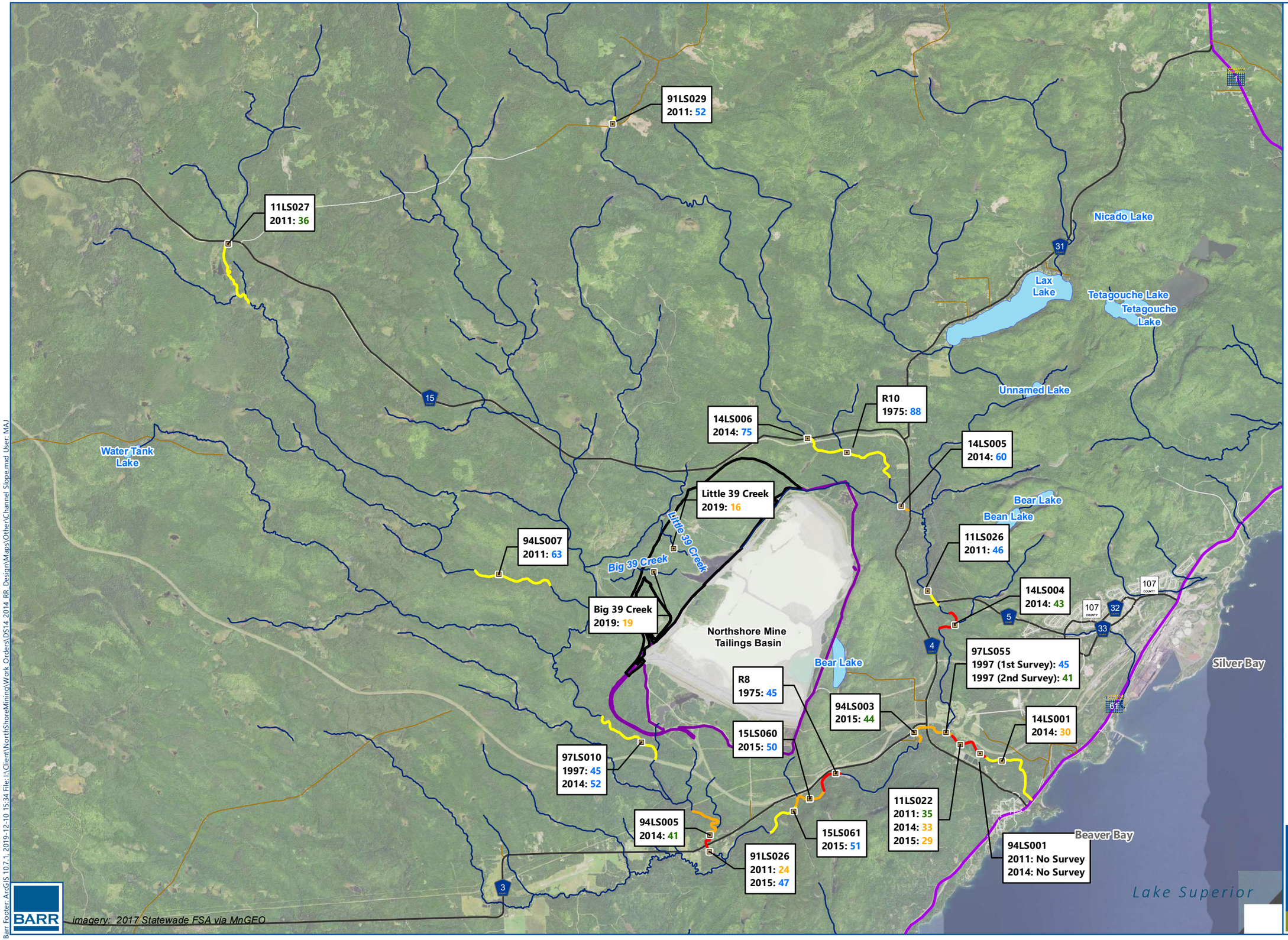



Figure 16
WTP Discharge Contribution to
Beaver River Streamflow 2001-2019




## Channel Slope

**Slope Pct**

- 0.0 - 0.2
- 0.2 - 0.5
- 0.5 - 1.4
- Biological Monitoring Sites
- Future Northshore Mine Operations
- Existing Northshore Mine Operations
- Lakes and Ponds

11LS027 — Station ID
2011: 36 — F-IBI Value
Monitoring Date

**Color Key for Fish-Based Index of Biological Integrity (F-IBI) Survey Results**

Orange = Does not meet or exceed biocriterion (35)[1]
Green = F-IBI meets or exceeds biocriterion (35)[1]
Blue = F-IBI meets or exceeds biocriterion upper confidence limit (45)[1]

[1]Biological criteria for Class 2Ag northern cold water streams (Minn. R. 7050.0222, Subp. 2d)

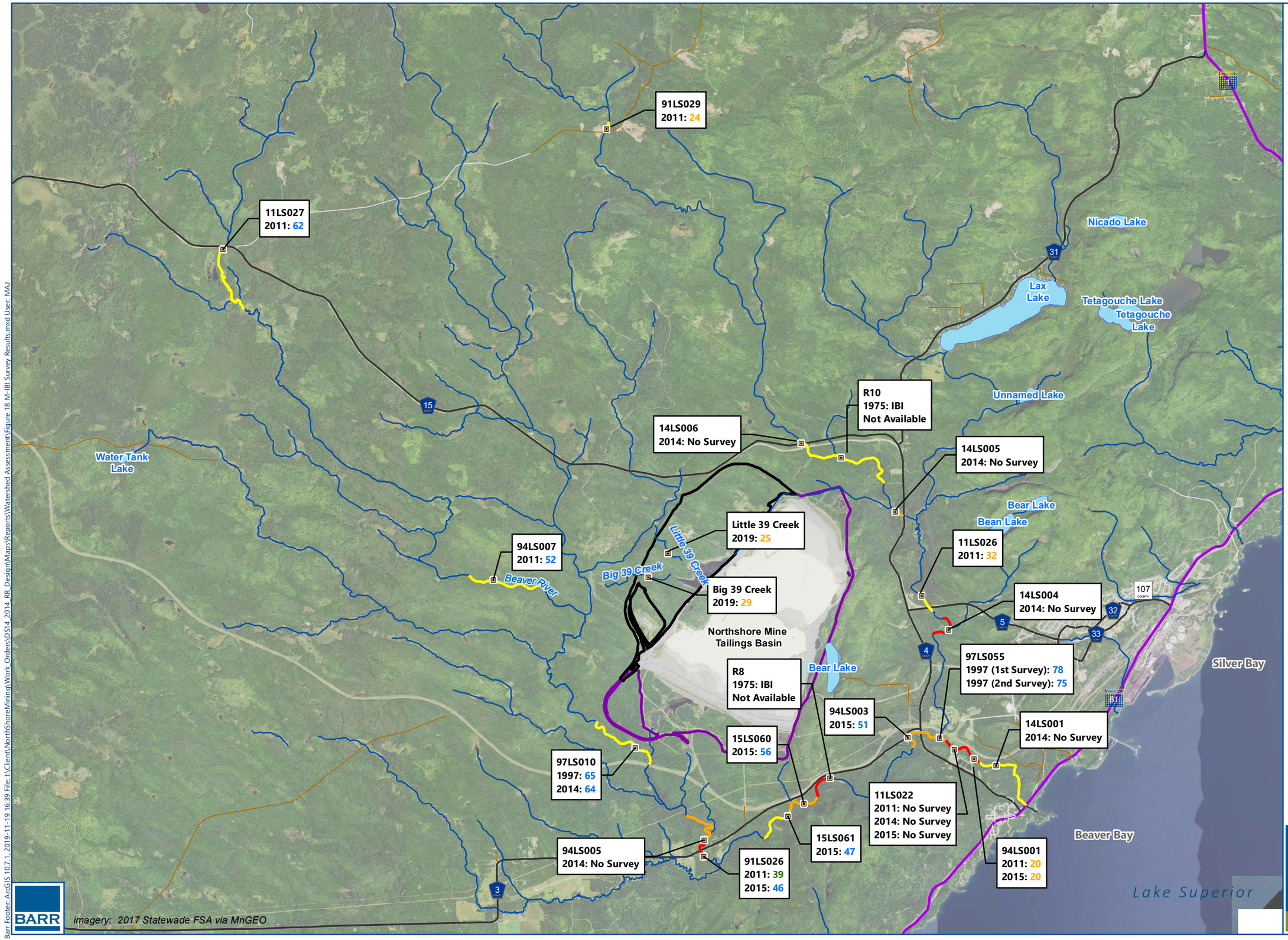
0 0.5 1
Miles

F-IBI SURVEY RESULTS
Watershed Analysis
Northshore Mining Company
Silver Bay, Minnesota

FIGURE 17

BARR

Barr Footer: ArcGIS 10.7.1, 2019-12-10 15:34 File: I:\Client\NorthShoreMining\Work_Orders\DS14_2014_RR_Design\Maps\Other\Channel Slope.mxd User: MAJ




## Channel Slope

**Slope Pct**

- 0.0 - 0.2
- 0.2 - 0.5
- 0.5 - 1.4
- Biological Monitoring Sites
- Rivers and Streams
- Existing Northshore Mine Operations
- Future Northshore Mine Operations
- Lakes and Ponds

11LS027 — Station ID
2011: 36 — M-IBI Value
Monitoring Date

**Color Key for Macroinvertebrate-Based Index of Biological Integrity (M-IBI) Survey Results**

Orange = Does not meet or exceed biocriterion (35)[1]
Green = M-IBI meets or exceeds biocriterion (35)[1]
Blue = M-IBI meets or exceeds biocriterion upper confidence limit (45)[1]

[1]Biological criteria for Class 2Ag northern cold water streams (Minn. R. 7050.0222, Subp. 2d)

0 0.5 1
Miles

M-IBI SURVEY RESULTS
Watershed Analysis
Northshore Mining Company
Silver Bay, Minnesota

FIGURE 18

BARR

Barr Footer: ArcGIS 10.7.1, 2019-11-19 16:39 File: I:\Client\NorthShoreMining\Work_Orders\DS14_2014_RR_Design\Maps\Reports\Watershed Assessment\Figure 18 M-IBI Survey Results.mxd User: MAJ

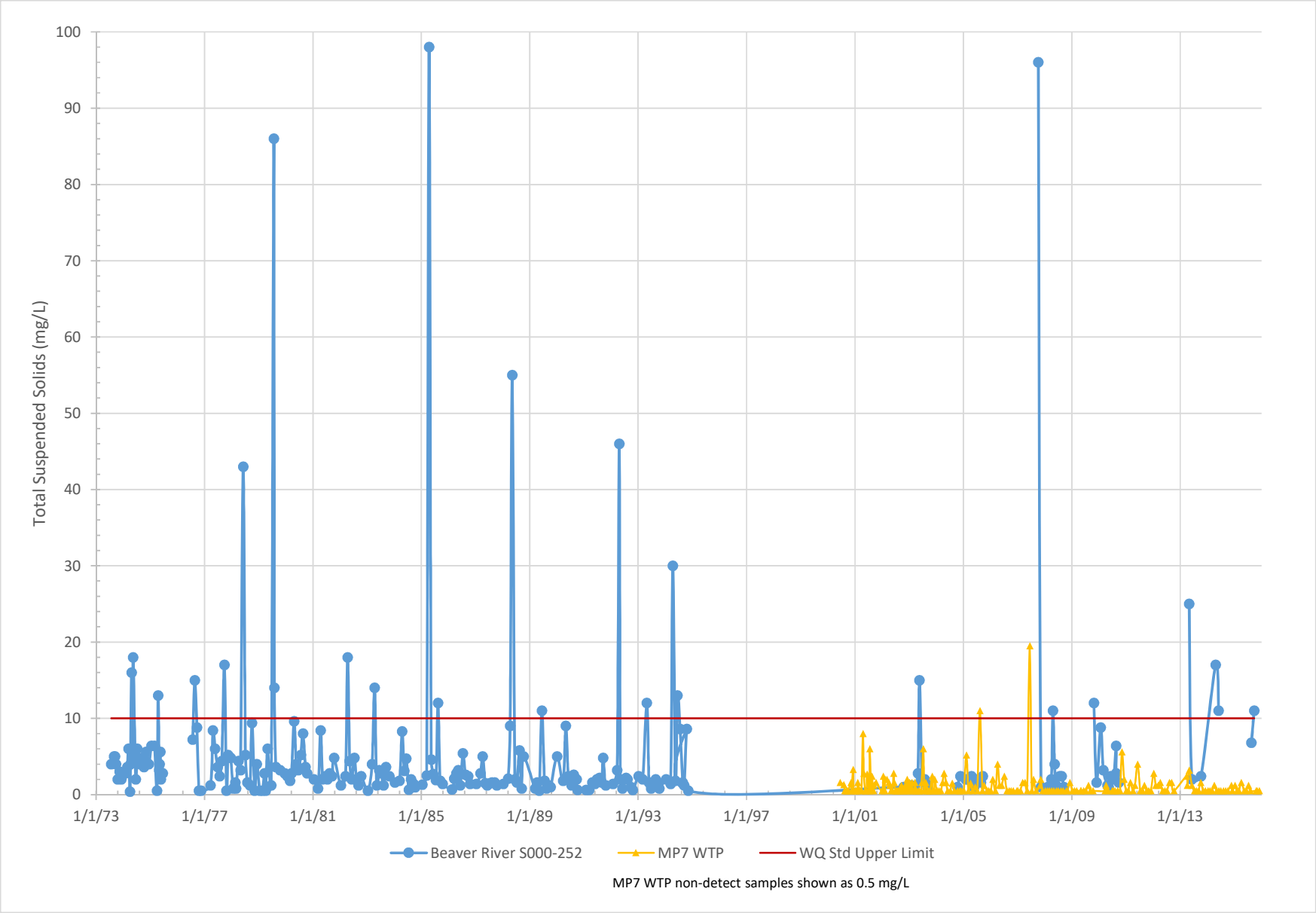



Figure 19
Total Suspended Solids
Beaver River and MP7 WTP 1973-2015

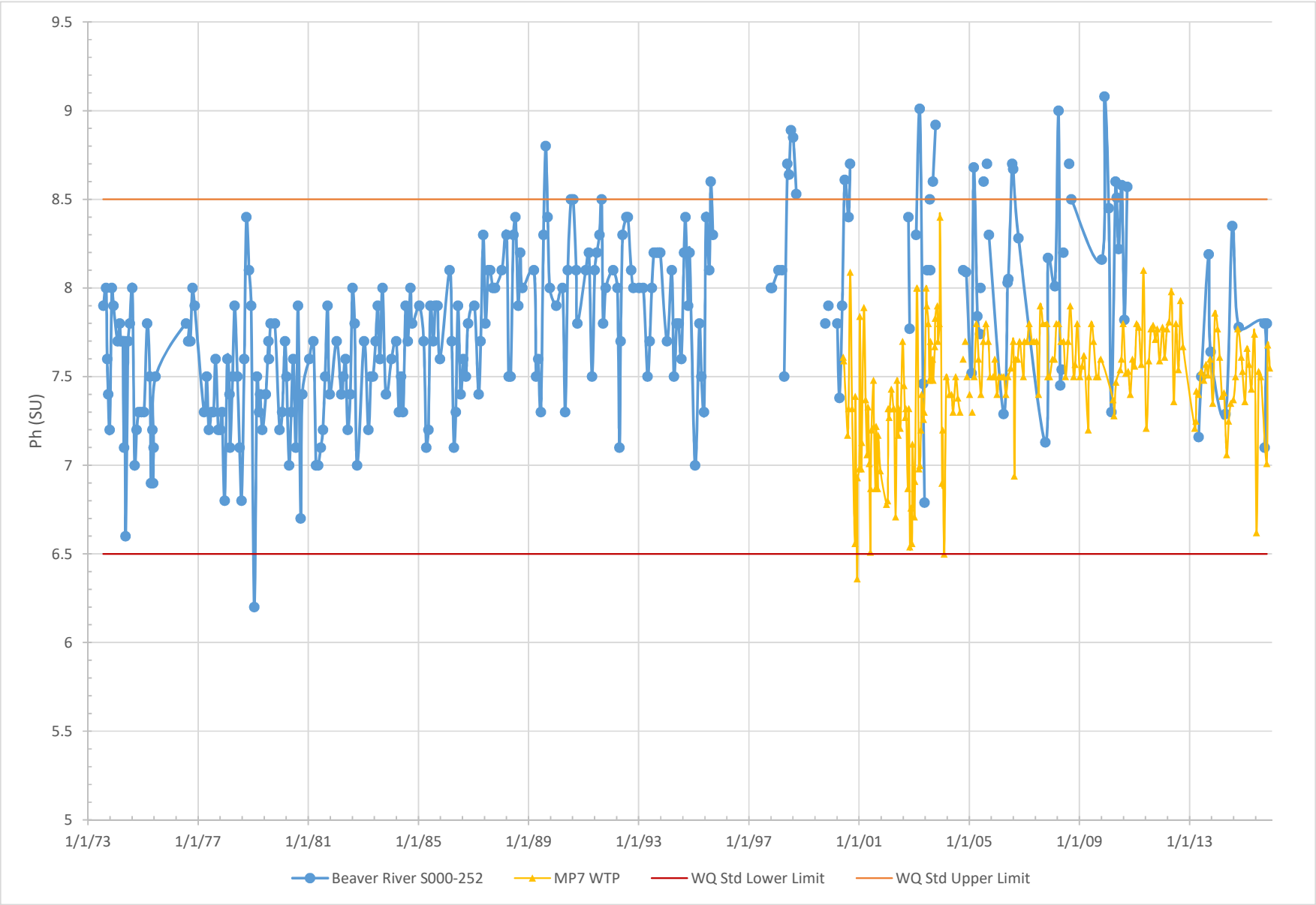



Figure 20
pH
Beaver River and MP7 WTP 1973-2015

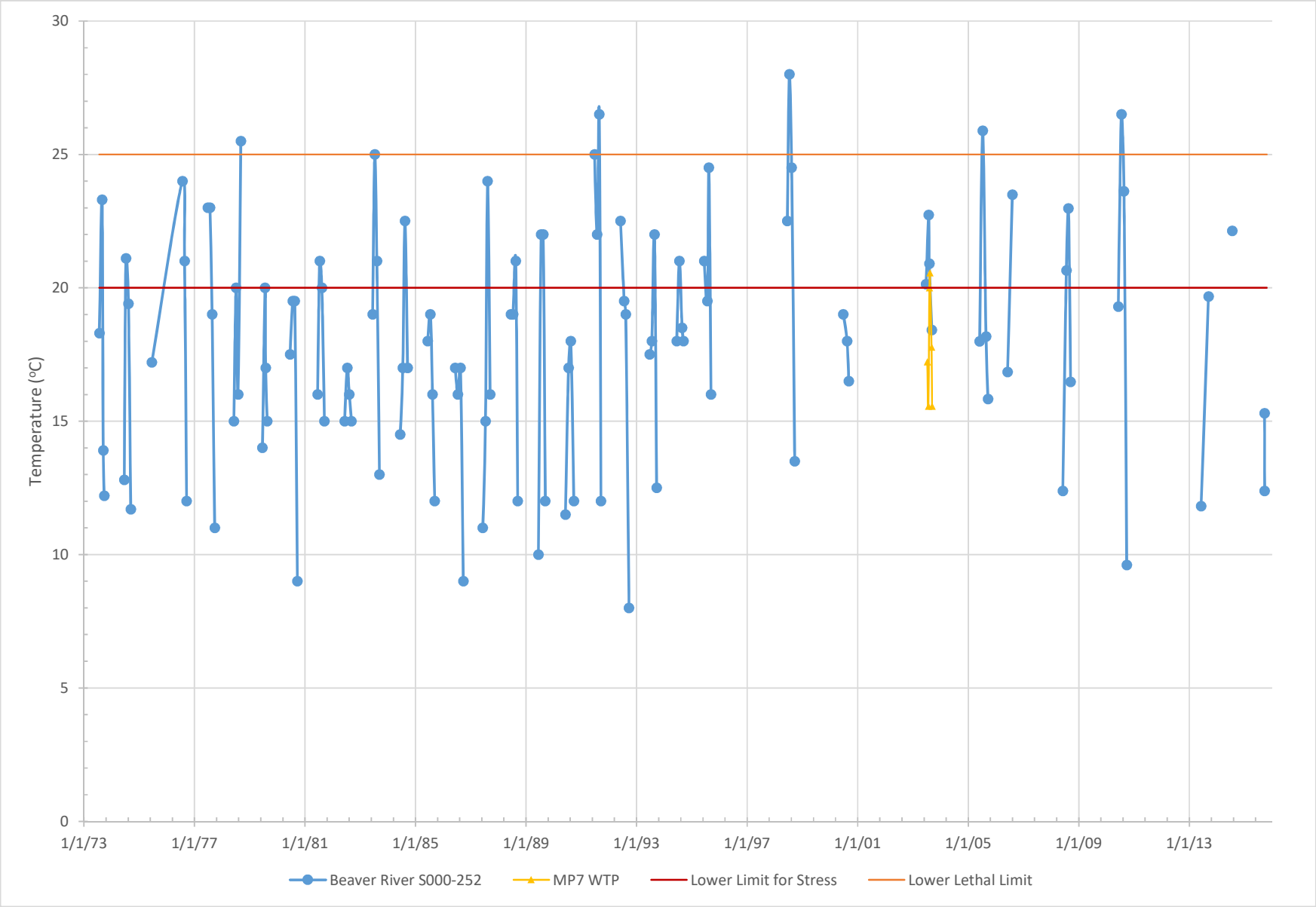



Figure 21
Beaver River and MP7 WTP Temperature
1973-2015

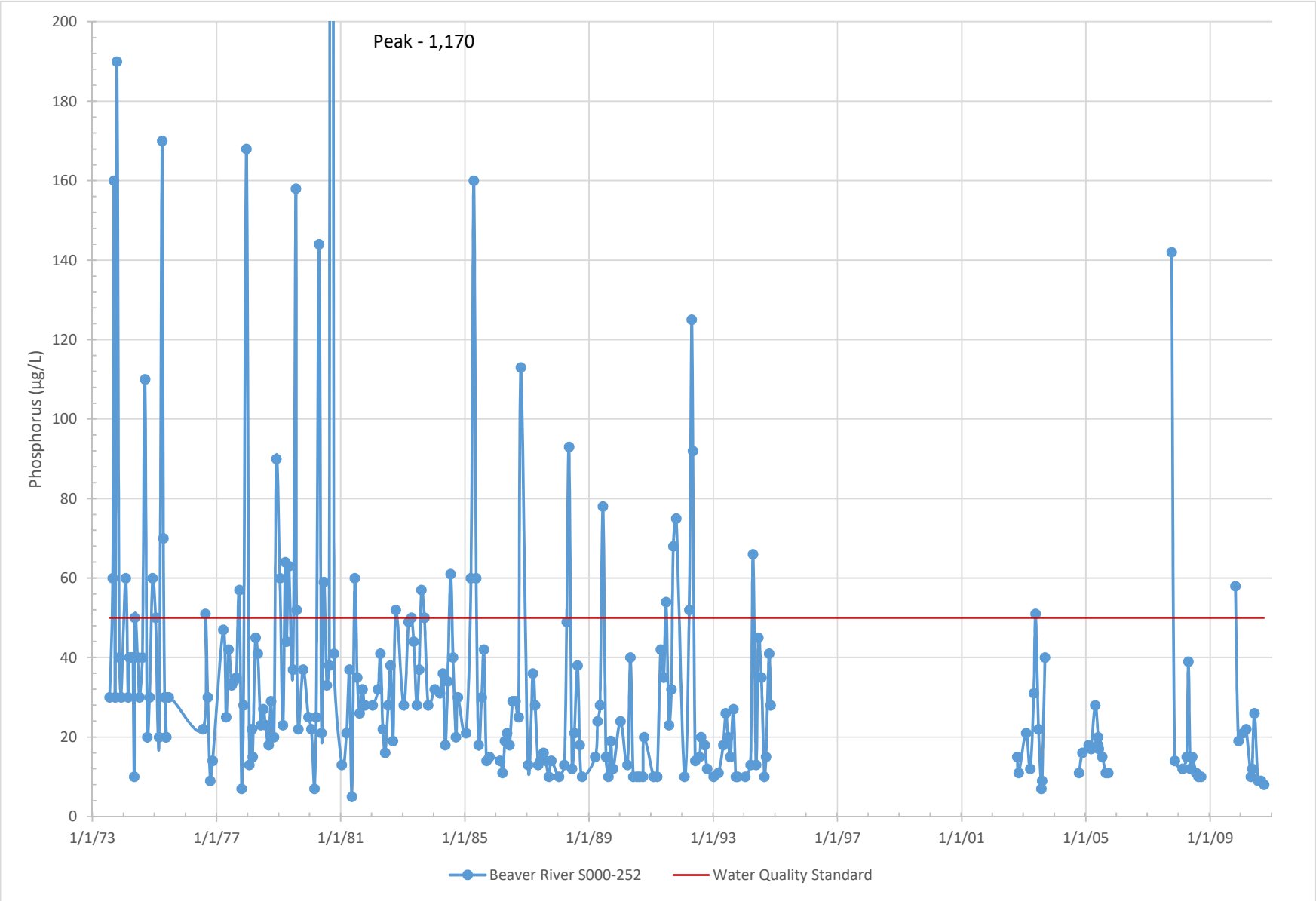



Figure 22
Phosphorus
Beaver River 1973-2011

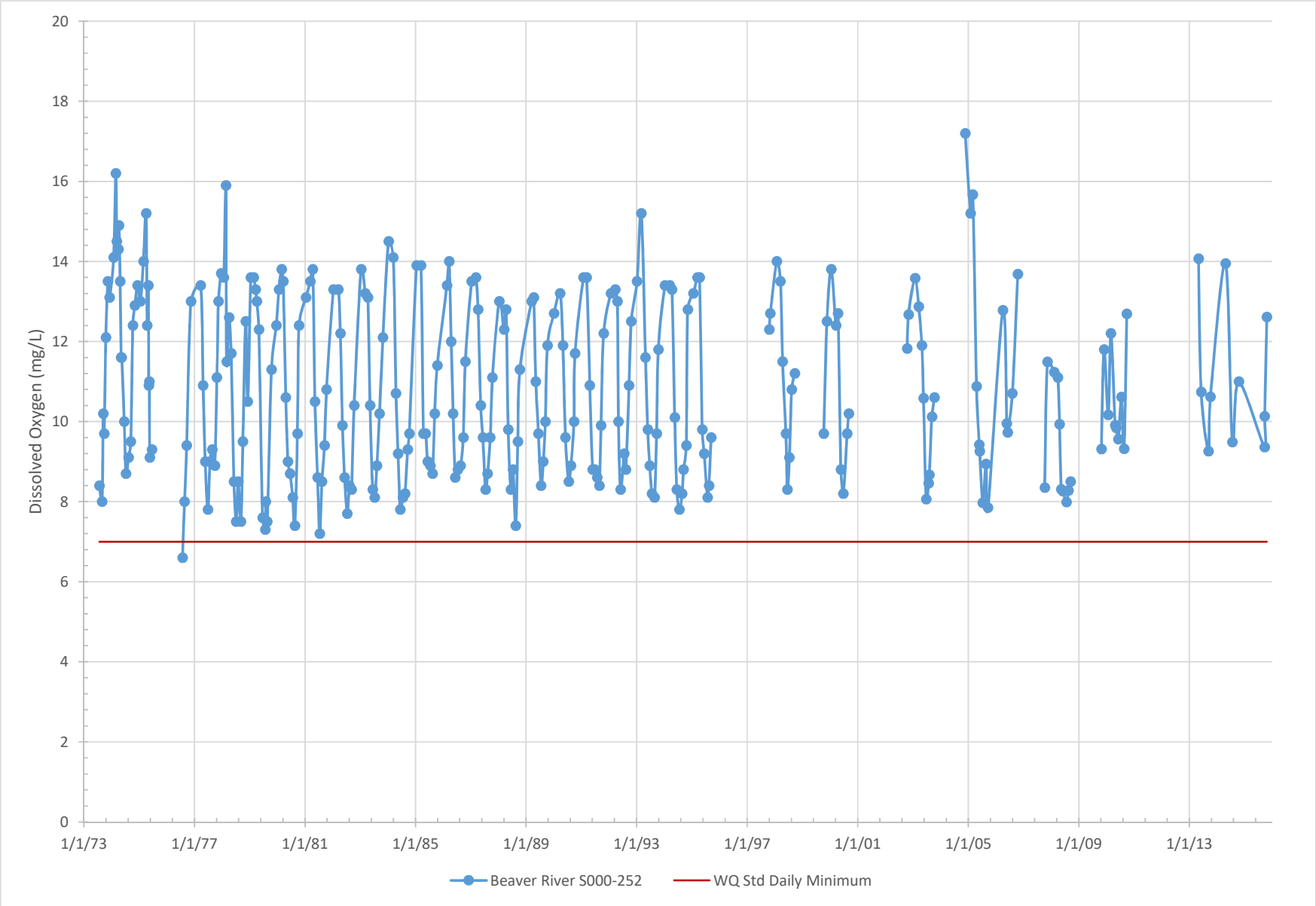



Figure 23
Dissolved Oxygen
Beaver River 1973-2015

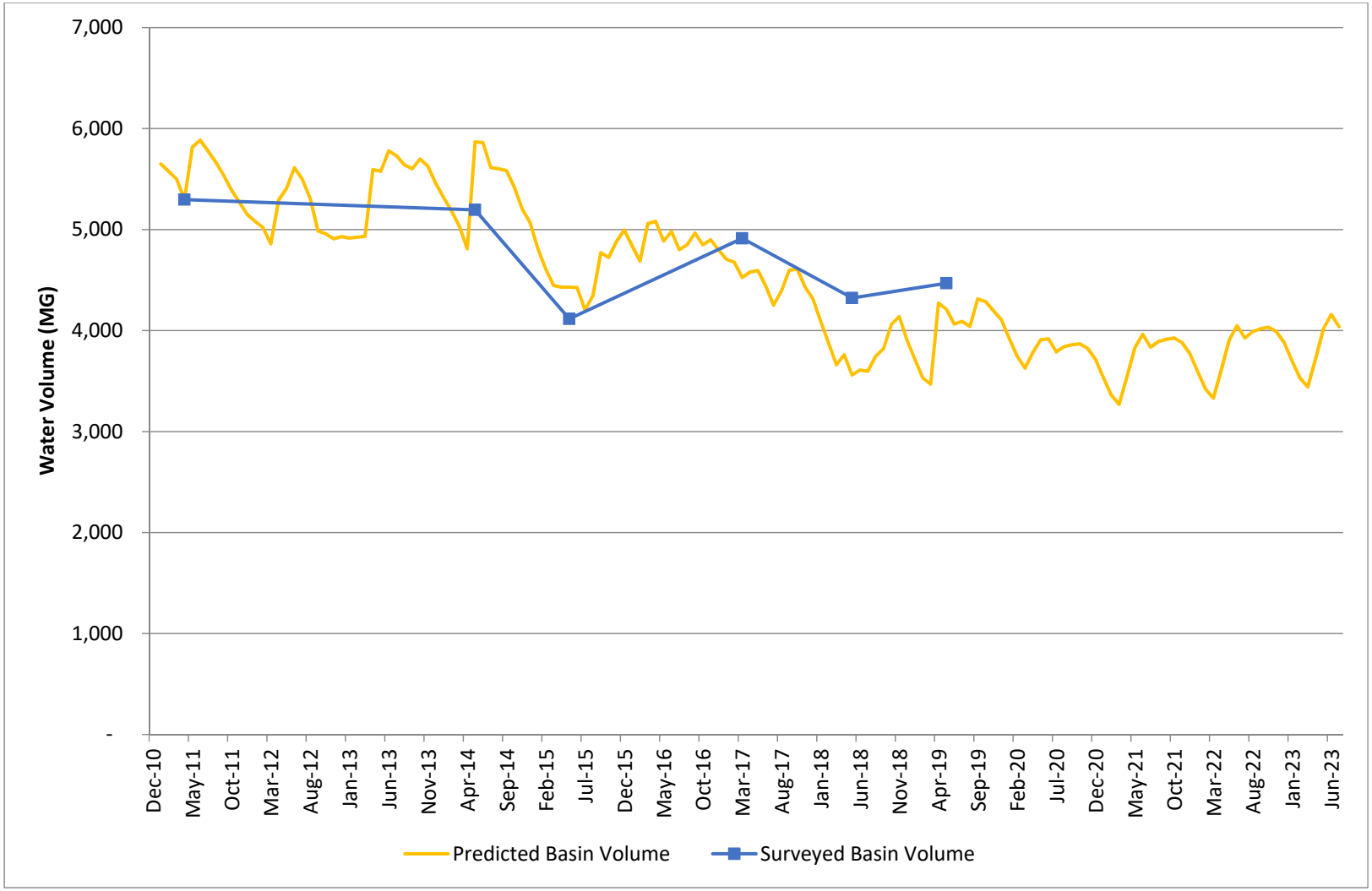
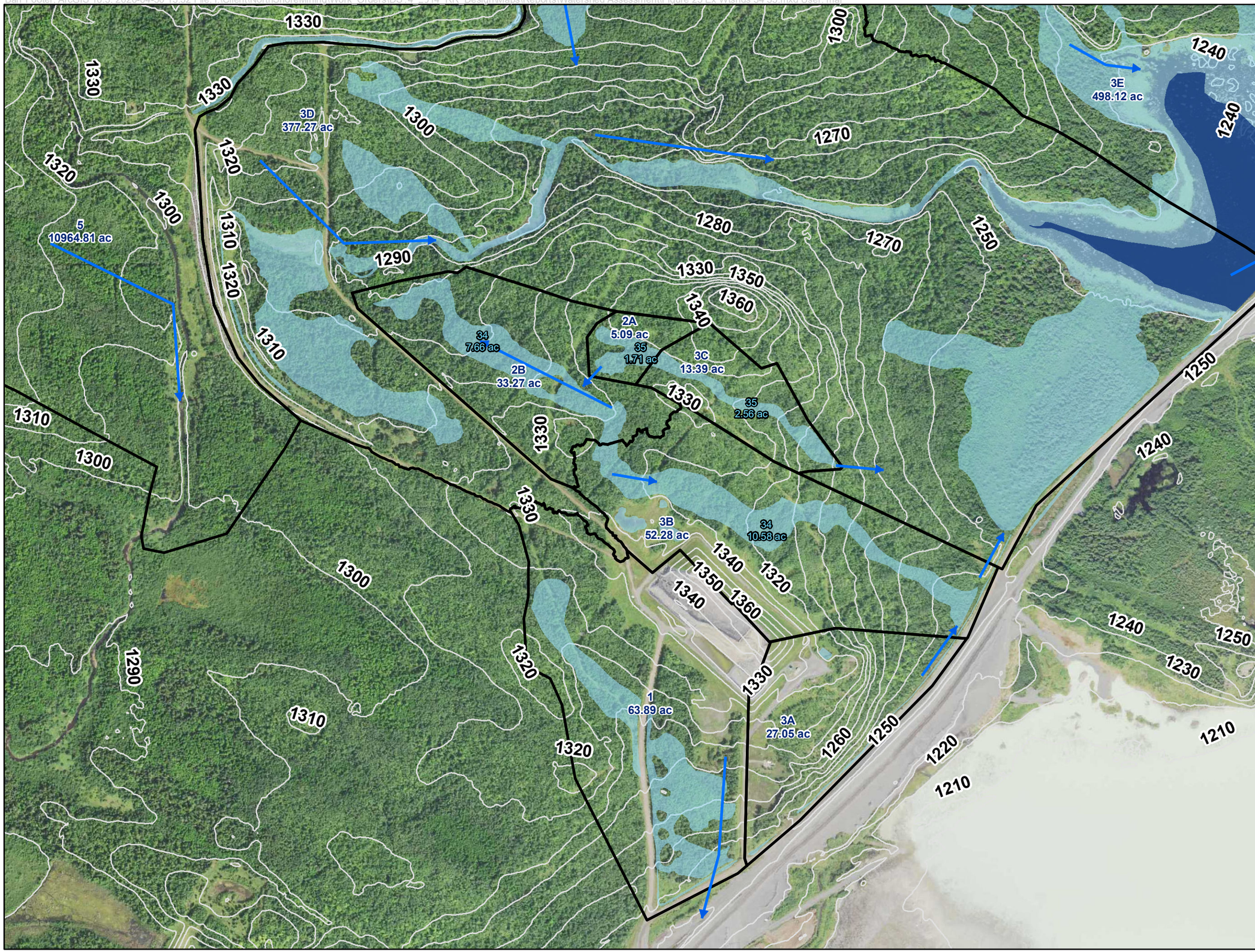



Figure 24
Predicted Basin Volume
Recent History and Proposed Basin
Progression Operation

Barr Footer: ArcGIS 10.3, 2020-04-30 13:32 File: I:\Client\NorthShoreMining\Work_Orders\DS_4_2014_RR_Design\Maps\Reports\Watershed Assessment\Figure 25 Ex Wtshds 34 35.mxd User: maj




**Legend**

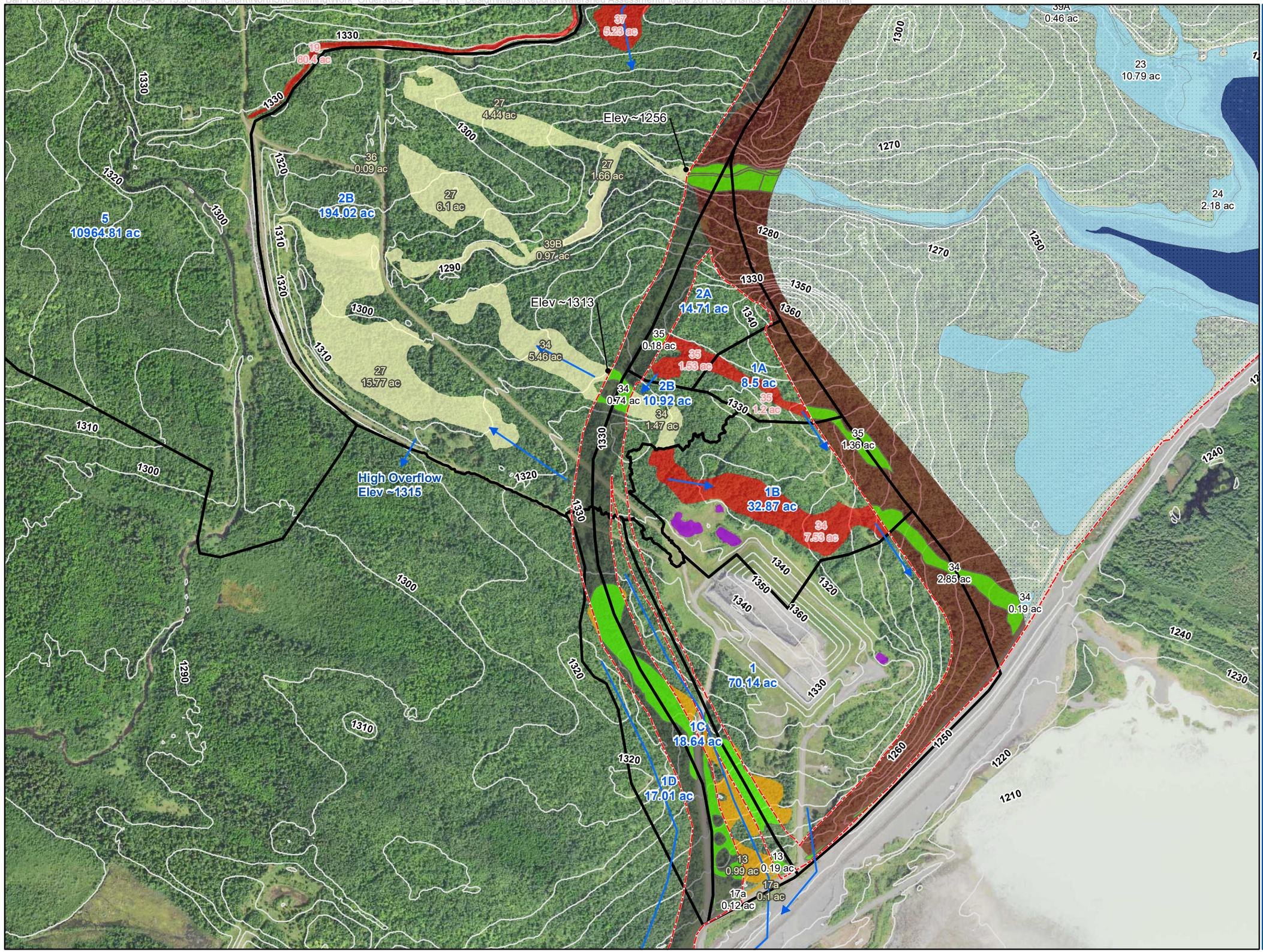
- Existing Flow
- Existing Watersheds
- Deepwater
- Wetlands
- 10 ft Contours

0 600 1,200
Feet

Source: 2017 FSA aerial photo

EXISTING WATERSHEDS
WETLANDS 34 AND 35
Northshore Mining Company
Lake County, Minnesota

FIGURE 25




**Legend**

- Proposed Flow
- Project Area
- Proposed Watersheds
- Remaining Wetlands
- Deepwater Impacts
- Nonjurisdictional Wetlands

**Indirect Wetland Impacts**

- Impoundment
- Fragmentation

**Direct Wetland Impacts**

- Railroad and Dams
- Tailings Basin Progression

**Project Features**

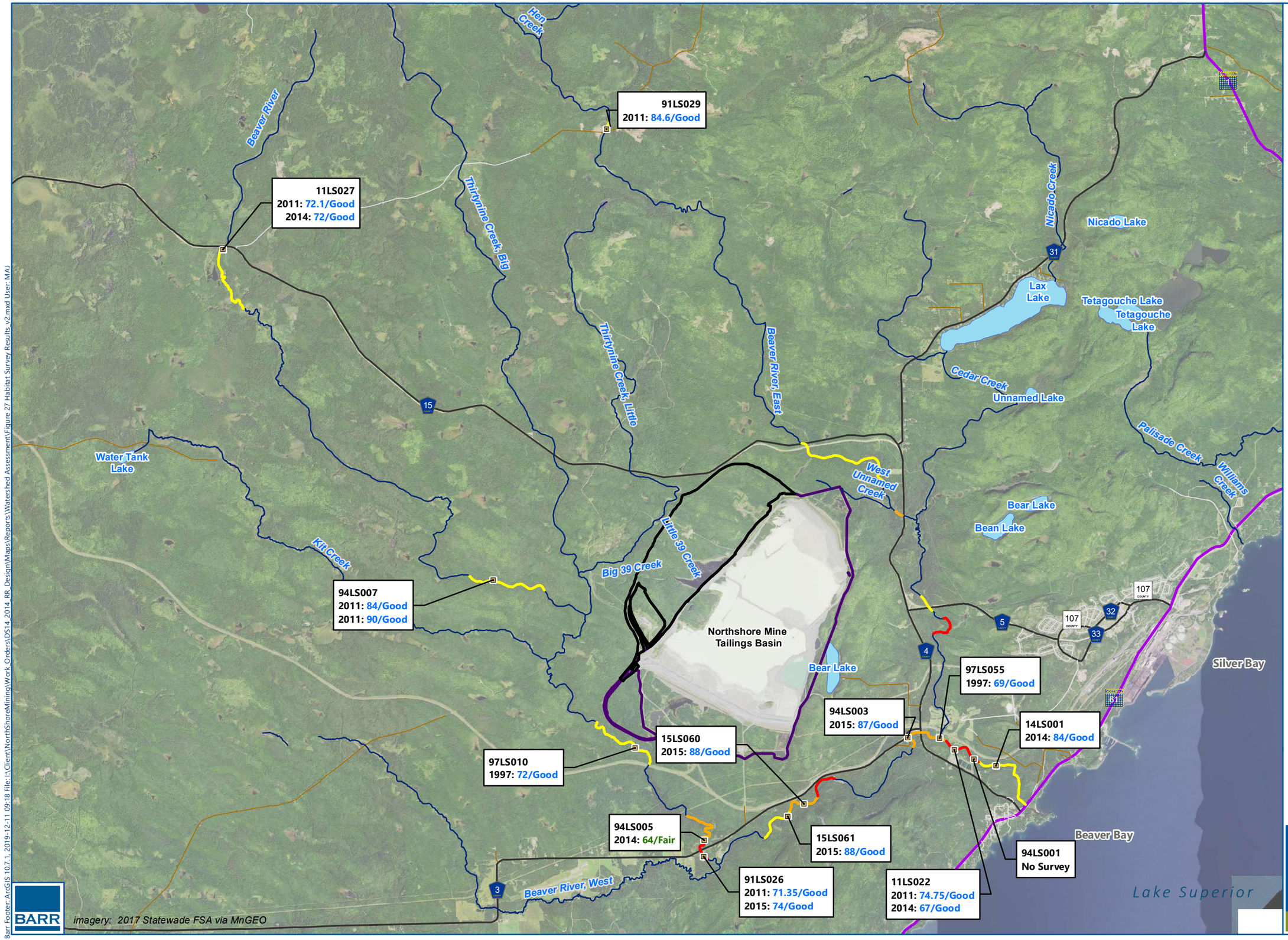
- Dam 1 Extension
- Dam 1 Rail Switchback
- Railroad Embankment
- Tailings Basin Progression
- 10 ft Contours

0 600 1,200
Feet

Source: 2017 FSA aerial photo

FUTURE WATERSHEDS
WETLANDS 34 AND 35
Northshore Mining Company
Lake County, Minnesota

FIGURE 26




## Channel Slope

**Slope Pct**

- 0.0 - 0.2
- 0.2 - 0.5
- 0.5 - 1.4
- Habitat Monitoring Sites
- Rivers and Streams
- Future Northshore Mine Operations
- Existing Northshore Mine Operations
- Lakes and Ponds

Station ID
Habitat Score
11LS027
2011: 84/Good
Monitoring Date

**Color Key for MSHA Habitat Score and Rating Survey Results**
Orange = Poor Rating[1]
Green = Fair Rating[1]
Blue = Good Rating[1]

[1]MSHA Rating from 2014 Stressor Study

0 0.5 1
Miles

HABITAT SURVEY RESULTS
Watershed Analysis
Northshore Mining Company
Silver Bay, Minnesota

FIGURE 27

Barr Footer:ArcGIS 10.7.1, 2019-12-11 09:18 File: I:\Client\NorthShoreMining\Work_Orders\DS14_2014_RR_Design\Maps\Reports\Watershed Assessment\Figure 27 Habitat Survey Results_v2.mxd User: MAJ

Barr Footer: ArcGIS 10.7.1, 2020-04-07 09:50 File: I:\Client\NorthShoreMining\Work_Orders\DS14_2014_RR_Design\Maps\Reports\Watershed Assessment\Figure 28 EBBR Wetlands.mxd User: maj

East Branch Beaver River Wetlands - 71 ac

Existing Rivers and Streams

Existing Watershed

Existing Northshore Mine Operations

Future Northshore Mine Operations

0 2,000 4,000

Feet

BARR

EAST BRANCH BEAVER RIVER WETLANDS
Watershed Analysis
Northshore Mining Company
Lake County, Minnesota

FIGURE 28

Beaver River Wetlands - 92 ac
Existing Rivers and Streams
Existing Watershed
Existing Northshore Mine Operations
Future Northshore Mine Operations

0 1,500 3,000
Feet

BEAVER RIVER
WETLANDS
Watershed Analysis
Northshore Mining Company
Lake County, Minnesota

FIGURE 29

BARR

# Appendices

# Appendix A

## Water Quality Dataset

# Appendix A
# Water Quality Dataset

| Station ID | Parameter | Sample Fraction Type | Lab Name Code | Sample Date | Detect Flag | Result | Result Unit |
|---|---|---|---|---|---|---|---|
| S000-252 | .alpha.-Hexachlorocyclohexane | Total | UNKNOWN | 11/8/1978 | < | 0.01 | ug/L |
| S000-252 | .alpha.-Hexachlorocyclohexane | Total | UNKNOWN | 10/16/1979 | < | 0.02 | ug/L |
| S000-252 | Alachlor | Total | UNKNOWN | 6/14/1988 | < | 0.02 | ug/L |
| S000-252 | Alachlor | Total | UNKNOWN | 6/14/1988 | < | 0.02 | ug/L |
| S000-252 | Alachlor | Total | MN00006 | 6/13/1989 | < | 0.02 | ug/L |
| S000-252 | Alachlor | Total | MN00100 | 5/29/1991 | < | 0.05 | ug/L |
| S000-252 | Alachlor | Total | MN00100 | 6/25/1991 | < | 0.05 | ug/L |
| S000-252 | Alachlor | Total | MN00100 | 6/25/1991 | < | 0.05 | ug/L |
| S000-252 | Alachlor | Total | MN00100 | 7/30/1991 | < | 0.05 | ug/L |
| S000-252 | Alachlor | Total | MN00100 | 5/6/1992 | < | 0.05 | ug/L |
| S000-252 | Alachlor | Total | MN00100 | 6/2/1992 | < | 0.05 | ug/L |
| S000-252 | Alachlor | Total | MN00100 | 7/21/1992 | < | 0.05 | ug/L |
| S000-252 | Alachlor | Total | MN00100 | 5/27/1993 | < | 0.05 | ug/L |
| S000-252 | Alachlor | Total | MN00100 | 6/23/1993 | < | 0.05 | ug/L |
| S000-252 | Alachlor | Total | MN00100 | 7/21/1993 | < | 0.05 | ug/L |
| S000-252 | Aldrin | Total | UNKNOWN | 11/8/1978 | < | 0.01 | ug/L |
| S000-252 | Aldrin | Total | UNKNOWN | 10/16/1979 | < | 0.02 | ug/L |
| S000-252 | Alkalinity, total as CaCO3 | Total | UNKNOWN | 7/24/1973 | | 50.00 | mg/L |
| S000-252 | Alkalinity, total as CaCO3 | Total | UNKNOWN | 8/29/1973 | | 50.00 | mg/L |
| S000-252 | Alkalinity, total as CaCO3 | Total | UNKNOWN | 9/13/1973 | | 40.00 | mg/L |
| S000-252 | Alkalinity, total as CaCO3 | Total | UNKNOWN | 9/26/1973 | | 40.00 | mg/L |
| S000-252 | Alkalinity, total as CaCO3 | Total | UNKNOWN | 10/17/1973 | | 40.00 | mg/L |
| S000-252 | Alkalinity, total as CaCO3 | Total | UNKNOWN | 11/14/1973 | | 40.00 | mg/L |
| S000-252 | Alkalinity, total as CaCO3 | Total | UNKNOWN | 12/5/1973 | | 56.00 | mg/L |
| S000-252 | Alkalinity, total as CaCO3 | Total | UNKNOWN | 1/29/1974 | | 61.00 | mg/L |
| S000-252 | Alkalinity, total as CaCO3 | Total | UNKNOWN | 2/26/1974 | | 55.00 | mg/L |
| S000-252 | Alkalinity, total as CaCO3 | Total | UNKNOWN | 3/12/1974 | | 62.00 | mg/L |
| S000-252 | Alkalinity, total as CaCO3 | Total | UNKNOWN | 4/2/1974 | | 66.00 | mg/L |
| S000-252 | Alkalinity, total as CaCO3 | Total | UNKNOWN | 4/9/1974 | | 60.00 | mg/L |
| S000-252 | Alkalinity, total as CaCO3 | Total | UNKNOWN | 4/24/1974 | < | 10.00 | mg/L |
| S000-252 | Alkalinity, total as CaCO3 | Total | UNKNOWN | 5/8/1974 | | 14.00 | mg/L |
| S000-252 | Alkalinity, total as CaCO3 | Total | UNKNOWN | 5/15/1974 | < | 10.00 | mg/L |
| S000-252 | Alkalinity, total as CaCO3 | Total | UNKNOWN | 6/18/1974 | | 25.00 | mg/L |
| S000-252 | Alkalinity, total as CaCO3 | Total | UNKNOWN | 7/10/1974 | | 86.00 | mg/L |
| S000-252 | Alkalinity, total as CaCO3 | Total | UNKNOWN | 8/13/1974 | | 51.00 | mg/L |
| S000-252 | Alkalinity, total as CaCO3 | Total | UNKNOWN | 9/12/1974 | | 46.00 | mg/L |
| S000-252 | Alkalinity, total as CaCO3 | Total | UNKNOWN | 10/9/1974 | | 60.00 | mg/L |
| S000-252 | Alkalinity, total as CaCO3 | Total | UNKNOWN | 11/5/1974 | | 27.00 | mg/L |
| S000-252 | Alkalinity, total as CaCO3 | Total | UNKNOWN | 12/11/1974 | | 64.00 | mg/L |
| S000-252 | Alkalinity, total as CaCO3 | Total | UNKNOWN | 1/16/1975 | | 41.00 | mg/L |
| S000-252 | Alkalinity, total as CaCO3 | Total | UNKNOWN | 2/26/1975 | | 59.00 | mg/L |
| S000-252 | Alkalinity, total as CaCO3 | Total | UNKNOWN | 4/2/1975 | | 52.00 | mg/L |
| S000-252 | Alkalinity, total as CaCO3 | Total | UNKNOWN | 4/17/1975 | | 27.00 | mg/L |
| S000-252 | Alkalinity, total as CaCO3 | Total | UNKNOWN | 5/1/1975 | | 18.00 | mg/L |
| S000-252 | Alkalinity, total as CaCO3 | Total | UNKNOWN | 5/8/1975 | | 10.00 | mg/L |
| S000-252 | Alkalinity, total as CaCO3 | Total | UNKNOWN | 5/15/1975 | | 18.00 | mg/L |
| S000-252 | Alkalinity, total as CaCO3 | Total | UNKNOWN | 5/22/1975 | | 30.00 | mg/L |
| S000-252 | Alkalinity, total as CaCO3 | Total | UNKNOWN | 6/18/1975 | | 37.00 | mg/L |
| S000-252 | Alkalinity, total as CaCO3 | Total | UNKNOWN | 7/26/1976 | | 79.00 | mg/L |
| S000-252 | Alkalinity, total as CaCO3 | Total | UNKNOWN | 10/18/1976 | | 86.00 | mg/L |
| S000-252 | Alkalinity, total as CaCO3 | Total | UNKNOWN | 4/25/1977 | | 22.00 | mg/L |
| S000-252 | Alkalinity, total as CaCO3 | Total | UNKNOWN | 7/25/1977 | | 71.00 | mg/L |
| S000-252 | Alkalinity, total as CaCO3 | Total | UNKNOWN | 10/14/1980 | | 42.00 | mg/L |
| S000-252 | Alkalinity, total as CaCO3 | Total | UNKNOWN | 1/14/1981 | | 80.00 | mg/L |
| S000-252 | Alkalinity, total as CaCO3 | Total | UNKNOWN | 3/11/1981 | | 70.00 | mg/L |
| S000-252 | Alkalinity, total as CaCO3 | Total | UNKNOWN | 4/14/1981 | | 18.00 | mg/L |
| S000-252 | Alkalinity, total as CaCO3 | Total | UNKNOWN | 5/12/1981 | | 32.00 | mg/L |
| S000-252 | Alkalinity, total as CaCO3 | Total | UNKNOWN | 6/16/1981 | | 32.00 | mg/L |
| S000-252 | Alkalinity, total as CaCO3 | Total | UNKNOWN | 7/14/1981 | | 108.00 | mg/L |
| S000-252 | Alkalinity, total as CaCO3 | Total | UNKNOWN | 8/12/1981 | | 58.00 | mg/L |
| S000-252 | Alkalinity, total as CaCO3 | Total | UNKNOWN | 9/15/1981 | | 80.00 | mg/L |
| S000-252 | Aluminum | Total | UNKNOWN | 6/14/1988 | | 140.00 | ug/L |
| S000-252 | Aluminum | Total | MN00006 | 5/2/1990 | | 780.00 | ug/L |
| S000-252 | Aluminum | Total | MN00006 | 6/25/1991 | < | 300.00 | ug/L |
| S000-252 | Aluminum | Total | MN00006 | 10/23/1991 | | 200.00 | ug/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 8/29/1973 | < | 0.20 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 9/13/1973 | < | 0.20 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 9/26/1973 | | 0.22 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 10/17/1973 | < | 0.20 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 11/14/1973 | | 0.29 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 12/5/1973 | < | 0.20 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 1/29/1974 | < | 0.20 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 2/26/1974 | < | 0.20 | mg/L |

# Appendix A
# Water Quality Dataset

| Station ID | Parameter | Sample Fraction Type | Lab Name Code | Sample Date | Detect Flag | Result | Result Unit |
|---|---|---|---|---|---|---|---|
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 3/12/1974 | < | 0.20 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 4/2/1974 | < | 0.20 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 4/9/1974 | < | 0.20 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 4/24/1974 | < | 0.20 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 5/8/1974 | < | 0.20 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 5/15/1974 | < | 0.20 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 6/18/1974 | | 0.36 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 7/10/1974 | | 0.30 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 8/13/1974 | < | 0.20 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 9/12/1974 | < | 0.20 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 10/9/1974 | < | 0.20 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 11/5/1974 | < | 0.20 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 12/11/1974 | | 0.53 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 1/16/1975 | < | 0.20 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 2/26/1975 | < | 0.20 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 4/2/1975 | | 0.21 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 4/17/1975 | < | 0.20 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 5/1/1975 | < | 0.20 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 5/8/1975 | < | 0.20 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 5/15/1975 | < | 0.20 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 5/22/1975 | < | 0.20 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 6/18/1975 | < | 0.20 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 7/26/1976 | < | 0.20 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 8/23/1976 | | 0.29 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 9/20/1976 | < | 0.20 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 10/18/1976 | < | 0.20 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 11/16/1976 | < | 0.20 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 3/22/1977 | | 0.66 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 4/25/1977 | | 0.27 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 5/23/1977 | < | 0.20 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 6/27/1977 | | 0.36 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 7/25/1977 | < | 0.20 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 8/22/1977 | < | 0.20 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 9/26/1977 | | 0.20 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 10/24/1977 | < | 0.20 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 11/14/1977 | < | 0.20 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 12/19/1977 | < | 0.20 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 1/23/1978 | < | 0.20 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 2/21/1978 | < | 0.20 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 3/1/1978 | < | 0.20 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 4/4/1978 | < | 0.20 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 5/1/1978 | < | 0.20 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 6/6/1978 | | 0.27 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 7/6/1978 | < | 0.20 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 8/1/1978 | | 0.21 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 9/6/1978 | | 0.14 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 10/3/1978 | | 0.17 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 11/8/1978 | < | 0.09 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 12/6/1978 | | 0.12 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 1/16/1979 | | 0.31 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 2/21/1979 | | 0.10 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 3/20/1979 | | 0.28 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 4/4/1979 | | 0.11 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 5/2/1979 | | 0.08 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 6/19/1979 | | 0.09 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 7/24/1979 | | 0.08 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 7/31/1979 | | 0.04 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 8/21/1979 | | 0.03 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 10/16/1979 | | 0.04 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 12/18/1979 | | 0.06 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 1/22/1980 | | 0.08 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 2/27/1980 | | 0.05 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 3/19/1980 | | 0.07 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 4/22/1980 | | 0.13 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 5/20/1980 | | 0.06 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 6/17/1980 | | 0.06 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 7/22/1980 | | 0.06 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 8/19/1980 | | 0.06 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 9/23/1980 | | 0.07 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 10/14/1980 | | 0.04 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 1/14/1981 | | 0.07 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 3/11/1981 | | 0.07 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 4/14/1981 | | 0.11 | mg/L |

# Appendix A
# Water Quality Dataset

| Station ID | Parameter | Sample Fraction Type | Lab Name Code | Sample Date | Detect Flag | Result | Result Unit |
|---|---|---|---|---|---|---|---|
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 5/12/1981 | | 0.08 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 6/16/1981 | | 0.08 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 7/14/1981 | | 0.10 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 8/12/1981 | | 0.04 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 9/15/1981 | | 0.02 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 10/12/1981 | | 0.06 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 1/12/1982 | | 0.10 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 3/16/1982 | | 0.06 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 4/13/1982 | | 0.06 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 5/11/1982 | | 0.04 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 6/8/1982 | | 0.07 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 7/13/1982 | | 0.10 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 8/10/1982 | | 0.08 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 9/8/1982 | | 0.06 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 10/12/1982 | | 0.06 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 1/12/1983 | | 0.07 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 3/9/1983 | | 0.16 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 4/12/1983 | | 0.13 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 5/10/1983 | | 0.09 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 6/14/1983 | | 0.09 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 7/12/1983 | | 0.10 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 8/9/1983 | | 0.06 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 9/13/1983 | | 0.08 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 10/27/1983 | | 0.06 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 1/10/1984 | | 0.06 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 3/13/1984 | | 0.04 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 4/17/1984 | | 0.06 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 5/15/1984 | | 0.05 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 6/12/1984 | | 0.08 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 7/17/1984 | | 0.06 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 8/14/1984 | | 0.07 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 9/18/1984 | | 0.05 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 10/10/1984 | | 0.08 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 1/14/1985 | | 0.10 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 3/13/1985 | | 0.19 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 4/15/1985 | | 0.10 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 5/14/1985 | | 0.08 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 6/10/1985 | | 0.06 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 7/17/1985 | | 0.06 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 8/13/1985 | | 0.08 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 9/11/1985 | | 0.07 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 10/15/1985 | | 0.04 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 2/19/1986 | | 0.04 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 3/20/1986 | | 0.05 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 4/17/1986 | | 0.03 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 5/12/1986 | | 0.04 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 6/10/1986 | | 0.03 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 7/15/1986 | | 0.06 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 8/19/1986 | | 0.06 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 9/24/1986 | | 0.07 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 10/21/1986 | | 0.04 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 1/13/1987 | | 0.05 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 3/10/1987 | | 0.09 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 4/7/1987 | | 0.03 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 5/12/1987 | | 0.03 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 6/9/1987 | | 0.04 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 7/15/1987 | | 0.04 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 8/11/1987 | < | 0.02 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 9/15/1987 | | 0.04 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 10/14/1987 | | 0.04 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 1/12/1988 | | 0.04 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 3/15/1988 | | 0.06 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 4/12/1988 | | 0.09 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 5/9/1988 | | 0.07 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 6/14/1988 | | 0.04 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 7/12/1988 | | 0.03 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 8/17/1988 | | 0.06 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 9/13/1988 | | 0.05 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | UNKNOWN | 10/11/1988 | | 0.04 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 3/14/1989 | | 0.05 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 4/11/1989 | | 0.05 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 5/9/1989 | | 0.02 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 6/13/1989 | | 0.07 | mg/L |

# Appendix A
# Water Quality Dataset

| Station ID | Parameter | Sample Fraction Type | Lab Name Code | Sample Date | Detect Flag | Result | Result Unit |
|---|---|---|---|---|---|---|---|
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 7/18/1989 | | 0.07 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 8/16/1989 | | 0.04 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 9/12/1989 | | 0.02 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 10/10/1989 | | 0.04 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 1/4/1990 | | 0.14 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 3/27/1990 | | 0.06 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 5/2/1990 | | 0.02 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 6/5/1990 | | 0.03 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 7/17/1990 | | 0.04 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 8/16/1990 | | 0.02 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 9/25/1990 | < | 0.02 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 10/9/1990 | | 0.02 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 1/29/1991 | < | 0.02 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 3/12/1991 | < | 0.02 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 4/23/1991 | < | 0.02 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 5/29/1991 | < | 0.02 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 6/25/1991 | < | 0.02 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 7/30/1991 | | 0.04 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 8/27/1991 | < | 0.02 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 9/18/1991 | < | 0.02 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 10/23/1991 | < | 0.02 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 1/28/1992 | | 0.02 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 3/24/1992 | < | 0.02 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 4/21/1992 | < | 0.02 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 5/6/1992 | < | 0.02 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 6/2/1992 | | 0.02 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 7/21/1992 | < | 0.02 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 8/11/1992 | | 0.02 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 9/23/1992 | | 0.02 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 10/21/1992 | < | 0.02 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 1/6/1993 | < | 0.02 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 3/3/1993 | | 0.07 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 4/28/1993 | | 0.03 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 5/27/1993 | < | 0.02 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 6/23/1993 | < | 0.02 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 7/21/1993 | | 0.07 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 8/25/1993 | < | 0.02 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 9/22/1993 | < | 0.02 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 10/14/1993 | < | 0.02 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 1/11/1994 | | 0.04 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 3/15/1994 | | 0.02 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 4/13/1994 | | 0.05 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 5/19/1994 | < | 0.02 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 6/15/1994 | < | 0.02 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 7/20/1994 | | 0.02 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 8/25/1994 | < | 0.02 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 9/13/1994 | < | 0.02 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 10/19/1994 | < | 0.02 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 11/7/1994 | < | 0.02 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 1/19/1995 | | 0.05 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 3/16/1995 | | 0.13 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 4/12/1995 | | 0.02 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 5/18/1995 | < | 0.02 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 6/13/1995 | < | 0.02 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 7/26/1995 | < | 0.02 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 8/14/1995 | < | 0.02 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 9/12/1995 | < | 0.02 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 10/21/1997 | < | 0.02 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 11/3/1997 | | 0.03 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 1/28/1998 | | 0.03 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 3/17/1998 | < | 0.02 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 4/14/1998 | < | 0.02 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 5/27/1998 | < | 0.02 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 6/16/1998 | < | 0.02 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 7/13/1998 | < | 0.02 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 8/12/1998 | | 0.04 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 9/22/1998 | < | 0.02 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 10/10/1999 | < | 0.02 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 11/21/1999 | < | 0.02 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 1/16/2000 | | 0.07 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 3/19/2000 | | 0.04 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 4/16/2000 | < | 0.02 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 5/23/2000 | < | 0.02 | mg/L |

# Appendix A
# Water Quality Dataset

| Station ID | Parameter | Sample Fraction Type | Lab Name Code | Sample Date | Detect Flag | Result | Result Unit |
|---|---|---|---|---|---|---|---|
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 6/25/2000 | < | 0.02 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 7/18/2000 | < | 0.02 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 8/14/2000 | < | 0.02 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 9/5/2000 | < | 0.02 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 10/17/2002 | < | 0.05 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 11/3/2002 | < | 0.05 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 1/28/2003 | < | 0.05 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 3/18/2003 | < | 0.05 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 4/29/2003 | | 0.11 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 5/20/2003 | < | 0.05 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 6/24/2003 | < | 0.05 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 8/5/2003 | < | 0.05 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 9/8/2003 | < | 0.05 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 10/13/2004 | < | 0.05 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 11/21/2004 | < | 0.05 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 2/1/2005 | < | 0.05 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 3/2/2005 | < | 0.05 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 4/20/2005 | < | 0.05 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 5/25/2005 | < | 0.05 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 5/25/2005 | < | 0.05 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 6/1/2005 | < | 0.05 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 7/11/2005 | < | 0.05 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 8/24/2005 | < | 0.05 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 9/19/2005 | < | 0.05 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 10/8/2007 | < | 0.05 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 10/8/2007 | < | 0.05 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 11/13/2007 | < | 0.05 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 2/12/2008 | | 0.10 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 2/12/2008 | | 0.05 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 3/31/2008 | < | 0.05 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 4/21/2008 | < | 0.05 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 4/21/2008 | < | 0.05 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 5/13/2008 | < | 0.05 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 6/4/2008 | | 0.16 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 7/21/2008 | < | 0.05 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 8/18/2008 | < | 0.05 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 9/16/2008 | < | 0.05 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 10/26/2009 | < | 0.05 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 10/26/2009 | < | 0.05 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 11/30/2009 | < | 0.05 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 1/25/2010 | < | 0.05 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 1/25/2010 | < | 0.05 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 3/1/2010 | < | 0.05 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 4/26/2010 | < | 0.05 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 4/26/2010 | < | 0.05 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 5/11/2010 | < | 0.05 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 6/7/2010 | < | 0.05 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 6/7/2010 | < | 0.05 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 7/18/2010 | < | 0.05 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 8/22/2010 | < | 0.05 | mg/L |
| S000-252 | Ammonia-nitrogen as N | Total | MN00006 | 9/27/2010 | < | 0.05 | mg/L |
| S000-252 | Aroclor 1016 | Total | UNKNOWN | 10/16/1979 | < | 0.50 | ug/L |
| S000-252 | Aroclor 1254 | Total | UNKNOWN | 10/16/1979 | < | 0.50 | ug/L |
| S000-252 | Aroclor 1260 | Total | UNKNOWN | 10/16/1979 | < | 0.50 | ug/L |
| S000-252 | Arsenic | Total | UNKNOWN | 9/26/1973 | < | 10.00 | ug/L |
| S000-252 | Arsenic | Total | UNKNOWN | 2/26/1974 | < | 10.00 | ug/L |
| S000-252 | Arsenic | Total | UNKNOWN | 4/24/1974 | < | 10.00 | ug/L |
| S000-252 | Arsenic | Total | UNKNOWN | 9/12/1974 | < | 10.00 | ug/L |
| S000-252 | Arsenic | Total | UNKNOWN | 2/26/1975 | < | 10.00 | ug/L |
| S000-252 | Arsenic | Total | UNKNOWN | 5/1/1975 | < | 10.00 | ug/L |
| S000-252 | Arsenic | Total | UNKNOWN | 7/26/1976 | | 0.90 | ug/L |
| S000-252 | Arsenic | Total | UNKNOWN | 10/18/1976 | < | 0.50 | ug/L |
| S000-252 | Arsenic | Total | UNKNOWN | 4/25/1977 | < | 1.00 | ug/L |
| S000-252 | Arsenic | Total | UNKNOWN | 7/25/1977 | < | 0.50 | ug/L |
| S000-252 | Arsenic | Total | UNKNOWN | 11/8/1978 | | 1.10 | ug/L |
| S000-252 | Arsenic | Total | UNKNOWN | 6/19/1979 | | 0.90 | ug/L |
| S000-252 | Arsenic | Total | UNKNOWN | 10/16/1979 | < | 1.00 | ug/L |
| S000-252 | Arsenic | Total | UNKNOWN | 10/14/1980 | < | 1.00 | ug/L |
| S000-252 | Arsenic | Total | UNKNOWN | 6/8/1982 | < | 1.00 | ug/L |
| S000-252 | Arsenic | Total | UNKNOWN | 6/14/1983 | < | 1.00 | ug/L |
| S000-252 | Arsenic | Total | UNKNOWN | 10/15/1985 | < | 1.00 | ug/L |
| S000-252 | Arsenic | Total | UNKNOWN | 10/21/1986 | < | 1.00 | ug/L |
| S000-252 | Arsenic | Total | UNKNOWN | 6/9/1987 | < | 1.00 | ug/L |

# Appendix A
# Water Quality Dataset

| Station ID | Parameter | Sample Fraction Type | Lab Name Code | Sample Date | Detect Flag | Result | Result Unit |
|---|---|---|---|---|---|---|---|
| S000-252 | Arsenic | Total | UNKNOWN | 6/14/1988 | < | 1.00 | ug/L |
| S000-252 | Arsenic | Total | MN00006 | 5/2/1990 | < | 1.00 | ug/L |
| S000-252 | Arsenic | Tot | WI00007 | 5/29/1996 | | 0.50 | ug/L |
| S000-252 | Arsenic | Dissolved | WI00007 | 6/27/1996 | | 0.70 | ug/L |
| S000-252 | Arsenic | Tot | WI00007 | 6/27/1996 | | 0.70 | ug/L |
| S000-252 | Arsenic | Tot | WI00007 | 9/4/1996 | | 0.70 | ug/L |
| S000-252 | Arsenic | Dissolved | WI00007 | 9/4/1996 | | 0.70 | ug/L |
| S000-252 | Arsenic | Dissolved | WI00007 | 9/25/1996 | | 0.70 | ug/L |
| S000-252 | Arsenic | Tot | WI00007 | 9/25/1996 | | 0.70 | ug/L |
| S000-252 | Atrazine | Total | UNKNOWN | 6/14/1988 | < | 0.02 | ug/L |
| S000-252 | Atrazine | Total | UNKNOWN | 6/14/1988 | < | 0.02 | ug/L |
| S000-252 | Atrazine | Total | MN00006 | 6/13/1989 | < | 0.02 | ug/L |
| S000-252 | Atrazine | Total | MN00100 | 5/29/1991 | < | 0.05 | ug/L |
| S000-252 | Atrazine | Total | MN00100 | 6/25/1991 | < | 0.05 | ug/L |
| S000-252 | Atrazine | Total | MN00100 | 6/25/1991 | < | 0.05 | ug/L |
| S000-252 | Atrazine | Total | MN00100 | 7/30/1991 | < | 0.05 | ug/L |
| S000-252 | Atrazine | Total | MN00100 | 5/6/1992 | < | 0.05 | ug/L |
| S000-252 | Atrazine | Total | MN00100 | 6/2/1992 | < | 0.05 | ug/L |
| S000-252 | Atrazine | Total | MN00100 | 7/21/1992 | < | 0.05 | ug/L |
| S000-252 | Atrazine | Total | MN00100 | 5/27/1993 | < | 0.05 | ug/L |
| S000-252 | Atrazine | Total | MN00100 | 6/23/1993 | < | 0.05 | ug/L |
| S000-252 | Atrazine | Total | MN00100 | 7/21/1993 | < | 0.05 | ug/L |
| S000-252 | Barium | Total | UNKNOWN | 9/26/1973 | < | 20.00 | ug/L |
| S000-252 | Barium | Total | UNKNOWN | 2/26/1974 | < | 20.00 | ug/L |
| S000-252 | Barium | Total | UNKNOWN | 4/24/1974 | < | 10.00 | ug/L |
| S000-252 | Barium | Total | UNKNOWN | 9/12/1974 | < | 15.00 | ug/L |
| S000-252 | Barium | Total | UNKNOWN | 2/26/1975 | < | 15.00 | ug/L |
| S000-252 | Barium | Total | UNKNOWN | 5/1/1975 | < | 15.00 | ug/L |
| S000-252 | Beta particle | Total | UNKNOWN | 9/26/1973 | | 4.00 | pCi/L |
| S000-252 | Beta particle | Total | UNKNOWN | 2/26/1974 | < | 3.00 | pCi/L |
| S000-252 | Beta particle | Total | UNKNOWN | 4/24/1974 | < | 4.00 | pCi/L |
| S000-252 | Beta particle | Total | UNKNOWN | 9/12/1974 | < | 3.00 | pCi/L |
| S000-252 | Beta particle | Total | UNKNOWN | 2/26/1975 | | 3.00 | pCi/L |
| S000-252 | Beta particle | Total | UNKNOWN | 5/1/1975 | | 4.00 | pCi/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 7/24/1973 | | 0.65 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 8/29/1973 | | 0.65 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 9/13/1973 | < | 0.50 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 9/26/1973 | | 0.60 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 10/17/1973 | < | 0.50 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 11/14/1973 | | 2.00 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 12/5/1973 | | 0.55 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 1/29/1974 | | 1.20 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 2/26/1974 | < | 0.50 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 3/12/1974 | < | 0.50 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 4/2/1974 | | 3.70 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 4/9/1974 | < | 0.50 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 4/24/1974 | | 1.40 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 5/8/1974 | | 2.20 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 5/15/1974 | | 0.75 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 6/18/1974 | | 1.70 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 7/10/1974 | | 1.60 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 8/13/1974 | | 0.95 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 9/12/1974 | | 0.50 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 10/9/1974 | | 0.75 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 11/5/1974 | | 0.65 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 12/11/1974 | < | 0.50 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 1/16/1975 | | 1.50 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 2/26/1975 | < | 0.50 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 4/2/1975 | < | 0.50 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 4/17/1975 | | 1.00 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 5/1/1975 | | 0.65 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 5/8/1975 | | 0.65 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 5/15/1975 | | 0.90 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 5/22/1975 | | 0.80 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 6/18/1975 | | 1.00 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 7/26/1976 | | 2.90 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 8/23/1976 | | 1.50 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 9/20/1976 | | 1.50 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 10/18/1976 | | 0.80 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 11/16/1976 | | 1.90 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 3/22/1977 | | 6.00 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 4/25/1977 | | 1.30 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 5/23/1977 | < | 0.50 | mg/L |

| Station ID | Parameter | Sample Fraction Type | Lab Name Code | Sample Date | Detect Flag | Result | Result Unit |
|---|---|---|---|---|---|---|---|
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 6/27/1977 | | 0.60 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 7/25/1977 | | 0.70 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 8/22/1977 | | 1.80 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 9/26/1977 | | 2.40 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 10/24/1977 | < | 0.50 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 11/14/1977 | | 0.70 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 12/19/1977 | < | 0.50 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 1/23/1978 | | 0.70 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 2/21/1978 | | 0.80 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 3/1/1978 | | 0.50 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 4/4/1978 | | 2.20 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 5/1/1978 | | 1.85 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 6/6/1978 | | 1.90 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 7/6/1978 | | 2.10 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 8/1/1978 | | 1.70 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 9/6/1978 | | 1.80 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 10/3/1978 | | 1.10 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 11/8/1978 | | 1.40 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 12/6/1978 | < | 0.50 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 1/16/1979 | | 1.20 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 2/21/1979 | | 1.40 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 3/20/1979 | | 4.30 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 4/4/1979 | | 0.70 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 5/2/1979 | | 0.90 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 6/19/1979 | | 1.90 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 7/24/1979 | | 3.10 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 8/21/1979 | | 0.70 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 10/16/1979 | | 1.00 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 12/18/1979 | | 1.70 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 1/22/1980 | | 1.00 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 2/27/1980 | | 1.20 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 3/19/1980 | | 1.40 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 4/22/1980 | | 1.30 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 5/20/1980 | | 0.70 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 6/17/1980 | | 1.30 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 7/22/1980 | | 0.80 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 8/19/1980 | | 0.90 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 9/23/1980 | | 0.90 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 10/14/1980 | | 1.00 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 1/14/1981 | < | 0.50 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 3/11/1981 | < | 0.50 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 4/14/1981 | | 1.00 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 5/12/1981 | | 0.50 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 6/16/1981 | | 1.10 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 7/14/1981 | | 0.90 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 8/12/1981 | | 0.80 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 9/15/1981 | | 0.70 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 10/12/1981 | | 0.50 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 1/12/1982 | | 0.60 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 3/16/1982 | | 1.00 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 4/13/1982 | | 1.20 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 5/11/1982 | | 1.20 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 6/8/1982 | | 0.50 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 7/13/1982 | | 0.80 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 8/10/1982 | | 0.60 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 9/8/1982 | | 1.00 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 10/12/1982 | | 0.95 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 1/12/1983 | < | 0.50 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 3/9/1983 | | 2.30 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 4/12/1983 | | 1.40 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 5/10/1983 | | 0.60 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 6/14/1983 | | 1.10 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 7/12/1983 | | 0.80 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 8/9/1983 | | 0.90 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 9/13/1983 | | 0.70 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 10/27/1983 | | 0.80 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 1/10/1984 | < | 0.50 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 3/13/1984 | < | 0.50 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 4/17/1984 | | 0.70 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 5/15/1984 | | 0.70 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 6/12/1984 | | 1.20 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 7/17/1984 | | 0.90 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 8/14/1984 | | 1.10 | mg/L |

| Station ID | Parameter | Sample Fraction Type | Lab Name Code | Sample Date | Detect Flag | Result | Result Unit |
|---|---|---|---|---|---|---|---|
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 9/18/1984 | | 0.90 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 10/10/1984 | | 0.90 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 1/14/1985 | < | 0.50 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 3/13/1985 | | 1.10 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 4/15/1985 | | 4.80 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 5/14/1985 | | 0.80 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 6/10/1985 | | 1.20 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 7/17/1985 | | 0.80 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 8/13/1985 | | 0.70 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 9/11/1985 | | 0.90 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 10/15/1985 | | 0.60 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 2/19/1986 | | 0.60 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 3/20/1986 | | 0.50 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 7/15/1986 | | 1.80 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 8/11/1987 | | 0.70 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 9/15/1987 | | 1.00 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 10/14/1987 | | 0.80 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 1/12/1988 | | 0.90 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 3/15/1988 | | 0.80 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 4/12/1988 | | 1.80 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 5/9/1988 | | 1.80 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 6/14/1988 | | 0.70 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 7/12/1988 | | 1.00 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 8/17/1988 | | 0.80 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 9/13/1988 | | 1.10 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | UNKNOWN | 10/11/1988 | | 0.90 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | MN00006 | 3/14/1989 | < | 0.50 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | MN00006 | 4/11/1989 | | 0.70 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | MN00006 | 5/9/1989 | | 1.20 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | MN00006 | 6/13/1989 | | 1.30 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | MN00006 | 7/18/1989 | | 0.80 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | MN00006 | 8/16/1989 | | 0.70 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | MN00006 | 9/12/1989 | | 0.80 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | MN00006 | 10/10/1989 | | 1.00 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | MN00006 | 1/4/1990 | | 1.70 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | MN00006 | 3/27/1990 | | 1.30 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | MN00006 | 5/2/1990 | | 1.00 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | MN00006 | 6/5/1990 | | 1.00 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | MN00006 | 7/17/1990 | | 0.70 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | MN00006 | 8/16/1990 | | 1.00 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | MN00006 | 9/25/1990 | | 0.60 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | MN00006 | 10/9/1990 | | 0.60 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | MN00006 | 1/29/1991 | | 0.80 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | MN00006 | 3/12/1991 | | 0.60 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | MN00006 | 4/23/1991 | | 0.80 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | MN00006 | 5/29/1991 | | 1.00 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | MN00006 | 6/25/1991 | | 1.20 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | MN00006 | 7/30/1991 | | 1.10 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | MN00006 | 8/27/1991 | | 0.90 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | MN00006 | 9/18/1991 | | 0.70 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | MN00006 | 10/23/1991 | | 0.90 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | MN00006 | 1/28/1992 | < | 0.50 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | MN00006 | 3/24/1992 | < | 0.50 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | MN00006 | 4/21/1992 | | 1.30 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | MN00006 | 5/6/1992 | < | 0.50 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | MN00006 | 6/2/1992 | < | 0.50 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | MN00006 | 7/21/1992 | | 0.70 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | MN00006 | 8/11/1992 | | 0.80 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | MN00006 | 9/23/1992 | < | 0.50 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | MN00006 | 10/21/1992 | | 0.70 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | MN00006 | 1/6/1993 | | 0.70 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | MN00006 | 3/3/1993 | | 0.60 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | MN00006 | 4/28/1993 | | 1.10 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | MN00006 | 5/27/1993 | | 1.10 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | MN00006 | 6/23/1993 | | 1.30 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | MN00006 | 7/21/1993 | | 1.30 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | MN00006 | 8/25/1993 | | 1.00 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | MN00006 | 9/22/1993 | | 0.60 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | MN00006 | 10/14/1993 | | 0.50 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | MN00006 | 1/11/1994 | | 1.50 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | MN00006 | 3/15/1994 | | 0.60 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | MN00006 | 4/13/1994 | | 1.60 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | MN00006 | 5/19/1994 | | 1.10 | mg/L |

# Appendix A
# Water Quality Dataset

| Station ID | Parameter | Sample Fraction Type | Lab Name Code | Sample Date | Detect Flag | Result | Result Unit |
|---|---|---|---|---|---|---|---|
| S000-252 | Biochemical oxygen demand, standard conditions | Total | MN00006 | 6/15/1994 | | 1.50 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | MN00006 | 7/20/1994 | | 1.70 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | MN00006 | 8/25/1994 | | 1.10 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | MN00006 | 9/13/1994 | | 1.20 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | MN00006 | 6/24/2003 | | 0.60 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | MN00006 | 7/28/2003 | < | 0.50 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | MN00006 | 8/5/2003 | < | 0.50 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | MN00006 | 9/8/2003 | | 0.70 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | MN00006 | 6/1/2005 | | 0.70 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | MN00006 | 7/11/2005 | | 0.60 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | MN00006 | 8/24/2005 | < | 0.50 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | MN00006 | 9/19/2005 | < | 0.50 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | MN00006 | 6/4/2008 | < | 0.50 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | MN00006 | 7/21/2008 | | 1.10 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | MN00006 | 8/18/2008 | | 0.70 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | MN00006 | 9/16/2008 | < | 0.50 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | MN00006 | 6/7/2010 | | 0.90 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | MN00006 | 7/18/2010 | | 1.30 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | MN00006 | 8/22/2010 | | 1.10 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | MN00006 | 8/22/2010 | < | 0.50 | mg/L |
| S000-252 | Biochemical oxygen demand, standard conditions | Total | MN00006 | 9/27/2010 | | 1.00 | mg/L |
| S000-252 | Butylate | Total | UNKNOWN | 6/14/1988 | < | 0.02 | ug/L |
| S000-252 | Butylate | Total | UNKNOWN | 6/14/1988 | < | 0.02 | ug/L |
| S000-252 | Butylate | Total | MN00006 | 6/13/1989 | < | 0.02 | ug/L |
| S000-252 | Cadmium | Total | UNKNOWN | 8/29/1973 | < | 10.00 | ug/L |
| S000-252 | Cadmium | Total | UNKNOWN | 9/13/1973 | < | 10.00 | ug/L |
| S000-252 | Cadmium | Total | UNKNOWN | 9/26/1973 | < | 10.00 | ug/L |
| S000-252 | Cadmium | Total | UNKNOWN | 12/5/1973 | < | 10.00 | ug/L |
| S000-252 | Cadmium | Total | UNKNOWN | 2/26/1974 | < | 10.00 | ug/L |
| S000-252 | Cadmium | Total | UNKNOWN | 4/9/1974 | < | 10.00 | ug/L |
| S000-252 | Cadmium | Total | UNKNOWN | 4/24/1974 | < | 10.00 | ug/L |
| S000-252 | Cadmium | Total | UNKNOWN | 5/8/1974 | < | 10.00 | ug/L |
| S000-252 | Cadmium | Total | UNKNOWN | 5/15/1974 | < | 10.00 | ug/L |
| S000-252 | Cadmium | Total | UNKNOWN | 6/18/1974 | < | 10.00 | ug/L |
| S000-252 | Cadmium | Total | UNKNOWN | 7/10/1974 | < | 10.00 | ug/L |
| S000-252 | Cadmium | Total | UNKNOWN | 8/13/1974 | < | 10.00 | ug/L |
| S000-252 | Cadmium | Total | UNKNOWN | 9/12/1974 | < | 10.00 | ug/L |
| S000-252 | Cadmium | Total | UNKNOWN | 10/9/1974 | < | 10.00 | ug/L |
| S000-252 | Cadmium | Total | UNKNOWN | 11/5/1974 | < | 10.00 | ug/L |
| S000-252 | Cadmium | Total | UNKNOWN | 12/11/1974 | < | 10.00 | ug/L |
| S000-252 | Cadmium | Total | UNKNOWN | 1/16/1975 | < | 10.00 | ug/L |
| S000-252 | Cadmium | Total | UNKNOWN | 2/26/1975 | < | 10.00 | ug/L |
| S000-252 | Cadmium | Total | UNKNOWN | 4/2/1975 | < | 10.00 | ug/L |
| S000-252 | Cadmium | Total | UNKNOWN | 4/17/1975 | < | 10.00 | ug/L |
| S000-252 | Cadmium | Total | UNKNOWN | 5/1/1975 | < | 10.00 | ug/L |
| S000-252 | Cadmium | Total | UNKNOWN | 5/8/1975 | < | 10.00 | ug/L |
| S000-252 | Cadmium | Total | UNKNOWN | 5/15/1975 | < | 10.00 | ug/L |
| S000-252 | Cadmium | Total | UNKNOWN | 5/22/1975 | < | 10.00 | ug/L |
| S000-252 | Cadmium | Total | UNKNOWN | 6/18/1975 | < | 10.00 | ug/L |
| S000-252 | Cadmium | Total | UNKNOWN | 7/26/1976 | < | 10.00 | ug/L |
| S000-252 | Cadmium | Total | UNKNOWN | 10/18/1976 | < | 10.00 | ug/L |
| S000-252 | Cadmium | Total | UNKNOWN | 4/25/1977 | < | 10.00 | ug/L |
| S000-252 | Cadmium | Total | UNKNOWN | 7/25/1977 | < | 10.00 | ug/L |
| S000-252 | Cadmium | Total | UNKNOWN | 11/8/1978 | | 0.01 | ug/L |
| S000-252 | Cadmium | Total | UNKNOWN | 6/19/1979 | | 0.02 | ug/L |
| S000-252 | Cadmium | Total | UNKNOWN | 10/16/1979 | | 0.01 | ug/L |
| S000-252 | Cadmium | Total | UNKNOWN | 10/14/1980 | | 0.02 | ug/L |
| S000-252 | Cadmium | Total | UNKNOWN | 6/8/1982 | | 0.01 | ug/L |
| S000-252 | Cadmium | Total | UNKNOWN | 6/14/1983 | | 0.03 | ug/L |
| S000-252 | Cadmium | Total | UNKNOWN | 10/15/1985 | | 0.01 | ug/L |
| S000-252 | Cadmium | Total | UNKNOWN | 10/21/1986 | < | 0.01 | ug/L |
| S000-252 | Cadmium | Total | UNKNOWN | 6/9/1987 | < | 0.01 | ug/L |
| S000-252 | Cadmium | Total | UNKNOWN | 6/14/1988 | < | 0.01 | ug/L |
| S000-252 | Cadmium | Total | MN00006 | 5/2/1990 | | 0.16 | ug/L |
| S000-252 | Cadmium | Total | MN00006 | 10/23/1991 | | 0.03 | ug/L |
| S000-252 | Cadmium | Tot | WI00007 | 5/29/1996 | | 0.04 | ug/L |
| S000-252 | Cadmium | Dissolved | WI00007 | 6/27/1996 | | 0.02 | ug/L |
| S000-252 | Cadmium | Tot | WI00007 | 6/27/1996 | | 0.05 | ug/L |
| S000-252 | Cadmium | Tot | WI00007 | 9/4/1996 | | 0.05 | ug/L |
| S000-252 | Cadmium | Dissolved | WI00007 | 9/4/1996 | | 0.05 | ug/L |
| S000-252 | Cadmium | Dissolved | WI00007 | 9/25/1996 | | 0.04 | ug/L |
| S000-252 | Cadmium | Tot | WI00007 | 9/25/1996 | | 0.04 | ug/L |
| S000-252 | Calcium as CaCO3 | Total | UNKNOWN | 7/24/1973 | | 27.00 | mg/L |

# Appendix A
# Water Quality Dataset

| Station ID | Parameter | Sample Fraction Type | Lab Name Code | Sample Date | Detect Flag | Result | Result Unit |
|---|---|---|---|---|---|---|---|
| S000-252 | Calcium as CaCO3 | Total | UNKNOWN | 8/29/1973 | | 38.00 | mg/L |
| S000-252 | Calcium as CaCO3 | Total | UNKNOWN | 9/13/1973 | | 30.00 | mg/L |
| S000-252 | Calcium as CaCO3 | Total | UNKNOWN | 9/26/1973 | | 32.00 | mg/L |
| S000-252 | Calcium as CaCO3 | Total | UNKNOWN | 11/14/1973 | | 28.00 | mg/L |
| S000-252 | Calcium as CaCO3 | Total | UNKNOWN | 12/5/1973 | | 20.00 | mg/L |
| S000-252 | Calcium as CaCO3 | Total | UNKNOWN | 1/29/1974 | | 38.00 | mg/L |
| S000-252 | Calcium as CaCO3 | Total | UNKNOWN | 2/26/1974 | | 68.00 | mg/L |
| S000-252 | Calcium as CaCO3 | Total | UNKNOWN | 3/12/1974 | | 39.00 | mg/L |
| S000-252 | Calcium as CaCO3 | Total | UNKNOWN | 4/2/1974 | | 36.00 | mg/L |
| S000-252 | Calcium as CaCO3 | Total | UNKNOWN | 4/9/1974 | | 43.00 | mg/L |
| S000-252 | Calcium as CaCO3 | Total | UNKNOWN | 4/24/1974 | | 10.00 | mg/L |
| S000-252 | Calcium as CaCO3 | Total | UNKNOWN | 5/8/1974 | | 19.00 | mg/L |
| S000-252 | Calcium as CaCO3 | Total | UNKNOWN | 5/15/1974 | < | 10.00 | mg/L |
| S000-252 | Calcium as CaCO3 | Total | UNKNOWN | 6/18/1974 | | 23.00 | mg/L |
| S000-252 | Calcium as CaCO3 | Total | UNKNOWN | 7/10/1974 | | 45.00 | mg/L |
| S000-252 | Calcium as CaCO3 | Total | UNKNOWN | 8/13/1974 | | 43.00 | mg/L |
| S000-252 | Calcium as CaCO3 | Total | UNKNOWN | 9/12/1974 | | 47.00 | mg/L |
| S000-252 | Calcium as CaCO3 | Total | UNKNOWN | 10/9/1974 | | 35.00 | mg/L |
| S000-252 | Calcium as CaCO3 | Total | UNKNOWN | 11/5/1974 | | 21.00 | mg/L |
| S000-252 | Calcium as CaCO3 | Total | UNKNOWN | 12/11/1974 | | 48.00 | mg/L |
| S000-252 | Calcium as CaCO3 | Total | UNKNOWN | 1/16/1975 | | 27.00 | mg/L |
| S000-252 | Calcium as CaCO3 | Total | UNKNOWN | 2/26/1975 | | 47.00 | mg/L |
| S000-252 | Calcium as CaCO3 | Total | UNKNOWN | 4/2/1975 | | 36.00 | mg/L |
| S000-252 | Calcium as CaCO3 | Total | UNKNOWN | 4/17/1975 | | 24.00 | mg/L |
| S000-252 | Calcium as CaCO3 | Total | UNKNOWN | 5/1/1975 | | 18.00 | mg/L |
| S000-252 | Calcium as CaCO3 | Total | UNKNOWN | 5/8/1975 | | 12.00 | mg/L |
| S000-252 | Calcium as CaCO3 | Total | UNKNOWN | 5/15/1975 | | 15.00 | mg/L |
| S000-252 | Calcium as CaCO3 | Total | UNKNOWN | 5/22/1975 | | 22.00 | mg/L |
| S000-252 | Calcium as CaCO3 | Total | UNKNOWN | 6/18/1975 | | 24.00 | mg/L |
| S000-252 | Calcium as CaCO3 | Total | UNKNOWN | 7/26/1976 | | 55.00 | mg/L |
| S000-252 | Calcium as CaCO3 | Total | UNKNOWN | 10/18/1976 | | 59.00 | mg/L |
| S000-252 | Calcium as CaCO3 | Total | UNKNOWN | 4/25/1977 | | 35.00 | mg/L |
| S000-252 | Calcium as CaCO3 | Total | UNKNOWN | 7/25/1977 | | 44.00 | mg/L |
| S000-252 | Calcium as CaCO3 | Total | UNKNOWN | 10/14/1980 | | 30.00 | mg/L |
| S000-252 | Calcium as CaCO3 | Total | UNKNOWN | 1/14/1981 | | 50.00 | mg/L |
| S000-252 | Calcium as CaCO3 | Total | UNKNOWN | 3/11/1981 | | 46.00 | mg/L |
| S000-252 | Calcium as CaCO3 | Total | UNKNOWN | 4/14/1981 | | 16.00 | mg/L |
| S000-252 | Calcium as CaCO3 | Total | UNKNOWN | 5/12/1981 | | 21.00 | mg/L |
| S000-252 | Calcium as CaCO3 | Total | UNKNOWN | 6/16/1981 | | 21.00 | mg/L |
| S000-252 | Calcium as CaCO3 | Total | UNKNOWN | 7/14/1981 | | 35.00 | mg/L |
| S000-252 | Calcium as CaCO3 | Total | UNKNOWN | 8/12/1981 | | 36.00 | mg/L |
| S000-252 | Calcium as CaCO3 | Total | UNKNOWN | 9/15/1981 | | 46.00 | mg/L |
| S000-252 | Calcium as CaCO3 | Total | UNKNOWN | 10/10/1984 | | 39.00 | mg/L |
| S000-252 | Calcium as CaCO3 | Total | UNKNOWN | 1/14/1985 | | 46.00 | mg/L |
| S000-252 | Calcium as CaCO3 | Total | UNKNOWN | 3/13/1985 | | 46.00 | mg/L |
| S000-252 | Calcium as CaCO3 | Total | UNKNOWN | 4/15/1985 | | 20.00 | mg/L |
| S000-252 | Calcium as CaCO3 | Total | UNKNOWN | 5/14/1985 | | 17.00 | mg/L |
| S000-252 | Calcium as CaCO3 | Total | UNKNOWN | 6/10/1985 | | 25.00 | mg/L |
| S000-252 | Calcium as CaCO3 | Total | UNKNOWN | 7/17/1985 | | 41.00 | mg/L |
| S000-252 | Calcium as CaCO3 | Total | UNKNOWN | 8/13/1985 | | 38.00 | mg/L |
| S000-252 | Calcium as CaCO3 | Total | UNKNOWN | 9/11/1985 | | 35.00 | mg/L |
| S000-252 | Calcium as CaCO3 | Total | UNKNOWN | 10/15/1985 | | 23.00 | mg/L |
| S000-252 | Calcium as CaCO3 | Total | UNKNOWN | 2/19/1986 | | 40.00 | mg/L |
| S000-252 | Calcium as CaCO3 | Total | UNKNOWN | 3/20/1986 | | 39.00 | mg/L |
| S000-252 | Calcium as CaCO3 | Total | UNKNOWN | 4/17/1986 | | 14.00 | mg/L |
| S000-252 | Calcium as CaCO3 | Total | UNKNOWN | 5/12/1986 | | 20.00 | mg/L |
| S000-252 | Calcium as CaCO3 | Total | UNKNOWN | 6/10/1986 | | 38.00 | mg/L |
| S000-252 | Calcium as CaCO3 | Total | UNKNOWN | 8/19/1986 | | 38.00 | mg/L |
| S000-252 | Calcium as CaCO3 | Total | UNKNOWN | 9/24/1986 | | 26.00 | mg/L |
| S000-252 | Calcium as CaCO3 | Total | UNKNOWN | 10/21/1986 | | 27.00 | mg/L |
| S000-252 | Calcium as CaCO3 | Total | UNKNOWN | 1/13/1987 | | 38.00 | mg/L |
| S000-252 | Calcium as CaCO3 | Total | UNKNOWN | 3/10/1987 | | 29.00 | mg/L |
| S000-252 | Calcium as CaCO3 | Total | UNKNOWN | 4/7/1987 | | 21.00 | mg/L |
| S000-252 | Calcium as CaCO3 | Total | UNKNOWN | 5/12/1987 | | 40.00 | mg/L |
| S000-252 | Calcium as CaCO3 | Total | UNKNOWN | 6/9/1987 | | 32.00 | mg/L |
| S000-252 | Calcium as CaCO3 | Total | UNKNOWN | 7/15/1987 | | 42.00 | mg/L |
| S000-252 | Calcium as CaCO3 | Total | UNKNOWN | 8/11/1987 | | 45.00 | mg/L |
| S000-252 | Calcium as CaCO3 | Total | UNKNOWN | 9/15/1987 | | 41.00 | mg/L |
| S000-252 | Calcium as CaCO3 | Total | UNKNOWN | 10/14/1987 | | 42.00 | mg/L |
| S000-252 | Calcium as CaCO3 | Total | UNKNOWN | 1/12/1988 | | 46.00 | mg/L |
| S000-252 | Calcium as CaCO3 | Total | UNKNOWN | 3/15/1988 | | 50.00 | mg/L |
| S000-252 | Calcium as CaCO3 | Total | UNKNOWN | 4/12/1988 | | 15.00 | mg/L |
| S000-252 | Calcium as CaCO3 | Total | UNKNOWN | 5/9/1988 | | 23.00 | mg/L |

# Appendix A
# Water Quality Dataset

| Station ID | Parameter | Sample Fraction Type | Lab Name Code | Sample Date | Detect Flag | Result | Result Unit |
|---|---|---|---|---|---|---|---|
| S000-252 | Calcium as CaCO3 | Total | UNKNOWN | 6/14/1988 | | 53.00 | mg/L |
| S000-252 | Calcium as CaCO3 | Total | UNKNOWN | 7/12/1988 | | 51.00 | mg/L |
| S000-252 | Calcium as CaCO3 | Total | UNKNOWN | 8/17/1988 | | 39.00 | mg/L |
| S000-252 | Calcium as CaCO3 | Total | UNKNOWN | 9/13/1988 | | 45.00 | mg/L |
| S000-252 | Calcium as CaCO3 | Total | UNKNOWN | 10/11/1988 | | 61.00 | mg/L |
| S000-252 | Calcium as CaCO3 | Total | MN00006 | 3/14/1989 | | 55.00 | mg/L |
| S000-252 | Calcium as CaCO3 | Total | MN00006 | 4/11/1989 | | 20.00 | mg/L |
| S000-252 | Calcium as CaCO3 | Total | MN00006 | 5/9/1989 | | 17.00 | mg/L |
| S000-252 | Calcium as CaCO3 | Total | MN00006 | 6/13/1989 | | 23.00 | mg/L |
| S000-252 | Calcium as CaCO3 | Total | MN00006 | 7/18/1989 | | 47.00 | mg/L |
| S000-252 | Calcium as CaCO3 | Total | MN00006 | 8/16/1989 | | 46.00 | mg/L |
| S000-252 | Calcium as CaCO3 | Total | MN00006 | 9/12/1989 | | 48.00 | mg/L |
| S000-252 | Calcium as CaCO3 | Total | MN00006 | 10/10/1989 | | 46.00 | mg/L |
| S000-252 | Calcium as CaCO3 | Total | MN00006 | 1/4/1990 | | 120.00 | mg/L |
| S000-252 | Calcium as CaCO3 | Total | MN00006 | 3/27/1990 | | 42.00 | mg/L |
| S000-252 | Calcium as CaCO3 | Total | MN00006 | 5/2/1990 | | 16.00 | mg/L |
| S000-252 | Calcium as CaCO3 | Total | MN00006 | 6/5/1990 | | 33.00 | mg/L |
| S000-252 | Calcium as CaCO3 | Total | MN00006 | 7/17/1990 | | 44.00 | mg/L |
| S000-252 | Calcium as CaCO3 | Total | MN00006 | 8/16/1990 | | 43.00 | mg/L |
| S000-252 | Calcium as CaCO3 | Total | MN00006 | 9/25/1990 | | 39.00 | mg/L |
| S000-252 | Calcium as CaCO3 | Total | MN00006 | 10/9/1990 | | 26.00 | mg/L |
| S000-252 | Calcium as CaCO3 | Total | MN00006 | 1/29/1991 | | 45.00 | mg/L |
| S000-252 | Calcium as CaCO3 | Total | MN00006 | 3/12/1991 | | 58.00 | mg/L |
| S000-252 | Calcium as CaCO3 | Total | MN00006 | 4/23/1991 | | 20.00 | mg/L |
| S000-252 | Calcium as CaCO3 | Total | MN00006 | 5/29/1991 | | 34.00 | mg/L |
| S000-252 | Calcium as CaCO3 | Total | MN00006 | 6/25/1991 | | 49.00 | mg/L |
| S000-252 | Calcium as CaCO3 | Total | MN00006 | 7/30/1991 | | 38.00 | mg/L |
| S000-252 | Calcium as CaCO3 | Total | MN00006 | 8/27/1991 | | 43.00 | mg/L |
| S000-252 | Calcium as CaCO3 | Total | MN00006 | 9/18/1991 | | 36.00 | mg/L |
| S000-252 | Calcium as CaCO3 | Total | MN00006 | 10/23/1991 | | 34.00 | mg/L |
| S000-252 | Calcium as CaCO3 | Total | MN00006 | 1/28/1992 | | 37.00 | mg/L |
| S000-252 | Calcium as CaCO3 | Total | MN00006 | 3/24/1992 | | 37.00 | mg/L |
| S000-252 | Calcium as CaCO3 | Total | MN00006 | 4/21/1992 | | 14.00 | mg/L |
| S000-252 | Calcium as CaCO3 | Total | MN00006 | 5/6/1992 | | 16.00 | mg/L |
| S000-252 | Calcium as CaCO3 | Total | MN00006 | 6/2/1992 | | 32.00 | mg/L |
| S000-252 | Calcium as CaCO3 | Total | MN00006 | 7/21/1992 | | 38.00 | mg/L |
| S000-252 | Calcium as CaCO3 | Total | MN00006 | 8/11/1992 | | 38.00 | mg/L |
| S000-252 | Calcium as CaCO3 | Total | MN00006 | 9/23/1992 | | 37.00 | mg/L |
| S000-252 | Calcium as CaCO3 | Total | MN00006 | 10/21/1992 | | 39.00 | mg/L |
| S000-252 | Calcium as CaCO3 | Total | MN00006 | 1/6/1993 | | 43.00 | mg/L |
| S000-252 | Calcium as CaCO3 | Total | MN00006 | 3/3/1993 | | 47.00 | mg/L |
| S000-252 | Calcium as CaCO3 | Total | MN00006 | 4/28/1993 | | 18.00 | mg/L |
| S000-252 | Calcium as CaCO3 | Total | MN00006 | 5/27/1993 | | 23.00 | mg/L |
| S000-252 | Calcium as CaCO3 | Total | MN00006 | 6/23/1993 | | 29.00 | mg/L |
| S000-252 | Calcium as CaCO3 | Total | MN00006 | 7/21/1993 | | 41.00 | mg/L |
| S000-252 | Calcium as CaCO3 | Total | MN00006 | 8/25/1993 | | 46.00 | mg/L |
| S000-252 | Calcium as CaCO3 | Total | MN00006 | 4/21/2008 | | 14.00 | mg/L |
| S000-252 | Carbaryl | Total | UNKNOWN | 6/14/1988 | < | 1.00 | ug/L |
| S000-252 | Carbaryl | Total | UNKNOWN | 6/14/1988 | < | 1.00 | ug/L |
| S000-252 | Carbofuran | Total | UNKNOWN | 6/14/1988 | < | 0.50 | ug/L |
| S000-252 | Carbofuran | Total | UNKNOWN | 6/14/1988 | < | 0.50 | ug/L |
| S000-252 | Carbon | Total | UNKNOWN | 9/13/1973 | | 34.00 | mg/L |
| S000-252 | Carbon | Total | UNKNOWN | 9/26/1973 | | 29.10 | mg/L |
| S000-252 | Carbon | Total | UNKNOWN | 10/17/1973 | | 28.50 | mg/L |
| S000-252 | Carbon | Total | UNKNOWN | 3/12/1974 | | 18.20 | mg/L |
| S000-252 | Carbon | Total | UNKNOWN | 4/9/1974 | | 21.30 | mg/L |
| S000-252 | Carbon | Total | UNKNOWN | 5/8/1974 | | 13.50 | mg/L |
| S000-252 | Carbon | Total | UNKNOWN | 5/15/1974 | | 14.00 | mg/L |
| S000-252 | Carbon | Total | UNKNOWN | 6/18/1974 | | 17.20 | mg/L |
| S000-252 | Carbonaceous biochemical oxygen demand, standard conditions | Total | UNKNOWN | 7/15/1987 | | 1.00 | mg/L |
| S000-252 | Carbonaceous biochemical oxygen demand, standard conditions | Total | UNKNOWN | 1/12/1988 | | 0.80 | mg/L |
| S000-252 | Carbonaceous biochemical oxygen demand, standard conditions | Total | UNKNOWN | 9/13/1988 | | 0.70 | mg/L |
| S000-252 | Carbonaceous biochemical oxygen demand, standard conditions | Total | UNKNOWN | 10/11/1988 | | 0.70 | mg/L |
| S000-252 | Chemical oxygen demand | Total | UNKNOWN | 9/26/1973 | | 28.00 | mg/L |
| S000-252 | Chemical oxygen demand | Total | UNKNOWN | 2/26/1974 | < | 50.00 | mg/L |
| S000-252 | Chemical oxygen demand | Total | UNKNOWN | 4/24/1974 | < | 50.00 | mg/L |
| S000-252 | Chemical oxygen demand | Total | UNKNOWN | 9/12/1974 | < | 50.00 | mg/L |
| S000-252 | Chemical oxygen demand | Total | UNKNOWN | 2/26/1975 | | 25.00 | mg/L |
| S000-252 | Chemical oxygen demand | Total | UNKNOWN | 5/1/1975 | | 32.00 | mg/L |
| S000-252 | Chemical oxygen demand | Total | UNKNOWN | 10/24/1977 | | 50.00 | mg/L |
| S000-252 | Chemical oxygen demand | Total | UNKNOWN | 11/14/1977 | | 52.00 | mg/L |
| S000-252 | Chemical oxygen demand | Total | UNKNOWN | 12/19/1977 | | 33.00 | mg/L |
| S000-252 | Chemical oxygen demand | Total | UNKNOWN | 1/23/1978 | | 24.00 | mg/L |

# Appendix A
# Water Quality Dataset

| Station ID | Parameter | Sample Fraction Type | Lab Name Code | Sample Date | Detect Flag | Result | Result Unit |
|---|---|---|---|---|---|---|---|
| S000-252 | Chemical oxygen demand | Total | UNKNOWN | 2/21/1978 | | 16.00 | mg/L |
| S000-252 | Chemical oxygen demand | Total | UNKNOWN | 3/1/1978 | | 17.00 | mg/L |
| S000-252 | Chemical oxygen demand | Total | UNKNOWN | 4/4/1978 | | 30.00 | mg/L |
| S000-252 | Chemical oxygen demand | Total | UNKNOWN | 5/1/1978 | | 37.00 | mg/L |
| S000-252 | Chemical oxygen demand | Total | UNKNOWN | 6/6/1978 | | 56.00 | mg/L |
| S000-252 | Chemical oxygen demand | Total | UNKNOWN | 7/6/1978 | | 67.00 | mg/L |
| S000-252 | Chemical oxygen demand | Total | UNKNOWN | 8/1/1978 | | 59.00 | mg/L |
| S000-252 | Chemical oxygen demand | Total | UNKNOWN | 9/6/1978 | | 51.00 | mg/L |
| S000-252 | Chemical oxygen demand | Total | UNKNOWN | 10/3/1978 | | 44.00 | mg/L |
| S000-252 | Chemical oxygen demand | Total | UNKNOWN | 11/8/1978 | | 30.00 | mg/L |
| S000-252 | Chemical oxygen demand | Total | UNKNOWN | 12/6/1978 | | 33.00 | mg/L |
| S000-252 | Chemical oxygen demand | Total | UNKNOWN | 1/16/1979 | | 44.00 | mg/L |
| S000-252 | Chemical oxygen demand | Total | UNKNOWN | 2/21/1979 | | 15.00 | mg/L |
| S000-252 | Chemical oxygen demand | Total | UNKNOWN | 3/20/1979 | | 29.00 | mg/L |
| S000-252 | Chemical oxygen demand | Total | UNKNOWN | 4/4/1979 | | 32.00 | mg/L |
| S000-252 | Chemical oxygen demand | Total | UNKNOWN | 5/2/1979 | | 68.00 | mg/L |
| S000-252 | Chemical oxygen demand | Total | UNKNOWN | 6/19/1979 | | 55.00 | mg/L |
| S000-252 | Chemical oxygen demand | Total | UNKNOWN | 7/24/1979 | | 72.00 | mg/L |
| S000-252 | Chemical oxygen demand | Total | UNKNOWN | 7/31/1979 | | 56.00 | mg/L |
| S000-252 | Chemical oxygen demand | Total | UNKNOWN | 8/21/1979 | | 37.00 | mg/L |
| S000-252 | Chemical oxygen demand | Total | UNKNOWN | 10/16/1979 | | 29.00 | mg/L |
| S000-252 | Chemical oxygen demand | Total | UNKNOWN | 12/18/1979 | | 47.00 | mg/L |
| S000-252 | Chemical oxygen demand | Total | UNKNOWN | 1/22/1980 | | 20.00 | mg/L |
| S000-252 | Chemical oxygen demand | Total | UNKNOWN | 2/27/1980 | | 14.00 | mg/L |
| S000-252 | Chemical oxygen demand | Total | UNKNOWN | 3/19/1980 | | 16.00 | mg/L |
| S000-252 | Chemical oxygen demand | Total | UNKNOWN | 4/22/1980 | | 39.00 | mg/L |
| S000-252 | Chemical oxygen demand | Total | UNKNOWN | 5/20/1980 | | 29.00 | mg/L |
| S000-252 | Chlordane | Total | UNKNOWN | 11/8/1978 | < | 0.10 | ug/L |
| S000-252 | Chlordane | Total | UNKNOWN | 10/16/1979 | < | 0.07 | ug/L |
| S000-252 | Chlordane, gamma | Total | UNKNOWN | 11/8/1978 | < | 0.01 | ug/L |
| S000-252 | Chlordane, gamma | Total | UNKNOWN | 10/16/1979 | < | 0.02 | ug/L |
| S000-252 | Chloride | Total | UNKNOWN | 7/24/1973 | | 3.00 | mg/L |
| S000-252 | Chloride | Total | UNKNOWN | 8/29/1973 | < | 1.00 | mg/L |
| S000-252 | Chloride | Total | UNKNOWN | 9/13/1973 | | 10.00 | mg/L |
| S000-252 | Chloride | Total | UNKNOWN | 9/26/1973 | | 6.20 | mg/L |
| S000-252 | Chloride | Total | UNKNOWN | 10/17/1973 | | 3.00 | mg/L |
| S000-252 | Chloride | Total | UNKNOWN | 11/14/1973 | | 2.30 | mg/L |
| S000-252 | Chloride | Total | UNKNOWN | 12/5/1973 | | 2.70 | mg/L |
| S000-252 | Chloride | Total | UNKNOWN | 1/29/1974 | | 2.00 | mg/L |
| S000-252 | Chloride | Total | UNKNOWN | 2/26/1974 | | 1.00 | mg/L |
| S000-252 | Chloride | Total | UNKNOWN | 3/12/1974 | | 2.70 | mg/L |
| S000-252 | Chloride | Total | UNKNOWN | 4/2/1974 | | 1.90 | mg/L |
| S000-252 | Chloride | Total | UNKNOWN | 4/9/1974 | | 2.00 | mg/L |
| S000-252 | Chloride | Total | UNKNOWN | 4/24/1974 | | 4.70 | mg/L |
| S000-252 | Chloride | Total | UNKNOWN | 5/8/1974 | | 4.70 | mg/L |
| S000-252 | Chloride | Total | UNKNOWN | 5/15/1974 | | 0.70 | mg/L |
| S000-252 | Chloride | Total | UNKNOWN | 6/18/1974 | | 4.00 | mg/L |
| S000-252 | Chloride | Total | UNKNOWN | 7/10/1974 | | 4.50 | mg/L |
| S000-252 | Chloride | Total | UNKNOWN | 8/13/1974 | | 6.70 | mg/L |
| S000-252 | Chloride | Total | UNKNOWN | 9/12/1974 | | 5.30 | mg/L |
| S000-252 | Chloride | Total | UNKNOWN | 10/9/1974 | | 1.90 | mg/L |
| S000-252 | Chloride | Total | UNKNOWN | 11/5/1974 | | 4.70 | mg/L |
| S000-252 | Chloride | Total | UNKNOWN | 12/11/1974 | | 2.90 | mg/L |
| S000-252 | Chloride | Total | UNKNOWN | 1/16/1975 | | 3.70 | mg/L |
| S000-252 | Chloride | Total | UNKNOWN | 2/26/1975 | | 3.10 | mg/L |
| S000-252 | Chloride | Total | UNKNOWN | 4/2/1975 | | 3.50 | mg/L |
| S000-252 | Chloride | Total | UNKNOWN | 4/17/1975 | | 5.60 | mg/L |
| S000-252 | Chloride | Total | UNKNOWN | 5/1/1975 | | 1.80 | mg/L |
| S000-252 | Chloride | Total | UNKNOWN | 5/8/1975 | | 1.20 | mg/L |
| S000-252 | Chloride | Total | UNKNOWN | 5/15/1975 | | 4.80 | mg/L |
| S000-252 | Chloride | Total | UNKNOWN | 5/22/1975 | | 4.00 | mg/L |
| S000-252 | Chloride | Total | UNKNOWN | 6/18/1975 | | 1.10 | mg/L |
| S000-252 | Chloride | Total | UNKNOWN | 7/26/1976 | | 3.30 | mg/L |
| S000-252 | Chloride | Total | UNKNOWN | 8/23/1976 | | 6.00 | mg/L |
| S000-252 | Chloride | Total | UNKNOWN | 9/20/1976 | | 9.40 | mg/L |
| S000-252 | Chloride | Total | UNKNOWN | 10/18/1976 | | 3.70 | mg/L |
| S000-252 | Chloride | Total | UNKNOWN | 11/16/1976 | | 4.30 | mg/L |
| S000-252 | Chloride | Total | UNKNOWN | 3/22/1977 | | 5.30 | mg/L |
| S000-252 | Chloride | Total | UNKNOWN | 4/25/1977 | | 1.50 | mg/L |
| S000-252 | Chloride | Total | UNKNOWN | 5/23/1977 | | 1.10 | mg/L |
| S000-252 | Chloride | Total | UNKNOWN | 6/27/1977 | | 0.84 | mg/L |
| S000-252 | Chloride | Total | UNKNOWN | 7/25/1977 | | 2.10 | mg/L |
| S000-252 | Chloride | Total | UNKNOWN | 8/22/1977 | | 3.20 | mg/L |

# Appendix A
# Water Quality Dataset

| Station ID | Parameter | Sample Fraction Type | Lab Name Code | Sample Date | Detect Flag | Result | Result Unit |
|---|---|---|---|---|---|---|---|
| S000-252 | Chloride | Total | UNKNOWN | 9/26/1977 | | 1.90 | mg/L |
| S000-252 | Chloride | Total | UNKNOWN | 10/10/1984 | | 1.50 | mg/L |
| S000-252 | Chloride | Total | UNKNOWN | 1/14/1985 | | 2.00 | mg/L |
| S000-252 | Chloride | Total | UNKNOWN | 3/13/1985 | | 7.30 | mg/L |
| S000-252 | Chloride | Total | UNKNOWN | 4/15/1985 | | 1.40 | mg/L |
| S000-252 | Chloride | Total | UNKNOWN | 5/14/1985 | | 0.93 | mg/L |
| S000-252 | Chloride | Total | UNKNOWN | 6/10/1985 | | 0.85 | mg/L |
| S000-252 | Chloride | Total | UNKNOWN | 7/17/1985 | | 0.98 | mg/L |
| S000-252 | Chloride | Total | UNKNOWN | 8/13/1985 | | 3.10 | mg/L |
| S000-252 | Chloride | Total | UNKNOWN | 9/11/1985 | | 8.80 | mg/L |
| S000-252 | Chloride | Total | UNKNOWN | 10/15/1985 | | 3.20 | mg/L |
| S000-252 | Chloride | Total | UNKNOWN | 2/19/1986 | | 16.00 | mg/L |
| S000-252 | Chloride | Total | UNKNOWN | 3/20/1986 | | 2.90 | mg/L |
| S000-252 | Chloride | Total | UNKNOWN | 4/17/1986 | | 0.88 | mg/L |
| S000-252 | Chloride | Total | UNKNOWN | 5/12/1986 | | 1.00 | mg/L |
| S000-252 | Chloride | Total | UNKNOWN | 6/10/1986 | | 1.50 | mg/L |
| S000-252 | Chloride | Total | UNKNOWN | 7/15/1986 | | 2.00 | mg/L |
| S000-252 | Chloride | Total | UNKNOWN | 8/19/1986 | | 7.70 | mg/L |
| S000-252 | Chloride | Total | UNKNOWN | 9/24/1986 | | 5.00 | mg/L |
| S000-252 | Chloride | Total | UNKNOWN | 10/21/1986 | | 6.00 | mg/L |
| S000-252 | Chloride | Total | UNKNOWN | 1/13/1987 | | 9.30 | mg/L |
| S000-252 | Chloride | Total | UNKNOWN | 3/10/1987 | | 3.40 | mg/L |
| S000-252 | Chloride | Total | UNKNOWN | 4/7/1987 | | 4.40 | mg/L |
| S000-252 | Chloride | Total | UNKNOWN | 5/12/1987 | | 17.00 | mg/L |
| S000-252 | Chloride | Total | UNKNOWN | 6/9/1987 | | 7.50 | mg/L |
| S000-252 | Chloride | Total | UNKNOWN | 7/15/1987 | | 16.00 | mg/L |
| S000-252 | Chloride | Total | UNKNOWN | 8/11/1987 | | 33.00 | mg/L |
| S000-252 | Chloride | Total | UNKNOWN | 9/15/1987 | | 15.00 | mg/L |
| S000-252 | Chloride | Total | UNKNOWN | 10/14/1987 | | 15.00 | mg/L |
| S000-252 | Chloride | Total | UNKNOWN | 1/12/1988 | | 34.00 | mg/L |
| S000-252 | Chloride | Total | UNKNOWN | 3/15/1988 | | 22.00 | mg/L |
| S000-252 | Chloride | Total | UNKNOWN | 4/12/1988 | | 1.90 | mg/L |
| S000-252 | Chloride | Total | UNKNOWN | 5/9/1988 | | 2.90 | mg/L |
| S000-252 | Chloride | Total | UNKNOWN | 6/14/1988 | | 28.00 | mg/L |
| S000-252 | Chloride | Total | UNKNOWN | 7/12/1988 | | 30.00 | mg/L |
| S000-252 | Chloride | Total | UNKNOWN | 8/17/1988 | | 7.40 | mg/L |
| S000-252 | Chloride | Total | UNKNOWN | 9/13/1988 | | 24.00 | mg/L |
| S000-252 | Chloride | Total | UNKNOWN | 10/11/1988 | | 13.00 | mg/L |
| S000-252 | Chloride | Total | MN00006 | 3/14/1989 | | 20.00 | mg/L |
| S000-252 | Chloride | Total | MN00006 | 4/11/1989 | | 2.00 | mg/L |
| S000-252 | Chloride | Total | MN00006 | 5/9/1989 | | 2.80 | mg/L |
| S000-252 | Chloride | Total | MN00006 | 6/13/1989 | | 3.80 | mg/L |
| S000-252 | Chloride | Total | MN00006 | 7/18/1989 | | 14.00 | mg/L |
| S000-252 | Chloride | Total | MN00006 | 8/16/1989 | | 25.00 | mg/L |
| S000-252 | Chloride | Total | MN00006 | 9/12/1989 | | 16.00 | mg/L |
| S000-252 | Chloride | Total | MN00006 | 10/10/1989 | | 1.20 | mg/L |
| S000-252 | Chloride | Total | MN00006 | 1/4/1990 | | 8.20 | mg/L |
| S000-252 | Chloride | Total | MN00006 | 3/27/1990 | | 18.00 | mg/L |
| S000-252 | Chloride | Total | MN00006 | 5/2/1990 | | 2.50 | mg/L |
| S000-252 | Chloride | Total | MN00006 | 6/5/1990 | | 6.50 | mg/L |
| S000-252 | Chloride | Total | MN00006 | 7/17/1990 | | 16.00 | mg/L |
| S000-252 | Chloride | Total | MN00006 | 8/16/1990 | | 31.00 | mg/L |
| S000-252 | Chloride | Total | MN00006 | 9/25/1990 | < | 0.50 | mg/L |
| S000-252 | Chloride | Total | MN00006 | 10/9/1990 | | 8.90 | mg/L |
| S000-252 | Chloride | Total | MN00006 | 1/29/1991 | | 27.00 | mg/L |
| S000-252 | Chloride | Total | MN00006 | 3/12/1991 | | 32.00 | mg/L |
| S000-252 | Chloride | Total | MN00006 | 4/23/1991 | | 0.88 | mg/L |
| S000-252 | Chloride | Total | MN00006 | 5/29/1991 | | 1.00 | mg/L |
| S000-252 | Chloride | Total | MN00006 | 6/25/1991 | | 1.40 | mg/L |
| S000-252 | Chloride | Total | MN00006 | 7/30/1991 | | 7.20 | mg/L |
| S000-252 | Chloride | Total | MN00006 | 8/27/1991 | | 25.00 | mg/L |
| S000-252 | Chloride | Total | MN00006 | 9/18/1991 | | 2.80 | mg/L |
| S000-252 | Chloride | Total | MN00006 | 10/23/1991 | | 8.00 | mg/L |
| S000-252 | Chloride | Total | MN00006 | 1/28/1992 | | 13.00 | mg/L |
| S000-252 | Chloride | Total | MN00006 | 3/24/1992 | | 9.20 | mg/L |
| S000-252 | Chloride | Total | MN00006 | 4/21/1992 | | 1.00 | mg/L |
| S000-252 | Chloride | Total | MN00006 | 5/6/1992 | | 2.70 | mg/L |
| S000-252 | Chloride | Total | MN00006 | 6/2/1992 | | 6.90 | mg/L |
| S000-252 | Chloride | Total | MN00006 | 7/21/1992 | | 8.80 | mg/L |
| S000-252 | Chloride | Total | MN00006 | 8/11/1992 | | 7.70 | mg/L |
| S000-252 | Chloride | Total | MN00006 | 9/23/1992 | | 11.00 | mg/L |
| S000-252 | Chloride | Total | MN00006 | 10/21/1992 | | 9.20 | mg/L |
| S000-252 | Chloride | Total | MN00006 | 1/6/1993 | | 19.00 | mg/L |

# Appendix A
# Water Quality Dataset

| Station ID | Parameter | Sample Fraction Type | Lab Name Code | Sample Date | Detect Flag | Result | Result Unit |
|---|---|---|---|---|---|---|---|
| S000-252 | Chloride | Total | MN00006 | 3/3/1993 | | 18.00 | mg/L |
| S000-252 | Chloride | Total | MN00006 | 4/28/1993 | | 2.20 | mg/L |
| S000-252 | Chloride | Total | MN00006 | 5/27/1993 | | 2.40 | mg/L |
| S000-252 | Chloride | Total | MN00006 | 6/23/1993 | | 5.10 | mg/L |
| S000-252 | Chloride | Total | MN00006 | 7/21/1993 | | 7.90 | mg/L |
| S000-252 | Chloride | Total | MN00006 | 10/14/1993 | | 17.00 | mg/L |
| S000-252 | Chloride | Total | MN00006 | 1/11/1994 | | 16.00 | mg/L |
| S000-252 | Chloride | Total | MN00006 | 3/15/1994 | | 16.00 | mg/L |
| S000-252 | Chloride | Total | MN00006 | 4/13/1994 | | 1.50 | mg/L |
| S000-252 | Chloride | Total | MN00006 | 5/19/1994 | | 4.70 | mg/L |
| S000-252 | Chloride | Total | MN00006 | 6/15/1994 | | 2.50 | mg/L |
| S000-252 | Chloride | Total | MN00006 | 7/20/1994 | | 2.10 | mg/L |
| S000-252 | Chloride | Total | MN00006 | 8/25/1994 | | 26.00 | mg/L |
| S000-252 | Chloride | Total | MN00006 | 9/13/1994 | | 21.00 | mg/L |
| S000-252 | Chloride | Total | MN00006 | 10/19/1994 | | 3.00 | mg/L |
| S000-252 | Chloride | Total | MN00006 | 11/7/1994 | | 1.60 | mg/L |
| S000-252 | Chloride | Total | MN00006 | 1/19/1995 | | 1.80 | mg/L |
| S000-252 | Chloride | Total | MN00006 | 3/16/1995 | | 5.10 | mg/L |
| S000-252 | Chloride | Total | MN00006 | 4/12/1995 | | 5.20 | mg/L |
| S000-252 | Chloride | Total | MN00006 | 5/18/1995 | | 2.90 | mg/L |
| S000-252 | Chloride | Total | MN00006 | 6/13/1995 | | 24.00 | mg/L |
| S000-252 | Chloride | Total | MN00006 | 7/26/1995 | | 12.00 | mg/L |
| S000-252 | Chloride | Total | MN00006 | 8/14/1995 | | 22.00 | mg/L |
| S000-252 | Chloride | Total | MN00006 | 9/12/1995 | | 13.00 | mg/L |
| S000-252 | Chloride | Total | MN00006 | 10/8/2007 | | 2.30 | mg/L |
| S000-252 | Chloride | Total | MN00006 | 2/12/2008 | | 50.00 | mg/L |
| S000-252 | Chloride | Total | MN00006 | 3/31/2008 | | 46.00 | mg/L |
| S000-252 | Chloride | Total | MN00006 | 4/21/2008 | | 2.12 | mg/L |
| S000-252 | Chloride | Total | MN00006 | 5/13/2008 | | 10.00 | mg/L |
| S000-252 | Chloride | Total | MN00006 | 6/4/2008 | | 24.80 | mg/L |
| S000-252 | Chloride | Total | MN00006 | 7/21/2008 | | 1.40 | mg/L |
| S000-252 | Chloride | Total | MN00006 | 8/18/2008 | | 89.00 | mg/L |
| S000-252 | Chloride | Total | MN00006 | 9/16/2008 | | 62.00 | mg/L |
| S000-252 | Chloride | Total | MN00006 | 10/26/2009 | | 2.43 | mg/L |
| S000-252 | Chloride | Total | MN00006 | 11/30/2009 | | 1.34 | mg/L |
| S000-252 | Chloride | Total | MN00006 | 1/25/2010 | | 5.61 | mg/L |
| S000-252 | Chloride | Total | MN00006 | 3/1/2010 | | 3.29 | mg/L |
| S000-252 | Chloride | Total | MN00006 | 4/26/2010 | | 27.90 | mg/L |
| S000-252 | Chloride | Total | MN00006 | 5/11/2010 | | 13.00 | mg/L |
| S000-252 | Chloride | Total | MN00006 | 6/7/2010 | | 1.20 | mg/L |
| S000-252 | Chloride | Total | MN00006 | 8/22/2010 | | 2.88 | mg/L |
| S000-252 | Chloride | Total | MN00006 | 8/22/2010 | | 37.80 | mg/L |
| S000-252 | Chloride | Total | MN00006 | 9/27/2010 | | 2.44 | mg/L |
| S000-252 | Chlorophyll a, corrected for pheophytin | Total | MN00006 | 6/24/2003 | | 0.88 | ug/L |
| S000-252 | Chlorophyll a, corrected for pheophytin | Total | MN00006 | 7/28/2003 | | 0.95 | ug/L |
| S000-252 | Chlorophyll a, corrected for pheophytin | Total | MN00006 | 8/5/2003 | | 0.46 | ug/L |
| S000-252 | Chlorophyll a, corrected for pheophytin | Total | MN00006 | 9/8/2003 | | 4.72 | ug/L |
| S000-252 | Chlorophyll a, corrected for pheophytin | Total | MN00006 | 6/1/2005 | | 1.26 | ug/L |
| S000-252 | Chlorophyll a, corrected for pheophytin | Total | MN00006 | 7/11/2005 | | 0.60 | ug/L |
| S000-252 | Chlorophyll a, corrected for pheophytin | Total | MN00006 | 8/24/2005 | | 1.69 | ug/L |
| S000-252 | Chlorophyll a, corrected for pheophytin | Total | MN00006 | 9/19/2005 | | 2.00 | ug/L |
| S000-252 | Chlorophyll a, corrected for pheophytin | Total | MN00006 | 6/4/2008 | | 0.28 | ug/L |
| S000-252 | Chlorophyll a, corrected for pheophytin | Total | MN00006 | 7/21/2008 | | 1.41 | ug/L |
| S000-252 | Chlorophyll a, corrected for pheophytin | Total | MN00006 | 8/18/2008 | | 1.66 | ug/L |
| S000-252 | Chlorophyll a, corrected for pheophytin | Total | MN00006 | 9/16/2008 | | 2.71 | ug/L |
| S000-252 | Chlorophyll a, corrected for pheophytin | Total | MN00006 | 6/7/2010 | < | 1.05 | ug/L |
| S000-252 | Chlorophyll a, corrected for pheophytin | Total | MN00006 | 7/18/2010 | < | 1.09 | ug/L |
| S000-252 | Chlorophyll a, corrected for pheophytin | Total | MN00006 | 8/22/2010 | | 2.22 | ug/L |
| S000-252 | Chlorophyll a, corrected for pheophytin | Total | MN00006 | 9/27/2010 | | 1.54 | ug/L |
| S000-252 | Chlorothalonil | Total | MN00100 | 5/29/1991 | < | 0.09 | ug/L |
| S000-252 | Chlorothalonil | Total | MN00100 | 6/25/1991 | < | 0.09 | ug/L |
| S000-252 | Chlorothalonil | Total | MN00100 | 6/25/1991 | < | 0.09 | ug/L |
| S000-252 | Chlorothalonil | Total | MN00100 | 7/30/1991 | < | 0.09 | ug/L |
| S000-252 | Chlorpyrifos | Total | UNKNOWN | 6/14/1988 | < | 0.01 | ug/L |
| S000-252 | Chlorpyrifos | Total | UNKNOWN | 6/14/1988 | < | 0.01 | ug/L |
| S000-252 | Chlorpyrifos | Total | MN00006 | 6/13/1989 | < | 0.01 | ug/L |
| S000-252 | Chlorpyrifos-methyl | Total | MN00100 | 5/6/1992 | < | 0.05 | ug/L |
| S000-252 | Chlorpyrifos-methyl | Total | MN00100 | 6/2/1992 | < | 0.05 | ug/L |
| S000-252 | Chlorpyrifos-methyl | Total | MN00100 | 7/21/1992 | < | 0.05 | ug/L |
| S000-252 | Chlorpyrifos-methyl | Total | MN00100 | 5/27/1993 | < | 0.05 | ug/L |
| S000-252 | Chlorpyrifos-methyl | Total | MN00100 | 6/23/1993 | < | 0.05 | ug/L |
| S000-252 | Chlorpyrifos-methyl | Total | MN00100 | 7/21/1993 | < | 0.05 | ug/L |
| S000-252 | Chromium | Total | UNKNOWN | 9/26/1973 | | 8.20 | ug/L |

# Appendix A
# Water Quality Dataset

| Station ID | Parameter | Sample Fraction Type | Lab Name Code | Sample Date | Detect Flag | Result | Result Unit |
|---|---|---|---|---|---|---|---|
| S000-252 | Chromium | Total | UNKNOWN | 2/26/1974 | | 2.00 | ug/L |
| S000-252 | Chromium | Total | UNKNOWN | 4/24/1974 | < | 2.00 | ug/L |
| S000-252 | Chromium | Total | UNKNOWN | 9/12/1974 | < | 2.00 | ug/L |
| S000-252 | Chromium | Total | UNKNOWN | 2/26/1975 | | 1.20 | ug/L |
| S000-252 | Chromium | Total | UNKNOWN | 5/1/1975 | | 0.70 | ug/L |
| S000-252 | Chromium | Total | UNKNOWN | 11/8/1978 | | 0.70 | ug/L |
| S000-252 | Chromium | Total | UNKNOWN | 6/19/1979 | | 2.50 | ug/L |
| S000-252 | Chromium | Total | UNKNOWN | 10/16/1979 | | 1.20 | ug/L |
| S000-252 | Chromium | Total | UNKNOWN | 10/14/1980 | | 0.60 | ug/L |
| S000-252 | Chromium | Total | UNKNOWN | 6/8/1982 | | 0.90 | ug/L |
| S000-252 | Chromium | Total | UNKNOWN | 6/14/1983 | | 0.80 | ug/L |
| S000-252 | Chromium | Total | UNKNOWN | 10/15/1985 | | 0.70 | ug/L |
| S000-252 | Chromium | Total | UNKNOWN | 10/21/1986 | < | 0.50 | ug/L |
| S000-252 | Chromium | Total | MN00006 | 6/25/1991 | < | 2.00 | ug/L |
| S000-252 | Chromium | Total | MN00006 | 10/23/1991 | < | 0.80 | ug/L |
| S000-252 | cis-Chlordane | Total | UNKNOWN | 11/8/1978 | < | 0.01 | ug/L |
| S000-252 | cis-Chlordane | Total | UNKNOWN | 11/8/1978 | < | 0.01 | ug/L |
| S000-252 | cis-Chlordane | Total | UNKNOWN | 10/16/1979 | < | 0.02 | ug/L |
| S000-252 | Coliform/Streptococcus ratio, fecal | Total | UNKNOWN | 4/24/1974 | | 0.67 | None |
| S000-252 | Coliform/Streptococcus ratio, fecal | Total | UNKNOWN | 7/26/1976 | | 4.58 | None |
| S000-252 | Copper | Total | UNKNOWN | 8/29/1973 | < | 10.00 | ug/L |
| S000-252 | Copper | Total | UNKNOWN | 9/13/1973 | < | 10.00 | ug/L |
| S000-252 | Copper | Total | UNKNOWN | 9/26/1973 | | 13.00 | ug/L |
| S000-252 | Copper | Total | UNKNOWN | 12/5/1973 | < | 10.00 | ug/L |
| S000-252 | Copper | Total | UNKNOWN | 2/26/1974 | < | 10.00 | ug/L |
| S000-252 | Copper | Total | UNKNOWN | 4/9/1974 | < | 10.00 | ug/L |
| S000-252 | Copper | Total | UNKNOWN | 4/24/1974 | < | 10.00 | ug/L |
| S000-252 | Copper | Total | UNKNOWN | 5/8/1974 | < | 10.00 | ug/L |
| S000-252 | Copper | Total | UNKNOWN | 5/15/1974 | < | 10.00 | ug/L |
| S000-252 | Copper | Total | UNKNOWN | 6/18/1974 | < | 10.00 | ug/L |
| S000-252 | Copper | Total | UNKNOWN | 7/10/1974 | < | 10.00 | ug/L |
| S000-252 | Copper | Total | UNKNOWN | 8/13/1974 | < | 10.00 | ug/L |
| S000-252 | Copper | Total | UNKNOWN | 9/12/1974 | < | 10.00 | ug/L |
| S000-252 | Copper | Total | UNKNOWN | 10/9/1974 | < | 10.00 | ug/L |
| S000-252 | Copper | Total | UNKNOWN | 11/5/1974 | < | 10.00 | ug/L |
| S000-252 | Copper | Total | UNKNOWN | 12/11/1974 | < | 10.00 | ug/L |
| S000-252 | Copper | Total | UNKNOWN | 1/16/1975 | < | 10.00 | ug/L |
| S000-252 | Copper | Total | UNKNOWN | 2/26/1975 | < | 10.00 | ug/L |
| S000-252 | Copper | Total | UNKNOWN | 4/2/1975 | | 10.00 | ug/L |
| S000-252 | Copper | Total | UNKNOWN | 4/17/1975 | < | 10.00 | ug/L |
| S000-252 | Copper | Total | UNKNOWN | 5/1/1975 | < | 10.00 | ug/L |
| S000-252 | Copper | Total | UNKNOWN | 5/8/1975 | | 10.00 | ug/L |
| S000-252 | Copper | Total | UNKNOWN | 5/15/1975 | | 10.00 | ug/L |
| S000-252 | Copper | Total | UNKNOWN | 5/22/1975 | < | 10.00 | ug/L |
| S000-252 | Copper | Total | UNKNOWN | 6/18/1975 | < | 10.00 | ug/L |
| S000-252 | Copper | Total | UNKNOWN | 7/26/1976 | < | 10.00 | ug/L |
| S000-252 | Copper | Total | UNKNOWN | 10/18/1976 | < | 10.00 | ug/L |
| S000-252 | Copper | Total | UNKNOWN | 4/25/1977 | < | 10.00 | ug/L |
| S000-252 | Copper | Total | UNKNOWN | 7/25/1977 | < | 50.00 | ug/L |
| S000-252 | Copper | Total | UNKNOWN | 11/8/1978 | | 1.40 | ug/L |
| S000-252 | Copper | Total | UNKNOWN | 6/19/1979 | | 1.00 | ug/L |
| S000-252 | Copper | Total | UNKNOWN | 10/16/1979 | | 1.40 | ug/L |
| S000-252 | Copper | Total | UNKNOWN | 10/14/1980 | | 1.80 | ug/L |
| S000-252 | Copper | Total | UNKNOWN | 6/8/1982 | | 2.40 | ug/L |
| S000-252 | Copper | Total | UNKNOWN | 6/14/1983 | | 2.20 | ug/L |
| S000-252 | Copper | Total | UNKNOWN | 10/15/1985 | | 1.50 | ug/L |
| S000-252 | Copper | Total | UNKNOWN | 10/21/1986 | | 0.60 | ug/L |
| S000-252 | Copper | Total | UNKNOWN | 6/9/1987 | | 1.50 | ug/L |
| S000-252 | Copper | Total | UNKNOWN | 6/14/1988 | | 1.10 | ug/L |
| S000-252 | Copper | Total | MN00006 | 5/2/1990 | | 2.90 | ug/L |
| S000-252 | Copper | Total | MN00006 | 6/25/1991 | | 2.00 | ug/L |
| S000-252 | Copper | Total | MN00006 | 10/23/1991 | < | 3.00 | ug/L |
| S000-252 | Copper | Tot | WI00007 | 5/29/1996 | | 1.67 | ug/L |
| S000-252 | Copper | Dissolved | WI00007 | 6/27/1996 | | 1.57 | ug/L |
| S000-252 | Copper | Tot | WI00007 | 6/27/1996 | | 1.99 | ug/L |
| S000-252 | Copper | Tot | WI00007 | 9/4/1996 | | 1.45 | ug/L |
| S000-252 | Copper | Dissolved | WI00007 | 9/4/1996 | | 1.27 | ug/L |
| S000-252 | Copper | Dissolved | WI00007 | 9/25/1996 | | 1.29 | ug/L |
| S000-252 | Copper | Tot | WI00007 | 9/25/1996 | | 1.45 | ug/L |
| S000-252 | Cyanazine | Total | UNKNOWN | 6/14/1988 | < | 0.10 | ug/L |
| S000-252 | Cyanazine | Total | UNKNOWN | 6/14/1988 | < | 0.10 | ug/L |
| S000-252 | Cyanazine | Total | MN00006 | 6/13/1989 | < | 0.10 | ug/L |
| S000-252 | Cyanazine | Total | MN00100 | 5/29/1991 | < | 0.10 | ug/L |

# Appendix A
# Water Quality Dataset

| Station ID | Parameter | Sample Fraction Type | Lab Name Code | Sample Date | Detect Flag | Result | Result Unit |
|---|---|---|---|---|---|---|---|
| S000-252 | Cyanazine | Total | MN00100 | 6/25/1991 | < | 0.10 | ug/L |
| S000-252 | Cyanazine | Total | MN00100 | 6/25/1991 | < | 0.10 | ug/L |
| S000-252 | Cyanazine | Total | MN00100 | 7/30/1991 | < | 0.10 | ug/L |
| S000-252 | Cyanazine | Total | MN00100 | 5/6/1992 | < | 0.10 | ug/L |
| S000-252 | Cyanazine | Total | MN00100 | 6/2/1992 | < | 0.10 | ug/L |
| S000-252 | Cyanazine | Total | MN00100 | 7/21/1992 | < | 0.10 | ug/L |
| S000-252 | Cyanazine | Total | MN00100 | 5/27/1993 | < | 0.10 | ug/L |
| S000-252 | Cyanazine | Total | MN00100 | 6/23/1993 | < | 0.10 | ug/L |
| S000-252 | Cyanazine | Total | MN00100 | 7/21/1993 | < | 0.10 | ug/L |
| S000-252 | Cyanide | Total | UNKNOWN | 9/26/1973 | < | 0.01 | mg/L |
| S000-252 | Cyanide | Total | UNKNOWN | 2/26/1974 | < | 0.01 | mg/L |
| S000-252 | Cyanide | Total | UNKNOWN | 4/24/1974 | < | 0.01 | mg/L |
| S000-252 | Cyanide | Total | UNKNOWN | 9/12/1974 | < | 0.01 | mg/L |
| S000-252 | Cyanide | Total | UNKNOWN | 2/26/1975 | < | 0.01 | mg/L |
| S000-252 | Cyanide | Total | UNKNOWN | 5/1/1975 | < | 0.01 | mg/L |
| S000-252 | Cyanide | Total | UNKNOWN | 6/19/1979 | | 0.00 | mg/L |
| S000-252 | Cyanide | Total | UNKNOWN | 6/9/1987 | < | 0.00 | mg/L |
| S000-252 | Cyanide | Total | UNKNOWN | 6/14/1988 | < | 0.00 | mg/L |
| S000-252 | Cyanide | Total | MN00006 | 7/30/1991 | | 0.00 | mg/L |
| S000-252 | Deisopropylatrazine | Total | MN00100 | 5/6/1992 | < | 0.50 | ug/L |
| S000-252 | Deisopropylatrazine | Total | MN00100 | 6/2/1992 | < | 0.50 | ug/L |
| S000-252 | Deisopropylatrazine | Total | MN00100 | 7/21/1992 | < | 0.50 | ug/L |
| S000-252 | Deisopropylatrazine | Total | MN00100 | 5/27/1993 | < | 0.50 | ug/L |
| S000-252 | Deisopropylatrazine | Total | MN00100 | 6/23/1993 | < | 0.50 | ug/L |
| S000-252 | Deisopropylatrazine | Total | MN00100 | 7/21/1993 | < | 0.50 | ug/L |
| S000-252 | Desethylatrazine | Total | MN00100 | 5/6/1992 | < | 0.50 | ug/L |
| S000-252 | Desethylatrazine | Total | MN00100 | 6/2/1992 | < | 0.50 | ug/L |
| S000-252 | Desethylatrazine | Total | MN00100 | 7/21/1992 | < | 0.50 | ug/L |
| S000-252 | Desethylatrazine | Total | MN00100 | 5/27/1993 | < | 0.50 | ug/L |
| S000-252 | Desethylatrazine | Total | MN00100 | 6/23/1993 | < | 0.50 | ug/L |
| S000-252 | Desethylatrazine | Total | MN00100 | 7/21/1993 | < | 0.50 | ug/L |
| S000-252 | Diallate | Total | UNKNOWN | 6/14/1988 | < | 0.05 | ug/L |
| S000-252 | Diallate | Total | UNKNOWN | 6/14/1988 | < | 0.05 | ug/L |
| S000-252 | Diallate | Total | MN00006 | 6/13/1989 | < | 0.05 | ug/L |
| S000-252 | Diazinon | Total | MN00100 | 5/6/1992 | < | 0.12 | ug/L |
| S000-252 | Diazinon | Total | MN00100 | 6/2/1992 | < | 0.12 | ug/L |
| S000-252 | Diazinon | Total | MN00100 | 7/21/1992 | < | 0.12 | ug/L |
| S000-252 | Diazinon | Total | MN00100 | 5/27/1993 | < | 0.12 | ug/L |
| S000-252 | Diazinon | Total | MN00100 | 6/23/1993 | < | 0.12 | ug/L |
| S000-252 | Diazinon | Total | MN00100 | 7/21/1993 | < | 0.12 | ug/L |
| S000-252 | Dieldrin | Total | UNKNOWN | 11/8/1978 | < | 0.05 | ug/L |
| S000-252 | Dieldrin | Total | UNKNOWN | 10/16/1979 | < | 0.03 | ug/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 7/24/1973 | | 8.40 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 8/29/1973 | | 8.00 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 9/13/1973 | | 10.20 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 9/26/1973 | | 9.70 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 10/17/1973 | | 12.10 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 11/14/1973 | | 13.50 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 12/5/1973 | | 13.10 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 1/29/1974 | | 14.10 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 2/26/1974 | | 16.20 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 3/12/1974 | | 14.50 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 4/2/1974 | | 14.30 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 4/9/1974 | | 14.90 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 4/24/1974 | | 13.50 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 5/8/1974 | | 11.60 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 5/15/1974 | | 11.60 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 6/18/1974 | | 10.00 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 7/10/1974 | | 8.70 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 8/13/1974 | | 9.10 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 9/12/1974 | | 9.50 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 10/9/1974 | | 12.40 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 11/5/1974 | | 12.90 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 12/11/1974 | | 13.40 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 1/16/1975 | | 13.00 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 2/26/1975 | | 14.00 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 4/2/1975 | | 15.20 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 4/17/1975 | | 12.40 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 5/1/1975 | | 13.40 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 5/8/1975 | | 10.90 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 5/15/1975 | | 11.00 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 5/22/1975 | | 9.10 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 6/18/1975 | | 9.30 | mg/L |

# Appendix A
# Water Quality Dataset

| Station ID | Parameter | Sample Fraction Type | Lab Name Code | Sample Date | Detect Flag | Result | Result Unit |
|---|---|---|---|---|---|---|---|
| S000-252 | Dissolved oxygen (DO) | Total | | 7/26/1976 | | 6.60 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 8/23/1976 | | 8.00 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 9/20/1976 | | 9.40 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 11/16/1976 | | 13.00 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 3/22/1977 | | 13.40 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 4/25/1977 | | 10.90 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 5/23/1977 | | 9.00 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 6/27/1977 | | 7.80 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 7/25/1977 | | 9.00 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 8/22/1977 | | 9.30 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 9/26/1977 | | 8.90 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 10/24/1977 | | 11.10 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 11/14/1977 | | 13.00 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 12/19/1977 | | 13.70 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 1/23/1978 | | 13.60 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 2/21/1978 | | 15.90 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 3/1/1978 | | 11.50 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 4/4/1978 | | 12.60 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 5/1/1978 | | 11.70 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 6/6/1978 | | 8.50 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 7/6/1978 | | 7.50 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 8/1/1978 | | 8.50 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 9/6/1978 | | 7.50 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 10/3/1978 | | 9.50 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 11/8/1978 | | 12.50 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 12/6/1978 | | 10.50 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 1/16/1979 | | 13.60 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 2/21/1979 | | 13.60 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 3/20/1979 | | 13.30 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 4/4/1979 | | 13.00 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 5/2/1979 | | 12.30 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 6/19/1979 | | 7.60 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 7/24/1979 | | 7.30 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 7/31/1979 | | 8.00 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 8/21/1979 | | 7.50 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 10/16/1979 | | 11.30 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 12/18/1979 | | 12.40 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 1/22/1980 | | 13.30 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 2/27/1980 | | 13.80 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 3/19/1980 | | 13.50 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 4/22/1980 | | 10.60 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 5/20/1980 | | 9.00 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 6/17/1980 | | 8.70 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 7/22/1980 | | 8.10 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 8/19/1980 | | 7.40 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 9/23/1980 | | 9.70 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 10/14/1980 | | 12.40 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 1/14/1981 | | 13.10 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 3/11/1981 | | 13.50 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 4/14/1981 | | 13.80 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 5/12/1981 | | 10.50 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 6/16/1981 | | 8.60 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 7/14/1981 | | 7.20 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 8/12/1981 | | 8.50 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 9/15/1981 | | 9.40 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 10/12/1981 | | 10.80 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 1/12/1982 | | 13.30 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 3/16/1982 | | 13.30 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 4/13/1982 | | 12.20 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 5/11/1982 | | 9.90 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 6/8/1982 | | 8.60 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 7/13/1982 | | 7.70 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 8/10/1982 | | 8.40 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 9/8/1982 | | 8.30 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 10/12/1982 | | 10.40 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 1/12/1983 | | 13.80 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 3/9/1983 | | 13.20 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 4/12/1983 | | 13.10 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 5/10/1983 | | 10.40 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 6/14/1983 | | 8.30 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 7/12/1983 | | 8.10 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 8/9/1983 | | 8.90 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 9/13/1983 | | 10.20 | mg/L |

# Appendix A
# Water Quality Dataset

| Station ID | Parameter | Sample Fraction Type | Lab Name Code | Sample Date | Detect Flag | Result | Result Unit |
|---|---|---|---|---|---|---|---|
| S000-252 | Dissolved oxygen (DO) | Total | | 10/27/1983 | | 12.10 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 1/10/1984 | | 14.50 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 3/13/1984 | | 14.10 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 4/17/1984 | | 10.70 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 5/15/1984 | | 9.20 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 6/12/1984 | | 7.80 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 7/17/1984 | | 8.10 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 8/14/1984 | | 8.20 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 9/18/1984 | | 9.30 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 10/10/1984 | | 9.70 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 1/14/1985 | | 13.90 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 3/13/1985 | | 13.90 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 4/15/1985 | | 9.70 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 5/14/1985 | | 9.70 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 6/10/1985 | | 9.00 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 7/17/1985 | | 8.90 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 8/13/1985 | | 8.70 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 9/11/1985 | | 10.20 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 10/15/1985 | | 11.40 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 2/19/1986 | | 13.40 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 3/20/1986 | | 14.00 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 4/17/1986 | | 12.00 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 5/12/1986 | | 10.20 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 6/10/1986 | | 8.60 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 7/15/1986 | | 8.80 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 8/19/1986 | | 8.90 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 9/24/1986 | | 9.60 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 10/21/1986 | | 11.50 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 1/13/1987 | | 13.50 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 3/10/1987 | | 13.60 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 4/7/1987 | | 12.80 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 5/12/1987 | | 10.40 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 6/9/1987 | | 9.60 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 7/15/1987 | | 8.30 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 8/11/1987 | | 8.70 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 9/15/1987 | | 9.60 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 10/14/1987 | | 11.10 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 1/12/1988 | | 13.00 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 3/15/1988 | | 12.30 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 4/12/1988 | | 12.80 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 5/9/1988 | | 9.80 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 6/14/1988 | | 8.30 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 7/12/1988 | | 8.80 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 8/17/1988 | | 7.40 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 9/13/1988 | | 9.50 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 10/11/1988 | | 11.30 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 3/14/1989 | | 13.00 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 4/11/1989 | | 13.10 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 5/9/1989 | | 11.00 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 6/13/1989 | | 9.70 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 7/18/1989 | | 8.40 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 8/16/1989 | | 9.00 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 9/12/1989 | | 10.00 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 10/10/1989 | | 11.90 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 1/4/1990 | | 12.70 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 3/27/1990 | | 13.20 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 5/2/1990 | | 11.90 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 6/5/1990 | | 9.60 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 7/17/1990 | | 8.50 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 8/16/1990 | | 8.90 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 9/25/1990 | | 10.00 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 10/9/1990 | | 11.70 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 1/29/1991 | | 13.60 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 3/12/1991 | | 13.60 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 4/23/1991 | | 10.90 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 5/29/1991 | | 8.80 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 6/25/1991 | | 8.80 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 7/30/1991 | | 8.60 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 8/27/1991 | | 8.40 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 9/18/1991 | | 9.90 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 10/23/1991 | | 12.20 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 1/28/1992 | | 13.20 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 3/24/1992 | | 13.30 | mg/L |

# Appendix A
# Water Quality Dataset

| Station ID | Parameter | Sample Fraction Type | Lab Name Code | Sample Date | Detect Flag | Result | Result Unit |
|---|---|---|---|---|---|---|---|
| S000-252 | Dissolved oxygen (DO) | Total | | 4/21/1992 | | 13.00 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 5/6/1992 | | 10.00 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 6/2/1992 | | 8.30 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 7/21/1992 | | 9.20 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 8/11/1992 | | 8.80 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 9/23/1992 | | 10.90 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 10/21/1992 | | 12.50 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 1/6/1993 | | 13.50 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 3/3/1993 | | 15.20 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 4/28/1993 | | 11.60 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 5/27/1993 | | 9.80 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 6/23/1993 | | 8.90 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 7/21/1993 | | 8.20 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 8/25/1993 | | 8.10 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 9/22/1993 | | 9.70 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 10/14/1993 | | 11.80 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 1/11/1994 | | 13.40 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 3/15/1994 | | 13.40 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 4/13/1994 | | 13.30 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 5/19/1994 | | 10.10 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 6/15/1994 | | 8.30 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 7/20/1994 | | 7.80 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 8/25/1994 | | 8.20 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 9/13/1994 | | 8.80 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 10/19/1994 | | 9.40 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 11/7/1994 | | 12.80 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 1/19/1995 | | 13.20 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 3/16/1995 | | 13.60 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 4/12/1995 | | 13.60 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 5/18/1995 | | 9.80 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 6/13/1995 | | 9.20 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 7/26/1995 | | 8.10 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 8/14/1995 | | 8.40 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 9/12/1995 | | 9.60 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 10/21/1997 | | 12.30 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 11/3/1997 | | 12.70 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 1/28/1998 | | 14.00 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 3/17/1998 | | 13.50 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 4/14/1998 | | 11.50 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 5/27/1998 | | 9.70 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 6/16/1998 | | 8.30 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 7/13/1998 | | 9.10 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 8/12/1998 | | 10.80 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 9/22/1998 | | 11.20 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 10/10/1999 | | 9.70 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 11/21/1999 | | 12.50 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 1/16/2000 | | 13.80 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 3/19/2000 | | 12.40 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 4/16/2000 | | 12.70 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 5/23/2000 | | 8.80 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 6/25/2000 | | 8.20 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 8/14/2000 | | 9.70 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 9/5/2000 | | 10.20 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 10/17/2002 | | 11.82 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 11/3/2002 | | 12.67 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 1/28/2003 | | 13.58 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 3/18/2003 | | 12.87 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 4/29/2003 | | 11.90 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 5/20/2003 | | 10.58 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 6/24/2003 | | 8.06 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 7/28/2003 | | 8.46 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 8/5/2003 | | 8.67 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 9/8/2003 | | 10.12 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 10/13/2003 | | 10.60 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 11/21/2004 | | 17.20 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 2/1/2005 | | 15.20 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 3/2/2005 | | 15.67 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 4/20/2005 | | 10.88 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 5/25/2005 | | 9.42 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 6/1/2005 | | 9.26 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 7/11/2005 | | 7.97 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 8/24/2005 | | 8.94 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 9/19/2005 | | 7.85 | mg/L |

# Appendix A
# Water Quality Dataset

| Station ID | Parameter | Sample Fraction Type | Lab Name Code | Sample Date | Detect Flag | Result | Result Unit |
|---|---|---|---|---|---|---|---|
| S000-252 | Dissolved oxygen (DO) | Total | | 4/3/2006 | | 12.78 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 5/25/2006 | | 9.95 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 6/5/2006 | | 9.73 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 8/7/2006 | | 10.70 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 10/17/2006 | | 13.68 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 10/8/2007 | | 8.35 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 11/13/2007 | | 11.49 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 2/12/2008 | | 11.23 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 3/31/2008 | | 11.10 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 4/21/2008 | | 9.93 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 5/13/2008 | | 8.31 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 6/4/2008 | | 8.26 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 7/21/2008 | | 7.99 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 8/18/2008 | | 8.28 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 9/16/2008 | | 8.50 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 10/26/2009 | | 9.31 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 11/30/2009 | | 11.80 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 1/25/2010 | | 10.17 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 3/1/2010 | | 12.20 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 4/26/2010 | | 9.91 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 5/11/2010 | | 9.84 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 6/7/2010 | | 9.56 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 7/18/2010 | | 10.61 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 8/22/2010 | | 9.32 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 9/27/2010 | | 12.69 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 5/2/2013 | | 14.07 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 6/6/2013 | | 10.74 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 9/12/2013 | | 9.26 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 10/7/2013 | | 10.62 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 4/24/2014 | | 13.95 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 7/23/2014 | | 9.49 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 10/16/2014 | | 11.00 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 9/22/2015 | | 9.36 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 9/24/2015 | | 10.13 | mg/L |
| S000-252 | Dissolved oxygen (DO) | Total | | 10/22/2015 | | 12.61 | mg/L |
| S000-252 | Dissolved oxygen saturation | Total | | 7/24/1973 | | 88.42 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 8/29/1973 | | 91.95 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 9/13/1973 | | 98.09 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 9/26/1973 | | 89.82 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 10/17/1973 | | 92.37 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 11/14/1973 | | 95.07 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 12/5/1973 | | 89.73 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 1/29/1974 | | 99.30 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 2/26/1974 | | 110.96 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 3/12/1974 | | 99.32 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 4/2/1974 | | 97.95 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 4/9/1974 | | 102.06 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 4/24/1974 | | 97.83 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 5/8/1974 | | 90.63 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 5/15/1974 | | 85.93 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 6/18/1974 | | 94.34 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 7/10/1974 | | 96.67 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 8/13/1974 | | 96.81 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 9/12/1974 | | 87.97 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 10/9/1974 | | 104.20 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 11/5/1974 | | 95.56 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 12/11/1974 | | 91.78 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 1/16/1975 | | 89.04 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 2/26/1975 | | 95.89 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 4/2/1975 | | 104.11 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 4/17/1975 | | 84.94 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 5/1/1975 | | 94.37 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 5/8/1975 | | 87.20 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 5/15/1975 | | 92.44 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 5/22/1975 | | 95.79 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 6/18/1975 | | 95.88 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 7/26/1976 | | 77.65 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 8/23/1976 | | 88.89 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 9/20/1976 | | 87.05 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 11/16/1976 | | 89.05 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 3/22/1977 | | 91.79 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 4/25/1977 | | 96.46 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 5/23/1977 | | 92.78 | % |

# Appendix A
# Water Quality Dataset

| Station ID | Parameter | Sample Fraction Type | Lab Name Code | Sample Date | Detect Flag | Result | Result Unit |
|---|---|---|---|---|---|---|---|
| S000-252 | Dissolved oxygen saturation | Total | | 6/27/1977 | | 89.66 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 7/25/1977 | | 103.45 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 8/22/1977 | | 98.94 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 9/26/1977 | | 80.18 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 10/24/1977 | | 88.80 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 11/14/1977 | | 91.55 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 12/19/1977 | | 93.84 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 1/23/1978 | | 93.15 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 2/21/1978 | | 108.90 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 3/1/1978 | | 78.77 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 4/4/1978 | | 86.30 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 5/1/1978 | | 93.60 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 6/6/1978 | | 83.33 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 7/6/1978 | | 81.52 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 8/1/1978 | | 85.00 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 9/6/1978 | | 89.29 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 10/3/1978 | | 87.96 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 11/8/1978 | | 88.03 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 12/6/1978 | | 71.92 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 1/16/1979 | | 93.15 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 2/21/1979 | | 93.15 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 3/20/1979 | | 91.10 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 4/4/1979 | | 89.04 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 5/2/1979 | | 91.11 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 6/19/1979 | | 73.08 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 7/24/1979 | | 79.35 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 7/31/1979 | | 82.47 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 8/21/1979 | | 73.53 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 10/16/1979 | | 86.26 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 12/18/1979 | | 84.93 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 1/22/1980 | | 91.10 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 2/27/1980 | | 94.52 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 3/19/1980 | | 92.47 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 4/22/1980 | | 82.81 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 5/20/1980 | | 83.33 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 6/17/1980 | | 89.69 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 7/22/1980 | | 86.17 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 8/19/1980 | | 78.72 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 9/23/1980 | | 83.62 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 10/14/1980 | | 96.88 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 1/14/1981 | | 89.73 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 3/11/1981 | | 97.83 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 4/14/1981 | | 97.18 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 5/12/1981 | | 90.52 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 6/16/1981 | | 86.00 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 7/14/1981 | | 80.00 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 8/12/1981 | | 92.39 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 9/15/1981 | | 92.16 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 10/12/1981 | | 95.58 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 1/12/1982 | | 91.10 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 3/16/1982 | | 93.66 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 4/13/1982 | | 93.13 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 5/11/1982 | | 91.67 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 6/8/1982 | | 84.31 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 7/13/1982 | | 79.38 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 8/10/1982 | | 84.00 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 9/8/1982 | | 81.37 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 10/12/1982 | | 89.66 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 1/12/1983 | | 94.52 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 3/9/1983 | | 90.41 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 4/12/1983 | | 89.73 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 5/10/1983 | | 96.30 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 6/14/1983 | | 88.30 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 7/12/1983 | | 96.43 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 8/9/1983 | | 98.89 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 9/13/1983 | | 96.23 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 10/27/1983 | | 96.80 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 1/10/1984 | | 99.32 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 3/13/1984 | | 96.58 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 4/17/1984 | | 85.60 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 5/15/1984 | | 85.19 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 6/12/1984 | | 75.00 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 7/17/1984 | | 83.51 | % |

# Appendix A
# Water Quality Dataset

| Station ID | Parameter | Sample Fraction Type | Lab Name Code | Sample Date | Detect Flag | Result | Result Unit |
|---|---|---|---|---|---|---|---|
| S000-252 | Dissolved oxygen saturation | Total | | 8/14/1984 | | 93.18 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 9/18/1984 | | 95.88 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 10/10/1984 | | 91.51 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 1/14/1985 | | 95.21 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 3/13/1985 | | 95.21 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 4/15/1985 | | 71.85 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 5/14/1985 | | 87.39 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 6/10/1985 | | 94.74 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 7/17/1985 | | 94.68 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 8/13/1985 | | 87.00 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 9/11/1985 | | 94.45 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 10/15/1985 | | 89.07 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 2/19/1986 | | 91.80 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 3/20/1986 | | 95.89 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 4/17/1986 | | 93.75 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 5/12/1986 | | 96.23 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 6/10/1986 | | 88.66 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 7/15/1986 | | 88.00 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 8/19/1986 | | 91.76 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 9/24/1986 | | 82.76 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 10/21/1986 | | 89.85 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 1/13/1987 | | 92.48 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 3/10/1987 | | 93.15 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 4/7/1987 | | 87.68 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 5/12/1987 | | 101.98 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 6/9/1987 | | 86.49 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 7/15/1987 | | 81.39 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 8/11/1987 | | 102.39 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 9/15/1987 | | 96.01 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 10/14/1987 | | 93.29 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 1/12/1988 | | 89.08 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 3/15/1988 | | 84.27 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 4/12/1988 | | 92.76 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 5/9/1988 | | 86.73 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 6/14/1988 | | 88.32 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 7/12/1988 | | 93.64 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 8/17/1988 | | 82.23 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 9/13/1988 | | 87.98 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 10/11/1988 | | 90.41 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 3/14/1989 | | 89.06 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 4/11/1989 | | 92.26 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 5/9/1989 | | 90.17 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 6/13/1989 | | 85.84 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 7/18/1989 | | 95.47 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 8/16/1989 | | 102.30 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 9/12/1989 | | 92.61 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 10/10/1989 | | 95.20 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 1/4/1990 | | 86.99 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 3/27/1990 | | 92.98 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 5/2/1990 | | 90.84 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 6/5/1990 | | 86.49 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 7/17/1990 | | 87.64 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 8/16/1990 | | 93.71 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 9/25/1990 | | 92.59 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 10/9/1990 | | 89.32 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 1/29/1991 | | 93.18 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 3/12/1991 | | 93.19 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 4/23/1991 | | 89.35 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 5/29/1991 | | 95.65 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 6/25/1991 | | 104.76 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 7/30/1991 | | 97.73 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 8/27/1991 | | 102.46 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 9/18/1991 | | 91.67 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 10/23/1991 | | 90.38 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 1/28/1992 | | 90.42 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 3/24/1992 | | 93.67 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 4/21/1992 | | 91.55 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 5/6/1992 | | 90.09 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 6/2/1992 | | 94.32 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 7/21/1992 | | 97.88 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 8/11/1992 | | 93.62 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 9/23/1992 | | 91.61 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 10/21/1992 | | 92.60 | % |

# Appendix A
# Water Quality Dataset

| Station ID | Parameter | Sample Fraction Type | Lab Name Code | Sample Date | Detect Flag | Result | Result Unit |
|---|---|---|---|---|---|---|---|
| S000-252 | Dissolved oxygen saturation | Total | | 1/6/1993 | | 92.49 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 3/3/1993 | | 104.13 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 4/28/1993 | | 92.80 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 5/27/1993 | | 88.29 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 6/23/1993 | | 91.76 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 7/21/1993 | | 86.32 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 8/25/1993 | | 92.05 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 9/22/1993 | | 89.81 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 10/14/1993 | | 99.18 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 1/11/1994 | | 91.80 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 3/15/1994 | | 91.80 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 4/13/1994 | | 93.66 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 5/19/1994 | | 91.00 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 6/15/1994 | | 87.37 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 7/20/1994 | | 86.67 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 8/25/1994 | | 86.34 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 9/13/1994 | | 92.65 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 10/19/1994 | | 87.04 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 11/7/1994 | | 97.71 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 1/19/1995 | | 90.41 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 3/16/1995 | | 93.16 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 4/12/1995 | | 93.16 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 5/18/1995 | | 88.29 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 6/13/1995 | | 102.25 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 7/26/1995 | | 86.18 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 8/14/1995 | | 98.84 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 9/12/1995 | | 96.01 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 10/21/1997 | | 93.89 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 11/3/1997 | | 92.03 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 1/28/1998 | | 95.89 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 3/17/1998 | | 97.83 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 4/14/1998 | | 89.84 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 5/27/1998 | | 105.44 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 6/16/1998 | | 94.32 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 7/13/1998 | | 115.19 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 8/12/1998 | | 127.06 | % |
| S000-252 | Dissolved oxygen saturation | Total | | 9/22/1998 | | 105.66 | % |
| S000-252 | Endrin | Total | UNKNOWN | 11/8/1978 | < | 0.05 | ug/L |
| S000-252 | Endrin | Total | UNKNOWN | 10/16/1979 | < | 0.07 | ug/L |
| S000-252 | Enterococcus | Total | UNKNOWN | 4/15/1985 | < | 5.00 | /100mL |
| S000-252 | Enterococcus | Total | UNKNOWN | 5/14/1985 | | 4.00 | /100mL |
| S000-252 | Enterococcus | Total | UNKNOWN | 7/17/1985 | | 80.00 | /100mL |
| S000-252 | Enterococcus | Total | UNKNOWN | 8/13/1985 | | 980.00 | /100mL |
| S000-252 | Enterococcus | Total | UNKNOWN | 9/11/1985 | | 12.00 | /100mL |
| S000-252 | Enterococcus | Total | UNKNOWN | 10/15/1985 | | 8.00 | /100mL |
| S000-252 | Enterococcus | Total | UNKNOWN | 2/19/1986 | < | 4.00 | /100mL |
| S000-252 | Enterococcus | Total | UNKNOWN | 3/20/1986 | < | 4.00 | /100mL |
| S000-252 | EPTC | Total | UNKNOWN | 6/14/1988 | < | 0.01 | ug/L |
| S000-252 | EPTC | Total | UNKNOWN | 6/14/1988 | < | 0.01 | ug/L |
| S000-252 | EPTC | Total | MN00006 | 6/13/1989 | < | 0.01 | ug/L |
| S000-252 | EPTC | Total | MN00100 | 5/6/1992 | < | 0.20 | ug/L |
| S000-252 | EPTC | Total | MN00100 | 6/2/1992 | < | 0.20 | ug/L |
| S000-252 | EPTC | Total | MN00100 | 7/21/1992 | < | 0.20 | ug/L |
| S000-252 | Escherichia coli | Total | UNKNOWN | 4/15/1985 | < | 5.00 | /100mL |
| S000-252 | Escherichia coli | Total | UNKNOWN | 5/14/1985 | | 32.00 | /100mL |
| S000-252 | Escherichia coli | Total | UNKNOWN | 6/10/1985 | | 16.00 | /100mL |
| S000-252 | Escherichia coli | Total | UNKNOWN | 7/17/1985 | | 24.00 | /100mL |
| S000-252 | Escherichia coli | Total | UNKNOWN | 8/13/1985 | | 740.00 | /100mL |
| S000-252 | Escherichia coli | Total | UNKNOWN | 9/11/1985 | | 12.00 | /100mL |
| S000-252 | Escherichia coli | Total | UNKNOWN | 10/15/1985 | < | 4.00 | /100mL |
| S000-252 | Escherichia coli | Total | UNKNOWN | 2/19/1986 | < | 4.00 | /100mL |
| S000-252 | Escherichia coli | Total | UNKNOWN | 3/20/1986 | | 8.00 | /100mL |
| S000-252 | Escherichia coli | Total | MN00006 | 7/18/2000 | | 10.00 | /100mL |
| S000-252 | Escherichia coli | Total | MN00006 | 8/14/2000 | | 52.00 | /100mL |
| S000-252 | Escherichia coli | Total | MN00006 | 9/5/2000 | | 4.00 | /100mL |
| S000-252 | Escherichia coli | Total | MN00006 | 10/17/2002 | | 4.00 | /100mL |
| S000-252 | Escherichia coli | Total | MN00006 | 4/29/2003 | < | 9.00 | /100mL |
| S000-252 | Escherichia coli | Total | MN00006 | 5/20/2003 | | 68.00 | /100mL |
| S000-252 | Escherichia coli | Total | MN00006 | 6/24/2003 | | 88.00 | /100mL |
| S000-252 | Escherichia coli | Total | MN00006 | 7/28/2003 | | 12.00 | /100mL |
| S000-252 | Escherichia coli | Total | MN00006 | 8/5/2003 | | 4.00 | /100mL |
| S000-252 | Escherichia coli | Total | MN00006 | 9/8/2003 | < | 4.00 | /100mL |
| S000-252 | Escherichia coli | Total | MN00006 | 10/13/2003 | < | 4.00 | /100mL |

# Appendix A
# Water Quality Dataset

| Station ID | Parameter | Sample Fraction Type | Lab Name Code | Sample Date | Detect Flag | Result | Result Unit |
|---|---|---|---|---|---|---|---|
| S000-252 | Escherichia coli | Total | MN00006 | 10/13/2004 | < | 4.00 | /100mL |
| S000-252 | Escherichia coli | Total | MN00006 | 4/20/2005 | < | 4.00 | /100mL |
| S000-252 | Escherichia coli | Total | MN00006 | 5/25/2005 | | 8.00 | /100mL |
| S000-252 | Escherichia coli | Total | MN00006 | 5/25/2005 | | 12.00 | /100mL |
| S000-252 | Escherichia coli | Total | MN00006 | 7/11/2005 | | 12.00 | /100mL |
| S000-252 | Escherichia coli | Total | MN00006 | 8/24/2005 | | 16.00 | /100mL |
| S000-252 | Escherichia coli | Total | MN00006 | 9/19/2005 | | 220.00 | /100mL |
| S000-252 | Escherichia coli | Total | MN00006 | 4/3/2006 | | 6.00 | PN/100m |
| S000-252 | Escherichia coli | Total | MN00006 | 5/25/2006 | | 4.00 | PN/100m |
| S000-252 | Escherichia coli | Total | MN00006 | 6/5/2006 | | 41.00 | PN/100m |
| S000-252 | Escherichia coli | Total | MN00006 | 7/24/2006 | < | 1.00 | PN/100m |
| S000-252 | Escherichia coli | Total | MN00006 | 7/24/2006 | | 67.00 | PN/100m |
| S000-252 | Escherichia coli | Total | MN00006 | 8/7/2006 | | 24.00 | PN/100m |
| S000-252 | Escherichia coli | Total | MN00006 | 9/14/2006 | | 51.00 | PN/100m |
| S000-252 | Escherichia coli | Total | MN00006 | 9/14/2006 | | 26.00 | PN/100m |
| S000-252 | Escherichia coli | Total | MN00006 | 10/17/2006 | | 83.00 | PN/100m |
| S000-252 | Escherichia coli | Total | MN00006 | 10/8/2007 | | 2400.00 | PN/100m |
| S000-252 | Escherichia coli | Total | MN00006 | 10/8/2007 | | 2400.00 | PN/100m |
| S000-252 | Escherichia coli | Total | MN00006 | 4/22/2008 | | 20.00 | PN/100m |
| S000-252 | Escherichia coli | Total | MN00006 | 4/22/2008 | | 23.00 | PN/100m |
| S000-252 | Escherichia coli | Total | MN00006 | 5/13/2008 | | 6.00 | PN/100m |
| S000-252 | Escherichia coli | Total | MN00006 | 6/5/2008 | | 88.00 | PN/100m |
| S000-252 | Escherichia coli | Total | MN00006 | 6/5/2008 | | 64.00 | PN/100m |
| S000-252 | Escherichia coli | Total | MN00006 | 7/21/2008 | | 17.00 | PN/100m |
| S000-252 | Escherichia coli | Total | MN00006 | 8/19/2008 | | 10.00 | PN/100m |
| S000-252 | Escherichia coli | Total | MN00006 | 9/16/2008 | | 15.00 | PN/100m |
| S000-252 | Ethalfluralin | Total | MN00100 | 5/29/1991 | < | 0.20 | ug/L |
| S000-252 | Ethalfluralin | Total | MN00100 | 6/25/1991 | < | 0.20 | ug/L |
| S000-252 | Ethalfluralin | Total | MN00100 | 6/25/1991 | < | 0.20 | ug/L |
| S000-252 | Ethalfluralin | Total | MN00100 | 7/30/1991 | < | 0.20 | ug/L |
| S000-252 | Ethalfluralin | Total | MN00100 | 5/6/1992 | < | 0.20 | ug/L |
| S000-252 | Ethalfluralin | Total | MN00100 | 6/2/1992 | < | 0.20 | ug/L |
| S000-252 | Ethalfluralin | Total | MN00100 | 7/21/1992 | < | 0.20 | ug/L |
| S000-252 | Ethalfluralin | Total | MN00100 | 5/27/1993 | < | 0.20 | ug/L |
| S000-252 | Ethalfluralin | Total | MN00100 | 6/23/1993 | < | 0.20 | ug/L |
| S000-252 | Ethalfluralin | Total | MN00100 | 7/21/1993 | < | 0.20 | ug/L |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 7/24/1973 | | 1100.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 8/29/1973 | | 8.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 9/13/1973 | | 17.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 9/26/1973 | | 70.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 10/17/1973 | | 5.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 11/14/1973 | | 34.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 12/5/1973 | | 11.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 1/29/1974 | | 23.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 2/26/1974 | | 33.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 3/12/1974 | | 6.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 4/2/1974 | | 40.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 4/9/1974 | | 33.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 4/24/1974 | | 6.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 5/8/1974 | | 49.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 5/15/1974 | | 22.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 6/18/1974 | | 110.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 7/10/1974 | | 110.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 8/13/1974 | | 49.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 9/12/1974 | | 49.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 10/9/1974 | | 23.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 11/5/1974 | | 23.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 12/11/1974 | | 2.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 1/16/1975 | | 80.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 2/26/1975 | | 79.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 4/2/1975 | | 5.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 4/17/1975 | | 11.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 5/1/1975 | | 49.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 5/8/1975 | | 5.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 5/15/1975 | | 13.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 5/22/1975 | | 9.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 6/18/1975 | | 33.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 7/26/1976 | | 330.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 8/23/1976 | | 140.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 9/20/1976 | | 50.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 10/18/1976 | < | 20.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 11/16/1976 | < | 20.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 3/22/1977 | < | 20.00 | /100mL |

# Appendix A
# Water Quality Dataset

| Station ID | Parameter | Sample Fraction Type | Lab Name Code | Sample Date | Detect Flag | Result | Result Unit |
|---|---|---|---|---|---|---|---|
| S000-252 | Fecal Coliform | Total | UNKNOWN | 4/25/1977 | < | 20.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 5/23/1977 | | 330.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 7/25/1977 | | 50.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 8/22/1977 | | 20.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 9/26/1977 | | 170.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 10/24/1977 | < | 20.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 11/14/1977 | | 20.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 12/19/1977 | | 80.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 1/23/1978 | < | 20.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 2/21/1978 | < | 20.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 3/1/1978 | < | 20.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 4/4/1978 | < | 20.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 5/1/1978 | < | 20.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 7/6/1978 | | 130.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 8/1/1978 | | 50.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 9/6/1978 | | 50.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 10/3/1978 | | 40.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 11/8/1978 | < | 20.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 12/6/1978 | | 20.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 1/16/1979 | < | 20.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 2/21/1979 | < | 20.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 3/20/1979 | | 80.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 4/4/1979 | < | 20.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 5/2/1979 | | 20.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 6/19/1979 | | 20.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 7/24/1979 | | 5400.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 7/31/1979 | | 80.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 8/21/1979 | < | 20.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 10/16/1979 | < | 20.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 12/18/1979 | < | 20.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 1/22/1980 | | 20.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 2/27/1980 | < | 20.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 3/19/1980 | < | 20.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 4/22/1980 | < | 20.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 5/20/1980 | < | 20.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 6/17/1980 | | 50.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 7/22/1980 | | 50.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 8/19/1980 | | 20.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 9/23/1980 | < | 20.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 10/14/1980 | < | 20.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 1/14/1981 | < | 20.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 3/11/1981 | < | 20.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 4/14/1981 | | 20.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 5/12/1981 | < | 20.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 6/16/1981 | | 20.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 7/14/1981 | | 50.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 8/12/1981 | | 40.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 9/15/1981 | < | 20.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 10/12/1981 | < | 20.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 1/12/1982 | < | 20.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 3/16/1982 | < | 20.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 4/13/1982 | | 20.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 5/11/1982 | < | 20.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 6/8/1982 | < | 20.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 7/13/1982 | | 80.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 8/10/1982 | | 130.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 9/8/1982 | < | 20.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 10/12/1982 | | 20.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 1/12/1983 | < | 20.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 3/9/1983 | | 50.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 4/12/1983 | | 20.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 5/10/1983 | < | 20.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 6/14/1983 | | 20.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 7/12/1983 | | 40.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 8/9/1983 | | 50.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 9/13/1983 | | 50.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 10/27/1983 | < | 20.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 1/10/1984 | | 20.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 3/13/1984 | < | 20.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 4/17/1984 | < | 20.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 5/15/1984 | < | 20.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 6/12/1984 | | 110.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 7/17/1984 | | 50.00 | /100mL |

# Appendix A
# Water Quality Dataset

| Station ID | Parameter | Sample Fraction Type | Lab Name Code | Sample Date | Detect Flag | Result | Result Unit |
|---|---|---|---|---|---|---|---|
| S000-252 | Fecal Coliform | Total | UNKNOWN | 8/14/1984 | | 20.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 9/18/1984 | < | 20.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 4/15/1985 | | 25.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 5/14/1985 | | 48.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 6/10/1985 | | 8.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 7/17/1985 | | 8.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 8/13/1985 | | 1200.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 9/11/1985 | | 12.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 10/15/1985 | < | 4.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 2/19/1986 | < | 4.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 3/20/1986 | < | 4.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 7/15/1986 | | 44.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 8/19/1986 | | 4.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 9/24/1986 | < | 4.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 1/13/1987 | < | 4.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 3/10/1987 | | 16.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 4/7/1987 | | 4.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 5/12/1987 | < | 4.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 6/9/1987 | | 4.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 7/15/1987 | | 20.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 8/11/1987 | | 16.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 9/15/1987 | | 8.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 10/14/1987 | < | 4.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 1/12/1988 | < | 4.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 3/15/1988 | < | 4.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 4/12/1988 | < | 4.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 5/9/1988 | | 5300.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 6/14/1988 | | 8.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 7/12/1988 | | 24.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 8/17/1988 | | 110.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 9/13/1988 | | 8.00 | /100mL |
| S000-252 | Fecal Coliform | Total | UNKNOWN | 10/11/1988 | < | 4.00 | /100mL |
| S000-252 | Fecal Coliform | Total | MN00006 | 3/14/1989 | < | 4.00 | /100mL |
| S000-252 | Fecal Coliform | Total | MN00006 | 4/11/1989 | | 16.00 | /100mL |
| S000-252 | Fecal Coliform | Total | MN00006 | 5/9/1989 | | 4.00 | /100mL |
| S000-252 | Fecal Coliform | Total | MN00006 | 6/13/1989 | | 1800.00 | /100mL |
| S000-252 | Fecal Coliform | Total | MN00006 | 7/18/1989 | | 72.00 | /100mL |
| S000-252 | Fecal Coliform | Total | MN00006 | 8/16/1989 | | 8.00 | /100mL |
| S000-252 | Fecal Coliform | Total | MN00006 | 9/12/1989 | | 16.00 | /100mL |
| S000-252 | Fecal Coliform | Total | MN00006 | 10/10/1989 | | 40.00 | /100mL |
| S000-252 | Fecal Coliform | Total | MN00006 | 1/4/1990 | < | 4.00 | /100mL |
| S000-252 | Fecal Coliform | Total | MN00006 | 3/27/1990 | < | 4.00 | /100mL |
| S000-252 | Fecal Coliform | Total | MN00006 | 5/2/1990 | | 4.00 | /100mL |
| S000-252 | Fecal Coliform | Total | MN00006 | 6/5/1990 | | 24.00 | /100mL |
| S000-252 | Fecal Coliform | Total | MN00006 | 7/17/1990 | | 20.00 | /100mL |
| S000-252 | Fecal Coliform | Total | MN00006 | 8/16/1990 | | 20.00 | /100mL |
| S000-252 | Fecal Coliform | Total | MN00006 | 9/25/1990 | | 8.00 | /100mL |
| S000-252 | Fecal Coliform | Total | MN00006 | 10/9/1990 | | 4.00 | /100mL |
| S000-252 | Fecal Coliform | Total | MN00006 | 1/29/1991 | < | 4.00 | /100mL |
| S000-252 | Fecal Coliform | Total | MN00006 | 3/12/1991 | < | 4.00 | /100mL |
| S000-252 | Fecal Coliform | Total | MN00006 | 4/23/1991 | < | 4.00 | /100mL |
| S000-252 | Fecal Coliform | Total | MN00006 | 5/29/1991 | | 16.00 | /100mL |
| S000-252 | Fecal Coliform | Total | MN00006 | 6/25/1991 | | 4.00 | /100mL |
| S000-252 | Fecal Coliform | Total | MN00006 | 7/30/1991 | | 40.00 | /100mL |
| S000-252 | Fecal Coliform | Total | MN00006 | 8/27/1991 | | 40.00 | /100mL |
| S000-252 | Fecal Coliform | Total | MN00006 | 9/18/1991 | | 150.00 | /100mL |
| S000-252 | Fecal Coliform | Total | MN00006 | 10/23/1991 | | 8.00 | /100mL |
| S000-252 | Fecal Coliform | Total | MN00006 | 1/28/1992 | | 8.00 | /100mL |
| S000-252 | Fecal Coliform | Total | MN00006 | 3/24/1992 | < | 4.00 | /100mL |
| S000-252 | Fecal Coliform | Total | MN00006 | 4/21/1992 | | 16.00 | /100mL |
| S000-252 | Fecal Coliform | Total | MN00006 | 5/6/1992 | < | 4.00 | /100mL |
| S000-252 | Fecal Coliform | Total | MN00006 | 6/2/1992 | | 8.00 | /100mL |
| S000-252 | Fecal Coliform | Total | MN00006 | 7/21/1992 | | 4.00 | /100mL |
| S000-252 | Fecal Coliform | Total | MN00006 | 8/11/1992 | | 36.00 | /100mL |
| S000-252 | Fecal Coliform | Total | MN00006 | 9/23/1992 | | 4.00 | /100mL |
| S000-252 | Fecal Coliform | Total | MN00006 | 10/21/1992 | | 4.00 | /100mL |
| S000-252 | Fecal Coliform | Total | MN00006 | 1/6/1993 | < | 4.00 | /100mL |
| S000-252 | Fecal Coliform | Total | MN00006 | 3/3/1993 | | 8.00 | /100mL |
| S000-252 | Fecal Coliform | Total | MN00006 | 4/28/1993 | | 8.00 | /100mL |
| S000-252 | Fecal Coliform | Total | MN00006 | 5/27/1993 | | 12.00 | /100mL |
| S000-252 | Fecal Coliform | Total | MN00006 | 6/23/1993 | | 4.00 | /100mL |
| S000-252 | Fecal Coliform | Total | MN00006 | 7/21/1993 | | 20.00 | /100mL |
| S000-252 | Fecal Coliform | Total | MN00006 | 8/25/1993 | | 60.00 | /100mL |

# Appendix A
# Water Quality Dataset

| Station ID | Parameter | Sample Fraction Type | Lab Name Code | Sample Date | Detect Flag | Result | Result Unit |
|---|---|---|---|---|---|---|---|
| S000-252 | Fecal Coliform | Total | MN00006 | 9/22/1993 | < | 4.00 | /100mL |
| S000-252 | Fecal Coliform | Total | MN00006 | 10/14/1993 | | 4.00 | /100mL |
| S000-252 | Fecal Coliform | Total | MN00006 | 1/11/1994 | < | 4.00 | /100mL |
| S000-252 | Fecal Coliform | Total | MN00006 | 3/15/1994 | | 4.00 | /100mL |
| S000-252 | Fecal Coliform | Total | MN00006 | 4/13/1994 | < | 4.00 | /100mL |
| S000-252 | Fecal Coliform | Total | MN00006 | 5/19/1994 | < | 4.00 | /100mL |
| S000-252 | Fecal Coliform | Total | MN00006 | 6/15/1994 | | 320.00 | /100mL |
| S000-252 | Fecal Coliform | Total | MN00006 | 7/20/1994 | | 63.00 | /100mL |
| S000-252 | Fecal Coliform | Total | MN00006 | 8/25/1994 | | 8.00 | /100mL |
| S000-252 | Fecal Coliform | Total | MN00006 | 9/13/1994 | | 20.00 | /100mL |
| S000-252 | Fecal Coliform | Total | MN00006 | 7/18/2000 | | 15.00 | /100mL |
| S000-252 | Fecal Coliform | Total | MN00006 | 8/14/2000 | | 32.00 | /100mL |
| S000-252 | Fecal Coliform | Total | MN00006 | 9/5/2000 | | 8.00 | /100mL |
| S000-252 | Fecal Coliform | Total | MN00006 | 10/17/2002 | < | 4.00 | /100mL |
| S000-252 | Fecal Coliform | Total | MN00006 | 4/29/2003 | < | 9.00 | /100mL |
| S000-252 | Fecal Coliform | Total | MN00006 | 5/20/2003 | | 94.00 | /100mL |
| S000-252 | Fecal Coliform | Total | MN00006 | 6/24/2003 | | 76.00 | /100mL |
| S000-252 | Fecal Coliform | Total | MN00006 | 7/28/2003 | | 12.00 | /100mL |
| S000-252 | Fecal Coliform | Total | MN00006 | 8/5/2003 | | 20.00 | /100mL |
| S000-252 | Fecal Coliform | Total | MN00006 | 9/8/2003 | | 4.00 | /100mL |
| S000-252 | Fecal Coliform | Total | MN00006 | 10/13/2003 | | 32.00 | /100mL |
| S000-252 | Fecal Coliform | Total | MN00006 | 10/13/2004 | < | 4.00 | /100mL |
| S000-252 | Fecal Streptococcus Group Bacteria | Total | UNKNOWN | 4/24/1974 | | 9.00 | /100mL |
| S000-252 | Fecal Streptococcus Group Bacteria | Total | UNKNOWN | 7/26/1976 | | 72.00 | /100mL |
| S000-252 | Flow | Total | | 7/24/1973 | | 80.00 | cfs |
| S000-252 | Flow | Total | | 8/29/1973 | | 101.00 | cfs |
| S000-252 | Flow | Total | | 9/13/1973 | | 38.00 | cfs |
| S000-252 | Flow | Total | | 9/26/1973 | | 38.00 | cfs |
| S000-252 | Flow | Total | | 10/17/1973 | | 119.00 | cfs |
| S000-252 | Flow | Total | | 11/14/1973 | | 38.00 | cfs |
| S000-252 | Flow | Total | | 12/5/1973 | | 30.00 | cfs |
| S000-252 | Flow | Total | | 1/29/1974 | | 26.00 | cfs |
| S000-252 | Flow | Total | | 2/26/1974 | | 21.00 | cfs |
| S000-252 | Flow | Total | | 3/12/1974 | | 11.00 | cfs |
| S000-252 | Flow | Total | | 4/2/1974 | | 26.00 | cfs |
| S000-252 | Flow | Total | | 4/9/1974 | | 26.00 | cfs |
| S000-252 | Flow | Total | | 4/24/1974 | | 811.00 | cfs |
| S000-252 | Flow | Total | | 5/8/1974 | | 185.00 | cfs |
| S000-252 | Flow | Total | | 5/15/1974 | | 770.00 | cfs |
| S000-252 | Flow | Total | | 6/18/1974 | | 218.00 | cfs |
| S000-252 | Flow | Total | | 7/10/1974 | | 6.00 | cfs |
| S000-252 | Flow | Total | | 8/13/1974 | | 37.00 | cfs |
| S000-252 | Flow | Total | | 9/12/1974 | | 48.00 | cfs |
| S000-252 | Flow | Total | | 10/9/1974 | | 74.00 | cfs |
| S000-252 | Flow | Total | | 11/5/1974 | | 60.00 | cfs |
| S000-252 | Flow | Total | | 12/11/1974 | | 54.00 | cfs |
| S000-252 | Flow | Total | | 1/16/1975 | | 66.00 | cfs |
| S000-252 | Flow | Total | | 2/26/1975 | | 27.00 | cfs |
| S000-252 | Flow | Total | | 4/2/1975 | | 38.00 | cfs |
| S000-252 | Flow | Total | | 4/17/1975 | | 233.00 | cfs |
| S000-252 | Flow | Total | | 5/1/1975 | | 1200.00 | cfs |
| S000-252 | Flow | Total | | 5/8/1975 | | 948.00 | cfs |
| S000-252 | Flow | Total | | 5/15/1975 | | 518.00 | cfs |
| S000-252 | Flow | Total | | 5/22/1975 | | 211.00 | cfs |
| S000-252 | Flow | Total | | 6/18/1975 | | 107.00 | cfs |
| S000-252 | Fluoride | Dissolved | UNKNOWN | 7/24/1973 | | 0.10 | mg/L |
| S000-252 | Fluoride | Dissolved | UNKNOWN | 8/29/1973 | | 0.21 | mg/L |
| S000-252 | Fluoride | Dissolved | UNKNOWN | 9/13/1973 | | 0.14 | mg/L |
| S000-252 | Fluoride | Dissolved | UNKNOWN | 9/26/1973 | | 0.19 | mg/L |
| S000-252 | Fluoride | Dissolved | UNKNOWN | 11/14/1973 | | 0.14 | mg/L |
| S000-252 | Fluoride | Dissolved | UNKNOWN | 12/5/1973 | | 0.11 | mg/L |
| S000-252 | Fluoride | Dissolved | UNKNOWN | 1/29/1974 | | 0.11 | mg/L |
| S000-252 | Fluoride | Dissolved | UNKNOWN | 2/26/1974 | | 0.10 | mg/L |
| S000-252 | Fluoride | Dissolved | UNKNOWN | 3/12/1974 | | 0.14 | mg/L |
| S000-252 | Fluoride | Dissolved | UNKNOWN | 4/2/1974 | | 0.15 | mg/L |
| S000-252 | Fluoride | Dissolved | UNKNOWN | 4/9/1974 | | 0.14 | mg/L |
| S000-252 | Fluoride | Dissolved | UNKNOWN | 4/24/1974 | | 0.10 | mg/L |
| S000-252 | Fluoride | Dissolved | UNKNOWN | 5/8/1974 | | 0.11 | mg/L |
| S000-252 | Fluoride | Dissolved | UNKNOWN | 5/15/1974 | | 0.10 | mg/L |
| S000-252 | Fluoride | Dissolved | UNKNOWN | 6/18/1974 | | 0.12 | mg/L |
| S000-252 | Fluoride | Dissolved | UNKNOWN | 7/10/1974 | | 0.17 | mg/L |
| S000-252 | Fluoride | Dissolved | UNKNOWN | 8/13/1974 | | 0.15 | mg/L |
| S000-252 | Fluoride | Dissolved | UNKNOWN | 9/12/1974 | | 0.17 | mg/L |

# Appendix A
# Water Quality Dataset

| Station ID | Parameter | Sample Fraction Type | Lab Name Code | Sample Date | Detect Flag | Result | Result Unit |
|---|---|---|---|---|---|---|---|
| S000-252 | Fluoride | Dissolved | UNKNOWN | 10/9/1974 | | 0.16 | mg/L |
| S000-252 | Fluoride | Dissolved | UNKNOWN | 11/5/1974 | | 0.16 | mg/L |
| S000-252 | Fluoride | Dissolved | UNKNOWN | 12/11/1974 | | 0.14 | mg/L |
| S000-252 | Fluoride | Dissolved | UNKNOWN | 1/16/1975 | | 0.10 | mg/L |
| S000-252 | Fluoride | Dissolved | UNKNOWN | 2/26/1975 | | 0.15 | mg/L |
| S000-252 | Fluoride | Dissolved | UNKNOWN | 4/2/1975 | | 0.17 | mg/L |
| S000-252 | Fluoride | Dissolved | UNKNOWN | 4/17/1975 | < | 0.10 | mg/L |
| S000-252 | Fluoride | Dissolved | UNKNOWN | 5/1/1975 | | 0.09 | mg/L |
| S000-252 | Fluoride | Dissolved | UNKNOWN | 5/8/1975 | | 0.56 | mg/L |
| S000-252 | Fluoride | Dissolved | UNKNOWN | 5/15/1975 | | 0.38 | mg/L |
| S000-252 | Fluoride | Dissolved | UNKNOWN | 5/22/1975 | | 0.13 | mg/L |
| S000-252 | Fluoride | Dissolved | UNKNOWN | 6/18/1975 | | 0.18 | mg/L |
| S000-252 | Fluoride | Dissolved | UNKNOWN | 7/26/1976 | | 0.20 | mg/L |
| S000-252 | Fluoride | Dissolved | UNKNOWN | 10/18/1976 | | 0.17 | mg/L |
| S000-252 | Fluoride | Dissolved | UNKNOWN | 4/25/1977 | | 0.10 | mg/L |
| S000-252 | Fluoride | Dissolved | UNKNOWN | 7/25/1977 | | 0.17 | mg/L |
| S000-252 | Fonofos | Total | UNKNOWN | 6/14/1988 | < | 0.01 | ug/L |
| S000-252 | Fonofos | Total | UNKNOWN | 6/14/1988 | < | 0.01 | ug/L |
| S000-252 | Fonofos | Total | MN00006 | 6/13/1989 | < | 0.01 | ug/L |
| S000-252 | Fonofos | Tot | MN00100 | 5/29/1991 | < | 0.12 | ug/L |
| S000-252 | Fonofos | Tot | MN00100 | 6/25/1991 | < | 0.12 | ug/L |
| S000-252 | Fonofos | Tot | MN00100 | 6/25/1991 | < | 0.12 | ug/L |
| S000-252 | Fonofos | Tot | MN00100 | 7/30/1991 | < | 0.12 | ug/L |
| S000-252 | Fonofos | Tot | MN00100 | 5/6/1992 | < | 0.12 | ug/L |
| S000-252 | Fonofos | Tot | MN00100 | 6/2/1992 | < | 0.12 | ug/L |
| S000-252 | Fonofos | Tot | MN00100 | 7/21/1992 | < | 0.12 | ug/L |
| S000-252 | Fonofos | Tot | MN00100 | 5/27/1993 | < | 0.12 | ug/L |
| S000-252 | Fonofos | Tot | MN00100 | 6/23/1993 | < | 0.12 | ug/L |
| S000-252 | Fonofos | Tot | MN00100 | 7/21/1993 | < | 0.12 | ug/L |
| S000-252 | Hardness, Ca, Mg as CaCO3 | Total | UNKNOWN | 7/24/1973 | | 39.00 | mg/L |
| S000-252 | Hardness, Ca, Mg as CaCO3 | Total | UNKNOWN | 9/13/1973 | | 62.00 | mg/L |
| S000-252 | Hardness, Ca, Mg as CaCO3 | Total | UNKNOWN | 9/26/1973 | | 48.00 | mg/L |
| S000-252 | Hardness, Ca, Mg as CaCO3 | Total | UNKNOWN | 11/14/1973 | | 41.00 | mg/L |
| S000-252 | Hardness, Ca, Mg as CaCO3 | Total | UNKNOWN | 12/5/1973 | | 27.00 | mg/L |
| S000-252 | Hardness, Ca, Mg as CaCO3 | Total | UNKNOWN | 1/29/1974 | | 54.00 | mg/L |
| S000-252 | Hardness, Ca, Mg as CaCO3 | Total | UNKNOWN | 2/26/1974 | | 77.00 | mg/L |
| S000-252 | Hardness, Ca, Mg as CaCO3 | Total | UNKNOWN | 3/12/1974 | | 55.00 | mg/L |
| S000-252 | Hardness, Ca, Mg as CaCO3 | Total | UNKNOWN | 4/2/1974 | | 61.00 | mg/L |
| S000-252 | Hardness, Ca, Mg as CaCO3 | Total | UNKNOWN | 4/9/1974 | | 53.00 | mg/L |
| S000-252 | Hardness, Ca, Mg as CaCO3 | Total | UNKNOWN | 4/24/1974 | | 16.00 | mg/L |
| S000-252 | Hardness, Ca, Mg as CaCO3 | Total | UNKNOWN | 5/8/1974 | | 25.00 | mg/L |
| S000-252 | Hardness, Ca, Mg as CaCO3 | Total | UNKNOWN | 5/15/1974 | | 12.00 | mg/L |
| S000-252 | Hardness, Ca, Mg as CaCO3 | Total | UNKNOWN | 6/18/1974 | | 32.00 | mg/L |
| S000-252 | Hardness, Ca, Mg as CaCO3 | Total | UNKNOWN | 7/10/1974 | | 57.00 | mg/L |
| S000-252 | Hardness, Ca, Mg as CaCO3 | Total | UNKNOWN | 8/13/1974 | | 57.00 | mg/L |
| S000-252 | Hardness, Ca, Mg as CaCO3 | Total | UNKNOWN | 9/12/1974 | | 55.00 | mg/L |
| S000-252 | Hardness, Ca, Mg as CaCO3 | Total | UNKNOWN | 10/9/1974 | | 49.00 | mg/L |
| S000-252 | Hardness, Ca, Mg as CaCO3 | Total | UNKNOWN | 11/5/1974 | | 35.00 | mg/L |
| S000-252 | Hardness, Ca, Mg as CaCO3 | Total | UNKNOWN | 12/11/1974 | | 69.00 | mg/L |
| S000-252 | Hardness, Ca, Mg as CaCO3 | Total | UNKNOWN | 1/16/1975 | | 62.00 | mg/L |
| S000-252 | Hardness, Ca, Mg as CaCO3 | Total | UNKNOWN | 2/26/1975 | | 57.00 | mg/L |
| S000-252 | Hardness, Ca, Mg as CaCO3 | Total | UNKNOWN | 4/2/1975 | | 64.00 | mg/L |
| S000-252 | Hardness, Ca, Mg as CaCO3 | Total | UNKNOWN | 4/17/1975 | | 41.00 | mg/L |
| S000-252 | Hardness, Ca, Mg as CaCO3 | Total | UNKNOWN | 5/1/1975 | | 27.00 | mg/L |
| S000-252 | Hardness, Ca, Mg as CaCO3 | Total | UNKNOWN | 5/8/1975 | | 21.00 | mg/L |
| S000-252 | Hardness, Ca, Mg as CaCO3 | Total | UNKNOWN | 5/15/1975 | | 26.00 | mg/L |
| S000-252 | Hardness, Ca, Mg as CaCO3 | Total | UNKNOWN | 5/22/1975 | | 38.00 | mg/L |
| S000-252 | Hardness, Ca, Mg as CaCO3 | Total | UNKNOWN | 6/18/1975 | | 34.00 | mg/L |
| S000-252 | Hardness, Ca, Mg as CaCO3 | Total | UNKNOWN | 7/26/1976 | | 79.00 | mg/L |
| S000-252 | Hardness, Ca, Mg as CaCO3 | Total | UNKNOWN | 10/18/1976 | | 93.00 | mg/L |
| S000-252 | Hardness, Ca, Mg as CaCO3 | Total | UNKNOWN | 4/25/1977 | | 52.00 | mg/L |
| S000-252 | Hardness, Ca, Mg as CaCO3 | Total | UNKNOWN | 7/25/1977 | | 67.00 | mg/L |
| S000-252 | Hardness, Ca, Mg as CaCO3 | Total | UNKNOWN | 10/14/1980 | | 45.00 | mg/L |
| S000-252 | Hardness, Ca, Mg as CaCO3 | Total | UNKNOWN | 1/14/1981 | | 76.00 | mg/L |
| S000-252 | Hardness, Ca, Mg as CaCO3 | Total | UNKNOWN | 3/11/1981 | | 68.00 | mg/L |
| S000-252 | Hardness, Ca, Mg as CaCO3 | Total | UNKNOWN | 4/14/1981 | | 21.00 | mg/L |
| S000-252 | Hardness, Ca, Mg as CaCO3 | Total | UNKNOWN | 5/12/1981 | | 32.00 | mg/L |
| S000-252 | Hardness, Ca, Mg as CaCO3 | Total | UNKNOWN | 6/16/1981 | | 31.00 | mg/L |
| S000-252 | Hardness, Ca, Mg as CaCO3 | Total | UNKNOWN | 7/14/1981 | | 52.00 | mg/L |
| S000-252 | Hardness, Ca, Mg as CaCO3 | Total | UNKNOWN | 8/12/1981 | | 55.00 | mg/L |
| S000-252 | Hardness, Ca, Mg as CaCO3 | Total | UNKNOWN | 9/15/1981 | | 69.00 | mg/L |
| S000-252 | Hardness, Ca, Mg as CaCO3 | Total | MN00006 | 6/25/1991 | | 76.00 | mg/L |
| S000-252 | Hardness, Ca, Mg as CaCO3 | Total | MN00006 | 7/30/1991 | | 61.00 | mg/L |

# Appendix A
# Water Quality Dataset

| Station ID | Parameter | Sample Fraction Type | Lab Name Code | Sample Date | Detect Flag | Result | Result Unit |
|---|---|---|---|---|---|---|---|
| S000-252 | Hardness, Ca, Mg as CaCO3 | Total | MN00006 | 10/23/1991 | | 55.00 | mg/L |
| S000-252 | Hardness, Ca, Mg as CaCO3 | Total | MN00006 | 4/21/2008 | | 24.00 | mg/L |
| S000-252 | Hexachlorobenzene | Total | UNKNOWN | 11/8/1978 | < | 0.01 | ug/L |
| S000-252 | Hexachlorobenzene | Total | UNKNOWN | 10/16/1979 | < | 0.02 | ug/L |
| S000-252 | Inorganic carbon | Total | UNKNOWN | 9/13/1973 | | 5.80 | mg/L |
| S000-252 | Inorganic carbon | Total | UNKNOWN | 9/26/1973 | | 8.10 | mg/L |
| S000-252 | Inorganic carbon | Total | UNKNOWN | 10/17/1973 | | 2.30 | mg/L |
| S000-252 | Inorganic carbon | Total | UNKNOWN | 3/12/1974 | | 10.80 | mg/L |
| S000-252 | Inorganic carbon | Total | UNKNOWN | 4/9/1974 | | 10.80 | mg/L |
| S000-252 | Inorganic carbon | Total | UNKNOWN | 5/8/1974 | | 8.00 | mg/L |
| S000-252 | Inorganic carbon | Total | UNKNOWN | 5/15/1974 | | 1.50 | mg/L |
| S000-252 | Inorganic carbon | Total | UNKNOWN | 6/18/1974 | | 5.00 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | UNKNOWN | 8/23/1976 | | 0.02 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | UNKNOWN | 9/20/1976 | | 0.04 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | UNKNOWN | 10/18/1976 | | 0.02 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | UNKNOWN | 11/16/1976 | | 0.01 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | UNKNOWN | 3/22/1977 | | 3.70 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | UNKNOWN | 4/25/1977 | | 0.70 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | UNKNOWN | 5/23/1977 | | 0.03 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | UNKNOWN | 6/27/1977 | | 0.03 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | UNKNOWN | 7/25/1977 | | 0.09 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | UNKNOWN | 8/22/1977 | | 0.03 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | UNKNOWN | 9/26/1977 | | 0.02 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | UNKNOWN | 10/24/1977 | | 0.03 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | UNKNOWN | 11/14/1977 | | 0.09 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | UNKNOWN | 12/19/1977 | | 1.60 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | UNKNOWN | 1/23/1978 | | 0.22 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | UNKNOWN | 2/21/1978 | | 0.28 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | UNKNOWN | 3/1/1978 | | 0.28 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | UNKNOWN | 4/4/1978 | | 0.31 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | UNKNOWN | 5/1/1978 | | 0.15 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | UNKNOWN | 6/6/1978 | | 0.03 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | UNKNOWN | 7/6/1978 | | 0.06 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | UNKNOWN | 8/1/1978 | | 0.02 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | UNKNOWN | 9/6/1978 | < | 0.01 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | UNKNOWN | 10/3/1978 | < | 0.01 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | UNKNOWN | 11/8/1978 | < | 0.01 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | UNKNOWN | 12/6/1978 | | 0.11 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | UNKNOWN | 1/16/1979 | | 0.41 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | UNKNOWN | 2/21/1979 | | 0.26 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | UNKNOWN | 3/20/1979 | | 1.00 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | UNKNOWN | 4/4/1979 | | 0.25 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | UNKNOWN | 5/2/1979 | | 0.12 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | UNKNOWN | 6/19/1979 | < | 0.01 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | UNKNOWN | 7/24/1979 | | 0.28 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | UNKNOWN | 7/31/1979 | | 0.04 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | UNKNOWN | 8/21/1979 | < | 0.01 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | UNKNOWN | 10/16/1979 | < | 0.01 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | UNKNOWN | 12/18/1979 | | 0.22 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | UNKNOWN | 1/22/1980 | | 0.25 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | UNKNOWN | 2/27/1980 | | 0.29 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | UNKNOWN | 3/19/1980 | | 0.33 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | UNKNOWN | 4/22/1980 | | 0.31 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | UNKNOWN | 5/20/1980 | < | 0.01 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | UNKNOWN | 6/17/1980 | < | 0.01 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | UNKNOWN | 7/22/1980 | < | 0.01 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | UNKNOWN | 8/19/1980 | | 0.02 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | UNKNOWN | 9/23/1980 | < | 0.01 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | UNKNOWN | 10/14/1980 | < | 0.01 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | UNKNOWN | 1/14/1981 | | 0.25 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | UNKNOWN | 3/11/1981 | | 0.27 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | UNKNOWN | 4/14/1981 | | 0.26 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | UNKNOWN | 5/12/1981 | < | 0.01 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | UNKNOWN | 6/16/1981 | | 0.03 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | UNKNOWN | 7/14/1981 | < | 0.01 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | UNKNOWN | 8/12/1981 | < | 0.01 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | UNKNOWN | 9/15/1981 | < | 0.01 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | UNKNOWN | 10/12/1981 | < | 0.01 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | UNKNOWN | 1/12/1982 | | 0.24 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | UNKNOWN | 3/16/1982 | | 0.32 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | UNKNOWN | 4/13/1982 | | 0.26 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | UNKNOWN | 5/11/1982 | < | 0.01 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | UNKNOWN | 6/8/1982 | < | 0.01 | mg/L |

# Appendix A
# Water Quality Dataset

| Station ID | Parameter | Sample Fraction Type | Lab Name Code | Sample Date | Detect Flag | Result | Result Unit |
|---|---|---|---|---|---|---|---|
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | UNKNOWN | 7/13/1982 | | 0.01 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | UNKNOWN | 8/10/1982 | < | 0.01 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | UNKNOWN | 9/8/1982 | < | 0.01 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | UNKNOWN | 10/12/1982 | | 0.01 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | UNKNOWN | 1/12/1983 | | 0.17 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | UNKNOWN | 3/9/1983 | | 0.80 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | UNKNOWN | 4/12/1983 | | 0.12 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | UNKNOWN | 5/10/1983 | | 0.04 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | UNKNOWN | 6/14/1983 | < | 0.01 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | UNKNOWN | 7/12/1983 | | 0.02 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | UNKNOWN | 8/9/1983 | | 0.01 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | UNKNOWN | 9/13/1983 | | 0.01 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | UNKNOWN | 10/27/1983 | < | 0.01 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | UNKNOWN | 1/10/1984 | | 0.12 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | UNKNOWN | 3/13/1984 | | 0.16 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | UNKNOWN | 4/17/1984 | | 0.14 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | UNKNOWN | 5/15/1984 | < | 0.01 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | UNKNOWN | 6/12/1984 | < | 0.01 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | UNKNOWN | 7/17/1984 | < | 0.01 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | UNKNOWN | 8/14/1984 | < | 0.01 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | UNKNOWN | 9/18/1984 | < | 0.01 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | UNKNOWN | 10/10/1984 | | 0.30 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | UNKNOWN | 1/14/1985 | | 0.24 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | UNKNOWN | 3/13/1985 | | 0.31 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | UNKNOWN | 4/15/1985 | | 0.07 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | UNKNOWN | 5/14/1985 | | 0.03 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | UNKNOWN | 6/10/1985 | | 0.02 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | UNKNOWN | 7/17/1985 | < | 0.01 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | UNKNOWN | 8/13/1985 | | 0.05 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | UNKNOWN | 9/11/1985 | | 0.02 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | UNKNOWN | 10/15/1985 | | 0.03 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | UNKNOWN | 2/19/1986 | | 0.24 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | UNKNOWN | 3/20/1986 | | 0.21 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | UNKNOWN | 4/17/1986 | | 0.04 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | UNKNOWN | 5/12/1986 | | 0.02 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | UNKNOWN | 6/10/1986 | < | 0.01 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | UNKNOWN | 7/15/1986 | < | 0.01 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | UNKNOWN | 8/19/1986 | < | 0.01 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | UNKNOWN | 9/24/1986 | < | 0.01 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | UNKNOWN | 10/21/1986 | < | 0.01 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | UNKNOWN | 1/13/1987 | | 0.12 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | UNKNOWN | 3/10/1987 | | 0.55 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | UNKNOWN | 4/7/1987 | | 0.15 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | UNKNOWN | 5/12/1987 | < | 0.01 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | UNKNOWN | 6/9/1987 | < | 0.01 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | UNKNOWN | 7/15/1987 | < | 0.01 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | UNKNOWN | 8/11/1987 | < | 0.01 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | UNKNOWN | 9/15/1987 | < | 0.01 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | UNKNOWN | 10/14/1987 | | 0.02 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | UNKNOWN | 1/12/1988 | | 0.09 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | UNKNOWN | 3/15/1988 | | 0.17 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | UNKNOWN | 4/12/1988 | | 0.19 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | UNKNOWN | 5/9/1988 | | 0.15 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | UNKNOWN | 6/14/1988 | < | 0.01 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | UNKNOWN | 7/12/1988 | < | 0.01 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | UNKNOWN | 8/17/1988 | < | 0.01 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | UNKNOWN | 9/13/1988 | | 0.05 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | UNKNOWN | 10/11/1988 | < | 0.01 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 3/14/1989 | | 0.11 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 4/11/1989 | | 0.14 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 5/9/1989 | < | 0.01 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 6/13/1989 | | 0.02 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 7/18/1989 | < | 0.01 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 8/16/1989 | < | 0.01 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 9/12/1989 | < | 0.01 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 10/10/1989 | < | 0.01 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 1/4/1990 | | 0.35 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 3/27/1990 | | 0.23 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 5/2/1990 | | 0.13 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 6/5/1990 | | 0.01 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 7/17/1990 | | 0.03 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 8/16/1990 | < | 0.01 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 9/25/1990 | < | 0.01 | mg/L |

# Appendix A
# Water Quality Dataset

| Station ID | Parameter | Sample Fraction Type | Lab Name Code | Sample Date | Detect Flag | Result | Result Unit |
|---|---|---|---|---|---|---|---|
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 10/9/1990 | < | 0.01 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 1/29/1991 | | 0.11 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 3/12/1991 | | 0.16 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 4/23/1991 | | 0.07 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 5/29/1991 | < | 0.01 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 6/25/1991 | | 0.01 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 7/30/1991 | < | 0.01 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 8/27/1991 | | 0.02 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 9/18/1991 | < | 0.01 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 10/23/1991 | | 0.02 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 1/28/1992 | | 0.12 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 3/24/1992 | | 0.17 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 4/21/1992 | | 0.18 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 5/6/1992 | | 0.02 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 6/2/1992 | < | 0.01 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 7/21/1992 | | 0.02 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 8/11/1992 | < | 0.01 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 9/23/1992 | < | 0.01 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 10/21/1992 | | 0.02 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 1/6/1993 | | 0.05 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 3/3/1993 | | 0.14 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 4/28/1993 | | 0.07 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 5/27/1993 | < | 0.01 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 6/23/1993 | | 0.01 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 7/21/1993 | | 0.02 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 8/25/1993 | | 0.02 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 9/22/1993 | < | 0.05 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 10/14/1993 | < | 0.05 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 1/11/1994 | | 0.13 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 3/15/1994 | | 0.17 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 4/13/1994 | | 0.36 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 5/19/1994 | < | 0.05 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 6/15/1994 | | 0.06 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 7/20/1994 | < | 0.05 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 8/25/1994 | < | 0.05 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 9/13/1994 | < | 0.05 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 10/19/1994 | | 0.10 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 11/7/1994 | < | 0.05 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 1/19/1995 | | 0.18 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 3/16/1995 | | 0.84 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 4/12/1995 | | 0.23 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 5/18/1995 | < | 0.05 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 6/13/1995 | < | 0.05 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 7/26/1995 | < | 0.05 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 8/14/1995 | < | 0.05 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 9/12/1995 | < | 0.05 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 10/21/1997 | < | 0.05 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 11/3/1997 | | 0.09 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 1/28/1998 | | 0.30 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 3/17/1998 | | 0.28 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 4/14/1998 | | 0.15 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 5/27/1998 | | 0.15 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 6/16/1998 | | 0.06 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 7/13/1998 | | 0.18 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 8/12/1998 | | 0.28 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 9/22/1998 | | 0.05 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 10/10/1999 | < | 0.05 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 11/21/1999 | | 0.13 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 1/16/2000 | | 0.48 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 3/19/2000 | | 0.36 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 4/16/2000 | | 0.22 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 5/23/2000 | | 0.13 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 6/25/2000 | | 0.11 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 7/18/2000 | | 0.30 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 8/14/2000 | | 0.39 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 9/5/2000 | | 0.24 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 10/17/2002 | | 0.16 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 11/3/2002 | | 0.19 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 1/28/2003 | | 1.10 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 3/18/2003 | | 1.20 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 4/29/2003 | | 0.53 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 5/20/2003 | | 0.34 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 6/24/2003 | | 0.19 | mg/L |

| Station ID | Parameter | Sample Fraction Type | Lab Name Code | Sample Date | Detect Flag | Result | Result Unit |
|---|---|---|---|---|---|---|---|
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 8/5/2003 | < | 0.05 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 9/8/2003 | | 0.77 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 10/13/2004 | | 0.40 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 11/21/2004 | | 0.24 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 2/1/2005 | | 0.47 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 3/2/2005 | | 0.65 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 4/20/2005 | | 0.09 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 5/25/2005 | | 0.08 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 5/25/2005 | | 0.07 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 6/1/2005 | | 0.10 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 7/11/2005 | | 0.50 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 8/24/2005 | | 1.40 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 9/19/2005 | | 1.20 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 10/8/2007 | | 0.10 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 10/8/2007 | | 0.10 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 11/13/2007 | | 0.27 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 2/12/2008 | | 1.30 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 2/12/2008 | | 1.30 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 3/31/2008 | | 1.40 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 4/21/2008 | | 0.31 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 4/21/2008 | | 0.31 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 5/13/2008 | | 0.23 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 6/4/2008 | | 0.71 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 7/21/2008 | | 0.92 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 8/18/2008 | | 2.10 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 9/16/2008 | | 1.30 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 10/26/2009 | | 0.21 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 10/26/2009 | | 0.21 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 11/30/2009 | < | 0.05 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 1/25/2010 | | 0.21 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 1/25/2010 | | 0.21 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 3/1/2010 | | 0.12 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 4/26/2010 | | 0.55 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 4/26/2010 | | 0.52 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 5/11/2010 | | 0.26 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 6/7/2010 | < | 0.05 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 6/7/2010 | < | 0.05 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 7/18/2010 | | 0.81 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 8/22/2010 | | 0.54 | mg/L |
| S000-252 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 9/27/2010 | < | 0.05 | mg/L |
| S000-252 | Iron | Total | UNKNOWN | 7/24/1973 | | 190.00 | ug/L |
| S000-252 | Iron | Total | UNKNOWN | 8/29/1973 | | 1400.00 | ug/L |
| S000-252 | Iron | Total | UNKNOWN | 9/13/1973 | | 1200.00 | ug/L |
| S000-252 | Iron | Total | UNKNOWN | 9/26/1973 | | 1100.00 | ug/L |
| S000-252 | Iron | Total | UNKNOWN | 10/17/1973 | | 980.00 | ug/L |
| S000-252 | Iron | Total | UNKNOWN | 11/14/1973 | | 870.00 | ug/L |
| S000-252 | Iron | Total | UNKNOWN | 12/5/1973 | | 380.00 | ug/L |
| S000-252 | Iron | Total | UNKNOWN | 1/29/1974 | | 1200.00 | ug/L |
| S000-252 | Iron | Total | UNKNOWN | 2/26/1974 | | 1100.00 | ug/L |
| S000-252 | Iron | Total | UNKNOWN | 3/12/1974 | | 530.00 | ug/L |
| S000-252 | Iron | Total | UNKNOWN | 4/9/1974 | | 910.00 | ug/L |
| S000-252 | Iron | Total | UNKNOWN | 4/24/1974 | | 1600.00 | ug/L |
| S000-252 | Iron | Total | UNKNOWN | 5/8/1974 | | 520.00 | ug/L |
| S000-252 | Iron | Total | UNKNOWN | 5/15/1974 | | 730.00 | ug/L |
| S000-252 | Iron | Total | UNKNOWN | 6/18/1974 | | 580.00 | ug/L |
| S000-252 | Iron | Total | UNKNOWN | 7/10/1974 | | 700.00 | ug/L |
| S000-252 | Iron | Total | UNKNOWN | 8/13/1974 | | 1000.00 | ug/L |
| S000-252 | Iron | Total | UNKNOWN | 9/12/1974 | | 680.00 | ug/L |
| S000-252 | Iron | Total | UNKNOWN | 10/9/1974 | | 960.00 | ug/L |
| S000-252 | Iron | Total | UNKNOWN | 11/5/1974 | | 1000.00 | ug/L |
| S000-252 | Iron | Total | UNKNOWN | 12/11/1974 | | 1000.00 | ug/L |
| S000-252 | Iron | Total | UNKNOWN | 1/16/1975 | | 94.00 | ug/L |
| S000-252 | Iron | Total | UNKNOWN | 2/26/1975 | | 650.00 | ug/L |
| S000-252 | Iron | Total | UNKNOWN | 4/2/1975 | | 760.00 | ug/L |
| S000-252 | Iron | Total | UNKNOWN | 4/17/1975 | | 1400.00 | ug/L |
| S000-252 | Iron | Total | UNKNOWN | 5/1/1975 | | 890.00 | ug/L |
| S000-252 | Iron | Total | UNKNOWN | 5/8/1975 | | 2600.00 | ug/L |
| S000-252 | Iron | Total | UNKNOWN | 5/15/1975 | | 680.00 | ug/L |
| S000-252 | Iron | Total | UNKNOWN | 5/22/1975 | | 520.00 | ug/L |
| S000-252 | Iron | Total | UNKNOWN | 6/18/1975 | | 420.00 | ug/L |
| S000-252 | Iron | Total | UNKNOWN | 7/26/1976 | | 700.00 | ug/L |
| S000-252 | Iron | Total | UNKNOWN | 10/18/1976 | | 180.00 | ug/L |
| S000-252 | Iron | Total | UNKNOWN | 4/25/1977 | | 280.00 | ug/L |

# Appendix A
# Water Quality Dataset

| Station ID | Parameter | Sample Fraction Type | Lab Name Code | Sample Date | Detect Flag | Result | Result Unit |
|---|---|---|---|---|---|---|---|
| S000-252 | Iron | Total | UNKNOWN | 7/25/1977 | | 620.00 | ug/L |
| S000-252 | Iron | Total | MN00006 | 10/23/1991 | | 410.00 | ug/L |
| S000-252 | Kjeldahl nitrogen as N | Total | UNKNOWN | 2/21/1979 | | 0.33 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | UNKNOWN | 3/20/1979 | | 0.67 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | UNKNOWN | 4/4/1979 | | 0.57 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | UNKNOWN | 5/2/1979 | | 0.54 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | UNKNOWN | 6/19/1979 | | 0.52 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | UNKNOWN | 7/24/1979 | | 1.18 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | UNKNOWN | 7/31/1979 | | 0.91 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | UNKNOWN | 8/21/1979 | | 0.83 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | UNKNOWN | 10/16/1979 | | 0.47 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | UNKNOWN | 12/18/1979 | | 0.82 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | UNKNOWN | 1/22/1980 | | 0.39 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | UNKNOWN | 2/27/1980 | | 0.37 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | UNKNOWN | 3/19/1980 | | 0.32 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | UNKNOWN | 4/22/1980 | | 2.04 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | UNKNOWN | 5/20/1980 | | 0.40 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | UNKNOWN | 6/17/1980 | | 0.39 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | UNKNOWN | 7/22/1980 | | 0.70 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | UNKNOWN | 8/19/1980 | | 0.64 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | UNKNOWN | 9/23/1980 | | 1.17 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | UNKNOWN | 10/14/1980 | | 0.52 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | UNKNOWN | 1/14/1981 | | 0.32 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | UNKNOWN | 3/11/1981 | | 0.18 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | UNKNOWN | 4/14/1981 | | 0.90 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | UNKNOWN | 5/12/1981 | | 0.44 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | UNKNOWN | 6/16/1981 | | 0.74 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | UNKNOWN | 7/14/1981 | | 0.79 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | UNKNOWN | 8/12/1981 | | 0.87 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | UNKNOWN | 9/15/1981 | | 0.42 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | UNKNOWN | 10/12/1981 | | 0.77 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | UNKNOWN | 1/12/1982 | | 0.48 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | UNKNOWN | 3/16/1982 | | 0.39 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | UNKNOWN | 4/13/1982 | | 0.62 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | UNKNOWN | 5/11/1982 | | 0.58 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | UNKNOWN | 6/8/1982 | | 0.65 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | UNKNOWN | 7/13/1982 | | 0.98 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | UNKNOWN | 8/10/1982 | | 0.80 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | UNKNOWN | 9/8/1982 | | 0.60 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | UNKNOWN | 10/12/1982 | | 0.92 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | UNKNOWN | 1/12/1983 | | 0.55 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | UNKNOWN | 3/9/1983 | | 0.68 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | UNKNOWN | 4/12/1983 | | 0.58 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | UNKNOWN | 5/10/1983 | | 0.90 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | UNKNOWN | 6/14/1983 | | 0.78 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | UNKNOWN | 7/12/1983 | | 1.20 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | UNKNOWN | 8/9/1983 | | 0.69 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | UNKNOWN | 9/13/1983 | | 0.78 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | UNKNOWN | 10/27/1983 | | 0.72 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | UNKNOWN | 1/10/1984 | | 0.49 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | UNKNOWN | 3/13/1984 | | 0.58 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | UNKNOWN | 4/17/1984 | | 0.58 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | UNKNOWN | 5/15/1984 | | 0.59 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | UNKNOWN | 6/12/1984 | | 0.79 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | UNKNOWN | 7/17/1984 | | 0.88 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | UNKNOWN | 8/14/1984 | | 0.84 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | UNKNOWN | 9/18/1984 | | 0.48 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | UNKNOWN | 10/10/1984 | | 0.53 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | UNKNOWN | 1/14/1985 | | 0.49 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | UNKNOWN | 3/13/1985 | | 0.57 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | UNKNOWN | 4/15/1985 | | 1.08 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | UNKNOWN | 5/14/1985 | | 0.86 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | UNKNOWN | 6/10/1985 | | 0.45 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | UNKNOWN | 7/17/1985 | | 0.65 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | UNKNOWN | 8/13/1985 | | 0.86 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | UNKNOWN | 9/11/1985 | | 0.63 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | UNKNOWN | 10/15/1985 | | 0.55 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | UNKNOWN | 2/19/1986 | | 0.24 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | UNKNOWN | 3/20/1986 | | 0.13 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | UNKNOWN | 4/17/1986 | | 0.41 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | UNKNOWN | 5/12/1986 | | 0.67 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | UNKNOWN | 6/10/1986 | | 0.54 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | UNKNOWN | 7/15/1986 | | 0.68 | mg/L |

# Appendix A
# Water Quality Dataset

| Station ID | Parameter | Sample Fraction Type | Lab Name Code | Sample Date | Detect Flag | Result | Result Unit |
|---|---|---|---|---|---|---|---|
| S000-252 | Kjeldahl nitrogen as N | Total | UNKNOWN | 8/19/1986 | | 0.99 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | UNKNOWN | 9/24/1986 | | 0.68 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | UNKNOWN | 10/21/1986 | | 0.47 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | UNKNOWN | 1/13/1987 | | 0.32 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | UNKNOWN | 3/10/1987 | | 0.54 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | UNKNOWN | 4/7/1987 | | 0.50 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | UNKNOWN | 5/12/1987 | | 0.35 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | UNKNOWN | 6/9/1987 | | 0.54 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | UNKNOWN | 7/15/1987 | | 0.40 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | UNKNOWN | 8/11/1987 | | 0.33 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | UNKNOWN | 9/15/1987 | | 0.50 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | UNKNOWN | 10/14/1987 | | 0.38 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | UNKNOWN | 1/12/1988 | | 0.34 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | UNKNOWN | 3/15/1988 | | 0.28 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | UNKNOWN | 4/12/1988 | | 0.89 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | UNKNOWN | 5/9/1988 | | 1.02 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | UNKNOWN | 6/14/1988 | | 0.40 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | UNKNOWN | 7/12/1988 | | 0.48 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | UNKNOWN | 8/17/1988 | | 0.83 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | UNKNOWN | 9/13/1988 | | 0.58 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | UNKNOWN | 10/11/1988 | | 0.50 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | MN00006 | 3/14/1989 | | 0.28 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | MN00006 | 4/11/1989 | | 0.48 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | MN00006 | 5/9/1989 | | 0.45 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | MN00006 | 6/13/1989 | | 0.93 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | MN00006 | 7/18/1989 | | 0.62 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | MN00006 | 8/16/1989 | | 0.22 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | MN00006 | 9/12/1989 | | 0.39 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | MN00006 | 10/10/1989 | | 0.44 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | MN00006 | 1/4/1990 | | 0.78 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | MN00006 | 3/27/1990 | | 0.50 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | MN00006 | 5/2/1990 | | 0.90 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | MN00006 | 6/5/1990 | | 0.78 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | MN00006 | 7/17/1990 | | 0.45 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | MN00006 | 8/16/1990 | | 0.40 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | MN00006 | 9/25/1990 | | 0.58 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | MN00006 | 10/9/1990 | | 0.73 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | MN00006 | 1/29/1991 | | 0.26 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | MN00006 | 3/12/1991 | | 0.62 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | MN00006 | 4/23/1991 | | 0.47 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | MN00006 | 5/29/1991 | | 0.66 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | MN00006 | 6/25/1991 | | 0.78 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | MN00006 | 7/30/1991 | | 0.46 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | MN00006 | 8/27/1991 | | 0.39 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | MN00006 | 9/18/1991 | | 0.57 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | MN00006 | 10/23/1991 | | 0.38 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | MN00006 | 1/28/1992 | | 0.41 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | MN00006 | 3/24/1992 | | 0.28 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | MN00006 | 4/21/1992 | | 0.86 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | MN00006 | 5/6/1992 | | 0.80 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | MN00006 | 6/2/1992 | | 0.57 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | MN00006 | 7/21/1992 | | 0.47 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | MN00006 | 8/11/1992 | | 0.46 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | MN00006 | 9/23/1992 | | 0.51 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | MN00006 | 10/21/1992 | | 0.41 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | MN00006 | 1/6/1993 | | 0.35 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | MN00006 | 3/3/1993 | < | 0.10 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | MN00006 | 4/28/1993 | | 0.33 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | MN00006 | 5/27/1993 | | 0.90 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | MN00006 | 6/23/1993 | | 0.34 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | MN00006 | 7/21/1993 | | 0.64 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | MN00006 | 8/25/1993 | | 0.51 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | MN00006 | 9/22/1993 | | 0.39 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | MN00006 | 10/14/1993 | | 0.38 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | MN00006 | 1/11/1994 | | 0.87 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | MN00006 | 3/15/1994 | | 0.34 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | MN00006 | 4/13/1994 | | 0.72 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | MN00006 | 5/19/1994 | | 0.37 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | MN00006 | 6/15/1994 | | 0.64 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | MN00006 | 7/20/1994 | | 0.82 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | MN00006 | 8/25/1994 | | 0.39 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | MN00006 | 9/13/1994 | | 0.46 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | MN00006 | 4/26/2010 | | 0.54 | mg/L |

# Appendix A
# Water Quality Dataset

| Station ID | Parameter | Sample Fraction Type | Lab Name Code | Sample Date | Detect Flag | Result | Result Unit |
|---|---|---|---|---|---|---|---|
| S000-252 | Kjeldahl nitrogen as N | Total | MN00006 | 4/26/2010 | | 0.48 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | MN00006 | 5/11/2010 | | 0.62 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | MN00006 | 6/7/2010 | | 0.95 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | MN00006 | 6/7/2010 | | 0.87 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | MN00006 | 7/18/2010 | | 0.62 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | MN00006 | 8/22/2010 | | 0.48 | mg/L |
| S000-252 | Kjeldahl nitrogen as N | Total | MN00006 | 9/27/2010 | | 0.36 | mg/L |
| S000-252 | Lead | Total | UNKNOWN | 8/29/1973 | < | 10.00 | ug/L |
| S000-252 | Lead | Total | UNKNOWN | 9/13/1973 | < | 10.00 | ug/L |
| S000-252 | Lead | Total | UNKNOWN | 9/26/1973 | < | 10.00 | ug/L |
| S000-252 | Lead | Total | UNKNOWN | 12/5/1973 | < | 10.00 | ug/L |
| S000-252 | Lead | Total | UNKNOWN | 2/26/1974 | < | 10.00 | ug/L |
| S000-252 | Lead | Total | UNKNOWN | 4/9/1974 | < | 10.00 | ug/L |
| S000-252 | Lead | Total | UNKNOWN | 4/24/1974 | < | 10.00 | ug/L |
| S000-252 | Lead | Total | UNKNOWN | 5/8/1974 | < | 10.00 | ug/L |
| S000-252 | Lead | Total | UNKNOWN | 5/15/1974 | < | 10.00 | ug/L |
| S000-252 | Lead | Total | UNKNOWN | 6/18/1974 | < | 10.00 | ug/L |
| S000-252 | Lead | Total | UNKNOWN | 7/10/1974 | < | 10.00 | ug/L |
| S000-252 | Lead | Total | UNKNOWN | 8/13/1974 | < | 10.00 | ug/L |
| S000-252 | Lead | Total | UNKNOWN | 9/12/1974 | < | 10.00 | ug/L |
| S000-252 | Lead | Total | UNKNOWN | 10/9/1974 | < | 10.00 | ug/L |
| S000-252 | Lead | Total | UNKNOWN | 11/5/1974 | < | 10.00 | ug/L |
| S000-252 | Lead | Total | UNKNOWN | 12/11/1974 | < | 10.00 | ug/L |
| S000-252 | Lead | Total | UNKNOWN | 1/16/1975 | < | 10.00 | ug/L |
| S000-252 | Lead | Total | UNKNOWN | 2/26/1975 | < | 10.00 | ug/L |
| S000-252 | Lead | Total | UNKNOWN | 4/2/1975 | < | 10.00 | ug/L |
| S000-252 | Lead | Total | UNKNOWN | 4/17/1975 | < | 10.00 | ug/L |
| S000-252 | Lead | Total | UNKNOWN | 5/1/1975 | < | 10.00 | ug/L |
| S000-252 | Lead | Total | UNKNOWN | 5/8/1975 | < | 10.00 | ug/L |
| S000-252 | Lead | Total | UNKNOWN | 5/15/1975 | | 19.00 | ug/L |
| S000-252 | Lead | Total | UNKNOWN | 5/22/1975 | < | 10.00 | ug/L |
| S000-252 | Lead | Total | UNKNOWN | 6/18/1975 | < | 10.00 | ug/L |
| S000-252 | Lead | Total | UNKNOWN | 7/26/1976 | < | 10.00 | ug/L |
| S000-252 | Lead | Total | UNKNOWN | 10/18/1976 | < | 10.00 | ug/L |
| S000-252 | Lead | Total | UNKNOWN | 4/25/1977 | < | 10.00 | ug/L |
| S000-252 | Lead | Total | UNKNOWN | 7/25/1977 | < | 50.00 | ug/L |
| S000-252 | Lead | Total | UNKNOWN | 11/8/1978 | | 0.32 | ug/L |
| S000-252 | Lead | Total | UNKNOWN | 6/19/1979 | | 0.37 | ug/L |
| S000-252 | Lead | Total | UNKNOWN | 10/16/1979 | < | 0.20 | ug/L |
| S000-252 | Lead | Total | UNKNOWN | 10/14/1980 | | 0.20 | ug/L |
| S000-252 | Lead | Total | UNKNOWN | 6/8/1982 | < | 0.20 | ug/L |
| S000-252 | Lead | Total | UNKNOWN | 6/14/1983 | < | 0.20 | ug/L |
| S000-252 | Lead | Total | UNKNOWN | 10/10/1984 | < | 0.20 | ug/L |
| S000-252 | Lead | Total | UNKNOWN | 1/14/1985 | < | 0.20 | ug/L |
| S000-252 | Lead | Total | UNKNOWN | 3/13/1985 | | 0.60 | ug/L |
| S000-252 | Lead | Total | UNKNOWN | 4/15/1985 | | 1.40 | ug/L |
| S000-252 | Lead | Total | UNKNOWN | 5/14/1985 | < | 0.20 | ug/L |
| S000-252 | Lead | Total | UNKNOWN | 6/10/1985 | < | 0.20 | ug/L |
| S000-252 | Lead | Total | UNKNOWN | 7/17/1985 | < | 0.20 | ug/L |
| S000-252 | Lead | Total | UNKNOWN | 8/13/1985 | | 0.22 | ug/L |
| S000-252 | Lead | Total | UNKNOWN | 9/11/1985 | < | 0.20 | ug/L |
| S000-252 | Lead | Total | UNKNOWN | 10/15/1985 | < | 0.20 | ug/L |
| S000-252 | Lead | Total | UNKNOWN | 2/19/1986 | < | 0.20 | ug/L |
| S000-252 | Lead | Total | UNKNOWN | 3/20/1986 | < | 0.20 | ug/L |
| S000-252 | Lead | Total | UNKNOWN | 4/17/1986 | < | 0.20 | ug/L |
| S000-252 | Lead | Total | UNKNOWN | 5/12/1986 | < | 0.20 | ug/L |
| S000-252 | Lead | Total | UNKNOWN | 6/10/1986 | < | 0.20 | ug/L |
| S000-252 | Lead | Total | UNKNOWN | 8/19/1986 | < | 0.20 | ug/L |
| S000-252 | Lead | Total | UNKNOWN | 9/24/1986 | < | 0.20 | ug/L |
| S000-252 | Lead | Total | UNKNOWN | 10/21/1986 | < | 0.20 | ug/L |
| S000-252 | Lead | Total | UNKNOWN | 1/13/1987 | < | 0.20 | ug/L |
| S000-252 | Lead | Total | UNKNOWN | 3/10/1987 | | 0.30 | ug/L |
| S000-252 | Lead | Total | UNKNOWN | 4/7/1987 | < | 0.20 | ug/L |
| S000-252 | Lead | Total | UNKNOWN | 5/12/1987 | < | 0.20 | ug/L |
| S000-252 | Lead | Total | UNKNOWN | 6/9/1987 | | 0.20 | ug/L |
| S000-252 | Lead | Total | UNKNOWN | 7/15/1987 | | 0.40 | ug/L |
| S000-252 | Lead | Total | UNKNOWN | 8/11/1987 | | 0.40 | ug/L |
| S000-252 | Lead | Total | UNKNOWN | 9/15/1987 | < | 0.20 | ug/L |
| S000-252 | Lead | Total | UNKNOWN | 10/14/1987 | < | 0.20 | ug/L |
| S000-252 | Lead | Total | UNKNOWN | 1/12/1988 | < | 0.20 | ug/L |
| S000-252 | Lead | Total | UNKNOWN | 3/15/1988 | < | 0.20 | ug/L |
| S000-252 | Lead | Total | UNKNOWN | 4/12/1988 | | 0.30 | ug/L |
| S000-252 | Lead | Total | UNKNOWN | 5/9/1988 | | 0.80 | ug/L |

# Appendix A
# Water Quality Dataset

| Station ID | Parameter | Sample Fraction Type | Lab Name Code | Sample Date | Detect Flag | Result | Result Unit |
|---|---|---|---|---|---|---|---|
| S000-252 | Lead | Total | UNKNOWN | 6/14/1988 | | 0.80 | ug/L |
| S000-252 | Lead | Total | UNKNOWN | 7/12/1988 | < | 0.20 | ug/L |
| S000-252 | Lead | Total | UNKNOWN | 8/17/1988 | < | 0.20 | ug/L |
| S000-252 | Lead | Total | UNKNOWN | 9/13/1988 | | 0.30 | ug/L |
| S000-252 | Lead | Total | UNKNOWN | 10/11/1988 | < | 0.20 | ug/L |
| S000-252 | Lead | Total | MN00006 | 3/14/1989 | < | 0.20 | ug/L |
| S000-252 | Lead | Total | MN00006 | 4/11/1989 | < | 0.20 | ug/L |
| S000-252 | Lead | Total | MN00006 | 5/9/1989 | < | 0.20 | ug/L |
| S000-252 | Lead | Total | MN00006 | 6/13/1989 | | 0.70 | ug/L |
| S000-252 | Lead | Total | MN00006 | 7/18/1989 | < | 0.20 | ug/L |
| S000-252 | Lead | Total | MN00006 | 8/16/1989 | < | 0.20 | ug/L |
| S000-252 | Lead | Total | MN00006 | 9/12/1989 | < | 0.20 | ug/L |
| S000-252 | Lead | Total | MN00006 | 10/10/1989 | < | 0.20 | ug/L |
| S000-252 | Lead | Total | MN00006 | 1/4/1990 | | 1.00 | ug/L |
| S000-252 | Lead | Total | MN00006 | 3/27/1990 | < | 0.20 | ug/L |
| S000-252 | Lead | Total | MN00006 | 5/2/1990 | < | 0.20 | ug/L |
| S000-252 | Lead | Total | MN00006 | 6/5/1990 | < | 0.20 | ug/L |
| S000-252 | Lead | Total | MN00006 | 7/17/1990 | < | 0.20 | ug/L |
| S000-252 | Lead | Total | MN00006 | 8/16/1990 | < | 0.20 | ug/L |
| S000-252 | Lead | Total | MN00006 | 9/25/1990 | < | 0.20 | ug/L |
| S000-252 | Lead | Total | MN00006 | 1/29/1991 | | 0.60 | ug/L |
| S000-252 | Lead | Total | MN00006 | 3/12/1991 | < | 0.20 | ug/L |
| S000-252 | Lead | Total | MN00006 | 4/23/1991 | < | 0.20 | ug/L |
| S000-252 | Lead | Total | MN00006 | 5/29/1991 | | 1.60 | ug/L |
| S000-252 | Lead | Total | MN00006 | 6/25/1991 | < | 2.50 | ug/L |
| S000-252 | Lead | Total | MN00006 | 7/30/1991 | < | 0.80 | ug/L |
| S000-252 | Lead | Total | MN00006 | 8/27/1991 | < | 0.90 | ug/L |
| S000-252 | Lead | Total | MN00006 | 9/18/1991 | | 0.70 | ug/L |
| S000-252 | Lead | Total | MN00006 | 10/23/1991 | < | 0.30 | ug/L |
| S000-252 | Lead | Total | MN00006 | 1/28/1992 | < | 1.70 | ug/L |
| S000-252 | Lead | Total | MN00006 | 3/24/1992 | | 0.70 | ug/L |
| S000-252 | Lead | Total | MN00006 | 4/21/1992 | | 1.40 | ug/L |
| S000-252 | Lead | Total | MN00006 | 5/6/1992 | < | 0.50 | ug/L |
| S000-252 | Lead | Total | MN00006 | 6/2/1992 | | 1.80 | ug/L |
| S000-252 | Lead | Total | MN00006 | 7/21/1992 | | 1.10 | ug/L |
| S000-252 | Lead | Total | MN00006 | 8/11/1992 | | 0.40 | ug/L |
| S000-252 | Lead | Total | MN00006 | 9/23/1992 | | 3.00 | ug/L |
| S000-252 | Lead | Total | MN00006 | 10/21/1992 | < | 0.40 | ug/L |
| S000-252 | Lead | Total | MN00006 | 1/6/1993 | < | 0.40 | ug/L |
| S000-252 | Lead | Total | MN00006 | 3/3/1993 | | 0.50 | ug/L |
| S000-252 | Lead | Total | MN00006 | 4/28/1993 | | 1.30 | ug/L |
| S000-252 | Lead | Total | MN00006 | 5/27/1993 | < | 1.00 | ug/L |
| S000-252 | Lead | Total | MN00006 | 6/23/1993 | < | 1.00 | ug/L |
| S000-252 | Lead | Total | MN00006 | 7/21/1993 | | 2.00 | ug/L |
| S000-252 | Lead | Total | MN00006 | 8/25/1993 | < | 1.00 | ug/L |
| S000-252 | Lead | Tot | WI00007 | 5/29/1996 | | 0.06 | ug/L |
| S000-252 | Lead | Dissolved | WI00007 | 6/27/1996 | | 0.04 | ug/L |
| S000-252 | Lead | Tot | WI00007 | 6/27/1996 | | 0.16 | ug/L |
| S000-252 | Lead | Tot | WI00007 | 9/4/1996 | | 0.04 | ug/L |
| S000-252 | Lead | Dissolved | WI00007 | 9/4/1996 | | 0.01 | ug/L |
| S000-252 | Lead | Dissolved | WI00007 | 9/25/1996 | | 0.03 | ug/L |
| S000-252 | Lead | Tot | WI00007 | 9/25/1996 | | 0.07 | ug/L |
| S000-252 | Lindane | Total | MN00100 | 5/29/1991 | < | 0.03 | ug/L |
| S000-252 | Lindane | Total | MN00100 | 6/25/1991 | < | 0.03 | ug/L |
| S000-252 | Lindane | Total | MN00100 | 6/25/1991 | < | 0.03 | ug/L |
| S000-252 | Lindane | Total | MN00100 | 7/30/1991 | < | 0.03 | ug/L |
| S000-252 | Linuron | Total | UNKNOWN | 6/14/1988 | < | 0.50 | ug/L |
| S000-252 | Linuron | Total | UNKNOWN | 6/14/1988 | < | 0.50 | ug/L |
| S000-252 | Linuron | Total | MN00006 | 6/13/1989 | < | 0.50 | ug/L |
| S000-252 | Magnesium as CaCO3 | Total | UNKNOWN | 9/26/1973 | < | 10.00 | mg/L |
| S000-252 | Magnesium as CaCO3 | Total | UNKNOWN | 2/26/1974 | < | 10.00 | mg/L |
| S000-252 | Magnesium as CaCO3 | Total | UNKNOWN | 4/24/1974 | | 6.00 | mg/L |
| S000-252 | Magnesium as CaCO3 | Total | UNKNOWN | 9/12/1974 | | 8.00 | mg/L |
| S000-252 | Magnesium as CaCO3 | Total | UNKNOWN | 2/26/1975 | | 10.00 | mg/L |
| S000-252 | Magnesium as CaCO3 | Total | UNKNOWN | 5/1/1975 | | 9.00 | mg/L |
| S000-252 | Magnesium as CaCO3 | Total | UNKNOWN | 7/26/1976 | | 24.00 | mg/L |
| S000-252 | Magnesium as CaCO3 | Total | UNKNOWN | 10/18/1976 | | 34.00 | mg/L |
| S000-252 | Magnesium as CaCO3 | Total | UNKNOWN | 4/25/1977 | | 17.00 | mg/L |
| S000-252 | Magnesium as CaCO3 | Total | UNKNOWN | 7/25/1977 | | 23.00 | mg/L |
| S000-252 | Magnesium as CaCO3 | Total | UNKNOWN | 10/14/1980 | | 15.00 | mg/L |
| S000-252 | Magnesium as CaCO3 | Total | UNKNOWN | 1/14/1981 | | 26.00 | mg/L |
| S000-252 | Magnesium as CaCO3 | Total | UNKNOWN | 3/11/1981 | | 22.00 | mg/L |
| S000-252 | Magnesium as CaCO3 | Total | UNKNOWN | 4/14/1981 | < | 10.00 | mg/L |

# Appendix A
# Water Quality Dataset

| Station ID | Parameter | Sample Fraction Type | Lab Name Code | Sample Date | Detect Flag | Result | Result Unit |
|---|---|---|---|---|---|---|---|
| S000-252 | Magnesium as CaCO3 | Total | UNKNOWN | 5/12/1981 | | 11.00 | mg/L |
| S000-252 | Magnesium as CaCO3 | Total | UNKNOWN | 6/16/1981 | | 10.00 | mg/L |
| S000-252 | Magnesium as CaCO3 | Total | UNKNOWN | 7/14/1981 | | 17.00 | mg/L |
| S000-252 | Magnesium as CaCO3 | Total | UNKNOWN | 8/12/1981 | | 19.00 | mg/L |
| S000-252 | Magnesium as CaCO3 | Total | UNKNOWN | 9/15/1981 | | 23.00 | mg/L |
| S000-252 | Magnesium as CaCO3 | Total | MN00006 | 6/25/1991 | | 27.00 | mg/L |
| S000-252 | Magnesium as CaCO3 | Total | MN00006 | 7/30/1991 | | 23.00 | mg/L |
| S000-252 | Magnesium as CaCO3 | Total | MN00006 | 10/23/1991 | | 21.00 | mg/L |
| S000-252 | Magnesium as CaCO3 | Total | MN00006 | 4/21/2008 | | 9.50 | mg/L |
| S000-252 | Manganese | Total | UNKNOWN | 7/24/1973 | | 27.00 | ug/L |
| S000-252 | Manganese | Total | UNKNOWN | 8/29/1973 | | 120.00 | ug/L |
| S000-252 | Manganese | Total | UNKNOWN | 9/13/1973 | < | 10.00 | ug/L |
| S000-252 | Manganese | Total | UNKNOWN | 9/26/1973 | | 13.00 | ug/L |
| S000-252 | Manganese | Total | UNKNOWN | 10/17/1973 | | 10.00 | ug/L |
| S000-252 | Manganese | Total | UNKNOWN | 11/14/1973 | | 20.00 | ug/L |
| S000-252 | Manganese | Total | UNKNOWN | 12/5/1973 | < | 10.00 | ug/L |
| S000-252 | Manganese | Total | UNKNOWN | 1/29/1974 | | 20.00 | ug/L |
| S000-252 | Manganese | Total | UNKNOWN | 2/26/1974 | < | 10.00 | ug/L |
| S000-252 | Manganese | Total | UNKNOWN | 3/12/1974 | < | 5.00 | ug/L |
| S000-252 | Manganese | Total | UNKNOWN | 4/9/1974 | | 9.00 | ug/L |
| S000-252 | Manganese | Total | UNKNOWN | 4/24/1974 | | 27.00 | ug/L |
| S000-252 | Manganese | Total | UNKNOWN | 5/8/1974 | | 13.00 | ug/L |
| S000-252 | Manganese | Total | UNKNOWN | 5/15/1974 | < | 10.00 | ug/L |
| S000-252 | Manganese | Total | UNKNOWN | 6/18/1974 | | 21.00 | ug/L |
| S000-252 | Manganese | Total | UNKNOWN | 7/10/1974 | | 19.00 | ug/L |
| S000-252 | Manganese | Total | UNKNOWN | 8/13/1974 | < | 10.00 | ug/L |
| S000-252 | Manganese | Total | UNKNOWN | 9/12/1974 | | 10.00 | ug/L |
| S000-252 | Manganese | Total | UNKNOWN | 10/9/1974 | < | 10.00 | ug/L |
| S000-252 | Manganese | Total | UNKNOWN | 11/5/1974 | < | 10.00 | ug/L |
| S000-252 | Manganese | Total | UNKNOWN | 12/11/1974 | | 24.00 | ug/L |
| S000-252 | Manganese | Total | UNKNOWN | 1/16/1975 | | 24.00 | ug/L |
| S000-252 | Manganese | Total | UNKNOWN | 2/26/1975 | | 48.00 | ug/L |
| S000-252 | Manganese | Total | UNKNOWN | 4/2/1975 | < | 10.00 | ug/L |
| S000-252 | Manganese | Total | UNKNOWN | 4/17/1975 | | 52.00 | ug/L |
| S000-252 | Manganese | Total | UNKNOWN | 5/1/1975 | | 55.00 | ug/L |
| S000-252 | Manganese | Total | UNKNOWN | 5/8/1975 | < | 10.00 | ug/L |
| S000-252 | Manganese | Total | UNKNOWN | 5/15/1975 | < | 10.00 | ug/L |
| S000-252 | Manganese | Total | UNKNOWN | 5/22/1975 | | 45.00 | ug/L |
| S000-252 | Manganese | Total | UNKNOWN | 6/18/1975 | < | 10.00 | ug/L |
| S000-252 | Manganese | Total | UNKNOWN | 7/26/1976 | | 64.00 | ug/L |
| S000-252 | Manganese | Total | UNKNOWN | 10/18/1976 | | 17.00 | ug/L |
| S000-252 | Manganese | Total | UNKNOWN | 4/25/1977 | < | 10.00 | ug/L |
| S000-252 | Manganese | Total | UNKNOWN | 7/25/1977 | | 60.00 | ug/L |
| S000-252 | Manganese | Total | MN00006 | 10/23/1991 | | 7.00 | ug/L |
| S000-252 | MBAS | Total | UNKNOWN | 12/5/1973 | < | 0.10 | mg/L |
| S000-252 | MBAS | Total | UNKNOWN | 1/29/1974 | | 10.00 | mg/L |
| S000-252 | Mercury | Total | UNKNOWN | 9/13/1973 | < | 0.10 | ug/L |
| S000-252 | Mercury | Total | UNKNOWN | 9/26/1973 | < | 0.10 | ug/L |
| S000-252 | Mercury | Total | UNKNOWN | 10/17/1973 | | 0.28 | ug/L |
| S000-252 | Mercury | Total | UNKNOWN | 2/26/1974 | | 0.17 | ug/L |
| S000-252 | Mercury | Total | UNKNOWN | 4/24/1974 | | 0.58 | ug/L |
| S000-252 | Mercury | Total | UNKNOWN | 9/12/1974 | < | 0.10 | ug/L |
| S000-252 | Mercury | Total | UNKNOWN | 2/26/1975 | < | 0.10 | ug/L |
| S000-252 | Mercury | Total | UNKNOWN | 5/1/1975 | < | 0.10 | ug/L |
| S000-252 | Mercury | Total | UNKNOWN | 7/26/1976 | | 0.19 | ug/L |
| S000-252 | Mercury | Total | UNKNOWN | 10/18/1976 | < | 0.10 | ug/L |
| S000-252 | Mercury | Total | UNKNOWN | 4/25/1977 | | 0.19 | ug/L |
| S000-252 | Mercury | Total | UNKNOWN | 7/25/1977 | < | 0.10 | ug/L |
| S000-252 | Mercury | Total | UNKNOWN | 11/8/1978 | | 0.19 | ug/L |
| S000-252 | Mercury | Total | UNKNOWN | 6/19/1979 | | 0.25 | ug/L |
| S000-252 | Mercury | Total | UNKNOWN | 10/16/1979 | | 0.27 | ug/L |
| S000-252 | Mercury | Total | UNKNOWN | 10/14/1980 | < | 0.10 | ug/L |
| S000-252 | Mercury | Total | UNKNOWN | 6/8/1982 | < | 0.10 | ug/L |
| S000-252 | Mercury | Total | UNKNOWN | 6/14/1983 | | 0.11 | ug/L |
| S000-252 | Mercury | Total | UNKNOWN | 10/15/1985 | | 0.10 | ug/L |
| S000-252 | Mercury | Tot | MNL0040 | 5/29/1996 | | 0.00 | ug/L |
| S000-252 | Mercury | Tot | MNL0040 | 6/27/1996 | | 0.00 | ug/L |
| S000-252 | Mercury | Dissolved | MNL0040 | 6/27/1996 | | 0.00 | ug/L |
| S000-252 | Mercury | Tot | MNL0040 | 8/8/1996 | | 0.01 | ug/L |
| S000-252 | Mercury | Dissolved | MNL0040 | 8/8/1996 | | 0.00 | ug/L |
| S000-252 | Mercury | Tot | MNL0040 | 9/4/1996 | | 0.00 | ug/L |
| S000-252 | Mercury | Dissolved | MNL0040 | 9/4/1996 | | 0.00 | ug/L |
| S000-252 | Mercury | Tot | MNL0040 | 9/25/1996 | | 0.00 | ug/L |

# Appendix A
# Water Quality Dataset

| Station ID | Parameter | Sample Fraction Type | Lab Name Code | Sample Date | Detect Flag | Result | Result Unit |
|---|---|---|---|---|---|---|---|
| S000-252 | Mercury | Dissolved | MNL0040 | 9/25/1996 | | 0.00 | ug/L |
| S000-252 | Mercury | Total | MN00006 | 10/26/2009 | | 8.70 | ng/L |
| S000-252 | Mercury | Total | MN00006 | 5/11/2010 | | 3.10 | ng/L |
| S000-252 | Mercury | Total | MN00006 | 5/11/2010 | | 3.28 | ng/L |
| S000-252 | Mercury | Total | MN00006 | 7/18/2010 | | 1.59 | ng/L |
| S000-252 | Methoxychlor | Total | UNKNOWN | 11/8/1978 | < | 0.50 | ug/L |
| S000-252 | Methoxychlor | Total | UNKNOWN | 10/16/1979 | < | 0.80 | ug/L |
| S000-252 | Methylmercury(1+) | Total | MN00006 | 10/26/2009 | | 0.15 | ng/L |
| S000-252 | Methylmercury(1+) | Total | MN00006 | 5/11/2010 | | 0.22 | ng/L |
| S000-252 | Methylmercury(1+) | Total | MN00006 | 5/11/2010 | | 0.20 | ng/L |
| S000-252 | Methylmercury(1+) | Total | MN00006 | 7/18/2010 | | 0.17 | ng/L |
| S000-252 | Metolachlor | Total | UNKNOWN | 6/14/1988 | < | 0.10 | ug/L |
| S000-252 | Metolachlor | Total | UNKNOWN | 6/14/1988 | < | 0.10 | ug/L |
| S000-252 | Metolachlor | Total | MN00006 | 6/13/1989 | < | 0.10 | ug/L |
| S000-252 | Metolachlor | Total | MN00100 | 5/29/1991 | < | 0.10 | ug/L |
| S000-252 | Metolachlor | Total | MN00100 | 6/25/1991 | < | 0.10 | ug/L |
| S000-252 | Metolachlor | Total | MN00100 | 6/25/1991 | < | 0.10 | ug/L |
| S000-252 | Metolachlor | Total | MN00100 | 7/30/1991 | < | 0.10 | ug/L |
| S000-252 | Metolachlor | Total | MN00100 | 5/6/1992 | < | 0.10 | ug/L |
| S000-252 | Metolachlor | Total | MN00100 | 6/2/1992 | < | 0.10 | ug/L |
| S000-252 | Metolachlor | Total | MN00100 | 7/21/1992 | < | 0.10 | ug/L |
| S000-252 | Metolachlor | Total | MN00100 | 5/27/1993 | < | 0.10 | ug/L |
| S000-252 | Metolachlor | Total | MN00100 | 6/23/1993 | < | 0.10 | ug/L |
| S000-252 | Metolachlor | Total | MN00100 | 7/21/1993 | < | 0.10 | ug/L |
| S000-252 | Metribuzin | Total | UNKNOWN | 6/14/1988 | < | 0.05 | ug/L |
| S000-252 | Metribuzin | Total | UNKNOWN | 6/14/1988 | < | 0.05 | ug/L |
| S000-252 | Metribuzin | Total | MN00006 | 6/13/1989 | < | 0.05 | ug/L |
| S000-252 | Metribuzin | Total | MN00100 | 5/29/1991 | < | 0.20 | ug/L |
| S000-252 | Metribuzin | Total | MN00100 | 6/25/1991 | < | 0.20 | ug/L |
| S000-252 | Metribuzin | Total | MN00100 | 6/25/1991 | < | 0.20 | ug/L |
| S000-252 | Metribuzin | Total | MN00100 | 7/30/1991 | < | 0.20 | ug/L |
| S000-252 | Metribuzin | Total | MN00100 | 5/6/1992 | < | 0.20 | ug/L |
| S000-252 | Metribuzin | Total | MN00100 | 6/2/1992 | < | 0.20 | ug/L |
| S000-252 | Metribuzin | Total | MN00100 | 7/21/1992 | < | 0.20 | ug/L |
| S000-252 | Metribuzin | Total | MN00100 | 5/27/1993 | < | 0.20 | ug/L |
| S000-252 | Metribuzin | Total | MN00100 | 6/23/1993 | < | 0.20 | ug/L |
| S000-252 | Metribuzin | Total | MN00100 | 7/21/1993 | < | 0.20 | ug/L |
| S000-252 | Nickel | Total | UNKNOWN | 8/29/1973 | < | 10.00 | ug/L |
| S000-252 | Nickel | Total | UNKNOWN | 9/13/1973 | < | 10.00 | ug/L |
| S000-252 | Nickel | Total | UNKNOWN | 9/26/1973 | < | 10.00 | ug/L |
| S000-252 | Nickel | Total | UNKNOWN | 12/5/1973 | < | 10.00 | ug/L |
| S000-252 | Nickel | Total | UNKNOWN | 2/26/1974 | < | 10.00 | ug/L |
| S000-252 | Nickel | Total | UNKNOWN | 4/9/1974 | < | 10.00 | ug/L |
| S000-252 | Nickel | Total | UNKNOWN | 4/24/1974 | < | 10.00 | ug/L |
| S000-252 | Nickel | Total | UNKNOWN | 5/8/1974 | < | 10.00 | ug/L |
| S000-252 | Nickel | Total | UNKNOWN | 5/15/1974 | < | 10.00 | ug/L |
| S000-252 | Nickel | Total | UNKNOWN | 6/18/1974 | < | 10.00 | ug/L |
| S000-252 | Nickel | Total | UNKNOWN | 7/10/1974 | < | 10.00 | ug/L |
| S000-252 | Nickel | Total | UNKNOWN | 8/13/1974 | | 16.00 | ug/L |
| S000-252 | Nickel | Total | UNKNOWN | 9/12/1974 | < | 10.00 | ug/L |
| S000-252 | Nickel | Total | UNKNOWN | 10/9/1974 | < | 10.00 | ug/L |
| S000-252 | Nickel | Total | UNKNOWN | 11/5/1974 | | 11.00 | ug/L |
| S000-252 | Nickel | Total | UNKNOWN | 12/11/1974 | < | 10.00 | ug/L |
| S000-252 | Nickel | Total | UNKNOWN | 1/16/1975 | < | 10.00 | ug/L |
| S000-252 | Nickel | Total | UNKNOWN | 2/26/1975 | < | 10.00 | ug/L |
| S000-252 | Nickel | Total | UNKNOWN | 4/2/1975 | < | 10.00 | ug/L |
| S000-252 | Nickel | Total | UNKNOWN | 4/17/1975 | | 10.00 | ug/L |
| S000-252 | Nickel | Total | UNKNOWN | 5/1/1975 | < | 10.00 | ug/L |
| S000-252 | Nickel | Total | UNKNOWN | 5/8/1975 | | 37.00 | ug/L |
| S000-252 | Nickel | Total | UNKNOWN | 5/15/1975 | < | 10.00 | ug/L |
| S000-252 | Nickel | Total | UNKNOWN | 5/22/1975 | < | 10.00 | ug/L |
| S000-252 | Nickel | Total | UNKNOWN | 6/18/1975 | < | 10.00 | ug/L |
| S000-252 | Nickel | Total | UNKNOWN | 7/26/1976 | < | 10.00 | ug/L |
| S000-252 | Nickel | Total | UNKNOWN | 10/18/1976 | < | 10.00 | ug/L |
| S000-252 | Nickel | Total | UNKNOWN | 4/25/1977 | < | 10.00 | ug/L |
| S000-252 | Nickel | Total | UNKNOWN | 7/25/1977 | < | 50.00 | ug/L |
| S000-252 | Nickel | Total | UNKNOWN | 11/8/1978 | < | 1.00 | ug/L |
| S000-252 | Nickel | Total | UNKNOWN | 6/19/1979 | | 1.40 | ug/L |
| S000-252 | Nickel | Total | UNKNOWN | 10/16/1979 | < | 1.00 | ug/L |
| S000-252 | Nickel | Total | UNKNOWN | 10/14/1980 | < | 1.00 | ug/L |
| S000-252 | Nickel | Total | UNKNOWN | 6/8/1982 | < | 1.00 | ug/L |
| S000-252 | Nickel | Total | UNKNOWN | 6/14/1983 | | 1.90 | ug/L |
| S000-252 | Nickel | Total | UNKNOWN | 10/15/1985 | < | 1.00 | ug/L |

# Appendix A
# Water Quality Dataset

| Station ID | Parameter | Sample Fraction Type | Lab Name Code | Sample Date | Detect Flag | Result | Result Unit |
|---|---|---|---|---|---|---|---|
| S000-252 | Nickel | Total | UNKNOWN | 10/21/1986 | < | 1.00 | ug/L |
| S000-252 | Nickel | Tot | WI00007 | 5/29/1996 | | 1.43 | ug/L |
| S000-252 | Nickel | Dissolved | WI00007 | 6/27/1996 | | 0.77 | ug/L |
| S000-252 | Nickel | Tot | WI00007 | 6/27/1996 | | 1.66 | ug/L |
| S000-252 | Nickel | Tot | WI00007 | 9/4/1996 | | 1.47 | ug/L |
| S000-252 | Nickel | Dissolved | WI00007 | 9/4/1996 | | 1.24 | ug/L |
| S000-252 | Nickel | Dissolved | WI00007 | 9/25/1996 | | 1.16 | ug/L |
| S000-252 | Nickel | Tot | WI00007 | 9/25/1996 | | 1.38 | ug/L |
| S000-252 | Nitrate as N | Total | UNKNOWN | 8/29/1973 | < | 0.10 | mg/L |
| S000-252 | Nitrate as N | Total | UNKNOWN | 9/13/1973 | | 0.17 | mg/L |
| S000-252 | Nitrate as N | Total | UNKNOWN | 9/26/1973 | | 0.13 | mg/L |
| S000-252 | Nitrate as N | Total | UNKNOWN | 10/17/1973 | | 0.17 | mg/L |
| S000-252 | Nitrate as N | Total | UNKNOWN | 11/14/1973 | | 0.12 | mg/L |
| S000-252 | Nitrate as N | Total | UNKNOWN | 12/5/1973 | | 0.20 | mg/L |
| S000-252 | Nitrate as N | Total | UNKNOWN | 1/29/1974 | | 0.22 | mg/L |
| S000-252 | Nitrate as N | Total | UNKNOWN | 2/26/1974 | | 0.32 | mg/L |
| S000-252 | Nitrate as N | Total | UNKNOWN | 3/12/1974 | | 0.58 | mg/L |
| S000-252 | Nitrate as N | Total | UNKNOWN | 4/2/1974 | | 0.41 | mg/L |
| S000-252 | Nitrate as N | Total | UNKNOWN | 4/9/1974 | | 0.31 | mg/L |
| S000-252 | Nitrate as N | Total | UNKNOWN | 4/24/1974 | | 0.19 | mg/L |
| S000-252 | Nitrate as N | Total | UNKNOWN | 5/8/1974 | < | 0.10 | mg/L |
| S000-252 | Nitrate as N | Total | UNKNOWN | 5/15/1974 | | 0.17 | mg/L |
| S000-252 | Nitrate as N | Total | UNKNOWN | 6/18/1974 | | 0.13 | mg/L |
| S000-252 | Nitrate as N | Total | UNKNOWN | 7/10/1974 | | 0.15 | mg/L |
| S000-252 | Nitrate as N | Total | UNKNOWN | 8/13/1974 | | 0.40 | mg/L |
| S000-252 | Nitrate as N | Total | UNKNOWN | 9/12/1974 | < | 0.10 | mg/L |
| S000-252 | Nitrate as N | Total | UNKNOWN | 10/9/1974 | < | 0.10 | mg/L |
| S000-252 | Nitrate as N | Total | UNKNOWN | 11/5/1974 | | 0.25 | mg/L |
| S000-252 | Nitrate as N | Total | UNKNOWN | 12/11/1974 | | 0.21 | mg/L |
| S000-252 | Nitrate as N | Total | UNKNOWN | 1/16/1975 | | 1.00 | mg/L |
| S000-252 | Nitrate as N | Total | UNKNOWN | 2/26/1975 | | 0.49 | mg/L |
| S000-252 | Nitrate as N | Total | UNKNOWN | 4/2/1975 | | 0.34 | mg/L |
| S000-252 | Nitrate as N | Total | UNKNOWN | 4/17/1975 | | 0.63 | mg/L |
| S000-252 | Nitrate as N | Total | UNKNOWN | 5/1/1975 | | 0.28 | mg/L |
| S000-252 | Nitrate as N | Total | UNKNOWN | 5/8/1975 | | 0.10 | mg/L |
| S000-252 | Nitrate as N | Total | UNKNOWN | 5/15/1975 | < | 0.10 | mg/L |
| S000-252 | Nitrate as N | Total | UNKNOWN | 5/22/1975 | < | 0.10 | mg/L |
| S000-252 | Nitrate as N | Total | UNKNOWN | 6/18/1975 | < | 0.10 | mg/L |
| S000-252 | Nitrate as N | Total | UNKNOWN | 7/26/1976 | < | 0.01 | mg/L |
| S000-252 | Nitrite as N | Total | UNKNOWN | 8/29/1973 | | 0.01 | mg/L |
| S000-252 | Nitrite as N | Total | UNKNOWN | 9/13/1973 | | 0.01 | mg/L |
| S000-252 | Nitrite as N | Total | UNKNOWN | 9/26/1973 | < | 0.01 | mg/L |
| S000-252 | Nitrite as N | Total | UNKNOWN | 10/17/1973 | | 0.01 | mg/L |
| S000-252 | Nitrite as N | Total | UNKNOWN | 11/14/1973 | | 0.01 | mg/L |
| S000-252 | Nitrite as N | Total | UNKNOWN | 12/5/1973 | | 0.01 | mg/L |
| S000-252 | Nitrite as N | Total | UNKNOWN | 1/29/1974 | | 0.01 | mg/L |
| S000-252 | Nitrite as N | Total | UNKNOWN | 2/26/1974 | < | 0.01 | mg/L |
| S000-252 | Nitrite as N | Total | UNKNOWN | 3/12/1974 | | 0.01 | mg/L |
| S000-252 | Nitrite as N | Total | UNKNOWN | 4/2/1974 | | 0.01 | mg/L |
| S000-252 | Nitrite as N | Total | UNKNOWN | 4/9/1974 | | 0.01 | mg/L |
| S000-252 | Nitrite as N | Total | UNKNOWN | 4/24/1974 | | 0.01 | mg/L |
| S000-252 | Nitrite as N | Total | UNKNOWN | 5/8/1974 | | 0.01 | mg/L |
| S000-252 | Nitrite as N | Total | UNKNOWN | 5/15/1974 | | 0.02 | mg/L |
| S000-252 | Nitrite as N | Total | UNKNOWN | 6/18/1974 | | 0.01 | mg/L |
| S000-252 | Nitrite as N | Total | UNKNOWN | 7/10/1974 | | 0.01 | mg/L |
| S000-252 | Nitrite as N | Total | UNKNOWN | 8/13/1974 | | 0.05 | mg/L |
| S000-252 | Nitrite as N | Total | UNKNOWN | 9/12/1974 | | 0.02 | mg/L |
| S000-252 | Nitrite as N | Total | UNKNOWN | 10/9/1974 | | 0.01 | mg/L |
| S000-252 | Nitrite as N | Total | UNKNOWN | 11/5/1974 | | 0.03 | mg/L |
| S000-252 | Nitrite as N | Total | UNKNOWN | 12/11/1974 | | 0.04 | mg/L |
| S000-252 | Nitrite as N | Total | UNKNOWN | 1/16/1975 | | 0.03 | mg/L |
| S000-252 | Nitrite as N | Total | UNKNOWN | 2/26/1975 | | 0.02 | mg/L |
| S000-252 | Nitrite as N | Total | UNKNOWN | 4/2/1975 | | 0.02 | mg/L |
| S000-252 | Nitrite as N | Total | UNKNOWN | 4/17/1975 | | 0.05 | mg/L |
| S000-252 | Nitrite as N | Total | UNKNOWN | 5/1/1975 | | 0.03 | mg/L |
| S000-252 | Nitrite as N | Total | UNKNOWN | 5/8/1975 | | 0.03 | mg/L |
| S000-252 | Nitrite as N | Total | UNKNOWN | 5/15/1975 | | 0.04 | mg/L |
| S000-252 | Nitrite as N | Total | UNKNOWN | 5/22/1975 | | 0.01 | mg/L |
| S000-252 | Nitrite as N | Total | UNKNOWN | 6/18/1975 | | 0.02 | mg/L |
| S000-252 | Nitrite as N | Total | UNKNOWN | 7/26/1976 | < | 0.01 | mg/L |
| S000-252 | Nutrient-nitrogen as N | Total | UNKNOWN | 8/29/1973 | | 0.90 | mg/L |
| S000-252 | Nutrient-nitrogen as N | Total | UNKNOWN | 9/13/1973 | | 1.20 | mg/L |
| S000-252 | Nutrient-nitrogen as N | Total | UNKNOWN | 9/26/1973 | | 1.19 | mg/L |

# Appendix A
# Water Quality Dataset

| Station ID | Parameter | Sample Fraction Type | Lab Name Code | Sample Date | Detect Flag | Result | Result Unit |
|---|---|---|---|---|---|---|---|
| S000-252 | Nutrient-nitrogen as N | Total | UNKNOWN | 10/17/1973 | | 1.01 | mg/L |
| S000-252 | Nutrient-nitrogen as N | Total | UNKNOWN | 11/14/1973 | | 1.62 | mg/L |
| S000-252 | Nutrient-nitrogen as N | Total | UNKNOWN | 12/5/1973 | | 0.85 | mg/L |
| S000-252 | Nutrient-nitrogen as N | Total | UNKNOWN | 1/29/1974 | | 0.77 | mg/L |
| S000-252 | Nutrient-nitrogen as N | Total | UNKNOWN | 2/26/1974 | | 1.00 | mg/L |
| S000-252 | Nutrient-nitrogen as N | Total | UNKNOWN | 3/12/1974 | | 1.13 | mg/L |
| S000-252 | Nutrient-nitrogen as N | Total | UNKNOWN | 4/2/1974 | | 0.93 | mg/L |
| S000-252 | Nutrient-nitrogen as N | Total | UNKNOWN | 4/9/1974 | | 0.78 | mg/L |
| S000-252 | Nutrient-nitrogen as N | Total | UNKNOWN | 4/24/1974 | | 0.92 | mg/L |
| S000-252 | Nutrient-nitrogen as N | Total | UNKNOWN | 5/8/1974 | | 0.68 | mg/L |
| S000-252 | Nutrient-nitrogen as N | Total | UNKNOWN | 5/15/1974 | | 0.69 | mg/L |
| S000-252 | Nutrient-nitrogen as N | Total | UNKNOWN | 6/18/1974 | | 1.26 | mg/L |
| S000-252 | Nutrient-nitrogen as N | Total | UNKNOWN | 7/10/1974 | | 1.21 | mg/L |
| S000-252 | Nutrient-nitrogen as N | Total | UNKNOWN | 8/13/1974 | | 0.90 | mg/L |
| S000-252 | Nutrient-nitrogen as N | Total | UNKNOWN | 9/12/1974 | | 0.77 | mg/L |
| S000-252 | Nutrient-nitrogen as N | Total | UNKNOWN | 10/9/1974 | | 0.54 | mg/L |
| S000-252 | Nutrient-nitrogen as N | Total | UNKNOWN | 11/5/1974 | | 0.84 | mg/L |
| S000-252 | Nutrient-nitrogen as N | Total | UNKNOWN | 12/11/1974 | | 1.63 | mg/L |
| S000-252 | Nutrient-nitrogen as N | Total | UNKNOWN | 1/16/1975 | | 1.65 | mg/L |
| S000-252 | Nutrient-nitrogen as N | Total | UNKNOWN | 2/26/1975 | | 0.93 | mg/L |
| S000-252 | Nutrient-nitrogen as N | Total | UNKNOWN | 4/2/1975 | | 1.10 | mg/L |
| S000-252 | Nutrient-nitrogen as N | Total | UNKNOWN | 4/17/1975 | | 1.38 | mg/L |
| S000-252 | Nutrient-nitrogen as N | Total | UNKNOWN | 5/1/1975 | | 0.72 | mg/L |
| S000-252 | Nutrient-nitrogen as N | Total | UNKNOWN | 5/8/1975 | | 0.79 | mg/L |
| S000-252 | Nutrient-nitrogen as N | Total | UNKNOWN | 5/15/1975 | | 0.57 | mg/L |
| S000-252 | Nutrient-nitrogen as N | Total | UNKNOWN | 5/22/1975 | | 0.81 | mg/L |
| S000-252 | Nutrient-nitrogen as N | Total | UNKNOWN | 6/18/1975 | | 1.62 | mg/L |
| S000-252 | o,p'-DDD | Total | UNKNOWN | 11/8/1978 | < | 0.05 | ug/L |
| S000-252 | o,p'-DDD | Total | UNKNOWN | 10/16/1979 | < | 0.05 | ug/L |
| S000-252 | o,p'-DDE | Total | UNKNOWN | 11/8/1978 | < | 0.05 | ug/L |
| S000-252 | o,p'-DDE | Total | UNKNOWN | 10/16/1979 | < | 0.05 | ug/L |
| S000-252 | o,p'-DDT | Total | UNKNOWN | 9/26/1973 | < | 0.01 | ug/L |
| S000-252 | o,p'-DDT | Total | UNKNOWN | 2/26/1975 | < | 0.01 | ug/L |
| S000-252 | o,p'-DDT | Total | UNKNOWN | 5/1/1975 | < | 0.01 | ug/L |
| S000-252 | o,p'-DDT | Total | UNKNOWN | 11/8/1978 | < | 0.05 | ug/L |
| S000-252 | o,p'-DDT | Total | UNKNOWN | 10/16/1979 | < | 0.10 | ug/L |
| S000-252 | Oil and Grease | Tot | UNKNOWN | 9/26/1973 | < | 0.50 | mg/L |
| S000-252 | Oil and Grease | Tot | UNKNOWN | 2/26/1974 | | 1.50 | mg/L |
| S000-252 | Oil and Grease | Tot | UNKNOWN | 4/24/1974 | | 0.70 | mg/L |
| S000-252 | Oil and Grease | Tot | UNKNOWN | 9/12/1974 | < | 0.50 | mg/L |
| S000-252 | Oil and Grease | Tot | UNKNOWN | 2/26/1975 | | 0.70 | mg/L |
| S000-252 | Oil and Grease | Tot | UNKNOWN | 5/1/1975 | < | 0.50 | mg/L |
| S000-252 | Organic carbon | Total | UNKNOWN | 9/13/1973 | | 28.20 | mg/L |
| S000-252 | Organic carbon | Total | UNKNOWN | 9/26/1973 | | 21.00 | mg/L |
| S000-252 | Organic carbon | Total | UNKNOWN | 10/17/1973 | | 26.20 | mg/L |
| S000-252 | Organic carbon | Total | UNKNOWN | 3/12/1974 | | 7.40 | mg/L |
| S000-252 | Organic carbon | Total | UNKNOWN | 4/9/1974 | | 10.50 | mg/L |
| S000-252 | Organic carbon | Total | UNKNOWN | 5/8/1974 | | 5.50 | mg/L |
| S000-252 | Organic carbon | Total | UNKNOWN | 5/15/1974 | | 12.50 | mg/L |
| S000-252 | Organic carbon | Total | UNKNOWN | 6/18/1974 | | 12.20 | mg/L |
| S000-252 | Organic carbon | Total | UNKNOWN | 2/26/1975 | | 10.00 | mg/L |
| S000-252 | Organic carbon | Total | UNKNOWN | 5/1/1975 | | 15.00 | mg/L |
| S000-252 | Organic carbon | Total | UNKNOWN | 7/26/1976 | | 16.00 | mg/L |
| S000-252 | Organic carbon | Total | UNKNOWN | 10/18/1976 | | 11.00 | mg/L |
| S000-252 | Organic carbon | Total | UNKNOWN | 4/25/1977 | | 16.00 | mg/L |
| S000-252 | Organic carbon | Total | UNKNOWN | 7/25/1977 | | 20.00 | mg/L |
| S000-252 | Organic carbon | Total | MN00006 | 11/13/2007 | | 12.00 | mg/L |
| S000-252 | Organic carbon | Total | MN00006 | 4/21/2008 | | 9.80 | mg/L |
| S000-252 | Organic carbon | Total | MN00006 | 10/26/2009 | | 18.00 | mg/L |
| S000-252 | Organic carbon | Total | MN00006 | 5/11/2010 | | 12.00 | mg/L |
| S000-252 | Organic carbon | Total | MN00006 | 7/18/2010 | | 7.50 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 8/29/1973 | | 0.82 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 9/13/1973 | | 0.81 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 9/26/1973 | | 0.84 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 10/17/1973 | | 0.83 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 11/14/1973 | | 1.20 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 12/5/1973 | | 0.56 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 1/29/1974 | | 0.43 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 2/26/1974 | | 0.62 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 3/12/1974 | | 0.54 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 4/2/1974 | | 0.37 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 4/9/1974 | | 0.46 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 4/24/1974 | | 0.72 | mg/L |

# Appendix A
# Water Quality Dataset

| Station ID | Parameter | Sample Fraction Type | Lab Name Code | Sample Date | Detect Flag | Result | Result Unit |
|---|---|---|---|---|---|---|---|
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 5/8/1974 | | 0.67 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 5/15/1974 | | 0.50 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 6/18/1974 | | 0.72 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 7/10/1974 | | 0.75 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 8/13/1974 | | 0.45 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 9/12/1974 | | 0.60 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 10/9/1974 | | 0.53 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 11/5/1974 | | 0.56 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 12/11/1974 | | 0.85 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 1/16/1975 | | 0.56 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 2/26/1975 | | 0.42 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 4/2/1975 | | 0.53 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 4/17/1975 | | 0.64 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 5/1/1975 | | 0.41 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 5/8/1975 | | 0.61 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 5/15/1975 | | 0.53 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 5/22/1975 | | 0.75 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 6/18/1975 | | 1.60 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 7/26/1976 | | 0.62 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 8/23/1976 | < | 0.30 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 9/20/1976 | < | 0.30 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 10/18/1976 | < | 0.30 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 11/16/1976 | | 0.31 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 3/22/1977 | | 2.60 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 4/25/1977 | | 0.87 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 5/23/1977 | | 0.71 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 6/27/1977 | | 1.00 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 7/25/1977 | | 0.70 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 8/22/1977 | | 0.50 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 9/26/1977 | | 1.10 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 10/24/1977 | | 0.48 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 11/14/1977 | | 0.60 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 12/19/1977 | | 0.64 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 1/23/1978 | | 0.46 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 2/21/1978 | < | 0.30 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 3/1/1978 | | 0.35 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 4/4/1978 | | 0.91 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 5/1/1978 | | 0.67 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 6/6/1978 | | 0.58 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 7/6/1978 | | 0.92 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 8/1/1978 | | 1.00 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 9/6/1978 | | 0.83 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 10/3/1978 | | 0.48 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 11/8/1978 | | 0.43 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 12/6/1978 | | 0.44 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 1/16/1979 | | 0.49 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 2/21/1979 | | 0.23 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 3/20/1979 | | 0.39 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 4/4/1979 | | 0.46 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 5/2/1979 | | 0.46 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 6/19/1979 | | 0.43 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 7/24/1979 | | 1.10 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 7/31/1979 | | 0.87 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 8/21/1979 | | 0.80 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 10/16/1979 | | 0.43 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 12/18/1979 | | 0.76 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 1/22/1980 | | 0.31 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 2/27/1980 | | 0.32 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 3/19/1980 | | 0.25 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 4/22/1980 | | 1.91 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 5/20/1980 | | 0.34 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 6/17/1980 | | 0.33 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 7/22/1980 | | 0.64 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 8/19/1980 | | 0.58 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 9/23/1980 | | 1.10 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 10/14/1980 | | 0.48 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 1/14/1981 | | 0.25 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 3/11/1981 | | 0.11 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 4/14/1981 | | 0.79 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 5/12/1981 | | 0.36 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 6/16/1981 | | 0.66 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 7/14/1981 | | 0.69 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 8/12/1981 | | 0.83 | mg/L |

# Appendix A
# Water Quality Dataset

| Station ID | Parameter | Sample Fraction Type | Lab Name Code | Sample Date | Detect Flag | Result | Result Unit |
|---|---|---|---|---|---|---|---|
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 9/15/1981 | | 0.40 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 10/12/1981 | | 0.71 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 1/12/1982 | | 0.38 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 3/16/1982 | | 0.33 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 4/13/1982 | | 0.56 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 5/11/1982 | | 0.54 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 6/8/1982 | | 0.58 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 7/13/1982 | | 0.88 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 8/10/1982 | | 0.72 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 9/8/1982 | | 0.54 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 10/12/1982 | | 0.86 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 1/12/1983 | | 0.48 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 3/9/1983 | | 0.52 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 4/12/1983 | | 0.45 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 5/10/1983 | | 0.81 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 6/14/1983 | | 0.69 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 7/12/1983 | | 1.10 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 8/9/1983 | | 0.69 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 9/13/1983 | | 0.70 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 10/27/1983 | | 0.66 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 1/10/1984 | | 0.43 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 3/13/1984 | | 0.54 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 4/17/1984 | | 0.52 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 5/15/1984 | | 0.54 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 6/12/1984 | | 0.71 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 7/17/1984 | | 0.82 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 8/14/1984 | | 0.77 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 9/18/1984 | | 0.43 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 10/10/1984 | | 0.45 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 1/14/1985 | | 0.39 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 3/13/1985 | | 0.38 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 4/15/1985 | | 0.98 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 5/14/1985 | | 0.78 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 6/10/1985 | | 0.39 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 7/17/1985 | | 0.59 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 8/13/1985 | | 0.78 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 9/11/1985 | | 0.56 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 10/15/1985 | | 0.51 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 2/19/1986 | | 0.20 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 3/20/1986 | | 0.08 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 4/17/1986 | | 0.38 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 5/12/1986 | | 0.63 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 6/10/1986 | | 0.51 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 7/15/1986 | | 0.62 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 8/19/1986 | | 0.93 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 9/24/1986 | | 0.61 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 10/21/1986 | | 0.43 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 1/13/1987 | | 0.27 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 3/10/1987 | | 0.45 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 4/7/1987 | | 0.47 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 5/12/1987 | | 0.32 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 6/9/1987 | | 0.50 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 7/15/1987 | | 0.36 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 8/11/1987 | | 0.33 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 9/15/1987 | | 0.46 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 10/14/1987 | | 0.34 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 1/12/1988 | | 0.30 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 3/15/1988 | | 0.22 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 4/12/1988 | | 0.80 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 5/9/1988 | | 0.95 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 6/14/1988 | | 0.36 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 7/12/1988 | | 0.45 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 8/17/1988 | | 0.77 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 9/13/1988 | | 0.53 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | UNKNOWN | 10/11/1988 | | 0.46 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | MN00006 | 3/14/1989 | | 0.23 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | MN00006 | 4/11/1989 | | 0.43 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | MN00006 | 5/9/1989 | | 0.43 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | MN00006 | 6/13/1989 | | 0.86 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | MN00006 | 7/18/1989 | | 0.55 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | MN00006 | 8/16/1989 | | 0.18 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | MN00006 | 9/12/1989 | | 0.37 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | MN00006 | 10/10/1989 | | 0.40 | mg/L |

# Appendix A
# Water Quality Dataset

| Station ID | Parameter | Sample Fraction Type | Lab Name Code | Sample Date | Detect Flag | Result | Result Unit |
|---|---|---|---|---|---|---|---|
| S000-252 | Organic Nitrogen as N | Total | MN00006 | 1/4/1990 | | 0.64 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | MN00006 | 3/27/1990 | | 0.44 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | MN00006 | 5/2/1990 | | 0.88 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | MN00006 | 6/5/1990 | | 0.75 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | MN00006 | 7/17/1990 | | 0.41 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | MN00006 | 8/16/1990 | | 0.38 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | MN00006 | 9/25/1990 | | 0.58 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | MN00006 | 10/9/1990 | | 0.71 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | MN00006 | 1/29/1991 | | 0.26 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | MN00006 | 3/12/1991 | | 0.62 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | MN00006 | 4/23/1991 | | 0.47 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | MN00006 | 5/29/1991 | | 0.66 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | MN00006 | 6/25/1991 | | 0.78 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | MN00006 | 7/30/1991 | | 0.42 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | MN00006 | 8/27/1991 | | 0.39 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | MN00006 | 9/18/1991 | | 0.57 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | MN00006 | 10/23/1991 | | 0.38 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | MN00006 | 1/28/1992 | | 0.39 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | MN00006 | 3/24/1992 | | 0.28 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | MN00006 | 4/21/1992 | | 0.86 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | MN00006 | 5/6/1992 | | 0.80 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | MN00006 | 6/2/1992 | | 0.55 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | MN00006 | 7/21/1992 | | 0.47 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | MN00006 | 8/11/1992 | | 0.44 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | MN00006 | 9/23/1992 | | 0.49 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | MN00006 | 10/21/1992 | | 0.41 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | MN00006 | 1/6/1993 | | 0.35 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | MN00006 | 3/3/1993 | < | 0.10 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | MN00006 | 4/28/1993 | | 0.30 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | MN00006 | 5/27/1993 | | 0.90 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | MN00006 | 6/23/1993 | | 0.34 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | MN00006 | 7/21/1993 | | 0.57 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | MN00006 | 8/25/1993 | | 0.51 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | MN00006 | 9/22/1993 | | 0.39 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | MN00006 | 10/14/1993 | | 0.38 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | MN00006 | 1/11/1994 | | 0.83 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | MN00006 | 3/15/1994 | | 0.32 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | MN00006 | 4/13/1994 | | 0.67 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | MN00006 | 5/19/1994 | | 0.37 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | MN00006 | 6/15/1994 | | 0.64 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | MN00006 | 7/20/1994 | | 0.80 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | MN00006 | 8/25/1994 | | 0.39 | mg/L |
| S000-252 | Organic Nitrogen as N | Total | MN00006 | 9/13/1994 | | 0.46 | mg/L |
| S000-252 | p,p'-DDD | Total | UNKNOWN | 11/8/1978 | < | 0.05 | ug/L |
| S000-252 | p,p'-DDD | Total | UNKNOWN | 10/16/1979 | < | 0.05 | ug/L |
| S000-252 | p,p'-DDE | Total | UNKNOWN | 2/26/1975 | < | 0.01 | ug/L |
| S000-252 | p,p'-DDE | Total | UNKNOWN | 11/8/1978 | < | 0.05 | ug/L |
| S000-252 | p,p'-DDE | Total | UNKNOWN | 10/16/1979 | < | 0.05 | ug/L |
| S000-252 | p,p'-DDT | Total | UNKNOWN | 9/26/1973 | < | 0.01 | ug/L |
| S000-252 | p,p'-DDT | Total | UNKNOWN | 2/26/1974 | < | 0.05 | ug/L |
| S000-252 | p,p'-DDT | Total | UNKNOWN | 4/24/1974 | < | 0.10 | ug/L |
| S000-252 | p,p'-DDT | Total | UNKNOWN | 2/26/1975 | < | 0.01 | ug/L |
| S000-252 | p,p'-DDT | Total | UNKNOWN | 5/1/1975 | < | 0.01 | ug/L |
| S000-252 | p,p'-DDT | Total | UNKNOWN | 11/8/1978 | < | 0.05 | ug/L |
| S000-252 | p,p'-DDT | Total | UNKNOWN | 10/16/1979 | < | 0.10 | ug/L |
| S000-252 | Parathion-methyl | Total | UNKNOWN | 6/14/1988 | < | 0.01 | ug/L |
| S000-252 | Parathion-methyl | Total | UNKNOWN | 6/14/1988 | < | 0.01 | ug/L |
| S000-252 | Parathion-methyl | Total | MN00006 | 6/13/1989 | < | 0.01 | ug/L |
| S000-252 | Parathion-methyl | Total | MN00100 | 5/6/1992 | < | 0.10 | ug/L |
| S000-252 | Parathion-methyl | Total | MN00100 | 6/2/1992 | < | 0.10 | ug/L |
| S000-252 | Parathion-methyl | Total | MN00100 | 7/21/1992 | < | 0.10 | ug/L |
| S000-252 | Parathion-methyl | Total | MN00100 | 5/27/1993 | < | 0.10 | ug/L |
| S000-252 | Parathion-methyl | Total | MN00100 | 6/23/1993 | < | 0.10 | ug/L |
| S000-252 | Parathion-methyl | Total | MN00100 | 7/21/1993 | < | 0.10 | ug/L |
| S000-252 | Pendimethalin | Total | MN00100 | 5/29/1991 | < | 0.10 | ug/L |
| S000-252 | Pendimethalin | Total | MN00100 | 6/25/1991 | < | 0.10 | ug/L |
| S000-252 | Pendimethalin | Total | MN00100 | 6/25/1991 | < | 0.10 | ug/L |
| S000-252 | Pendimethalin | Total | MN00100 | 7/30/1991 | < | 0.10 | ug/L |
| S000-252 | Pendimethalin | Total | MN00100 | 5/6/1992 | < | 0.10 | ug/L |
| S000-252 | Pendimethalin | Total | MN00100 | 6/2/1992 | < | 0.10 | ug/L |
| S000-252 | Pendimethalin | Total | MN00100 | 7/21/1992 | < | 0.10 | ug/L |
| S000-252 | Pendimethalin | Total | MN00100 | 5/27/1993 | < | 0.10 | ug/L |
| S000-252 | Pendimethalin | Total | MN00100 | 6/23/1993 | < | 0.10 | ug/L |

# Appendix A
# Water Quality Dataset

| Station ID | Parameter | Sample Fraction Type | Lab Name Code | Sample Date | Detect Flag | Result | Result Unit |
|---|---|---|---|---|---|---|---|
| S000-252 | Pendimethalin | Total | MN00100 | 7/21/1993 | < | 0.10 | ug/L |
| S000-252 | Pentachlorophenol | Total | UNKNOWN | 11/8/1978 | < | 0.10 | ug/L |
| S000-252 | Pentachlorophenol | Total | UNKNOWN | 10/16/1979 | < | 0.25 | ug/L |
| S000-252 | Pesticide mix, unspecified | Total | UNKNOWN | 11/8/1978 | < | 0.05 | ug/L |
| S000-252 | Pesticide mix, unspecified | Total | UNKNOWN | 10/16/1979 | < | 0.40 | ug/L |
| S000-252 | Petroleum phenols | Tot | UNKNOWN | 7/24/1973 | | 8.00 | ug/L |
| S000-252 | Petroleum phenols | Tot | UNKNOWN | 8/29/1973 | | 4.00 | ug/L |
| S000-252 | Petroleum phenols | Tot | UNKNOWN | 9/13/1973 | | 4.00 | ug/L |
| S000-252 | Petroleum phenols | Tot | UNKNOWN | 9/26/1973 | | 2.00 | ug/L |
| S000-252 | Petroleum phenols | Tot | UNKNOWN | 10/17/1973 | < | 2.00 | ug/L |
| S000-252 | Petroleum phenols | Tot | UNKNOWN | 11/14/1973 | | 4.00 | ug/L |
| S000-252 | Petroleum phenols | Tot | UNKNOWN | 12/5/1973 | | 5.00 | ug/L |
| S000-252 | Petroleum phenols | Tot | UNKNOWN | 1/29/1974 | < | 2.00 | ug/L |
| S000-252 | Petroleum phenols | Tot | UNKNOWN | 2/26/1974 | < | 2.00 | ug/L |
| S000-252 | Petroleum phenols | Tot | UNKNOWN | 3/12/1974 | < | 2.00 | ug/L |
| S000-252 | Petroleum phenols | Tot | UNKNOWN | 4/2/1974 | | 16.00 | ug/L |
| S000-252 | Petroleum phenols | Tot | UNKNOWN | 4/9/1974 | | 9.00 | ug/L |
| S000-252 | Petroleum phenols | Tot | UNKNOWN | 4/24/1974 | | 2.00 | ug/L |
| S000-252 | Petroleum phenols | Tot | UNKNOWN | 5/8/1974 | < | 2.00 | ug/L |
| S000-252 | Petroleum phenols | Tot | UNKNOWN | 5/15/1974 | < | 2.00 | ug/L |
| S000-252 | Petroleum phenols | Tot | UNKNOWN | 6/18/1974 | < | 2.00 | ug/L |
| S000-252 | Petroleum phenols | Tot | UNKNOWN | 7/10/1974 | | 10.00 | ug/L |
| S000-252 | Petroleum phenols | Tot | UNKNOWN | 8/13/1974 | | 9.00 | ug/L |
| S000-252 | Petroleum phenols | Tot | UNKNOWN | 9/12/1974 | | 2.00 | ug/L |
| S000-252 | Petroleum phenols | Tot | UNKNOWN | 10/9/1974 | < | 2.00 | ug/L |
| S000-252 | Petroleum phenols | Tot | UNKNOWN | 11/5/1974 | | 11.00 | ug/L |
| S000-252 | Petroleum phenols | Tot | UNKNOWN | 12/11/1974 | < | 2.00 | ug/L |
| S000-252 | Petroleum phenols | Tot | UNKNOWN | 1/16/1975 | < | 2.00 | ug/L |
| S000-252 | Petroleum phenols | Tot | UNKNOWN | 2/26/1975 | | 4.00 | ug/L |
| S000-252 | Petroleum phenols | Tot | UNKNOWN | 4/2/1975 | < | 2.00 | ug/L |
| S000-252 | Petroleum phenols | Tot | UNKNOWN | 4/17/1975 | | 6.00 | ug/L |
| S000-252 | Petroleum phenols | Tot | UNKNOWN | 5/1/1975 | | 2.00 | ug/L |
| S000-252 | Petroleum phenols | Tot | UNKNOWN | 5/8/1975 | < | 2.00 | ug/L |
| S000-252 | Petroleum phenols | Tot | UNKNOWN | 5/15/1975 | | 8.00 | ug/L |
| S000-252 | Petroleum phenols | Tot | UNKNOWN | 5/22/1975 | | 6.50 | ug/L |
| S000-252 | Petroleum phenols | Tot | UNKNOWN | 6/18/1975 | | 2.20 | ug/L |
| S000-252 | Petroleum phenols | Tot | UNKNOWN | 6/14/1988 | | 3.60 | ug/L |
| S000-252 | pH | Total | | 7/24/1973 | | 7.90 | None |
| S000-252 | pH | Total | | 8/29/1973 | | 8.00 | None |
| S000-252 | pH | Total | | 9/13/1973 | | 7.60 | None |
| S000-252 | pH | Total | | 9/26/1973 | | 7.40 | None |
| S000-252 | pH | Total | | 10/17/1973 | | 7.20 | None |
| S000-252 | pH | Total | | 11/14/1973 | | 8.00 | None |
| S000-252 | pH | Total | | 12/5/1973 | | 7.90 | None |
| S000-252 | pH | Total | | 1/29/1974 | | 7.70 | None |
| S000-252 | pH | Total | | 2/26/1974 | | 7.80 | None |
| S000-252 | pH | Total | | 3/12/1974 | | 7.70 | None |
| S000-252 | pH | Total | | 4/2/1974 | | 7.70 | None |
| S000-252 | pH | Total | | 4/9/1974 | | 7.70 | None |
| S000-252 | pH | Total | | 4/24/1974 | | 7.10 | None |
| S000-252 | pH | Total | | 5/8/1974 | | 7.70 | None |
| S000-252 | pH | Total | | 5/15/1974 | | 6.60 | None |
| S000-252 | pH | Total | | 6/18/1974 | | 7.70 | None |
| S000-252 | pH | Total | | 7/10/1974 | | 7.80 | None |
| S000-252 | pH | Total | | 8/13/1974 | | 8.00 | None |
| S000-252 | pH | Total | | 9/12/1974 | | 7.00 | None |
| S000-252 | pH | Total | | 10/9/1974 | | 7.20 | None |
| S000-252 | pH | Total | | 11/5/1974 | | 7.30 | None |
| S000-252 | pH | Total | | 12/11/1974 | | 7.30 | None |
| S000-252 | pH | Total | | 1/16/1975 | | 7.30 | None |
| S000-252 | pH | Total | | 2/26/1975 | | 7.80 | None |
| S000-252 | pH | Total | | 4/2/1975 | | 7.50 | None |
| S000-252 | pH | Total | | 4/17/1975 | | 6.90 | None |
| S000-252 | pH | Total | | 5/1/1975 | | 6.90 | None |
| S000-252 | pH | Total | | 5/8/1975 | | 7.20 | None |
| S000-252 | pH | Total | | 5/15/1975 | | 6.90 | None |
| S000-252 | pH | Total | | 5/22/1975 | | 7.10 | None |
| S000-252 | pH | Total | | 6/18/1975 | | 7.50 | None |
| S000-252 | pH | Total | | 7/26/1976 | | 7.80 | None |
| S000-252 | pH | Total | | 8/23/1976 | | 7.70 | None |
| S000-252 | pH | Total | | 9/20/1976 | | 7.70 | None |
| S000-252 | pH | Total | | 10/18/1976 | | 8.00 | None |
| S000-252 | pH | Total | | 11/16/1976 | | 7.90 | None |

# Appendix A
# Water Quality Dataset

| Station ID | Parameter | Sample Fraction Type | Lab Name Code | Sample Date | Detect Flag | Result | Result Unit |
|---|---|---|---|---|---|---|---|
| S000-252 | pH | Total | | 3/22/1977 | | 7.30 | None |
| S000-252 | pH | Total | | 4/25/1977 | | 7.50 | None |
| S000-252 | pH | Total | | 5/23/1977 | | 7.20 | None |
| S000-252 | pH | Total | | 6/27/1977 | | 7.30 | None |
| S000-252 | pH | Total | UNKNOWN | 7/25/1977 | | 7.30 | None |
| S000-252 | pH | Total | UNKNOWN | 8/22/1977 | | 7.60 | None |
| S000-252 | pH | Total | UNKNOWN | 9/26/1977 | | 7.20 | None |
| S000-252 | pH | Total | UNKNOWN | 10/24/1977 | | 7.20 | None |
| S000-252 | pH | Total | UNKNOWN | 11/14/1977 | | 7.30 | None |
| S000-252 | pH | Total | UNKNOWN | 12/19/1977 | | 6.80 | None |
| S000-252 | pH | Total | UNKNOWN | 1/23/1978 | | 7.60 | None |
| S000-252 | pH | Total | UNKNOWN | 2/21/1978 | | 7.40 | None |
| S000-252 | pH | Total | UNKNOWN | 3/1/1978 | | 7.10 | None |
| S000-252 | pH | Total | UNKNOWN | 4/4/1978 | | 7.50 | None |
| S000-252 | pH | Total | UNKNOWN | 5/1/1978 | | 7.90 | None |
| S000-252 | pH | Total | UNKNOWN | 6/6/1978 | | 7.50 | None |
| S000-252 | pH | Total | UNKNOWN | 7/6/1978 | | 7.10 | None |
| S000-252 | pH | Total | UNKNOWN | 8/1/1978 | | 6.80 | None |
| S000-252 | pH | Total | UNKNOWN | 9/6/1978 | | 7.60 | None |
| S000-252 | pH | Total | UNKNOWN | 10/3/1978 | | 8.40 | None |
| S000-252 | pH | Total | UNKNOWN | 11/8/1978 | | 8.10 | None |
| S000-252 | pH | Total | UNKNOWN | 12/6/1978 | | 7.90 | None |
| S000-252 | pH | Total | UNKNOWN | 1/16/1979 | | 6.20 | None |
| S000-252 | pH | Total | UNKNOWN | 2/21/1979 | | 7.50 | None |
| S000-252 | pH | Total | UNKNOWN | 3/20/1979 | | 7.30 | None |
| S000-252 | pH | Total | UNKNOWN | 4/4/1979 | | 7.40 | None |
| S000-252 | pH | Total | UNKNOWN | 5/2/1979 | | 7.20 | None |
| S000-252 | pH | Total | UNKNOWN | 6/19/1979 | | 7.40 | None |
| S000-252 | pH | Total | UNKNOWN | 7/24/1979 | | 7.70 | None |
| S000-252 | pH | Total | UNKNOWN | 7/31/1979 | | 7.60 | None |
| S000-252 | pH | Total | UNKNOWN | 8/21/1979 | | 7.80 | None |
| S000-252 | pH | Total | UNKNOWN | 10/16/1979 | | 7.80 | None |
| S000-252 | pH | Total | UNKNOWN | 12/18/1979 | | 7.20 | None |
| S000-252 | pH | Total | UNKNOWN | 1/22/1980 | | 7.30 | None |
| S000-252 | pH | Total | UNKNOWN | 2/27/1980 | | 7.70 | None |
| S000-252 | pH | Total | UNKNOWN | 3/19/1980 | | 7.50 | None |
| S000-252 | pH | Total | UNKNOWN | 4/22/1980 | | 7.00 | None |
| S000-252 | pH | Total | UNKNOWN | 5/20/1980 | | 7.30 | None |
| S000-252 | pH | Total | UNKNOWN | 6/17/1980 | | 7.60 | None |
| S000-252 | pH | Total | UNKNOWN | 7/22/1980 | | 7.10 | None |
| S000-252 | pH | Total | UNKNOWN | 8/19/1980 | | 7.90 | None |
| S000-252 | pH | Total | UNKNOWN | 9/23/1980 | | 6.70 | None |
| S000-252 | pH | Total | UNKNOWN | 10/14/1980 | | 7.40 | None |
| S000-252 | pH | Total | UNKNOWN | 1/14/1981 | | 7.60 | None |
| S000-252 | pH | Total | UNKNOWN | 3/11/1981 | | 7.70 | None |
| S000-252 | pH | Total | UNKNOWN | 4/14/1981 | | 7.00 | None |
| S000-252 | pH | Total | UNKNOWN | 5/12/1981 | | 7.00 | None |
| S000-252 | pH | Total | UNKNOWN | 6/16/1981 | | 7.10 | None |
| S000-252 | pH | Total | UNKNOWN | 7/14/1981 | | 7.20 | None |
| S000-252 | pH | Total | UNKNOWN | 8/12/1981 | | 7.50 | None |
| S000-252 | pH | Total | UNKNOWN | 9/15/1981 | | 7.90 | None |
| S000-252 | pH | Total | UNKNOWN | 10/12/1981 | | 7.40 | None |
| S000-252 | pH | Total | UNKNOWN | 1/12/1982 | | 7.70 | None |
| S000-252 | pH | Total | UNKNOWN | 3/16/1982 | | 7.40 | None |
| S000-252 | pH | Total | UNKNOWN | 4/13/1982 | | 7.50 | None |
| S000-252 | pH | Total | UNKNOWN | 5/11/1982 | | 7.60 | None |
| S000-252 | pH | Total | UNKNOWN | 6/8/1982 | | 7.20 | None |
| S000-252 | pH | Total | UNKNOWN | 7/13/1982 | | 7.40 | None |
| S000-252 | pH | Total | UNKNOWN | 8/10/1982 | | 8.00 | None |
| S000-252 | pH | Total | UNKNOWN | 9/8/1982 | | 7.80 | None |
| S000-252 | pH | Total | UNKNOWN | 10/12/1982 | | 7.00 | None |
| S000-252 | pH | Total | UNKNOWN | 1/12/1983 | | 7.70 | None |
| S000-252 | pH | Total | UNKNOWN | 3/9/1983 | | 7.20 | None |
| S000-252 | pH | Total | UNKNOWN | 4/12/1983 | | 7.50 | None |
| S000-252 | pH | Total | UNKNOWN | 5/10/1983 | | 7.50 | None |
| S000-252 | pH | Total | UNKNOWN | 6/14/1983 | | 7.70 | None |
| S000-252 | pH | Total | UNKNOWN | 7/12/1983 | | 7.90 | None |
| S000-252 | pH | Total | UNKNOWN | 8/9/1983 | | 7.60 | None |
| S000-252 | pH | Total | UNKNOWN | 9/13/1983 | | 8.00 | None |
| S000-252 | pH | Total | UNKNOWN | 10/27/1983 | | 7.40 | None |
| S000-252 | pH | Total | UNKNOWN | 1/10/1984 | | 7.60 | None |
| S000-252 | pH | Total | UNKNOWN | 3/13/1984 | | 7.70 | None |
| S000-252 | pH | Total | UNKNOWN | 4/17/1984 | | 7.30 | None |

| Station ID | Parameter | Sample Fraction Type | Lab Name Code | Sample Date | Detect Flag | Result | Result Unit |
|---|---|---|---|---|---|---|---|
| S000-252 | pH | Total | UNKNOWN | 5/15/1984 | | 7.50 | None |
| S000-252 | pH | Total | UNKNOWN | 6/12/1984 | | 7.30 | None |
| S000-252 | pH | Total | UNKNOWN | 7/17/1984 | | 7.90 | None |
| S000-252 | pH | Total | UNKNOWN | 8/14/1984 | | 7.70 | None |
| S000-252 | pH | Total | UNKNOWN | 9/18/1984 | | 8.00 | None |
| S000-252 | pH | Total | UNKNOWN | 10/10/1984 | | 7.80 | None |
| S000-252 | pH | Total | UNKNOWN | 1/14/1985 | | 7.90 | None |
| S000-252 | pH | Total | UNKNOWN | 3/13/1985 | | 7.70 | None |
| S000-252 | pH | Total | UNKNOWN | 4/15/1985 | | 7.10 | None |
| S000-252 | pH | Total | UNKNOWN | 5/14/1985 | | 7.20 | None |
| S000-252 | pH | Total | UNKNOWN | 6/10/1985 | | 7.90 | None |
| S000-252 | pH | Total | UNKNOWN | 7/17/1985 | | 7.70 | None |
| S000-252 | pH | Total | UNKNOWN | 8/13/1985 | | 7.90 | None |
| S000-252 | pH | Total | UNKNOWN | 9/11/1985 | | 7.90 | None |
| S000-252 | pH | Total | UNKNOWN | 10/15/1985 | | 7.60 | None |
| S000-252 | pH | Total | UNKNOWN | 2/19/1986 | | 8.10 | None |
| S000-252 | pH | Total | UNKNOWN | 3/20/1986 | | 7.70 | None |
| S000-252 | pH | Total | UNKNOWN | 4/17/1986 | | 7.10 | None |
| S000-252 | pH | Total | UNKNOWN | 5/12/1986 | | 7.30 | None |
| S000-252 | pH | Total | UNKNOWN | 6/10/1986 | | 7.90 | None |
| S000-252 | pH | Total | UNKNOWN | 7/15/1986 | | 7.40 | None |
| S000-252 | pH | Total | UNKNOWN | 8/19/1986 | | 7.60 | None |
| S000-252 | pH | Total | UNKNOWN | 9/24/1986 | | 7.50 | None |
| S000-252 | pH | Total | UNKNOWN | 10/21/1986 | | 7.80 | None |
| S000-252 | pH | Total | UNKNOWN | 1/13/1987 | | 7.90 | None |
| S000-252 | pH | Total | UNKNOWN | 3/10/1987 | | 7.40 | None |
| S000-252 | pH | Total | UNKNOWN | 4/7/1987 | | 7.70 | None |
| S000-252 | pH | Total | UNKNOWN | 5/12/1987 | | 8.30 | None |
| S000-252 | pH | Total | UNKNOWN | 6/9/1987 | | 7.80 | None |
| S000-252 | pH | Total | UNKNOWN | 7/15/1987 | | 8.10 | None |
| S000-252 | pH | Total | UNKNOWN | 8/11/1987 | | 8.10 | None |
| S000-252 | pH | Total | UNKNOWN | 9/15/1987 | | 8.00 | None |
| S000-252 | pH | Total | UNKNOWN | 10/14/1987 | | 8.00 | None |
| S000-252 | pH | Total | UNKNOWN | 1/12/1988 | | 8.10 | None |
| S000-252 | pH | Total | UNKNOWN | 3/15/1988 | | 8.30 | None |
| S000-252 | pH | Total | UNKNOWN | 4/12/1988 | | 7.50 | None |
| S000-252 | pH | Total | UNKNOWN | 5/9/1988 | | 7.50 | None |
| S000-252 | pH | Total | UNKNOWN | 6/14/1988 | | 8.30 | None |
| S000-252 | pH | Total | UNKNOWN | 7/12/1988 | | 8.40 | None |
| S000-252 | pH | Total | UNKNOWN | 8/17/1988 | | 7.90 | None |
| S000-252 | pH | Total | UNKNOWN | 9/13/1988 | | 8.20 | None |
| S000-252 | pH | Total | UNKNOWN | 10/11/1988 | | 8.00 | None |
| S000-252 | pH | Total | MN00006 | 3/14/1989 | | 8.10 | None |
| S000-252 | pH | Total | MN00006 | 4/11/1989 | | 7.50 | None |
| S000-252 | pH | Total | MN00006 | 5/9/1989 | | 7.60 | None |
| S000-252 | pH | Total | MN00006 | 6/13/1989 | | 7.30 | None |
| S000-252 | pH | Total | MN00006 | 7/18/1989 | | 8.30 | None |
| S000-252 | pH | Total | MN00006 | 8/16/1989 | | 8.80 | None |
| S000-252 | pH | Total | MN00006 | 9/12/1989 | | 8.40 | None |
| S000-252 | pH | Total | MN00006 | 10/10/1989 | | 8.00 | None |
| S000-252 | pH | Total | MN00006 | 1/4/1990 | | 7.90 | None |
| S000-252 | pH | Total | MN00006 | 3/27/1990 | | 8.00 | None |
| S000-252 | pH | Total | MN00006 | 5/2/1990 | | 7.30 | None |
| S000-252 | pH | Total | MN00006 | 6/5/1990 | | 8.10 | None |
| S000-252 | pH | Total | MN00006 | 7/17/1990 | | 8.50 | None |
| S000-252 | pH | Total | MN00006 | 8/16/1990 | | 8.50 | None |
| S000-252 | pH | Total | MN00006 | 9/25/1990 | | 8.10 | None |
| S000-252 | pH | Total | MN00006 | 10/9/1990 | | 7.80 | None |
| S000-252 | pH | Total | MN00006 | 1/29/1991 | | 8.10 | None |
| S000-252 | pH | Total | MN00006 | 3/12/1991 | | 8.20 | None |
| S000-252 | pH | Total | MN00006 | 4/23/1991 | | 7.50 | None |
| S000-252 | pH | Total | MN00006 | 5/29/1991 | | 8.10 | None |
| S000-252 | pH | Total | MN00006 | 6/25/1991 | | 8.20 | None |
| S000-252 | pH | Total | MN00006 | 7/30/1991 | | 8.30 | None |
| S000-252 | pH | Total | MN00006 | 8/27/1991 | | 8.50 | None |
| S000-252 | pH | Total | MN00006 | 9/18/1991 | | 7.80 | None |
| S000-252 | pH | Total | MN00006 | 10/23/1991 | | 8.00 | None |
| S000-252 | pH | Total | MN00006 | 1/28/1992 | | 8.10 | None |
| S000-252 | pH | Total | MN00006 | 3/24/1992 | | 8.00 | None |
| S000-252 | pH | Total | MN00006 | 4/21/1992 | | 7.10 | None |
| S000-252 | pH | Total | MN00006 | 5/6/1992 | | 7.70 | None |
| S000-252 | pH | Total | MN00006 | 6/2/1992 | | 8.30 | None |
| S000-252 | pH | Total | MN00006 | 7/21/1992 | | 8.40 | None |

# Appendix A
# Water Quality Dataset

| Station ID | Parameter | Sample Fraction Type | Lab Name Code | Sample Date | Detect Flag | Result | Result Unit |
|---|---|---|---|---|---|---|---|
| S000-252 | pH | Total | MN00006 | 8/11/1992 | | 8.40 | None |
| S000-252 | pH | Total | MN00006 | 9/23/1992 | | 8.10 | None |
| S000-252 | pH | Total | MN00006 | 10/21/1992 | | 8.00 | None |
| S000-252 | pH | Total | MN00006 | 1/6/1993 | | 8.00 | None |
| S000-252 | pH | Total | MN00006 | 3/3/1993 | | 8.00 | None |
| S000-252 | pH | Total | MN00006 | 4/28/1993 | | 7.50 | None |
| S000-252 | pH | Total | MN00006 | 5/27/1993 | | 7.70 | None |
| S000-252 | pH | Total | MN00006 | 6/23/1993 | | 8.00 | None |
| S000-252 | pH | Total | MN00006 | 7/21/1993 | | 8.20 | None |
| S000-252 | pH | Total | MN00006 | 8/25/1993 | | 8.20 | None |
| S000-252 | pH | Total | MN00006 | 9/22/1993 | | 8.20 | None |
| S000-252 | pH | Total | MN00006 | 10/14/1993 | | 8.20 | None |
| S000-252 | pH | Total | MN00006 | 1/11/1994 | | 7.70 | None |
| S000-252 | pH | Total | MN00006 | 3/15/1994 | | 8.10 | None |
| S000-252 | pH | Total | MN00006 | 4/13/1994 | | 7.50 | None |
| S000-252 | pH | Total | MN00006 | 5/19/1994 | | 7.80 | None |
| S000-252 | pH | Total | MN00006 | 6/15/1994 | | 7.80 | None |
| S000-252 | pH | Total | MN00006 | 7/20/1994 | | 7.60 | None |
| S000-252 | pH | Total | MN00006 | 8/25/1994 | | 8.20 | None |
| S000-252 | pH | Total | MN00006 | 9/13/1994 | | 8.40 | None |
| S000-252 | pH | Total | MN00006 | 10/19/1994 | | 7.90 | None |
| S000-252 | pH | Total | MN00006 | 11/7/1994 | | 8.20 | None |
| S000-252 | pH | Total | MN00006 | 1/19/1995 | | 7.00 | None |
| S000-252 | pH | Total | MN00006 | 3/16/1995 | | 7.80 | None |
| S000-252 | pH | Total | MN00006 | 4/12/1995 | | 7.50 | None |
| S000-252 | pH | Total | MN00006 | 5/18/1995 | | 7.30 | None |
| S000-252 | pH | Total | MN00006 | 6/13/1995 | | 8.40 | None |
| S000-252 | pH | Total | MN00006 | 7/26/1995 | | 8.10 | None |
| S000-252 | pH | Total | MN00006 | 8/14/1995 | | 8.60 | None |
| S000-252 | pH | Total | MN00006 | 9/12/1995 | | 8.30 | None |
| S000-252 | pH | Total | MN00006 | 10/21/1997 | | 8.00 | None |
| S000-252 | pH | Total | MN00006 | 11/3/1997 | | 8.00 | None |
| S000-252 | pH | Total | MN00006 | 1/28/1998 | | 8.10 | None |
| S000-252 | pH | Total | MN00006 | 3/17/1998 | | 8.10 | None |
| S000-252 | pH | Total | | 3/17/1998 | | 7.60 | None |
| S000-252 | pH | Total | | 4/14/1998 | | 7.50 | None |
| S000-252 | pH | Total | | 5/27/1998 | | 8.70 | None |
| S000-252 | pH | Total | | 6/16/1998 | | 8.64 | None |
| S000-252 | pH | Total | | 7/13/1998 | | 8.89 | None |
| S000-252 | pH | Total | | 8/12/1998 | | 8.85 | None |
| S000-252 | pH | Total | | 9/22/1998 | | 8.53 | None |
| S000-252 | pH | Total | | 10/10/1999 | | 7.54 | None |
| S000-252 | pH | Total | MN00006 | 10/10/1999 | | 7.80 | None |
| S000-252 | pH | Total | | 11/21/1999 | | 7.71 | None |
| S000-252 | pH | Total | MN00006 | 11/21/1999 | | 7.90 | None |
| S000-252 | pH | Total | | 1/16/2000 | | 6.78 | None |
| S000-252 | pH | Total | MN00006 | 1/16/2000 | | 7.90 | None |
| S000-252 | pH | Total | | 3/19/2000 | | 7.34 | None |
| S000-252 | pH | Total | MN00006 | 3/19/2000 | | 7.80 | None |
| S000-252 | pH | Total | | 4/16/2000 | | 7.38 | None |
| S000-252 | pH | Total | | 5/23/2000 | | 7.90 | None |
| S000-252 | pH | Total | | 6/25/2000 | | 8.61 | None |
| S000-252 | pH | Total | MN00006 | 8/14/2000 | | 8.40 | None |
| S000-252 | pH | Total | | 9/5/2000 | | 8.70 | None |
| S000-252 | pH | Total | | 10/17/2002 | | 8.40 | None |
| S000-252 | pH | Total | | 11/3/2002 | | 7.77 | None |
| S000-252 | pH | Total | | 1/28/2003 | | 8.30 | None |
| S000-252 | pH | Total | | 3/18/2003 | | 9.01 | None |
| S000-252 | pH | Total | | 4/29/2003 | | 7.46 | None |
| S000-252 | pH | Total | | 5/20/2003 | | 6.79 | None |
| S000-252 | pH | Total | | 6/24/2003 | | 7.91 | None |
| S000-252 | pH | Total | MN00006 | 6/24/2003 | | 8.10 | None |
| S000-252 | pH | Total | | 7/28/2003 | | 8.26 | None |
| S000-252 | pH | Total | MN00006 | 7/28/2003 | | 8.50 | None |
| S000-252 | pH | Total | | 8/5/2003 | | 8.10 | None |
| S000-252 | pH | Total | MN00006 | 8/5/2003 | | 8.10 | None |
| S000-252 | pH | Total | | 9/8/2003 | | 8.50 | None |
| S000-252 | pH | Total | MN00006 | 9/8/2003 | | 8.60 | None |
| S000-252 | pH | Total | | 10/13/2003 | | 8.92 | None |
| S000-252 | pH | Total | MN00006 | 10/13/2004 | | 8.10 | None |
| S000-252 | pH | Total | | 11/21/2004 | | 8.09 | None |
| S000-252 | pH | Total | | 2/1/2005 | | 7.52 | None |
| S000-252 | pH | Total | | 3/2/2005 | | 8.68 | None |

# Appendix A
# Water Quality Dataset

| Station ID | Parameter | Sample Fraction Type | Lab Name Code | Sample Date | Detect Flag | Result | Result Unit |
|---|---|---|---|---|---|---|---|
| S000-252 | pH | Total | | 4/20/2005 | | 7.84 | None |
| S000-252 | pH | Total | | 5/25/2005 | | 7.74 | None |
| S000-252 | pH | Total | | 6/1/2005 | | 8.01 | None |
| S000-252 | pH | Total | MN00006 | 6/1/2005 | | 8.00 | None |
| S000-252 | pH | Total | | 7/11/2005 | | 8.47 | None |
| S000-252 | pH | Total | MN00006 | 7/11/2005 | | 8.60 | None |
| S000-252 | pH | Total | | 8/24/2005 | | 8.58 | None |
| S000-252 | pH | Total | MN00006 | 8/24/2005 | | 8.70 | None |
| S000-252 | pH | Total | | 9/19/2005 | | 8.20 | None |
| S000-252 | pH | Total | MN00006 | 9/19/2005 | | 8.30 | None |
| S000-252 | pH | Total | | 4/3/2006 | | 7.29 | None |
| S000-252 | pH | Total | | 5/25/2006 | | 8.03 | None |
| S000-252 | pH | Total | | 6/5/2006 | | 8.05 | None |
| S000-252 | pH | Total | MN00006 | 7/24/2006 | | 8.70 | None |
| S000-252 | pH | Total | | 8/7/2006 | | 8.67 | None |
| S000-252 | pH | Total | | 10/17/2006 | | 8.28 | None |
| S000-252 | pH | Total | | 10/8/2007 | | 7.13 | None |
| S000-252 | pH | Total | | 11/13/2007 | | 8.17 | None |
| S000-252 | pH | Total | | 2/12/2008 | | 8.01 | None |
| S000-252 | pH | Total | | 3/31/2008 | | 9.00 | None |
| S000-252 | pH | Total | | 4/21/2008 | | 7.45 | None |
| S000-252 | pH | Total | | 5/13/2008 | | 7.54 | None |
| S000-252 | pH | Total | | 6/4/2008 | | 8.31 | None |
| S000-252 | pH | Total | MN00006 | 6/4/2008 | | 8.20 | None |
| S000-252 | pH | Total | | 7/21/2008 | | 8.29 | None |
| S000-252 | pH | Total | MN00006 | 7/21/2008 | | 7.30 | None |
| S000-252 | pH | Total | | 8/18/2008 | | 8.64 | None |
| S000-252 | pH | Total | MN00006 | 8/18/2008 | | 8.70 | None |
| S000-252 | pH | Total | | 9/16/2008 | | 8.05 | None |
| S000-252 | pH | Total | MN00006 | 9/16/2008 | | 8.50 | None |
| S000-252 | pH | Total | | 10/26/2009 | | 8.16 | None |
| S000-252 | pH | Total | | 11/30/2009 | | 9.08 | None |
| S000-252 | pH | Total | | 1/25/2010 | | 8.45 | None |
| S000-252 | pH | Total | MN00006 | 3/1/2010 | | 7.30 | None |
| S000-252 | pH | Total | | 4/26/2010 | | 8.60 | None |
| S000-252 | pH | Total | | 5/11/2010 | | 8.51 | None |
| S000-252 | pH | Total | | 6/7/2010 | | 8.22 | None |
| S000-252 | pH | Total | | 7/18/2010 | | 8.58 | None |
| S000-252 | pH | Total | | 8/22/2010 | | 7.82 | None |
| S000-252 | pH | Total | | 9/27/2010 | | 8.57 | None |
| S000-252 | pH | Total | | 5/2/2013 | | 7.16 | None |
| S000-252 | pH | Total | | 6/6/2013 | | 7.50 | None |
| S000-252 | pH | Total | | 9/12/2013 | | 8.19 | None |
| S000-252 | pH | Total | | 10/7/2013 | | 7.64 | None |
| S000-252 | pH | Total | | 4/24/2014 | | 7.29 | None |
| S000-252 | pH | Total | | 7/23/2014 | | 8.35 | None |
| S000-252 | pH | Total | | 10/16/2014 | | 7.78 | None |
| S000-252 | pH | Total | | 9/22/2015 | | 7.80 | None |
| S000-252 | pH | Total | | 9/24/2015 | | 7.10 | None |
| S000-252 | pH | Total | | 10/22/2015 | | 7.80 | None |
| S000-252 | Pheophytin a | Total | MN00006 | 6/24/2003 | | 1.03 | ug/L |
| S000-252 | Pheophytin a | Total | MN00006 | 7/28/2003 | | 0.56 | ug/L |
| S000-252 | Pheophytin a | Total | MN00006 | 8/5/2003 | < | 0.19 | ug/L |
| S000-252 | Pheophytin a | Total | MN00006 | 9/8/2003 | | 0.65 | ug/L |
| S000-252 | Pheophytin a | Total | MN00006 | 6/1/2005 | < | 0.30 | ug/L |
| S000-252 | Pheophytin a | Total | MN00006 | 7/11/2005 | | 0.36 | ug/L |
| S000-252 | Pheophytin a | Total | MN00006 | 8/24/2005 | | 0.52 | ug/L |
| S000-252 | Pheophytin a | Total | MN00006 | 9/19/2005 | | 0.65 | ug/L |
| S000-252 | Pheophytin a | Total | MN00006 | 6/4/2008 | | 1.40 | ug/L |
| S000-252 | Pheophytin a | Total | MN00006 | 7/21/2008 | < | 0.32 | ug/L |
| S000-252 | Pheophytin a | Total | MN00006 | 8/18/2008 | | 0.90 | ug/L |
| S000-252 | Pheophytin a | Total | MN00006 | 9/16/2008 | < | 0.69 | ug/L |
| S000-252 | Pheophytin a | Total | MN00006 | 6/7/2010 | < | 1.05 | ug/L |
| S000-252 | Pheophytin a | Total | MN00006 | 7/18/2010 | | 2.77 | ug/L |
| S000-252 | Pheophytin a | Total | MN00006 | 8/22/2010 | < | 1.11 | ug/L |
| S000-252 | Pheophytin a | Total | MN00006 | 9/27/2010 | | 0.91 | ug/L |
| S000-252 | Phorate | Total | UNKNOWN | 6/14/1988 | < | 0.05 | ug/L |
| S000-252 | Phorate | Total | UNKNOWN | 6/14/1988 | < | 0.05 | ug/L |
| S000-252 | Phorate | Total | MN00006 | 6/13/1989 | < | 0.05 | ug/L |
| S000-252 | Phorate | Total | MN00100 | 5/6/1992 | < | 0.25 | ug/L |
| S000-252 | Phorate | Total | MN00100 | 6/2/1992 | < | 0.25 | ug/L |
| S000-252 | Phorate | Total | MN00100 | 7/21/1992 | < | 0.25 | ug/L |
| S000-252 | Phorate | Total | MN00100 | 5/27/1993 | < | 0.25 | ug/L |

| Station ID | Parameter | Sample Fraction Type | Lab Name Code | Sample Date | Detect Flag | Result | Result Unit |
|---|---|---|---|---|---|---|---|
| S000-252 | Phorate | Total | MN00100 | 6/23/1993 | < | 0.25 | ug/L |
| S000-252 | Phorate | Total | MN00100 | 7/21/1993 | < | 0.25 | ug/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 7/24/1973 | | 0.03 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 8/29/1973 | | 0.06 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 9/13/1973 | | 0.16 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 9/26/1973 | | 0.03 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 10/17/1973 | | 0.19 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 11/14/1973 | | 0.04 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 12/5/1973 | | 0.03 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 1/29/1974 | | 0.06 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 2/26/1974 | | 0.03 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 3/12/1974 | | 0.04 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 4/2/1974 | | 0.04 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 4/9/1974 | | 0.04 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 4/24/1974 | | 0.04 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 5/8/1974 | < | 0.01 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 5/15/1974 | | 0.05 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 6/18/1974 | | 0.04 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 7/10/1974 | | 0.03 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 8/13/1974 | | 0.04 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 9/12/1974 | | 0.11 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 10/9/1974 | | 0.02 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 11/5/1974 | | 0.03 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 12/11/1974 | | 0.06 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 1/16/1975 | | 0.05 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 2/26/1975 | | 0.02 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 4/2/1975 | | 0.17 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 4/17/1975 | | 0.07 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 5/1/1975 | | 0.03 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 5/8/1975 | | 0.03 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 5/15/1975 | | 0.02 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 5/22/1975 | | 0.02 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 6/18/1975 | | 0.03 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 7/26/1976 | | 0.02 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 8/23/1976 | | 0.05 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 9/20/1976 | | 0.03 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 10/18/1976 | | 0.01 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 11/16/1976 | | 0.01 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 3/22/1977 | | 0.05 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 4/25/1977 | | 0.03 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 5/23/1977 | | 0.04 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 6/27/1977 | | 0.03 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 7/25/1977 | | 0.03 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 8/22/1977 | | 0.04 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 9/26/1977 | | 0.06 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 10/24/1977 | | 0.01 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 11/14/1977 | | 0.03 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 12/19/1977 | | 0.17 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 1/23/1978 | | 0.01 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 2/21/1978 | | 0.02 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 3/1/1978 | | 0.02 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 4/4/1978 | | 0.05 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 5/1/1978 | | 0.04 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 6/6/1978 | | 0.02 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 7/6/1978 | | 0.03 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 8/1/1978 | | 0.02 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 9/6/1978 | | 0.02 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 10/3/1978 | | 0.03 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 11/8/1978 | | 0.02 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 12/6/1978 | | 0.09 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 1/16/1979 | | 0.06 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 2/21/1979 | | 0.02 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 3/20/1979 | | 0.06 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 4/4/1979 | | 0.04 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 5/2/1979 | | 0.06 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 6/19/1979 | | 0.04 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 7/24/1979 | | 0.16 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 7/31/1979 | | 0.05 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 8/21/1979 | | 0.02 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 10/16/1979 | | 0.04 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 12/18/1979 | | 0.03 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 1/22/1980 | | 0.02 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 2/27/1980 | | 0.01 | mg/L |

# Appendix A
# Water Quality Dataset

| Station ID | Parameter | Sample Fraction Type | Lab Name Code | Sample Date | Detect Flag | Result | Result Unit |
|---|---|---|---|---|---|---|---|
| S000-252 | Phosphorus as P | Total | UNKNOWN | 3/19/1980 | | 0.03 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 4/22/1980 | | 0.14 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 5/20/1980 | | 0.02 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 6/17/1980 | | 0.06 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 7/22/1980 | | 0.03 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 8/19/1980 | | 0.04 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 9/23/1980 | | 1.17 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 10/14/1980 | | 0.04 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 1/14/1981 | | 0.01 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 3/11/1981 | | 0.02 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 4/14/1981 | | 0.04 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 5/12/1981 | | 0.01 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 6/16/1981 | | 0.06 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 7/14/1981 | | 0.04 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 8/12/1981 | | 0.03 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 9/15/1981 | | 0.03 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 10/12/1981 | | 0.03 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 1/12/1982 | | 0.03 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 3/16/1982 | | 0.03 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 4/13/1982 | | 0.04 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 5/11/1982 | | 0.02 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 6/8/1982 | | 0.02 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 7/13/1982 | | 0.03 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 8/10/1982 | | 0.04 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 9/8/1982 | | 0.02 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 10/12/1982 | | 0.05 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 1/12/1983 | | 0.03 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 3/9/1983 | | 0.05 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 4/12/1983 | | 0.05 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 5/10/1983 | | 0.04 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 6/14/1983 | | 0.03 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 7/12/1983 | | 0.04 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 8/9/1983 | | 0.06 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 9/13/1983 | | 0.05 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 10/27/1983 | | 0.03 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 1/10/1984 | | 0.03 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 3/13/1984 | | 0.03 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 4/17/1984 | | 0.04 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 5/15/1984 | | 0.02 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 6/12/1984 | | 0.03 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 7/17/1984 | | 0.06 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 8/14/1984 | | 0.04 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 9/18/1984 | | 0.02 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 10/10/1984 | | 0.03 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 1/14/1985 | | 0.02 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 3/13/1985 | | 0.06 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 4/15/1985 | | 0.16 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 5/14/1985 | | 0.06 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 6/10/1985 | | 0.02 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 7/17/1985 | | 0.03 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 8/13/1985 | | 0.04 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 9/11/1985 | | 0.01 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 10/15/1985 | | 0.02 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 2/19/1986 | | 0.01 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 3/20/1986 | | 0.01 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 4/17/1986 | | 0.02 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 5/12/1986 | | 0.02 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 6/10/1986 | | 0.02 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 7/15/1986 | | 0.03 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 8/19/1986 | | 0.03 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 9/24/1986 | | 0.03 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 10/21/1986 | | 0.11 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 1/13/1987 | | 0.01 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 3/10/1987 | | 0.04 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 4/7/1987 | | 0.03 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 5/12/1987 | | 0.01 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 6/9/1987 | | 0.01 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 7/15/1987 | | 0.02 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 8/11/1987 | | 0.01 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 9/15/1987 | < | 0.01 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 10/14/1987 | | 0.01 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 1/12/1988 | | 0.01 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 3/15/1988 | | 0.01 | mg/L |

# Appendix A
# Water Quality Dataset

| Station ID | Parameter | Sample Fraction Type | Lab Name Code | Sample Date | Detect Flag | Result | Result Unit |
|---|---|---|---|---|---|---|---|
| S000-252 | Phosphorus as P | Total | UNKNOWN | 4/12/1988 | | 0.05 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 5/9/1988 | | 0.09 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 6/14/1988 | | 0.01 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 7/12/1988 | | 0.02 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 8/17/1988 | | 0.04 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 9/13/1988 | | 0.02 | mg/L |
| S000-252 | Phosphorus as P | Total | UNKNOWN | 10/11/1988 | | 0.01 | mg/L |
| S000-252 | Phosphorus as P | Total | MN00006 | 3/14/1989 | | 0.02 | mg/L |
| S000-252 | Phosphorus as P | Total | MN00006 | 4/11/1989 | | 0.02 | mg/L |
| S000-252 | Phosphorus as P | Total | MN00006 | 5/9/1989 | | 0.03 | mg/L |
| S000-252 | Phosphorus as P | Total | MN00006 | 6/13/1989 | | 0.08 | mg/L |
| S000-252 | Phosphorus as P | Total | MN00006 | 7/18/1989 | | 0.02 | mg/L |
| S000-252 | Phosphorus as P | Total | MN00006 | 8/16/1989 | < | 0.01 | mg/L |
| S000-252 | Phosphorus as P | Total | MN00006 | 9/12/1989 | | 0.02 | mg/L |
| S000-252 | Phosphorus as P | Total | MN00006 | 10/10/1989 | | 0.01 | mg/L |
| S000-252 | Phosphorus as P | Total | MN00006 | 1/4/1990 | | 0.02 | mg/L |
| S000-252 | Phosphorus as P | Total | MN00006 | 3/27/1990 | | 0.01 | mg/L |
| S000-252 | Phosphorus as P | Total | MN00006 | 5/2/1990 | | 0.04 | mg/L |
| S000-252 | Phosphorus as P | Total | MN00006 | 6/5/1990 | < | 0.01 | mg/L |
| S000-252 | Phosphorus as P | Total | MN00006 | 7/17/1990 | < | 0.01 | mg/L |
| S000-252 | Phosphorus as P | Total | MN00006 | 8/16/1990 | < | 0.01 | mg/L |
| S000-252 | Phosphorus as P | Total | MN00006 | 9/25/1990 | < | 0.01 | mg/L |
| S000-252 | Phosphorus as P | Total | MN00006 | 10/9/1990 | | 0.02 | mg/L |
| S000-252 | Phosphorus as P | Total | MN00006 | 1/29/1991 | < | 0.01 | mg/L |
| S000-252 | Phosphorus as P | Total | MN00006 | 3/12/1991 | < | 0.01 | mg/L |
| S000-252 | Phosphorus as P | Total | MN00006 | 4/23/1991 | | 0.04 | mg/L |
| S000-252 | Phosphorus as P | Total | MN00006 | 5/29/1991 | | 0.04 | mg/L |
| S000-252 | Phosphorus as P | Total | MN00006 | 6/25/1991 | | 0.05 | mg/L |
| S000-252 | Phosphorus as P | Total | MN00006 | 7/30/1991 | | 0.02 | mg/L |
| S000-252 | Phosphorus as P | Total | MN00006 | 8/27/1991 | | 0.03 | mg/L |
| S000-252 | Phosphorus as P | Total | MN00006 | 9/18/1991 | | 0.07 | mg/L |
| S000-252 | Phosphorus as P | Total | MN00006 | 10/23/1991 | | 0.08 | mg/L |
| S000-252 | Phosphorus as P | Total | MN00006 | 1/28/1992 | < | 0.01 | mg/L |
| S000-252 | Phosphorus as P | Total | MN00006 | 3/24/1992 | | 0.05 | mg/L |
| S000-252 | Phosphorus as P | Total | MN00006 | 4/21/1992 | | 0.13 | mg/L |
| S000-252 | Phosphorus as P | Total | MN00006 | 5/6/1992 | | 0.09 | mg/L |
| S000-252 | Phosphorus as P | Total | MN00006 | 6/2/1992 | | 0.01 | mg/L |
| S000-252 | Phosphorus as P | Total | MN00006 | 7/21/1992 | | 0.02 | mg/L |
| S000-252 | Phosphorus as P | Total | MN00006 | 8/11/1992 | | 0.02 | mg/L |
| S000-252 | Phosphorus as P | Total | MN00006 | 9/23/1992 | | 0.02 | mg/L |
| S000-252 | Phosphorus as P | Total | MN00006 | 10/21/1992 | | 0.01 | mg/L |
| S000-252 | Phosphorus as P | Total | MN00006 | 1/6/1993 | | 0.01 | mg/L |
| S000-252 | Phosphorus as P | Total | MN00006 | 3/3/1993 | | 0.01 | mg/L |
| S000-252 | Phosphorus as P | Total | MN00006 | 4/28/1993 | | 0.02 | mg/L |
| S000-252 | Phosphorus as P | Total | MN00006 | 5/27/1993 | | 0.03 | mg/L |
| S000-252 | Phosphorus as P | Total | MN00006 | 6/23/1993 | | 0.02 | mg/L |
| S000-252 | Phosphorus as P | Total | MN00006 | 7/21/1993 | | 0.02 | mg/L |
| S000-252 | Phosphorus as P | Total | MN00006 | 8/25/1993 | | 0.03 | mg/L |
| S000-252 | Phosphorus as P | Total | MN00006 | 9/22/1993 | | 0.01 | mg/L |
| S000-252 | Phosphorus as P | Total | MN00006 | 10/14/1993 | < | 0.01 | mg/L |
| S000-252 | Phosphorus as P | Total | MN00006 | 1/11/1994 | < | 0.01 | mg/L |
| S000-252 | Phosphorus as P | Total | MN00006 | 3/15/1994 | | 0.01 | mg/L |
| S000-252 | Phosphorus as P | Total | MN00006 | 4/13/1994 | | 0.07 | mg/L |
| S000-252 | Phosphorus as P | Total | MN00006 | 5/19/1994 | | 0.01 | mg/L |
| S000-252 | Phosphorus as P | Total | MN00006 | 6/15/1994 | | 0.05 | mg/L |
| S000-252 | Phosphorus as P | Total | MN00006 | 7/20/1994 | | 0.04 | mg/L |
| S000-252 | Phosphorus as P | Total | MN00006 | 8/25/1994 | < | 0.01 | mg/L |
| S000-252 | Phosphorus as P | Total | MN00006 | 9/13/1994 | | 0.02 | mg/L |
| S000-252 | Phosphorus as P | Total | MN00006 | 10/19/1994 | | 0.04 | mg/L |
| S000-252 | Phosphorus as P | Total | MN00006 | 11/7/1994 | | 0.03 | mg/L |
| S000-252 | Phosphorus as P | Total | MN00006 | 10/17/2002 | | 0.02 | mg/L |
| S000-252 | Phosphorus as P | Total | MN00006 | 11/3/2002 | | 0.01 | mg/L |
| S000-252 | Phosphorus as P | Total | MN00006 | 1/28/2003 | | 0.02 | mg/L |
| S000-252 | Phosphorus as P | Total | MN00006 | 3/18/2003 | | 0.01 | mg/L |
| S000-252 | Phosphorus as P | Total | MN00006 | 4/29/2003 | | 0.03 | mg/L |
| S000-252 | Phosphorus as P | Total | MN00006 | 5/20/2003 | | 0.05 | mg/L |
| S000-252 | Phosphorus as P | Total | MN00006 | 6/24/2003 | | 0.02 | mg/L |
| S000-252 | Phosphorus as P | Total | MN00006 | 7/28/2003 | | 0.01 | mg/L |
| S000-252 | Phosphorus as P | Total | MN00006 | 8/5/2003 | | 0.01 | mg/L |
| S000-252 | Phosphorus as P | Total | MN00006 | 9/8/2003 | | 0.04 | mg/L |
| S000-252 | Phosphorus as P | Total | MN00006 | 10/13/2004 | | 0.01 | mg/L |
| S000-252 | Phosphorus as P | Total | MN00006 | 11/21/2004 | | 0.02 | mg/L |
| S000-252 | Phosphorus as P | Total | MN00006 | 2/1/2005 | | 0.02 | mg/L |

# Appendix A
# Water Quality Dataset

| Station ID | Parameter | Sample Fraction Type | Lab Name Code | Sample Date | Detect Flag | Result | Result Unit |
|---|---|---|---|---|---|---|---|
| S000-252 | Phosphorus as P | Total | MN00006 | 3/2/2005 | | 0.02 | mg/L |
| S000-252 | Phosphorus as P | Total | MN00006 | 4/20/2005 | | 0.03 | mg/L |
| S000-252 | Phosphorus as P | Total | MN00006 | 5/25/2005 | | 0.02 | mg/L |
| S000-252 | Phosphorus as P | Total | MN00006 | 5/25/2005 | | 0.02 | mg/L |
| S000-252 | Phosphorus as P | Total | MN00006 | 6/1/2005 | | 0.02 | mg/L |
| S000-252 | Phosphorus as P | Total | MN00006 | 7/11/2005 | | 0.02 | mg/L |
| S000-252 | Phosphorus as P | Total | MN00006 | 8/24/2005 | | 0.01 | mg/L |
| S000-252 | Phosphorus as P | Total | MN00006 | 9/19/2005 | | 0.01 | mg/L |
| S000-252 | Phosphorus as P | Total | MN00006 | 10/8/2007 | | 0.14 | mg/L |
| S000-252 | Phosphorus as P | Total | MN00006 | 11/13/2007 | | 0.01 | mg/L |
| S000-252 | Phosphorus as P | Total | MN00006 | 2/12/2008 | | 0.01 | mg/L |
| S000-252 | Phosphorus as P | Total | MN00006 | 3/31/2008 | | 0.02 | mg/L |
| S000-252 | Phosphorus as P | Total | MN00006 | 4/21/2008 | | 0.04 | mg/L |
| S000-252 | Phosphorus as P | Total | MN00006 | 5/13/2008 | | 0.01 | mg/L |
| S000-252 | Phosphorus as P | Total | MN00006 | 6/4/2008 | | 0.02 | mg/L |
| S000-252 | Phosphorus as P | Total | MN00006 | 7/21/2008 | | 0.01 | mg/L |
| S000-252 | Phosphorus as P | Total | MN00006 | 8/18/2008 | | 0.01 | mg/L |
| S000-252 | Phosphorus as P | Total | MN00006 | 9/16/2008 | | 0.01 | mg/L |
| S000-252 | Phosphorus as P | Total | MN00006 | 10/26/2009 | | 0.06 | mg/L |
| S000-252 | Phosphorus as P | Total | MN00006 | 11/30/2009 | | 0.02 | mg/L |
| S000-252 | Phosphorus as P | Total | MN00006 | 1/25/2010 | | 0.02 | mg/L |
| S000-252 | Phosphorus as P | Total | MN00006 | 3/1/2010 | | 0.02 | mg/L |
| S000-252 | Phosphorus as P | Total | MN00006 | 4/26/2010 | | 0.01 | mg/L |
| S000-252 | Phosphorus as P | Total | MN00006 | 5/11/2010 | | 0.01 | mg/L |
| S000-252 | Phosphorus as P | Total | MN00006 | 6/7/2010 | | 0.03 | mg/L |
| S000-252 | Phosphorus as P | Total | MN00006 | 7/18/2010 | | 0.01 | mg/L |
| S000-252 | Phosphorus as P | Total | MN00006 | 8/22/2010 | | 0.01 | mg/L |
| S000-252 | Phosphorus as P | Total | MN00006 | 9/27/2010 | | 0.01 | mg/L |
| S000-252 | Polychlorinated biphenyls | Total | UNKNOWN | 11/8/1978 | < | 0.10 | ug/L |
| S000-252 | Potassium | Dissolved | UNKNOWN | 7/24/1973 | < | 1.00 | mg/L |
| S000-252 | Potassium | Dissolved | UNKNOWN | 8/29/1973 | < | 1.00 | mg/L |
| S000-252 | Potassium | Dissolved | UNKNOWN | 9/13/1973 | < | 1.00 | mg/L |
| S000-252 | Potassium | Dissolved | UNKNOWN | 9/26/1973 | < | 1.00 | mg/L |
| S000-252 | Potassium | Dissolved | UNKNOWN | 11/14/1973 | | 3.00 | mg/L |
| S000-252 | Potassium | Dissolved | UNKNOWN | 1/29/1974 | | 1.00 | mg/L |
| S000-252 | Potassium | Dissolved | UNKNOWN | 2/26/1974 | < | 1.00 | mg/L |
| S000-252 | Potassium | Dissolved | UNKNOWN | 3/12/1974 | < | 1.00 | mg/L |
| S000-252 | Potassium | Dissolved | UNKNOWN | 4/2/1974 | < | 1.00 | mg/L |
| S000-252 | Potassium | Dissolved | UNKNOWN | 4/9/1974 | | 1.70 | mg/L |
| S000-252 | Potassium | Dissolved | UNKNOWN | 4/24/1974 | < | 1.00 | mg/L |
| S000-252 | Potassium | Dissolved | UNKNOWN | 5/8/1974 | | 1.10 | mg/L |
| S000-252 | Potassium | Dissolved | UNKNOWN | 5/15/1974 | < | 1.00 | mg/L |
| S000-252 | Potassium | Dissolved | UNKNOWN | 6/18/1974 | | 1.40 | mg/L |
| S000-252 | Potassium | Dissolved | UNKNOWN | 7/10/1974 | | 1.40 | mg/L |
| S000-252 | Potassium | Dissolved | UNKNOWN | 8/13/1974 | < | 1.00 | mg/L |
| S000-252 | Potassium | Dissolved | UNKNOWN | 9/12/1974 | < | 1.00 | mg/L |
| S000-252 | Potassium | Dissolved | UNKNOWN | 10/9/1974 | | 1.30 | mg/L |
| S000-252 | Potassium | Dissolved | UNKNOWN | 11/5/1974 | | 2.40 | mg/L |
| S000-252 | Potassium | Dissolved | UNKNOWN | 12/11/1974 | < | 1.00 | mg/L |
| S000-252 | Potassium | Dissolved | UNKNOWN | 1/16/1975 | | 1.00 | mg/L |
| S000-252 | Potassium | Dissolved | UNKNOWN | 2/26/1975 | < | 1.00 | mg/L |
| S000-252 | Potassium | Dissolved | UNKNOWN | 4/2/1975 | < | 1.00 | mg/L |
| S000-252 | Potassium | Dissolved | UNKNOWN | 4/17/1975 | < | 1.00 | mg/L |
| S000-252 | Potassium | Dissolved | UNKNOWN | 5/1/1975 | | 0.50 | mg/L |
| S000-252 | Potassium | Dissolved | UNKNOWN | 5/8/1975 | | 0.90 | mg/L |
| S000-252 | Potassium | Dissolved | UNKNOWN | 5/15/1975 | < | 0.50 | mg/L |
| S000-252 | Potassium | Dissolved | UNKNOWN | 5/22/1975 | | 0.80 | mg/L |
| S000-252 | Potassium | Dissolved | UNKNOWN | 6/18/1975 | | 0.50 | mg/L |
| S000-252 | Potassium | Dissolved | UNKNOWN | 7/26/1976 | | 0.96 | mg/L |
| S000-252 | Potassium | Dissolved | UNKNOWN | 10/18/1976 | | 0.90 | mg/L |
| S000-252 | Potassium | Dissolved | UNKNOWN | 4/25/1977 | | 0.50 | mg/L |
| S000-252 | Potassium | Dissolved | UNKNOWN | 7/25/1977 | | 0.60 | mg/L |
| S000-252 | Prometon | Total | MN00100 | 5/29/1991 | < | 0.20 | ug/L |
| S000-252 | Prometon | Total | MN00100 | 6/25/1991 | < | 0.20 | ug/L |
| S000-252 | Prometon | Total | MN00100 | 6/25/1991 | < | 0.20 | ug/L |
| S000-252 | Prometon | Total | MN00100 | 7/30/1991 | < | 0.20 | ug/L |
| S000-252 | Prometon | Total | MN00100 | 5/6/1992 | < | 0.20 | ug/L |
| S000-252 | Prometon | Total | MN00100 | 6/2/1992 | < | 0.20 | ug/L |
| S000-252 | Prometon | Total | MN00100 | 7/21/1992 | < | 0.20 | ug/L |
| S000-252 | Prometon | Total | MN00100 | 5/27/1993 | < | 0.20 | ug/L |
| S000-252 | Prometon | Total | MN00100 | 6/23/1993 | < | 0.20 | ug/L |
| S000-252 | Prometon | Total | MN00100 | 7/21/1993 | < | 0.20 | ug/L |
| S000-252 | Propachlor | Tot | UNKNOWN | 6/14/1988 | < | 0.01 | ug/L |

| Station ID | Parameter | Sample Fraction Type | Lab Name Code | Sample Date | Detect Flag | Result | Result Unit |
|---|---|---|---|---|---|---|---|
| S000-252 | Propachlor | Tot | UNKNOWN | 6/14/1988 | < | 0.01 | ug/L |
| S000-252 | Propachlor | Tot | MN00006 | 6/13/1989 | < | 0.01 | ug/L |
| S000-252 | Propachlor | Tot | MN00100 | 5/29/1991 | < | 0.25 | ug/L |
| S000-252 | Propachlor | Tot | MN00100 | 6/25/1991 | < | 0.25 | ug/L |
| S000-252 | Propachlor | Tot | MN00100 | 6/25/1991 | < | 0.25 | ug/L |
| S000-252 | Propachlor | Tot | MN00100 | 7/30/1991 | < | 0.25 | ug/L |
| S000-252 | Propachlor | Tot | MN00100 | 5/6/1992 | < | 0.25 | ug/L |
| S000-252 | Propachlor | Tot | MN00100 | 6/2/1992 | < | 0.25 | ug/L |
| S000-252 | Propachlor | Tot | MN00100 | 7/21/1992 | < | 0.25 | ug/L |
| S000-252 | Propachlor | Tot | MN00100 | 5/27/1993 | < | 0.25 | ug/L |
| S000-252 | Propachlor | Tot | MN00100 | 6/23/1993 | < | 0.25 | ug/L |
| S000-252 | Propachlor | Tot | MN00100 | 7/21/1993 | < | 0.25 | ug/L |
| S000-252 | Propazine | Total | MN00100 | 5/29/1991 | < | 0.25 | ug/L |
| S000-252 | Propazine | Total | MN00100 | 6/25/1991 | < | 0.25 | ug/L |
| S000-252 | Propazine | Total | MN00100 | 6/25/1991 | < | 0.25 | ug/L |
| S000-252 | Propazine | Total | MN00100 | 7/30/1991 | < | 0.25 | ug/L |
| S000-252 | Propazine | Total | MN00100 | 5/6/1992 | < | 0.25 | ug/L |
| S000-252 | Propazine | Total | MN00100 | 6/2/1992 | < | 0.25 | ug/L |
| S000-252 | Propazine | Total | MN00100 | 7/21/1992 | < | 0.25 | ug/L |
| S000-252 | Propazine | Total | MN00100 | 5/27/1993 | < | 0.25 | ug/L |
| S000-252 | Propazine | Total | MN00100 | 6/23/1993 | < | 0.25 | ug/L |
| S000-252 | Propazine | Total | MN00100 | 7/21/1993 | < | 0.25 | ug/L |
| S000-252 | Radium-226 | Total | UNKNOWN | 9/26/1973 | < | 11.00 | pCi/L |
| S000-252 | Radium-226 | Total | UNKNOWN | 2/26/1974 | < | 11.00 | pCi/L |
| S000-252 | Radium-226 | Total | UNKNOWN | 4/24/1974 | < | 11.00 | pCi/L |
| S000-252 | Radium-226 | Total | UNKNOWN | 9/12/1974 | < | 2.00 | pCi/L |
| S000-252 | Radium-226 | Total | UNKNOWN | 2/26/1975 | < | 3.00 | pCi/L |
| S000-252 | Radium-226 | Total | UNKNOWN | 5/1/1975 | < | 2.00 | pCi/L |
| S000-252 | Selenium | Total | UNKNOWN | 9/26/1973 | < | 2.00 | ug/L |
| S000-252 | Selenium | Total | UNKNOWN | 2/26/1974 | < | 2.00 | ug/L |
| S000-252 | Selenium | Total | UNKNOWN | 4/24/1974 | < | 2.00 | ug/L |
| S000-252 | Selenium | Total | UNKNOWN | 9/12/1974 | < | 2.00 | ug/L |
| S000-252 | Selenium | Total | UNKNOWN | 2/26/1975 | < | 2.00 | ug/L |
| S000-252 | Selenium | Total | UNKNOWN | 5/1/1975 | < | 2.00 | ug/L |
| S000-252 | Selenium | Total | UNKNOWN | 6/14/1988 | < | 1.00 | ug/L |
| S000-252 | Selenium | Total | MN00006 | 5/2/1990 | < | 1.00 | ug/L |
| S000-252 | Silica as SiO2 | Dissolved | UNKNOWN | 7/24/1973 | | 9.00 | mg/L |
| S000-252 | Silica as SiO2 | Dissolved | UNKNOWN | 8/29/1973 | | 11.00 | mg/L |
| S000-252 | Silica as SiO2 | Dissolved | UNKNOWN | 9/13/1973 | | 13.00 | mg/L |
| S000-252 | Silica as SiO2 | Dissolved | UNKNOWN | 9/26/1973 | | 9.60 | mg/L |
| S000-252 | Silica as SiO2 | Dissolved | UNKNOWN | 10/17/1973 | | 11.00 | mg/L |
| S000-252 | Silica as SiO2 | Dissolved | UNKNOWN | 11/14/1973 | | 11.00 | mg/L |
| S000-252 | Silica as SiO2 | Dissolved | UNKNOWN | 12/5/1973 | | 12.00 | mg/L |
| S000-252 | Silica as SiO2 | Dissolved | UNKNOWN | 1/29/1974 | | 15.00 | mg/L |
| S000-252 | Silica as SiO2 | Dissolved | UNKNOWN | 2/26/1974 | | 16.00 | mg/L |
| S000-252 | Silica as SiO2 | Dissolved | UNKNOWN | 3/12/1974 | | 16.00 | mg/L |
| S000-252 | Silica as SiO2 | Dissolved | UNKNOWN | 4/2/1974 | | 15.00 | mg/L |
| S000-252 | Silica as SiO2 | Dissolved | UNKNOWN | 4/9/1974 | | 15.00 | mg/L |
| S000-252 | Silica as SiO2 | Dissolved | UNKNOWN | 4/24/1974 | | 8.50 | mg/L |
| S000-252 | Silica as SiO2 | Dissolved | UNKNOWN | 5/8/1974 | | 3.60 | mg/L |
| S000-252 | Silica as SiO2 | Dissolved | UNKNOWN | 5/15/1974 | | 7.10 | mg/L |
| S000-252 | Silica as SiO2 | Dissolved | UNKNOWN | 6/18/1974 | | 6.00 | mg/L |
| S000-252 | Silica as SiO2 | Dissolved | UNKNOWN | 7/10/1974 | | 6.80 | mg/L |
| S000-252 | Silica as SiO2 | Dissolved | UNKNOWN | 8/13/1974 | | 6.50 | mg/L |
| S000-252 | Silica as SiO2 | Dissolved | UNKNOWN | 9/12/1974 | | 6.40 | mg/L |
| S000-252 | Silica as SiO2 | Dissolved | UNKNOWN | 10/9/1974 | | 9.10 | mg/L |
| S000-252 | Silica as SiO2 | Dissolved | UNKNOWN | 11/5/1974 | | 8.70 | mg/L |
| S000-252 | Silica as SiO2 | Dissolved | UNKNOWN | 12/11/1974 | | 11.00 | mg/L |
| S000-252 | Silica as SiO2 | Dissolved | UNKNOWN | 1/16/1975 | | 12.00 | mg/L |
| S000-252 | Silica as SiO2 | Dissolved | UNKNOWN | 2/26/1975 | | 14.00 | mg/L |
| S000-252 | Silica as SiO2 | Dissolved | UNKNOWN | 4/2/1975 | | 11.00 | mg/L |
| S000-252 | Silica as SiO2 | Dissolved | UNKNOWN | 5/1/1975 | | 7.22 | mg/L |
| S000-252 | Silica as SiO2 | Dissolved | UNKNOWN | 5/8/1975 | | 6.30 | mg/L |
| S000-252 | Silica as SiO2 | Dissolved | UNKNOWN | 5/15/1975 | | 4.10 | mg/L |
| S000-252 | Silica as SiO2 | Dissolved | UNKNOWN | 5/22/1975 | | 3.60 | mg/L |
| S000-252 | Silica as SiO2 | Dissolved | UNKNOWN | 6/18/1975 | | 4.90 | mg/L |
| S000-252 | Silicate | Total | UNKNOWN | 1/14/1985 | | 15.00 | mg/L |
| S000-252 | Silicate | Total | UNKNOWN | 3/13/1985 | | 13.00 | mg/L |
| S000-252 | Silicate | Total | UNKNOWN | 4/15/1985 | | 5.50 | mg/L |
| S000-252 | Silicate | Total | UNKNOWN | 5/14/1985 | | 6.10 | mg/L |
| S000-252 | Silicate | Total | UNKNOWN | 6/10/1985 | | 5.60 | mg/L |
| S000-252 | Silicate | Total | UNKNOWN | 7/17/1985 | | 9.00 | mg/L |
| S000-252 | Silicate | Total | UNKNOWN | 8/13/1985 | | 9.30 | mg/L |

# Appendix A
# Water Quality Dataset

| Station ID | Parameter | Sample Fraction Type | Lab Name Code | Sample Date | Detect Flag | Result | Result Unit |
|---|---|---|---|---|---|---|---|
| S000-252 | Silicate | Total | UNKNOWN | 9/11/1985 | | 8.50 | mg/L |
| S000-252 | Silicate | Total | UNKNOWN | 10/15/1985 | | 9.00 | mg/L |
| S000-252 | Silicate | Total | UNKNOWN | 2/19/1986 | | 13.00 | mg/L |
| S000-252 | Silicate | Total | UNKNOWN | 3/20/1986 | | 12.00 | mg/L |
| S000-252 | Silicate | Total | UNKNOWN | 4/17/1986 | | 8.60 | mg/L |
| S000-252 | Silicate | Total | UNKNOWN | 5/12/1986 | | 7.00 | mg/L |
| S000-252 | Silicate | Total | UNKNOWN | 6/10/1986 | | 6.70 | mg/L |
| S000-252 | Silicate | Total | UNKNOWN | 8/19/1986 | | 8.30 | mg/L |
| S000-252 | Silicate | Total | UNKNOWN | 9/24/1986 | | 9.70 | mg/L |
| S000-252 | Silicate | Total | UNKNOWN | 10/21/1986 | | 8.00 | mg/L |
| S000-252 | Silicate | Total | UNKNOWN | 1/13/1987 | | 11.00 | mg/L |
| S000-252 | Silicate | Total | UNKNOWN | 3/10/1987 | | 10.00 | mg/L |
| S000-252 | Silicate | Total | UNKNOWN | 4/7/1987 | | 8.90 | mg/L |
| S000-252 | Silicate | Total | UNKNOWN | 5/12/1987 | | 6.00 | mg/L |
| S000-252 | Silicate | Total | UNKNOWN | 6/9/1987 | | 6.10 | mg/L |
| S000-252 | Silicate | Total | UNKNOWN | 7/15/1987 | | 4.80 | mg/L |
| S000-252 | Silicate | Total | UNKNOWN | 8/11/1987 | | 4.10 | mg/L |
| S000-252 | Silicate | Total | UNKNOWN | 9/15/1987 | | 6.90 | mg/L |
| S000-252 | Silicate | Total | UNKNOWN | 10/14/1987 | | 7.80 | mg/L |
| S000-252 | Silicate | Total | UNKNOWN | 1/12/1988 | | 11.00 | mg/L |
| S000-252 | Silicate | Total | UNKNOWN | 3/15/1988 | | 11.00 | mg/L |
| S000-252 | Silicate | Total | UNKNOWN | 4/12/1988 | | 7.00 | mg/L |
| S000-252 | Silicate | Total | UNKNOWN | 5/9/1988 | | 5.80 | mg/L |
| S000-252 | Silicate | Total | UNKNOWN | 6/14/1988 | | 5.60 | mg/L |
| S000-252 | Silicate | Total | UNKNOWN | 7/12/1988 | | 10.00 | mg/L |
| S000-252 | Silicate | Total | UNKNOWN | 8/17/1988 | | 8.90 | mg/L |
| S000-252 | Silicate | Total | UNKNOWN | 9/13/1988 | | 17.00 | mg/L |
| S000-252 | Silicate | Total | UNKNOWN | 10/11/1988 | | 9.60 | mg/L |
| S000-252 | Silicate | Total | MN00006 | 3/14/1989 | | 16.00 | mg/L |
| S000-252 | Silicate | Total | MN00006 | 4/11/1989 | | 16.00 | mg/L |
| S000-252 | Silicate | Total | MN00006 | 5/9/1989 | | 10.00 | mg/L |
| S000-252 | Silicate | Total | MN00006 | 6/13/1989 | | 35.00 | mg/L |
| S000-252 | Silicate | Total | MN00006 | 7/18/1989 | | 16.00 | mg/L |
| S000-252 | Silicate | Total | MN00006 | 8/16/1989 | | 10.00 | mg/L |
| S000-252 | Silicate | Total | MN00006 | 9/12/1989 | | 13.00 | mg/L |
| S000-252 | Silicate | Total | MN00006 | 10/10/1989 | | 16.00 | mg/L |
| S000-252 | Silicate | Total | MN00006 | 1/4/1990 | | 26.00 | mg/L |
| S000-252 | Silicate | Total | MN00006 | 3/27/1990 | | 9.20 | mg/L |
| S000-252 | Silicate | Total | MN00006 | 5/2/1990 | | 8.00 | mg/L |
| S000-252 | Silicate | Total | MN00006 | 6/5/1990 | | 5.50 | mg/L |
| S000-252 | Silicate | Total | MN00006 | 7/17/1990 | | 5.40 | mg/L |
| S000-252 | Silicate | Total | MN00006 | 8/16/1990 | | 4.20 | mg/L |
| S000-252 | Silicate | Total | MN00006 | 9/25/1990 | | 7.10 | mg/L |
| S000-252 | Silicate | Total | MN00006 | 10/9/1990 | | 8.70 | mg/L |
| S000-252 | Silicate | Total | MN00006 | 1/29/1991 | | 9.40 | mg/L |
| S000-252 | Silicate | Total | MN00006 | 3/12/1991 | | 8.60 | mg/L |
| S000-252 | Silicate | Total | MN00006 | 4/23/1991 | | 6.50 | mg/L |
| S000-252 | Silicate | Total | MN00006 | 5/29/1991 | | 6.30 | mg/L |
| S000-252 | Silicate | Total | MN00006 | 6/25/1991 | | 5.70 | mg/L |
| S000-252 | Silicate | Total | MN00006 | 7/30/1991 | | 8.30 | mg/L |
| S000-252 | Silicate | Total | MN00006 | 8/27/1991 | | 6.30 | mg/L |
| S000-252 | Silicate | Total | MN00006 | 9/18/1991 | | 11.00 | mg/L |
| S000-252 | Silicate | Total | MN00006 | 10/23/1991 | | 7.60 | mg/L |
| S000-252 | Silicate | Total | MN00006 | 1/28/1992 | | 9.20 | mg/L |
| S000-252 | Silicate | Total | MN00006 | 3/24/1992 | | 10.00 | mg/L |
| S000-252 | Silicate | Total | MN00006 | 4/21/1992 | | 5.90 | mg/L |
| S000-252 | Silicate | Total | MN00006 | 5/6/1992 | | 5.30 | mg/L |
| S000-252 | Silicate | Total | MN00006 | 6/2/1992 | | 4.60 | mg/L |
| S000-252 | Silicate | Total | MN00006 | 7/21/1992 | | 7.20 | mg/L |
| S000-252 | Silicate | Total | MN00006 | 8/11/1992 | | 7.30 | mg/L |
| S000-252 | Silicate | Total | MN00006 | 9/23/1992 | | 8.80 | mg/L |
| S000-252 | Silicate | Total | MN00006 | 10/21/1992 | | 8.50 | mg/L |
| S000-252 | Silicate | Total | MN00006 | 1/6/1993 | | 8.70 | mg/L |
| S000-252 | Silicate | Total | MN00006 | 3/3/1993 | | 9.40 | mg/L |
| S000-252 | Silicate | Total | MN00006 | 4/28/1993 | | 5.90 | mg/L |
| S000-252 | Silicate | Total | MN00006 | 5/27/1993 | | 4.70 | mg/L |
| S000-252 | Silicate | Total | MN00006 | 6/23/1993 | | 5.50 | mg/L |
| S000-252 | Silicate | Total | MN00006 | 7/21/1993 | | 6.40 | mg/L |
| S000-252 | Silicate | Total | MN00006 | 8/25/1993 | | 7.20 | mg/L |
| S000-252 | Silicate | Total | MN00006 | 9/22/1993 | | 6.60 | mg/L |
| S000-252 | Silicate | Total | MN00006 | 10/14/1993 | | 6.60 | mg/L |
| S000-252 | Silicate | Total | MN00006 | 1/11/1994 | | 9.30 | mg/L |
| S000-252 | Silicate | Total | MN00006 | 3/15/1994 | | 8.90 | mg/L |

| Station ID | Parameter | Sample Fraction Type | Lab Name Code | Sample Date | Detect Flag | Result | Result Unit |
|---|---|---|---|---|---|---|---|
| S000-252 | Silicate | Total | MN00006 | 4/13/1994 | | 6.50 | mg/L |
| S000-252 | Silicate | Total | MN00006 | 5/19/1994 | | 3.10 | mg/L |
| S000-252 | Silicate | Total | MN00006 | 6/15/1994 | | 6.20 | mg/L |
| S000-252 | Silicate | Total | MN00006 | 7/20/1994 | | 7.60 | mg/L |
| S000-252 | Silicate | Total | MN00006 | 8/25/1994 | | 6.30 | mg/L |
| S000-252 | Silicate | Total | MN00006 | 9/13/1994 | | 6.50 | mg/L |
| S000-252 | Simazine | Total | UNKNOWN | 6/14/1988 | < | 0.05 | ug/L |
| S000-252 | Simazine | Total | UNKNOWN | 6/14/1988 | < | 0.05 | ug/L |
| S000-252 | Simazine | Total | MN00006 | 6/13/1989 | < | 0.05 | ug/L |
| S000-252 | Sodium | Dissolved | UNKNOWN | 7/24/1973 | | 4.00 | mg/L |
| S000-252 | Sodium | Dissolved | UNKNOWN | 8/29/1973 | | 3.00 | mg/L |
| S000-252 | Sodium | Dissolved | UNKNOWN | 9/13/1973 | | 2.00 | mg/L |
| S000-252 | Sodium | Dissolved | UNKNOWN | 9/26/1973 | | 3.00 | mg/L |
| S000-252 | Sodium | Dissolved | UNKNOWN | 11/14/1973 | | 5.00 | mg/L |
| S000-252 | Sodium | Dissolved | UNKNOWN | 12/5/1973 | | 5.30 | mg/L |
| S000-252 | Sodium | Dissolved | UNKNOWN | 1/29/1974 | | 5.00 | mg/L |
| S000-252 | Sodium | Dissolved | UNKNOWN | 2/26/1974 | | 5.10 | mg/L |
| S000-252 | Sodium | Dissolved | UNKNOWN | 3/12/1974 | | 5.30 | mg/L |
| S000-252 | Sodium | Dissolved | UNKNOWN | 4/2/1974 | | 6.50 | mg/L |
| S000-252 | Sodium | Dissolved | UNKNOWN | 4/9/1974 | | 7.90 | mg/L |
| S000-252 | Sodium | Dissolved | UNKNOWN | 4/24/1974 | | 1.50 | mg/L |
| S000-252 | Sodium | Dissolved | UNKNOWN | 5/8/1974 | | 1.30 | mg/L |
| S000-252 | Sodium | Dissolved | UNKNOWN | 5/15/1974 | | 1.70 | mg/L |
| S000-252 | Sodium | Dissolved | UNKNOWN | 6/18/1974 | | 3.10 | mg/L |
| S000-252 | Sodium | Dissolved | UNKNOWN | 7/10/1974 | | 2.20 | mg/L |
| S000-252 | Sodium | Dissolved | UNKNOWN | 8/13/1974 | | 2.20 | mg/L |
| S000-252 | Sodium | Dissolved | UNKNOWN | 9/12/1974 | | 3.70 | mg/L |
| S000-252 | Sodium | Dissolved | UNKNOWN | 10/9/1974 | | 6.10 | mg/L |
| S000-252 | Sodium | Dissolved | UNKNOWN | 11/5/1974 | | 6.60 | mg/L |
| S000-252 | Sodium | Dissolved | UNKNOWN | 12/11/1974 | | 3.60 | mg/L |
| S000-252 | Sodium | Dissolved | UNKNOWN | 1/16/1975 | | 1.30 | mg/L |
| S000-252 | Sodium | Dissolved | UNKNOWN | 2/26/1975 | | 7.40 | mg/L |
| S000-252 | Sodium | Dissolved | UNKNOWN | 4/2/1975 | | 3.40 | mg/L |
| S000-252 | Sodium | Dissolved | UNKNOWN | 4/17/1975 | | 1.60 | mg/L |
| S000-252 | Sodium | Dissolved | UNKNOWN | 5/1/1975 | | 0.90 | mg/L |
| S000-252 | Sodium | Dissolved | UNKNOWN | 5/8/1975 | | 0.80 | mg/L |
| S000-252 | Sodium | Dissolved | UNKNOWN | 5/15/1975 | | 1.20 | mg/L |
| S000-252 | Sodium | Dissolved | UNKNOWN | 5/22/1975 | | 2.00 | mg/L |
| S000-252 | Sodium | Dissolved | UNKNOWN | 6/18/1975 | | 2.30 | mg/L |
| S000-252 | Sodium | Dissolved | UNKNOWN | 7/26/1976 | | 4.80 | mg/L |
| S000-252 | Sodium | Dissolved | UNKNOWN | 10/18/1976 | | 5.80 | mg/L |
| S000-252 | Sodium | Dissolved | UNKNOWN | 4/25/1977 | | 2.60 | mg/L |
| S000-252 | Sodium | Dissolved | UNKNOWN | 7/25/1977 | | 3.50 | mg/L |
| S000-252 | Sodium | Total | UNKNOWN | 1/12/1982 | | 3.30 | mg/L |
| S000-252 | Sodium | Total | UNKNOWN | 10/10/1984 | | 2.40 | mg/L |
| S000-252 | Sodium | Total | UNKNOWN | 1/14/1985 | | 3.50 | mg/L |
| S000-252 | Sodium | Total | UNKNOWN | 3/13/1985 | | 6.00 | mg/L |
| S000-252 | Sodium | Total | UNKNOWN | 4/15/1985 | | 0.79 | mg/L |
| S000-252 | Sodium | Total | UNKNOWN | 5/14/1985 | | 1.40 | mg/L |
| S000-252 | Sodium | Total | UNKNOWN | 6/10/1985 | | 1.80 | mg/L |
| S000-252 | Sodium | Total | UNKNOWN | 7/17/1985 | | 2.20 | mg/L |
| S000-252 | Sodium | Total | UNKNOWN | 8/13/1985 | | 5.00 | mg/L |
| S000-252 | Sodium | Total | UNKNOWN | 9/11/1985 | | 14.00 | mg/L |
| S000-252 | Sodium | Total | UNKNOWN | 10/15/1985 | | 4.10 | mg/L |
| S000-252 | Sodium | Total | UNKNOWN | 2/19/1986 | | 30.00 | mg/L |
| S000-252 | Sodium | Total | UNKNOWN | 3/20/1986 | | 3.60 | mg/L |
| S000-252 | Sodium | Total | UNKNOWN | 4/17/1986 | | 1.10 | mg/L |
| S000-252 | Sodium | Total | UNKNOWN | 5/12/1986 | | 1.60 | mg/L |
| S000-252 | Sodium | Total | UNKNOWN | 6/10/1986 | | 2.90 | mg/L |
| S000-252 | Sodium | Total | UNKNOWN | 8/19/1986 | | 15.00 | mg/L |
| S000-252 | Sodium | Total | UNKNOWN | 9/24/1986 | | 6.40 | mg/L |
| S000-252 | Sodium | Total | UNKNOWN | 10/21/1986 | | 11.00 | mg/L |
| S000-252 | Sodium | Total | UNKNOWN | 1/13/1987 | | 20.00 | mg/L |
| S000-252 | Sodium | Total | UNKNOWN | 3/10/1987 | | 5.30 | mg/L |
| S000-252 | Sodium | Total | UNKNOWN | 4/7/1987 | | 6.30 | mg/L |
| S000-252 | Sodium | Total | UNKNOWN | 5/12/1987 | | 37.00 | mg/L |
| S000-252 | Sodium | Total | UNKNOWN | 6/9/1987 | | 14.00 | mg/L |
| S000-252 | Sodium | Total | UNKNOWN | 7/15/1987 | | 40.00 | mg/L |
| S000-252 | Sodium | Total | UNKNOWN | 8/11/1987 | | 56.00 | mg/L |
| S000-252 | Sodium | Total | UNKNOWN | 9/15/1987 | | 31.00 | mg/L |
| S000-252 | Sodium | Total | UNKNOWN | 10/14/1987 | | 33.00 | mg/L |
| S000-252 | Sodium | Total | UNKNOWN | 1/12/1988 | | 52.00 | mg/L |
| S000-252 | Sodium | Total | UNKNOWN | 3/15/1988 | | 41.00 | mg/L |

# Appendix A
# Water Quality Dataset

| Station ID | Parameter | Sample Fraction Type | Lab Name Code | Sample Date | Detect Flag | Result | Result Unit |
|---|---|---|---|---|---|---|---|
| S000-252 | Sodium | Total | UNKNOWN | 4/12/1988 | | 2.30 | mg/L |
| S000-252 | Sodium | Total | UNKNOWN | 5/9/1988 | | 2.70 | mg/L |
| S000-252 | Sodium | Total | UNKNOWN | 6/14/1988 | | 42.00 | mg/L |
| S000-252 | Sodium | Total | UNKNOWN | 7/12/1988 | | 51.00 | mg/L |
| S000-252 | Sodium | Total | UNKNOWN | 8/17/1988 | | 13.00 | mg/L |
| S000-252 | Sodium | Total | UNKNOWN | 9/13/1988 | | 35.00 | mg/L |
| S000-252 | Sodium | Total | UNKNOWN | 10/11/1988 | | 20.00 | mg/L |
| S000-252 | Sodium | Total | MN00006 | 3/14/1989 | | 33.00 | mg/L |
| S000-252 | Sodium | Total | MN00006 | 4/11/1989 | | 4.10 | mg/L |
| S000-252 | Sodium | Total | MN00006 | 5/9/1989 | | 3.80 | mg/L |
| S000-252 | Sodium | Total | MN00006 | 6/13/1989 | | 2.30 | mg/L |
| S000-252 | Sodium | Total | MN00006 | 7/18/1989 | | 25.00 | mg/L |
| S000-252 | Sodium | Total | MN00006 | 8/16/1989 | | 52.00 | mg/L |
| S000-252 | Sodium | Total | MN00006 | 9/12/1989 | | 35.00 | mg/L |
| S000-252 | Sodium | Total | MN00006 | 10/10/1989 | | 3.00 | mg/L |
| S000-252 | Sodium | Total | MN00006 | 1/4/1990 | | 11.00 | mg/L |
| S000-252 | Sodium | Total | MN00006 | 3/27/1990 | | 27.00 | mg/L |
| S000-252 | Sodium | Total | MN00006 | 5/2/1990 | | 2.00 | mg/L |
| S000-252 | Sodium | Total | MN00006 | 6/5/1990 | | 12.90 | mg/L |
| S000-252 | Sodium | Total | MN00006 | 7/17/1990 | | 31.00 | mg/L |
| S000-252 | Sodium | Total | MN00006 | 8/16/1990 | | 61.00 | mg/L |
| S000-252 | Sodium | Total | MN00006 | 9/25/1990 | | 24.00 | mg/L |
| S000-252 | Sodium | Total | MN00006 | 10/9/1990 | | 14.00 | mg/L |
| S000-252 | Sodium | Total | MN00006 | 1/29/1991 | | 45.00 | mg/L |
| S000-252 | Sodium | Total | MN00006 | 3/12/1991 | | 53.00 | mg/L |
| S000-252 | Sodium | Total | MN00006 | 4/23/1991 | | 1.80 | mg/L |
| S000-252 | Sodium | Total | MN00006 | 5/29/1991 | | 2.40 | mg/L |
| S000-252 | Sodium | Total | MN00006 | 6/25/1991 | | 3.50 | mg/L |
| S000-252 | Sodium | Total | MN00006 | 7/30/1991 | | 15.00 | mg/L |
| S000-252 | Sodium | Total | MN00006 | 8/27/1991 | | 50.00 | mg/L |
| S000-252 | Sodium | Total | MN00006 | 9/18/1991 | | 6.80 | mg/L |
| S000-252 | Sodium | Total | MN00006 | 10/23/1991 | | 15.00 | mg/L |
| S000-252 | Sodium | Total | MN00006 | 1/28/1992 | | 23.00 | mg/L |
| S000-252 | Sodium | Total | MN00006 | 3/24/1992 | | 18.80 | mg/L |
| S000-252 | Sodium | Total | MN00006 | 4/21/1992 | | 1.80 | mg/L |
| S000-252 | Sodium | Total | MN00006 | 5/6/1992 | | 4.70 | mg/L |
| S000-252 | Sodium | Total | MN00006 | 6/2/1992 | | 19.60 | mg/L |
| S000-252 | Sodium | Total | MN00006 | 7/21/1992 | | 20.00 | mg/L |
| S000-252 | Sodium | Total | MN00006 | 8/11/1992 | | 19.00 | mg/L |
| S000-252 | Sodium | Total | MN00006 | 9/23/1992 | | 20.00 | mg/L |
| S000-252 | Sodium | Total | MN00006 | 10/21/1992 | | 16.00 | mg/L |
| S000-252 | Sodium | Total | MN00006 | 1/6/1993 | | 34.00 | mg/L |
| S000-252 | Sodium | Total | MN00006 | 3/3/1993 | | 32.00 | mg/L |
| S000-252 | Sodium | Total | MN00006 | 4/28/1993 | | 4.10 | mg/L |
| S000-252 | Sodium | Total | MN00006 | 5/27/1993 | | 5.80 | mg/L |
| S000-252 | Sodium | Total | MN00006 | 6/23/1993 | | 11.00 | mg/L |
| S000-252 | Sodium | Total | MN00006 | 7/21/1993 | | 16.00 | mg/L |
| S000-252 | Sodium | Total | MN00006 | 8/25/1993 | | 17.00 | mg/L |
| S000-252 | Specific conductance | Total | UNKNOWN | 7/24/1973 | | 89.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 8/29/1973 | | 79.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 9/13/1973 | | 87.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 9/26/1973 | | 91.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 10/17/1973 | | 63.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 11/14/1973 | | 81.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 12/5/1973 | | 75.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 1/29/1974 | | 110.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 2/26/1974 | | 130.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 3/12/1974 | | 110.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 4/2/1974 | | 110.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 4/9/1974 | | 110.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 4/24/1974 | | 39.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 5/8/1974 | | 46.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 5/15/1974 | | 41.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 6/18/1974 | | 60.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 7/10/1974 | | 110.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 8/13/1974 | | 110.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 9/12/1974 | | 120.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 10/9/1974 | | 130.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 11/5/1974 | | 86.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 12/11/1974 | | 130.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 1/16/1975 | | 100.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 2/26/1975 | | 120.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 4/2/1975 | | 110.00 | uS/cm |

# Appendix A
# Water Quality Dataset

| Station ID | Parameter | Sample Fraction Type | Lab Name Code | Sample Date | Detect Flag | Result | Result Unit |
|---|---|---|---|---|---|---|---|
| S000-252 | Specific conductance | Total | UNKNOWN | 4/17/1975 | | 68.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 5/1/1975 | | 47.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 5/8/1975 | | 38.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 5/15/1975 | | 48.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 5/22/1975 | | 64.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 6/18/1975 | | 68.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 7/26/1976 | | 160.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 8/23/1976 | | 190.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 9/20/1976 | | 210.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 10/18/1976 | | 190.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 11/16/1976 | | 240.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 3/22/1977 | | 160.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 4/25/1977 | | 120.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 5/23/1977 | | 130.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 6/27/1977 | | 110.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 7/25/1977 | | 140.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 8/22/1977 | | 160.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 9/26/1977 | | 57.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 10/24/1977 | | 66.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 11/14/1977 | | 72.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 12/19/1977 | | 80.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 1/23/1978 | | 110.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 2/21/1978 | | 130.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 3/1/1978 | | 130.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 4/4/1978 | | 93.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 5/1/1978 | | 110.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 6/6/1978 | | 80.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 7/6/1978 | | 180.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 8/1/1978 | | 95.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 9/6/1978 | | 640.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 10/3/1978 | | 160.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 11/8/1978 | | 130.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 12/6/1978 | | 100.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 1/16/1979 | | 240.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 2/21/1979 | | 160.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 3/20/1979 | | 110.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 4/4/1979 | | 85.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 5/2/1979 | | 50.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 6/19/1979 | | 80.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 7/24/1979 | | 130.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 7/31/1979 | | 120.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 8/21/1979 | | 140.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 10/16/1979 | | 140.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 12/18/1979 | | 160.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 1/22/1980 | | 68.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 2/27/1980 | | 160.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 3/19/1980 | | 540.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 4/22/1980 | | 62.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 5/20/1980 | | 100.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 6/17/1980 | | 110.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 7/22/1980 | | 190.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 8/19/1980 | | 175.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 9/23/1980 | | 70.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 10/14/1980 | | 50.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 1/14/1981 | | 170.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 3/11/1981 | | 150.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 4/14/1981 | | 54.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 5/12/1981 | | 65.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 6/16/1981 | | 74.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 7/14/1981 | | 110.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 8/12/1981 | | 110.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 9/15/1981 | | 160.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 10/12/1981 | | 86.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 1/12/1982 | | 140.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 3/16/1982 | | 150.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 4/13/1982 | | 270.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 5/11/1982 | | 56.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 6/8/1982 | | 94.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 7/13/1982 | | 70.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 8/10/1982 | | 120.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 9/8/1982 | | 120.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 10/12/1982 | | 54.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 1/12/1983 | | 130.00 | uS/cm |

# Appendix A
# Water Quality Dataset

| Station ID | Parameter | Sample Fraction Type | Lab Name Code | Sample Date | Detect Flag | Result | Result Unit |
|---|---|---|---|---|---|---|---|
| S000-252 | Specific conductance | Total | UNKNOWN | 3/9/1983 | | 80.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 4/12/1983 | | 92.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 5/10/1983 | | 54.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 6/14/1983 | | 83.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 7/12/1983 | | 92.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 8/9/1983 | | 150.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 9/13/1983 | | 110.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 10/27/1983 | | 78.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 1/10/1984 | | 100.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 3/13/1984 | | 130.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 4/17/1984 | | 51.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 5/15/1984 | | 63.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 6/12/1984 | | 58.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 7/17/1984 | | 123.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 8/14/1984 | | 110.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 9/18/1984 | | 160.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 10/10/1984 | | 130.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 1/14/1985 | | 160.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 3/13/1985 | | 170.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 4/15/1985 | | 56.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 5/14/1985 | | 56.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 6/10/1985 | | 78.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 7/17/1985 | | 110.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 8/13/1985 | | 140.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 9/11/1985 | | 160.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 10/15/1985 | | 80.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 2/19/1986 | | 270.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 3/20/1986 | | 130.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 4/17/1986 | | 45.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 5/12/1986 | | 63.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 6/10/1986 | | 120.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 7/15/1986 | | 65.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 8/19/1986 | | 160.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 9/24/1986 | | 100.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 10/21/1986 | | 140.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 1/13/1987 | | 210.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 3/10/1987 | | 120.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 4/7/1987 | | 100.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 5/12/1987 | | 290.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 6/9/1987 | | 160.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 7/15/1987 | | 300.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 8/11/1987 | | 390.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 9/15/1987 | | 270.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 10/14/1987 | | 300.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 1/12/1988 | | 420.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 3/15/1988 | | 250.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 4/12/1988 | | 60.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 5/9/1988 | | 78.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 6/14/1988 | | 380.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 7/12/1988 | | 420.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 8/17/1988 | | 170.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 9/13/1988 | | 310.00 | uS/cm |
| S000-252 | Specific conductance | Total | UNKNOWN | 10/11/1988 | | 200.00 | uS/cm |
| S000-252 | Specific conductance | Total | MN00006 | 3/14/1989 | | 300.00 | uS/cm |
| S000-252 | Specific conductance | Total | MN00006 | 4/11/1989 | | 84.00 | uS/cm |
| S000-252 | Specific conductance | Total | MN00006 | 5/9/1989 | | 68.00 | uS/cm |
| S000-252 | Specific conductance | Total | MN00006 | 6/13/1989 | | 66.00 | uS/cm |
| S000-252 | Specific conductance | Total | MN00006 | 7/18/1989 | | 250.00 | uS/cm |
| S000-252 | Specific conductance | Total | MN00006 | 8/16/1989 | | 400.00 | uS/cm |
| S000-252 | Specific conductance | Total | MN00006 | 9/12/1989 | | 300.00 | uS/cm |
| S000-252 | Specific conductance | Total | MN00006 | 10/10/1989 | | 120.00 | uS/cm |
| S000-252 | Specific conductance | Total | MN00006 | 1/4/1990 | | 340.00 | uS/cm |
| S000-252 | Specific conductance | Total | MN00006 | 3/27/1990 | | 240.00 | uS/cm |
| S000-252 | Specific conductance | Total | MN00006 | 5/2/1990 | | 52.00 | uS/cm |
| S000-252 | Specific conductance | Total | MN00006 | 6/5/1990 | | 160.00 | uS/cm |
| S000-252 | Specific conductance | Total | MN00006 | 7/17/1990 | | 250.00 | uS/cm |
| S000-252 | Specific conductance | Total | MN00006 | 8/16/1990 | | 430.00 | uS/cm |
| S000-252 | Specific conductance | Total | MN00006 | 9/25/1990 | | 220.00 | uS/cm |
| S000-252 | Specific conductance | Total | MN00006 | 10/9/1990 | | 140.00 | uS/cm |
| S000-252 | Specific conductance | Total | MN00006 | 1/29/1991 | | 350.00 | uS/cm |
| S000-252 | Specific conductance | Total | MN00006 | 3/12/1991 | | 400.00 | uS/cm |
| S000-252 | Specific conductance | Total | MN00006 | 4/23/1991 | | 60.00 | uS/cm |
| S000-252 | Specific conductance | Total | MN00006 | 5/29/1991 | | 85.00 | uS/cm |

# Appendix A
# Water Quality Dataset

| Station ID | Parameter | Sample Fraction Type | Lab Name Code | Sample Date | Detect Flag | Result | Result Unit |
|---|---|---|---|---|---|---|---|
| S000-252 | Specific conductance | Total | MN00006 | 6/25/1991 | | 150.00 | uS/cm |
| S000-252 | Specific conductance | Total | MN00006 | 7/30/1991 | | 180.00 | uS/cm |
| S000-252 | Specific conductance | Total | MN00006 | 8/27/1991 | | 380.00 | uS/cm |
| S000-252 | Specific conductance | Total | MN00006 | 9/18/1991 | | 120.00 | uS/cm |
| S000-252 | Specific conductance | Total | MN00006 | 10/23/1991 | | 170.00 | uS/cm |
| S000-252 | Specific conductance | Total | MN00006 | 1/28/1992 | | 230.00 | uS/cm |
| S000-252 | Specific conductance | Total | MN00006 | 3/24/1992 | | 200.00 | uS/cm |
| S000-252 | Specific conductance | Total | MN00006 | 4/21/1992 | | 39.00 | uS/cm |
| S000-252 | Specific conductance | Total | MN00006 | 5/6/1992 | | 72.00 | uS/cm |
| S000-252 | Specific conductance | Total | MN00006 | 6/2/1992 | | 180.00 | uS/cm |
| S000-252 | Specific conductance | Total | MN00006 | 7/21/1992 | | 210.00 | uS/cm |
| S000-252 | Specific conductance | Total | MN00006 | 8/11/1992 | | 190.00 | uS/cm |
| S000-252 | Specific conductance | Total | MN00006 | 9/23/1992 | | 190.00 | uS/cm |
| S000-252 | Specific conductance | Total | MN00006 | 10/21/1992 | | 170.00 | uS/cm |
| S000-252 | Specific conductance | Total | MN00006 | 1/6/1993 | | 280.00 | uS/cm |
| S000-252 | Specific conductance | Total | MN00006 | 3/3/1993 | | 270.00 | uS/cm |
| S000-252 | Specific conductance | Total | MN00006 | 4/28/1993 | | 61.00 | uS/cm |
| S000-252 | Specific conductance | Total | MN00006 | 5/27/1993 | | 88.00 | uS/cm |
| S000-252 | Specific conductance | Total | MN00006 | 6/23/1993 | | 130.00 | uS/cm |
| S000-252 | Specific conductance | Total | MN00006 | 7/21/1993 | | 170.00 | uS/cm |
| S000-252 | Specific conductance | Total | MN00006 | 8/25/1993 | | 200.00 | uS/cm |
| S000-252 | Specific conductance | Total | MN00006 | 9/22/1993 | | 270.00 | uS/cm |
| S000-252 | Specific conductance | Total | MN00006 | 10/14/1993 | | 280.00 | uS/cm |
| S000-252 | Specific conductance | Total | MN00006 | 1/11/1994 | | 260.00 | uS/cm |
| S000-252 | Specific conductance | Total | MN00006 | 3/15/1994 | | 280.00 | uS/cm |
| S000-252 | Specific conductance | Total | MN00006 | 4/13/1994 | | 68.00 | uS/cm |
| S000-252 | Specific conductance | Total | MN00006 | 5/19/1994 | | 120.00 | uS/cm |
| S000-252 | Specific conductance | Total | MN00006 | 6/15/1994 | | 120.00 | uS/cm |
| S000-252 | Specific conductance | Total | MN00006 | 7/20/1994 | | 100.00 | uS/cm |
| S000-252 | Specific conductance | Total | MN00006 | 8/25/1994 | | 400.00 | uS/cm |
| S000-252 | Specific conductance | Total | MN00006 | 9/13/1994 | | 340.00 | uS/cm |
| S000-252 | Specific conductance | Total | MN00006 | 10/19/1994 | | 99.00 | uS/cm |
| S000-252 | Specific conductance | Total | MN00006 | 11/7/1994 | | 97.00 | uS/cm |
| S000-252 | Specific conductance | Total | MN00006 | 1/19/1995 | | 150.00 | uS/cm |
| S000-252 | Specific conductance | Total | MN00006 | 3/16/1995 | | 130.00 | uS/cm |
| S000-252 | Specific conductance | Total | MN00006 | 4/12/1995 | | 120.00 | uS/cm |
| S000-252 | Specific conductance | Total | MN00006 | 5/18/1995 | | 80.00 | uS/cm |
| S000-252 | Specific conductance | Total | MN00006 | 6/13/1995 | | 330.00 | uS/cm |
| S000-252 | Specific conductance | Total | MN00006 | 7/26/1995 | | 220.00 | uS/cm |
| S000-252 | Specific conductance | Total | MN00006 | 8/14/1995 | | 330.00 | uS/cm |
| S000-252 | Specific conductance | Total | MN00006 | 9/12/1995 | | 220.00 | uS/cm |
| S000-252 | Specific conductance | Total | MN00006 | 10/21/1997 | | 180.00 | uS/cm |
| S000-252 | Specific conductance | Total | MN00006 | 11/3/1997 | | 160.00 | uS/cm |
| S000-252 | Specific conductance | Total | MN00006 | 1/28/1998 | | 390.00 | uS/cm |
| S000-252 | Specific conductance | Total | MN00006 | 3/17/1998 | | 230.00 | uS/cm |
| S000-252 | Specific conductance | Total | MN00006 | 4/14/1998 | | 47.00 | uS/cm |
| S000-252 | Specific conductance | Total | MN00006 | 5/27/1998 | | 310.00 | uS/cm |
| S000-252 | Specific conductance | Total | MN00006 | 6/16/1998 | | 180.00 | uS/cm |
| S000-252 | Specific conductance | Total | MN00006 | 7/13/1998 | | 400.00 | uS/cm |
| S000-252 | Specific conductance | Total | MN00006 | 8/12/1998 | | 600.00 | uS/cm |
| S000-252 | Specific conductance | Total | MN00006 | 9/22/1998 | | 250.00 | uS/cm |
| S000-252 | Specific conductance | Total | | 10/10/1999 | | 100.00 | uS/cm |
| S000-252 | Specific conductance | Total | MN00006 | 10/10/1999 | | 96.00 | uS/cm |
| S000-252 | Specific conductance | Total | | 11/21/1999 | | 130.00 | uS/cm |
| S000-252 | Specific conductance | Total | MN00006 | 11/21/1999 | | 130.00 | uS/cm |
| S000-252 | Specific conductance | Total | | 1/16/2000 | | 260.00 | uS/cm |
| S000-252 | Specific conductance | Total | MN00006 | 1/16/2000 | | 360.00 | uS/cm |
| S000-252 | Specific conductance | Total | | 3/19/2000 | | 188.00 | uS/cm |
| S000-252 | Specific conductance | Total | MN00006 | 3/19/2000 | | 190.00 | uS/cm |
| S000-252 | Specific conductance | Total | | 4/16/2000 | | 960.00 | uS/cm |
| S000-252 | Specific conductance | Total | | 5/23/2000 | | 1525.00 | uS/cm |
| S000-252 | Specific conductance | Total | | 6/25/2000 | | 146.00 | uS/cm |
| S000-252 | Specific conductance | Total | MN00006 | 8/14/2000 | | 400.00 | uS/cm |
| S000-252 | Specific conductance | Total | | 9/5/2000 | | 340.00 | uS/cm |
| S000-252 | Specific conductance | Total | | 10/17/2002 | | 218.00 | uS/cm |
| S000-252 | Specific conductance | Total | | 11/3/2002 | | 207.00 | uS/cm |
| S000-252 | Specific conductance | Total | | 1/28/2003 | | 700.00 | uS/cm |
| S000-252 | Specific conductance | Total | | 3/18/2003 | | 587.00 | uS/cm |
| S000-252 | Specific conductance | Total | | 4/29/2003 | | 88.00 | uS/cm |
| S000-252 | Specific conductance | Total | | 5/20/2003 | | 76.00 | uS/cm |
| S000-252 | Specific conductance | Total | | 6/24/2003 | | 155.00 | uS/cm |
| S000-252 | Specific conductance | Total | | 7/28/2003 | | 340.00 | uS/cm |
| S000-252 | Specific conductance | Total | | 8/5/2003 | | 219.00 | uS/cm |

# Appendix A
# Water Quality Dataset

| Station ID | Parameter | Sample Fraction Type | Lab Name Code | Sample Date | Detect Flag | Result | Result Unit |
|---|---|---|---|---|---|---|---|
| S000-252 | Specific conductance | Total | | 9/8/2003 | | 546.00 | uS/cm |
| S000-252 | Specific conductance | Total | | 10/13/2003 | | 256.00 | uS/cm |
| S000-252 | Specific conductance | Total | MN00006 | 10/13/2004 | | 280.00 | uS/cm |
| S000-252 | Specific conductance | Total | | 11/21/2004 | | 164.00 | uS/cm |
| S000-252 | Specific conductance | Total | | 2/1/2005 | | 59.00 | uS/cm |
| S000-252 | Specific conductance | Total | | 3/2/2005 | | 298.00 | uS/cm |
| S000-252 | Specific conductance | Total | | 4/20/2005 | | 97.00 | uS/cm |
| S000-252 | Specific conductance | Total | | 5/25/2005 | | 109.00 | uS/cm |
| S000-252 | Specific conductance | Total | | 6/1/2005 | | 119.00 | uS/cm |
| S000-252 | Specific conductance | Total | | 7/11/2005 | | 298.00 | uS/cm |
| S000-252 | Specific conductance | Total | | 8/24/2005 | | 623.00 | uS/cm |
| S000-252 | Specific conductance | Total | | 9/19/2005 | | 541.00 | uS/cm |
| S000-252 | Specific conductance | Total | | 4/3/2006 | | 81.00 | uS/cm |
| S000-252 | Specific conductance | Total | | 5/25/2006 | | 156.00 | uS/cm |
| S000-252 | Specific conductance | Total | | 6/5/2006 | | 302.00 | uS/cm |
| S000-252 | Specific conductance | Total | MN00006 | 7/24/2006 | | 550.00 | uS/cm |
| S000-252 | Specific conductance | Total | | 8/7/2006 | | 350.00 | uS/cm |
| S000-252 | Specific conductance | Total | | 10/17/2006 | | 297.00 | uS/cm |
| S000-252 | Specific conductance | Total | | 10/8/2007 | | 62.00 | uS/cm |
| S000-252 | Specific conductance | Total | | 11/13/2007 | | 161.00 | uS/cm |
| S000-252 | Specific conductance | Total | | 2/12/2008 | | 483.00 | uS/cm |
| S000-252 | Specific conductance | Total | | 3/31/2008 | | 473.00 | uS/cm |
| S000-252 | Specific conductance | Total | | 4/21/2008 | | 66.00 | uS/cm |
| S000-252 | Specific conductance | Total | | 5/13/2008 | | 136.00 | uS/cm |
| S000-252 | Specific conductance | Total | | 6/4/2008 | | 300.00 | uS/cm |
| S000-252 | Specific conductance | Total | | 7/21/2008 | | 411.00 | uS/cm |
| S000-252 | Specific conductance | Total | | 8/18/2008 | | 725.00 | uS/cm |
| S000-252 | Specific conductance | Total | | 9/16/2008 | | 517.00 | uS/cm |
| S000-252 | Specific conductance | Total | | 10/26/2009 | | 77.00 | uS/cm |
| S000-252 | Specific conductance | Total | | 11/30/2009 | | 86.00 | uS/cm |
| S000-252 | Specific conductance | Total | | 1/25/2010 | | 160.00 | uS/cm |
| S000-252 | Specific conductance | Total | | 3/1/2010 | | 165.00 | uS/cm |
| S000-252 | Specific conductance | Total | | 4/26/2010 | | 288.00 | uS/cm |
| S000-252 | Specific conductance | Total | | 5/11/2010 | | 164.00 | uS/cm |
| S000-252 | Specific conductance | Total | | 6/7/2010 | | 97.00 | uS/cm |
| S000-252 | Specific conductance | Total | | 7/18/2010 | | 423.00 | uS/cm |
| S000-252 | Specific conductance | Total | | 8/22/2010 | | 414.00 | uS/cm |
| S000-252 | Specific conductance | Total | | 9/27/2010 | | 152.00 | uS/cm |
| S000-252 | Specific conductance | Total | | 5/2/2013 | | 62.00 | uS/cm |
| S000-252 | Specific conductance | Total | | 6/6/2013 | | 151.00 | uS/cm |
| S000-252 | Specific conductance | Total | | 9/12/2013 | | 635.00 | uS/cm |
| S000-252 | Specific conductance | Total | | 10/7/2013 | | 243.00 | uS/cm |
| S000-252 | Specific conductance | Total | | 4/24/2014 | | 59.00 | uS/cm |
| S000-252 | Specific conductance | Total | | 7/23/2014 | | 374.00 | uS/cm |
| S000-252 | Specific conductance | Total | | 10/16/2014 | | 320.00 | uS/cm |
| S000-252 | Specific conductance | Total | | 9/22/2015 | | 100.00 | uS/cm |
| S000-252 | Specific conductance | Total | | 9/24/2015 | | 144.00 | uS/cm |
| S000-252 | Specific conductance | Total | | 10/22/2015 | | 238.00 | uS/cm |
| S000-252 | Stream condition (text) | Total | | 10/21/1997 | | NSWO | (null) |
| S000-252 | Stream condition (text) | Total | | 11/3/1997 | | NSWC | (null) |
| S000-252 | Stream condition (text) | Total | | 1/28/1998 | | NSWC | (null) |
| S000-252 | Stream condition (text) | Total | | 3/17/1998 | | NMOC | (null) |
| S000-252 | Stream condition (text) | Total | | 4/14/1998 | | NSWC | (null) |
| S000-252 | Stream condition (text) | Total | | 5/27/1998 | | LSLC | (null) |
| S000-252 | Stream condition (text) | Total | | 6/16/1998 | | NMOC | (null) |
| S000-252 | Stream condition (text) | Total | | 7/13/1998 | | NMOC | (null) |
| S000-252 | Stream condition (text) | Total | | 8/12/1998 | | LMOC | (null) |
| S000-252 | Stream condition (text) | Total | | 9/22/1998 | | NMOC | (null) |
| S000-252 | Stream condition (text) | Total | | 10/10/1999 | | NSWO | (null) |
| S000-252 | Stream condition (text) | Total | | 11/21/1999 | | NSWO | (null) |
| S000-252 | Stream condition (text) | Total | | 3/19/2000 | | NSWO | (null) |
| S000-252 | Stream condition (text) | Total | | 4/16/2000 | | NSWO | (null) |
| S000-252 | Stream condition (text) | Total | | 5/23/2000 | | NSWC | (null) |
| S000-252 | Stream condition (text) | Total | | 6/25/2000 | | NSWO | (null) |
| S000-252 | Stream condition (text) | Total | | 7/18/2000 | | N | (null) |
| S000-252 | Stream condition (text) | Total | | 8/14/2000 | | LSWO | (null) |
| S000-252 | Stream condition (text) | Total | | 9/5/2000 | | NSWC | (null) |
| S000-252 | Stream condition (text) | Total | | 10/17/2002 | | NSWC | (null) |
| S000-252 | Stream condition (text) | Total | | 11/3/2002 | | NSWO | (null) |
| S000-252 | Stream condition (text) | Total | | 1/28/2003 | | NMOO | (null) |
| S000-252 | Stream condition (text) | Total | | 3/18/2003 | | NSWO | (null) |
| S000-252 | Stream condition (text) | Total | | 4/29/2003 | | NSWO | (null) |
| S000-252 | Stream condition (text) | Total | | 5/20/2003 | | HSWM | (null) |

# Appendix A
# Water Quality Dataset

| Station ID | Parameter | Sample Fraction Type | Lab Name Code | Sample Date | Detect Flag | Result | Result Unit |
|---|---|---|---|---|---|---|---|
| S000-252 | Stream condition (text) | Total | | 6/24/2003 | | NMOO | (null) |
| S000-252 | Stream condition (text) | Total | | 7/28/2003 | | NMOO | (null) |
| S000-252 | Stream condition (text) | Total | | 8/5/2003 | | NMOO | (null) |
| S000-252 | Stream condition (text) | Total | | 9/8/2003 | | NSWO | (null) |
| S000-252 | Stream condition (text) | Total | | 10/13/2003 | | NSWO | (null) |
| S000-252 | Stream condition (text) | Total | | 10/13/2004 | | NSWO | (null) |
| S000-252 | Stream condition (text) | Total | | 11/21/2004 | | NSWO | (null) |
| S000-252 | Stream condition (text) | Total | | 2/1/2005 | | NSWC | (null) |
| S000-252 | Stream condition (text) | Total | | 3/2/2005 | | NSWO | (null) |
| S000-252 | Stream condition (text) | Total | | 4/20/2005 | | NSWO | (null) |
| S000-252 | Stream condition (text) | Total | | 5/25/2005 | | NSWO | (null) |
| S000-252 | Stream condition (text) | Total | | 6/1/2005 | | NSWO | (null) |
| S000-252 | Stream condition (text) | Total | | 7/11/2005 | | NSWO | (null) |
| S000-252 | Stream condition (text) | Total | | 9/19/2005 | | NSWO | (null) |
| S000-252 | Stream condition (text) | Total | | 5/25/2006 | | NSWO | (null) |
| S000-252 | Stream condition (text) | Total | | 6/5/2006 | | NSWO | (null) |
| S000-252 | Stream condition (text) | Total | | 7/24/2006 | | LMOO | (null) |
| S000-252 | Stream condition (text) | Total | | 8/7/2006 | | LMOO | (null) |
| S000-252 | Stream condition (text) | Total | | 10/17/2006 | | NMOO | (null) |
| S000-252 | Stream condition (text) | Total | | 10/8/2007 | | HSWM | (null) |
| S000-252 | Stream condition (text) | Total | | 11/13/2007 | | NSWO | (null) |
| S000-252 | Stream condition (text) | Total | | 2/12/2008 | | ICE | (null) |
| S000-252 | Stream condition (text) | Total | | 3/31/2008 | | ICE | (null) |
| S000-252 | Stream condition (text) | Total | | 4/21/2008 | | HSWM | (null) |
| S000-252 | Stream condition (text) | Total | | 5/13/2008 | | NSWO | (null) |
| S000-252 | Stream condition (text) | Total | | 6/4/2008 | | NMOO | (null) |
| S000-252 | Stream condition (text) | Total | | 7/21/2008 | | NMOO | (null) |
| S000-252 | Stream condition (text) | Total | | 8/18/2008 | | LMOO | (null) |
| S000-252 | Stream condition (text) | Total | | 9/16/2008 | | LSWO | (null) |
| S000-252 | Stream condition (text) | Total | | 10/26/2009 | | HSWM | (null) |
| S000-252 | Stream condition (text) | Total | | 11/30/2009 | | NSWO | (null) |
| S000-252 | Stream condition (text) | Total | | 1/25/2010 | | ICE | (null) |
| S000-252 | Stream condition (text) | Total | | 3/1/2010 | | ICE | (null) |
| S000-252 | Stream condition (text) | Total | | 4/26/2010 | | LSWO | (null) |
| S000-252 | Stream condition (text) | Total | | 5/11/2010 | | NSWO | (null) |
| S000-252 | Stream condition (text) | Total | | 6/7/2010 | | HSWO | (null) |
| S000-252 | Stream condition (text) | Total | | 7/18/2010 | | LMOO | (null) |
| S000-252 | Stream condition (text) | Total | | 8/22/2010 | | NSWO | (null) |
| S000-252 | Stream condition (text) | Total | | 9/27/2010 | | LMOO | (null) |
| S000-252 | Stream condition (text) | Total | | 9/24/2015 | | H | (null) |
| S000-252 | Stream physical appearance (choice list) | Total | | 10/10/1999 | | 4.TEA-COLOR | (null) |
| S000-252 | Stream physical appearance (choice list) | Total | | 11/21/1999 | | 4.TEA-COLOR | (null) |
| S000-252 | Stream physical appearance (choice list) | Total | | 3/19/2000 | | 4.TEA-COLOR | (null) |
| S000-252 | Stream physical appearance (choice list) | Total | | 4/16/2000 | | 4.TEA-COLOR | (null) |
| S000-252 | Stream physical appearance (choice list) | Total | | 5/23/2000 | | 1.CLEAR | (null) |
| S000-252 | Stream physical appearance (choice list) | Total | | 6/25/2000 | | 4.TEA-COLOR | (null) |
| S000-252 | Stream physical appearance (choice list) | Total | | 7/18/2000 | | 4.TEA-COLOR | (null) |
| S000-252 | Stream physical appearance (choice list) | Total | | 8/14/2000 | | 4.TEA-COLOR | (null) |
| S000-252 | Stream physical appearance (choice list) | Total | | 9/5/2000 | | 1.CLEAR | (null) |
| S000-252 | Stream physical appearance (choice list) | Total | | 10/17/2002 | | 1.CLEAR | (null) |
| S000-252 | Stream physical appearance (choice list) | Total | | 11/3/2002 | | 4.TEA-COLOR | (null) |
| S000-252 | Stream physical appearance (choice list) | Total | | 1/28/2003 | | 4.TEA-COLOR | (null) |
| S000-252 | Stream physical appearance (choice list) | Total | | 3/18/2003 | | 4.TEA-COLOR | (null) |
| S000-252 | Stream physical appearance (choice list) | Total | | 4/29/2003 | | 4.TEA-COLOR | (null) |
| S000-252 | Stream physical appearance (choice list) | Total | | 5/20/2003 | | 5.MUDDY | (null) |
| S000-252 | Stream physical appearance (choice list) | Total | | 6/24/2003 | | 4.TEA-COLOR | (null) |
| S000-252 | Stream physical appearance (choice list) | Total | | 7/28/2003 | | 4.TEA-COLOR | (null) |
| S000-252 | Stream physical appearance (choice list) | Total | | 8/5/2003 | | 4.TEA-COLOR | (null) |
| S000-252 | Stream physical appearance (choice list) | Total | | 9/8/2003 | | 4.TEA-COLOR | (null) |
| S000-252 | Stream physical appearance (choice list) | Total | | 10/13/2003 | | 4.TEA-COLOR | (null) |
| S000-252 | Stream Physical Appearance, Minnesota (choice list) | Total | | 10/13/2004 | | 4.GREEN | (null) |
| S000-252 | Stream Physical Appearance, Minnesota (choice list) | Total | | 11/21/2004 | | 1B.TEA-COLOR | (null) |
| S000-252 | Stream Physical Appearance, Minnesota (choice list) | Total | | 2/1/2005 | | 1B.TEA-COLOR | (null) |
| S000-252 | Stream Physical Appearance, Minnesota (choice list) | Total | | 3/2/2005 | | 1B.TEA-COLOR | (null) |
| S000-252 | Stream Physical Appearance, Minnesota (choice list) | Total | | 4/20/2005 | | 1B.TEA-COLOR | (null) |
| S000-252 | Stream Physical Appearance, Minnesota (choice list) | Total | | 5/25/2005 | | 1B.TEA-COLOR | (null) |
| S000-252 | Stream Physical Appearance, Minnesota (choice list) | Total | | 6/1/2005 | | 1B.TEA-COLOR | (null) |
| S000-252 | Stream Physical Appearance, Minnesota (choice list) | Total | | 7/11/2005 | | 1B.TEA-COLOR | (null) |
| S000-252 | Stream Physical Appearance, Minnesota (choice list) | Total | | 9/19/2005 | | 1B.TEA-COLOR | (null) |
| S000-252 | Stream Physical Appearance, Minnesota (choice list) | Total | | 5/25/2006 | | 1B.TEA-COLOR | (null) |
| S000-252 | Stream Physical Appearance, Minnesota (choice list) | Total | | 6/5/2006 | | 1B.TEA-COLOR | (null) |
| S000-252 | Stream Physical Appearance, Minnesota (choice list) | Total | | 7/24/2006 | | 1B.TEA-COLOR | (null) |
| S000-252 | Stream Physical Appearance, Minnesota (choice list) | Total | | 8/7/2006 | | 1B.TEA-COLOR | (null) |

# Appendix A
# Water Quality Dataset

| Station ID | Parameter | Sample Fraction Type | Lab Name Code | Sample Date | Detect Flag | Result | Result Unit |
|---|---|---|---|---|---|---|---|
| S000-252 | Stream Physical Appearance, Minnesota (choice list) | Total | | 10/17/2006 | | 1B.TEA-COLOR | (null) |
| S000-252 | Stream Physical Appearance, Minnesota (choice list) | Total | | 10/8/2007 | | 3.MUDDY | (null) |
| S000-252 | Stream Physical Appearance, Minnesota (choice list) | Total | | 11/13/2007 | | 1B.TEA-COLOR | (null) |
| S000-252 | Stream Physical Appearance, Minnesota (choice list) | Total | | 2/12/2008 | | 1B.TEA-COLOR | (null) |
| S000-252 | Stream Physical Appearance, Minnesota (choice list) | Total | | 3/31/2008 | | 1B.TEA-COLOR | (null) |
| S000-252 | Stream Physical Appearance, Minnesota (choice list) | Total | | 4/21/2008 | | 3.MUDDY | (null) |
| S000-252 | Stream Physical Appearance, Minnesota (choice list) | Total | | 5/13/2008 | | 1B.TEA-COLOR | (null) |
| S000-252 | Stream Physical Appearance, Minnesota (choice list) | Total | | 6/4/2008 | | 1B.TEA-COLOR | (null) |
| S000-252 | Stream Physical Appearance, Minnesota (choice list) | Total | | 7/21/2008 | | 1B.TEA-COLOR | (null) |
| S000-252 | Stream Physical Appearance, Minnesota (choice list) | Total | | 8/18/2008 | | 1B.TEA-COLOR | (null) |
| S000-252 | Stream Physical Appearance, Minnesota (choice list) | Total | | 9/16/2008 | | 1B.TEA-COLOR | (null) |
| S000-252 | Stream Physical Appearance, Minnesota (choice list) | Total | | 10/26/2009 | | 1B.TEA-COLOR | (null) |
| S000-252 | Stream Physical Appearance, Minnesota (choice list) | Total | | 11/30/2009 | | 1B.TEA-COLOR | (null) |
| S000-252 | Stream Physical Appearance, Minnesota (choice list) | Total | | 4/26/2010 | | 1B.TEA-COLOR | (null) |
| S000-252 | Stream Physical Appearance, Minnesota (choice list) | Total | | 5/11/2010 | | 1B.TEA-COLOR | (null) |
| S000-252 | Stream Physical Appearance, Minnesota (choice list) | Total | | 6/7/2010 | | 1B.TEA-COLOR | (null) |
| S000-252 | Stream Physical Appearance, Minnesota (choice list) | Total | | 7/18/2010 | | 1B.TEA-COLOR | (null) |
| S000-252 | Stream Physical Appearance, Minnesota (choice list) | Total | | 8/22/2010 | | 1B.TEA-COLOR | (null) |
| S000-252 | Stream Physical Appearance, Minnesota (choice list) | Total | | 9/27/2010 | | 1B.TEA-COLOR | (null) |
| S000-252 | Stream Physical Appearance, Minnesota (choice list) | Total | | 9/12/2013 | | 1A.CLEAR | (null) |
| S000-252 | Stream Physical Appearance, Minnesota (choice list) | Total | | 9/22/2015 | | 1A.CLEAR | (null) |
| S000-252 | Stream Physical Appearance, Minnesota (choice list) | Total | | 9/24/2015 | | 2.CLOUDY | (null) |
| S000-252 | Stream Physical Appearance, Minnesota (choice list) | Total | | 10/22/2015 | | 1A.CLEAR | (null) |
| S000-252 | Stream recreational suitability (choice list) | Total | | 10/21/1997 | | 1.VERY GOOD | (null) |
| S000-252 | Stream recreational suitability (choice list) | Total | | 11/3/1997 | | 1.VERY GOOD | (null) |
| S000-252 | Stream recreational suitability (choice list) | Total | | 4/14/1998 | | 2.GOOD | (null) |
| S000-252 | Stream recreational suitability (choice list) | Total | | 5/27/1998 | | 2.GOOD | (null) |
| S000-252 | Stream recreational suitability (choice list) | Total | | 6/16/1998 | | 1.VERY GOOD | (null) |
| S000-252 | Stream recreational suitability (choice list) | Total | | 7/13/1998 | | 1.VERY GOOD | (null) |
| S000-252 | Stream recreational suitability (choice list) | Total | | 8/12/1998 | | 1.VERY GOOD | (null) |
| S000-252 | Stream recreational suitability (choice list) | Total | | 9/22/1998 | | 1.VERY GOOD | (null) |
| S000-252 | Stream recreational suitability (choice list) | Total | | 10/10/1999 | | 2.GOOD | (null) |
| S000-252 | Stream recreational suitability (choice list) | Total | | 11/21/1999 | | 2.GOOD | (null) |
| S000-252 | Stream recreational suitability (choice list) | Total | | 3/19/2000 | | 2.GOOD | (null) |
| S000-252 | Stream recreational suitability (choice list) | Total | | 4/16/2000 | | 2.GOOD | (null) |
| S000-252 | Stream recreational suitability (choice list) | Total | | 5/23/2000 | | 1.VERY GOOD | (null) |
| S000-252 | Stream recreational suitability (choice list) | Total | | 6/25/2000 | | 2.GOOD | (null) |
| S000-252 | Stream recreational suitability (choice list) | Total | | 7/18/2000 | | 2.GOOD | (null) |
| S000-252 | Stream recreational suitability (choice list) | Total | | 8/14/2000 | | 2.GOOD | (null) |
| S000-252 | Stream recreational suitability (choice list) | Total | | 9/5/2000 | | 2.GOOD | (null) |
| S000-252 | Stream recreational suitability (choice list) | Total | | 10/17/2002 | | 2.GOOD | (null) |
| S000-252 | Stream recreational suitability (choice list) | Total | | 11/3/2002 | | 3.FAIR | (null) |
| S000-252 | Stream recreational suitability (choice list) | Total | | 1/28/2003 | | 2.GOOD | (null) |
| S000-252 | Stream recreational suitability (choice list) | Total | | 3/18/2003 | | 2.GOOD | (null) |
| S000-252 | Stream recreational suitability (choice list) | Total | | 4/29/2003 | | 3.FAIR | (null) |
| S000-252 | Stream recreational suitability (choice list) | Total | | 5/20/2003 | | 3.FAIR | (null) |
| S000-252 | Stream recreational suitability (choice list) | Total | | 6/24/2003 | | 1.VERY GOOD | (null) |
| S000-252 | Stream recreational suitability (choice list) | Total | | 7/28/2003 | | 2.GOOD | (null) |
| S000-252 | Stream recreational suitability (choice list) | Total | | 8/5/2003 | | 2.GOOD | (null) |
| S000-252 | Stream recreational suitability (choice list) | Total | | 9/8/2003 | | 2.GOOD | (null) |
| S000-252 | Stream recreational suitability (choice list) | Total | | 10/13/2003 | | 2.GOOD | (null) |
| S000-252 | Stream recreational suitability (choice list) | Total | | 10/13/2004 | | 2.GOOD | (null) |
| S000-252 | Stream recreational suitability (choice list) | Total | | 11/21/2004 | | 2.GOOD | (null) |
| S000-252 | Stream recreational suitability (choice list) | Total | | 2/1/2005 | | 2.GOOD | (null) |
| S000-252 | Stream recreational suitability (choice list) | Total | | 3/2/2005 | | 2.GOOD | (null) |
| S000-252 | Stream recreational suitability (choice list) | Total | | 4/20/2005 | | 2.GOOD | (null) |
| S000-252 | Stream recreational suitability (choice list) | Total | | 5/25/2005 | | 2.GOOD | (null) |
| S000-252 | Stream recreational suitability (choice list) | Total | | 6/1/2005 | | 2.GOOD | (null) |
| S000-252 | Stream recreational suitability (choice list) | Total | | 7/11/2005 | | 2.GOOD | (null) |
| S000-252 | Stream recreational suitability (choice list) | Total | | 9/19/2005 | | 3.FAIR | (null) |
| S000-252 | Stream recreational suitability (choice list) | Total | | 5/25/2006 | | 2.GOOD | (null) |
| S000-252 | Stream recreational suitability (choice list) | Total | | 6/5/2006 | | 2.GOOD | (null) |
| S000-252 | Stream recreational suitability (choice list) | Total | | 7/24/2006 | | 3.FAIR | (null) |
| S000-252 | Stream recreational suitability (choice list) | Total | | 8/7/2006 | | 3.FAIR | (null) |
| S000-252 | Stream recreational suitability (choice list) | Total | | 10/17/2006 | | 3.FAIR | (null) |
| S000-252 | Stream recreational suitability (choice list) | Total | | 10/8/2007 | | 3.FAIR | (null) |
| S000-252 | Stream recreational suitability (choice list) | Total | | 11/13/2007 | | 2.GOOD | (null) |
| S000-252 | Stream recreational suitability (choice list) | Total | | 2/12/2008 | | 3.FAIR | (null) |
| S000-252 | Stream recreational suitability (choice list) | Total | | 4/21/2008 | | 3.FAIR | (null) |
| S000-252 | Stream recreational suitability (choice list) | Total | | 5/13/2008 | | 3.FAIR | (null) |
| S000-252 | Stream recreational suitability (choice list) | Total | | 6/4/2008 | | 3.FAIR | (null) |
| S000-252 | Stream recreational suitability (choice list) | Total | | 7/21/2008 | | 3.FAIR | (null) |
| S000-252 | Stream recreational suitability (choice list) | Total | | 8/18/2008 | | 2.GOOD | (null) |

| Station ID | Parameter | Sample Fraction Type | Lab Name Code | Sample Date | Detect Flag | Result | Result Unit |
|---|---|---|---|---|---|---|---|
| S000-252 | Stream recreational suitability (choice list) | Total | | 9/16/2008 | | 3.FAIR | (null) |
| S000-252 | Stream recreational suitability (choice list) | Total | | 10/26/2009 | | 3.FAIR | (null) |
| S000-252 | Stream recreational suitability (choice list) | Total | | 11/30/2009 | | 2.GOOD | (null) |
| S000-252 | Stream recreational suitability (choice list) | Total | | 4/26/2010 | | 2.GOOD | (null) |
| S000-252 | Stream recreational suitability (choice list) | Total | | 5/11/2010 | | 3.FAIR | (null) |
| S000-252 | Stream recreational suitability (choice list) | Total | | 6/7/2010 | | 3.FAIR | (null) |
| S000-252 | Stream recreational suitability (choice list) | Total | | 7/18/2010 | | 2.GOOD | (null) |
| S000-252 | Stream recreational suitability (choice list) | Total | | 8/22/2010 | | 4.POOR | (null) |
| S000-252 | Stream recreational suitability (choice list) | Total | | 9/27/2010 | | 2.GOOD | (null) |
| S000-252 | Strontium-90 | Total | UNKNOWN | 9/26/1973 | | 1.00 | pCi/L |
| S000-252 | Strontium-90 | Total | UNKNOWN | 2/26/1974 | | 0.80 | pCi/L |
| S000-252 | Strontium-90 | Total | UNKNOWN | 4/24/1974 | | 0.57 | pCi/L |
| S000-252 | Strontium-90 | Total | UNKNOWN | 9/12/1974 | | 0.88 | pCi/L |
| S000-252 | Strontium-90 | Total | UNKNOWN | 2/26/1975 | | 0.72 | pCi/L |
| S000-252 | Strontium-90 | Total | UNKNOWN | 5/1/1975 | | 0.41 | pCi/L |
| S000-252 | Sulfate as SO4 | Total | UNKNOWN | 9/26/1973 | | 6.30 | mg/L |
| S000-252 | Sulfate as SO4 | Total | UNKNOWN | 1/29/1974 | | 11.00 | mg/L |
| S000-252 | Sulfate as SO4 | Total | UNKNOWN | 2/26/1974 | | 12.00 | mg/L |
| S000-252 | Sulfate as SO4 | Total | UNKNOWN | 4/2/1974 | | 10.00 | mg/L |
| S000-252 | Sulfate as SO4 | Total | UNKNOWN | 4/9/1974 | | 12.00 | mg/L |
| S000-252 | Sulfate as SO4 | Total | UNKNOWN | 4/24/1974 | < | 5.00 | mg/L |
| S000-252 | Sulfate as SO4 | Total | UNKNOWN | 5/8/1974 | | 11.00 | mg/L |
| S000-252 | Sulfate as SO4 | Total | UNKNOWN | 5/15/1974 | | 6.00 | mg/L |
| S000-252 | Sulfate as SO4 | Total | UNKNOWN | 6/18/1974 | | 12.00 | mg/L |
| S000-252 | Sulfate as SO4 | Total | UNKNOWN | 7/10/1974 | | 8.50 | mg/L |
| S000-252 | Sulfate as SO4 | Total | UNKNOWN | 8/13/1974 | < | 5.00 | mg/L |
| S000-252 | Sulfate as SO4 | Total | UNKNOWN | 9/12/1974 | < | 5.00 | mg/L |
| S000-252 | Sulfate as SO4 | Total | UNKNOWN | 10/9/1974 | < | 5.00 | mg/L |
| S000-252 | Sulfate as SO4 | Total | UNKNOWN | 11/5/1974 | | 11.00 | mg/L |
| S000-252 | Sulfate as SO4 | Total | UNKNOWN | 12/11/1974 | | 9.00 | mg/L |
| S000-252 | Sulfate as SO4 | Total | UNKNOWN | 1/16/1975 | | 13.00 | mg/L |
| S000-252 | Sulfate as SO4 | Total | UNKNOWN | 2/26/1975 | | 8.70 | mg/L |
| S000-252 | Sulfate as SO4 | Total | UNKNOWN | 4/2/1975 | | 10.00 | mg/L |
| S000-252 | Sulfate as SO4 | Total | UNKNOWN | 4/17/1975 | | 9.00 | mg/L |
| S000-252 | Sulfate as SO4 | Total | UNKNOWN | 5/1/1975 | | 9.20 | mg/L |
| S000-252 | Sulfate as SO4 | Total | UNKNOWN | 5/8/1975 | | 8.40 | mg/L |
| S000-252 | Sulfate as SO4 | Total | UNKNOWN | 5/15/1975 | | 8.00 | mg/L |
| S000-252 | Sulfate as SO4 | Total | UNKNOWN | 5/22/1975 | | 10.70 | mg/L |
| S000-252 | Sulfate as SO4 | Total | UNKNOWN | 6/18/1975 | < | 5.00 | mg/L |
| S000-252 | Sulfate as SO4 | Total | UNKNOWN | 7/26/1976 | < | 5.00 | mg/L |
| S000-252 | Sulfate as SO4 | Total | UNKNOWN | 10/18/1976 | | 6.90 | mg/L |
| S000-252 | Sulfate as SO4 | Total | UNKNOWN | 4/25/1977 | | 30.00 | mg/L |
| S000-252 | Sulfate as SO4 | Total | UNKNOWN | 7/25/1977 | < | 5.00 | mg/L |
| S000-252 | Sulfate as SO4 | Total | UNKNOWN | 1/14/1981 | | 10.00 | mg/L |
| S000-252 | Sulfate as SO4 | Total | UNKNOWN | 3/11/1981 | | 11.00 | mg/L |
| S000-252 | Sulfate as SO4 | Total | UNKNOWN | 4/14/1981 | | 8.40 | mg/L |
| S000-252 | Sulfate as SO4 | Total | UNKNOWN | 5/12/1981 | | 6.90 | mg/L |
| S000-252 | Sulfate as SO4 | Total | UNKNOWN | 6/16/1981 | < | 5.00 | mg/L |
| S000-252 | Sulfate as SO4 | Total | UNKNOWN | 7/14/1981 | < | 5.00 | mg/L |
| S000-252 | Sulfate as SO4 | Total | UNKNOWN | 8/12/1981 | < | 1.00 | mg/L |
| S000-252 | Sulfate as SO4 | Total | UNKNOWN | 9/15/1981 | < | 5.00 | mg/L |
| S000-252 | Sulfate as SO4 | Total | UNKNOWN | 1/12/1982 | | 10.00 | mg/L |
| S000-252 | Sulfate as SO4 | Total | UNKNOWN | 10/10/1984 | | 5.00 | mg/L |
| S000-252 | Sulfate as SO4 | Total | UNKNOWN | 1/14/1985 | | 8.50 | mg/L |
| S000-252 | Sulfate as SO4 | Total | UNKNOWN | 3/13/1985 | | 8.00 | mg/L |
| S000-252 | Sulfate as SO4 | Total | UNKNOWN | 4/15/1985 | | 4.50 | mg/L |
| S000-252 | Sulfate as SO4 | Total | UNKNOWN | 5/14/1985 | | 4.70 | mg/L |
| S000-252 | Sulfate as SO4 | Total | UNKNOWN | 6/10/1985 | | 4.80 | mg/L |
| S000-252 | Sulfate as SO4 | Total | UNKNOWN | 7/17/1985 | < | 5.00 | mg/L |
| S000-252 | Sulfate as SO4 | Total | UNKNOWN | 8/13/1985 | | 6.90 | mg/L |
| S000-252 | Sulfate as SO4 | Total | UNKNOWN | 9/11/1985 | | 12.00 | mg/L |
| S000-252 | Sulfate as SO4 | Total | UNKNOWN | 10/15/1985 | | 7.80 | mg/L |
| S000-252 | Sulfate as SO4 | Total | UNKNOWN | 2/19/1986 | | 9.90 | mg/L |
| S000-252 | Sulfate as SO4 | Total | UNKNOWN | 3/20/1986 | | 5.60 | mg/L |
| S000-252 | Sulfate as SO4 | Total | UNKNOWN | 4/17/1986 | | 5.30 | mg/L |
| S000-252 | Sulfate as SO4 | Total | UNKNOWN | 5/12/1986 | < | 5.00 | mg/L |
| S000-252 | Sulfate as SO4 | Total | UNKNOWN | 6/10/1986 | < | 5.00 | mg/L |
| S000-252 | Sulfate as SO4 | Total | UNKNOWN | 8/19/1986 | < | 5.00 | mg/L |
| S000-252 | Sulfate as SO4 | Total | UNKNOWN | 9/24/1986 | < | 5.00 | mg/L |
| S000-252 | Sulfate as SO4 | Total | UNKNOWN | 10/21/1986 | | 8.30 | mg/L |
| S000-252 | Sulfate as SO4 | Total | UNKNOWN | 1/13/1987 | | 19.00 | mg/L |
| S000-252 | Sulfate as SO4 | Total | UNKNOWN | 3/10/1987 | | 6.20 | mg/L |
| S000-252 | Sulfate as SO4 | Total | UNKNOWN | 4/7/1987 | | 5.70 | mg/L |

# Appendix A
# Water Quality Dataset

| Station ID | Parameter | Sample Fraction Type | Lab Name Code | Sample Date | Detect Flag | Result | Result Unit |
|---|---|---|---|---|---|---|---|
| S000-252 | Sulfate as SO4 | Total | UNKNOWN | 5/12/1987 | | 10.00 | mg/L |
| S000-252 | Sulfate as SO4 | Total | UNKNOWN | 6/9/1987 | | 10.00 | mg/L |
| S000-252 | Sulfate as SO4 | Total | UNKNOWN | 7/15/1987 | | 12.00 | mg/L |
| S000-252 | Sulfate as SO4 | Total | UNKNOWN | 8/11/1987 | | 14.00 | mg/L |
| S000-252 | Sulfate as SO4 | Total | UNKNOWN | 9/15/1987 | | 11.00 | mg/L |
| S000-252 | Sulfate as SO4 | Total | UNKNOWN | 10/14/1987 | | 12.00 | mg/L |
| S000-252 | Sulfate as SO4 | Total | UNKNOWN | 1/12/1988 | | 17.00 | mg/L |
| S000-252 | Sulfate as SO4 | Total | UNKNOWN | 3/15/1988 | | 14.00 | mg/L |
| S000-252 | Sulfate as SO4 | Total | UNKNOWN | 4/12/1988 | | 7.40 | mg/L |
| S000-252 | Sulfate as SO4 | Total | UNKNOWN | 5/9/1988 | | 6.00 | mg/L |
| S000-252 | Sulfate as SO4 | Total | UNKNOWN | 6/14/1988 | | 15.00 | mg/L |
| S000-252 | Sulfate as SO4 | Total | UNKNOWN | 7/12/1988 | | 16.00 | mg/L |
| S000-252 | Sulfate as SO4 | Total | UNKNOWN | 8/17/1988 | | 13.00 | mg/L |
| S000-252 | Sulfate as SO4 | Total | UNKNOWN | 9/13/1988 | | 13.00 | mg/L |
| S000-252 | Sulfate as SO4 | Total | UNKNOWN | 10/11/1988 | | 11.00 | mg/L |
| S000-252 | Sulfate as SO4 | Total | MN00006 | 3/14/1989 | | 16.00 | mg/L |
| S000-252 | Sulfate as SO4 | Total | MN00006 | 4/11/1989 | | 9.90 | mg/L |
| S000-252 | Sulfate as SO4 | Total | MN00006 | 5/9/1989 | | 9.10 | mg/L |
| S000-252 | Sulfate as SO4 | Total | MN00006 | 6/13/1989 | | 8.70 | mg/L |
| S000-252 | Sulfate as SO4 | Total | MN00006 | 7/18/1989 | | 9.60 | mg/L |
| S000-252 | Sulfate as SO4 | Total | MN00006 | 8/16/1989 | | 16.00 | mg/L |
| S000-252 | Sulfate as SO4 | Total | MN00006 | 9/12/1989 | | 14.00 | mg/L |
| S000-252 | Sulfate as SO4 | Total | MN00006 | 10/10/1989 | | 8.20 | mg/L |
| S000-252 | Sulfate as SO4 | Total | MN00006 | 1/4/1990 | | 21.00 | mg/L |
| S000-252 | Sulfate as SO4 | Total | MN00006 | 3/27/1990 | | 12.00 | mg/L |
| S000-252 | Sulfate as SO4 | Total | MN00006 | 5/2/1990 | | 5.00 | mg/L |
| S000-252 | Sulfate as SO4 | Total | MN00006 | 6/5/1990 | | 6.40 | mg/L |
| S000-252 | Sulfate as SO4 | Total | MN00006 | 7/17/1990 | | 6.20 | mg/L |
| S000-252 | Sulfate as SO4 | Total | MN00006 | 8/16/1990 | | 18.00 | mg/L |
| S000-252 | Sulfate as SO4 | Total | MN00006 | 9/25/1990 | | 6.50 | mg/L |
| S000-252 | Sulfate as SO4 | Total | MN00006 | 10/9/1990 | | 5.80 | mg/L |
| S000-252 | Sulfate as SO4 | Total | MN00006 | 1/29/1991 | | 16.00 | mg/L |
| S000-252 | Sulfate as SO4 | Total | MN00006 | 3/12/1991 | | 17.00 | mg/L |
| S000-252 | Sulfate as SO4 | Total | MN00006 | 4/23/1991 | < | 5.00 | mg/L |
| S000-252 | Sulfate as SO4 | Total | MN00006 | 5/29/1991 | < | 5.00 | mg/L |
| S000-252 | Sulfate as SO4 | Total | MN00006 | 6/25/1991 | < | 5.00 | mg/L |
| S000-252 | Sulfate as SO4 | Total | MN00006 | 7/30/1991 | < | 5.00 | mg/L |
| S000-252 | Sulfate as SO4 | Total | MN00006 | 8/27/1991 | | 18.00 | mg/L |
| S000-252 | Sulfate as SO4 | Total | MN00006 | 9/18/1991 | | 12.00 | mg/L |
| S000-252 | Sulfate as SO4 | Total | MN00006 | 10/23/1991 | | 9.20 | mg/L |
| S000-252 | Sulfate as SO4 | Total | MN00006 | 1/28/1992 | | 12.00 | mg/L |
| S000-252 | Sulfate as SO4 | Total | MN00006 | 3/24/1992 | | 12.00 | mg/L |
| S000-252 | Sulfate as SO4 | Total | MN00006 | 4/21/1992 | | 9.20 | mg/L |
| S000-252 | Sulfate as SO4 | Total | MN00006 | 5/6/1992 | | 9.30 | mg/L |
| S000-252 | Sulfate as SO4 | Total | MN00006 | 6/2/1992 | | 10.00 | mg/L |
| S000-252 | Sulfate as SO4 | Total | MN00006 | 7/21/1992 | | 11.00 | mg/L |
| S000-252 | Sulfate as SO4 | Total | MN00006 | 8/11/1992 | | 11.00 | mg/L |
| S000-252 | Sulfate as SO4 | Total | MN00006 | 9/23/1992 | | 11.00 | mg/L |
| S000-252 | Sulfate as SO4 | Total | MN00006 | 10/21/1992 | | 10.00 | mg/L |
| S000-252 | Sulfate as SO4 | Total | MN00006 | 1/6/1993 | | 13.00 | mg/L |
| S000-252 | Sulfate as SO4 | Total | MN00006 | 3/3/1993 | | 12.00 | mg/L |
| S000-252 | Sulfate as SO4 | Total | MN00006 | 4/28/1993 | < | 5.00 | mg/L |
| S000-252 | Sulfate as SO4 | Total | MN00006 | 5/27/1993 | | 13.00 | mg/L |
| S000-252 | Sulfate as SO4 | Total | MN00006 | 6/23/1993 | | 9.50 | mg/L |
| S000-252 | Sulfate as SO4 | Total | MN00006 | 7/21/1993 | | 11.00 | mg/L |
| S000-252 | Sulfate as SO4 | Total | MN00006 | 8/25/1993 | < | 5.00 | mg/L |
| S000-252 | Sulfate as SO4 | Total | MN00006 | 9/22/1993 | | 8.70 | mg/L |
| S000-252 | Sulfate as SO4 | Total | MN00006 | 10/14/1993 | | 8.90 | mg/L |
| S000-252 | Sulfate as SO4 | Total | MN00006 | 1/11/1994 | | 15.00 | mg/L |
| S000-252 | Sulfate as SO4 | Total | MN00006 | 3/15/1994 | | 12.00 | mg/L |
| S000-252 | Sulfate as SO4 | Total | MN00006 | 4/13/1994 | < | 5.00 | mg/L |
| S000-252 | Sulfate as SO4 | Total | MN00006 | 5/19/1994 | | 8.60 | mg/L |
| S000-252 | Sulfate as SO4 | Total | MN00006 | 6/15/1994 | | 9.60 | mg/L |
| S000-252 | Sulfate as SO4 | Total | MN00006 | 7/20/1994 | | 9.30 | mg/L |
| S000-252 | Sulfate as SO4 | Total | MN00006 | 8/25/1994 | | 17.00 | mg/L |
| S000-252 | Sulfate as SO4 | Total | MN00006 | 9/13/1994 | | 13.00 | mg/L |
| S000-252 | Sulfate as SO4 | Total | MN00006 | 11/7/1994 | | 6.40 | mg/L |
| S000-252 | Sulfate as SO4 | Total | MN00006 | 1/19/1995 | | 7.40 | mg/L |
| S000-252 | Sulfate as SO4 | Total | MN00006 | 3/16/1995 | | 11.00 | mg/L |
| S000-252 | Sulfate as SO4 | Total | MN00006 | 4/12/1995 | | 11.00 | mg/L |
| S000-252 | Sulfate as SO4 | Total | MN00006 | 5/18/1995 | < | 5.00 | mg/L |
| S000-252 | Sulfate as SO4 | Total | MN00006 | 6/13/1995 | | 14.00 | mg/L |
| S000-252 | Sulfate as SO4 | Total | MN00006 | 7/26/1995 | | 11.00 | mg/L |

# Appendix A
# Water Quality Dataset

| Station ID | Parameter | Sample Fraction Type | Lab Name Code | Sample Date | Detect Flag | Result | Result Unit |
|---|---|---|---|---|---|---|---|
| S000-252 | Sulfate as SO4 | Total | MN00006 | 8/14/1995 | | 13.00 | mg/L |
| S000-252 | Sulfate as SO4 | Total | MN00006 | 9/12/1995 | | 11.00 | mg/L |
| S000-252 | Sulfate as SO4 | Total | MN00006 | 10/8/2007 | | 3.07 | mg/L |
| S000-252 | Sulfate as SO4 | Total | MN00006 | 11/13/2007 | | 9.17 | mg/L |
| S000-252 | Sulfate as SO4 | Total | MN00006 | 2/12/2008 | | 29.60 | mg/L |
| S000-252 | Sulfate as SO4 | Total | MN00006 | 3/31/2008 | | 27.60 | mg/L |
| S000-252 | Sulfate as SO4 | Total | MN00006 | 4/21/2008 | | 4.27 | mg/L |
| S000-252 | Sulfate as SO4 | Total | MN00006 | 5/13/2008 | | 7.83 | mg/L |
| S000-252 | Sulfate as SO4 | Total | MN00006 | 6/4/2008 | | 15.60 | mg/L |
| S000-252 | Sulfate as SO4 | Total | MN00006 | 7/21/2008 | | 3.03 | mg/L |
| S000-252 | Sulfate as SO4 | Total | MN00006 | 8/18/2008 | | 46.50 | mg/L |
| S000-252 | Sulfate as SO4 | Total | MN00006 | 9/16/2008 | | 29.30 | mg/L |
| S000-252 | Sulfate as SO4 | Total | MN00006 | 10/26/2009 | | 6.51 | mg/L |
| S000-252 | Sulfate as SO4 | Total | MN00006 | 11/30/2009 | | 5.82 | mg/L |
| S000-252 | Sulfate as SO4 | Total | MN00006 | 1/25/2010 | | 5.21 | mg/L |
| S000-252 | Sulfate as SO4 | Total | MN00006 | 3/1/2010 | | 5.26 | mg/L |
| S000-252 | Sulfate as SO4 | Total | MN00006 | 4/26/2010 | | 17.20 | mg/L |
| S000-252 | Sulfate as SO4 | Total | MN00006 | 5/11/2010 | | 9.39 | mg/L |
| S000-252 | Sulfate as SO4 | Total | MN00006 | 6/7/2010 | | 1.41 | mg/L |
| S000-252 | Sulfate as SO4 | Total | MN00006 | 7/18/2010 | | 25.10 | mg/L |
| S000-252 | Sulfate as SO4 | Total | MN00006 | 8/22/2010 | | 1.61 | mg/L |
| S000-252 | Sulfate as SO4 | Total | MN00006 | 8/22/2010 | | 21.80 | mg/L |
| S000-252 | Sulfate as SO4 | Total | MN00006 | 9/27/2010 | | 4.08 | mg/L |
| S000-252 | Temperature, water | Total | | 7/24/1973 | | 18.30 | deg C |
| S000-252 | Temperature, water | Total | | 8/29/1973 | | 23.30 | deg C |
| S000-252 | Temperature, water | Total | | 9/13/1973 | | 13.90 | deg C |
| S000-252 | Temperature, water | Total | | 9/26/1973 | | 12.20 | deg C |
| S000-252 | Temperature, water | Total | | 10/17/1973 | | 4.00 | deg C |
| S000-252 | Temperature, water | Total | | 11/14/1973 | | 0.60 | deg C |
| S000-252 | Temperature, water | Total | | 12/5/1973 | | 0.00 | deg C |
| S000-252 | Temperature, water | Total | | 1/29/1974 | | 0.60 | deg C |
| S000-252 | Temperature, water | Total | | 2/26/1974 | | 0.00 | deg C |
| S000-252 | Temperature, water | Total | | 3/12/1974 | | 0.00 | deg C |
| S000-252 | Temperature, water | Total | | 4/2/1974 | | 0.00 | deg C |
| S000-252 | Temperature, water | Total | | 4/9/1974 | | 0.00 | deg C |
| S000-252 | Temperature, water | Total | | 4/24/1974 | | 1.70 | deg C |
| S000-252 | Temperature, water | Total | | 5/8/1974 | | 5.00 | deg C |
| S000-252 | Temperature, water | Total | | 5/15/1974 | | 3.30 | deg C |
| S000-252 | Temperature, water | Total | | 6/18/1974 | | 12.80 | deg C |
| S000-252 | Temperature, water | Total | | 7/10/1974 | | 21.10 | deg C |
| S000-252 | Temperature, water | Total | | 8/13/1974 | | 19.40 | deg C |
| S000-252 | Temperature, water | Total | | 9/12/1974 | | 11.70 | deg C |
| S000-252 | Temperature, water | Total | | 10/9/1974 | | 7.80 | deg C |
| S000-252 | Temperature, water | Total | | 11/5/1974 | | 2.80 | deg C |
| S000-252 | Temperature, water | Total | | 12/11/1974 | | 0.00 | deg C |
| S000-252 | Temperature, water | Total | | 1/16/1975 | | 0.00 | deg C |
| S000-252 | Temperature, water | Total | | 2/26/1975 | | 0.00 | deg C |
| S000-252 | Temperature, water | Total | | 4/2/1975 | | 0.00 | deg C |
| S000-252 | Temperature, water | Total | | 4/17/1975 | | 0.00 | deg C |
| S000-252 | Temperature, water | Total | | 5/1/1975 | | 1.10 | deg C |
| S000-252 | Temperature, water | Total | | 5/8/1975 | | 5.60 | deg C |
| S000-252 | Temperature, water | Total | | 5/15/1975 | | 8.30 | deg C |
| S000-252 | Temperature, water | Total | | 5/22/1975 | | 17.80 | deg C |
| S000-252 | Temperature, water | Total | | 6/18/1975 | | 17.20 | deg C |
| S000-252 | Temperature, water | Total | | 7/26/1976 | | 24.00 | deg C |
| S000-252 | Temperature, water | Total | | 8/23/1976 | | 21.00 | deg C |
| S000-252 | Temperature, water | Total | | 9/20/1976 | | 12.00 | deg C |
| S000-252 | Temperature, water | Total | | 11/16/1976 | | 0.00 | deg C |
| S000-252 | Temperature, water | Total | | 3/22/1977 | | 0.00 | deg C |
| S000-252 | Temperature, water | Total | | 4/25/1977 | | 10.00 | deg C |
| S000-252 | Temperature, water | Total | | 5/23/1977 | | 17.00 | deg C |
| S000-252 | Temperature, water | Total | | 6/27/1977 | | 23.00 | deg C |
| S000-252 | Temperature, water | Total | | 7/25/1977 | | 23.00 | deg C |
| S000-252 | Temperature, water | Total | | 8/22/1977 | | 19.00 | deg C |
| S000-252 | Temperature, water | Total | | 9/26/1977 | | 11.00 | deg C |
| S000-252 | Temperature, water | Total | | 10/24/1977 | | 6.00 | deg C |
| S000-252 | Temperature, water | Total | | 11/14/1977 | | 1.00 | deg C |
| S000-252 | Temperature, water | Total | | 12/19/1977 | | 0.00 | deg C |
| S000-252 | Temperature, water | Total | | 1/23/1978 | | 0.00 | deg C |
| S000-252 | Temperature, water | Total | | 2/21/1978 | | 0.00 | deg C |
| S000-252 | Temperature, water | Total | | 3/1/1978 | | 0.00 | deg C |
| S000-252 | Temperature, water | Total | | 4/4/1978 | | 0.50 | deg C |
| S000-252 | Temperature, water | Total | | 5/1/1978 | | 6.00 | deg C |

# Appendix A
# Water Quality Dataset

| Station ID | Parameter | Sample Fraction Type | Lab Name Code | Sample Date | Detect Flag | Result | Result Unit |
|---|---|---|---|---|---|---|---|
| S000-252 | Temperature, water | Total | | 6/6/1978 | | 15.00 | deg C |
| S000-252 | Temperature, water | Total | | 7/6/1978 | | 20.00 | deg C |
| S000-252 | Temperature, water | Total | | 8/1/1978 | | 16.00 | deg C |
| S000-252 | Temperature, water | Total | | 9/6/1978 | | 25.50 | deg C |
| S000-252 | Temperature, water | Total | | 10/3/1978 | | 12.00 | deg C |
| S000-252 | Temperature, water | Total | | 11/8/1978 | | 1.50 | deg C |
| S000-252 | Temperature, water | Total | | 12/6/1978 | | 0.50 | deg C |
| S000-252 | Temperature, water | Total | | 1/16/1979 | | 0.00 | deg C |
| S000-252 | Temperature, water | Total | | 2/21/1979 | | 0.00 | deg C |
| S000-252 | Temperature, water | Total | | 3/20/1979 | | 0.00 | deg C |
| S000-252 | Temperature, water | Total | | 4/4/1979 | | 0.00 | deg C |
| S000-252 | Temperature, water | Total | | 5/2/1979 | | 3.00 | deg C |
| S000-252 | Temperature, water | Total | | 6/19/1979 | | 14.00 | deg C |
| S000-252 | Temperature, water | Total | | 7/24/1979 | | 20.00 | deg C |
| S000-252 | Temperature, water | Total | | 7/31/1979 | | 17.00 | deg C |
| S000-252 | Temperature, water | Total | | 8/21/1979 | | 15.00 | deg C |
| S000-252 | Temperature, water | Total | | 10/16/1979 | | 4.00 | deg C |
| S000-252 | Temperature, water | Total | | 12/18/1979 | | 0.00 | deg C |
| S000-252 | Temperature, water | Total | | 1/22/1980 | | 0.00 | deg C |
| S000-252 | Temperature, water | Total | | 2/27/1980 | | 0.00 | deg C |
| S000-252 | Temperature, water | Total | | 3/19/1980 | | 0.00 | deg C |
| S000-252 | Temperature, water | Total | | 4/22/1980 | | 5.00 | deg C |
| S000-252 | Temperature, water | Total | | 5/20/1980 | | 12.00 | deg C |
| S000-252 | Temperature, water | Total | | 6/17/1980 | | 17.50 | deg C |
| S000-252 | Temperature, water | Total | | 7/22/1980 | | 19.50 | deg C |
| S000-252 | Temperature, water | Total | | 8/19/1980 | | 19.50 | deg C |
| S000-252 | Temperature, water | Total | | 9/23/1980 | | 9.00 | deg C |
| S000-252 | Temperature, water | Total | | 10/14/1980 | | 5.00 | deg C |
| S000-252 | Temperature, water | Total | | 1/14/1981 | | 0.00 | deg C |
| S000-252 | Temperature, water | Total | | 3/11/1981 | | 2.00 | deg C |
| S000-252 | Temperature, water | Total | | 4/14/1981 | | 1.50 | deg C |
| S000-252 | Temperature, water | Total | | 5/12/1981 | | 9.50 | deg C |
| S000-252 | Temperature, water | Total | | 6/16/1981 | | 16.00 | deg C |
| S000-252 | Temperature, water | Total | | 7/14/1981 | | 21.00 | deg C |
| S000-252 | Temperature, water | Total | | 8/12/1981 | | 20.00 | deg C |
| S000-252 | Temperature, water | Total | | 9/15/1981 | | 15.00 | deg C |
| S000-252 | Temperature, water | Total | | 10/12/1981 | | 10.00 | deg C |
| S000-252 | Temperature, water | Total | | 1/12/1982 | | 0.00 | deg C |
| S000-252 | Temperature, water | Total | | 3/16/1982 | | 1.50 | deg C |
| S000-252 | Temperature, water | Total | | 4/13/1982 | | 4.00 | deg C |
| S000-252 | Temperature, water | Total | | 5/11/1982 | | 12.00 | deg C |
| S000-252 | Temperature, water | Total | | 6/8/1982 | | 15.00 | deg C |
| S000-252 | Temperature, water | Total | | 7/13/1982 | | 17.00 | deg C |
| S000-252 | Temperature, water | Total | | 8/10/1982 | | 16.00 | deg C |
| S000-252 | Temperature, water | Total | | 9/8/1982 | | 15.00 | deg C |
| S000-252 | Temperature, water | Total | | 10/12/1982 | | 9.00 | deg C |
| S000-252 | Temperature, water | Total | | 1/12/1983 | | 0.00 | deg C |
| S000-252 | Temperature, water | Total | | 3/9/1983 | | 0.00 | deg C |
| S000-252 | Temperature, water | Total | | 4/12/1983 | | 0.00 | deg C |
| S000-252 | Temperature, water | Total | | 5/10/1983 | | 12.00 | deg C |
| S000-252 | Temperature, water | Total | | 6/14/1983 | | 19.00 | deg C |
| S000-252 | Temperature, water | Total | | 7/12/1983 | | 25.00 | deg C |
| S000-252 | Temperature, water | Total | | 8/9/1983 | | 21.00 | deg C |
| S000-252 | Temperature, water | Total | | 9/13/1983 | | 13.00 | deg C |
| S000-252 | Temperature, water | Total | | 10/27/1983 | | 6.00 | deg C |
| S000-252 | Temperature, water | Total | | 1/10/1984 | | 0.00 | deg C |
| S000-252 | Temperature, water | Total | | 3/13/1984 | | 0.00 | deg C |
| S000-252 | Temperature, water | Total | | 4/17/1984 | | 6.00 | deg C |
| S000-252 | Temperature, water | Total | | 5/15/1984 | | 12.50 | deg C |
| S000-252 | Temperature, water | Total | | 6/12/1984 | | 14.50 | deg C |
| S000-252 | Temperature, water | Total | | 7/17/1984 | | 17.00 | deg C |
| S000-252 | Temperature, water | Total | | 8/14/1984 | | 22.50 | deg C |
| S000-252 | Temperature, water | Total | | 9/18/1984 | | 17.00 | deg C |
| S000-252 | Temperature, water | Total | | 10/10/1984 | | 13.50 | deg C |
| S000-252 | Temperature, water | Total | | 1/14/1985 | | 0.00 | deg C |
| S000-252 | Temperature, water | Total | | 3/13/1985 | | 0.00 | deg C |
| S000-252 | Temperature, water | Total | | 4/15/1985 | | 3.00 | deg C |
| S000-252 | Temperature, water | Total | | 5/14/1985 | | 11.00 | deg C |
| S000-252 | Temperature, water | Total | | 6/10/1985 | | 18.00 | deg C |
| S000-252 | Temperature, water | Total | | 7/17/1985 | | 19.00 | deg C |
| S000-252 | Temperature, water | Total | | 8/13/1985 | | 16.00 | deg C |
| S000-252 | Temperature, water | Total | | 9/11/1985 | | 12.00 | deg C |
| S000-252 | Temperature, water | Total | | 10/15/1985 | | 5.00 | deg C |

# Appendix A
# Water Quality Dataset

| Station ID | Parameter | Sample Fraction Type | Lab Name Code | Sample Date | Detect Flag | Result | Result Unit |
|---|---|---|---|---|---|---|---|
| S000-252 | Temperature, water | Total | | 2/19/1986 | | 0.00 | deg C |
| S000-252 | Temperature, water | Total | | 3/20/1986 | | 0.00 | deg C |
| S000-252 | Temperature, water | Total | | 4/17/1986 | | 5.00 | deg C |
| S000-252 | Temperature, water | Total | | 5/12/1986 | | 13.50 | deg C |
| S000-252 | Temperature, water | Total | | 6/10/1986 | | 17.00 | deg C |
| S000-252 | Temperature, water | Total | | 7/15/1986 | | 16.00 | deg C |
| S000-252 | Temperature, water | Total | | 8/19/1986 | | 17.00 | deg C |
| S000-252 | Temperature, water | Total | | 9/24/1986 | | 9.00 | deg C |
| S000-252 | Temperature, water | Total | | 10/21/1986 | | 5.50 | deg C |
| S000-252 | Temperature, water | Total | | 1/13/1987 | | 0.00 | deg C |
| S000-252 | Temperature, water | Total | | 3/10/1987 | | 0.00 | deg C |
| S000-252 | Temperature, water | Total | | 4/7/1987 | | 0.00 | deg C |
| S000-252 | Temperature, water | Total | | 5/12/1987 | | 15.00 | deg C |
| S000-252 | Temperature, water | Total | | 6/9/1987 | | 11.00 | deg C |
| S000-252 | Temperature, water | Total | | 7/15/1987 | | 15.00 | deg C |
| S000-252 | Temperature, water | Total | | 8/11/1987 | | 24.00 | deg C |
| S000-252 | Temperature, water | Total | | 9/15/1987 | | 16.00 | deg C |
| S000-252 | Temperature, water | Total | | 10/14/1987 | | 8.00 | deg C |
| S000-252 | Temperature, water | Total | | 1/12/1988 | | 0.00 | deg C |
| S000-252 | Temperature, water | Total | | 3/15/1988 | | 0.00 | deg C |
| S000-252 | Temperature, water | Total | | 4/12/1988 | | 2.50 | deg C |
| S000-252 | Temperature, water | Total | | 5/9/1988 | | 10.00 | deg C |
| S000-252 | Temperature, water | Total | | 6/14/1988 | | 19.00 | deg C |
| S000-252 | Temperature, water | Total | | 7/12/1988 | | 19.00 | deg C |
| S000-252 | Temperature, water | Total | | 8/17/1988 | | 21.00 | deg C |
| S000-252 | Temperature, water | Total | | 9/13/1988 | | 12.00 | deg C |
| S000-252 | Temperature, water | Total | | 10/11/1988 | | 6.00 | deg C |
| S000-252 | Temperature, water | Total | | 3/14/1989 | | 0.00 | deg C |
| S000-252 | Temperature, water | Total | | 4/11/1989 | | 1.00 | deg C |
| S000-252 | Temperature, water | Total | | 5/9/1989 | | 7.00 | deg C |
| S000-252 | Temperature, water | Total | | 6/13/1989 | | 10.00 | deg C |
| S000-252 | Temperature, water | Total | | 7/18/1989 | | 22.00 | deg C |
| S000-252 | Temperature, water | Total | | 8/16/1989 | | 22.00 | deg C |
| S000-252 | Temperature, water | Total | | 9/12/1989 | | 12.00 | deg C |
| S000-252 | Temperature, water | Total | | 10/10/1989 | | 6.00 | deg C |
| S000-252 | Temperature, water | Total | | 1/4/1990 | | 0.00 | deg C |
| S000-252 | Temperature, water | Total | | 3/27/1990 | | 1.00 | deg C |
| S000-252 | Temperature, water | Total | | 5/2/1990 | | 4.00 | deg C |
| S000-252 | Temperature, water | Total | | 6/5/1990 | | 11.50 | deg C |
| S000-252 | Temperature, water | Total | | 7/17/1990 | | 17.00 | deg C |
| S000-252 | Temperature, water | Total | | 8/16/1990 | | 18.00 | deg C |
| S000-252 | Temperature, water | Total | | 9/25/1990 | | 12.00 | deg C |
| S000-252 | Temperature, water | Total | | 10/9/1990 | | 4.00 | deg C |
| S000-252 | Temperature, water | Total | | 1/29/1991 | | 0.00 | deg C |
| S000-252 | Temperature, water | Total | | 3/12/1991 | | 0.00 | deg C |
| S000-252 | Temperature, water | Total | | 4/23/1991 | | 7.50 | deg C |
| S000-252 | Temperature, water | Total | | 5/29/1991 | | 20.00 | deg C |
| S000-252 | Temperature, water | Total | | 6/25/1991 | | 25.00 | deg C |
| S000-252 | Temperature, water | Total | | 7/30/1991 | | 22.00 | deg C |
| S000-252 | Temperature, water | Total | | 8/27/1991 | | 26.50 | deg C |
| S000-252 | Temperature, water | Total | | 9/18/1991 | | 12.00 | deg C |
| S000-252 | Temperature, water | Total | | 10/23/1991 | | 3.00 | deg C |
| S000-252 | Temperature, water | Total | | 1/28/1992 | | 0.00 | deg C |
| S000-252 | Temperature, water | Total | | 3/24/1992 | | 1.50 | deg C |
| S000-252 | Temperature, water | Total | | 4/21/1992 | | 1.50 | deg C |
| S000-252 | Temperature, water | Total | | 5/6/1992 | | 11.50 | deg C |
| S000-252 | Temperature, water | Total | | 6/2/1992 | | 22.50 | deg C |
| S000-252 | Temperature, water | Total | | 7/21/1992 | | 19.50 | deg C |
| S000-252 | Temperature, water | Total | | 8/11/1992 | | 19.00 | deg C |
| S000-252 | Temperature, water | Total | | 9/23/1992 | | 8.00 | deg C |
| S000-252 | Temperature, water | Total | | 10/21/1992 | | 3.00 | deg C |
| S000-252 | Temperature, water | Total | | 1/6/1993 | | 0.00 | deg C |
| S000-252 | Temperature, water | Total | | 3/3/1993 | | 0.00 | deg C |
| S000-252 | Temperature, water | Total | | 4/28/1993 | | 6.00 | deg C |
| S000-252 | Temperature, water | Total | | 5/27/1993 | | 11.00 | deg C |
| S000-252 | Temperature, water | Total | | 6/23/1993 | | 17.50 | deg C |
| S000-252 | Temperature, water | Total | | 7/21/1993 | | 18.00 | deg C |
| S000-252 | Temperature, water | Total | | 8/25/1993 | | 22.00 | deg C |
| S000-252 | Temperature, water | Total | | 9/22/1993 | | 12.50 | deg C |
| S000-252 | Temperature, water | Total | | 10/14/1993 | | 8.00 | deg C |
| S000-252 | Temperature, water | Total | | 1/11/1994 | | 0.00 | deg C |
| S000-252 | Temperature, water | Total | | 3/15/1994 | | 0.00 | deg C |
| S000-252 | Temperature, water | Total | | 4/13/1994 | | 1.00 | deg C |

# Appendix A
# Water Quality Dataset

| Station ID | Parameter | Sample Fraction Type | Lab Name Code | Sample Date | Detect Flag | Result | Result Unit |
|---|---|---|---|---|---|---|---|
| S000-252 | Temperature, water | Total | | 5/19/1994 | | 11.50 | deg C |
| S000-252 | Temperature, water | Total | | 6/15/1994 | | 18.00 | deg C |
| S000-252 | Temperature, water | Total | | 7/20/1994 | | 21.00 | deg C |
| S000-252 | Temperature, water | Total | | 8/25/1994 | | 18.50 | deg C |
| S000-252 | Temperature, water | Total | | 9/13/1994 | | 18.00 | deg C |
| S000-252 | Temperature, water | Total | | 10/19/1994 | | 12.00 | deg C |
| S000-252 | Temperature, water | Total | | 11/7/1994 | | 4.00 | deg C |
| S000-252 | Temperature, water | Total | | 1/19/1995 | | 0.00 | deg C |
| S000-252 | Temperature, water | Total | | 3/16/1995 | | 0.00 | deg C |
| S000-252 | Temperature, water | Total | | 4/12/1995 | | 0.50 | deg C |
| S000-252 | Temperature, water | Total | | 5/18/1995 | | 11.50 | deg C |
| S000-252 | Temperature, water | Total | | 6/13/1995 | | 21.00 | deg C |
| S000-252 | Temperature, water | Total | | 7/26/1995 | | 19.50 | deg C |
| S000-252 | Temperature, water | Total | | 8/14/1995 | | 24.50 | deg C |
| S000-252 | Temperature, water | Total | | 9/12/1995 | | 16.00 | deg C |
| S000-252 | Temperature, water | Total | | 10/21/1997 | | 4.00 | deg C |
| S000-252 | Temperature, water | Total | | 11/3/1997 | | 2.50 | deg C |
| S000-252 | Temperature, water | Total | | 1/28/1998 | | 0.00 | deg C |
| S000-252 | Temperature, water | Total | | 3/17/1998 | | 2.00 | deg C |
| S000-252 | Temperature, water | Total | | 4/14/1998 | | 5.00 | deg C |
| S000-252 | Temperature, water | Total | | 5/27/1998 | | 20.00 | deg C |
| S000-252 | Temperature, water | Total | | 6/16/1998 | | 22.50 | deg C |
| S000-252 | Temperature, water | Total | | 7/13/1998 | | 28.00 | deg C |
| S000-252 | Temperature, water | Total | | 8/12/1998 | | 24.50 | deg C |
| S000-252 | Temperature, water | Total | | 9/22/1998 | | 13.50 | deg C |
| S000-252 | Temperature, water | Total | | 10/10/1999 | | 10.50 | deg C |
| S000-252 | Temperature, water | Total | | 11/21/1999 | | 1.50 | deg C |
| S000-252 | Temperature, water | Total | | 1/16/2000 | | 0.00 | deg C |
| S000-252 | Temperature, water | Total | | 3/19/2000 | | 2.00 | deg C |
| S000-252 | Temperature, water | Total | | 4/16/2000 | | 2.00 | deg C |
| S000-252 | Temperature, water | Total | | 5/23/2000 | | 17.50 | deg C |
| S000-252 | Temperature, water | Total | | 6/25/2000 | | 19.00 | deg C |
| S000-252 | Temperature, water | Total | | 8/14/2000 | | 18.00 | deg C |
| S000-252 | Temperature, water | Total | | 9/5/2000 | | 16.50 | deg C |
| S000-252 | Temperature, water | Total | | 10/17/2002 | | 2.98 | deg C |
| S000-252 | Temperature, water | Total | | 11/3/2002 | | 1.20 | deg C |
| S000-252 | Temperature, water | Total | | 1/28/2003 | | 0.00 | deg C |
| S000-252 | Temperature, water | Total | | 3/18/2003 | | 0.60 | deg C |
| S000-252 | Temperature, water | Total | | 4/29/2003 | | 7.93 | deg C |
| S000-252 | Temperature, water | Total | | 5/20/2003 | | 8.15 | deg C |
| S000-252 | Temperature, water | Total | | 6/24/2003 | | 20.13 | deg C |
| S000-252 | Temperature, water | Total | | 7/28/2003 | | 22.73 | deg C |
| S000-252 | Temperature, water | Total | | 8/5/2003 | | 20.90 | deg C |
| S000-252 | Temperature, water | Total | | 9/8/2003 | | 18.42 | deg C |
| S000-252 | Temperature, water | Total | | 10/13/2003 | | 9.16 | deg C |
| S000-252 | Temperature, water | Total | | 10/13/2004 | | 9.50 | deg C |
| S000-252 | Temperature, water | Total | | 11/21/2004 | | 1.27 | deg C |
| S000-252 | Temperature, water | Total | | 2/1/2005 | | -0.11 | deg C |
| S000-252 | Temperature, water | Total | | 3/2/2005 | | -0.20 | deg C |
| S000-252 | Temperature, water | Total | | 4/20/2005 | | 10.30 | deg C |
| S000-252 | Temperature, water | Total | | 5/25/2005 | | 14.11 | deg C |
| S000-252 | Temperature, water | Total | | 6/1/2005 | | 17.99 | deg C |
| S000-252 | Temperature, water | Total | | 7/11/2005 | | 25.89 | deg C |
| S000-252 | Temperature, water | Total | | 8/24/2005 | | 18.17 | deg C |
| S000-252 | Temperature, water | Total | | 9/19/2005 | | 15.83 | deg C |
| S000-252 | Temperature, water | Total | | 4/3/2006 | | 0.29 | deg C |
| S000-252 | Temperature, water | Total | | 5/25/2006 | | 15.05 | deg C |
| S000-252 | Temperature, water | Total | | 6/5/2006 | | 16.84 | deg C |
| S000-252 | Temperature, water | Total | | 8/7/2006 | | 23.49 | deg C |
| S000-252 | Temperature, water | Total | | 10/17/2006 | | 7.36 | deg C |
| S000-252 | Temperature, water | Total | | 10/8/2007 | | 11.91 | deg C |
| S000-252 | Temperature, water | Total | | 11/13/2007 | | 1.86 | deg C |
| S000-252 | Temperature, water | Total | | 2/12/2008 | | -0.01 | deg C |
| S000-252 | Temperature, water | Total | | 3/31/2008 | | 1.08 | deg C |
| S000-252 | Temperature, water | Total | | 4/21/2008 | | 3.51 | deg C |
| S000-252 | Temperature, water | Total | | 5/13/2008 | | 7.03 | deg C |
| S000-252 | Temperature, water | Total | | 6/4/2008 | | 12.38 | deg C |
| S000-252 | Temperature, water | Total | | 7/21/2008 | | 20.65 | deg C |
| S000-252 | Temperature, water | Total | | 8/18/2008 | | 22.97 | deg C |
| S000-252 | Temperature, water | Total | | 9/16/2008 | | 16.47 | deg C |
| S000-252 | Temperature, water | Total | | 10/26/2009 | | 4.94 | deg C |
| S000-252 | Temperature, water | Total | | 11/30/2009 | | 0.01 | deg C |
| S000-252 | Temperature, water | Total | | 1/25/2010 | | -0.04 | deg C |

# Appendix A
# Water Quality Dataset

| Station ID | Parameter | Sample Fraction Type | Lab Name Code | Sample Date | Detect Flag | Result | Result Unit |
|---|---|---|---|---|---|---|---|
| S000-252 | Temperature, water | Total | | 3/1/2010 | | -0.04 | deg C |
| S000-252 | Temperature, water | Total | | 4/26/2010 | | 12.36 | deg C |
| S000-252 | Temperature, water | Total | | 5/11/2010 | | 9.15 | deg C |
| S000-252 | Temperature, water | Total | | 6/7/2010 | | 19.29 | deg C |
| S000-252 | Temperature, water | Total | | 7/18/2010 | | 26.50 | deg C |
| S000-252 | Temperature, water | Total | | 8/22/2010 | | 23.62 | deg C |
| S000-252 | Temperature, water | Total | | 9/27/2010 | | 9.61 | deg C |
| S000-252 | Temperature, water | Total | | 5/2/2013 | | 0.41 | deg C |
| S000-252 | Temperature, water | Total | | 6/6/2013 | | 11.81 | deg C |
| S000-252 | Temperature, water | Total | | 9/12/2013 | | 19.67 | deg C |
| S000-252 | Temperature, water | Total | | 10/7/2013 | | 10.92 | deg C |
| S000-252 | Temperature, water | Total | | 4/24/2014 | | 0.20 | deg C |
| S000-252 | Temperature, water | Total | | 7/23/2014 | | 22.13 | deg C |
| S000-252 | Temperature, water | Total | | 10/16/2014 | | 6.38 | deg C |
| S000-252 | Temperature, water | Total | | 9/22/2015 | | 15.30 | deg C |
| S000-252 | Temperature, water | Total | | 9/24/2015 | | 12.38 | deg C |
| S000-252 | Temperature, water | Total | | 10/22/2015 | | 5.86 | deg C |
| S000-252 | Terbufos | Total | UNKNOWN | 6/14/1988 | < | 0.05 | ug/L |
| S000-252 | Terbufos | Total | UNKNOWN | 6/14/1988 | < | 0.05 | ug/L |
| S000-252 | Terbufos | Total | MN00100 | 5/29/1991 | < | 0.15 | ug/L |
| S000-252 | Terbufos | Total | MN00100 | 6/25/1991 | < | 0.15 | ug/L |
| S000-252 | Terbufos | Total | MN00100 | 6/25/1991 | < | 0.15 | ug/L |
| S000-252 | Terbufos | Total | MN00100 | 7/30/1991 | < | 0.15 | ug/L |
| S000-252 | Terbufos | Total | MN00100 | 5/6/1992 | < | 0.15 | ug/L |
| S000-252 | Terbufos | Total | MN00100 | 6/2/1992 | < | 0.15 | ug/L |
| S000-252 | Terbufos | Total | MN00100 | 7/21/1992 | < | 0.15 | ug/L |
| S000-252 | Terbufos | Total | MN00100 | 5/27/1993 | < | 0.15 | ug/L |
| S000-252 | Terbufos | Total | MN00100 | 6/23/1993 | < | 0.15 | ug/L |
| S000-252 | Terbufos | Total | MN00100 | 7/21/1993 | < | 0.15 | ug/L |
| S000-252 | Total Coliform | Total | UNKNOWN | 7/24/1973 | | 2200.00 | /100mL |
| S000-252 | Total Coliform | Total | UNKNOWN | 8/29/1973 | | 790.00 | /100mL |
| S000-252 | Total Coliform | Total | UNKNOWN | 9/13/1973 | | 110.00 | /100mL |
| S000-252 | Total Coliform | Total | UNKNOWN | 9/26/1973 | | 790.00 | /100mL |
| S000-252 | Total Coliform | Total | UNKNOWN | 10/17/1973 | | 170.00 | /100mL |
| S000-252 | Total Coliform | Total | UNKNOWN | 11/14/1973 | | 1300.00 | /100mL |
| S000-252 | Total Coliform | Total | UNKNOWN | 12/5/1973 | | 170.00 | /100mL |
| S000-252 | Total Coliform | Total | UNKNOWN | 1/29/1974 | | 27.00 | /100mL |
| S000-252 | Total Coliform | Total | UNKNOWN | 2/26/1974 | | 330.00 | /100mL |
| S000-252 | Total Coliform | Total | UNKNOWN | 3/12/1974 | | 350.00 | /100mL |
| S000-252 | Total Coliform | Total | UNKNOWN | 4/2/1974 | | 140.00 | /100mL |
| S000-252 | Total Coliform | Total | UNKNOWN | 4/9/1974 | | 490.00 | /100mL |
| S000-252 | Total Coliform | Total | UNKNOWN | 4/24/1974 | | 36.00 | /100mL |
| S000-252 | Total Coliform | Total | UNKNOWN | 5/8/1974 | | 79.00 | /100mL |
| S000-252 | Total Coliform | Total | UNKNOWN | 5/15/1974 | | 230.00 | /100mL |
| S000-252 | Total Coliform | Total | UNKNOWN | 6/18/1974 | | 330.00 | /100mL |
| S000-252 | Total Coliform | Total | UNKNOWN | 7/10/1974 | | 330.00 | /100mL |
| S000-252 | Total Coliform | Total | UNKNOWN | 8/13/1974 | | 700.00 | /100mL |
| S000-252 | Total Coliform | Total | UNKNOWN | 9/12/1974 | | 700.00 | /100mL |
| S000-252 | Total Coliform | Total | UNKNOWN | 10/9/1974 | | 110.00 | /100mL |
| S000-252 | Total Coliform | Total | UNKNOWN | 11/5/1974 | | 230.00 | /100mL |
| S000-252 | Total Coliform | Total | UNKNOWN | 12/11/1974 | | 49.00 | /100mL |
| S000-252 | Total Coliform | Total | UNKNOWN | 1/16/1975 | | 1700.00 | /100mL |
| S000-252 | Total Coliform | Total | UNKNOWN | 2/26/1975 | | 230.00 | /100mL |
| S000-252 | Total Coliform | Total | UNKNOWN | 4/2/1975 | | 110.00 | /100mL |
| S000-252 | Total Coliform | Total | UNKNOWN | 4/17/1975 | | 1300.00 | /100mL |
| S000-252 | Total Coliform | Total | UNKNOWN | 5/1/1975 | | 130.00 | /100mL |
| S000-252 | Total Coliform | Total | UNKNOWN | 5/8/1975 | | 330.00 | /100mL |
| S000-252 | Total Coliform | Total | UNKNOWN | 5/15/1975 | | 1300.00 | /100mL |
| S000-252 | Total Coliform | Total | UNKNOWN | 5/22/1975 | | 230.00 | /100mL |
| S000-252 | Total Coliform | Total | UNKNOWN | 6/18/1975 | | 330.00 | /100mL |
| S000-252 | Total Coliform | Total | UNKNOWN | 7/26/1976 | | 1100.00 | /100mL |
| S000-252 | Total dissolved solids | Total | UNKNOWN | 1/29/1974 | | 63.20 | mg/L |
| S000-252 | Total dissolved solids | Total | UNKNOWN | 2/26/1974 | | 91.40 | mg/L |
| S000-252 | Total dissolved solids | Total | UNKNOWN | 3/12/1974 | | 84.00 | mg/L |
| S000-252 | Total dissolved solids | Total | UNKNOWN | 4/2/1974 | | 95.60 | mg/L |
| S000-252 | Total dissolved solids | Total | UNKNOWN | 4/9/1974 | | 92.00 | mg/L |
| S000-252 | Total dissolved solids | Total | UNKNOWN | 4/24/1974 | | 46.00 | mg/L |
| S000-252 | Total dissolved solids | Total | UNKNOWN | 5/8/1974 | | 54.60 | mg/L |
| S000-252 | Total dissolved solids | Total | UNKNOWN | 5/15/1974 | | 45.00 | mg/L |
| S000-252 | Total dissolved solids | Total | UNKNOWN | 6/18/1974 | | 78.00 | mg/L |
| S000-252 | Total dissolved solids | Total | UNKNOWN | 7/10/1974 | | 56.00 | mg/L |
| S000-252 | Total dissolved solids | Total | UNKNOWN | 8/13/1974 | | 106.00 | mg/L |
| S000-252 | Total dissolved solids | Total | UNKNOWN | 9/12/1974 | | 95.20 | mg/L |

# Appendix A
# Water Quality Dataset

| Station ID | Parameter | Sample Fraction Type | Lab Name Code | Sample Date | Detect Flag | Result | Result Unit |
|---|---|---|---|---|---|---|---|
| S000-252 | Total dissolved solids | Total | UNKNOWN | 10/9/1974 | | 96.40 | mg/L |
| S000-252 | Total dissolved solids | Total | UNKNOWN | 11/5/1974 | | 92.40 | mg/L |
| S000-252 | Total dissolved solids | Total | UNKNOWN | 12/11/1974 | | 106.00 | mg/L |
| S000-252 | Total dissolved solids | Total | UNKNOWN | 1/16/1975 | | 88.60 | mg/L |
| S000-252 | Total dissolved solids | Total | UNKNOWN | 2/26/1975 | | 90.60 | mg/L |
| S000-252 | Total dissolved solids | Total | UNKNOWN | 4/2/1975 | | 94.00 | mg/L |
| S000-252 | Total dissolved solids | Total | UNKNOWN | 4/17/1975 | | 85.00 | mg/L |
| S000-252 | Total dissolved solids | Total | UNKNOWN | 5/1/1975 | | 62.80 | mg/L |
| S000-252 | Total dissolved solids | Total | UNKNOWN | 5/8/1975 | | 63.00 | mg/L |
| S000-252 | Total dissolved solids | Total | UNKNOWN | 5/15/1975 | | 57.40 | mg/L |
| S000-252 | Total dissolved solids | Total | UNKNOWN | 5/22/1975 | | 71.00 | mg/L |
| S000-252 | Total dissolved solids | Total | UNKNOWN | 6/18/1975 | | 91.20 | mg/L |
| S000-252 | Total solids | Total | UNKNOWN | 1/29/1974 | | 66.00 | mg/L |
| S000-252 | Total solids | Total | UNKNOWN | 2/26/1974 | | 95.00 | mg/L |
| S000-252 | Total solids | Total | UNKNOWN | 3/12/1974 | | 90.00 | mg/L |
| S000-252 | Total solids | Total | UNKNOWN | 4/2/1974 | | 96.00 | mg/L |
| S000-252 | Total solids | Total | UNKNOWN | 4/9/1974 | | 96.00 | mg/L |
| S000-252 | Total solids | Total | UNKNOWN | 4/24/1974 | | 62.00 | mg/L |
| S000-252 | Total solids | Total | UNKNOWN | 5/8/1974 | | 59.00 | mg/L |
| S000-252 | Total solids | Total | UNKNOWN | 5/15/1974 | | 63.00 | mg/L |
| S000-252 | Total solids | Total | UNKNOWN | 6/18/1974 | | 80.00 | mg/L |
| S000-252 | Total solids | Total | UNKNOWN | 7/10/1974 | | 62.00 | mg/L |
| S000-252 | Total solids | Total | UNKNOWN | 8/13/1974 | | 110.00 | mg/L |
| S000-252 | Total solids | Total | UNKNOWN | 9/12/1974 | | 100.00 | mg/L |
| S000-252 | Total solids | Total | UNKNOWN | 10/9/1974 | | 100.00 | mg/L |
| S000-252 | Total solids | Total | UNKNOWN | 11/5/1974 | | 98.00 | mg/L |
| S000-252 | Total solids | Total | UNKNOWN | 12/11/1974 | | 110.00 | mg/L |
| S000-252 | Total solids | Total | UNKNOWN | 1/16/1975 | | 95.00 | mg/L |
| S000-252 | Total solids | Total | UNKNOWN | 2/26/1975 | | 97.00 | mg/L |
| S000-252 | Total solids | Total | UNKNOWN | 4/2/1975 | | 94.00 | mg/L |
| S000-252 | Total solids | Total | UNKNOWN | 4/17/1975 | | 98.00 | mg/L |
| S000-252 | Total solids | Total | UNKNOWN | 5/1/1975 | | 66.00 | mg/L |
| S000-252 | Total solids | Total | UNKNOWN | 5/8/1975 | | 67.00 | mg/L |
| S000-252 | Total solids | Total | UNKNOWN | 5/15/1975 | | 63.00 | mg/L |
| S000-252 | Total solids | Total | UNKNOWN | 5/22/1975 | | 73.00 | mg/L |
| S000-252 | Total solids | Total | UNKNOWN | 6/18/1975 | | 94.00 | mg/L |
| S000-252 | Total solids | Total | UNKNOWN | 7/26/1976 | | 120.00 | mg/L |
| S000-252 | Total solids | Total | UNKNOWN | 8/23/1976 | | 160.00 | mg/L |
| S000-252 | Total solids | Total | UNKNOWN | 9/20/1976 | | 150.00 | mg/L |
| S000-252 | Total solids | Total | UNKNOWN | 10/18/1976 | | 130.00 | mg/L |
| S000-252 | Total solids | Total | UNKNOWN | 11/16/1976 | | 170.00 | mg/L |
| S000-252 | Total solids | Total | UNKNOWN | 3/22/1977 | | 160.00 | mg/L |
| S000-252 | Total solids | Total | UNKNOWN | 4/25/1977 | | 120.00 | mg/L |
| S000-252 | Total solids | Total | UNKNOWN | 5/23/1977 | | 130.00 | mg/L |
| S000-252 | Total solids | Total | UNKNOWN | 6/27/1977 | | 120.00 | mg/L |
| S000-252 | Total solids | Total | UNKNOWN | 7/25/1977 | | 120.00 | mg/L |
| S000-252 | Total solids | Total | UNKNOWN | 8/22/1977 | | 92.00 | mg/L |
| S000-252 | Total solids | Total | UNKNOWN | 9/26/1977 | | 110.00 | mg/L |
| S000-252 | Total solids | Total | UNKNOWN | 6/28/1978 | | 76.00 | % |
| S000-252 | Total suspended solids | Total | UNKNOWN | 7/24/1973 | | 4.00 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 8/29/1973 | | 5.00 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 9/13/1973 | | 5.00 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 9/26/1973 | | 4.00 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 10/17/1973 | | 2.00 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 11/14/1973 | | 3.00 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 12/5/1973 | | 2.00 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 1/29/1974 | | 2.80 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 2/26/1974 | | 3.60 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 3/12/1974 | | 6.00 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 4/2/1974 | | 0.40 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 4/9/1974 | | 4.00 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 4/24/1974 | | 16.00 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 5/8/1974 | | 4.40 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 5/15/1974 | | 18.00 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 6/18/1974 | | 2.00 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 7/10/1974 | | 6.00 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 8/13/1974 | | 4.00 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 9/12/1974 | | 4.80 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 10/9/1974 | | 3.60 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 11/5/1974 | | 5.60 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 12/11/1974 | | 4.00 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 1/16/1975 | | 6.40 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 2/26/1975 | | 6.40 | mg/L |

# Appendix A
# Water Quality Dataset

| Station ID | Parameter | Sample Fraction Type | Lab Name Code | Sample Date | Detect Flag | Result | Result Unit |
|---|---|---|---|---|---|---|---|
| S000-252 | Total suspended solids | Total | UNKNOWN | 4/2/1975 | < | 0.50 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 4/17/1975 | | 13.00 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 5/1/1975 | | 3.20 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 5/8/1975 | | 4.00 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 5/15/1975 | | 5.60 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 5/22/1975 | | 2.00 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 6/18/1975 | | 2.80 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 7/26/1976 | | 7.20 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 8/23/1976 | | 15.00 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 9/20/1976 | | 8.80 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 10/18/1976 | < | 0.50 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 11/16/1976 | < | 0.50 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 3/22/1977 | | 1.20 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 4/25/1977 | | 8.40 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 5/23/1977 | | 6.00 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 6/27/1977 | | 3.60 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 7/25/1977 | | 2.40 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 8/22/1977 | | 4.40 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 9/26/1977 | | 17.00 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 10/24/1977 | < | 0.50 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 11/14/1977 | | 5.20 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 12/19/1977 | | 4.80 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 1/23/1978 | | 0.80 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 2/21/1978 | | 1.60 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 3/1/1978 | | 0.80 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 4/4/1978 | | 4.40 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 5/1/1978 | | 3.20 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 6/6/1978 | | 43.00 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 7/6/1978 | | 5.20 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 8/1/1978 | | 1.60 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 9/6/1978 | | 1.20 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 10/3/1978 | | 9.40 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 11/8/1978 | < | 0.50 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 12/6/1978 | | 4.00 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 1/16/1979 | < | 0.50 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 2/21/1979 | < | 0.50 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 3/20/1979 | | 2.80 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 4/4/1979 | < | 0.50 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 5/2/1979 | | 6.00 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 6/19/1979 | | 1.20 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 7/24/1979 | | 86.00 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 7/31/1979 | | 14.00 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 8/21/1979 | | 3.60 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 10/16/1979 | | 3.20 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 12/18/1979 | | 2.80 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 1/22/1980 | | 2.40 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 2/27/1980 | | 1.80 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 3/19/1980 | | 2.80 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 4/22/1980 | | 9.60 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 5/20/1980 | | 4.00 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 6/17/1980 | | 3.20 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 7/22/1980 | | 5.20 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 8/19/1980 | | 8.00 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 9/23/1980 | | 3.60 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 10/14/1980 | | 2.80 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 1/14/1981 | | 2.00 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 3/11/1981 | | 0.80 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 4/14/1981 | | 8.40 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 5/12/1981 | | 2.00 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 6/16/1981 | | 2.40 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 7/14/1981 | | 2.00 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 8/12/1981 | | 2.80 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 9/15/1981 | | 2.40 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 10/12/1981 | | 4.80 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 1/12/1982 | | 1.20 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 3/16/1982 | | 2.40 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 4/13/1982 | | 18.00 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 5/11/1982 | | 4.40 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 6/8/1982 | | 2.00 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 7/13/1982 | | 4.80 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 8/10/1982 | | 2.00 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 9/8/1982 | | 1.20 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 10/12/1982 | | 2.40 | mg/L |

# Appendix A
# Water Quality Dataset

| Station ID | Parameter | Sample Fraction Type | Lab Name Code | Sample Date | Detect Flag | Result | Result Unit |
|---|---|---|---|---|---|---|---|
| S000-252 | Total suspended solids | Total | UNKNOWN | 1/12/1983 | < | 0.50 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 3/9/1983 | | 4.00 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 4/12/1983 | | 14.00 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 5/10/1983 | | 1.20 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 6/14/1983 | | 3.20 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 7/12/1983 | | 2.80 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 8/9/1983 | | 1.20 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 9/13/1983 | | 3.60 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 10/27/1983 | | 2.40 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 1/10/1984 | | 1.60 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 3/13/1984 | | 1.80 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 4/17/1984 | | 8.30 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 5/15/1984 | | 3.10 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 6/12/1984 | | 4.70 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 7/17/1984 | | 0.64 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 8/14/1984 | | 2.00 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 9/18/1984 | | 1.40 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 10/10/1984 | | 0.96 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 1/14/1985 | | 1.30 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 3/13/1985 | | 2.50 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 4/15/1985 | | 98.00 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 5/14/1985 | | 4.60 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 6/10/1985 | | 2.70 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 7/17/1985 | | 1.90 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 8/13/1985 | | 12.00 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 9/11/1985 | | 1.80 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 10/15/1985 | | 1.40 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 2/19/1986 | | 0.68 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 3/20/1986 | | 2.10 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 4/17/1986 | | 2.80 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 5/12/1986 | | 3.20 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 6/10/1986 | | 1.20 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 7/15/1986 | | 5.40 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 8/19/1986 | | 2.60 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 9/24/1986 | | 2.40 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 10/21/1986 | | 1.40 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 1/13/1987 | | 1.40 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 3/10/1987 | | 2.80 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 4/7/1987 | | 5.00 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 5/12/1987 | | 1.50 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 6/9/1987 | | 1.20 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 7/15/1987 | | 1.50 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 8/11/1987 | | 1.60 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 9/15/1987 | | 1.60 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 10/14/1987 | | 1.20 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 1/12/1988 | | 1.40 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 3/15/1988 | | 2.10 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 4/12/1988 | | 9.00 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 5/9/1988 | | 55.00 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 6/14/1988 | | 2.00 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 7/12/1988 | | 1.60 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 8/17/1988 | | 5.80 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 9/13/1988 | | 0.80 | mg/L |
| S000-252 | Total suspended solids | Total | UNKNOWN | 10/11/1988 | | 5.00 | mg/L |
| S000-252 | Total suspended solids | Total | MN00006 | 3/14/1989 | | 0.80 | mg/L |
| S000-252 | Total suspended solids | Total | MN00006 | 4/11/1989 | | 1.60 | mg/L |
| S000-252 | Total suspended solids | Total | MN00006 | 5/9/1989 | < | 0.50 | mg/L |
| S000-252 | Total suspended solids | Total | MN00006 | 6/13/1989 | | 11.00 | mg/L |
| S000-252 | Total suspended solids | Total | MN00006 | 7/18/1989 | | 1.80 | mg/L |
| S000-252 | Total suspended solids | Total | MN00006 | 8/16/1989 | | 0.80 | mg/L |
| S000-252 | Total suspended solids | Total | MN00006 | 9/12/1989 | | 1.20 | mg/L |
| S000-252 | Total suspended solids | Total | MN00006 | 10/10/1989 | | 1.00 | mg/L |
| S000-252 | Total suspended solids | Total | MN00006 | 1/4/1990 | | 5.00 | mg/L |
| S000-252 | Total suspended solids | Total | MN00006 | 3/27/1990 | | 1.80 | mg/L |
| S000-252 | Total suspended solids | Total | MN00006 | 5/2/1990 | | 9.00 | mg/L |
| S000-252 | Total suspended solids | Total | MN00006 | 6/5/1990 | | 2.40 | mg/L |
| S000-252 | Total suspended solids | Total | MN00006 | 7/17/1990 | | 1.20 | mg/L |
| S000-252 | Total suspended solids | Total | MN00006 | 8/16/1990 | | 2.60 | mg/L |
| S000-252 | Total suspended solids | Total | MN00006 | 9/25/1990 | | 2.00 | mg/L |
| S000-252 | Total suspended solids | Total | MN00006 | 10/9/1990 | | 0.60 | mg/L |
| S000-252 | Total suspended solids | Total | MN00006 | 1/29/1991 | | 0.60 | mg/L |
| S000-252 | Total suspended solids | Total | MN00006 | 3/12/1991 | | 0.60 | mg/L |
| S000-252 | Total suspended solids | Total | MN00006 | 4/23/1991 | | 1.60 | mg/L |

# Appendix A
# Water Quality Dataset

| Station ID | Parameter | Sample Fraction Type | Lab Name Code | Sample Date | Detect Flag | Result | Result Unit |
|---|---|---|---|---|---|---|---|
| S000-252 | Total suspended solids | Total | MN00006 | 5/29/1991 | | 1.40 | mg/L |
| S000-252 | Total suspended solids | Total | MN00006 | 6/25/1991 | | 2.00 | mg/L |
| S000-252 | Total suspended solids | Total | MN00006 | 7/30/1991 | | 2.20 | mg/L |
| S000-252 | Total suspended solids | Total | MN00006 | 8/27/1991 | | 1.60 | mg/L |
| S000-252 | Total suspended solids | Total | MN00006 | 9/18/1991 | | 4.80 | mg/L |
| S000-252 | Total suspended solids | Total | MN00006 | 10/23/1991 | | 1.20 | mg/L |
| S000-252 | Total suspended solids | Total | MN00006 | 1/28/1992 | | 1.40 | mg/L |
| S000-252 | Total suspended solids | Total | MN00006 | 3/24/1992 | | 3.20 | mg/L |
| S000-252 | Total suspended solids | Total | MN00006 | 4/21/1992 | | 46.00 | mg/L |
| S000-252 | Total suspended solids | Total | MN00006 | 5/6/1992 | | 2.00 | mg/L |
| S000-252 | Total suspended solids | Total | MN00006 | 6/2/1992 | | 0.80 | mg/L |
| S000-252 | Total suspended solids | Total | MN00006 | 7/21/1992 | | 2.20 | mg/L |
| S000-252 | Total suspended solids | Total | MN00006 | 8/11/1992 | | 2.00 | mg/L |
| S000-252 | Total suspended solids | Total | MN00006 | 9/23/1992 | | 1.00 | mg/L |
| S000-252 | Total suspended solids | Total | MN00006 | 10/21/1992 | | 0.60 | mg/L |
| S000-252 | Total suspended solids | Total | MN00006 | 1/6/1993 | | 2.40 | mg/L |
| S000-252 | Total suspended solids | Total | MN00006 | 3/3/1993 | | 2.00 | mg/L |
| S000-252 | Total suspended solids | Total | MN00006 | 4/28/1993 | | 12.00 | mg/L |
| S000-252 | Total suspended solids | Total | MN00006 | 5/27/1993 | | 1.60 | mg/L |
| S000-252 | Total suspended solids | Total | MN00006 | 6/23/1993 | | 0.80 | mg/L |
| S000-252 | Total suspended solids | Total | MN00006 | 7/21/1993 | | 1.40 | mg/L |
| S000-252 | Total suspended solids | Total | MN00006 | 8/25/1993 | | 2.00 | mg/L |
| S000-252 | Total suspended solids | Total | MN00006 | 9/22/1993 | | 1.60 | mg/L |
| S000-252 | Total suspended solids | Total | MN00006 | 10/14/1993 | | 0.80 | mg/L |
| S000-252 | Total suspended solids | Total | MN00006 | 1/11/1994 | | 2.00 | mg/L |
| S000-252 | Total suspended solids | Total | MN00006 | 3/15/1994 | | 1.40 | mg/L |
| S000-252 | Total suspended solids | Total | MN00006 | 4/13/1994 | | 30.00 | mg/L |
| S000-252 | Total suspended solids | Total | MN00006 | 5/19/1994 | | 1.80 | mg/L |
| S000-252 | Total suspended solids | Total | MN00006 | 6/15/1994 | | 13.00 | mg/L |
| S000-252 | Total suspended solids | Total | MN00006 | 7/20/1994 | | 8.60 | mg/L |
| S000-252 | Total suspended solids | Total | MN00006 | 8/25/1994 | | 1.60 | mg/L |
| S000-252 | Total suspended solids | Total | MN00006 | 9/13/1994 | | 1.20 | mg/L |
| S000-252 | Total suspended solids | Total | MN00006 | 10/19/1994 | | 8.60 | mg/L |
| S000-252 | Total suspended solids | Total | MN00006 | 11/7/1994 | < | 0.50 | mg/L |
| S000-252 | Total suspended solids | Total | MN00006 | 10/17/2002 | < | 1.00 | mg/L |
| S000-252 | Total suspended solids | Total | MN00006 | 11/3/2002 | < | 1.00 | mg/L |
| S000-252 | Total suspended solids | Total | MN00006 | 1/28/2003 | | 1.20 | mg/L |
| S000-252 | Total suspended solids | Total | MN00006 | 3/18/2003 | < | 1.00 | mg/L |
| S000-252 | Total suspended solids | Total | MN00006 | 4/29/2003 | | 2.80 | mg/L |
| S000-252 | Total suspended solids | Total | MN00006 | 5/20/2003 | | 15.00 | mg/L |
| S000-252 | Total suspended solids | Total | MN00006 | 6/24/2003 | | 1.80 | mg/L |
| S000-252 | Total suspended solids | Total | MN00006 | 7/28/2003 | | 2.00 | mg/L |
| S000-252 | Total suspended solids | Total | MN00006 | 8/5/2003 | | 1.60 | mg/L |
| S000-252 | Total suspended solids | Total | MN00006 | 9/8/2003 | < | 1.00 | mg/L |
| S000-252 | Total suspended solids | Total | MN00006 | 10/13/2004 | < | 1.00 | mg/L |
| S000-252 | Total suspended solids | Total | MN00006 | 11/21/2004 | | 2.40 | mg/L |
| S000-252 | Total suspended solids | Total | MN00006 | 2/1/2005 | | 2.00 | mg/L |
| S000-252 | Total suspended solids | Total | MN00006 | 3/2/2005 | | 2.00 | mg/L |
| S000-252 | Total suspended solids | Total | MN00006 | 4/20/2005 | | 2.40 | mg/L |
| S000-252 | Total suspended solids | Total | MN00006 | 5/25/2005 | | 1.60 | mg/L |
| S000-252 | Total suspended solids | Total | MN00006 | 5/25/2005 | < | 1.00 | mg/L |
| S000-252 | Total suspended solids | Total | MN00006 | 6/1/2005 | | 1.60 | mg/L |
| S000-252 | Total suspended solids | Total | MN00006 | 7/11/2005 | | 2.00 | mg/L |
| S000-252 | Total suspended solids | Total | MN00006 | 8/24/2005 | | 1.60 | mg/L |
| S000-252 | Total suspended solids | Total | MN00006 | 9/19/2005 | | 2.40 | mg/L |
| S000-252 | Total suspended solids | Total | MN00006 | 10/8/2007 | | 96.00 | mg/L |
| S000-252 | Total suspended solids | Total | MN00006 | 11/13/2007 | < | 1.00 | mg/L |
| S000-252 | Total suspended solids | Total | MN00006 | 2/12/2008 | < | 1.00 | mg/L |
| S000-252 | Total suspended solids | Total | MN00006 | 3/31/2008 | | 2.00 | mg/L |
| S000-252 | Total suspended solids | Total | MN00006 | 4/21/2008 | | 11.00 | mg/L |
| S000-252 | Total suspended solids | Total | MN00006 | 5/13/2008 | | 4.00 | mg/L |
| S000-252 | Total suspended solids | Total | MN00006 | 6/4/2008 | | 1.20 | mg/L |
| S000-252 | Total suspended solids | Total | MN00006 | 7/21/2008 | | 2.40 | mg/L |
| S000-252 | Total suspended solids | Total | MN00006 | 8/18/2008 | | 2.40 | mg/L |
| S000-252 | Total suspended solids | Total | MN00006 | 9/16/2008 | < | 1.00 | mg/L |
| S000-252 | Total suspended solids | Total | MN00006 | 10/26/2009 | | 12.00 | mg/L |
| S000-252 | Total suspended solids | Total | MN00006 | 11/30/2009 | | 1.60 | mg/L |
| S000-252 | Total suspended solids | Total | MN00006 | 1/25/2010 | | 8.80 | mg/L |
| S000-252 | Total suspended solids | Total | MN00006 | 3/1/2010 | | 3.20 | mg/L |
| S000-252 | Total suspended solids | Total | MN00006 | 4/26/2010 | | 1.20 | mg/L |
| S000-252 | Total suspended solids | Total | MN00006 | 5/11/2010 | < | 1.00 | mg/L |
| S000-252 | Total suspended solids | Total | MN00006 | 6/7/2010 | | 2.40 | mg/L |
| S000-252 | Total suspended solids | Total | MN00006 | 7/18/2010 | | 2.00 | mg/L |

# Appendix A
# Water Quality Dataset

| Station ID | Parameter | Sample Fraction Type | Lab Name Code | Sample Date | Detect Flag | Result | Result Unit |
|---|---|---|---|---|---|---|---|
| S000-252 | Total suspended solids | Total | MN00006 | 8/22/2010 | | 6.40 | mg/L |
| S000-252 | Total suspended solids | Total | MN00006 | 8/22/2010 | | 2.80 | mg/L |
| S000-252 | Total suspended solids | Total | MN00006 | 9/27/2010 | | 1.60 | mg/L |
| S000-252 | Total suspended solids | Total | MN00006 | 5/2/2013 | | 25.00 | mg/L |
| S000-252 | Total suspended solids | Total | MN00006 | 6/6/2013 | | 2.00 | mg/L |
| S000-252 | Total suspended solids | Total | MN00006 | 10/7/2013 | | 2.40 | mg/L |
| S000-252 | Total suspended solids | Total | MN00006 | 4/24/2014 | | 17.00 | mg/L |
| S000-252 | Total suspended solids | Total | MN00006 | 6/3/2014 | | 11.00 | mg/L |
| S000-252 | Total suspended solids | Total | MN00006 | 8/19/2015 | | 6.80 | mg/L |
| S000-252 | Total suspended solids | Total | MN00006 | 9/24/2015 | | 11.00 | mg/L |
| S000-252 | trans-Chlordane | Total | UNKNOWN | 11/8/1978 | < | 0.01 | ug/L |
| S000-252 | trans-Chlordane | Total | UNKNOWN | 11/8/1978 | < | 0.01 | ug/L |
| S000-252 | trans-Chlordane | Total | UNKNOWN | 10/16/1979 | < | 0.02 | ug/L |
| S000-252 | trans-Chlordane | Total | UNKNOWN | 10/16/1979 | < | 0.03 | ug/L |
| S000-252 | Transparency, tube with disk | Total | | 10/21/1997 | > | 60.00 | cm |
| S000-252 | Transparency, tube with disk | Total | | 11/3/1997 | > | 60.00 | cm |
| S000-252 | Transparency, tube with disk | Total | | 4/14/1998 | | 55.00 | cm |
| S000-252 | Transparency, tube with disk | Total | | 5/27/1998 | > | 60.00 | cm |
| S000-252 | Transparency, tube with disk | Total | | 6/16/1998 | > | 60.00 | cm |
| S000-252 | Transparency, tube with disk | Total | | 7/13/1998 | > | 60.00 | cm |
| S000-252 | Transparency, tube with disk | Total | | 8/12/1998 | > | 60.00 | cm |
| S000-252 | Transparency, tube with disk | Total | | 9/22/1998 | > | 60.00 | cm |
| S000-252 | Transparency, tube with disk | Total | | 10/10/1999 | > | 60.00 | cm |
| S000-252 | Transparency, tube with disk | Total | | 11/21/1999 | > | 60.00 | cm |
| S000-252 | Transparency, tube with disk | Total | | 3/19/2000 | > | 60.00 | cm |
| S000-252 | Transparency, tube with disk | Total | | 4/16/2000 | > | 60.00 | cm |
| S000-252 | Transparency, tube with disk | Total | | 5/23/2000 | > | 60.00 | cm |
| S000-252 | Transparency, tube with disk | Total | | 6/25/2000 | > | 60.00 | cm |
| S000-252 | Transparency, tube with disk | Total | | 7/18/2000 | > | 60.00 | cm |
| S000-252 | Transparency, tube with disk | Total | | 8/14/2000 | > | 60.00 | cm |
| S000-252 | Transparency, tube with disk | Total | | 9/5/2000 | > | 60.00 | cm |
| S000-252 | Transparency, tube with disk | Total | | 10/17/2002 | > | 60.00 | cm |
| S000-252 | Transparency, tube with disk | Total | | 10/17/2002 | > | 100.00 | cm |
| S000-252 | Transparency, tube with disk | Total | | 11/3/2002 | > | 60.00 | cm |
| S000-252 | Transparency, tube with disk | Total | | 11/3/2002 | > | 100.00 | cm |
| S000-252 | Transparency, tube with disk | Total | | 4/29/2003 | > | 60.00 | cm |
| S000-252 | Transparency, tube with disk | Total | | 5/20/2003 | | 30.00 | cm |
| S000-252 | Transparency, tube with disk | Total | | 6/24/2003 | > | 60.00 | cm |
| S000-252 | Transparency, tube with disk | Total | | 7/28/2003 | > | 60.00 | cm |
| S000-252 | Transparency, tube with disk | Total | | 7/28/2003 | > | 100.00 | cm |
| S000-252 | Transparency, tube with disk | Total | | 8/5/2003 | > | 100.00 | cm |
| S000-252 | Transparency, tube with disk | Total | | 9/8/2003 | > | 60.00 | cm |
| S000-252 | Transparency, tube with disk | Total | | 9/8/2003 | > | 100.00 | cm |
| S000-252 | Transparency, tube with disk | Total | | 10/13/2004 | > | 60.00 | cm |
| S000-252 | Transparency, tube with disk | Total | | 10/13/2004 | > | 100.00 | cm |
| S000-252 | Transparency, tube with disk | Total | | 4/20/2005 | > | 100.00 | cm |
| S000-252 | Transparency, tube with disk | Total | | 5/25/2005 | > | 60.00 | cm |
| S000-252 | Transparency, tube with disk | Total | | 5/25/2005 | > | 100.00 | cm |
| S000-252 | Transparency, tube with disk | Total | | 6/1/2005 | | 90.00 | cm |
| S000-252 | Transparency, tube with disk | Total | | 7/11/2005 | > | 60.00 | cm |
| S000-252 | Transparency, tube with disk | Total | | 7/11/2005 | > | 100.00 | cm |
| S000-252 | Transparency, tube with disk | Total | | 8/24/2005 | > | 100.00 | cm |
| S000-252 | Transparency, tube with disk | Total | | 9/19/2005 | > | 60.00 | cm |
| S000-252 | Transparency, tube with disk | Total | | 9/19/2005 | > | 100.00 | cm |
| S000-252 | Transparency, tube with disk | Total | | 5/25/2006 | > | 100.00 | cm |
| S000-252 | Transparency, tube with disk | Total | | 6/5/2006 | > | 60.00 | cm |
| S000-252 | Transparency, tube with disk | Total | | 6/5/2006 | > | 100.00 | cm |
| S000-252 | Transparency, tube with disk | Total | | 7/24/2006 | > | 100.00 | cm |
| S000-252 | Transparency, tube with disk | Total | | 8/7/2006 | > | 60.00 | cm |
| S000-252 | Transparency, tube with disk | Total | | 8/7/2006 | > | 100.00 | cm |
| S000-252 | Transparency, tube with disk | Total | | 10/17/2006 | > | 60.00 | cm |
| S000-252 | Transparency, tube with disk | Total | | 10/8/2007 | | 10.00 | cm |
| S000-252 | Transparency, tube with disk | Total | | 4/21/2008 | | 70.00 | cm |
| S000-252 | Transparency, tube with disk | Total | | 5/13/2008 | > | 100.00 | cm |
| S000-252 | Transparency, tube with disk | Total | | 6/4/2008 | > | 100.00 | cm |
| S000-252 | Transparency, tube with disk | Total | | 7/21/2008 | > | 60.00 | cm |
| S000-252 | Transparency, tube with disk | Total | | 7/21/2008 | > | 100.00 | cm |
| S000-252 | Transparency, tube with disk | Total | | 8/18/2008 | > | 100.00 | cm |
| S000-252 | Transparency, tube with disk | Total | | 9/16/2008 | > | 60.00 | cm |
| S000-252 | Transparency, tube with disk | Total | | 9/16/2008 | > | 100.00 | cm |
| S000-252 | Transparency, tube with disk | Total | | 10/26/2009 | | 34.00 | cm |
| S000-252 | Transparency, tube with disk | Total | | 11/30/2009 | > | 100.00 | cm |
| S000-252 | Transparency, tube with disk | Total | | 4/26/2010 | > | 100.00 | cm |

# Appendix A
# Water Quality Dataset

| Station ID | Parameter | Sample Fraction Type | Lab Name Code | Sample Date | Detect Flag | Result | Result Unit |
|---|---|---|---|---|---|---|---|
| S000-252 | Transparency, tube with disk | Total | | 5/11/2010 | > | 100.00 | cm |
| S000-252 | Transparency, tube with disk | Total | | 6/7/2010 | > | 100.00 | cm |
| S000-252 | Transparency, tube with disk | Total | | 7/18/2010 | > | 100.00 | cm |
| S000-252 | Transparency, tube with disk | Total | | 8/22/2010 | > | 100.00 | cm |
| S000-252 | Transparency, tube with disk | Total | | 9/27/2010 | > | 100.00 | cm |
| S000-252 | Transparency, tube with disk | Total | | 5/2/2013 | | 49.00 | cm |
| S000-252 | Transparency, tube with disk | Total | | 6/6/2013 | > | 100.00 | cm |
| S000-252 | Transparency, tube with disk | Total | | 9/12/2013 | > | 100.00 | cm |
| S000-252 | Transparency, tube with disk | Total | | 10/7/2013 | | 96.00 | cm |
| S000-252 | Transparency, tube with disk | Total | | 4/24/2014 | | 50.00 | cm |
| S000-252 | Transparency, tube with disk | Total | | 6/3/2014 | | 56.00 | cm |
| S000-252 | Transparency, tube with disk | Total | | 10/16/2014 | > | 100.00 | cm |
| S000-252 | Transparency, tube with disk | Total | | 8/19/2015 | | 85.00 | cm |
| S000-252 | Transparency, tube with disk | Total | | 9/24/2015 | | 52.00 | cm |
| S000-252 | Transparency, tube with disk | Total | | 10/22/2015 | > | 100.00 | cm |
| S000-252 | Trifluralin | Total | UNKNOWN | 6/14/1988 | < | 0.05 | ug/L |
| S000-252 | Trifluralin | Total | UNKNOWN | 6/14/1988 | < | 0.05 | ug/L |
| S000-252 | Trifluralin | Total | MN00006 | 6/13/1989 | < | 0.05 | ug/L |
| S000-252 | Trifluralin | Total | MN00100 | 5/29/1991 | < | 0.10 | ug/L |
| S000-252 | Trifluralin | Total | MN00100 | 6/25/1991 | < | 0.10 | ug/L |
| S000-252 | Trifluralin | Total | MN00100 | 6/25/1991 | < | 0.10 | ug/L |
| S000-252 | Trifluralin | Total | MN00100 | 7/30/1991 | < | 0.10 | ug/L |
| S000-252 | Trifluralin | Total | MN00100 | 5/6/1992 | < | 0.10 | ug/L |
| S000-252 | Trifluralin | Total | MN00100 | 6/2/1992 | < | 0.10 | ug/L |
| S000-252 | Trifluralin | Total | MN00100 | 7/21/1992 | < | 0.10 | ug/L |
| S000-252 | Trifluralin | Total | MN00100 | 5/27/1993 | < | 0.10 | ug/L |
| S000-252 | Trifluralin | Total | MN00100 | 6/23/1993 | < | 0.10 | ug/L |
| S000-252 | Trifluralin | Total | MN00100 | 7/21/1993 | < | 0.10 | ug/L |
| S000-252 | Tritium | Total | UNKNOWN | 9/26/1973 | | 320.00 | pCi/L |
| S000-252 | Tritium | Total | UNKNOWN | 2/26/1974 | | 540.00 | pCi/L |
| S000-252 | Tritium | Total | UNKNOWN | 4/24/1974 | < | 190.00 | pCi/L |
| S000-252 | Tritium | Total | UNKNOWN | 9/12/1974 | | 760.00 | pCi/L |
| S000-252 | Tritium | Total | UNKNOWN | 2/26/1975 | | 190.00 | pCi/L |
| S000-252 | Tritium | Total | UNKNOWN | 5/1/1975 | | 360.00 | pCi/L |
| S000-252 | Turbidity | Total | UNKNOWN | 7/24/1973 | | 7.80 | None |
| S000-252 | Turbidity | Total | UNKNOWN | 8/29/1973 | | 3.30 | None |
| S000-252 | Turbidity | Total | UNKNOWN | 9/13/1973 | | 4.50 | None |
| S000-252 | Turbidity | Total | UNKNOWN | 9/26/1973 | | 6.30 | None |
| S000-252 | Turbidity | Total | UNKNOWN | 10/17/1973 | | 2.70 | None |
| S000-252 | Turbidity | Total | UNKNOWN | 11/14/1973 | | 3.90 | None |
| S000-252 | Turbidity | Total | UNKNOWN | 12/5/1973 | | 3.90 | None |
| S000-252 | Turbidity | Total | UNKNOWN | 1/29/1974 | | 3.40 | None |
| S000-252 | Turbidity | Total | UNKNOWN | 2/26/1974 | | 3.90 | None |
| S000-252 | Turbidity | Total | UNKNOWN | 3/12/1974 | | 4.80 | None |
| S000-252 | Turbidity | Total | UNKNOWN | 4/2/1974 | | 4.50 | None |
| S000-252 | Turbidity | Total | UNKNOWN | 4/9/1974 | | 6.00 | None |
| S000-252 | Turbidity | Total | UNKNOWN | 4/24/1974 | | 10.00 | None |
| S000-252 | Turbidity | Total | UNKNOWN | 5/8/1974 | | 4.00 | None |
| S000-252 | Turbidity | Total | UNKNOWN | 5/15/1974 | | 6.50 | None |
| S000-252 | Turbidity | Total | UNKNOWN | 6/18/1974 | | 3.80 | None |
| S000-252 | Turbidity | Total | UNKNOWN | 7/10/1974 | | 8.20 | None |
| S000-252 | Turbidity | Total | UNKNOWN | 8/13/1974 | | 7.00 | None |
| S000-252 | Turbidity | Total | UNKNOWN | 9/12/1974 | | 4.50 | None |
| S000-252 | Turbidity | Total | UNKNOWN | 10/9/1974 | | 4.20 | None |
| S000-252 | Turbidity | Total | UNKNOWN | 11/5/1974 | | 7.40 | None |
| S000-252 | Turbidity | Total | UNKNOWN | 12/11/1974 | | 4.50 | None |
| S000-252 | Turbidity | Total | UNKNOWN | 1/16/1975 | | 9.80 | None |
| S000-252 | Turbidity | Total | UNKNOWN | 2/26/1975 | | 3.80 | None |
| S000-252 | Turbidity | Total | UNKNOWN | 4/2/1975 | | 6.80 | None |
| S000-252 | Turbidity | Total | UNKNOWN | 4/17/1975 | | 18.00 | None |
| S000-252 | Turbidity | Total | UNKNOWN | 5/1/1975 | | 7.70 | None |
| S000-252 | Turbidity | Total | UNKNOWN | 5/8/1975 | | 8.00 | None |
| S000-252 | Turbidity | Total | UNKNOWN | 5/15/1975 | | 4.30 | None |
| S000-252 | Turbidity | Total | UNKNOWN | 5/22/1975 | | 3.40 | None |
| S000-252 | Turbidity | Total | UNKNOWN | 6/18/1975 | | 4.70 | None |
| S000-252 | Turbidity | Total | UNKNOWN | 7/26/1976 | | 14.00 | None |
| S000-252 | Turbidity | Total | UNKNOWN | 8/23/1976 | | 17.00 | None |
| S000-252 | Turbidity | Total | UNKNOWN | 9/20/1976 | | 12.00 | None |
| S000-252 | Turbidity | Total | UNKNOWN | 10/18/1976 | | 6.20 | None |
| S000-252 | Turbidity | Total | UNKNOWN | 11/16/1976 | | 6.00 | None |
| S000-252 | Turbidity | Total | UNKNOWN | 3/22/1977 | | 4.20 | None |
| S000-252 | Turbidity | Total | UNKNOWN | 4/25/1977 | | 7.20 | None |
| S000-252 | Turbidity | Total | UNKNOWN | 5/23/1977 | | 10.00 | None |

# Appendix A
# Water Quality Dataset

| Station ID | Parameter | Sample Fraction Type | Lab Name Code | Sample Date | Detect Flag | Result | Result Unit |
|---|---|---|---|---|---|---|---|
| S000-252 | Turbidity | Total | UNKNOWN | 6/27/1977 | | 5.80 | None |
| S000-252 | Turbidity | Total | UNKNOWN | 7/25/1977 | | 11.00 | None |
| S000-252 | Turbidity | Total | UNKNOWN | 8/22/1977 | | 14.00 | None |
| S000-252 | Turbidity | Total | UNKNOWN | 9/26/1977 | | 10.00 | None |
| S000-252 | Turbidity | Total | MN00006 | 10/19/1994 | | 12.00 | None |
| S000-252 | Turbidity | Total | MN00006 | 11/7/1994 | | 2.70 | None |
| S000-252 | Turbidity | Total | MN00006 | 1/19/1995 | | 3.90 | None |
| S000-252 | Turbidity | Total | MN00006 | 3/16/1995 | | 12.00 | None |
| S000-252 | Turbidity | Total | MN00006 | 4/12/1995 | | 14.00 | None |
| S000-252 | Turbidity | Total | MN00006 | 5/18/1995 | | 3.90 | None |
| S000-252 | Turbidity | Total | MN00006 | 6/13/1995 | | 1.00 | None |
| S000-252 | Turbidity | Total | MN00006 | 7/26/1995 | | 3.50 | None |
| S000-252 | Turbidity | Total | MN00006 | 8/14/1995 | | 1.30 | None |
| S000-252 | Turbidity | Total | MN00006 | 9/12/1995 | | 1.90 | None |
| S000-252 | Turbidity | Total | MN00006 | 10/21/1997 | | 2.80 | NTRU |
| S000-252 | Turbidity | Total | MN00006 | 11/3/1997 | | 9.60 | NTRU |
| S000-252 | Turbidity | Total | MN00006 | 1/28/1998 | | 3.00 | NTRU |
| S000-252 | Turbidity | Total | MN00006 | 3/17/1998 | | 3.20 | NTRU |
| S000-252 | Turbidity | Total | | 3/17/1998 | | 2.80 | None |
| S000-252 | Turbidity | Total | | 4/14/1998 | | 7.80 | None |
| S000-252 | Turbidity | Total | | 5/27/1998 | | 1.00 | None |
| S000-252 | Turbidity | Total | | 6/16/1998 | | 3.80 | None |
| S000-252 | Turbidity | Total | | 7/13/1998 | | 1.20 | None |
| S000-252 | Turbidity | Total | | 8/12/1998 | | 1.20 | None |
| S000-252 | Turbidity | Total | | 9/22/1998 | | 5.80 | None |
| S000-252 | Turbidity | Total | | 10/10/1999 | | 7.40 | None |
| S000-252 | Turbidity | Total | MN00006 | 10/10/1999 | | 6.60 | NTRU |
| S000-252 | Turbidity | Total | | 11/21/1999 | | 7.86 | None |
| S000-252 | Turbidity | Total | MN00006 | 11/21/1999 | | 6.80 | NTRU |
| S000-252 | Turbidity | Total | | 1/16/2000 | | 4.61 | None |
| S000-252 | Turbidity | Total | MN00006 | 1/16/2000 | | 4.70 | NTRU |
| S000-252 | Turbidity | Total | | 3/19/2000 | | 4.17 | None |
| S000-252 | Turbidity | Total | MN00006 | 3/19/2000 | | 4.40 | NTRU |
| S000-252 | Turbidity | Total | | 4/16/2000 | | 8.11 | None |
| S000-252 | Turbidity | Total | | 5/23/2000 | | 4.80 | None |
| S000-252 | Turbidity | Total | | 6/25/2000 | | 4.04 | None |
| S000-252 | Turbidity | Total | MN00006 | 8/14/2000 | | 1.60 | NTRU |
| S000-252 | Turbidity | Total | | 9/5/2000 | | 2.90 | None |
| S000-252 | Turbidity | Total | | 10/17/2002 | | 0.50 | FNMU |
| S000-252 | Turbidity | Total | | 11/3/2002 | | 5.40 | FNMU |
| S000-252 | Turbidity | Total | | 1/28/2003 | | 2.80 | FNMU |
| S000-252 | Turbidity | Total | | 3/18/2003 | | 212.00 | FNMU |
| S000-252 | Turbidity | Total | | 4/29/2003 | | 2.80 | FNMU |
| S000-252 | Turbidity | Total | MN00006 | 4/29/2003 | | 4.10 | NTRU |
| S000-252 | Turbidity | Total | | 5/20/2003 | | 29.90 | FNMU |
| S000-252 | Turbidity | Total | | 6/24/2003 | | 2.50 | FNMU |
| S000-252 | Turbidity | Total | MN00006 | 6/24/2003 | | 2.70 | NTRU |
| S000-252 | Turbidity | Total | | 7/28/2003 | | 1.70 | FNMU |
| S000-252 | Turbidity | Total | | 8/5/2003 | | 2.00 | FNMU |
| S000-252 | Turbidity | Total | MN00006 | 8/5/2003 | | 0.81 | NTRU |
| S000-252 | Turbidity | Total | | 9/8/2003 | | 45.10 | FNMU |
| S000-252 | Turbidity | Total | | 10/13/2003 | | 7.70 | FNMU |
| S000-252 | Turbidity | Total | MN00006 | 10/13/2004 | | 2.10 | NTRU |
| S000-252 | Turbidity | Total | | 11/21/2004 | | 11.40 | FNMU |
| S000-252 | Turbidity | Total | | 2/1/2005 | | 14.00 | FNMU |
| S000-252 | Turbidity | Total | | 3/2/2005 | | 4.50 | FNMU |
| S000-252 | Turbidity | Total | | 4/20/2005 | | 0.10 | FNMU |
| S000-252 | Turbidity | Total | | 5/25/2005 | | 1.10 | FNMU |
| S000-252 | Turbidity | Total | | 6/1/2005 | | 1.80 | FNMU |
| S000-252 | Turbidity | Total | | 7/11/2005 | | 0.20 | FNMU |
| S000-252 | Turbidity | Total | MN00006 | 8/24/2005 | | 1.20 | NTRU |
| S000-252 | Turbidity | Total | | 9/19/2005 | | 0.00 | FNMU |
| S000-252 | Turbidity | Total | MN00006 | 9/19/2005 | | 3.70 | NTRU |
| S000-252 | Turbidity | Total | | 4/3/2006 | | 41.00 | FNMU |
| S000-252 | Turbidity | Total | | 5/25/2006 | | 5.60 | FNMU |
| S000-252 | Turbidity | Total | | 6/5/2006 | | 4.80 | FNMU |
| S000-252 | Turbidity | Total | MN00006 | 7/24/2006 | | 1.60 | NTRU |
| S000-252 | Turbidity | Total | | 8/7/2006 | | 7.60 | FNMU |
| S000-252 | Turbidity | Total | | 10/17/2006 | | 33.50 | FNMU |
| S000-252 | Turbidity | Total | | 10/8/2007 | | 115.00 | FNMU |
| S000-252 | Turbidity | Total | | 11/13/2007 | | 10.30 | FNMU |
| S000-252 | Turbidity | Total | | 2/12/2008 | | 6.20 | FNMU |
| S000-252 | Turbidity | Total | | 3/31/2008 | | 5.00 | FNMU |

# Appendix A
# Water Quality Dataset

| Station ID | Parameter | Sample Fraction Type | Lab Name Code | Sample Date | Detect Flag | Result | Result Unit |
|---|---|---|---|---|---|---|---|
| S000-252 | Turbidity | Total | | 4/21/2008 | | 15.40 | FNMU |
| S000-252 | Turbidity | Total | | 5/13/2008 | | 2.60 | FNMU |
| S000-252 | Turbidity | Total | | 6/4/2008 | | 3.80 | FNMU |
| S000-252 | Turbidity | Total | | 7/21/2008 | | 1.50 | FNMU |
| S000-252 | Turbidity | Total | | 8/18/2008 | | 4.40 | FNMU |
| S000-252 | Turbidity | Total | | 9/16/2008 | | 3.10 | FNMU |
| S000-252 | Turbidity | Total | | 10/26/2009 | | 41.40 | FNMU |
| S000-252 | Turbidity | Total | | 11/30/2009 | | 10.40 | FNMU |
| S000-252 | Turbidity | Total | | 1/25/2010 | | 11.10 | FNMU |
| S000-252 | Turbidity | Total | | 3/1/2010 | | 17.20 | FNMU |
| S000-252 | Turbidity | Total | | 4/26/2010 | | 9.70 | FNMU |
| S000-252 | Turbidity | Total | | 5/11/2010 | | 8.60 | FNMU |
| S000-252 | Turbidity | Total | | 6/7/2010 | | 22.10 | FNMU |
| S000-252 | Turbidity | Total | | 7/18/2010 | | 6.30 | FNMU |
| S000-252 | Turbidity | Total | | 8/22/2010 | | 6.50 | FNMU |
| S000-252 | Turbidity | Total | | 9/27/2010 | | 11.20 | FNMU |
| S000-252 | Turbidity | Total | MN00006 | 6/3/2014 | | 14.00 | NTRU |
| S000-252 | Volatile suspended solids | Total | MN00006 | 6/24/2003 | | 1.20 | mg/L |
| S000-252 | Volatile suspended solids | Total | MN00006 | 7/28/2003 | < | 1.00 | mg/L |
| S000-252 | Volatile suspended solids | Total | MN00006 | 8/5/2003 | | 1.60 | mg/L |
| S000-252 | Volatile suspended solids | Total | MN00006 | 9/8/2003 | < | 1.00 | mg/L |
| S000-252 | Volatile suspended solids | Total | MN00006 | 6/1/2005 | | 1.60 | mg/L |
| S000-252 | Volatile suspended solids | Total | MN00006 | 7/11/2005 | | 1.20 | mg/L |
| S000-252 | Volatile suspended solids | Total | MN00006 | 8/24/2005 | | 1.20 | mg/L |
| S000-252 | Volatile suspended solids | Total | MN00006 | 9/19/2005 | < | 1.00 | mg/L |
| S000-252 | Volatile suspended solids | Total | MN00006 | 6/4/2008 | < | 1.00 | mg/L |
| S000-252 | Volatile suspended solids | Total | MN00006 | 7/21/2008 | | 1.20 | mg/L |
| S000-252 | Volatile suspended solids | Total | MN00006 | 8/18/2008 | < | 1.00 | mg/L |
| S000-252 | Volatile suspended solids | Total | MN00006 | 9/16/2008 | < | 1.00 | mg/L |
| S000-252 | Volatile suspended solids | Total | MN00006 | 6/7/2010 | < | 1.00 | mg/L |
| S000-252 | Volatile suspended solids | Total | MN00006 | 7/18/2010 | | 1.20 | mg/L |
| S000-252 | Volatile suspended solids | Total | MN00006 | 8/22/2010 | | 1.60 | mg/L |
| S000-252 | Volatile suspended solids | Total | MN00006 | 8/22/2010 | < | 1.00 | mg/L |
| S000-252 | Volatile suspended solids | Total | MN00006 | 9/27/2010 | | 1.60 | mg/L |
| S000-252 | Volatile suspended solids | Total | MN00006 | 5/2/2013 | | 3.60 | mg/L |
| S000-252 | Volatile suspended solids | Total | MN00006 | 6/6/2013 | < | 1.00 | mg/L |
| S000-252 | Volatile suspended solids | Total | MN00006 | 10/7/2013 | | 1.60 | mg/L |
| S000-252 | Volatile suspended solids | Total | MN00006 | 9/24/2015 | | 3.60 | mg/L |
| S000-252 | Zinc | Total | UNKNOWN | 8/29/1973 | | 22.00 | ug/L |
| S000-252 | Zinc | Total | UNKNOWN | 9/13/1973 | < | 10.00 | ug/L |
| S000-252 | Zinc | Total | UNKNOWN | 9/26/1973 | | 380.00 | ug/L |
| S000-252 | Zinc | Total | UNKNOWN | 12/5/1973 | < | 10.00 | ug/L |
| S000-252 | Zinc | Total | UNKNOWN | 2/26/1974 | < | 10.00 | ug/L |
| S000-252 | Zinc | Total | UNKNOWN | 4/9/1974 | | 20.00 | ug/L |
| S000-252 | Zinc | Total | UNKNOWN | 4/24/1974 | | 23.00 | ug/L |
| S000-252 | Zinc | Total | UNKNOWN | 5/8/1974 | < | 10.00 | ug/L |
| S000-252 | Zinc | Total | UNKNOWN | 5/15/1974 | | 16.00 | ug/L |
| S000-252 | Zinc | Total | UNKNOWN | 6/18/1974 | < | 10.00 | ug/L |
| S000-252 | Zinc | Total | UNKNOWN | 7/10/1974 | | 14.00 | ug/L |
| S000-252 | Zinc | Total | UNKNOWN | 8/13/1974 | | 34.00 | ug/L |
| S000-252 | Zinc | Total | UNKNOWN | 9/12/1974 | < | 10.00 | ug/L |
| S000-252 | Zinc | Total | UNKNOWN | 10/9/1974 | < | 10.00 | ug/L |
| S000-252 | Zinc | Total | UNKNOWN | 11/5/1974 | < | 10.00 | ug/L |
| S000-252 | Zinc | Total | UNKNOWN | 12/11/1974 | < | 10.00 | ug/L |
| S000-252 | Zinc | Total | UNKNOWN | 1/16/1975 | | 38.00 | ug/L |
| S000-252 | Zinc | Total | UNKNOWN | 2/26/1975 | | 11.00 | ug/L |
| S000-252 | Zinc | Total | UNKNOWN | 4/2/1975 | | 16.00 | ug/L |
| S000-252 | Zinc | Total | UNKNOWN | 4/17/1975 | | 11.00 | ug/L |
| S000-252 | Zinc | Total | UNKNOWN | 5/1/1975 | | 24.00 | ug/L |
| S000-252 | Zinc | Total | UNKNOWN | 5/8/1975 | | 48.00 | ug/L |
| S000-252 | Zinc | Total | UNKNOWN | 5/15/1975 | | 120.00 | ug/L |
| S000-252 | Zinc | Total | UNKNOWN | 5/22/1975 | | 67.00 | ug/L |
| S000-252 | Zinc | Total | UNKNOWN | 6/18/1975 | < | 10.00 | ug/L |
| S000-252 | Zinc | Total | UNKNOWN | 7/26/1976 | < | 10.00 | ug/L |
| S000-252 | Zinc | Total | UNKNOWN | 10/18/1976 | < | 10.00 | ug/L |
| S000-252 | Zinc | Total | UNKNOWN | 4/25/1977 | < | 10.00 | ug/L |
| S000-252 | Zinc | Total | UNKNOWN | 7/25/1977 | < | 10.00 | ug/L |
| S000-252 | Zinc | Total | UNKNOWN | 11/8/1978 | | 1.40 | ug/L |
| S000-252 | Zinc | Total | UNKNOWN | 6/19/1979 | | 1.70 | ug/L |
| S000-252 | Zinc | Total | UNKNOWN | 10/16/1979 | < | 0.20 | ug/L |
| S000-252 | Zinc | Total | UNKNOWN | 10/14/1980 | | 1.10 | ug/L |
| S000-252 | Zinc | Total | UNKNOWN | 6/8/1982 | | 0.90 | ug/L |
| S000-252 | Zinc | Total | UNKNOWN | 6/14/1983 | | 1.90 | ug/L |

# Appendix A
# Water Quality Dataset

| Station ID | Parameter | Sample Fraction Type | Lab Name Code | Sample Date | Detect Flag | Result | Result Unit |
|---|---|---|---|---|---|---|---|
| S000-252 | Zinc | Total | UNKNOWN | 10/15/1985 | | 2.60 | ug/L |
| S000-252 | Zinc | Total | UNKNOWN | 10/21/1986 | | 2.30 | ug/L |
| S000-252 | Zinc | Total | UNKNOWN | 6/9/1987 | | 0.90 | ug/L |
| S000-252 | Zinc | Total | MN00006 | 6/25/1991 | | 21.00 | ug/L |
| S000-252 | Zinc | Total | MN00006 | 10/23/1991 | < | 3.00 | ug/L |
| S004-955 | Ammonia-nitrogen as N | Dissolved | MN01042 | 4/9/2008 | | 0.04 | mg/L |
| S004-955 | Ammonia-nitrogen as N | Dissolved | MN01042 | 4/15/2008 | | 0.02 | mg/L |
| S004-955 | Ammonia-nitrogen as N | Dissolved | MN01042 | 4/22/2008 | | 0.04 | mg/L |
| S004-955 | Ammonia-nitrogen as N | Dissolved | MN01042 | 4/25/2008 | | 0.03 | mg/L |
| S004-955 | Ammonia-nitrogen as N | Dissolved | MN01042 | 5/1/2008 | | 0.03 | mg/L |
| S004-955 | Ammonia-nitrogen as N | Dissolved | MN01042 | 5/21/2008 | | 0.01 | mg/L |
| S004-955 | Ammonia-nitrogen as N | Dissolved | MN01042 | 6/6/2008 | | 0.02 | mg/L |
| S004-955 | Ammonia-nitrogen as N | Dissolved | MN01042 | 6/12/2008 | | 0.01 | mg/L |
| S004-955 | Ammonia-nitrogen as N | Dissolved | MN01042 | 7/10/2008 | | 0.01 | mg/L |
| S004-955 | Ammonia-nitrogen as N | Dissolved | MN01042 | 7/29/2008 | | 0.01 | mg/L |
| S004-955 | Ammonia-nitrogen as N | Dissolved | MN01042 | 8/27/2008 | | 0.01 | mg/L |
| S004-955 | Ammonia-nitrogen as N | Dissolved | MN01042 | 9/3/2008 | | 0.01 | mg/L |
| S004-955 | Ammonia-nitrogen as N | Dissolved | MN01042 | 10/7/2008 | | 0.01 | mg/L |
| S004-955 | Ammonia-nitrogen as N | Dissolved | MN01042 | 4/8/2009 | | 0.01 | mg/L |
| S004-955 | Ammonia-nitrogen as N | Dissolved | MN01042 | 4/15/2009 | | 0.01 | mg/L |
| S004-955 | Ammonia-nitrogen as N | Dissolved | MN01042 | 4/28/2009 | | 0.02 | mg/L |
| S004-955 | Ammonia-nitrogen as N | Dissolved | MN01042 | 6/2/2009 | | 0.01 | mg/L |
| S004-955 | Ammonia-nitrogen as N | Dissolved | MN01042 | 6/9/2009 | | 0.01 | mg/L |
| S004-955 | Ammonia-nitrogen as N | Dissolved | MN01042 | 7/22/2009 | | 0.01 | mg/L |
| S004-955 | Ammonia-nitrogen as N | Total | MN00006 | 8/10/2015 | < | 0.05 | mg/L |
| S004-955 | Biochemical oxygen demand, standard conditions | Total | MN00006 | 8/10/2015 | | 1.90 | mg/L |
| S004-955 | Chloride | Total | MN01042 | 4/9/2008 | | 5.97 | mg/L |
| S004-955 | Chloride | Total | MN01042 | 4/15/2008 | | 5.72 | mg/L |
| S004-955 | Chloride | Total | MN01042 | 4/22/2008 | | 1.52 | mg/L |
| S004-955 | Chloride | Total | MN01042 | 4/25/2008 | | 1.73 | mg/L |
| S004-955 | Chloride | Total | MN01042 | 5/1/2008 | | 2.98 | mg/L |
| S004-955 | Chloride | Total | MN01042 | 5/21/2008 | | 9.41 | mg/L |
| S004-955 | Chloride | Total | MN01042 | 6/6/2008 | | 1.87 | mg/L |
| S004-955 | Chloride | Total | MN01042 | 6/12/2008 | | 1.57 | mg/L |
| S004-955 | Chloride | Total | MN01042 | 7/10/2008 | | 20.79 | mg/L |
| S004-955 | Chloride | Total | MN01042 | 7/29/2008 | | 49.08 | mg/L |
| S004-955 | Chloride | Total | MN01042 | 8/27/2008 | | 102.42 | mg/L |
| S004-955 | Chloride | Total | MN01042 | 9/3/2008 | | 28.33 | mg/L |
| S004-955 | Chloride | Total | MN01042 | 10/7/2008 | | 16.65 | mg/L |
| S004-955 | Chloride | Dissolved | MN01042 | 4/8/2009 | | 2.70 | mg/L |
| S004-955 | Chloride | Dissolved | MN01042 | 4/15/2009 | | 1.40 | mg/L |
| S004-955 | Chloride | Dissolved | MN01042 | 4/28/2009 | | 2.09 | mg/L |
| S004-955 | Chloride | Dissolved | MN01042 | 5/5/2009 | | 3.70 | mg/L |
| S004-955 | Chloride | Dissolved | MN01042 | 6/2/2009 | | 1.30 | mg/L |
| S004-955 | Chloride | Dissolved | MN01042 | 6/9/2009 | | 13.10 | mg/L |
| S004-955 | Chloride | Dissolved | MN01042 | 7/22/2009 | | 2.90 | mg/L |
| S004-955 | Chloride | Total | MN00006 | 8/10/2015 | | 70.20 | mg/L |
| S004-955 | Dissolved oxygen (DO) | Total | | 4/9/2008 | | 16.05 | mg/L |
| S004-955 | Dissolved oxygen (DO) | Total | | 4/15/2008 | | 16.63 | mg/L |
| S004-955 | Dissolved oxygen (DO) | Total | | 4/22/2008 | | 13.01 | mg/L |
| S004-955 | Dissolved oxygen (DO) | Total | | 4/25/2008 | | 12.75 | mg/L |
| S004-955 | Dissolved oxygen (DO) | Total | | 5/1/2008 | | 12.33 | mg/L |
| S004-955 | Dissolved oxygen (DO) | Total | | 5/21/2008 | | 10.90 | mg/L |
| S004-955 | Dissolved oxygen (DO) | Total | | 6/6/2008 | | 10.89 | mg/L |
| S004-955 | Dissolved oxygen (DO) | Total | | 6/12/2008 | | 10.94 | mg/L |
| S004-955 | Dissolved oxygen (DO) | Total | | 7/10/2008 | | 8.76 | mg/L |
| S004-955 | Dissolved oxygen (DO) | Total | | 7/29/2008 | | 8.83 | mg/L |
| S004-955 | Dissolved oxygen (DO) | Total | | 8/27/2008 | | 10.72 | mg/L |
| S004-955 | Dissolved oxygen (DO) | Total | | 9/3/2008 | | 10.39 | mg/L |
| S004-955 | Dissolved oxygen (DO) | Total | | 10/7/2008 | | 10.99 | mg/L |
| S004-955 | Dissolved oxygen (DO) | Total | | 4/8/2009 | | 15.50 | mg/L |
| S004-955 | Dissolved oxygen (DO) | Total | | 4/15/2009 | | 11.20 | mg/L |
| S004-955 | Dissolved oxygen (DO) | Total | | 4/28/2009 | | 13.30 | mg/L |
| S004-955 | Dissolved oxygen (DO) | Total | | 5/5/2009 | | 11.90 | mg/L |
| S004-955 | Dissolved oxygen (DO) | Total | | 6/2/2009 | | 11.00 | mg/L |
| S004-955 | Dissolved oxygen (DO) | Total | | 6/9/2009 | | 10.10 | mg/L |
| S004-955 | Dissolved oxygen (DO) | Total | | 7/22/2009 | | 9.70 | mg/L |
| S004-955 | Dissolved oxygen (DO) | Total | | 8/10/2015 | | 9.39 | mg/L |
| S004-955 | Dissolved oxygen (DO) | Total | | 9/24/2015 | | 10.19 | mg/L |
| S004-955 | Dissolved oxygen saturation | Total | | 4/9/2008 | | 111.50 | % |
| S004-955 | Dissolved oxygen saturation | Total | | 4/15/2008 | | 117.20 | % |
| S004-955 | Dissolved oxygen saturation | Total | | 4/22/2008 | | 115.60 | % |
| S004-955 | Dissolved oxygen saturation | Total | | 4/25/2008 | | 115.80 | % |

# Appendix A
# Water Quality Dataset

| Station ID | Parameter | Sample Fraction Type | Lab Name Code | Sample Date | Detect Flag | Result | Result Unit |
|---|---|---|---|---|---|---|---|
| S004-955 | Dissolved oxygen saturation | Total | | 5/1/2008 | | 114.70 | % |
| S004-955 | Dissolved oxygen saturation | Total | | 5/21/2008 | | 104.10 | % |
| S004-955 | Dissolved oxygen saturation | Total | | 6/6/2008 | | 102.50 | % |
| S004-955 | Dissolved oxygen saturation | Total | | 6/12/2008 | | 102.90 | % |
| S004-955 | Dissolved oxygen saturation | Total | | 7/10/2008 | | 92.10 | % |
| S004-955 | Dissolved oxygen saturation | Total | | 7/29/2008 | | 105.60 | % |
| S004-955 | Dissolved oxygen saturation | Total | | 8/27/2008 | | 112.40 | % |
| S004-955 | Dissolved oxygen saturation | Total | | 9/3/2008 | | 110.20 | % |
| S004-955 | Dissolved oxygen saturation | Total | | 10/7/2008 | | 97.50 | % |
| S004-955 | Dissolved oxygen saturation | Total | | 4/8/2009 | | 110.00 | % |
| S004-955 | Dissolved oxygen saturation | Total | | 4/15/2009 | | 80.00 | % |
| S004-955 | Dissolved oxygen saturation | Total | | 4/28/2009 | | 108.00 | % |
| S004-955 | Dissolved oxygen saturation | Total | | 5/5/2009 | | 106.00 | % |
| S004-955 | Dissolved oxygen saturation | Total | | 6/2/2009 | | 105.00 | % |
| S004-955 | Dissolved oxygen saturation | Total | | 6/9/2009 | | 91.00 | % |
| S004-955 | Dissolved oxygen saturation | Total | | 7/22/2009 | | 107.00 | % |
| S004-955 | Escherichia coli | Total | MN01011 | 4/9/2008 | | 7.00 | MPN/10 |
| S004-955 | Escherichia coli | Total | MN01011 | 4/15/2008 | | 9.00 | $MP^mN/10$ |
| S004-955 | Escherichia coli | Total | MN01011 | 4/22/2008 | | 33.00 | $MP^mN/10$ |
| S004-955 | Escherichia coli | Total | MN01011 | 5/1/2008 | | 3.00 | $MP^mN/10$ |
| S004-955 | Escherichia coli | Total | MN01011 | 5/21/2008 | | 4.00 | $MP^mN/10$ |
| S004-955 | Escherichia coli | Total | MN01011 | 6/12/2008 | | 308.00 | $MP^mN/10$ |
| S004-955 | Escherichia coli | Total | MN01011 | 7/10/2008 | | 66.00 | $MP^mN/10$ |
| S004-955 | Escherichia coli | Total | MN01011 | 7/29/2008 | | 37.00 | $MP^mN/10$ |
| S004-955 | Escherichia coli | Total | MN01011 | 8/27/2008 | | 15.00 | $MP^mN/10$ |
| S004-955 | Escherichia coli | Total | MN01011 | 9/3/2008 | | 30.00 | $MP^mN/10$ |
| S004-955 | Escherichia coli | Total | MN01011 | 10/7/2008 | | 11.00 | $MP^mN/10$ |
| S004-955 | Escherichia coli | Total | MN01011 | 4/8/2009 | | 1.00 | $MP^mN/10$ |
| S004-955 | Escherichia coli | Total | MN01011 | 4/15/2009 | | 4.00 | $MP^mN/10$ |
| S004-955 | Escherichia coli | Total | MN01011 | 4/28/2009 | | 1.00 | $MP^mN/10$ |
| S004-955 | Escherichia coli | Total | MN01011 | 5/5/2009 | | 1.00 | $MP^mN/10$ |
| S004-955 | Escherichia coli | Total | MN01011 | 6/2/2009 | | 4.00 | $MP^mN/10$ |
| S004-955 | Escherichia coli | Total | MN01011 | 6/9/2009 | | 31.00 | $MP^mN/10$ |
| S004-955 | Escherichia coli | Total | MN01011 | 7/22/2009 | | 27.00 | m |
| S004-955 | Hardness, Ca, Mg as CaCO3 | Total | MN00006 | 8/10/2015 | | 89.00 | mg/L |
| S004-955 | Inorganic nitrogen (nitrate and nitrite) as N | Dissolved | MN01042 | 4/9/2008 | | 0.67 | mg/L |
| S004-955 | Inorganic nitrogen (nitrate and nitrite) as N | Dissolved | MN01042 | 4/15/2008 | | 0.39 | mg/L |
| S004-955 | Inorganic nitrogen (nitrate and nitrite) as N | Dissolved | MN01042 | 4/22/2008 | | 0.30 | mg/L |
| S004-955 | Inorganic nitrogen (nitrate and nitrite) as N | Dissolved | MN01042 | 4/25/2008 | | 0.28 | mg/L |
| S004-955 | Inorganic nitrogen (nitrate and nitrite) as N | Dissolved | MN01042 | 5/1/2008 | | 0.18 | mg/L |
| S004-955 | Inorganic nitrogen (nitrate and nitrite) as N | Dissolved | MN01042 | 5/21/2008 | | 0.20 | mg/L |
| S004-955 | Inorganic nitrogen (nitrate and nitrite) as N | Dissolved | MN01042 | 6/6/2008 | | 0.16 | mg/L |
| S004-955 | Inorganic nitrogen (nitrate and nitrite) as N | Dissolved | MN01042 | 6/12/2008 | | 0.04 | mg/L |
| S004-955 | Inorganic nitrogen (nitrate and nitrite) as N | Dissolved | MN01042 | 7/10/2008 | | 0.51 | mg/L |
| S004-955 | Inorganic nitrogen (nitrate and nitrite) as N | Dissolved | MN01042 | 7/29/2008 | | 0.89 | mg/L |
| S004-955 | Inorganic nitrogen (nitrate and nitrite) as N | Dissolved | MN01042 | 8/27/2008 | | 1.88 | mg/L |
| S004-955 | Inorganic nitrogen (nitrate and nitrite) as N | Dissolved | MN01042 | 9/3/2008 | | 0.53 | mg/L |
| S004-955 | Inorganic nitrogen (nitrate and nitrite) as N | Dissolved | MN01042 | 10/7/2008 | | 0.32 | mg/L |
| S004-955 | Inorganic nitrogen (nitrate and nitrite) as N | Dissolved | MN01042 | 4/8/2009 | | 0.16 | mg/L |
| S004-955 | Inorganic nitrogen (nitrate and nitrite) as N | Dissolved | MN01042 | 4/15/2009 | | 0.14 | mg/L |
| S004-955 | Inorganic nitrogen (nitrate and nitrite) as N | Dissolved | MN01042 | 4/28/2009 | | 0.18 | mg/L |
| S004-955 | Inorganic nitrogen (nitrate and nitrite) as N | Dissolved | MN01042 | 5/5/2009 | | 0.13 | mg/L |
| S004-955 | Inorganic nitrogen (nitrate and nitrite) as N | Dissolved | MN01042 | 6/2/2009 | | 0.00 | mg/L |
| S004-955 | Inorganic nitrogen (nitrate and nitrite) as N | Dissolved | MN01042 | 6/9/2009 | | 0.25 | mg/L |
| S004-955 | Inorganic nitrogen (nitrate and nitrite) as N | Dissolved | MN01042 | 7/22/2009 | | 0.00 | mg/L |
| S004-955 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 8/10/2015 | | 0.54 | mg/L |
| S004-955 | Nutrient-nitrogen as N | Total | MN01042 | 4/9/2008 | | 1.07 | mg/L |
| S004-955 | Nutrient-nitrogen as N | Total | MN01042 | 4/15/2008 | | 0.74 | mg/L |
| S004-955 | Nutrient-nitrogen as N | Total | MN01042 | 4/22/2008 | | 0.96 | mg/L |
| S004-955 | Nutrient-nitrogen as N | Total | MN01042 | 4/25/2008 | | 0.84 | mg/L |
| S004-955 | Nutrient-nitrogen as N | Total | MN01042 | 5/1/2008 | | 0.60 | mg/L |
| S004-955 | Nutrient-nitrogen as N | Total | MN01042 | 5/21/2008 | | 0.65 | mg/L |
| S004-955 | Nutrient-nitrogen as N | Total | MN01042 | 6/6/2008 | | 0.92 | mg/L |
| S004-955 | Nutrient-nitrogen as N | Total | MN01042 | 6/12/2008 | | 0.65 | mg/L |
| S004-955 | Nutrient-nitrogen as N | Total | MN01042 | 7/10/2008 | | 0.66 | mg/L |
| S004-955 | Nutrient-nitrogen as N | Total | MN01042 | 7/29/2008 | | 1.21 | mg/L |
| S004-955 | Nutrient-nitrogen as N | Total | MN01042 | 8/27/2008 | | 1.70 | mg/L |
| S004-955 | Nutrient-nitrogen as N | Total | MN01042 | 9/3/2008 | | 0.86 | mg/L |
| S004-955 | Nutrient-nitrogen as N | Total | MN01042 | 10/7/2008 | | 0.74 | mg/L |
| S004-955 | Nutrient-nitrogen as N | Total | MN01042 | 4/8/2009 | | 0.53 | mg/L |
| S004-955 | Nutrient-nitrogen as N | Total | MN01042 | 4/15/2009 | | 0.52 | mg/L |
| S004-955 | Nutrient-nitrogen as N | Total | MN01042 | 4/28/2009 | | 0.67 | mg/L |
| S004-955 | Nutrient-nitrogen as N | Total | MN01042 | 5/5/2009 | | 0.58 | mg/L |

# Appendix A
# Water Quality Dataset

| Station ID | Parameter | Sample Fraction Type | Lab Name Code | Sample Date | Detect Flag | Result | Result Unit |
|---|---|---|---|---|---|---|---|
| S004-955 | Nutrient-nitrogen as N | Total | MN01042 | 6/2/2009 | | 0.44 | mg/L |
| S004-955 | Nutrient-nitrogen as N | Total | MN01042 | 6/9/2009 | | 0.65 | mg/L |
| S004-955 | Nutrient-nitrogen as N | Total | MN01042 | 7/22/2009 | | 0.40 | mg/L |
| S004-955 | Organic carbon | Total | MN00006 | 6/17/2015 | | 15.00 | mg/L |
| S004-955 | Organic carbon | Dissolved | MN00006 | 6/17/2015 | | 14.20 | mg/L |
| S004-955 | Organic carbon | Total | MN00006 | 7/13/2015 | | 16.00 | mg/L |
| S004-955 | Organic carbon | Total | MN00006 | 8/25/2015 | | 15.00 | mg/L |
| S004-955 | pH | Total | | 4/15/2008 | | 7.52 | None |
| S004-955 | pH | Total | | 4/22/2008 | | 7.36 | None |
| S004-955 | pH | Total | | 4/25/2008 | | 7.45 | None |
| S004-955 | pH | Total | | 5/1/2008 | | 7.33 | None |
| S004-955 | pH | Total | | 5/21/2008 | | 8.02 | None |
| S004-955 | pH | Total | | 6/6/2008 | | 8.11 | None |
| S004-955 | pH | Total | | 6/12/2008 | | 7.70 | None |
| S004-955 | pH | Total | | 7/10/2008 | | 8.26 | None |
| S004-955 | pH | Total | | 7/29/2008 | | 8.73 | None |
| S004-955 | pH | Total | | 8/27/2008 | | 7.66 | None |
| S004-955 | pH | Total | | 9/3/2008 | | 8.05 | None |
| S004-955 | pH | Total | | 10/7/2008 | | 7.57 | None |
| S004-955 | pH | Total | | 4/8/2009 | | 6.84 | None |
| S004-955 | pH | Total | | 4/15/2009 | | 7.26 | None |
| S004-955 | pH | Total | | 4/28/2009 | | 7.44 | None |
| S004-955 | pH | Total | | 5/5/2009 | | 7.62 | None |
| S004-955 | pH | Total | | 6/2/2009 | | 7.66 | None |
| S004-955 | pH | Total | | 6/9/2009 | | 7.42 | None |
| S004-955 | pH | Total | | 7/22/2009 | | 7.42 | None |
| S004-955 | pH | Total | | 8/10/2015 | | 8.37 | None |
| S004-955 | pH | Total | | 9/24/2015 | | 7.34 | None |
| S004-955 | Phosphorus as P | Total | MN01042 | 4/9/2008 | | 0.03 | mg/L |
| S004-955 | Phosphorus as P | Total | MN01042 | 4/15/2008 | | 0.03 | mg/L |
| S004-955 | Phosphorus as P | Total | MN01042 | 4/22/2008 | | 0.09 | mg/L |
| S004-955 | Phosphorus as P | Total | MN01042 | 4/25/2008 | | 0.04 | mg/L |
| S004-955 | Phosphorus as P | Total | MN01042 | 5/1/2008 | | 0.03 | mg/L |
| S004-955 | Phosphorus as P | Total | MN01042 | 5/21/2008 | | 0.01 | mg/L |
| S004-955 | Phosphorus as P | Total | MN01042 | 6/6/2008 | | 0.09 | mg/L |
| S004-955 | Phosphorus as P | Total | MN01042 | 6/12/2008 | | 0.04 | mg/L |
| S004-955 | Phosphorus as P | Total | MN01042 | 7/10/2008 | | 0.04 | mg/L |
| S004-955 | Phosphorus as P | Total | MN01042 | 7/29/2008 | | 0.01 | mg/L |
| S004-955 | Phosphorus as P | Total | MN01042 | 8/27/2008 | | 0.02 | mg/L |
| S004-955 | Phosphorus as P | Total | MN01042 | 9/3/2008 | | 0.02 | mg/L |
| S004-955 | Phosphorus as P | Total | MN01042 | 10/7/2008 | | 0.02 | mg/L |
| S004-955 | Phosphorus as P | Total | MN01042 | 4/8/2009 | | 0.02 | mg/L |
| S004-955 | Phosphorus as P | Total | MN01042 | 4/15/2009 | | 0.03 | mg/L |
| S004-955 | Phosphorus as P | Total | MN01042 | 4/28/2009 | | 0.03 | mg/L |
| S004-955 | Phosphorus as P | Total | MN01042 | 5/5/2009 | | 0.02 | mg/L |
| S004-955 | Phosphorus as P | Total | MN01042 | 6/2/2009 | | 0.01 | mg/L |
| S004-955 | Phosphorus as P | Total | MN01042 | 6/9/2009 | | 0.01 | mg/L |
| S004-955 | Phosphorus as P | Total | MN01042 | 7/22/2009 | | 0.02 | mg/L |
| S004-955 | Phosphorus as P | Total | MN00006 | 8/10/2015 | | 0.01 | mg/L |
| S004-955 | Precipitation 24hr prior to monitoring event (choice list) | Total | | 6/24/2017 | | NO | (null) |
| S004-955 | Precipitation 24hr prior to monitoring event (choice list) | Total | | 7/21/2017 | | NO | (null) |
| S004-955 | Precipitation 24hr prior to monitoring event (choice list) | Total | | 7/31/2017 | | NO | (null) |
| S004-955 | Precipitation 24hr prior to monitoring event (choice list) | Total | | 8/6/2017 | | NO | (null) |
| S004-955 | Precipitation 24hr prior to monitoring event (choice list) | Total | | 8/10/2017 | | YES | (null) |
| S004-955 | Precipitation 24hr prior to monitoring event (choice list) | Total | | 8/14/2017 | | NO | (null) |
| S004-955 | Precipitation 24hr prior to monitoring event (choice list) | Total | | 8/20/2017 | | NO | (null) |
| S004-955 | Precipitation 24hr prior to monitoring event (choice list) | Total | | 8/28/2017 | | NO | (null) |
| S004-955 | Precipitation 24hr prior to monitoring event (choice list) | Total | | 9/7/2017 | | NO | (null) |
| S004-955 | Precipitation 24hr prior to monitoring event (choice list) | Total | | 9/15/2017 | | YES | (null) |
| S004-955 | Specific conductance | Total | | 4/9/2008 | | 107.20 | uS/cm |
| S004-955 | Specific conductance | Total | | 4/15/2008 | | 107.30 | uS/cm |
| S004-955 | Specific conductance | Total | | 4/22/2008 | | 51.50 | uS/cm |
| S004-955 | Specific conductance | Total | | 4/25/2008 | | 52.50 | uS/cm |
| S004-955 | Specific conductance | Total | | 5/1/2008 | | 66.80 | uS/cm |
| S004-955 | Specific conductance | Total | | 5/21/2008 | | 129.00 | uS/cm |
| S004-955 | Specific conductance | Total | | 6/6/2008 | | 54.50 | uS/cm |
| S004-955 | Specific conductance | Total | | 6/12/2008 | | 62.80 | uS/cm |
| S004-955 | Specific conductance | Total | | 7/10/2008 | | 287.70 | uS/cm |
| S004-955 | Specific conductance | Total | | 7/29/2008 | | 425.40 | uS/cm |
| S004-955 | Specific conductance | Total | | 8/27/2008 | | 697.80 | uS/cm |
| S004-955 | Specific conductance | Total | | 9/3/2008 | | 306.70 | uS/cm |
| S004-955 | Specific conductance | Total | | 10/7/2008 | | 207.40 | uS/cm |
| S004-955 | Specific conductance | Total | | 4/8/2009 | | 90.00 | uS/cm |

# Appendix A
# Water Quality Dataset

| Station ID | Parameter | Sample Fraction Type | Lab Name Code | Sample Date | Detect Flag | Result | Result Unit |
|---|---|---|---|---|---|---|---|
| S004-955 | Specific conductance | Total | | 4/15/2009 | | 69.00 | uS/cm |
| S004-955 | Specific conductance | Total | | 4/28/2009 | | 54.00 | uS/cm |
| S004-955 | Specific conductance | Total | | 5/5/2009 | | 71.00 | uS/cm |
| S004-955 | Specific conductance | Total | | 6/2/2009 | | 84.00 | uS/cm |
| S004-955 | Specific conductance | Total | | 6/9/2009 | | 180.00 | uS/cm |
| S004-955 | Specific conductance | Total | | 7/22/2009 | | 148.00 | uS/cm |
| S004-955 | Specific conductance | Total | | 8/10/2015 | | 612.00 | uS/cm |
| S004-955 | Specific conductance | Total | | 9/24/2015 | | 142.00 | uS/cm |
| S004-955 | Stream condition (text) | Total | | 6/9/2009 | | N | (null) |
| S004-955 | Stream condition (text) | Total | | 8/10/2015 | | LSLO | (null) |
| S004-955 | Stream condition (text) | Total | | 9/24/2015 | | H | (null) |
| S004-955 | Stream condition (text) | Total | | 6/24/2017 | | N | (null) |
| S004-955 | Stream condition (text) | Total | | 7/21/2017 | | N | (null) |
| S004-955 | Stream condition (text) | Total | | 7/31/2017 | | N | (null) |
| S004-955 | Stream condition (text) | Total | | 8/6/2017 | | N | (null) |
| S004-955 | Stream condition (text) | Total | | 8/10/2017 | | H | (null) |
| S004-955 | Stream condition (text) | Total | | 8/14/2017 | | N | (null) |
| S004-955 | Stream condition (text) | Total | | 8/20/2017 | | N | (null) |
| S004-955 | Stream condition (text) | Total | | 8/28/2017 | | H | (null) |
| S004-955 | Stream condition (text) | Total | | 9/7/2017 | | H | (null) |
| S004-955 | Stream condition (text) | Total | | 9/15/2017 | | H | (null) |
| S004-955 | Stream condition (text) | Total | | 9/17/2017 | | H | (null) |
| S004-955 | Stream Physical Appearance, Minnesota (choice list) | Total | | 6/2/2009 | | 1A.CLEAR | (null) |
| S004-955 | Stream Physical Appearance, Minnesota (choice list) | Total | | 6/9/2009 | | 1A.CLEAR | (null) |
| S004-955 | Stream Physical Appearance, Minnesota (choice list) | Total | | 9/24/2015 | | 2.CLOUDY | (null) |
| S004-955 | Stream Physical Appearance, Minnesota (choice list) | Total | | 6/24/2017 | | 1B.TEA- $1^{C}B^{O}.T^{L}E^{O}A^{R}$- | (null) |
| S004-955 | Stream Physical Appearance, Minnesota (choice list) | Total | | 7/21/2017 | | $1^{C}B^{O}.T^{L}E^{O}A^{R}$- | (null) |
| S004-955 | Stream Physical Appearance, Minnesota (choice list) | Total | | 7/31/2017 | | $1^{C}B^{O}.T^{L}E^{O}A^{R}$- | (null) |
| S004-955 | Stream Physical Appearance, Minnesota (choice list) | Total | | 8/6/2017 | | COLOR | (null) |
| S004-955 | Stream Physical Appearance, Minnesota (choice list) | Total | | 8/10/2017 | | 3.MUDDY | (null) |
| S004-955 | Stream Physical Appearance, Minnesota (choice list) | Total | | 8/14/2017 | | 1B.TEA- COLOR | (null) |
| S004-955 | Stream Physical Appearance, Minnesota (choice list) | Total | | 8/20/2017 | | 2.CLOUDY | (null) |
| S004-955 | Stream Physical Appearance, Minnesota (choice list) | Total | | 8/28/2017 | | 2.CLOUDY | (null) |
| S004-955 | Stream Physical Appearance, Minnesota (choice list) | Total | | 9/7/2017 | | 1B.TEA- COLOR | (null) |
| S004-955 | Stream Physical Appearance, Minnesota (choice list) | Total | | 9/15/2017 | | 2.CLOUDY | (null) |
| S004-955 | Stream Physical Appearance, Minnesota (choice list) | Total | | 9/17/2017 | | 2.CLOUDY | (null) |
| S004-955 | Stream recreational suitability (choice list) | Total | | 6/2/2009 | | 1.VERY GOOD | (null) |
| S004-955 | Stream recreational suitability (choice list) | Total | | 6/9/2009 | | 2.GOOD | (null) |
| S004-955 | Stream recreational suitability (choice list) | Total | | 6/24/2017 | | 2.GOOD | (null) |
| S004-955 | Stream recreational suitability (choice list) | Total | | 7/21/2017 | | 2.GOOD | (null) |
| S004-955 | Stream recreational suitability (choice list) | Total | | 7/31/2017 | | 2.GOOD | (null) |
| S004-955 | Stream recreational suitability (choice list) | Total | | 8/6/2017 | | 2.GOOD | (null) |
| S004-955 | Stream recreational suitability (choice list) | Total | | 8/10/2017 | | 3.FAIR | (null) |
| S004-955 | Stream recreational suitability (choice list) | Total | | 8/14/2017 | | 2.GOOD | (null) |
| S004-955 | Stream recreational suitability (choice list) | Total | | 8/20/2017 | | 2.GOOD | (null) |
| S004-955 | Stream recreational suitability (choice list) | Total | | 8/28/2017 | | 2.GOOD | (null) |
| S004-955 | Stream recreational suitability (choice list) | Total | | 9/7/2017 | | 2.GOOD | (null) |
| S004-955 | Stream recreational suitability (choice list) | Total | | 9/15/2017 | | 2.GOOD | (null) |
| S004-955 | Stream recreational suitability (choice list) | Total | | 9/17/2017 | | 2.GOOD | (null) |
| S004-955 | Sulfate as SO4 | Total | MN00006 | 8/10/2015 | | 36.60 | mg/L |
| S004-955 | Temperature, water | Total | | 4/9/2008 | | 0.60 | deg C |
| S004-955 | Temperature, water | Total | | 4/15/2008 | | 1.10 | deg C |
| S004-955 | Temperature, water | Total | | 4/22/2008 | | 3.23 | deg C |
| S004-955 | Temperature, water | Total | | 4/25/2008 | | 4.06 | deg C |
| S004-955 | Temperature, water | Total | | 5/1/2008 | | 4.93 | deg C |
| S004-955 | Temperature, water | Total | | 5/21/2008 | | 10.53 | deg C |
| S004-955 | Temperature, water | Total | | 6/6/2008 | | 10.13 | deg C |
| S004-955 | Temperature, water | Total | | 6/12/2008 | | 10.10 | deg C |
| S004-955 | Temperature, water | Total | | 7/10/2008 | | 17.70 | deg C |
| S004-955 | Temperature, water | Total | | 7/29/2008 | | 21.25 | deg C |
| S004-955 | Temperature, water | Total | | 8/27/2008 | | 16.45 | deg C |
| S004-955 | Temperature, water | Total | | 9/3/2008 | | 17.06 | deg C |
| S004-955 | Temperature, water | Total | | 10/7/2008 | | 10.10 | deg C |
| S004-955 | Temperature, water | Total | | 4/8/2009 | | 0.50 | deg C |
| S004-955 | Temperature, water | Total | | 4/15/2009 | | 1.10 | deg C |
| S004-955 | Temperature, water | Total | | 4/28/2009 | | 4.60 | deg C |
| S004-955 | Temperature, water | Total | | 5/5/2009 | | 8.00 | deg C |
| S004-955 | Temperature, water | Total | | 6/2/2009 | | 13.30 | deg C |
| S004-955 | Temperature, water | Total | | 6/9/2009 | | 11.50 | deg C |
| S004-955 | Temperature, water | Total | | 7/22/2009 | | 20.10 | deg C |
| S004-955 | Temperature, water | Total | | 5/29/2015 | | 14.00 | deg C |
| S004-955 | Temperature, water | Total | | 6/16/2015 | | 14.38 | deg C |
| S004-955 | Temperature, water | Total | | 7/21/2015 | | 14.97 | deg C |

# Appendix A
# Water Quality Dataset

| Station ID | Parameter | Sample Fraction Type | Lab Name Code | Sample Date | Detect Flag | Result | Result Unit |
|---|---|---|---|---|---|---|---|
| S004-955 | Temperature, water | Total | | 8/10/2015 | | 22.63 | deg C |
| S004-955 | Temperature, water | Total | | 9/8/2015 | | 15.11 | deg C |
| S004-955 | Temperature, water | Total | | 9/24/2015 | | 12.43 | deg C |
| S004-955 | Temperature, water | Total | | 10/12/2015 | | 14.70 | deg C |
| S004-955 | Total suspended solids | Total | MN01042 | 4/9/2008 | | 11.00 | mg/L |
| S004-955 | Total suspended solids | Total | MN01042 | 4/15/2008 | | 14.60 | mg/L |
| S004-955 | Total suspended solids | Total | MN01042 | 4/22/2008 | | 79.00 | mg/L |
| S004-955 | Total suspended solids | Total | MN01042 | 4/25/2008 | | 15.00 | mg/L |
| S004-955 | Total suspended solids | Total | MN01042 | 5/1/2008 | | 6.50 | mg/L |
| S004-955 | Total suspended solids | Total | MN01042 | 5/21/2008 | | 2.50 | mg/L |
| S004-955 | Total suspended solids | Total | MN01042 | 6/6/2008 | | 99.00 | mg/L |
| S004-955 | Total suspended solids | Total | MN01042 | 6/12/2008 | | 18.40 | mg/L |
| S004-955 | Total suspended solids | Total | MN01042 | 7/10/2008 | | 10.50 | mg/L |
| S004-955 | Total suspended solids | Total | MN01042 | 7/29/2008 | | 6.70 | mg/L |
| S004-955 | Total suspended solids | Total | MN01042 | 8/27/2008 | | 8.40 | mg/L |
| S004-955 | Total suspended solids | Total | MN01042 | 9/3/2008 | | 8.70 | mg/L |
| S004-955 | Total suspended solids | Total | MN01042 | 10/7/2008 | | 4.40 | mg/L |
| S004-955 | Total suspended solids | Total | MN01042 | 4/8/2009 | | 5.50 | mg/L |
| S004-955 | Total suspended solids | Total | MN01042 | 4/15/2009 | | 25.80 | mg/L |
| S004-955 | Total suspended solids | Total | MN01042 | 4/28/2009 | | 7.10 | mg/L |
| S004-955 | Total suspended solids | Total | MN01042 | 5/5/2009 | | 5.30 | mg/L |
| S004-955 | Total suspended solids | Total | MN01042 | 6/2/2009 | | 3.90 | mg/L |
| S004-955 | Total suspended solids | Total | MN01042 | 6/9/2009 | | 4.00 | mg/L |
| S004-955 | Total suspended solids | Total | MN01042 | 7/22/2009 | | 7.20 | mg/L |
| S004-955 | Total suspended solids | Total | MN00006 | 8/10/2015 | | 6.40 | mg/L |
| S004-955 | Total suspended solids | Total | MN00006 | 8/19/2015 | | 18.00 | mg/L |
| S004-955 | Total suspended solids | Total | MN00006 | 9/24/2015 | | 10.00 | mg/L |
| S004-955 | Transparency, tube with disk | Total | | 4/9/2008 | | 60.00 | cm |
| S004-955 | Transparency, tube with disk | Total | | 4/15/2008 | | 39.00 | cm |
| S004-955 | Transparency, tube with disk | Total | | 4/22/2008 | | 13.00 | cm |
| S004-955 | Transparency, tube with disk | Total | | 5/1/2008 | | 91.20 | cm |
| S004-955 | Transparency, tube with disk | Total | | 5/21/2008 | | 115.00 | cm |
| S004-955 | Transparency, tube with disk | Total | | 6/6/2008 | | 9.00 | cm |
| S004-955 | Transparency, tube with disk | Total | | 6/12/2008 | | 34.00 | cm |
| S004-955 | Transparency, tube with disk | Total | | 7/10/2008 | | 59.50 | cm |
| S004-955 | Transparency, tube with disk | Total | | 7/29/2008 | | 91.00 | cm |
| S004-955 | Transparency, tube with disk | Total | | 8/27/2008 | | 88.00 | cm |
| S004-955 | Transparency, tube with disk | Total | | 9/3/2008 | | 59.00 | cm |
| S004-955 | Transparency, tube with disk | Total | | 10/7/2008 | | 102.00 | cm |
| S004-955 | Transparency, tube with disk | Total | | 4/8/2009 | | 86.00 | cm |
| S004-955 | Transparency, tube with disk | Total | | 4/15/2009 | | 32.00 | cm |
| S004-955 | Transparency, tube with disk | Total | | 4/28/2009 | | 71.00 | cm |
| S004-955 | Transparency, tube with disk | Total | | 5/5/2009 | | 110.00 | cm |
| S004-955 | Transparency, tube with disk | Total | | 6/2/2009 | > | 120.00 | cm |
| S004-955 | Transparency, tube with disk | Total | | 7/22/2009 | | 105.00 | cm |
| S004-955 | Transparency, tube with disk | Total | | 8/10/2015 | | 72.00 | cm |
| S004-955 | Transparency, tube with disk | Total | | 8/19/2015 | | 31.00 | cm |
| S004-955 | Transparency, tube with disk | Total | | 9/24/2015 | | 47.00 | cm |
| S004-955 | Transparency, tube with disk | Total | | 6/24/2017 | > | 100.00 | cm |
| S004-955 | Transparency, tube with disk | Total | | 7/21/2017 | > | 100.00 | cm |
| S004-955 | Transparency, tube with disk | Total | | 7/31/2017 | > | 100.00 | cm |
| S004-955 | Transparency, tube with disk | Total | | 8/6/2017 | > | 100.00 | cm |
| S004-955 | Transparency, tube with disk | Total | | 8/10/2017 | | 45.00 | cm |
| S004-955 | Transparency, tube with disk | Total | | 8/14/2017 | > | 100.00 | cm |
| S004-955 | Transparency, tube with disk | Total | | 8/20/2017 | | 97.00 | cm |
| S004-955 | Transparency, tube with disk | Total | | 8/28/2017 | | 52.00 | cm |
| S004-955 | Transparency, tube with disk | Total | | 9/7/2017 | > | 100.00 | cm |
| S004-955 | Transparency, tube with disk | Total | | 9/15/2017 | | 20.00 | cm |
| S004-955 | True color | Dissolved | MN01042 | 4/15/2008 | | 131.00 | PCU |
| S004-955 | True color | Dissolved | MN01042 | 4/22/2008 | | 125.00 | PCU |
| S004-955 | True color | Dissolved | MN01042 | 4/25/2008 | | 126.00 | PCU |
| S004-955 | True color | Dissolved | MN01042 | 5/1/2008 | | 108.00 | PCU |
| S004-955 | True color | Dissolved | MN01042 | 6/6/2008 | | 238.00 | PCU |
| S004-955 | True color | Dissolved | MN01042 | 6/12/2008 | | 193.00 | PCU |
| S004-955 | True color | Dissolved | MN01042 | 7/10/2008 | | 64.00 | PCU |
| S004-955 | True color | Dissolved | MN01042 | 7/29/2008 | | 39.00 | PCU |
| S004-955 | True color | Dissolved | MN01042 | 8/27/2008 | | 13.00 | PCU |
| S004-955 | True color | Dissolved | MN01042 | 9/3/2008 | | 57.00 | PCU |
| S004-955 | True color | Dissolved | MN01042 | 10/7/2008 | | 102.00 | PCU |
| S004-955 | True color | Dissolved | MN01042 | 4/8/2009 | | 98.00 | PCU |
| S004-955 | True color | Dissolved | MN01042 | 4/8/2009 | | 98.00 | PCU |
| S004-955 | True color | Dissolved | MN01042 | 4/15/2009 | | 50.00 | PCU |
| S004-955 | True color | Dissolved | MN01042 | 4/15/2009 | | 50.00 | PCU |

# Appendix A
# Water Quality Dataset

| Station ID | Parameter | Sample Fraction Type | Lab Name Code | Sample Date | Detect Flag | Result | Result Unit |
|---|---|---|---|---|---|---|---|
| S004-955 | True color | Dissolved | MN01042 | 4/28/2009 | | 120.00 | PCU |
| S004-955 | True color | Dissolved | MN01042 | 4/28/2009 | | 120.00 | PCU |
| S004-955 | True color | Dissolved | MN01042 | 5/5/2009 | | 61.00 | PCU |
| S004-955 | True color | Dissolved | MN01042 | 5/5/2009 | | 61.00 | PCU |
| S004-955 | True color | Dissolved | MN01042 | 6/2/2009 | | 106.00 | PCU |
| S004-955 | True color | Dissolved | MN01042 | 6/2/2009 | | 106.00 | PCU |
| S004-955 | True color | Dissolved | MN01042 | 6/9/2009 | | 86.00 | PCU |
| S004-955 | True color | Dissolved | MN01042 | 6/9/2009 | | 86.00 | PCU |
| S004-955 | True color | Dissolved | MN01042 | 7/22/2009 | | 62.00 | PCU |
| S004-955 | True color | Dissolved | MN01042 | 7/22/2009 | | 62.00 | PCU |
| S004-955 | Turbidity | Total | MN01042 | 4/9/2008 | | 22.70 | NTRU |
| S004-955 | Turbidity | Total | MN01042 | 4/15/2008 | | 25.50 | NTRU |
| S004-955 | Turbidity | Total | | 4/22/2008 | | 155.50 | FNU |
| S004-955 | Turbidity | Total | MN01042 | 4/22/2008 | | 81.40 | NTRU |
| S004-955 | Turbidity | Total | | 4/25/2008 | | 33.90 | FNU |
| S004-955 | Turbidity | Total | MN01042 | 4/25/2008 | | 18.70 | NTRU |
| S004-955 | Turbidity | Total | | 5/1/2008 | | 8.20 | FNU |
| S004-955 | Turbidity | Total | MN01042 | 5/1/2008 | | 8.59 | NTRU |
| S004-955 | Turbidity | Total | | 5/21/2008 | | 6.60 | FNU |
| S004-955 | Turbidity | Total | MN01042 | 5/21/2008 | | 4.37 | NTRU |
| S004-955 | Turbidity | Total | | 6/6/2008 | | 257.00 | FNU |
| S004-955 | Turbidity | Total | MN01042 | 6/6/2008 | | 157.00 | NTRU |
| S004-955 | Turbidity | Total | | 6/12/2008 | | 40.20 | FNU |
| S004-955 | Turbidity | Total | MN01042 | 6/12/2008 | | 33.50 | NTRU |
| S004-955 | Turbidity | Total | MN01042 | 7/10/2008 | | 16.20 | NTRU |
| S004-955 | Turbidity | Total | | 7/29/2008 | | 8.20 | FNU |
| S004-955 | Turbidity | Total | MN01042 | 7/29/2008 | | 8.53 | NTRU |
| S004-955 | Turbidity | Total | | 8/27/2008 | | 10.30 | FNU |
| S004-955 | Turbidity | Total | MN01042 | 8/27/2008 | | 9.47 | NTRU |
| S004-955 | Turbidity | Total | | 9/3/2008 | | 13.20 | FNU |
| S004-955 | Turbidity | Total | MN01042 | 9/3/2008 | | 12.20 | NTRU |
| S004-955 | Turbidity | Total | MN01042 | 10/7/2008 | | 6.62 | NTRU |
| S004-955 | Turbidity | Total | MN01042 | 4/8/2009 | | 12.60 | NTRU |
| S004-955 | Turbidity | Total | MN01042 | 4/15/2009 | | 24.70 | NTRU |
| S004-955 | Turbidity | Total | MN01042 | 4/28/2009 | | 9.43 | NTRU |
| S004-955 | Turbidity | Total | MN01042 | 5/5/2009 | | 7.10 | NTRU |
| S004-955 | Turbidity | Total | MN01042 | 6/2/2009 | | 6.04 | NTRU |
| S004-955 | Turbidity | Total | MN01042 | 6/9/2009 | | 8.34 | NTRU |
| S004-955 | Turbidity | Total | MN01042 | 7/22/2009 | | 10.90 | NTRU |
| S004-955 | UV Absorbance at 254 nm | Total | MN00006 | 7/13/2015 | | 0.52 | units/cm |
| S004-955 | UV Absorbance at 254 nm | Total | MN00006 | 8/25/2015 | | 0.56 | units/cm |
| S004-955 | Volatile suspended solids | Total | MN00006 | 8/10/2015 | | 1.60 | mg/L |
| S004-955 | Volatile suspended solids | Total | MN00006 | 9/24/2015 | | 3.60 | mg/L |
| S006-234 | Ammonia-nitrogen as N | Total | MN00037 | 5/9/2011 | < | 0.02 | mg/L |
| S006-234 | Ammonia-nitrogen as N | Total | MN00037 | 5/25/2011 | < | 0.02 | mg/L |
| S006-234 | Ammonia-nitrogen as N | Total | MN00037 | 6/1/2011 | < | 0.02 | mg/L |
| S006-234 | Ammonia-nitrogen as N | Total | MN00037 | 6/15/2011 | < | 0.01 | mg/L |
| S006-234 | Ammonia-nitrogen as N | Total | MN00037 | 7/5/2011 | < | 0.02 | mg/L |
| S006-234 | Ammonia-nitrogen as N | Total | MN00037 | 7/11/2011 | < | 0.02 | mg/L |
| S006-234 | Ammonia-nitrogen as N | Total | MN00037 | 8/8/2011 | < | 0.02 | mg/L |
| S006-234 | Ammonia-nitrogen as N | Total | MN00037 | 8/15/2011 | < | 0.02 | mg/L |
| S006-234 | Ammonia-nitrogen as N | Total | MN00037 | 9/1/2011 | < | 0.02 | mg/L |
| S006-234 | Ammonia-nitrogen as N | Total | MN00037 | 9/11/2011 | < | 0.02 | mg/L |
| S006-234 | Ammonia-nitrogen as N | Total | MN00037 | 9/11/2011 | | 0.02 | mg/L |
| S006-234 | Chloride | Total | MN00037 | 5/9/2011 | | 4.80 | mg/L |
| S006-234 | Chloride | Total | MN00037 | 5/25/2011 | | 4.60 | mg/L |
| S006-234 | Chloride | Total | MN00037 | 6/1/2011 | | 1.50 | mg/L |
| S006-234 | Chloride | Total | MN00037 | 6/15/2011 | | 25.00 | mg/L |
| S006-234 | Chloride | Total | MN00037 | 7/5/2011 | | 9.50 | mg/L |
| S006-234 | Chloride | Total | MN00037 | 7/5/2011 | | 9.50 | mg/L |
| S006-234 | Chloride | Total | MN00037 | 7/11/2011 | | 7.60 | mg/L |
| S006-234 | Chloride | Total | MN00037 | 8/8/2011 | | 14.00 | mg/L |
| S006-234 | Chloride | Total | MN00037 | 8/15/2011 | | 29.00 | mg/L |
| S006-234 | Chloride | Total | MN00037 | 9/1/2011 | | 60.00 | mg/L |
| S006-234 | Chloride | Total | MN00037 | 9/11/2011 | | 60.00 | mg/L |
| S006-234 | Dissolved oxygen (DO) | Total | | 7/21/2010 | | 9.42 | mg/L |
| S006-234 | Escherichia coli | Total | MN00037 | 6/3/2010 | | 20.00 | MPN/100 |
| S006-234 | Escherichia coli | Total | MN00037 | 6/10/2010 | | 99.00 | MPN/100 |
| S006-234 | Escherichia coli | Total | MN00037 | 6/24/2010 | | 48.00 | MPN/100 |
| S006-234 | Escherichia coli | Total | MN00037 | 7/8/2010 | | 20.00 | MPN/100 |
| S006-234 | Escherichia coli | Total | MN00037 | 7/15/2010 | | 580.00 | MPN/100 |
| S006-234 | Escherichia coli | Total | MN00037 | 7/15/2010 | | 370.00 | MPN/100 |
| S006-234 | Escherichia coli | Total | MN00037 | 7/21/2010 | | 20.00 | MPN/100 |

# Appendix A
# Water Quality Dataset

| Station ID | Parameter | Sample Fraction Type | Lab Name Code | Sample Date | Detect Flag | Result | Result Unit |
|---|---|---|---|---|---|---|---|
| S006-234 | Escherichia coli | Total | MN00037 | 8/5/2010 | | 26.00 | MPN/100 |
| S006-234 | Escherichia coli | Total | MN00037 | 8/12/2010 | | 250.00 | MPN/100 |
| S006-234 | Escherichia coli | Total | MN00037 | 8/12/2010 | | 170.00 | MPN/100 |
| S006-234 | Escherichia coli | Total | MN00037 | 8/19/2010 | | 110.00 | MPN/100 |
| S006-234 | Escherichia coli | Total | MN00037 | 6/1/2011 | | 13.00 | MPN/100 |
| S006-234 | Escherichia coli | Total | MN00037 | 6/15/2011 | | 11.00 | MPN/100 |
| S006-234 | Escherichia coli | Total | MN00037 | 6/15/2011 | | 10.00 | MPN/100 |
| S006-234 | Escherichia coli | Total | MN00037 | 7/5/2011 | | 30.00 | MPN/100 |
| S006-234 | Escherichia coli | Total | MN00037 | 7/11/2011 | | 30.00 | MPN/100 |
| S006-234 | Escherichia coli | Total | MN00037 | 8/8/2011 | | 78.00 | MPN/100 |
| S006-234 | Escherichia coli | Total | MN00037 | 8/15/2011 | | 84.00 | MPN/100 |
| S006-234 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00037 | 5/9/2011 | | 0.02 | mg/L |
| S006-234 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00037 | 5/25/2011 | | 0.03 | mg/L |
| S006-234 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00037 | 6/1/2011 | < | 0.05 | mg/L |
| S006-234 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00037 | 6/15/2011 | | 0.29 | mg/L |
| S006-234 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00037 | 7/5/2011 | | 0.09 | mg/L |
| S006-234 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00037 | 7/11/2011 | | 0.07 | mg/L |
| S006-234 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00037 | 8/8/2011 | | 0.11 | mg/L |
| S006-234 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00037 | 8/15/2011 | | 0.27 | mg/L |
| S006-234 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00037 | 9/1/2011 | | 3.97 | mg/L |
| S006-234 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00037 | 9/11/2011 | | 0.50 | mg/L |
| S006-234 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00037 | 9/11/2011 | | 0.52 | mg/L |
| S006-234 | Kjeldahl nitrogen as N | Total | MN00037 | 5/9/2011 | | 0.50 | mg/L |
| S006-234 | Kjeldahl nitrogen as N | Total | MN00037 | 5/25/2011 | | 0.70 | mg/L |
| S006-234 | Kjeldahl nitrogen as N | Total | MN00037 | 6/1/2011 | | 0.70 | mg/L |
| S006-234 | Kjeldahl nitrogen as N | Total | MN00037 | 6/15/2011 | | 0.30 | mg/L |
| S006-234 | Kjeldahl nitrogen as N | Total | MN00037 | 7/5/2011 | | 0.60 | mg/L |
| S006-234 | Kjeldahl nitrogen as N | Total | MN00037 | 7/11/2011 | | 0.60 | mg/L |
| S006-234 | Kjeldahl nitrogen as N | Total | MN00037 | 8/8/2011 | | 0.60 | mg/L |
| S006-234 | Kjeldahl nitrogen as N | Total | MN00037 | 8/15/2011 | | 0.50 | mg/L |
| S006-234 | Kjeldahl nitrogen as N | Total | MN00037 | 9/1/2011 | | 0.30 | mg/L |
| S006-234 | Kjeldahl nitrogen as N | Total | MN00037 | 9/11/2011 | | 0.30 | mg/L |
| S006-234 | Kjeldahl nitrogen as N | Total | MN00037 | 9/11/2011 | | 0.30 | mg/L |
| S006-234 | pH | Total | | 6/3/2010 | | 8.07 | None |
| S006-234 | pH | Total | | 6/10/2010 | | 7.66 | None |
| S006-234 | pH | Total | | 6/24/2010 | | 7.90 | None |
| S006-234 | pH | Total | | 7/8/2010 | | 8.53 | None |
| S006-234 | pH | Total | | 7/15/2010 | | 8.25 | None |
| S006-234 | pH | Total | | 7/21/2010 | | 8.33 | None |
| S006-234 | pH | Total | | 8/5/2010 | | 8.53 | None |
| S006-234 | pH | Total | | 8/12/2010 | | 8.34 | None |
| S006-234 | pH | Total | | 8/19/2010 | | 8.53 | None |
| S006-234 | pH | Total | | 5/9/2011 | | 7.67 | None |
| S006-234 | pH | Total | | 5/25/2011 | | 8.02 | None |
| S006-234 | pH | Total | | 6/1/2011 | | 7.60 | None |
| S006-234 | pH | Total | | 6/15/2011 | | 7.70 | None |
| S006-234 | pH | Total | | 7/5/2011 | | 7.80 | None |
| S006-234 | pH | Total | | 7/11/2011 | | 7.90 | None |
| S006-234 | pH | Total | | 8/8/2011 | | 8.03 | None |
| S006-234 | pH | Total | | 8/15/2011 | | 8.03 | None |
| S006-234 | pH | Total | | 9/1/2011 | | 8.20 | None |
| S006-234 | pH | Total | | 9/11/2011 | | 8.22 | None |
| S006-234 | Phosphorus as P | Total | MN00037 | 5/9/2011 | | 0.02 | mg/L |
| S006-234 | Phosphorus as P | Total | MN00037 | 5/25/2011 | | 0.03 | mg/L |
| S006-234 | Phosphorus as P | Total | MN00037 | 6/1/2011 | | 0.03 | mg/L |
| S006-234 | Phosphorus as P | Total | MN00037 | 6/15/2011 | | 0.02 | mg/L |
| S006-234 | Phosphorus as P | Total | MN00037 | 7/5/2011 | | 0.02 | mg/L |
| S006-234 | Phosphorus as P | Total | MN00037 | 7/11/2011 | | 0.02 | mg/L |
| S006-234 | Phosphorus as P | Total | MN00037 | 8/8/2011 | | 0.02 | mg/L |
| S006-234 | Phosphorus as P | Total | MN00037 | 8/15/2011 | | 0.03 | mg/L |
| S006-234 | Phosphorus as P | Total | MN00037 | 9/1/2011 | | 0.02 | mg/L |
| S006-234 | Phosphorus as P | Total | MN00037 | 9/11/2011 | | 0.02 | mg/L |
| S006-234 | Phosphorus as P | Total | MN00037 | 9/11/2011 | | 0.02 | mg/L |
| S006-234 | Precipitation 24hr prior to monitoring event (choice list) | Total | | 4/8/2017 | | NO | |
| S006-234 | Precipitation 24hr prior to monitoring event (choice list) | Total | | 4/13/2017 | | NO | |
| S006-234 | Precipitation 24hr prior to monitoring event (choice list) | Total | | 4/20/2017 | | YES | |
| S006-234 | Precipitation 24hr prior to monitoring event (choice list) | Total | | 4/27/2017 | | NO | |
| S006-234 | Precipitation 24hr prior to monitoring event (choice list) | Total | | 5/2/2017 | | YES | |
| S006-234 | Precipitation 24hr prior to monitoring event (choice list) | Total | | 5/13/2017 | | NO | |
| S006-234 | Precipitation 24hr prior to monitoring event (choice list) | Total | | 5/17/2017 | | NO | |
| S006-234 | Precipitation 24hr prior to monitoring event (choice list) | Total | | 5/25/2017 | | NO | |
| S006-234 | Specific conductance | Total | | 6/3/2010 | | 114.40 | uS/cm |
| S006-234 | Specific conductance | Total | | 6/10/2010 | | 78.20 | uS/cm |

# Appendix A
# Water Quality Dataset

| Station ID | Parameter | Sample Fraction Type | Lab Name Code | Sample Date | Detect Flag | Result | Result Unit |
|---|---|---|---|---|---|---|---|
| S006-234 | Specific conductance | Total | | 6/24/2010 | | 101.20 | uS/cm |
| S006-234 | Specific conductance | Total | | 7/8/2010 | | 264.00 | uS/cm |
| S006-234 | Specific conductance | Total | | 7/15/2010 | | 179.00 | uS/cm |
| S006-234 | Specific conductance | Total | | 7/21/2010 | | 332.00 | uS/cm |
| S006-234 | Specific conductance | Total | | 8/5/2010 | | 312.00 | uS/cm |
| S006-234 | Specific conductance | Total | | 8/12/2010 | | 266.00 | uS/cm |
| S006-234 | Specific conductance | Total | | 8/19/2010 | | 442.00 | uS/cm |
| S006-234 | Stream condition (text) | Total | | 6/3/2010 | | N | |
| S006-234 | Stream condition (text) | Total | | 6/10/2010 | | H | |
| S006-234 | Stream condition (text) | Total | | 6/24/2010 | | H | |
| S006-234 | Stream condition (text) | Total | | 7/8/2010 | | N | |
| S006-234 | Stream condition (text) | Total | | 7/15/2010 | | H | |
| S006-234 | Stream condition (text) | Total | | 7/21/2010 | | N | |
| S006-234 | Stream condition (text) | Total | | 8/5/2010 | | L | |
| S006-234 | Stream condition (text) | Total | | 8/12/2010 | | N | |
| S006-234 | Stream condition (text) | Total | | 8/19/2010 | | N | |
| S006-234 | Stream condition (text) | Total | | 5/9/2011 | | N | |
| S006-234 | Stream condition (text) | Total | | 5/25/2011 | | N | |
| S006-234 | Stream condition (text) | Total | | 6/1/2011 | | N | |
| S006-234 | Stream condition (text) | Total | | 6/15/2011 | | L | |
| S006-234 | Stream condition (text) | Total | | 7/5/2011 | | N | |
| S006-234 | Stream condition (text) | Total | | 7/11/2011 | | N | |
| S006-234 | Stream condition (text) | Total | | 8/8/2011 | | N | |
| S006-234 | Stream condition (text) | Total | | 8/15/2011 | | N | |
| S006-234 | Stream condition (text) | Total | | 9/1/2011 | | N | |
| S006-234 | Stream condition (text) | Total | | 9/11/2011 | | L | |
| S006-234 | Stream condition (text) | Total | | 4/8/2017 | | H | |
| S006-234 | Stream condition (text) | Total | | 4/13/2017 | | H | |
| S006-234 | Stream condition (text) | Total | | 4/20/2017 | | H | |
| S006-234 | Stream condition (text) | Total | | 4/27/2017 | | H | |
| S006-234 | Stream condition (text) | Total | | 5/2/2017 | | H | |
| S006-234 | Stream condition (text) | Total | | 5/13/2017 | | H | |
| S006-234 | Stream condition (text) | Total | | 5/17/2017 | | H | |
| S006-234 | Stream condition (text) | Total | | 5/25/2017 | | H | |
| S006-234 | Stream Physical Appearance, Minnesota (choice list) | Total | | 6/3/2010 | | 1B.TEA-COLOR | |
| S006-234 | Stream Physical Appearance, Minnesota (choice list) | Total | | 6/10/2010 | | 1B.TEA-COLOR | |
| S006-234 | Stream Physical Appearance, Minnesota (choice list) | Total | | 6/24/2010 | | 1B.TEA-COLOR | |
| S006-234 | Stream Physical Appearance, Minnesota (choice list) | Total | | 7/8/2010 | | 1B.TEA-COLOR | |
| S006-234 | Stream Physical Appearance, Minnesota (choice list) | Total | | 7/15/2010 | | 2.CLOUDY | |
| S006-234 | Stream Physical Appearance, Minnesota (choice list) | Total | | 7/21/2010 | | 2.CLOUDY | |
| S006-234 | Stream Physical Appearance, Minnesota (choice list) | Total | | 8/5/2010 | | 2.CLOUDY | |
| S006-234 | Stream Physical Appearance, Minnesota (choice list) | Total | | 8/12/2010 | | 2.CLOUDY | |
| S006-234 | Stream Physical Appearance, Minnesota (choice list) | Total | | 8/19/2010 | | 2.CLOUDY | |
| S006-234 | Stream Physical Appearance, Minnesota (choice list) | Total | | 5/9/2011 | | 2.CLOUDY | |
| S006-234 | Stream Physical Appearance, Minnesota (choice list) | Total | | 5/25/2011 | | 2.CLOUDY | |
| S006-234 | Stream Physical Appearance, Minnesota (choice list) | Total | | 6/1/2011 | | 2.CLOUDY | |
| S006-234 | Stream Physical Appearance, Minnesota (choice list) | Total | | 6/15/2011 | | 2.CLOUDY | |
| S006-234 | Stream Physical Appearance, Minnesota (choice list) | Total | | 7/5/2011 | | 1B.TEA-COLOR | |
| S006-234 | Stream Physical Appearance, Minnesota (choice list) | Total | | 7/11/2011 | | 1B.TEA-COLOR | |
| S006-234 | Stream Physical Appearance, Minnesota (choice list) | Total | | 8/8/2011 | | 1B.TEA-COLOR | |
| S006-234 | Stream Physical Appearance, Minnesota (choice list) | Total | | 8/15/2011 | | 1B.TEA-COLOR | |
| S006-234 | Stream Physical Appearance, Minnesota (choice list) | Total | | 9/1/2011 | | 2.CLOUDY | |
| S006-234 | Stream Physical Appearance, Minnesota (choice list) | Total | | 9/11/2011 | | 2.CLOUDY | |
| S006-234 | Stream Physical Appearance, Minnesota (choice list) | Total | | 4/8/2017 | | 1B.TEA-COLOR | |
| S006-234 | Stream Physical Appearance, Minnesota (choice list) | Total | | 4/13/2017 | | 1B.TEA-COLOR | |
| S006-234 | Stream Physical Appearance, Minnesota (choice list) | Total | | 4/20/2017 | | 1B.TEA-COLOR | |
| S006-234 | Stream Physical Appearance, Minnesota (choice list) | Total | | 4/27/2017 | | 1B.TEA-COLOR | |
| S006-234 | Stream Physical Appearance, Minnesota (choice list) | Total | | 5/2/2017 | | 1B.TEA-COLOR | |
| S006-234 | Stream Physical Appearance, Minnesota (choice list) | Total | | 5/13/2017 | | 1B.TEA-COLOR | |
| S006-234 | Stream Physical Appearance, Minnesota (choice list) | Total | | 5/17/2017 | | 1B.TEA-COLOR | |
| S006-234 | Stream Physical Appearance, Minnesota (choice list) | Total | | 5/25/2017 | | 1B.TEA-COLOR | |
| S006-234 | Stream recreational suitability (choice list) | Total | | 6/3/2010 | | 2.GOOD | |
| S006-234 | Stream recreational suitability (choice list) | Total | | 6/10/2010 | | 2.GOOD | |
| S006-234 | Stream recreational suitability (choice list) | Total | | 6/24/2010 | | 2.GOOD | |
| S006-234 | Stream recreational suitability (choice list) | Total | | 7/8/2010 | | 2.GOOD | |
| S006-234 | Stream recreational suitability (choice list) | Total | | 7/15/2010 | | 2.GOOD | |
| S006-234 | Stream recreational suitability (choice list) | Total | | 7/21/2010 | | 2.GOOD | |
| S006-234 | Stream recreational suitability (choice list) | Total | | 8/5/2010 | | 2.GOOD | |
| S006-234 | Stream recreational suitability (choice list) | Total | | 8/12/2010 | | 2.GOOD | |
| S006-234 | Stream recreational suitability (choice list) | Total | | 8/19/2010 | | 2.GOOD | |
| S006-234 | Stream recreational suitability (choice list) | Total | | 5/9/2011 | | 1.VERY GOOD | |
| S006-234 | Stream recreational suitability (choice list) | Total | | 5/25/2011 | | 1.VERY GOOD | |
| S006-234 | Stream recreational suitability (choice list) | Total | | 6/1/2011 | | 1.VERY GOOD | |

# Appendix A
# Water Quality Dataset

| Station ID | Parameter | Sample Fraction Type | Lab Name Code | Sample Date | Detect Flag | Result | Result Unit |
|---|---|---|---|---|---|---|---|
| S006-234 | Stream recreational suitability (choice list) | Total | | 6/15/2011 | | 1.VERY GOOD | |
| S006-234 | Stream recreational suitability (choice list) | Total | | 7/5/2011 | | 2.GOOD | |
| S006-234 | Stream recreational suitability (choice list) | Total | | 7/11/2011 | | 2.GOOD | |
| S006-234 | Stream recreational suitability (choice list) | Total | | 8/8/2011 | | 2.GOOD | |
| S006-234 | Stream recreational suitability (choice list) | Total | | 8/15/2011 | | 2.GOOD | |
| S006-234 | Stream recreational suitability (choice list) | Total | | 9/1/2011 | | 2.GOOD | |
| S006-234 | Stream recreational suitability (choice list) | Total | | 9/11/2011 | | 2.GOOD | |
| S006-234 | Stream recreational suitability (choice list) | Total | | 4/8/2017 | | 5.VERY POOR | |
| S006-234 | Stream recreational suitability (choice list) | Total | | 4/13/2017 | | 5.VERY POOR | |
| S006-234 | Stream recreational suitability (choice list) | Total | | 4/20/2017 | | 5.VERY POOR | |
| S006-234 | Stream recreational suitability (choice list) | Total | | 4/27/2017 | | 5.VERY POOR | |
| S006-234 | Stream recreational suitability (choice list) | Total | | 5/2/2017 | | 5.VERY POOR | |
| S006-234 | Stream recreational suitability (choice list) | Total | | 5/13/2017 | | 4.POOR | |
| S006-234 | Stream recreational suitability (choice list) | Total | | 5/17/2017 | | 4.POOR | |
| S006-234 | Stream recreational suitability (choice list) | Total | | 5/25/2017 | | 4.POOR | |
| S006-234 | Temperature, water | Total | | 6/3/2010 | | 16.30 | deg C |
| S006-234 | Temperature, water | Total | | 6/10/2010 | | 14.10 | deg C |
| S006-234 | Temperature, water | Total | | 6/24/2010 | | 17.60 | deg C |
| S006-234 | Temperature, water | Total | | 7/8/2010 | | 23.10 | deg C |
| S006-234 | Temperature, water | Total | | 7/15/2010 | | 18.90 | deg C |
| S006-234 | Temperature, water | Total | | 7/21/2010 | | 19.40 | deg C |
| S006-234 | Temperature, water | Total | | 8/5/2010 | | 21.40 | deg C |
| S006-234 | Temperature, water | Total | | 8/12/2010 | | 21.90 | deg C |
| S006-234 | Temperature, water | Total | | 8/19/2010 | | 16.90 | deg C |
| S006-234 | Temperature, water | Total | | 5/9/2011 | | 10.70 | deg C |
| S006-234 | Temperature, water | Total | | 5/25/2011 | | 14.70 | deg C |
| S006-234 | Temperature, water | Total | | 6/1/2011 | | 12.80 | deg C |
| S006-234 | Temperature, water | Total | | 6/15/2011 | | 17.10 | deg C |
| S006-234 | Temperature, water | Total | | 7/5/2011 | | 22.30 | deg C |
| S006-234 | Temperature, water | Total | | 7/11/2011 | | 21.90 | deg C |
| S006-234 | Temperature, water | Total | | 8/8/2011 | | 19.70 | deg C |
| S006-234 | Temperature, water | Total | | 8/15/2011 | | 20.00 | deg C |
| S006-234 | Temperature, water | Total | | 9/1/2011 | | 18.30 | deg C |
| S006-234 | Temperature, water | Total | | 9/11/2011 | | 18.10 | deg C |
| S006-234 | Total suspended solids | Total | MN00037 | 5/9/2011 | | 4.00 | mg/L |
| S006-234 | Total suspended solids | Total | MN00037 | 5/25/2011 | | 3.00 | mg/L |
| S006-234 | Total suspended solids | Total | MN00037 | 6/1/2011 | | 4.00 | mg/L |
| S006-234 | Total suspended solids | Total | MN00037 | 6/15/2011 | | 3.00 | mg/L |
| S006-234 | Total suspended solids | Total | MN00037 | 7/5/2011 | | 4.00 | mg/L |
| S006-234 | Total suspended solids | Total | MN00037 | 7/5/2011 | | 4.00 | mg/L |
| S006-234 | Total suspended solids | Total | MN00037 | 7/11/2011 | | 3.00 | mg/L |
| S006-234 | Total suspended solids | Total | MN00037 | 8/8/2011 | | 4.00 | mg/L |
| S006-234 | Total suspended solids | Total | MN00037 | 8/15/2011 | | 5.00 | mg/L |
| S006-234 | Total suspended solids | Total | MN00037 | 9/1/2011 | | 8.00 | mg/L |
| S006-234 | Total suspended solids | Total | MN00037 | 9/11/2011 | | 9.00 | mg/L |
| S006-234 | Transparency, tube with disk | Total | | 6/3/2010 | | 61.00 | cm |
| S006-234 | Transparency, tube with disk | Total | | 6/10/2010 | | 50.00 | cm |
| S006-234 | Transparency, tube with disk | Total | | 6/24/2010 | | 59.00 | cm |
| S006-234 | Transparency, tube with disk | Total | | 7/8/2010 | | 67.00 | cm |
| S006-234 | Transparency, tube with disk | Total | | 7/15/2010 | | 40.50 | cm |
| S006-234 | Transparency, tube with disk | Total | | 7/21/2010 | | 69.00 | cm |
| S006-234 | Transparency, tube with disk | Total | | 8/5/2010 | | 53.00 | cm |
| S006-234 | Transparency, tube with disk | Total | | 8/12/2010 | | 43.00 | cm |
| S006-234 | Transparency, tube with disk | Total | | 8/19/2010 | | 87.00 | cm |
| S006-234 | Transparency, tube with disk | Total | | 5/9/2011 | > | 100.00 | cm |
| S006-234 | Transparency, tube with disk | Total | | 5/25/2011 | | 81.00 | cm |
| S006-234 | Transparency, tube with disk | Total | | 6/1/2011 | | 75.00 | cm |
| S006-234 | Transparency, tube with disk | Total | | 6/15/2011 | > | 100.00 | cm |
| S006-234 | Transparency, tube with disk | Total | | 7/5/2011 | > | 100.00 | cm |
| S006-234 | Transparency, tube with disk | Total | | 7/11/2011 | > | 100.00 | cm |
| S006-234 | Transparency, tube with disk | Total | | 8/8/2011 | > | 100.00 | cm |
| S006-234 | Transparency, tube with disk | Total | | 8/15/2011 | | 88.00 | cm |
| S006-234 | Transparency, tube with disk | Total | | 9/1/2011 | | 63.00 | cm |
| S006-234 | Transparency, tube with disk | Total | | 9/11/2011 | | 49.50 | cm |
| S006-234 | Transparency, tube with disk | Total | | 4/8/2017 | | 69.00 | cm |
| S006-234 | Transparency, tube with disk | Total | | 4/13/2017 | | 75.00 | cm |
| S006-234 | Transparency, tube with disk | Total | | 4/20/2017 | | 77.00 | cm |
| S006-234 | Transparency, tube with disk | Total | | 4/27/2017 | | 70.00 | cm |
| S006-234 | Transparency, tube with disk | Total | | 5/2/2017 | | 64.00 | cm |
| S006-234 | Transparency, tube with disk | Total | | 5/13/2017 | > | 100.00 | cm |
| S006-234 | Transparency, tube with disk | Total | | 5/17/2017 | > | 100.00 | cm |
| S006-234 | Transparency, tube with disk | Total | | 5/25/2017 | > | 100.00 | cm |
| S006-234 | Volatile suspended solids | Total | MN00037 | 5/9/2011 | | 2.00 | mg/L |

# Appendix A
# Water Quality Dataset

| Station ID | Parameter | Sample Fraction Type | Lab Name Code | Sample Date | Detect Flag | Result | Result Unit |
|---|---|---|---|---|---|---|---|
| S006-234 | Volatile suspended solids | Total | MN00037 | 5/25/2011 | | 1.00 | mg/L |
| S006-234 | Volatile suspended solids | Total | MN00037 | 6/1/2011 | | 1.00 | mg/L |
| S006-234 | Volatile suspended solids | Total | MN00037 | 6/15/2011 | < | 1.00 | mg/L |
| S006-234 | Volatile suspended solids | Total | MN00037 | 7/5/2011 | | 2.00 | mg/L |
| S006-234 | Volatile suspended solids | Total | MN00037 | 7/5/2011 | | 3.00 | mg/L |
| S006-234 | Volatile suspended solids | Total | MN00037 | 7/11/2011 | | 1.00 | mg/L |
| S006-234 | Volatile suspended solids | Total | MN00037 | 8/8/2011 | | 2.00 | mg/L |
| S006-234 | Volatile suspended solids | Total | MN00037 | 8/15/2011 | | 3.00 | mg/L |
| S006-234 | Volatile suspended solids | Total | MN00037 | 9/1/2011 | | 2.00 | mg/L |
| S006-234 | Volatile suspended solids | Total | MN00037 | 9/11/2011 | | 1.00 | mg/L |
| S006-273 | Alkalinity, total as CaCO3 | Total | MNL0043 | 7/30/1998 | | 89.84 | mg/L |
| S006-273 | Alkalinity, total as CaCO3 | Total | MNL0043 | 4/14/1999 | | 13.91 | mg/L |
| S006-273 | Alkalinity, total as CaCO3 | Total | MNL0043 | 5/14/1999 | | 22.28 | mg/L |
| S006-273 | Alkalinity, total as CaCO3 | Total | MNL0043 | 6/16/1999 | | 52.20 | mg/L |
| S006-273 | Alkalinity, total as CaCO3 | Total | MNL0043 | 8/12/1999 | | 69.34 | mg/L |
| S006-273 | Alkalinity, total as CaCO3 | Total | MN00006 | 2/5/2015 | | 90.00 | mg/L |
| S006-273 | Alkalinity, total as CaCO3 | Total | MN00006 | 2/5/2015 | | 90.00 | mg/L |
| S006-273 | Aluminum | Total | MN00006 | 8/19/2014 | | 105.00 | ug/L |
| S006-273 | Aluminum | Total | MN00006 | 7/13/2015 | | 144.00 | ug/L |
| S006-273 | Ammonia-nitrogen as N | Dissolved | MNL0043 | 7/30/1998 | | 0.01 | mg/L |
| S006-273 | Ammonia-nitrogen as N | Dissolved | MNL0043 | 10/1/1998 | | 0.01 | mg/L |
| S006-273 | Ammonia-nitrogen as N | Dissolved | MNL0043 | 4/14/1999 | | 0.01 | mg/L |
| S006-273 | Ammonia-nitrogen as N | Dissolved | MNL0043 | 5/14/1999 | | 0.01 | mg/L |
| S006-273 | Ammonia-nitrogen as N | Dissolved | MNL0043 | 6/16/1999 | | 0.01 | mg/L |
| S006-273 | Ammonia-nitrogen as N | Dissolved | MNL0043 | 7/6/1999 | | 0.04 | mg/L |
| S006-273 | Ammonia-nitrogen as N | Dissolved | MNL0043 | 7/7/1999 | | 0.01 | mg/L |
| S006-273 | Ammonia-nitrogen as N | Dissolved | MNL0043 | 7/8/1999 | | 0.01 | mg/L |
| S006-273 | Ammonia-nitrogen as N | Dissolved | MNL0043 | 7/9/1999 | | 0.01 | mg/L |
| S006-273 | Ammonia-nitrogen as N | Dissolved | MNL0043 | 7/11/1999 | | 0.01 | mg/L |
| S006-273 | Ammonia-nitrogen as N | Dissolved | MNL0043 | 7/12/1999 | < | 0.00 | mg/L |
| S006-273 | Ammonia-nitrogen as N | Dissolved | MNL0043 | 7/13/1999 | < | 0.00 | mg/L |
| S006-273 | Ammonia-nitrogen as N | Dissolved | MNL0043 | 7/16/1999 | | 0.01 | mg/L |
| S006-273 | Ammonia-nitrogen as N | Dissolved | MNL0043 | 7/18/1999 | | 0.02 | mg/L |
| S006-273 | Ammonia-nitrogen as N | Dissolved | MNL0043 | 7/19/1999 | | 0.01 | mg/L |
| S006-273 | Ammonia-nitrogen as N | Dissolved | MNL0043 | 7/20/1999 | | 0.01 | mg/L |
| S006-273 | Ammonia-nitrogen as N | Dissolved | MNL0043 | 7/21/1999 | | 0.01 | mg/L |
| S006-273 | Ammonia-nitrogen as N | Dissolved | MNL0043 | 8/12/1999 | | 0.01 | mg/L |
| S006-273 | Ammonia-nitrogen as N | Dissolved | MNL0043 | 8/15/1999 | | 0.04 | mg/L |
| S006-273 | Ammonia-nitrogen as N | Dissolved | MNL0043 | 8/16/1999 | | 0.01 | mg/L |
| S006-273 | Ammonia-nitrogen as N | Dissolved | MNL0043 | 8/17/1999 | | 0.01 | mg/L |
| S006-273 | Ammonia-nitrogen as N | Dissolved | MNL0043 | 8/18/1999 | | 0.01 | mg/L |
| S006-273 | Ammonia-nitrogen as N | Dissolved | MNL0043 | 8/19/1999 | | 0.01 | mg/L |
| S006-273 | Ammonia-nitrogen as N | Dissolved | MNL0043 | 8/20/1999 | | 0.01 | mg/L |
| S006-273 | Ammonia-nitrogen as N | Dissolved | MNL0043 | 8/22/1999 | | 0.01 | mg/L |
| S006-273 | Ammonia-nitrogen as N | Dissolved | MNL0043 | 8/23/1999 | | 0.01 | mg/L |
| S006-273 | Ammonia-nitrogen as N | Total | MN00006 | 2/5/2015 | < | 0.05 | mg/L |
| S006-273 | Ammonia-nitrogen as N | Total | MN00006 | 2/5/2015 | < | 0.05 | mg/L |
| S006-273 | Ammonia-nitrogen as N | Total | MN00006 | 7/13/2015 | < | 0.05 | mg/L |
| S006-273 | Ammonia-nitrogen as N | Total | MN00006 | 8/10/2015 | < | 0.05 | mg/L |
| S006-273 | Arsenic | Total | MN00006 | 8/19/2014 | < | 1.00 | ug/L |
| S006-273 | Barium | Total | MN00006 | 8/19/2014 | | 5.82 | ug/L |
| S006-273 | Beryllium | Total | MN00006 | 8/19/2014 | < | 0.40 | ug/L |
| S006-273 | Biochemical oxygen demand, standard conditions | Total | MN00006 | 8/19/2014 | | 0.60 | mg/L |
| S006-273 | Biochemical oxygen demand, standard conditions | Total | MN00006 | 8/10/2015 | < | 1.50 | mg/L |
| S006-273 | Biochemical oxygen demand, standard conditions | Total | MN00006 | 8/19/2015 | < | 1.50 | mg/L |
| S006-273 | Bromide | Total | MN00006 | 2/5/2015 | | 0.01 | mg/L |
| S006-273 | Bromide | Total | MN00006 | 2/5/2015 | | 0.01 | mg/L |
| S006-273 | Cadmium | Total | MN00006 | 8/19/2014 | < | 0.10 | ug/L |
| S006-273 | Calcium | Total | MN00006 | 2/5/2015 | | 23.00 | mg/L |
| S006-273 | Calcium | Total | MN00006 | 2/5/2015 | | 23.00 | mg/L |
| S006-273 | Chemical oxygen demand | Total | MN00006 | 8/19/2015 | | 28.00 | mg/L |
| S006-273 | Chloride | Total | MN00006 | 2/5/2015 | | 1.90 | mg/L |
| S006-273 | Chloride | Total | MN00006 | 2/5/2015 | | 1.90 | mg/L |
| S006-273 | Chromium | Total | MN00006 | 8/19/2014 | < | 1.00 | ug/L |
| S006-273 | Cobalt | Total | MN00006 | 8/19/2014 | < | 1.00 | ug/L |
| S006-273 | Copper | Total | MN00006 | 8/19/2014 | < | 10.00 | ug/L |
| S006-273 | Dissolved oxygen (DO) | Total | | 5/2/2013 | | 13.94 | mg/L |
| S006-273 | Dissolved oxygen (DO) | Total | | 6/6/2013 | | 10.38 | mg/L |
| S006-273 | Dissolved oxygen (DO) | Total | | 8/22/2013 | | 9.21 | mg/L |
| S006-273 | Dissolved oxygen (DO) | Total | | 9/12/2013 | | 9.02 | mg/L |
| S006-273 | Dissolved oxygen (DO) | Total | | 10/7/2013 | | 10.45 | mg/L |
| S006-273 | Dissolved oxygen (DO) | Total | | 8/19/2014 | | 9.37 | mg/L |
| S006-273 | Dissolved oxygen (DO) | Total | | 2/5/2015 | | 13.01 | mg/L |

# Appendix A
# Water Quality Dataset

| Station ID | Parameter | Sample Fraction Type | Lab Name Code | Sample Date | Detect Flag | Result | Result Unit |
|---|---|---|---|---|---|---|---|
| S006-273 | Dissolved oxygen (DO) | Total | | 5/28/2015 | | 9.12 | mg/L |
| S006-273 | Dissolved oxygen (DO) | Total | | 6/16/2015 | | 9.30 | mg/L |
| S006-273 | Dissolved oxygen (DO) | Total | | 7/13/2015 | | 8.45 | mg/L |
| S006-273 | Dissolved oxygen (DO) | Total | | 7/21/2015 | | 8.57 | mg/L |
| S006-273 | Dissolved oxygen (DO) | Total | | 8/10/2015 | | 8.78 | mg/L |
| S006-273 | Dissolved oxygen (DO) | Total | | 8/19/2015 | | 8.99 | mg/L |
| S006-273 | Dissolved oxygen (DO) | Total | | 9/8/2015 | | 9.03 | mg/L |
| S006-273 | Dissolved oxygen (DO) | Total | | 9/17/2015 | | 8.31 | mg/L |
| S006-273 | Dissolved oxygen (DO) | Total | | 9/22/2015 | | 8.76 | mg/L |
| S006-273 | Dissolved oxygen (DO) | Total | | 9/24/2015 | | 10.04 | mg/L |
| S006-273 | Dissolved oxygen (DO) | Total | | 10/12/2015 | | 9.17 | mg/L |
| S006-273 | Distance from/to | Total | | 5/2/2013 | | 8.15 | ft |
| S006-273 | Distance from/to | Total | | 6/6/2013 | | 11.62 | ft |
| S006-273 | Distance from/to | Total | | 8/22/2013 | | 11.91 | ft |
| S006-273 | Distance from/to | Total | | 10/7/2013 | | 11.53 | ft |
| S006-273 | Distance from/to | Total | | 6/3/2014 | | 10.07 | ft |
| S006-273 | Distance from/to | Total | | 8/19/2014 | | 12.70 | ft |
| S006-273 | Fluoride | Dissolved | MN00006 | 2/5/2015 | < | 0.20 | mg/L |
| S006-273 | Fluoride | Dissolved | MN00006 | 2/5/2015 | < | 0.20 | mg/L |
| S006-273 | Fluoride | Total | MN00006 | 2/5/2015 | < | 0.20 | mg/L |
| S006-273 | Fluoride | Total | MN00006 | 2/5/2015 | < | 0.20 | mg/L |
| S006-273 | Fluoride | Total | MN00006 | 7/13/2015 | < | 0.20 | mg/L |
| S006-273 | Hardness, Ca, Mg as CaCO3 | Total | MN00006 | 8/19/2014 | | 65.00 | mg/L |
| S006-273 | Hardness, Ca, Mg as CaCO3 | Total | MN00006 | 7/13/2015 | | 62.00 | mg/L |
| S006-273 | Hardness, Ca, Mg as CaCO3 | Total | MN00006 | 8/3/2015 | | 64.00 | mg/L |
| S006-273 | Inorganic nitrogen (nitrate and nitrite) as N | Dissolved | MNL0043 | 7/30/1998 | | 0.01 | mg/L |
| S006-273 | Inorganic nitrogen (nitrate and nitrite) as N | Dissolved | MNL0043 | 10/1/1998 | | 0.01 | mg/L |
| S006-273 | Inorganic nitrogen (nitrate and nitrite) as N | Dissolved | MNL0043 | 4/14/1999 | | 0.17 | mg/L |
| S006-273 | Inorganic nitrogen (nitrate and nitrite) as N | Dissolved | MNL0043 | 5/14/1999 | | 0.00 | mg/L |
| S006-273 | Inorganic nitrogen (nitrate and nitrite) as N | Dissolved | MNL0043 | 6/16/1999 | | 0.00 | mg/L |
| S006-273 | Inorganic nitrogen (nitrate and nitrite) as N | Dissolved | MNL0043 | 7/6/1999 | | 0.20 | mg/L |
| S006-273 | Inorganic nitrogen (nitrate and nitrite) as N | Dissolved | MNL0043 | 7/7/1999 | | 0.03 | mg/L |
| S006-273 | Inorganic nitrogen (nitrate and nitrite) as N | Dissolved | MNL0043 | 7/8/1999 | | 0.02 | mg/L |
| S006-273 | Inorganic nitrogen (nitrate and nitrite) as N | Dissolved | MNL0043 | 7/9/1999 | | 0.04 | mg/L |
| S006-273 | Inorganic nitrogen (nitrate and nitrite) as N | Dissolved | MNL0043 | 7/11/1999 | | 0.02 | mg/L |
| S006-273 | Inorganic nitrogen (nitrate and nitrite) as N | Dissolved | MNL0043 | 7/12/1999 | | 0.02 | mg/L |
| S006-273 | Inorganic nitrogen (nitrate and nitrite) as N | Dissolved | MNL0043 | 7/13/1999 | | 0.03 | mg/L |
| S006-273 | Inorganic nitrogen (nitrate and nitrite) as N | Dissolved | MNL0043 | 7/16/1999 | | 0.10 | mg/L |
| S006-273 | Inorganic nitrogen (nitrate and nitrite) as N | Dissolved | MNL0043 | 7/18/1999 | | 0.03 | mg/L |
| S006-273 | Inorganic nitrogen (nitrate and nitrite) as N | Dissolved | MNL0043 | 7/19/1999 | | 0.02 | mg/L |
| S006-273 | Inorganic nitrogen (nitrate and nitrite) as N | Dissolved | MNL0043 | 7/20/1999 | | 0.02 | mg/L |
| S006-273 | Inorganic nitrogen (nitrate and nitrite) as N | Dissolved | MNL0043 | 7/21/1999 | | 0.01 | mg/L |
| S006-273 | Inorganic nitrogen (nitrate and nitrite) as N | Dissolved | MNL0043 | 8/12/1999 | | 0.04 | mg/L |
| S006-273 | Inorganic nitrogen (nitrate and nitrite) as N | Dissolved | MNL0043 | 8/15/1999 | | 0.07 | mg/L |
| S006-273 | Inorganic nitrogen (nitrate and nitrite) as N | Dissolved | MNL0043 | 8/16/1999 | | 0.05 | mg/L |
| S006-273 | Inorganic nitrogen (nitrate and nitrite) as N | Dissolved | MNL0043 | 8/17/1999 | | 0.02 | mg/L |
| S006-273 | Inorganic nitrogen (nitrate and nitrite) as N | Dissolved | MNL0043 | 8/18/1999 | | 0.02 | mg/L |
| S006-273 | Inorganic nitrogen (nitrate and nitrite) as N | Dissolved | MNL0043 | 8/19/1999 | | 0.03 | mg/L |
| S006-273 | Inorganic nitrogen (nitrate and nitrite) as N | Dissolved | MNL0043 | 8/20/1999 | | 0.03 | mg/L |
| S006-273 | Inorganic nitrogen (nitrate and nitrite) as N | Dissolved | MNL0043 | 8/22/1999 | | 0.01 | mg/L |
| S006-273 | Inorganic nitrogen (nitrate and nitrite) as N | Dissolved | MNL0043 | 8/23/1999 | | 0.03 | mg/L |
| S006-273 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 8/19/2014 | < | 0.05 | mg/L |
| S006-273 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 2/5/2015 | | 0.31 | mg/L |
| S006-273 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 2/5/2015 | | 0.31 | mg/L |
| S006-273 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 7/13/2015 | | 0.06 | mg/L |
| S006-273 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 8/10/2015 | < | 0.05 | mg/L |
| S006-273 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 8/17/2015 | < | 0.05 | mg/L |
| S006-273 | Iron | Total | MN00006 | 8/19/2014 | | 633.00 | ug/L |
| S006-273 | Iron | Total | MN00006 | 2/5/2015 | | 759.00 | ug/L |
| S006-273 | Iron | Total | MN00006 | 2/5/2015 | | 759.00 | ug/L |
| S006-273 | Lead | Total | MN00006 | 8/19/2014 | < | 1.00 | ug/L |
| S006-273 | Lithium | Total | MN00006 | 8/19/2014 | < | 20.00 | ug/L |
| S006-273 | Magnesium | Total | MN00006 | 2/5/2015 | | 7.63 | mg/L |
| S006-273 | Magnesium | Total | MN00006 | 2/5/2015 | | 7.63 | mg/L |
| S006-273 | Manganese | Total | MN00006 | 8/19/2014 | | 20.20 | ug/L |
| S006-273 | Manganese | Total | MN00006 | 2/5/2015 | | 29.20 | ug/L |
| S006-273 | Manganese | Total | MN00006 | 2/5/2015 | | 29.20 | ug/L |
| S006-273 | Molybdenum | Total | MN00006 | 8/19/2014 | < | 1.00 | ug/L |
| S006-273 | Nickel | Total | MN00006 | 8/19/2014 | | 1.23 | ug/L |
| S006-273 | Nutrient-nitrogen as N | Total | MNL0043 | 7/30/1998 | | 0.39 | mg/L |
| S006-273 | Nutrient-nitrogen as N | Total | MNL0043 | 10/1/1998 | | 0.51 | mg/L |
| S006-273 | Nutrient-nitrogen as N | Total | MNL0043 | 4/14/1999 | | 0.69 | mg/L |
| S006-273 | Nutrient-nitrogen as N | Total | MNL0043 | 5/14/1999 | | 0.46 | mg/L |

# Appendix A
# Water Quality Dataset

| Station ID | Parameter | Sample Fraction Type | Lab Name Code | Sample Date | Detect Flag | Result | Result Unit |
|---|---|---|---|---|---|---|---|
| S006-273 | Nutrient-nitrogen as N | Total | MNL0043 | 6/16/1999 | | 0.71 | mg/L |
| S006-273 | Nutrient-nitrogen as N | Total | MNL0043 | 7/6/1999 | | 1.10 | mg/L |
| S006-273 | Nutrient-nitrogen as N | Total | MNL0043 | 7/7/1999 | | 0.82 | mg/L |
| S006-273 | Nutrient-nitrogen as N | Total | MNL0043 | 7/8/1999 | | 0.79 | mg/L |
| S006-273 | Nutrient-nitrogen as N | Total | MNL0043 | 7/9/1999 | | 0.86 | mg/L |
| S006-273 | Nutrient-nitrogen as N | Total | MNL0043 | 7/11/1999 | | 0.82 | mg/L |
| S006-273 | Nutrient-nitrogen as N | Total | MNL0043 | 7/12/1999 | | 0.75 | mg/L |
| S006-273 | Nutrient-nitrogen as N | Total | MNL0043 | 7/13/1999 | | 0.88 | mg/L |
| S006-273 | Nutrient-nitrogen as N | Total | MNL0043 | 7/16/1999 | | 0.88 | mg/L |
| S006-273 | Nutrient-nitrogen as N | Total | MNL0043 | 7/18/1999 | | 0.87 | mg/L |
| S006-273 | Nutrient-nitrogen as N | Total | MNL0043 | 7/19/1999 | | 0.71 | mg/L |
| S006-273 | Nutrient-nitrogen as N | Total | MNL0043 | 7/20/1999 | | 0.69 | mg/L |
| S006-273 | Nutrient-nitrogen as N | Total | MNL0043 | 7/21/1999 | | 0.63 | mg/L |
| S006-273 | Nutrient-nitrogen as N | Total | MNL0043 | 8/12/1999 | | 0.63 | mg/L |
| S006-273 | Nutrient-nitrogen as N | Total | MNL0043 | 8/15/1999 | | 0.64 | mg/L |
| S006-273 | Nutrient-nitrogen as N | Total | MNL0043 | 8/16/1999 | | 0.82 | mg/L |
| S006-273 | Nutrient-nitrogen as N | Total | MNL0043 | 8/17/1999 | | 0.71 | mg/L |
| S006-273 | Nutrient-nitrogen as N | Total | MNL0043 | 8/18/1999 | | 0.64 | mg/L |
| S006-273 | Nutrient-nitrogen as N | Total | MNL0043 | 8/19/1999 | | 0.86 | mg/L |
| S006-273 | Nutrient-nitrogen as N | Total | MNL0043 | 8/20/1999 | | 0.73 | mg/L |
| S006-273 | Nutrient-nitrogen as N | Total | MNL0043 | 8/22/1999 | | 0.70 | mg/L |
| S006-273 | Orthophosphate as P | Dissolved | MNL0043 | 7/30/1998 | < | 0.01 | mg/L |
| S006-273 | Orthophosphate as P | Dissolved | MNL0043 | 10/1/1998 | < | 0.01 | mg/L |
| S006-273 | Orthophosphate as P | Dissolved | MNL0043 | 4/14/1999 | < | 0.01 | mg/L |
| S006-273 | Orthophosphate as P | Dissolved | MNL0043 | 5/14/1999 | < | 0.01 | mg/L |
| S006-273 | Orthophosphate as P | Dissolved | MNL0043 | 6/16/1999 | < | 0.01 | mg/L |
| S006-273 | Orthophosphate as P | Dissolved | MNL0043 | 7/6/1999 | < | 0.01 | mg/L |
| S006-273 | Orthophosphate as P | Dissolved | MNL0043 | 7/7/1999 | < | 0.01 | mg/L |
| S006-273 | Orthophosphate as P | Dissolved | MNL0043 | 7/8/1999 | < | 0.01 | mg/L |
| S006-273 | Orthophosphate as P | Dissolved | MNL0043 | 7/9/1999 | < | 0.01 | mg/L |
| S006-273 | Orthophosphate as P | Dissolved | MNL0043 | 7/11/1999 | < | 0.01 | mg/L |
| S006-273 | Orthophosphate as P | Dissolved | MNL0043 | 7/12/1999 | < | 0.01 | mg/L |
| S006-273 | Orthophosphate as P | Dissolved | MNL0043 | 7/13/1999 | < | 0.01 | mg/L |
| S006-273 | Orthophosphate as P | Dissolved | MNL0043 | 7/16/1999 | < | 0.01 | mg/L |
| S006-273 | Orthophosphate as P | Dissolved | MNL0043 | 7/18/1999 | | 0.01 | mg/L |
| S006-273 | Orthophosphate as P | Dissolved | MNL0043 | 7/19/1999 | < | 0.01 | mg/L |
| S006-273 | Orthophosphate as P | Dissolved | MNL0043 | 7/20/1999 | < | 0.01 | mg/L |
| S006-273 | Orthophosphate as P | Dissolved | MNL0043 | 7/21/1999 | < | 0.01 | mg/L |
| S006-273 | Orthophosphate as P | Dissolved | MNL0043 | 8/12/1999 | < | 0.01 | mg/L |
| S006-273 | Orthophosphate as P | Dissolved | MNL0043 | 8/15/1999 | < | 0.01 | mg/L |
| S006-273 | Orthophosphate as P | Dissolved | MNL0043 | 8/16/1999 | < | 0.01 | mg/L |
| S006-273 | Orthophosphate as P | Dissolved | MNL0043 | 8/17/1999 | < | 0.01 | mg/L |
| S006-273 | Orthophosphate as P | Dissolved | MNL0043 | 8/18/1999 | < | 0.01 | mg/L |
| S006-273 | Orthophosphate as P | Dissolved | MNL0043 | 8/19/1999 | < | 0.01 | mg/L |
| S006-273 | Orthophosphate as P | Dissolved | MNL0043 | 8/20/1999 | < | 0.01 | mg/L |
| S006-273 | Orthophosphate as P | Dissolved | MNL0043 | 8/22/1999 | < | 0.01 | mg/L |
| S006-273 | Orthophosphate as P | Dissolved | MNL0043 | 8/23/1999 | < | 0.01 | mg/L |
| S006-273 | pH | Total | | 5/2/2013 | | 7.11 | None |
| S006-273 | pH | Total | | 6/6/2013 | | 7.23 | None |
| S006-273 | pH | Total | | 8/22/2013 | | 7.52 | None |
| S006-273 | pH | Total | | 9/12/2013 | | 7.42 | None |
| S006-273 | pH | Total | | 10/7/2013 | | 7.39 | None |
| S006-273 | pH | Total | | 8/19/2014 | | 7.93 | None |
| S006-273 | pH | Total | | 2/5/2015 | | 7.07 | None |
| S006-273 | pH | Total | | 5/28/2015 | | 7.80 | None |
| S006-273 | pH | Total | | 6/16/2015 | | 7.94 | None |
| S006-273 | pH | Total | | 7/13/2015 | | 8.06 | None |
| S006-273 | pH | Total | | 7/21/2015 | | 8.32 | None |
| S006-273 | pH | Total | | 8/10/2015 | | 7.78 | None |
| S006-273 | pH | Total | | 8/19/2015 | | 7.39 | None |
| S006-273 | pH | Total | | 9/8/2015 | | 7.94 | None |
| S006-273 | pH | Total | | 9/17/2015 | | 7.36 | None |
| S006-273 | pH | Total | | 9/22/2015 | | 7.67 | None |
| S006-273 | pH | Total | | 9/24/2015 | | 7.11 | None |
| S006-273 | pH | Total | | 10/12/2015 | | 7.75 | None |
| S006-273 | Phosphorus as P | Total | MNL0043 | 7/30/1998 | < | 0.01 | mg/L |
| S006-273 | Phosphorus as P | Total | MNL0043 | 10/1/1998 | | 0.03 | mg/L |
| S006-273 | Phosphorus as P | Total | MNL0043 | 4/14/1999 | | 0.02 | mg/L |
| S006-273 | Phosphorus as P | Total | MNL0043 | 5/14/1999 | < | 0.01 | mg/L |
| S006-273 | Phosphorus as P | Total | MNL0043 | 6/16/1999 | | 0.02 | mg/L |
| S006-273 | Phosphorus as P | Total | MNL0043 | 7/6/1999 | | 0.13 | mg/L |
| S006-273 | Phosphorus as P | Total | MNL0043 | 7/7/1999 | | 0.04 | mg/L |
| S006-273 | Phosphorus as P | Total | MNL0043 | 7/8/1999 | | 0.03 | mg/L |

# Appendix A
# Water Quality Dataset

| Station ID | Parameter | Sample Fraction Type | Lab Name Code | Sample Date | Detect Flag | Result | Result Unit |
|---|---|---|---|---|---|---|---|
| S006-273 | Phosphorus as P | Total | MNL0043 | 7/9/1999 | | 0.03 | mg/L |
| S006-273 | Phosphorus as P | Total | MNL0043 | 7/11/1999 | | 0.02 | mg/L |
| S006-273 | Phosphorus as P | Total | MNL0043 | 7/12/1999 | | 0.02 | mg/L |
| S006-273 | Phosphorus as P | Total | MNL0043 | 7/13/1999 | | 0.02 | mg/L |
| S006-273 | Phosphorus as P | Total | MNL0043 | 7/16/1999 | | 0.05 | mg/L |
| S006-273 | Phosphorus as P | Total | MNL0043 | 7/18/1999 | | 0.02 | mg/L |
| S006-273 | Phosphorus as P | Total | MNL0043 | 7/19/1999 | | 0.02 | mg/L |
| S006-273 | Phosphorus as P | Total | MNL0043 | 7/20/1999 | | 0.02 | mg/L |
| S006-273 | Phosphorus as P | Total | MNL0043 | 7/21/1999 | | 0.03 | mg/L |
| S006-273 | Phosphorus as P | Total | MNL0043 | 8/12/1999 | | 0.02 | mg/L |
| S006-273 | Phosphorus as P | Total | MNL0043 | 8/15/1999 | | 0.02 | mg/L |
| S006-273 | Phosphorus as P | Total | MNL0043 | 8/16/1999 | | 0.03 | mg/L |
| S006-273 | Phosphorus as P | Total | MNL0043 | 8/17/1999 | | 0.04 | mg/L |
| S006-273 | Phosphorus as P | Total | MNL0043 | 8/18/1999 | | 0.05 | mg/L |
| S006-273 | Phosphorus as P | Total | MNL0043 | 8/19/1999 | | 0.05 | mg/L |
| S006-273 | Phosphorus as P | Total | MNL0043 | 8/20/1999 | < | 0.01 | mg/L |
| S006-273 | Phosphorus as P | Total | MNL0043 | 8/22/1999 | | 0.02 | mg/L |
| S006-273 | Phosphorus as P | Total | MNL0043 | 8/23/1999 | | 0.12 | mg/L |
| S006-273 | Phosphorus as P | Total | MN00006 | 8/19/2014 | | 0.01 | mg/L |
| S006-273 | Phosphorus as P | Total | MN00006 | 2/5/2015 | | 0.01 | mg/L |
| S006-273 | Phosphorus as P | Total | MN00006 | 2/5/2015 | | 0.01 | mg/L |
| S006-273 | Phosphorus as P | Total | MN00006 | 7/13/2015 | | 0.01 | mg/L |
| S006-273 | Phosphorus as P | Total | MN00006 | 8/10/2015 | | 0.00 | mg/L |
| S006-273 | Phosphorus as P | Total | MN00006 | 8/19/2015 | | 0.01 | mg/L |
| S006-273 | Phosphorus as P | Total | MN00006 | 9/17/2015 | | 0.02 | mg/L |
| S006-273 | Phosphorus as P | Total | MN00006 | 9/17/2015 | | 0.02 | mg/L |
| S006-273 | Potassium | Total | MN00006 | 2/5/2015 | | 0.54 | mg/L |
| S006-273 | Potassium | Total | MN00006 | 2/5/2015 | | 0.54 | mg/L |
| S006-273 | Silver | Total | MN00006 | 8/19/2014 | < | 0.20 | ug/L |
| S006-273 | Sodium | Total | MN00006 | 2/5/2015 | | 4.04 | mg/L |
| S006-273 | Sodium | Total | MN00006 | 2/5/2015 | | 4.04 | mg/L |
| S006-273 | Specific conductance | Total | | 7/30/1998 | | 166.00 | uS/cm |
| S006-273 | Specific conductance | Total | | 8/13/1998 | | 172.00 | uS/cm |
| S006-273 | Specific conductance | Total | | 8/26/1998 | | 126.00 | uS/cm |
| S006-273 | Specific conductance | Total | | 8/27/1998 | | 171.00 | uS/cm |
| S006-273 | Specific conductance | Total | | 10/1/1998 | | 117.00 | uS/cm |
| S006-273 | Specific conductance | Total | | 10/1/1998 | | 107.00 | uS/cm |
| S006-273 | Specific conductance | Total | | 4/14/1999 | | 39.00 | uS/cm |
| S006-273 | Specific conductance | Total | | 5/14/1999 | | 50.00 | uS/cm |
| S006-273 | Specific conductance | Total | | 6/16/1999 | | 96.00 | uS/cm |
| S006-273 | Specific conductance | Total | | 7/6/1999 | | 71.00 | uS/cm |
| S006-273 | Specific conductance | Total | | 7/7/1999 | | 51.00 | uS/cm |
| S006-273 | Specific conductance | Total | | 7/8/1999 | | 56.00 | uS/cm |
| S006-273 | Specific conductance | Total | | 7/9/1999 | | 62.00 | uS/cm |
| S006-273 | Specific conductance | Total | | 7/11/1999 | | 53.00 | uS/cm |
| S006-273 | Specific conductance | Total | | 7/12/1999 | | 61.00 | uS/cm |
| S006-273 | Specific conductance | Total | | 7/13/1999 | | 67.00 | uS/cm |
| S006-273 | Specific conductance | Total | | 7/16/1999 | | 82.00 | uS/cm |
| S006-273 | Specific conductance | Total | | 7/18/1999 | | 67.00 | uS/cm |
| S006-273 | Specific conductance | Total | | 7/19/1999 | | 71.00 | uS/cm |
| S006-273 | Specific conductance | Total | | 7/20/1999 | | 76.00 | uS/cm |
| S006-273 | Specific conductance | Total | | 7/21/1999 | | 82.00 | uS/cm |
| S006-273 | Specific conductance | Total | | 8/12/1999 | | 127.00 | uS/cm |
| S006-273 | Specific conductance | Total | | 8/12/1999 | | 128.00 | uS/cm |
| S006-273 | Specific conductance | Total | | 8/15/1999 | | 98.00 | uS/cm |
| S006-273 | Specific conductance | Total | | 8/16/1999 | | 93.00 | uS/cm |
| S006-273 | Specific conductance | Total | | 8/17/1999 | | 87.00 | uS/cm |
| S006-273 | Specific conductance | Total | | 8/18/1999 | | 86.00 | uS/cm |
| S006-273 | Specific conductance | Total | | 8/19/1999 | | 84.00 | uS/cm |
| S006-273 | Specific conductance | Total | | 8/20/1999 | | 76.00 | uS/cm |
| S006-273 | Specific conductance | Total | | 8/22/1999 | | 82.00 | uS/cm |
| S006-273 | Specific conductance | Total | | 8/23/1999 | | 87.00 | uS/cm |
| S006-273 | Specific conductance | Total | | 5/2/2013 | | 53.00 | uS/cm |
| S006-273 | Specific conductance | Total | | 6/6/2013 | | 82.00 | uS/cm |
| S006-273 | Specific conductance | Total | | 8/22/2013 | | 144.00 | uS/cm |
| S006-273 | Specific conductance | Total | | 9/12/2013 | | 171.00 | uS/cm |
| S006-273 | Specific conductance | Total | | 10/7/2013 | | 134.00 | uS/cm |
| S006-273 | Specific conductance | Total | | 8/19/2014 | | 130.00 | uS/cm |
| S006-273 | Specific conductance | Total | | 2/5/2015 | | 189.00 | uS/cm |
| S006-273 | Specific conductance | Total | | 5/28/2015 | | 99.00 | uS/cm |
| S006-273 | Specific conductance | Total | | 6/16/2015 | | 100.00 | uS/cm |
| S006-273 | Specific conductance | Total | | 7/13/2015 | | 125.00 | uS/cm |
| S006-273 | Specific conductance | Total | | 7/21/2015 | | 138.00 | uS/cm |

# Appendix A
# Water Quality Dataset

| Station ID | Parameter | Sample Fraction Type | Lab Name Code | Sample Date | Detect Flag | Result | Result Unit |
|---|---|---|---|---|---|---|---|
| S006-273 | Specific conductance | Total | | 8/10/2015 | | 186.00 | uS/cm |
| S006-273 | Specific conductance | Total | | 8/19/2015 | | 144.00 | uS/cm |
| S006-273 | Specific conductance | Total | | 9/8/2015 | | 119.00 | uS/cm |
| S006-273 | Specific conductance | Total | | 9/17/2015 | | 106.00 | uS/cm |
| S006-273 | Specific conductance | Total | | 9/22/2015 | | 107.00 | uS/cm |
| S006-273 | Specific conductance | Total | | 9/24/2015 | | 144.00 | uS/cm |
| S006-273 | Specific conductance | Total | | 10/12/2015 | | 100.00 | uS/cm |
| S006-273 | Stream condition (text) | Total | | 8/10/2015 | | LMOC | |
| S006-273 | Stream condition (text) | Total | | 9/24/2015 | | H | |
| S006-273 | Stream Physical Appearance, Minnesota (choice list) | Total | | 9/12/2013 | | 1A.CLEAR | |
| S006-273 | Stream Physical Appearance, Minnesota (choice list) | Total | | 9/24/2015 | | 2.CLOUDY | |
| S006-273 | Strontium | Total | MN00006 | 8/19/2014 | | 45.30 | ug/L |
| S006-273 | Strontium | Total | MN00006 | 2/5/2015 | | 54.70 | ug/L |
| S006-273 | Strontium | Total | MN00006 | 2/5/2015 | | 54.70 | ug/L |
| S006-273 | Sulfate as SO4 | Total | MNL0043 | 7/30/1998 | | 2.20 | mg/L |
| S006-273 | Sulfate as SO4 | Total | MNL0043 | 10/1/1998 | | 7.84 | mg/L |
| S006-273 | Sulfate as SO4 | Total | MNL0043 | 4/14/1999 | | 3.67 | mg/L |
| S006-273 | Sulfate as SO4 | Total | MNL0043 | 5/14/1999 | | 3.26 | mg/L |
| S006-273 | Sulfate as SO4 | Total | MNL0043 | 6/16/1999 | | 1.41 | mg/L |
| S006-273 | Sulfate as SO4 | Total | MNL0043 | 8/12/1999 | | 1.70 | mg/L |
| S006-273 | Sulfate as SO4 | Total | MNL0043 | 8/17/1999 | | 1.54 | mg/L |
| S006-273 | Sulfate as SO4 | Total | MNL0043 | 8/18/1999 | | 1.34 | mg/L |
| S006-273 | Sulfate as SO4 | Total | MNL0043 | 8/19/1999 | | 1.27 | mg/L |
| S006-273 | Sulfate as SO4 | Total | MNL0043 | 8/20/1999 | | 1.33 | mg/L |
| S006-273 | Sulfate as SO4 | Total | MNL0043 | 8/22/1999 | | 1.02 | mg/L |
| S006-273 | Sulfate as SO4 | Total | MNL0043 | 8/23/1999 | | 1.00 | mg/L |
| S006-273 | Sulfate as SO4 | Total | MN00006 | 2/5/2015 | | 4.23 | mg/L |
| S006-273 | Sulfate as SO4 | Total | MN00006 | 2/5/2015 | | 4.23 | mg/L |
| S006-273 | Sulfate as SO4 | Total | MN00006 | 7/13/2015 | | 1.13 | mg/L |
| S006-273 | Temperature, water | Total | | 8/13/1998 | | 25.68 | deg C |
| S006-273 | Temperature, water | Total | | 8/26/1998 | | 20.07 | deg C |
| S006-273 | Temperature, water | Total | | 8/27/1998 | | 21.50 | deg C |
| S006-273 | Temperature, water | Total | | 10/1/1998 | | 11.54 | deg C |
| S006-273 | Temperature, water | Total | | 8/12/1999 | | 16.26 | deg C |
| S006-273 | Temperature, water | Total | | 5/2/2013 | | 0.14 | deg C |
| S006-273 | Temperature, water | Total | | 6/6/2013 | | 12.27 | deg C |
| S006-273 | Temperature, water | Total | | 8/22/2013 | | 21.11 | deg C |
| S006-273 | Temperature, water | Total | | 9/12/2013 | | 16.87 | deg C |
| S006-273 | Temperature, water | Total | | 10/7/2013 | | 11.16 | deg C |
| S006-273 | Temperature, water | Total | | 8/19/2014 | | 16.77 | deg C |
| S006-273 | Temperature, water | Total | | 2/5/2015 | | 0.00 | deg C |
| S006-273 | Temperature, water | Total | | 5/28/2015 | | 18.92 | deg C |
| S006-273 | Temperature, water | Total | | 6/16/2015 | | 20.16 | deg C |
| S006-273 | Temperature, water | Total | | 7/13/2015 | | 23.85 | deg C |
| S006-273 | Temperature, water | Total | | 7/21/2015 | | 24.11 | deg C |
| S006-273 | Temperature, water | Total | | 8/10/2015 | | 21.38 | deg C |
| S006-273 | Temperature, water | Total | | 8/19/2015 | | 16.02 | deg C |
| S006-273 | Temperature, water | Total | | 9/8/2015 | | 20.79 | deg C |
| S006-273 | Temperature, water | Total | | 9/17/2015 | | 18.57 | deg C |
| S006-273 | Temperature, water | Total | | 9/22/2015 | | 19.82 | deg C |
| S006-273 | Temperature, water | Total | | 9/24/2015 | | 12.22 | deg C |
| S006-273 | Temperature, water | Total | | 10/12/2015 | | 19.20 | deg C |
| S006-273 | Titanium | Total | MN00006 | 8/19/2014 | < | 5.00 | ug/L |
| S006-273 | Total suspended solids | Total | MNL0043 | 7/30/1998 | < | 2.80 | mg/L |
| S006-273 | Total suspended solids | Total | MNL0043 | 10/1/1998 | < | 2.80 | mg/L |
| S006-273 | Total suspended solids | Total | MNL0043 | 4/14/1999 | | 16.60 | mg/L |
| S006-273 | Total suspended solids | Total | MNL0043 | 5/14/1999 | | 3.70 | mg/L |
| S006-273 | Total suspended solids | Total | MNL0043 | 6/16/1999 | < | 2.80 | mg/L |
| S006-273 | Total suspended solids | Total | MNL0043 | 7/6/1999 | | 60.90 | mg/L |
| S006-273 | Total suspended solids | Total | MNL0043 | 7/7/1999 | | 12.80 | mg/L |
| S006-273 | Total suspended solids | Total | MNL0043 | 7/8/1999 | | 7.90 | mg/L |
| S006-273 | Total suspended solids | Total | MNL0043 | 7/9/1999 | | 10.40 | mg/L |
| S006-273 | Total suspended solids | Total | MNL0043 | 7/11/1999 | | 3.30 | mg/L |
| S006-273 | Total suspended solids | Total | MNL0043 | 7/12/1999 | | 5.70 | mg/L |
| S006-273 | Total suspended solids | Total | MNL0043 | 7/13/1999 | | 3.30 | mg/L |
| S006-273 | Total suspended solids | Total | MNL0043 | 7/16/1999 | | 25.30 | mg/L |
| S006-273 | Total suspended solids | Total | MNL0043 | 7/18/1999 | | 4.80 | mg/L |
| S006-273 | Total suspended solids | Total | MNL0043 | 7/19/1999 | | 3.50 | mg/L |
| S006-273 | Total suspended solids | Total | MNL0043 | 7/20/1999 | < | 2.80 | mg/L |
| S006-273 | Total suspended solids | Total | MNL0043 | 7/21/1999 | < | 2.80 | mg/L |
| S006-273 | Total suspended solids | Total | MNL0043 | 8/12/1999 | < | 2.80 | mg/L |
| S006-273 | Total suspended solids | Total | MNL0043 | 8/15/1999 | | 5.60 | mg/L |
| S006-273 | Total suspended solids | Total | MNL0043 | 8/16/1999 | | 12.20 | mg/L |

# Appendix A
# Water Quality Dataset

| Station ID | Parameter | Sample Fraction Type | Lab Name Code | Sample Date | Detect Flag | Result | Result Unit |
|---|---|---|---|---|---|---|---|
| S006-273 | Total suspended solids | Total | MNL0043 | 8/17/1999 | | 5.90 | mg/L |
| S006-273 | Total suspended solids | Total | MNL0043 | 8/18/1999 | | 5.40 | mg/L |
| S006-273 | Total suspended solids | Total | MNL0043 | 8/19/1999 | | 11.70 | mg/L |
| S006-273 | Total suspended solids | Total | MNL0043 | 8/20/1999 | | 8.10 | mg/L |
| S006-273 | Total suspended solids | Total | MNL0043 | 8/22/1999 | | 4.30 | mg/L |
| S006-273 | Total suspended solids | Total | MNL0043 | 8/23/1999 | < | 2.80 | mg/L |
| S006-273 | Total suspended solids | Total | MN00006 | 5/2/2013 | | 30.00 | mg/L |
| S006-273 | Total suspended solids | Total | MN00006 | 6/6/2013 | | 1.60 | mg/L |
| S006-273 | Total suspended solids | Total | MN00006 | 10/7/2013 | | 1.20 | mg/L |
| S006-273 | Total suspended solids | Total | MN00006 | 6/3/2014 | | 7.20 | mg/L |
| S006-273 | Total suspended solids | Total | MN00006 | 8/19/2014 | | 2.80 | mg/L |
| S006-273 | Total suspended solids | Total | MN00006 | 2/5/2015 | | 2.40 | mg/L |
| S006-273 | Total suspended solids | Total | MN00006 | 2/5/2015 | | 2.40 | mg/L |
| S006-273 | Total suspended solids | Total | MN00006 | 7/13/2015 | | 4.80 | mg/L |
| S006-273 | Total suspended solids | Total | MN00006 | 8/10/2015 | | 1.60 | mg/L |
| S006-273 | Total suspended solids | Total | MN00006 | 8/19/2015 | | 6.40 | mg/L |
| S006-273 | Total suspended solids | Total | MN00006 | 9/17/2015 | | 22.00 | mg/L |
| S006-273 | Total suspended solids | Total | MN00006 | 9/17/2015 | | 18.00 | mg/L |
| S006-273 | Total suspended solids | Total | MN00006 | 9/24/2015 | | 10.00 | mg/L |
| S006-273 | Total suspended solids | Total | MN00006 | 9/24/2015 | | 12.00 | mg/L |
| S006-273 | Transparency, tube with disk | Total | | 5/2/2013 | | 40.00 | cm |
| S006-273 | Transparency, tube with disk | Total | | 6/6/2013 | > | 100.00 | cm |
| S006-273 | Transparency, tube with disk | Total | | 9/12/2013 | > | 100.00 | cm |
| S006-273 | Transparency, tube with disk | Total | | 10/7/2013 | > | 100.00 | cm |
| S006-273 | Transparency, tube with disk | Total | | 6/3/2014 | | 75.00 | cm |
| S006-273 | Transparency, tube with disk | Total | | 8/19/2014 | > | 100.00 | cm |
| S006-273 | Transparency, tube with disk | Total | | 7/13/2015 | > | 100.00 | cm |
| S006-273 | Transparency, tube with disk | Total | | 8/19/2015 | > | 100.00 | cm |
| S006-273 | Transparency, tube with disk | Total | | 9/24/2015 | | 67.00 | cm |
| S006-273 | Turbidity | Total | | 7/30/1998 | | 1.10 | NTRU |
| S006-273 | Turbidity | Total | | 8/13/1998 | | 6.60 | NTRU |
| S006-273 | Turbidity | Total | | 8/26/1998 | | 0.30 | NTRU |
| S006-273 | Turbidity | Total | | 8/27/1998 | | 3.80 | NTRU |
| S006-273 | Turbidity | Total | | 10/1/1998 | | 2.80 | NTRU |
| S006-273 | Turbidity | Total | | 10/1/1998 | | 2.20 | NTRU |
| S006-273 | Turbidity | Total | | 4/14/1999 | | 9.10 | NTRU |
| S006-273 | Turbidity | Total | | 5/14/1999 | | 2.60 | NTRU |
| S006-273 | Turbidity | Total | | 6/16/1999 | | 1.60 | NTRU |
| S006-273 | Turbidity | Total | | 7/6/1999 | | 36.60 | NTRU |
| S006-273 | Turbidity | Total | | 7/7/1999 | | 5.90 | NTRU |
| S006-273 | Turbidity | Total | | 7/8/1999 | | 5.10 | NTRU |
| S006-273 | Turbidity | Total | | 7/9/1999 | | 16.00 | NTRU |
| S006-273 | Turbidity | Total | | 7/11/1999 | | 5.00 | NTRU |
| S006-273 | Turbidity | Total | | 7/12/1999 | | 4.90 | NTRU |
| S006-273 | Turbidity | Total | | 7/13/1999 | | 3.30 | NTRU |
| S006-273 | Turbidity | Total | | 7/16/1999 | | 15.30 | NTRU |
| S006-273 | Turbidity | Total | | 7/18/1999 | | 5.10 | NTRU |
| S006-273 | Turbidity | Total | | 7/19/1999 | | 3.10 | NTRU |
| S006-273 | Turbidity | Total | | 7/20/1999 | | 2.10 | NTRU |
| S006-273 | Turbidity | Total | | 7/21/1999 | | 1.90 | NTRU |
| S006-273 | Turbidity | Total | | 8/12/1999 | | 2.70 | NTRU |
| S006-273 | Turbidity | Total | | 8/12/1999 | | 0.30 | NTRU |
| S006-273 | Turbidity | Total | | 8/15/1999 | | 4.40 | NTRU |
| S006-273 | Turbidity | Total | | 8/16/1999 | | 5.60 | NTRU |
| S006-273 | Turbidity | Total | | 8/17/1999 | | 3.70 | NTRU |
| S006-273 | Turbidity | Total | | 8/18/1999 | | 3.50 | NTRU |
| S006-273 | Turbidity | Total | | 8/19/1999 | | 4.60 | NTRU |
| S006-273 | Turbidity | Total | | 8/20/1999 | | 4.70 | NTRU |
| S006-273 | Turbidity | Total | | 8/22/1999 | | 2.60 | NTRU |
| S006-273 | Turbidity | Total | | 8/23/1999 | | 2.10 | NTRU |
| S006-273 | Turbidity | Total | MN00006 | 6/3/2014 | | 17.00 | NTRU |
| S006-273 | Vanadium | Total | MN00006 | 8/19/2014 | < | 2.00 | ug/L |
| S006-273 | Volatile suspended solids | Total | MNL0043 | 7/30/1998 | < | 5.00 | mg/L |
| S006-273 | Volatile suspended solids | Total | MNL0043 | 10/1/1998 | < | 5.00 | mg/L |
| S006-273 | Volatile suspended solids | Total | MNL0043 | 4/14/1999 | < | 5.00 | mg/L |
| S006-273 | Volatile suspended solids | Total | MNL0043 | 5/14/1999 | < | 5.00 | mg/L |
| S006-273 | Volatile suspended solids | Total | MNL0043 | 6/16/1999 | < | 5.00 | mg/L |
| S006-273 | Volatile suspended solids | Total | MNL0043 | 7/6/1999 | | 9.40 | mg/L |
| S006-273 | Volatile suspended solids | Total | MNL0043 | 7/7/1999 | < | 5.00 | mg/L |
| S006-273 | Volatile suspended solids | Total | MNL0043 | 7/8/1999 | < | 5.00 | mg/L |
| S006-273 | Volatile suspended solids | Total | MNL0043 | 7/9/1999 | < | 5.00 | mg/L |
| S006-273 | Volatile suspended solids | Total | MNL0043 | 7/11/1999 | < | 5.00 | mg/L |
| S006-273 | Volatile suspended solids | Total | MNL0043 | 7/12/1999 | < | 5.00 | mg/L |

# Appendix A
# Water Quality Dataset

| Station ID | Parameter | Sample Fraction Type | Lab Name Code | Sample Date | Detect Flag | Result | Result Unit |
|---|---|---|---|---|---|---|---|
| S006-273 | Volatile suspended solids | Total | MNL0043 | 7/13/1999 | < | 5.00 | mg/L |
| S006-273 | Volatile suspended solids | Total | MNL0043 | 7/16/1999 | < | 5.00 | mg/L |
| S006-273 | Volatile suspended solids | Total | MNL0043 | 7/18/1999 | < | 5.00 | mg/L |
| S006-273 | Volatile suspended solids | Total | MNL0043 | 7/19/1999 | < | 5.00 | mg/L |
| S006-273 | Volatile suspended solids | Total | MNL0043 | 7/20/1999 | < | 5.00 | mg/L |
| S006-273 | Volatile suspended solids | Total | MNL0043 | 7/21/1999 | < | 5.00 | mg/L |
| S006-273 | Volatile suspended solids | Total | MNL0043 | 8/12/1999 | < | 5.00 | mg/L |
| S006-273 | Volatile suspended solids | Total | MNL0043 | 8/15/1999 | < | 5.00 | mg/L |
| S006-273 | Volatile suspended solids | Total | MNL0043 | 8/16/1999 | < | 5.00 | mg/L |
| S006-273 | Volatile suspended solids | Total | MNL0043 | 8/17/1999 | < | 5.00 | mg/L |
| S006-273 | Volatile suspended solids | Total | MNL0043 | 8/18/1999 | < | 5.00 | mg/L |
| S006-273 | Volatile suspended solids | Total | MNL0043 | 8/19/1999 | < | 5.00 | mg/L |
| S006-273 | Volatile suspended solids | Total | MNL0043 | 8/20/1999 | < | 5.00 | mg/L |
| S006-273 | Volatile suspended solids | Total | MNL0043 | 8/22/1999 | < | 5.00 | mg/L |
| S006-273 | Volatile suspended solids | Total | MNL0043 | 8/23/1999 | < | 5.00 | mg/L |
| S006-273 | Volatile suspended solids | Total | MN00006 | 5/2/2013 | | 4.00 | mg/L |
| S006-273 | Volatile suspended solids | Total | MN00006 | 6/6/2013 | | 1.20 | mg/L |
| S006-273 | Volatile suspended solids | Total | MN00006 | 10/7/2013 | | 1.20 | mg/L |
| S006-273 | Volatile suspended solids | Total | MN00006 | 8/19/2014 | | 2.00 | mg/L |
| S006-273 | Volatile suspended solids | Total | MN00006 | 2/5/2015 | | 2.00 | mg/L |
| S006-273 | Volatile suspended solids | Total | MN00006 | 2/5/2015 | | 2.00 | mg/L |
| S006-273 | Volatile suspended solids | Total | MN00006 | 7/13/2015 | | 2.00 | mg/L |
| S006-273 | Volatile suspended solids | Total | MN00006 | 8/10/2015 | | 1.20 | mg/L |
| S006-273 | Volatile suspended solids | Total | MN00006 | 9/17/2015 | | 2.40 | mg/L |
| S006-273 | Volatile suspended solids | Total | MN00006 | 9/17/2015 | | 2.80 | mg/L |
| S006-273 | Volatile suspended solids | Total | MN00006 | 9/24/2015 | | 3.20 | mg/L |
| S006-273 | Volatile suspended solids | Total | MN00006 | 9/24/2015 | | 3.60 | mg/L |
| S006-273 | Zinc | Total | MN00006 | 8/19/2014 | < | 10.00 | ug/L |
| S006-277 | Alkalinity, total as CaCO3 | Total | MNL0043 | 7/24/1997 | | 49.59 | mg/L |
| S006-277 | Alkalinity, total as CaCO3 | Total | MNL0043 | 8/29/1997 | | 108.49 | mg/L |
| S006-277 | Alkalinity, total as CaCO3 | Total | MNL0043 | 3/27/1998 | | 36.32 | mg/L |
| S006-277 | Alkalinity, total as CaCO3 | Total | MNL0043 | 4/29/1998 | | 22.72 | mg/L |
| S006-277 | Alkalinity, total as CaCO3 | Total | MNL0043 | 5/28/1998 | | 36.6 | mg/L |
| S006-277 | Alkalinity, total as CaCO3 | Total | MNL0043 | 6/24/1998 | | 33.89 | mg/L |
| S006-277 | Alkalinity, total as CaCO3 | Total | MNL0043 | 8/27/1998 | | 81.96 | mg/L |
| S006-277 | Ammonia-nitrogen as N | Dissolved | MNL0043 | 7/24/1997 | | 0.007 | mg/L |
| S006-277 | Ammonia-nitrogen as N | Dissolved | MNL0043 | 8/29/1997 | | 0.038 | mg/L |
| S006-277 | Ammonia-nitrogen as N | Dissolved | MNL0043 | 3/27/1998 | | 0.041 | mg/L |
| S006-277 | Ammonia-nitrogen as N | Dissolved | MNL0043 | 4/29/1998 | | 0.011 | mg/L |
| S006-277 | Ammonia-nitrogen as N | Dissolved | MNL0043 | 5/28/1998 | | 0.011 | mg/L |
| S006-277 | Ammonia-nitrogen as N | Dissolved | MNL0043 | 6/24/1998 | | 0.028 | mg/L |
| S006-277 | Ammonia-nitrogen as N | Dissolved | MNL0043 | 8/27/1998 | | 0.004 | mg/L |
| S006-277 | Inorganic nitrogen (nitrate and nitrite) as N | Dissolved | MNL0043 | 7/24/1997 | | 0.027 | mg/L |
| S006-277 | Inorganic nitrogen (nitrate and nitrite) as N | Dissolved | MNL0043 | 8/29/1997 | | 0.027 | mg/L |
| S006-277 | Inorganic nitrogen (nitrate and nitrite) as N | Dissolved | MNL0043 | 3/27/1998 | | 0.382 | mg/L |
| S006-277 | Inorganic nitrogen (nitrate and nitrite) as N | Dissolved | MNL0043 | 4/29/1998 | | 0.012 | mg/L |
| S006-277 | Inorganic nitrogen (nitrate and nitrite) as N | Dissolved | MNL0043 | 5/28/1998 | | 0.076 | mg/L |
| S006-277 | Inorganic nitrogen (nitrate and nitrite) as N | Dissolved | MNL0043 | 6/24/1998 | | 0.087 | mg/L |
| S006-277 | Inorganic nitrogen (nitrate and nitrite) as N | Dissolved | MNL0043 | 8/27/1998 | | 0.058 | mg/L |
| S006-277 | Nutrient-nitrogen as N | Total | MNL0043 | 7/24/1997 | | 0.55 | mg/L |
| S006-277 | Nutrient-nitrogen as N | Total | MNL0043 | 8/29/1997 | | 0.4 | mg/L |
| S006-277 | Nutrient-nitrogen as N | Total | MNL0043 | 3/27/1998 | | 0.88 | mg/L |
| S006-277 | Nutrient-nitrogen as N | Total | MNL0043 | 4/29/1998 | | 0.5 | mg/L |
| S006-277 | Nutrient-nitrogen as N | Total | MNL0043 | 5/28/1998 | | 0.58 | mg/L |
| S006-277 | Nutrient-nitrogen as N | Total | MNL0043 | 6/24/1998 | | 0.61 | mg/L |
| S006-277 | Nutrient-nitrogen as N | Total | MNL0043 | 8/27/1998 | | 0.35 | mg/L |
| S006-277 | Orthophosphate as P | Dissolved | MNL0043 | 7/24/1997 | | 0.047 | mg/L |
| S006-277 | Orthophosphate as P | Dissolved | MNL0043 | 8/29/1997 | | 0.01 | mg/L |
| S006-277 | Orthophosphate as P | Dissolved | MNL0043 | 3/27/1998 | | 0.01 | mg/L |
| S006-277 | Orthophosphate as P | Dissolved | MNL0043 | 4/29/1998 | | 0.01 | mg/L |
| S006-277 | Orthophosphate as P | Dissolved | MNL0043 | 5/28/1998 | | 0.014 | mg/L |
| S006-277 | Orthophosphate as P | Dissolved | MNL0043 | 6/24/1998 | | 0.01 | mg/L |
| S006-277 | Orthophosphate as P | Dissolved | MNL0043 | 8/27/1998 | | 0.01 | mg/L |
| S006-277 | Phosphorus as P | Total | MNL0043 | 7/24/1997 | | 0.019 | mg/L |
| S006-277 | Phosphorus as P | Total | MNL0043 | 8/29/1997 | | 0.019 | mg/L |
| S006-277 | Phosphorus as P | Total | MNL0043 | 3/27/1998 | | 0.048 | mg/L |
| S006-277 | Phosphorus as P | Total | MNL0043 | 4/29/1998 | | 0.027 | mg/L |
| S006-277 | Phosphorus as P | Total | MNL0043 | 5/28/1998 | | 0.01 | mg/L |
| S006-277 | Phosphorus as P | Total | MNL0043 | 6/24/1998 | | 0.01 | mg/L |
| S006-277 | Phosphorus as P | Total | MNL0043 | 8/27/1998 | | 0.012 | mg/L |
| S006-277 | Specific conductance | Total | | 7/24/1997 | | 105 | uS/cm |
| S006-277 | Specific conductance | Total | | 8/29/1997 | | 98 | uS/cm |
| S006-277 | Specific conductance | Total | | 4/29/1998 | | 55 | uS/cm |

# Appendix A
# Water Quality Dataset

| Station ID | Parameter | Sample Fraction Type | Lab Name Code | Sample Date | Detect Flag | Result | Result Unit |
|---|---|---|---|---|---|---|---|
| S006-277 | Specific conductance | Total | | 5/28/1998 | | 76 | uS/cm |
| S006-277 | Specific conductance | Total | | 6/24/1998 | | 77 | uS/cm |
| S006-277 | Specific conductance | Total | | 8/27/1998 | | 170 | uS/cm |
| S006-277 | Specific conductance | Total | | 10/5/1998 | | 78 | uS/cm |
| S006-277 | Sulfate as SO4 | Total | MNL0043 | 7/24/1997 | | 1.65 | mg/L |
| S006-277 | Sulfate as SO4 | Total | MNL0043 | 8/29/1997 | | 1.82 | mg/L |
| S006-277 | Sulfate as SO4 | Total | MNL0043 | 3/27/1998 | | 6.67 | mg/L |
| S006-277 | Sulfate as SO4 | Total | MNL0043 | 4/29/1998 | | 3.84 | mg/L |
| S006-277 | Sulfate as SO4 | Total | MNL0043 | 5/28/1998 | | 2.48 | mg/L |
| S006-277 | Sulfate as SO4 | Total | MNL0043 | 6/24/1998 | | 1 | mg/L |
| S006-277 | Sulfate as SO4 | Total | MNL0043 | 8/27/1998 | | 2.51 | mg/L |
| S006-277 | Temperature, water | Total | | 10/5/1998 | | 9.15 | deg C |
| S006-277 | Total suspended solids | Total | MNL0043 | 8/29/1997 | | 4.4 | mg/L |
| S006-277 | Total suspended solids | Total | MNL0043 | 3/27/1998 | | 9.7 | mg/L |
| S006-277 | Total suspended solids | Total | MNL0043 | 4/29/1998 | | 28.6 | mg/L |
| S006-277 | Total suspended solids | Total | MNL0043 | 5/28/1998 | | 2.8 | mg/L |
| S006-277 | Total suspended solids | Total | MNL0043 | 6/24/1998 | | 2.8 | mg/L |
| S006-277 | Total suspended solids | Total | MNL0043 | 8/27/1998 | | 3.4 | mg/L |
| S006-277 | Turbidity | Total | | 7/24/1997 | | 3 | NTRU |
| S006-277 | Turbidity | Total | | 8/29/1997 | | 1.2 | NTRU |
| S006-277 | Turbidity | Total | | 3/27/1998 | | 14.2 | NTRU |
| S006-277 | Turbidity | Total | | 4/29/1998 | | 56.2 | NTRU |
| S006-277 | Turbidity | Total | | 5/28/1998 | | 1.3 | NTRU |
| S006-277 | Turbidity | Total | | 6/24/1998 | | 1.4 | NTRU |
| S006-277 | Turbidity | Total | | 8/27/1998 | | 1.8 | NTRU |
| S006-277 | Turbidity | Total | | 10/5/1998 | | 10.3 | NTRU |
| S006-277 | Volatile suspended solids | Total | MNL0043 | 8/29/1997 | | 5 | mg/L |
| S006-277 | Volatile suspended solids | Total | MNL0043 | 3/27/1998 | | 5 | mg/L |
| S006-277 | Volatile suspended solids | Total | MNL0043 | 4/29/1998 | | 5 | mg/L |
| S006-277 | Volatile suspended solids | Total | MNL0043 | 5/28/1998 | | 5 | mg/L |
| S006-277 | Volatile suspended solids | Total | MNL0043 | 6/24/1998 | | 5 | mg/L |
| S006-277 | Volatile suspended solids | Total | MNL0043 | 8/27/1998 | | 5 | mg/L |
| S007-354 | Alkalinity, total as CaCO3 | Total | MN00006 | 5/2/2013 | | 15.00 | mg/L |
| S007-354 | Ammonia-nitrogen as N | Total | MN00006 | 5/2/2013 | < | 0.05 | mg/L |
| S007-354 | Bromide | Total | MN00006 | 5/2/2013 | | 0.01 | mg/L |
| S007-354 | Calcium | Total | MN00006 | 5/2/2013 | | 7.00 | mg/L |
| S007-354 | Chloride | Total | MN00006 | 5/2/2013 | | 1.47 | mg/L |
| S007-354 | Dissolved oxygen (DO) | Total | | 5/2/2013 | | 14.83 | mg/L |
| S007-354 | Dissolved oxygen (DO) | Total | | 6/6/2013 | | 10.75 | mg/L |
| S007-354 | Dissolved oxygen (DO) | Total | | 8/22/2013 | | 9.71 | mg/L |
| S007-354 | Dissolved oxygen (DO) | Total | | 9/12/2013 | | 9.54 | mg/L |
| S007-354 | Dissolved oxygen (DO) | Total | | 10/7/2013 | | 10.79 | mg/L |
| S007-354 | Dissolved oxygen (DO) | Total | | 4/24/2014 | | 13.86 | mg/L |
| S007-354 | Dissolved oxygen (DO) | Total | | 5/28/2015 | | 8.90 | mg/L |
| S007-354 | Dissolved oxygen (DO) | Total | | 7/13/2015 | | 8.74 | mg/L |
| S007-354 | Distance from/to | Total | | 8/22/2013 | | 22.20 | ft |
| S007-354 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 5/2/2013 | | 0.61 | mg/L |
| S007-354 | Iron | Total | MN00006 | 5/2/2013 | | 1330.00 | ug/L |
| S007-354 | Magnesium | Total | MN00006 | 5/2/2013 | | 2.69 | mg/L |
| S007-354 | Manganese | Total | MN00006 | 5/2/2013 | | 60.20 | ug/L |
| S007-354 | pH | Total | | 5/2/2013 | | 7.32 | None |
| S007-354 | pH | Total | | 6/6/2013 | | 7.50 | None |
| S007-354 | pH | Total | | 8/22/2013 | | 8.04 | None |
| S007-354 | pH | Total | | 9/12/2013 | | 7.72 | None |
| S007-354 | pH | Total | | 10/7/2013 | | 7.64 | None |
| S007-354 | pH | Total | | 4/24/2014 | | 7.10 | None |
| S007-354 | pH | Total | | 5/28/2015 | | 7.84 | None |
| S007-354 | pH | Total | | 7/13/2015 | | 8.19 | None |
| S007-354 | Potassium | Total | MN00006 | 5/2/2013 | | 0.85 | mg/L |
| S007-354 | Sodium | Total | MN00006 | 5/2/2013 | | 2.38 | mg/L |
| S007-354 | Specific conductance | Total | | 5/2/2013 | | 58.00 | uS/cm |
| S007-354 | Specific conductance | Total | | 6/6/2013 | | 118.00 | uS/cm |
| S007-354 | Specific conductance | Total | | 8/22/2013 | | 453.00 | uS/cm |
| S007-354 | Specific conductance | Total | | 9/12/2013 | | 431.00 | uS/cm |
| S007-354 | Specific conductance | Total | | 10/7/2013 | | 153.00 | uS/cm |
| S007-354 | Specific conductance | Total | | 4/24/2014 | | 110.00 | uS/cm |
| S007-354 | Specific conductance | Total | | 5/28/2015 | | 168.00 | uS/cm |
| S007-354 | Specific conductance | Total | | 7/13/2015 | | 231.00 | uS/cm |
| S007-354 | Stream Physical Appearance, Minnesota (choice list) | Total | | 9/12/2013 | | 1A.CLEAR | |
| S007-354 | Stream Physical Appearance, Minnesota (choice list) | Total | | 4/24/2014 | | 3.MUDDY | |
| S007-354 | Strontium | Total | MN00006 | 5/2/2013 | | 18.60 | ug/L |
| S007-354 | Sulfate as SO4 | Total | MN00006 | 5/2/2013 | | 4.50 | mg/L |
| S007-354 | Temperature, water | Total | | 5/2/2013 | | 0.78 | deg C |

# Appendix A
# Water Quality Dataset

| Station ID | Parameter | Sample Fraction Type | Lab Name Code | Sample Date | Detect Flag | Result | Result Unit |
|---|---|---|---|---|---|---|---|
| S007-354 | Temperature, water | Total | | 6/6/2013 | | 11.24 | deg C |
| S007-354 | Temperature, water | Total | | 8/22/2013 | | 22.49 | deg C |
| S007-354 | Temperature, water | Total | | 9/12/2013 | | 17.29 | deg C |
| S007-354 | Temperature, water | Total | | 10/7/2013 | | 10.37 | deg C |
| S007-354 | Temperature, water | Total | | 4/24/2014 | | 0.93 | deg C |
| S007-354 | Temperature, water | Total | | 5/28/2015 | | 17.35 | deg C |
| S007-354 | Temperature, water | Total | | 7/13/2015 | | 21.44 | deg C |
| S007-354 | Total suspended solids | Total | MN00006 | 5/2/2013 | | 22.00 | mg/L |
| S007-354 | Total suspended solids | Total | MN00006 | 6/6/2013 | | 3.60 | mg/L |
| S007-354 | Total suspended solids | Total | MN00006 | 10/7/2013 | | 6.00 | mg/L |
| S007-354 | Total suspended solids | Total | MN00006 | 4/24/2014 | | 22.00 | mg/L |
| S007-354 | Total suspended solids | Total | MN00006 | 6/3/2014 | | 14.00 | mg/L |
| S007-354 | Total suspended solids | Total | MN00006 | 7/13/2015 | | 8.00 | mg/L |
| S007-354 | Total suspended solids | Total | MN00006 | 8/19/2015 | | 23.00 | mg/L |
| S007-354 | Transparency, tube with disk | Total | | 5/2/2013 | | 31.00 | cm |
| S007-354 | Transparency, tube with disk | Total | | 6/6/2013 | > | 100.00 | cm |
| S007-354 | Transparency, tube with disk | Total | | 9/12/2013 | > | 100.00 | cm |
| S007-354 | Transparency, tube with disk | Total | | 10/7/2013 | | 75.00 | cm |
| S007-354 | Transparency, tube with disk | Total | | 4/24/2014 | | 30.00 | cm |
| S007-354 | Transparency, tube with disk | Total | | 6/3/2014 | | 53.00 | cm |
| S007-354 | Transparency, tube with disk | Total | | 7/13/2015 | | 95.00 | cm |
| S007-354 | Transparency, tube with disk | Total | | 8/19/2015 | | 25.00 | cm |
| S007-354 | Transparency, tube with disk | Total | | 10/12/2015 | | 57.00 | cm |
| S007-354 | Turbidity | Total | MN00006 | 6/3/2014 | | 15.00 | NTRU |
| S007-354 | Volatile suspended solids | Total | MN00006 | 5/2/2013 | | 2.40 | mg/L |
| S007-354 | Volatile suspended solids | Total | MN00006 | 6/6/2013 | | 1.20 | mg/L |
| S007-354 | Volatile suspended solids | Total | MN00006 | 10/7/2013 | | 2.00 | mg/L |
| S007-354 | Volatile suspended solids | Total | MN00006 | 7/13/2015 | | 2.40 | mg/L |
| S007-355 | Alkalinity, total as CaCO3 | Total | MN00006 | 2/5/2015 | | 180.00 | mg/L |
| S007-355 | Alkalinity, total as CaCO3 | Total | MN00006 | 2/5/2015 | | 180.00 | mg/L |
| S007-355 | Ammonia-nitrogen as N | Total | MN00006 | 2/5/2015 | | 0.05 | mg/L |
| S007-355 | Ammonia-nitrogen as N | Total | MN00006 | 2/5/2015 | | 0.05 | mg/L |
| S007-355 | Bromide | Total | MN00006 | 2/5/2015 | | 0.22 | mg/L |
| S007-355 | Bromide | Total | MN00006 | 2/5/2015 | | 0.22 | mg/L |
| S007-355 | Calcium | Total | MN00006 | 2/5/2015 | | 24.00 | mg/L |
| S007-355 | Calcium | Total | MN00006 | 2/5/2015 | | 24.00 | mg/L |
| S007-355 | Chloride | Total | MN00006 | 2/5/2015 | | 70.70 | mg/L |
| S007-355 | Chloride | Total | MN00006 | 2/5/2015 | | 70.70 | mg/L |
| S007-355 | Dissolved oxygen (DO) | Total | | 5/2/2013 | | 14.16 | mg/L |
| S007-355 | Dissolved oxygen (DO) | Total | | 6/6/2013 | | 10.75 | mg/L |
| S007-355 | Dissolved oxygen (DO) | Total | | 8/1/2013 | | 3.02 | mg/L |
| S007-355 | Dissolved oxygen (DO) | Total | | 9/12/2013 | | 10.00 | mg/L |
| S007-355 | Dissolved oxygen (DO) | Total | | 10/7/2013 | | 10.88 | mg/L |
| S007-355 | Dissolved oxygen (DO) | Total | | 4/24/2014 | | 13.38 | mg/L |
| S007-355 | Dissolved oxygen (DO) | Total | | 2/5/2015 | | 14.25 | mg/L |
| S007-355 | Dissolved oxygen (DO) | Total | | 9/24/2015 | | 10.17 | mg/L |
| S007-355 | Distance from/to | Total | | 5/2/2013 | | 17.27 | ft |
| S007-355 | Distance from/to | Total | | 6/6/2013 | | 21.10 | ft |
| S007-355 | Distance from/to | Total | | 10/7/2013 | | 21.59 | ft |
| S007-355 | Distance from/to | Total | | 4/24/2014 | | 17.40 | ft |
| S007-355 | Distance from/to | Total | | 6/3/2014 | | 19.28 | ft |
| S007-355 | Fluoride | Dissolved | MN00006 | 2/5/2015 | | 3.80 | mg/L |
| S007-355 | Fluoride | Dissolved | MN00006 | 2/5/2015 | | 3.80 | mg/L |
| S007-355 | Fluoride | Total | MN00006 | 2/5/2015 | | 3.90 | mg/L |
| S007-355 | Fluoride | Total | MN00006 | 2/5/2015 | | 3.90 | mg/L |
| S007-355 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 2/5/2015 | | 0.91 | mg/L |
| S007-355 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 2/5/2015 | | 0.91 | mg/L |
| S007-355 | Iron | Total | MN00006 | 2/5/2015 | | 318.00 | ug/L |
| S007-355 | Iron | Total | MN00006 | 2/5/2015 | | 318.00 | ug/L |
| S007-355 | Magnesium | Total | MN00006 | 2/5/2015 | | 12.70 | mg/L |
| S007-355 | Magnesium | Total | MN00006 | 2/5/2015 | | 12.70 | mg/L |
| S007-355 | Manganese | Total | MN00006 | 2/5/2015 | | 30.30 | ug/L |
| S007-355 | Manganese | Total | MN00006 | 2/5/2015 | | 30.30 | ug/L |
| S007-355 | pH | Total | | 5/2/2013 | | 7.29 | None |
| S007-355 | pH | Total | | 6/6/2013 | | 7.60 | None |
| S007-355 | pH | Total | | 9/12/2013 | | 8.29 | None |
| S007-355 | pH | Total | | 10/7/2013 | | 7.55 | None |
| S007-355 | pH | Total | | 4/24/2014 | | 7.31 | None |
| S007-355 | pH | Total | | 2/5/2015 | | 7.75 | None |
| S007-355 | pH | Total | | 9/24/2015 | | 7.40 | None |
| S007-355 | Phosphorus as P | Total | MN00006 | 2/5/2015 | | 0.01 | mg/L |
| S007-355 | Phosphorus as P | Total | MN00006 | 2/5/2015 | | 0.01 | mg/L |
| S007-355 | Potassium | Total | MN00006 | 2/5/2015 | | 7.95 | mg/L |

# Appendix A
# Water Quality Dataset

| Station ID | Parameter | Sample Fraction Type | Lab Name Code | Sample Date | Detect Flag | Result | Result Unit |
|---|---|---|---|---|---|---|---|
| S007-355 | Potassium | Total | MN00006 | 2/5/2015 | | 7.95 | mg/L |
| S007-355 | Sodium | Total | MN00006 | 2/5/2015 | | 100.00 | mg/L |
| S007-355 | Sodium | Total | MN00006 | 2/5/2015 | | 100.00 | mg/L |
| S007-355 | Specific conductance | Total | | 5/2/2013 | | 62.00 | uS/cm |
| S007-355 | Specific conductance | Total | | 6/6/2013 | | 157.00 | uS/cm |
| S007-355 | Specific conductance | Total | | 9/12/2013 | | 578.00 | uS/cm |
| S007-355 | Specific conductance | Total | | 10/7/2013 | | 243.00 | uS/cm |
| S007-355 | Specific conductance | Total | | 4/24/2014 | | 97.00 | uS/cm |
| S007-355 | Specific conductance | Total | | 2/5/2015 | | 693.00 | uS/cm |
| S007-355 | Specific conductance | Total | | 9/24/2015 | | 147.00 | uS/cm |
| S007-355 | Stream condition (text) | Total | | 9/24/2015 | | H | |
| S007-355 | Stream Physical Appearance, Minnesota (choice list) | Total | | 9/12/2013 | | 1A.CLEAR | |
| S007-355 | Stream Physical Appearance, Minnesota (choice list) | Total | | 4/24/2014 | | 3.MUDDY | |
| S007-355 | Stream Physical Appearance, Minnesota (choice list) | Total | | 9/24/2015 | | 2.CLOUDY | |
| S007-355 | Strontium | Total | MN00006 | 2/5/2015 | | 130.00 | ug/L |
| S007-355 | Strontium | Total | MN00006 | 2/5/2015 | | 130.00 | ug/L |
| S007-355 | Sulfate as SO4 | Total | MN00006 | 2/5/2015 | | 44.60 | mg/L |
| S007-355 | Sulfate as SO4 | Total | MN00006 | 2/5/2015 | | 44.60 | mg/L |
| S007-355 | Temperature, water | Total | | 5/2/2013 | | 0.58 | deg C |
| S007-355 | Temperature, water | Total | | 6/6/2013 | | 11.72 | deg C |
| S007-355 | Temperature, water | Total | | 8/1/2013 | | 21.40 | deg C |
| S007-355 | Temperature, water | Total | | 9/12/2013 | | 18.69 | deg C |
| S007-355 | Temperature, water | Total | | 10/7/2013 | | 10.63 | deg C |
| S007-355 | Temperature, water | Total | | 4/24/2014 | | 0.59 | deg C |
| S007-355 | Temperature, water | Total | | 2/5/2015 | | 0.00 | deg C |
| S007-355 | Temperature, water | Total | | 9/24/2015 | | 12.28 | deg C |
| S007-355 | Total suspended solids | Total | MN00006 | 5/2/2013 | | 19.00 | mg/L |
| S007-355 | Total suspended solids | Total | MN00006 | 6/6/2013 | | 3.20 | mg/L |
| S007-355 | Total suspended solids | Total | MN00006 | 10/7/2013 | | 4.40 | mg/L |
| S007-355 | Total suspended solids | Total | MN00006 | 4/24/2014 | | 19.00 | mg/L |
| S007-355 | Total suspended solids | Total | MN00006 | 6/3/2014 | | 12.00 | mg/L |
| S007-355 | Total suspended solids | Total | MN00006 | 2/5/2015 | | 3.20 | mg/L |
| S007-355 | Total suspended solids | Total | MN00006 | 2/5/2015 | | 3.20 | mg/L |
| S007-355 | Total suspended solids | Total | MN00006 | 8/19/2015 | | 14.00 | mg/L |
| S007-355 | Total suspended solids | Total | MN00006 | 9/24/2015 | | 9.60 | mg/L |
| S007-355 | Total suspended solids | Total | MN00006 | 9/24/2015 | | 12.00 | mg/L |
| S007-355 | Transparency, tube with disk | Total | | 5/2/2013 | | 47.00 | cm |
| S007-355 | Transparency, tube with disk | Total | | 6/6/2013 | > | 100.00 | cm |
| S007-355 | Transparency, tube with disk | Total | | 9/12/2013 | | 95.00 | cm |
| S007-355 | Transparency, tube with disk | Total | | 10/7/2013 | | 85.00 | cm |
| S007-355 | Transparency, tube with disk | Total | | 4/24/2014 | | 33.00 | cm |
| S007-355 | Transparency, tube with disk | Total | | 6/3/2014 | | 45.00 | cm |
| S007-355 | Transparency, tube with disk | Total | | 8/19/2015 | | 36.00 | cm |
| S007-355 | Transparency, tube with disk | Total | | 9/24/2015 | | 43.00 | cm |
| S007-355 | Turbidity | Total | MN00006 | 6/3/2014 | | 16.00 | NTRU |
| S007-355 | Volatile suspended solids | Total | MN00006 | 5/2/2013 | | 2.00 | mg/L |
| S007-355 | Volatile suspended solids | Total | MN00006 | 6/6/2013 | < | 1.00 | mg/L |
| S007-355 | Volatile suspended solids | Total | MN00006 | 10/7/2013 | | 2.40 | mg/L |
| S007-355 | Volatile suspended solids | Total | MN00006 | 2/5/2015 | | 1.60 | mg/L |
| S007-355 | Volatile suspended solids | Total | MN00006 | 2/5/2015 | | 1.60 | mg/L |
| S007-355 | Volatile suspended solids | Total | MN00006 | 9/24/2015 | | 2.40 | mg/L |
| S007-355 | Volatile suspended solids | Total | MN00006 | 9/24/2015 | | 3.60 | mg/L |
| S007-356 | Dissolved oxygen (DO) | Total | | 5/2/2013 | | 13.12 | mg/L |
| S007-356 | Dissolved oxygen (DO) | Total | | 6/6/2013 | | 10.52 | mg/L |
| S007-356 | Dissolved oxygen (DO) | Total | | 10/7/2013 | | 10.17 | mg/L |
| S007-356 | Dissolved oxygen (DO) | Total | | 4/24/2014 | | 13.61 | mg/L |
| S007-356 | Dissolved oxygen (DO) | Total | | 9/24/2015 | | 9.87 | mg/L |
| S007-356 | pH | Total | | 5/2/2013 | | 7.00 | None |
| S007-356 | pH | Total | | 6/6/2013 | | 7.14 | None |
| S007-356 | pH | Total | | 10/7/2013 | | 7.47 | None |
| S007-356 | pH | Total | | 4/24/2014 | | 7.07 | None |
| S007-356 | pH | Total | | 9/24/2015 | | 7.13 | None |
| S007-356 | Specific conductance | Total | | 5/2/2013 | | 55.00 | uS/cm |
| S007-356 | Specific conductance | Total | | 6/6/2013 | | 73.00 | uS/cm |
| S007-356 | Specific conductance | Total | | 10/7/2013 | | 101.00 | uS/cm |
| S007-356 | Specific conductance | Total | | 4/24/2014 | | 50.00 | uS/cm |
| S007-356 | Specific conductance | Total | | 9/24/2015 | | 142.00 | uS/cm |
| S007-356 | Stream condition (text) | Total | | 9/24/2015 | | H | |
| S007-356 | Stream Physical Appearance, Minnesota (choice list) | Total | | 9/24/2015 | | 1B.TEA-COLOR | |
| S007-356 | Temperature, water | Total | | 5/2/2013 | | 0.00 | deg C |
| S007-356 | Temperature, water | Total | | 6/6/2013 | | 10.19 | deg C |
| S007-356 | Temperature, water | Total | | 10/7/2013 | | 9.83 | deg C |
| S007-356 | Temperature, water | Total | | 4/24/2014 | | 0.16 | deg C |

# Appendix A
# Water Quality Dataset

| Station ID | Parameter | Sample Fraction Type | Lab Name Code | Sample Date | Detect Flag | Result | Result Unit |
|---|---|---|---|---|---|---|---|
| S007-356 | Temperature, water | Total | | 6/3/2015 | | 14.48 | deg C |
| S007-356 | Temperature, water | Total | | 9/24/2015 | | 11.92 | deg C |
| S007-356 | Total suspended solids | Total | MN00006 | 5/2/2013 | | 15.00 | mg/L |
| S007-356 | Total suspended solids | Total | MN00006 | 6/6/2013 | | 1.60 | mg/L |
| S007-356 | Total suspended solids | Total | MN00006 | 10/7/2013 | | 1.20 | mg/L |
| S007-356 | Total suspended solids | Total | MN00006 | 4/24/2014 | | 4.80 | mg/L |
| S007-356 | Total suspended solids | Total | MN00006 | 9/24/2015 | | 6.40 | mg/L |
| S007-356 | Total suspended solids | Total | MN00006 | 9/24/2015 | | 5.20 | mg/L |
| S007-356 | Transparency, tube with disk | Total | | 5/2/2013 | > | 100.00 | cm |
| S007-356 | Transparency, tube with disk | Total | | 6/6/2013 | > | 100.00 | cm |
| S007-356 | Transparency, tube with disk | Total | | 10/7/2013 | > | 100.00 | cm |
| S007-356 | Transparency, tube with disk | Total | | 4/24/2014 | > | 100.00 | cm |
| S007-356 | Transparency, tube with disk | Total | | 9/24/2015 | > | 100.00 | cm |
| S007-356 | Volatile suspended solids | Total | MN00006 | 5/2/2013 | | 4.80 | mg/L |
| S007-356 | Volatile suspended solids | Total | MN00006 | 6/6/2013 | < | 1.00 | mg/L |
| S007-356 | Volatile suspended solids | Total | MN00006 | 10/7/2013 | | 1.20 | mg/L |
| S007-356 | Volatile suspended solids | Total | MN00006 | 9/24/2015 | | 3.20 | mg/L |
| S007-356 | Volatile suspended solids | Total | MN00006 | 9/24/2015 | | 3.20 | mg/L |
| S007-357 | Alkalinity, total as CaCO3 | Total | MN00006 | 5/2/2013 | < | 10.00 | mg/L |
| S007-357 | Alkalinity, total as CaCO3 | Total | MN00006 | 2/5/2015 | | 66.00 | mg/L |
| S007-357 | Alkalinity, total as CaCO3 | Total | MN00006 | 2/5/2015 | | 66.00 | mg/L |
| S007-357 | Aluminum | Total | MN00006 | 7/13/2015 | | 232.00 | ug/L |
| S007-357 | Aluminum | Total | MN00006 | 8/11/2015 | | 245.00 | ug/L |
| S007-357 | Ammonia-nitrogen as N | Total | MN00006 | 5/2/2013 | < | 0.05 | mg/L |
| S007-357 | Ammonia-nitrogen as N | Total | MN00006 | 2/5/2015 | | 0.10 | mg/L |
| S007-357 | Ammonia-nitrogen as N | Total | MN00006 | 2/5/2015 | | 0.10 | mg/L |
| S007-357 | Ammonia-nitrogen as N | Total | MN00006 | 7/13/2015 | < | 0.05 | mg/L |
| S007-357 | Biochemical oxygen demand, standard conditions | Total | MN00006 | 8/18/2015 | < | 1.50 | mg/L |
| S007-357 | Biochemical oxygen demand, standard conditions | Total | MN00006 | 8/21/2015 | < | 1.50 | mg/L |
| S007-357 | Bromide | Total | MN00006 | 5/2/2013 | < | 0.01 | mg/L |
| S007-357 | Bromide | Total | MN00006 | 2/5/2015 | | 0.01 | mg/L |
| S007-357 | Bromide | Total | MN00006 | 2/5/2015 | | 0.01 | mg/L |
| S007-357 | Calcium | Total | MN00006 | 5/2/2013 | | 4.40 | mg/L |
| S007-357 | Calcium | Total | MN00006 | 2/5/2015 | | 14.00 | mg/L |
| S007-357 | Calcium | Total | MN00006 | 2/5/2015 | | 14.00 | mg/L |
| S007-357 | Calcium | Total | MN00006 | 2/26/2015 | | 14.10 | mg/L |
| S007-357 | Chloride | Total | MN00006 | 5/2/2013 | < | 0.50 | mg/L |
| S007-357 | Chloride | Total | MN00006 | 2/5/2015 | | 0.63 | mg/L |
| S007-357 | Chloride | Total | MN00006 | 2/5/2015 | | 0.63 | mg/L |
| S007-357 | Dissolved oxygen (DO) | Total | | 5/2/2013 | | 12.44 | mg/L |
| S007-357 | Dissolved oxygen (DO) | Total | | 6/6/2013 | | 9.98 | mg/L |
| S007-357 | Dissolved oxygen (DO) | Total | | 8/22/2013 | | 7.82 | mg/L |
| S007-357 | Dissolved oxygen (DO) | Total | | 9/12/2013 | | 8.37 | mg/L |
| S007-357 | Dissolved oxygen (DO) | Total | | 10/7/2013 | | 9.85 | mg/L |
| S007-357 | Dissolved oxygen (DO) | Total | | 2/5/2015 | | 12.19 | mg/L |
| S007-357 | Dissolved oxygen (DO) | Total | | 7/13/2015 | | 7.58 | mg/L |
| S007-357 | Dissolved oxygen (DO) | Total | | 8/18/2015 | | 6.78 | mg/L |
| S007-357 | Distance from/to | Total | | 5/2/2013 | | 3.20 | ft |
| S007-357 | Distance from/to | Total | | 6/6/2013 | | 5.67 | ft |
| S007-357 | Distance from/to | Total | | 8/22/2013 | | 6.43 | ft |
| S007-357 | Distance from/to | Total | | 10/7/2013 | | 5.72 | ft |
| S007-357 | Distance from/to | Total | | 6/3/2014 | | 5.10 | ft |
| S007-357 | Fluoride | Dissolved | MN00006 | 2/5/2015 | | 0.31 | mg/L |
| S007-357 | Fluoride | Dissolved | MN00006 | 2/5/2015 | | 0.31 | mg/L |
| S007-357 | Fluoride | Total | MN00006 | 2/5/2015 | | 0.30 | mg/L |
| S007-357 | Fluoride | Total | MN00006 | 2/5/2015 | | 0.30 | mg/L |
| S007-357 | Fluoride | Dissolved | MN00006 | 2/25/2015 | | 0.31 | mg/L |
| S007-357 | Fluoride | Total | MN00006 | 7/13/2015 | | 0.20 | mg/L |
| S007-357 | Hardness, Ca, Mg as CaCO3 | Total | MN00006 | 7/13/2015 | | 44.00 | mg/L |
| S007-357 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 5/2/2013 | | 0.53 | mg/L |
| S007-357 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 2/5/2015 | | 0.35 | mg/L |
| S007-357 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 2/5/2015 | | 0.35 | mg/L |
| S007-357 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 7/13/2015 | | 0.11 | mg/L |
| S007-357 | Iron | Total | MN00006 | 5/2/2013 | | 820.00 | ug/L |
| S007-357 | Iron | Total | MN00006 | 2/5/2015 | | 1390.00 | ug/L |
| S007-357 | Iron | Total | MN00006 | 2/5/2015 | | 1390.00 | ug/L |
| S007-357 | Iron | Total | MN00006 | 2/26/2015 | | 1400.00 | ug/L |
| S007-357 | Magnesium | Total | MN00006 | 5/2/2013 | < | 2.00 | mg/L |
| S007-357 | Magnesium | Total | MN00006 | 2/5/2015 | | 6.14 | mg/L |
| S007-357 | Magnesium | Total | MN00006 | 2/5/2015 | | 6.14 | mg/L |
| S007-357 | Magnesium | Total | MN00006 | 2/26/2015 | | 6.22 | mg/L |
| S007-357 | Manganese | Total | MN00006 | 5/2/2013 | | 129.00 | ug/L |
| S007-357 | Manganese | Total | MN00006 | 2/5/2015 | | 78.80 | ug/L |

# Appendix A
# Water Quality Dataset

| Station ID | Parameter | Sample Fraction Type | Lab Name Code | Sample Date | Detect Flag | Result | Result Unit |
|---|---|---|---|---|---|---|---|
| S007-357 | Manganese | Total | MN00006 | 2/5/2015 | | 78.80 | ug/L |
| S007-357 | Manganese | Total | MN00006 | 2/26/2015 | | 79.50 | ug/L |
| S007-357 | Organic carbon | Dissolved | MN00006 | 8/18/2015 | | 16.20 | mg/L |
| S007-357 | pH | Total | | 5/2/2013 | | 6.30 | None |
| S007-357 | pH | Total | | 6/6/2013 | | 6.58 | None |
| S007-357 | pH | Total | | 8/22/2013 | | 7.05 | None |
| S007-357 | pH | Total | | 9/12/2013 | | 7.28 | None |
| S007-357 | pH | Total | | 10/7/2013 | | 7.63 | None |
| S007-357 | pH | Total | | 2/5/2015 | | 6.85 | None |
| S007-357 | pH | Total | | 7/13/2015 | | 7.23 | None |
| S007-357 | pH | Total | | 8/18/2015 | | 7.28 | None |
| S007-357 | Phosphorus as P | Total | MN00006 | 2/5/2015 | | 0.02 | mg/L |
| S007-357 | Phosphorus as P | Total | MN00006 | 2/5/2015 | | 0.02 | mg/L |
| S007-357 | Phosphorus as P | Total | MN00006 | 7/13/2015 | | 0.03 | mg/L |
| S007-357 | Phosphorus as P | Total | MN00006 | 8/18/2015 | | 0.02 | mg/L |
| S007-357 | Potassium | Total | MN00006 | 5/2/2013 | | 0.71 | mg/L |
| S007-357 | Potassium | Total | MN00006 | 2/5/2015 | | 0.65 | mg/L |
| S007-357 | Potassium | Total | MN00006 | 2/5/2015 | | 0.65 | mg/L |
| S007-357 | Potassium | Total | MN00006 | 2/26/2015 | | 0.64 | mg/L |
| S007-357 | Sodium | Total | MN00006 | 5/2/2013 | | 1.21 | mg/L |
| S007-357 | Sodium | Total | MN00006 | 2/5/2015 | | 5.30 | mg/L |
| S007-357 | Sodium | Total | MN00006 | 2/5/2015 | | 5.30 | mg/L |
| S007-357 | Sodium | Total | MN00006 | 2/26/2015 | | 5.15 | mg/L |
| S007-357 | Specific conductance | Total | | 5/2/2013 | | 40.00 | uS/cm |
| S007-357 | Specific conductance | Total | | 6/6/2013 | | 59.00 | uS/cm |
| S007-357 | Specific conductance | Total | | 8/22/2013 | | 90.00 | uS/cm |
| S007-357 | Specific conductance | Total | | 9/12/2013 | | 109.00 | uS/cm |
| S007-357 | Specific conductance | Total | | 10/7/2013 | | 91.00 | uS/cm |
| S007-357 | Specific conductance | Total | | 2/5/2015 | | 139.00 | uS/cm |
| S007-357 | Specific conductance | Total | | 7/13/2015 | | 87.00 | uS/cm |
| S007-357 | Specific conductance | Total | | 8/18/2015 | | 143.00 | uS/cm |
| S007-357 | Stream Physical Appearance, Minnesota (choice list) | Total | | 9/12/2013 | | 1A.CLEAR | |
| S007-357 | Stream stage | Total | | 6/3/2014 | | 8.10 | ft |
| S007-357 | Strontium | Total | MN00006 | 5/2/2013 | | 15.00 | ug/L |
| S007-357 | Strontium | Total | MN00006 | 2/5/2015 | | 50.70 | ug/L |
| S007-357 | Strontium | Total | MN00006 | 2/5/2015 | | 50.70 | ug/L |
| S007-357 | Strontium | Total | MN00006 | 2/26/2015 | | 52.10 | ug/L |
| S007-357 | Sulfate as SO4 | Total | MN00006 | 5/2/2013 | | 2.48 | mg/L |
| S007-357 | Sulfate as SO4 | Total | MN00006 | 2/5/2015 | | 2.61 | mg/L |
| S007-357 | Sulfate as SO4 | Total | MN00006 | 2/5/2015 | | 2.61 | mg/L |
| S007-357 | Sulfate as SO4 | Total | MN00006 | 2/12/2015 | | 2.55 | mg/L |
| S007-357 | Sulfate as SO4 | Total | MN00006 | 7/13/2015 | | 0.71 | mg/L |
| S007-357 | Temperature, water | Total | | 5/2/2013 | | 0.00 | deg C |
| S007-357 | Temperature, water | Total | | 6/6/2013 | | 8.54 | deg C |
| S007-357 | Temperature, water | Total | | 8/22/2013 | | 18.06 | deg C |
| S007-357 | Temperature, water | Total | | 9/12/2013 | | 14.04 | deg C |
| S007-357 | Temperature, water | Total | | 10/7/2013 | | 8.55 | deg C |
| S007-357 | Temperature, water | Total | | 2/5/2015 | | 0.00 | deg C |
| S007-357 | Temperature, water | Total | | 5/28/2015 | | 13.41 | deg C |
| S007-357 | Temperature, water | Total | | 6/16/2015 | | 13.04 | deg C |
| S007-357 | Temperature, water | Total | | 7/13/2015 | | 18.90 | deg C |
| S007-357 | Temperature, water | Total | | 7/14/2015 | | 12.99 | deg C |
| S007-357 | Temperature, water | Total | | 7/22/2015 | | 13.69 | deg C |
| S007-357 | Temperature, water | Total | | 8/18/2015 | | 15.43 | deg C |
| S007-357 | Temperature, water | Total | | 9/22/2015 | | 13.49 | deg C |
| S007-357 | Temperature, water | Total | | 10/12/2015 | | 13.22 | deg C |
| S007-357 | Total suspended solids | Total | MN00006 | 5/2/2013 | | 10.00 | mg/L |
| S007-357 | Total suspended solids | Total | MN00006 | 6/6/2013 | | 2.40 | mg/L |
| S007-357 | Total suspended solids | Total | MN00006 | 10/7/2013 | | 1.60 | mg/L |
| S007-357 | Total suspended solids | Total | MN00006 | 6/3/2014 | | 2.80 | mg/L |
| S007-357 | Total suspended solids | Total | MN00006 | 2/5/2015 | | 2.00 | mg/L |
| S007-357 | Total suspended solids | Total | MN00006 | 2/5/2015 | | 2.00 | mg/L |
| S007-357 | Total suspended solids | Total | MN00006 | 7/13/2015 | | 8.80 | mg/L |
| S007-357 | Transparency, tube with disk | Total | | 5/2/2013 | > | 100.00 | cm |
| S007-357 | Transparency, tube with disk | Total | | 6/6/2013 | > | 100.00 | cm |
| S007-357 | Transparency, tube with disk | Total | | 9/12/2013 | > | 100.00 | cm |
| S007-357 | Transparency, tube with disk | Total | | 10/7/2013 | > | 100.00 | cm |
| S007-357 | Transparency, tube with disk | Total | | 6/3/2014 | > | 100.00 | cm |
| S007-357 | Transparency, tube with disk | Total | | 7/13/2015 | > | 100.00 | cm |
| S007-357 | Turbidity | Total | MN00006 | 6/3/2014 | | 1.00 | NTRU |
| S007-357 | Volatile suspended solids | Total | MN00006 | 5/2/2013 | | 5.20 | mg/L |
| S007-357 | Volatile suspended solids | Total | MN00006 | 6/6/2013 | | 2.00 | mg/L |
| S007-357 | Volatile suspended solids | Total | MN00006 | 10/7/2013 | | 1.60 | mg/L |

# Appendix A
# Water Quality Dataset

| Station ID | Parameter | Sample Fraction Type | Lab Name Code | Sample Date | Detect Flag | Result | Result Unit |
|---|---|---|---|---|---|---|---|
| S007-357 | Volatile suspended solids | Total | MN00006 | 2/5/2015 | | 1.60 | mg/L |
| S007-357 | Volatile suspended solids | Total | MN00006 | 2/5/2015 | | 1.60 | mg/L |
| S007-357 | Volatile suspended solids | Total | MN00006 | 7/13/2015 | | 4.40 | mg/L |
| S007-358 | Alkalinity, total as CaCO3 | Total | MN00006 | 5/2/2013 | | 14 | mg/L |
| S007-358 | Ammonia-nitrogen as N | Total | MN00006 | 5/2/2013 | | 0.05 | mg/L |
| S007-358 | Bromide | Total | MN00006 | 5/2/2013 | | 0.0075 | mg/L |
| S007-358 | Calcium | Total | MN00006 | 5/2/2013 | | 6.9 | mg/L |
| S007-358 | Chloride | Total | MN00006 | 5/2/2013 | | 0.803 | mg/L |
| S007-358 | Dissolved oxygen (DO) | Total | | 5/2/2013 | | 14.49 | mg/L |
| S007-358 | Dissolved oxygen (DO) | Total | | 6/6/2013 | | 10.86 | mg/L |
| S007-358 | Dissolved oxygen (DO) | Total | | 10/7/2013 | | 10.49 | mg/L |
| S007-358 | Dissolved oxygen (DO) | Total | | 4/24/2014 | | 13.71 | mg/L |
| S007-358 | Dissolved oxygen (DO) | Total | | 9/24/2015 | | 10.33 | mg/L |
| S007-358 | Distance from/to | Total | | 5/2/2013 | | 5.52 | ft |
| S007-358 | Distance from/to | Total | | 6/6/2013 | | 7.33 | ft |
| S007-358 | Distance from/to | Total | | 10/7/2013 | | 7.4 | ft |
| S007-358 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 5/2/2013 | | 0.5 | mg/L |
| S007-358 | Iron | Total | MN00006 | 5/2/2013 | | 1800 | ug/L |
| S007-358 | Magnesium | Total | MN00006 | 5/2/2013 | | 2.57 | mg/L |
| S007-358 | Manganese | Total | MN00006 | 5/2/2013 | | 94.3 | ug/L |
| S007-358 | pH | Total | | 5/2/2013 | | 7.24 | None |
| S007-358 | pH | Total | | 6/6/2013 | | 7.18 | None |
| S007-358 | pH | Total | | 10/7/2013 | | 7.42 | None |
| S007-358 | pH | Total | | 4/24/2014 | | 7.42 | None |
| S007-358 | pH | Total | | 9/24/2015 | | 7.44 | None |
| S007-358 | Potassium | Total | MN00006 | 5/2/2013 | | 0.82 | mg/L |
| S007-358 | Sodium | Total | MN00006 | 5/2/2013 | | 1.69 | mg/L |
| S007-358 | Specific conductance | Total | | 5/2/2013 | | 50 | uS/cm |
| S007-358 | Specific conductance | Total | | 6/6/2013 | | 79 | uS/cm |
| S007-358 | Specific conductance | Total | | 10/7/2013 | | 88 | uS/cm |
| S007-358 | Specific conductance | Total | | 4/24/2014 | | 80 | uS/cm |
| S007-358 | Specific conductance | Total | | 9/24/2015 | | 135 | uS/cm |
| S007-358 | Stream condition (text) | Total | | 9/24/2015 | | H | (null) |
| S007-358 | Stream Physical Appearance, Minnesota (choice list) | Total | | 4/24/2014 | | 3.MUDDY | (null) |
| S007-358 | Stream Physical Appearance, Minnesota (choice list) | Total | | 9/24/2015 | | 2.CLOUDY | (null) |
| S007-358 | Strontium | Total | MN00006 | 5/2/2013 | | 18.5 | ug/L |
| S007-358 | Sulfate as SO4 | Total | MN00006 | 5/2/2013 | | 3.52 | mg/L |
| S007-358 | Temperature, water | Total | | 5/2/2013 | | 0.41 | deg C |
| S007-358 | Temperature, water | Total | | 6/6/2013 | | 9.36 | deg C |
| S007-358 | Temperature, water | Total | | 10/7/2013 | | 10.16 | deg C |
| S007-358 | Temperature, water | Total | | 4/24/2014 | | 0.42 | deg C |
| S007-358 | Temperature, water | Total | | 9/24/2015 | | 12.53 | deg C |
| S007-358 | Total suspended solids | Total | MN00006 | 5/2/2013 | | 36 | mg/L |
| S007-358 | Total suspended solids | Total | MN00006 | 6/6/2013 | | 2 | mg/L |
| S007-358 | Total suspended solids | Total | MN00006 | 10/7/2013 | | 5.2 | mg/L |
| S007-358 | Total suspended solids | Total | MN00006 | 4/24/2014 | | 26 | mg/L |
| S007-358 | Total suspended solids | Total | MN00006 | 6/3/2014 | | 10 | mg/L |
| S007-358 | Total suspended solids | Total | MN00006 | 9/24/2015 | | 9.2 | mg/L |
| S007-358 | Transparency, tube with disk | Total | | 5/2/2013 | | 31 | cm |
| S007-358 | Transparency, tube with disk | Total | | 6/6/2013 | > | 100 | cm |
| S007-358 | Transparency, tube with disk | Total | | 10/7/2013 | | 84 | cm |
| S007-358 | Transparency, tube with disk | Total | | 4/24/2014 | | 32 | cm |
| S007-358 | Transparency, tube with disk | Total | | 6/3/2014 | | 65 | cm |
| S007-358 | Transparency, tube with disk | Total | | 9/24/2015 | | 77 | cm |
| S007-358 | Turbidity | Total | MN00006 | 6/3/2014 | | 7.1 | NTRU |
| S007-358 | Volatile suspended solids | Total | MN00006 | 9/24/2015 | | 2.4 | mg/L |
| S007-358 | Volatile suspended solids | Total | MN00006 | 5/2/2013 | | 5.2 | mg/L |
| S007-358 | Volatile suspended solids | Total | MN00006 | 6/6/2013 | | 1.2 | mg/L |
| S007-358 | Volatile suspended solids | Total | MN00006 | 10/7/2013 | | 2.4 | mg/L |
| S007-359 | Dissolved oxygen (DO) | Total | | 5/2/2013 | | 13.42 | mg/L |
| S007-359 | Dissolved oxygen (DO) | Total | | 6/6/2013 | | 10.57 | mg/L |
| S007-359 | Dissolved oxygen (DO) | Total | | 7/17/2013 | | 8.06 | mg/L |
| S007-359 | Dissolved oxygen (DO) | Total | | 9/12/2013 | | 9.63 | mg/L |
| S007-359 | Dissolved oxygen (DO) | Total | | 10/7/2013 | | 10.58 | mg/L |
| S007-359 | Dissolved oxygen (DO) | Total | | 4/24/2014 | | 13.09 | mg/L |
| S007-359 | Dissolved oxygen (DO) | Total | | 9/24/2015 | | 9.36 | mg/L |
| S007-359 | Distance from/to | Total | | 5/2/2013 | | 5.08 | ft |
| S007-359 | Distance from/to | Total | | 6/6/2013 | | 10.96 | ft |
| S007-359 | Distance from/to | Total | | 7/17/2013 | | 11.25 | ft |
| S007-359 | Distance from/to | Total | | 10/7/2013 | | 11.25 | ft |
| S007-359 | Distance from/to | Total | | 4/24/2014 | | 9.1 | ft |
| S007-359 | Distance from/to | Total | | 6/3/2014 | | 9.96 | ft |
| S007-359 | pH | Total | | 5/2/2013 | | 6.87 | None |

# Appendix A
# Water Quality Dataset

| Station ID | Parameter | Sample Fraction Type | Lab Name Code | Sample Date | Detect Flag | Result | Result Unit |
|---|---|---|---|---|---|---|---|
| S007-359 | pH | Total | | 6/6/2013 | | 7.13 | None |
| S007-359 | pH | Total | | 7/17/2013 | | 7.06 | None |
| S007-359 | pH | Total | | 9/12/2013 | | 7.85 | None |
| S007-359 | pH | Total | | 10/7/2013 | | 7.15 | None |
| S007-359 | pH | Total | | 4/24/2014 | | 7.22 | None |
| S007-359 | pH | Total | | 9/24/2015 | | 7.22 | None |
| S007-359 | Specific conductance | Total | | 5/2/2013 | | 52 | uS/cm |
| S007-359 | Specific conductance | Total | | 6/6/2013 | | 78 | uS/cm |
| S007-359 | Specific conductance | Total | | 7/17/2013 | | 73 | uS/cm |
| S007-359 | Specific conductance | Total | | 9/12/2013 | | 129 | uS/cm |
| S007-359 | Specific conductance | Total | | 10/7/2013 | | 85 | uS/cm |
| S007-359 | Specific conductance | Total | | 4/24/2014 | | 77 | uS/cm |
| S007-359 | Specific conductance | Total | | 9/24/2015 | | 133 | uS/cm |
| S007-359 | Stream condition (text) | Total | | 9/24/2015 | | H | (null) |
| S007-359 | Stream Physical Appearance, Minnesota (choice list) | Total | | 9/12/2013 | | 1A.CLEAR | (null) |
| S007-359 | Stream Physical Appearance, Minnesota (choice list) | Total | | 4/24/2014 | | 3.MUDDY | (null) |
| S007-359 | Stream Physical Appearance, Minnesota (choice list) | Total | | 9/24/2015 | | 1B.TEA-COLOR | (null) |
| S007-359 | Temperature, water | Total | | 5/2/2013 | | 0 | deg C |
| S007-359 | Temperature, water | Total | | 6/6/2013 | | 9.23 | deg C |
| S007-359 | Temperature, water | Total | | 7/17/2013 | | 24.72 | deg C |
| S007-359 | Temperature, water | Total | | 9/12/2013 | | 19 | deg C |
| S007-359 | Temperature, water | Total | | 10/7/2013 | | 9.19 | deg C |
| S007-359 | Temperature, water | Total | | 4/24/2014 | | 0.28 | deg C |
| S007-359 | Temperature, water | Total | | 9/24/2015 | | 12.39 | deg C |
| S007-359 | Total suspended solids | Total | MN00006 | 5/2/2013 | | 34 | mg/L |
| S007-359 | Total suspended solids | Total | MN00006 | 6/6/2013 | | 2.4 | mg/L |
| S007-359 | Total suspended solids | Total | MN00006 | 10/7/2013 | | 5.2 | mg/L |
| S007-359 | Total suspended solids | Total | MN00006 | 4/24/2014 | | 21 | mg/L |
| S007-359 | Total suspended solids | Total | MN00006 | 6/3/2014 | | 8.4 | mg/L |
| S007-359 | Total suspended solids | Total | MN00006 | 9/24/2015 | | 6.4 | mg/L |
| S007-359 | Transparency, tube with disk | Total | | 5/2/2013 | | 48 | cm |
| S007-359 | Transparency, tube with disk | Total | | 6/6/2013 | > | 100 | cm |
| S007-359 | Transparency, tube with disk | Total | | 9/12/2013 | > | 100 | cm |
| S007-359 | Transparency, tube with disk | Total | | 10/7/2013 | | 85 | cm |
| S007-359 | Transparency, tube with disk | Total | | 4/24/2014 | | 41 | cm |
| S007-359 | Transparency, tube with disk | Total | | 6/3/2014 | | 95 | cm |
| S007-359 | Transparency, tube with disk | Total | | 9/24/2015 | | 90 | cm |
| S007-359 | Turbidity | Total | MN00006 | 6/3/2014 | | 6.5 | NTRU |
| S007-359 | Volatile suspended solids | Total | MN00006 | 5/2/2013 | | 8.4 | mg/L |
| S007-359 | Volatile suspended solids | Total | MN00006 | 6/6/2013 | | 1.6 | mg/L |
| S007-359 | Volatile suspended solids | Total | MN00006 | 10/7/2013 | | 2 | mg/L |
| S007-359 | Volatile suspended solids | Total | MN00006 | 9/24/2015 | | 2 | mg/L |
| S007-360 | Dissolved oxygen (DO) | Total | | 5/2/2013 | | 13.65 | mg/L |
| S007-360 | Dissolved oxygen (DO) | Total | | 6/6/2013 | | 10.39 | mg/L |
| S007-360 | Dissolved oxygen (DO) | Total | | 9/12/2013 | | 8.74 | mg/L |
| S007-360 | Dissolved oxygen (DO) | Total | | 10/7/2013 | | 10.44 | mg/L |
| S007-360 | Dissolved oxygen (DO) | Total | | 4/24/2014 | | 14.01 | mg/L |
| S007-360 | Dissolved oxygen (DO) | Total | | 9/24/2015 | | 9.97 | mg/L |
| S007-360 | Distance from/to | Total | | 5/2/2013 | | 8.68 | ft |
| S007-360 | Distance from/to | Total | | 6/6/2013 | | 9.39 | ft |
| S007-360 | Distance from/to | Total | | 10/7/2013 | | 9.28 | ft |
| S007-360 | Distance from/to | Total | | 6/3/2014 | | 8.1 | ft |
| S007-360 | pH | Total | | 5/2/2013 | | 6.82 | None |
| S007-360 | pH | Total | | 6/6/2013 | | 7.22 | None |
| S007-360 | pH | Total | | 9/12/2013 | | 7.63 | None |
| S007-360 | pH | Total | | 10/7/2013 | | 7.25 | None |
| S007-360 | pH | Total | | 4/24/2014 | | 7.18 | None |
| S007-360 | pH | Total | | 9/24/2015 | | 7.14 | None |
| S007-360 | Specific conductance | Total | | 5/2/2013 | | 48 | uS/cm |
| S007-360 | Specific conductance | Total | | 6/6/2013 | | 79 | uS/cm |
| S007-360 | Specific conductance | Total | | 9/12/2013 | | 122 | uS/cm |
| S007-360 | Specific conductance | Total | | 10/7/2013 | | 79 | uS/cm |
| S007-360 | Specific conductance | Total | | 4/24/2014 | | 46 | uS/cm |
| S007-360 | Specific conductance | Total | | 9/24/2015 | | 127 | uS/cm |
| S007-360 | Stream condition (text) | Total | | 9/24/2015 | | H | (null) |
| S007-360 | Stream Physical Appearance, Minnesota (choice list) | Total | | 9/12/2013 | | 1A.CLEAR | (null) |
| S007-360 | Stream Physical Appearance, Minnesota (choice list) | Total | | 9/24/2015 | | 1B.TEA-COLOR | (null) |
| S007-360 | Temperature, water | Total | | 5/2/2013 | | 0 | deg C |
| S007-360 | Temperature, water | Total | | 6/6/2013 | | 9.19 | deg C |
| S007-360 | Temperature, water | Total | | 9/12/2013 | | 16.36 | deg C |
| S007-360 | Temperature, water | Total | | 10/7/2013 | | 9.37 | deg C |
| S007-360 | Temperature, water | Total | | 4/24/2014 | | 0.01 | deg C |
| S007-360 | Temperature, water | Total | | 9/24/2015 | | 12.32 | deg C |

# Appendix A
# Water Quality Dataset

| Station ID | Parameter | Sample Fraction Type | Lab Name Code | Sample Date | Detect Flag | Result | Result Unit |
|---|---|---|---|---|---|---|---|
| S007-360 | Total suspended solids | Total | MN00006 | 5/2/2013 | | 32 | mg/L |
| S007-360 | Total suspended solids | Total | MN00006 | 6/6/2013 | | 1.2 | mg/L |
| S007-360 | Total suspended solids | Total | MN00006 | 10/7/2013 | | 4.4 | mg/L |
| S007-360 | Total suspended solids | Total | MN00006 | 4/24/2014 | | 14 | mg/L |
| S007-360 | Total suspended solids | Total | MN00006 | 6/3/2014 | | 8.8 | mg/L |
| S007-360 | Total suspended solids | Total | MN00006 | 9/24/2015 | | 5.6 | mg/L |
| S007-360 | Transparency, tube with disk | Total | | 5/2/2013 | | 53 | cm |
| S007-360 | Transparency, tube with disk | Total | | 6/6/2013 | > | 100 | cm |
| S007-360 | Transparency, tube with disk | Total | | 9/12/2013 | > | 100 | cm |
| S007-360 | Transparency, tube with disk | Total | | 10/7/2013 | > | 100 | cm |
| S007-360 | Transparency, tube with disk | Total | | 4/24/2014 | | 69 | cm |
| S007-360 | Transparency, tube with disk | Total | | 6/3/2014 | > | 100 | cm |
| S007-360 | Transparency, tube with disk | Total | | 9/24/2015 | | 97 | cm |
| S007-360 | Turbidity | Total | MN00006 | 6/3/2014 | | 3.8 | NTRU |
| S007-360 | Volatile suspended solids | Total | MN00006 | 5/2/2013 | | 7.2 | mg/L |
| S007-360 | Volatile suspended solids | Total | MN00006 | 6/6/2013 | | 1 | mg/L |
| S007-360 | Volatile suspended solids | Total | MN00006 | 10/7/2013 | | 2 | mg/L |
| S007-360 | Volatile suspended solids | Total | MN00006 | 9/24/2015 | | 2 | mg/L |
| S007-598 | Alkalinity, total as CaCO3 | Total | MN00006 | 3/26/2013 | | 230.00 | mg/L |
| S007-598 | Aluminum | Total | MN00006 | 8/19/2014 | | 80.70 | ug/L |
| S007-598 | Ammonia-nitrogen as N | Total | MN00006 | 3/26/2013 | | 0.15 | mg/L |
| S007-598 | Arsenic | Total | MN00006 | 8/19/2014 | | 1.00 | ug/L |
| S007-598 | Barium | Total | MN00006 | 8/19/2014 | | 7.40 | ug/L |
| S007-598 | Beryllium | Total | MN00006 | 8/19/2014 | | 0.40 | ug/L |
| S007-598 | Bromide | Total | MN00006 | 3/26/2013 | | 0.33 | mg/L |
| S007-598 | Cadmium | Total | MN00006 | 8/19/2014 | | 0.10 | ug/L |
| S007-598 | Calcium | Total | MN00006 | 3/26/2013 | | 26.00 | mg/L |
| S007-598 | Chloride | Total | MN00006 | 3/26/2013 | | 109.00 | mg/L |
| S007-598 | Chromium | Total | MN00006 | 8/19/2014 | | 1.00 | ug/L |
| S007-598 | Cobalt | Total | MN00006 | 8/19/2014 | | 1.00 | ug/L |
| S007-598 | Copper | Total | MN00006 | 8/19/2014 | | 10.00 | ug/L |
| S007-598 | Dissolved oxygen (DO) | Total | | 9/12/2013 | | 8.91 | mg/L |
| S007-598 | Dissolved oxygen (DO) | Total | | 8/19/2014 | | 9.54 | mg/L |
| S007-598 | Hardness, Ca, Mg as CaCO3 | Total | MN00006 | 8/19/2014 | | 110.00 | mg/L |
| S007-598 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 3/26/2013 | | 1.40 | mg/L |
| S007-598 | Iron | Total | MN00006 | 3/26/2013 | | 145.00 | ug/L |
| S007-598 | Iron | Total | MN00006 | 8/19/2014 | | 104.00 | ug/L |
| S007-598 | Lead | Total | MN00006 | 8/19/2014 | | 1.00 | ug/L |
| S007-598 | Lithium | Total | MN00006 | 8/19/2014 | | 87.90 | ug/L |
| S007-598 | Magnesium | Total | MN00006 | 3/26/2013 | | 15.30 | mg/L |
| S007-598 | Manganese | Total | MN00006 | 3/26/2013 | | 145.00 | ug/L |
| S007-598 | Manganese | Total | MN00006 | 8/19/2014 | | 27.20 | ug/L |
| S007-598 | Molybdenum | Total | MN00006 | 8/19/2014 | | 54.70 | ug/L |
| S007-598 | Nickel | Total | MN00006 | 8/19/2014 | | 1.97 | ug/L |
| S007-598 | Orthophosphate as P | Total | MN00006 | 3/26/2013 | | 0.01 | mg/L |
| S007-598 | pH | Total | | 9/12/2013 | | 8.30 | None |
| S007-598 | pH | Total | | 8/19/2014 | | 7.99 | None |
| S007-598 | Potassium | Total | MN00006 | 3/26/2013 | | 12.20 | mg/L |
| S007-598 | Silver | Total | MN00006 | 8/19/2014 | | 0.20 | ug/L |
| S007-598 | Sodium | Total | MN00006 | 3/26/2013 | | 156.00 | mg/L |
| S007-598 | Specific conductance | Total | | 9/12/2013 | | 848.00 | uS/cm |
| S007-598 | Specific conductance | Total | | 8/19/2014 | | 138.00 | uS/cm |
| S007-598 | Strontium | Total | MN00006 | 3/26/2013 | | 194.00 | ug/L |
| S007-598 | Strontium | Total | MN00006 | 8/19/2014 | | 159.00 | ug/L |
| S007-598 | Sulfate as SO4 | Total | MN00006 | 3/26/2013 | | 75.50 | mg/L |
| S007-598 | Temperature, water | Total | | 9/12/2013 | | 19.33 | deg C |
| S007-598 | Temperature, water | Total | | 8/19/2014 | | 19.39 | deg C |
| S007-598 | Titanium | Total | MN00006 | 8/19/2014 | | 5.00 | ug/L |
| S007-598 | Total dissolved solids | Total | MN00006 | 3/26/2013 | | 570.00 | mg/L |
| S007-598 | Total suspended solids | Total | MN00006 | 3/26/2013 | | 3.20 | mg/L |
| S007-598 | Transparency, tube with disk | Total | | 9/12/2013 | > | 100.00 | cm |
| S007-598 | Transparency, tube with disk | Total | | 8/19/2014 | > | 100.00 | cm |
| S007-598 | Vanadium | Total | MN00006 | 8/19/2014 | | 2.00 | ug/L |
| S007-598 | Volatile suspended solids | Total | MN00006 | 3/26/2013 | | 1.20 | mg/L |
| S007-598 | Zinc | Total | MN00006 | 8/19/2014 | | 10.00 | ug/L |
| S007-603 | Alkalinity, total as CaCO3 | Total | MN00006 | 5/2/2013 | | 10 | mg/L |
| S007-603 | Ammonia-nitrogen as N | Total | MN00006 | 5/2/2013 | | 0.05 | mg/L |
| S007-603 | Bromide | Total | MN00006 | 5/2/2013 | | 0.005 | mg/L |
| S007-603 | Calcium | Total | MN00006 | 5/2/2013 | | 5 | mg/L |
| S007-603 | Chloride | Total | MN00006 | 5/2/2013 | | 0.5 | mg/L |
| S007-603 | Dissolved oxygen (DO) | Total | | 5/2/2013 | | 13.6 | mg/L |
| S007-603 | Dissolved oxygen (DO) | Total | | 6/6/2013 | | 10.72 | mg/L |
| S007-603 | Dissolved oxygen (DO) | Total | | 9/12/2013 | | 9.64 | mg/L |

# Appendix A
# Water Quality Dataset

| Station ID | Parameter | Sample Fraction Type | Lab Name Code | Sample Date | Detect Flag | Result | Result Unit |
|---|---|---|---|---|---|---|---|
| S007-603 | Dissolved oxygen (DO) | Total | | 4/24/2014 | | 14.25 | mg/L |
| S007-603 | Distance from/to | Total | | 5/2/2013 | | 5.7 | ft |
| S007-603 | Distance from/to | Total | | 6/6/2013 | | 6.99 | ft |
| S007-603 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 5/2/2013 | | 0.79 | mg/L |
| S007-603 | Iron | Total | MN00006 | 5/2/2013 | | 701 | ug/L |
| S007-603 | Magnesium | Total | MN00006 | 5/2/2013 | | 2 | mg/L |
| S007-603 | Manganese | Total | MN00006 | 5/2/2013 | | 80.1 | ug/L |
| S007-603 | pH | Total | | 5/2/2013 | | 6.47 | None |
| S007-603 | pH | Total | | 6/6/2013 | | 6.9 | None |
| S007-603 | pH | Total | | 9/12/2013 | | 7.56 | None |
| S007-603 | pH | Total | | 4/24/2014 | | 7.14 | None |
| S007-603 | Potassium | Total | MN00006 | 5/2/2013 | | 0.58 | mg/L |
| S007-603 | Sodium | Total | MN00006 | 5/2/2013 | | 1.12 | mg/L |
| S007-603 | Specific conductance | Total | | 5/2/2013 | | 42 | uS/cm |
| S007-603 | Specific conductance | Total | | 6/6/2013 | | 58 | uS/cm |
| S007-603 | Specific conductance | Total | | 9/12/2013 | | 100 | uS/cm |
| S007-603 | Specific conductance | Total | | 4/24/2014 | | 38 | uS/cm |
| S007-603 | Stream Physical Appearance, Minnesota (choice list) | Total | | 9/12/2013 | | 1A.CLEAR | (null) |
| S007-603 | Strontium | Total | MN00006 | 5/2/2013 | | 14.2 | ug/L |
| S007-603 | Sulfate as SO4 | Total | MN00006 | 5/2/2013 | | 3.33 | mg/L |
| S007-603 | Temperature, water | Total | | 5/2/2013 | | 0 | deg C |
| S007-603 | Temperature, water | Total | | 6/6/2013 | | 9.05 | deg C |
| S007-603 | Temperature, water | Total | | 9/12/2013 | | 15.5 | deg C |
| S007-603 | Temperature, water | Total | | 4/24/2014 | | 0.01 | deg C |
| S007-603 | Total suspended solids | Total | MN00006 | 5/2/2013 | | 13 | mg/L |
| S007-603 | Total suspended solids | Total | MN00006 | 6/6/2013 | | 1.2 | mg/L |
| S007-603 | Total suspended solids | Total | MN00006 | 4/24/2014 | | 5.6 | mg/L |
| S007-603 | Total suspended solids | Total | MN00006 | 6/3/2014 | | 5.2 | mg/L |
| S007-603 | Transparency, tube with disk | Total | | 5/2/2013 | | 97 | cm |
| S007-603 | Transparency, tube with disk | Total | | 6/6/2013 | > | 100 | cm |
| S007-603 | Transparency, tube with disk | Total | | 9/12/2013 | > | 100 | cm |
| S007-603 | Transparency, tube with disk | Total | | 4/24/2014 | > | 100 | cm |
| S007-603 | Transparency, tube with disk | Total | | 6/3/2014 | > | 100 | cm |
| S007-603 | Turbidity | Total | MN00006 | 6/3/2014 | | 1.9 | NTRU |
| S007-603 | Volatile suspended solids | Total | MN00006 | 5/2/2013 | | 4.4 | mg/L |
| S007-603 | Volatile suspended solids | Total | MN00006 | 6/6/2013 | | 1 | mg/L |
| S007-967 | Aluminum | Total | MN00006 | 8/19/2014 | | 102.00 | ug/L |
| S007-967 | Ammonia-nitrogen as N | Total | MN00006 | 8/19/2014 | < | 0.05 | mg/L |
| S007-967 | Ammonia-nitrogen as N | Total | MN00006 | 8/10/2015 | < | 0.05 | mg/L |
| S007-967 | Arsenic | Total | MN00006 | 8/19/2014 | < | 1.00 | ug/L |
| S007-967 | Barium | Total | MN00006 | 8/19/2014 | | 6.47 | ug/L |
| S007-967 | Beryllium | Total | MN00006 | 8/19/2014 | < | 0.40 | ug/L |
| S007-967 | Biochemical oxygen demand, standard conditions | Total | MN00006 | 8/19/2014 | | 1.00 | mg/L |
| S007-967 | Biochemical oxygen demand, standard conditions | Total | MN00006 | 8/10/2015 | | 2.00 | mg/L |
| S007-967 | Cadmium | Total | MN00006 | 8/19/2014 | < | 0.10 | ug/L |
| S007-967 | Chloride | Total | MN00006 | 8/19/2014 | | 1.43 | mg/L |
| S007-967 | Chloride | Total | MN00006 | 8/10/2015 | | 1.31 | mg/L |
| S007-967 | Chromium | Total | MN00006 | 8/19/2014 | < | 1.00 | ug/L |
| S007-967 | Cobalt | Total | MN00006 | 8/19/2014 | < | 1.00 | ug/L |
| S007-967 | Copper | Total | MN00006 | 8/19/2014 | < | 10.00 | ug/L |
| S007-967 | Dissolved oxygen (DO) | Total | | 8/19/2014 | | 9.54 | mg/L |
| S007-967 | Dissolved oxygen (DO) | Total | | 8/10/2015 | | 9.39 | mg/L |
| S007-967 | Dissolved oxygen (DO) | Total | | 10/12/2015 | | 8.05 | mg/L |
| S007-967 | Hardness, Ca, Mg as CaCO3 | Total | MN00006 | 8/19/2014 | | 71.00 | mg/L |
| S007-967 | Hardness, Ca, Mg as CaCO3 | Total | MN00006 | 8/10/2015 | | 81.00 | mg/L |
| S007-967 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 8/19/2014 | < | 0.05 | mg/L |
| S007-967 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 8/10/2015 | < | 0.05 | mg/L |
| S007-967 | Iron | Total | MN00006 | 8/19/2014 | | 585.00 | ug/L |
| S007-967 | Lead | Total | MN00006 | 8/19/2014 | < | 1.00 | ug/L |
| S007-967 | Lithium | Total | MN00006 | 8/19/2014 | < | 20.00 | ug/L |
| S007-967 | Manganese | Total | MN00006 | 8/19/2014 | | 20.40 | ug/L |
| S007-967 | Molybdenum | Total | MN00006 | 8/19/2014 | < | 1.00 | ug/L |
| S007-967 | Nickel | Total | MN00006 | 8/19/2014 | | 1.27 | ug/L |
| S007-967 | pH | Total | | 8/19/2014 | | 7.99 | None |
| S007-967 | pH | Total | | 8/10/2015 | | 8.39 | None |
| S007-967 | pH | Total | | 10/12/2015 | | 7.80 | None |
| S007-967 | Phosphorus as P | Total | MN00006 | 8/19/2014 | | 0.01 | mg/L |
| S007-967 | Phosphorus as P | Total | MN00006 | 8/10/2015 | | 0.01 | mg/L |
| S007-967 | Silver | Total | MN00006 | 8/19/2014 | < | 0.20 | ug/L |
| S007-967 | Specific conductance | Total | | 8/19/2014 | | 138.00 | uS/cm |
| S007-967 | Specific conductance | Total | | 8/10/2015 | | 182.00 | uS/cm |
| S007-967 | Specific conductance | Total | | 10/12/2015 | | 873.00 | uS/cm |
| S007-967 | Stream condition (text) | Total | | 8/10/2015 | | LMOC | |

# Appendix A
# Water Quality Dataset

| Station ID | Parameter | Sample Fraction Type | Lab Name Code | Sample Date | Detect Flag | Result | Result Unit |
|---|---|---|---|---|---|---|---|
| S007-967 | Strontium | Total | MN00006 | 8/19/2014 | | 47.30 | ug/L |
| S007-967 | Sulfate as SO4 | Total | MN00006 | 8/19/2014 | | 1.90 | mg/L |
| S007-967 | Sulfate as SO4 | Total | MN00006 | 8/10/2015 | | 2.13 | mg/L |
| S007-967 | Temperature, water | Total | | 8/19/2014 | | 16.75 | deg C |
| S007-967 | Temperature, water | Total | | 8/10/2015 | | 24.01 | deg C |
| S007-967 | Temperature, water | Total | | 10/12/2015 | | 20.15 | deg C |
| S007-967 | Titanium | Total | MN00006 | 8/19/2014 | < | 5.00 | ug/L |
| S007-967 | Total suspended solids | Total | MN00006 | 8/19/2014 | | 2.40 | mg/L |
| S007-967 | Total suspended solids | Total | MN00006 | 8/10/2015 | | 2.00 | mg/L |
| S007-967 | Transparency, tube with disk | Total | | 8/19/2014 | > | 100.00 | cm |
| S007-967 | Transparency, tube with disk | Total | | 5/28/2015 | | 80.00 | cm |
| S007-967 | Transparency, tube with disk | Total | | 7/14/2015 | | 85.00 | cm |
| S007-967 | Transparency, tube with disk | Total | | 7/21/2015 | > | 100.00 | cm |
| S007-967 | Transparency, tube with disk | Total | | 10/12/2015 | > | 100.00 | cm |
| S007-967 | Vanadium | Total | MN00006 | 8/19/2014 | < | 2.00 | ug/L |
| S007-967 | Volatile suspended solids | Total | MN00006 | 8/19/2014 | | 2.00 | mg/L |
| S007-967 | Volatile suspended solids | Total | MN00006 | 8/10/2015 | | 1.20 | mg/L |
| S007-967 | Zinc | Total | MN00006 | 8/19/2014 | < | 10.00 | ug/L |
| S007-968 | Alkalinity, total as CaCO3 | Total | MN00006 | 2/5/2015 | | 210.00 | mg/L |
| S007-968 | Alkalinity, total as CaCO3 | Total | MN00006 | 2/5/2015 | | 210.00 | mg/L |
| S007-968 | Aluminum | Total | MN00006 | 8/19/2014 | | 174.00 | ug/L |
| S007-968 | Ammonia-nitrogen as N | Total | MN00006 | 8/19/2014 | < | 0.05 | mg/L |
| S007-968 | Ammonia-nitrogen as N | Total | MN00006 | 2/5/2015 | | 0.05 | mg/L |
| S007-968 | Ammonia-nitrogen as N | Total | MN00006 | 2/5/2015 | | 0.05 | mg/L |
| S007-968 | Ammonia-nitrogen as N | Total | MN00006 | 8/10/2015 | < | 0.05 | mg/L |
| S007-968 | Arsenic | Total | MN00006 | 8/19/2014 | < | 1.00 | ug/L |
| S007-968 | Barium | Total | MN00006 | 8/19/2014 | | 9.22 | ug/L |
| S007-968 | Beryllium | Total | MN00006 | 8/19/2014 | < | 0.40 | ug/L |
| S007-968 | Biochemical oxygen demand, standard conditions | Total | MN00006 | 8/19/2014 | | 0.70 | mg/L |
| S007-968 | Biochemical oxygen demand, standard conditions | Total | MN00006 | 8/10/2015 | | 1.80 | mg/L |
| S007-968 | Bromide | Total | MN00006 | 2/5/2015 | | 0.29 | mg/L |
| S007-968 | Bromide | Total | MN00006 | 2/5/2015 | | 0.29 | mg/L |
| S007-968 | Cadmium | Total | MN00006 | 8/19/2014 | < | 0.10 | ug/L |
| S007-968 | Calcium | Total | MN00006 | 2/5/2015 | | 23.00 | mg/L |
| S007-968 | Calcium | Total | MN00006 | 2/5/2015 | | 23.00 | mg/L |
| S007-968 | Chloride | Total | MN00006 | 8/19/2014 | | 31.90 | mg/L |
| S007-968 | Chloride | Total | MN00006 | 2/5/2015 | | 90.90 | mg/L |
| S007-968 | Chloride | Total | MN00006 | 2/5/2015 | | 90.90 | mg/L |
| S007-968 | Chloride | Total | MN00006 | 8/10/2015 | | 95.30 | mg/L |
| S007-968 | Chromium | Total | MN00006 | 8/19/2014 | | 1.98 | ug/L |
| S007-968 | Cobalt | Total | MN00006 | 8/19/2014 | < | 1.00 | ug/L |
| S007-968 | Copper | Total | MN00006 | 8/19/2014 | < | 10.00 | ug/L |
| S007-968 | Dissolved oxygen (DO) | Total | | 8/19/2014 | | 9.34 | mg/L |
| S007-968 | Dissolved oxygen (DO) | Total | | 2/5/2015 | | 13.05 | mg/L |
| S007-968 | Dissolved oxygen (DO) | Total | | 8/10/2015 | | 8.86 | mg/L |
| S007-968 | Dissolved oxygen (DO) | Total | | 8/19/2015 | | 9.81 | mg/L |
| S007-968 | Fluoride | Dissolved | MN00006 | 2/5/2015 | | 4.90 | mg/L |
| S007-968 | Fluoride | Dissolved | MN00006 | 2/5/2015 | | 4.90 | mg/L |
| S007-968 | Fluoride | Total | MN00006 | 2/5/2015 | | 5.00 | mg/L |
| S007-968 | Fluoride | Total | MN00006 | 2/5/2015 | | 5.00 | mg/L |
| S007-968 | Hardness, Ca, Mg as CaCO3 | Total | MN00006 | 8/19/2014 | | 84.00 | mg/L |
| S007-968 | Hardness, Ca, Mg as CaCO3 | Total | MN00006 | 8/10/2015 | | 93.00 | mg/L |
| S007-968 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 8/19/2014 | | 0.26 | mg/L |
| S007-968 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 2/5/2015 | | 1.00 | mg/L |
| S007-968 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 2/5/2015 | | 1.00 | mg/L |
| S007-968 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 8/10/2015 | | 0.86 | mg/L |
| S007-968 | Iron | Total | MN00006 | 8/19/2014 | | 485.00 | ug/L |
| S007-968 | Iron | Total | MN00006 | 2/5/2015 | | 224.00 | ug/L |
| S007-968 | Iron | Total | MN00006 | 2/5/2015 | | 224.00 | ug/L |
| S007-968 | Lead | Total | MN00006 | 8/19/2014 | < | 1.00 | ug/L |
| S007-968 | Lithium | Total | MN00006 | 8/19/2014 | | 28.60 | ug/L |
| S007-968 | Magnesium | Total | MN00006 | 2/5/2015 | | 13.80 | mg/L |
| S007-968 | Magnesium | Total | MN00006 | 2/5/2015 | | 13.80 | mg/L |
| S007-968 | Manganese | Total | MN00006 | 8/19/2014 | | 33.40 | ug/L |
| S007-968 | Manganese | Total | MN00006 | 2/5/2015 | | 76.30 | ug/L |
| S007-968 | Manganese | Total | MN00006 | 2/5/2015 | | 76.30 | ug/L |
| S007-968 | Molybdenum | Total | MN00006 | 8/19/2014 | | 17.00 | ug/L |
| S007-968 | Nickel | Total | MN00006 | 8/19/2014 | | 3.68 | ug/L |
| S007-968 | pH | Total | | 8/19/2014 | | 8.25 | None |
| S007-968 | pH | Total | | 2/5/2015 | | 7.95 | None |
| S007-968 | pH | Total | | 8/10/2015 | | 8.43 | None |
| S007-968 | pH | Total | | 8/19/2015 | | 7.79 | None |
| S007-968 | Phosphorus as P | Total | MN00006 | 8/19/2014 | | 0.01 | mg/L |

# Appendix A
# Water Quality Dataset

| Station ID | Parameter | Sample Fraction Type | Lab Name Code | Sample Date | Detect Flag | Result | Result Unit |
|---|---|---|---|---|---|---|---|
| S007-968 | Phosphorus as P | Total | MN00006 | 2/5/2015 | | 0.01 | mg/L |
| S007-968 | Phosphorus as P | Total | MN00006 | 2/5/2015 | | 0.01 | mg/L |
| S007-968 | Phosphorus as P | Total | MN00006 | 8/10/2015 | | 0.00 | mg/L |
| S007-968 | Potassium | Total | MN00006 | 2/5/2015 | | 10.10 | mg/L |
| S007-968 | Potassium | Total | MN00006 | 2/5/2015 | | 10.10 | mg/L |
| S007-968 | Silver | Total | MN00006 | 8/19/2014 | < | 0.20 | ug/L |
| S007-968 | Sodium | Total | MN00006 | 2/5/2015 | | 122.00 | mg/L |
| S007-968 | Sodium | Total | MN00006 | 2/5/2015 | | 122.00 | mg/L |
| S007-968 | Specific conductance | Total | | 8/19/2014 | | 340.00 | uS/cm |
| S007-968 | Specific conductance | Total | | 2/5/2015 | | 831.00 | uS/cm |
| S007-968 | Specific conductance | Total | | 8/10/2015 | | 774.00 | uS/cm |
| S007-968 | Specific conductance | Total | | 8/19/2015 | | 158.00 | uS/cm |
| S007-968 | Stream condition (text) | Total | | 8/10/2015 | | LMOC | |
| S007-968 | Strontium | Total | MN00006 | 8/19/2014 | | 88.10 | ug/L |
| S007-968 | Strontium | Total | MN00006 | 2/5/2015 | | 152.00 | ug/L |
| S007-968 | Strontium | Total | MN00006 | 2/5/2015 | | 152.00 | ug/L |
| S007-968 | Sulfate as SO4 | Total | MN00006 | 8/19/2014 | | 20.10 | mg/L |
| S007-968 | Sulfate as SO4 | Total | MN00006 | 2/5/2015 | | 54.90 | mg/L |
| S007-968 | Sulfate as SO4 | Total | MN00006 | 2/5/2015 | | 54.90 | mg/L |
| S007-968 | Sulfate as SO4 | Total | MN00006 | 8/10/2015 | | 49.50 | mg/L |
| S007-968 | Temperature, water | Total | | 8/19/2014 | | 17.57 | deg C |
| S007-968 | Temperature, water | Total | | 2/5/2015 | | 0.50 | deg C |
| S007-968 | Temperature, water | Total | | 8/10/2015 | | 21.95 | deg C |
| S007-968 | Temperature, water | Total | | 8/19/2015 | | 16.26 | deg C |
| S007-968 | Titanium | Total | MN00006 | 8/19/2014 | | 6.61 | ug/L |
| S007-968 | Total suspended solids | Total | MN00006 | 8/19/2014 | | 4.00 | mg/L |
| S007-968 | Total suspended solids | Total | MN00006 | 2/5/2015 | | 3.60 | mg/L |
| S007-968 | Total suspended solids | Total | MN00006 | 2/5/2015 | | 3.60 | mg/L |
| S007-968 | Total suspended solids | Total | MN00006 | 8/10/2015 | | 3.20 | mg/L |
| S007-968 | Total suspended solids | Total | MN00006 | 8/19/2015 | | 7.60 | mg/L |
| S007-968 | Transparency, tube with disk | Total | | 8/19/2014 | > | 100.00 | cm |
| S007-968 | Transparency, tube with disk | Total | | 5/28/2015 | | 30.00 | cm |
| S007-968 | Transparency, tube with disk | Total | | 7/21/2015 | | 42.00 | cm |
| S007-968 | Transparency, tube with disk | Total | | 7/22/2015 | | 42.00 | cm |
| S007-968 | Transparency, tube with disk | Total | | 8/19/2015 | | 90.00 | cm |
| S007-968 | Transparency, tube with disk | Total | | 10/12/2015 | | 51.00 | cm |
| S007-968 | Vanadium | Total | MN00006 | 8/19/2014 | < | 2.00 | ug/L |
| S007-968 | Volatile suspended solids | Total | MN00006 | 8/19/2014 | | 2.00 | mg/L |
| S007-968 | Volatile suspended solids | Total | MN00006 | 2/5/2015 | | 2.40 | mg/L |
| S007-968 | Volatile suspended solids | Total | MN00006 | 2/5/2015 | | 2.40 | mg/L |
| S007-968 | Volatile suspended solids | Total | MN00006 | 8/10/2015 | | 1.20 | mg/L |
| S007-968 | Zinc | Total | MN00006 | 8/19/2014 | < | 10.00 | ug/L |
| S007-970 | Aluminum | Total | MN00006 | 8/19/2014 | | 212.00 | ug/L |
| S007-970 | Aluminum | Total | MN00006 | 7/13/2015 | | 320.00 | ug/L |
| S007-970 | Ammonia-nitrogen as N | Total | MN00006 | 7/13/2015 | < | 0.05 | mg/L |
| S007-970 | Arsenic | Total | MN00006 | 8/19/2014 | < | 1.00 | ug/L |
| S007-970 | Barium | Total | MN00006 | 8/19/2014 | | 8.22 | ug/L |
| S007-970 | Beryllium | Total | MN00006 | 8/19/2014 | < | 0.40 | ug/L |
| S007-970 | Biochemical oxygen demand, standard conditions | Total | MN00006 | 8/19/2014 | | 0.80 | mg/L |
| S007-970 | Cadmium | Total | MN00006 | 8/19/2014 | < | 0.10 | ug/L |
| S007-970 | Chromium | Total | MN00006 | 8/19/2014 | < | 1.00 | ug/L |
| S007-970 | Cobalt | Total | MN00006 | 8/19/2014 | < | 1.00 | ug/L |
| S007-970 | Copper | Total | MN00006 | 8/19/2014 | < | 10.00 | ug/L |
| S007-970 | Dissolved oxygen (DO) | Total | | 8/19/2014 | | 9.47 | mg/L |
| S007-970 | Dissolved oxygen (DO) | Total | | 7/13/2015 | | 8.75 | mg/L |
| S007-970 | Fluoride | Total | MN00006 | 7/13/2015 | | 0.68 | mg/L |
| S007-970 | Fluoride | Total | MN00006 | 7/22/2015 | | 0.68 | mg/L |
| S007-970 | Hardness, Ca, Mg as CaCO3 | Total | MN00006 | 8/19/2014 | | 79.00 | mg/L |
| S007-970 | Hardness, Ca, Mg as CaCO3 | Total | MN00006 | 7/13/2015 | | 53.00 | mg/L |
| S007-970 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 7/13/2015 | | 0.18 | mg/L |
| S007-970 | Lead | Total | MN00006 | 8/19/2014 | < | 1.00 | ug/L |
| S007-970 | Lithium | Total | MN00006 | 8/19/2014 | < | 20.00 | ug/L |
| S007-970 | Manganese | Total | MN00006 | 8/19/2014 | | 23.90 | ug/L |
| S007-970 | Molybdenum | Total | MN00006 | 8/19/2014 | | 11.40 | ug/L |
| S007-970 | Nickel | Total | MN00006 | 8/19/2014 | | 1.36 | ug/L |
| S007-970 | pH | Total | | 8/19/2014 | | 8.10 | None |
| S007-970 | pH | Total | | 7/13/2015 | | 8.04 | None |
| S007-970 | Phosphorus as P | Total | MN00006 | 8/19/2014 | | 0.01 | mg/L |
| S007-970 | Phosphorus as P | Total | MN00006 | 7/13/2015 | | 0.01 | mg/L |
| S007-970 | Silver | Total | MN00006 | 8/19/2014 | < | 0.20 | ug/L |
| S007-970 | Specific conductance | Total | | 8/19/2014 | | 287.00 | uS/cm |
| S007-970 | Specific conductance | Total | | 7/13/2015 | | 205.00 | uS/cm |
| S007-970 | Strontium | Total | MN00006 | 8/19/2014 | | 76.00 | ug/L |

# Appendix A
# Water Quality Dataset

| Station ID | Parameter | Sample Fraction Type | Lab Name Code | Sample Date | Detect Flag | Result | Result Unit |
|---|---|---|---|---|---|---|---|
| S007-970 | Sulfate as SO4 | Total | MN00006 | 7/13/2015 | | 7.40 | mg/L |
| S007-970 | Temperature, water | Total | | 8/19/2014 | | 17.29 | deg C |
| S007-970 | Temperature, water | Total | | 7/13/2015 | | 21.99 | deg C |
| S007-970 | Titanium | Total | MN00006 | 8/19/2014 | | 8.04 | ug/L |
| S007-970 | Total suspended solids | Total | MN00006 | 7/13/2015 | | 5.20 | mg/L |
| S007-970 | Transparency, tube with disk | Total | | 8/19/2014 | > | 100.00 | cm |
| S007-970 | Transparency, tube with disk | Total | | 7/13/2015 | > | 100.00 | cm |
| S007-970 | Vanadium | Total | MN00006 | 8/19/2014 | < | 2.00 | ug/L |
| S007-970 | Volatile suspended solids | Total | MN00006 | 7/13/2015 | | 1.20 | mg/L |
| S007-970 | Zinc | Total | MN00006 | 8/19/2014 | < | 10.00 | ug/L |
| S007-971 | Aluminum | Total | MN00006 | 8/19/2014 | | 279.00 | ug/L |
| S007-971 | Ammonia-nitrogen as N | Total | MN00006 | 8/19/2014 | < | 0.05 | mg/L |
| S007-971 | Arsenic | Total | MN00006 | 8/19/2014 | < | 1.00 | ug/L |
| S007-971 | Barium | Total | MN00006 | 8/19/2014 | | 8.97 | ug/L |
| S007-971 | Beryllium | Total | MN00006 | 8/19/2014 | < | 0.40 | ug/L |
| S007-971 | Biochemical oxygen demand, standard conditions | Total | MN00006 | 8/19/2014 | | 0.70 | mg/L |
| S007-971 | Cadmium | Total | MN00006 | 8/19/2014 | < | 0.10 | ug/L |
| S007-971 | Chloride | Total | MN00006 | 8/19/2014 | | 19.10 | mg/L |
| S007-971 | Chromium | Total | MN00006 | 8/19/2014 | | 1.07 | ug/L |
| S007-971 | Cobalt | Total | MN00006 | 8/19/2014 | < | 1.00 | ug/L |
| S007-971 | Copper | Total | MN00006 | 8/19/2014 | < | 10.00 | ug/L |
| S007-971 | Dissolved oxygen (DO) | Total | | 8/19/2014 | | 9.22 | mg/L |
| S007-971 | Hardness, Ca, Mg as CaCO3 | Total | MN00006 | 8/19/2014 | | 82.00 | mg/L |
| S007-971 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 8/19/2014 | | 0.16 | mg/L |
| S007-971 | Iron | Total | MN00006 | 8/19/2014 | | 573.00 | ug/L |
| S007-971 | Lead | Total | MN00006 | 8/19/2014 | < | 1.00 | ug/L |
| S007-971 | Lithium | Total | MN00006 | 8/19/2014 | < | 20.00 | ug/L |
| S007-971 | Manganese | Total | MN00006 | 8/19/2014 | | 27.10 | ug/L |
| S007-971 | Molybdenum | Total | MN00006 | 8/19/2014 | | 10.40 | ug/L |
| S007-971 | Nickel | Total | MN00006 | 8/19/2014 | | 1.71 | ug/L |
| S007-971 | pH | Total | | 8/19/2014 | | 7.77 | None |
| S007-971 | Phosphorus as P | Total | MN00006 | 8/19/2014 | | 0.01 | mg/L |
| S007-971 | Silver | Total | MN00006 | 8/19/2014 | < | 0.20 | ug/L |
| S007-971 | Specific conductance | Total | | 8/19/2014 | | 271.00 | uS/cm |
| S007-971 | Strontium | Total | MN00006 | 8/19/2014 | | 75.80 | ug/L |
| S007-971 | Sulfate as SO4 | Total | MN00006 | 8/19/2014 | | 12.10 | mg/L |
| S007-971 | Temperature, water | Total | | 8/19/2014 | | 16.89 | deg C |
| S007-971 | Titanium | Total | MN00006 | 8/19/2014 | | 10.50 | ug/L |
| S007-971 | Total suspended solids | Total | MN00006 | 8/19/2014 | | 4.80 | mg/L |
| S007-971 | Transparency, tube with disk | Total | | 8/19/2014 | | 91.00 | cm |
| S007-971 | Vanadium | Total | MN00006 | 8/19/2014 | < | 2.00 | ug/L |
| S007-971 | Volatile suspended solids | Total | MN00006 | 8/19/2014 | | 2.00 | mg/L |
| S007-971 | Zinc | Total | MN00006 | 8/19/2014 | < | 10.00 | ug/L |
| S008-004 | Aluminum | Total | MN00006 | 8/19/2014 | | 99.80 | ug/L |
| S008-004 | Ammonia-nitrogen as N | Total | MN00006 | 8/19/2014 | < | 0.05 | mg/L |
| S008-004 | Arsenic | Total | MN00006 | 8/19/2014 | < | 1.00 | ug/L |
| S008-004 | Barium | Total | MN00006 | 8/19/2014 | | 5.94 | ug/L |
| S008-004 | Beryllium | Total | MN00006 | 8/19/2014 | < | 0.40 | ug/L |
| S008-004 | Biochemical oxygen demand, standard conditions | Total | MN00006 | 8/19/2014 | | 0.80 | mg/L |
| S008-004 | Cadmium | Total | MN00006 | 8/19/2014 | < | 0.10 | ug/L |
| S008-004 | Chloride | Total | MN00006 | 8/19/2014 | < | 1.00 | mg/L |
| S008-004 | Chromium | Total | MN00006 | 8/19/2014 | | 1.02 | ug/L |
| S008-004 | Cobalt | Total | MN00006 | 8/19/2014 | < | 1.00 | ug/L |
| S008-004 | Copper | Total | MN00006 | 8/19/2014 | < | 10.00 | ug/L |
| S008-004 | Dissolved oxygen (DO) | Total | | 8/19/2014 | | 9.29 | mg/L |
| S008-004 | Dissolved oxygen (DO) | Total | | 9/24/2015 | | 10.02 | mg/L |
| S008-004 | Hardness, Ca, Mg as CaCO3 | Total | MN00006 | 8/19/2014 | | 54.00 | mg/L |
| S008-004 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 8/19/2014 | | 0.05 | mg/L |
| S008-004 | Iron | Total | MN00006 | 8/19/2014 | | 1210.00 | ug/L |
| S008-004 | Lead | Total | MN00006 | 8/19/2014 | < | 1.00 | ug/L |
| S008-004 | Lithium | Total | MN00006 | 8/19/2014 | < | 20.00 | ug/L |
| S008-004 | Manganese | Total | MN00006 | 8/19/2014 | | 59.20 | ug/L |
| S008-004 | Molybdenum | Total | MN00006 | 8/19/2014 | < | 1.00 | ug/L |
| S008-004 | Nickel | Total | MN00006 | 8/19/2014 | | 1.14 | ug/L |
| S008-004 | pH | Total | | 8/19/2014 | | 7.72 | None |
| S008-004 | pH | Total | | 9/24/2015 | | 7.19 | None |
| S008-004 | Phosphorus as P | Total | MN00006 | 8/19/2014 | | 0.01 | mg/L |
| S008-004 | Silver | Total | MN00006 | 8/19/2014 | < | 0.20 | ug/L |
| S008-004 | Specific conductance | Total | | 8/19/2014 | | 141.00 | uS/cm |
| S008-004 | Specific conductance | Total | | 9/24/2015 | | 132.00 | uS/cm |
| S008-004 | Stream condition (text) | Total | | 9/24/2015 | | H | |
| S008-004 | Stream Physical Appearance, Minnesota (choice list) | Total | | 9/24/2015 | | 1B.TEA-COLOR | |
| S008-004 | Strontium | Total | MN00006 | 8/19/2014 | | 46.60 | ug/L |

# Appendix A
# Water Quality Dataset

| Station ID | Parameter | Sample Fraction Type | Lab Name Code | Sample Date | Detect Flag | Result | Result Unit |
|---|---|---|---|---|---|---|---|
| S008-004 | Temperature, water | Total | | 8/19/2014 | | 16.09 | deg C |
| S008-004 | Temperature, water | Total | | 6/3/2015 | | 13.29 | deg C |
| S008-004 | Temperature, water | Total | | 9/24/2015 | | 11.82 | deg C |
| S008-004 | Titanium | Total | MN00006 | 8/19/2014 | < | 5.00 | ug/L |
| S008-004 | Total suspended solids | Total | MN00006 | 6/3/2014 | | 4.40 | mg/L |
| S008-004 | Total suspended solids | Total | MN00006 | 8/19/2014 | | 2.80 | mg/L |
| S008-004 | Total suspended solids | Total | MN00006 | 9/24/2015 | | 4.80 | mg/L |
| S008-004 | Transparency, tube with disk | Total | | 6/3/2014 | > | 100.00 | cm |
| S008-004 | Transparency, tube with disk | Total | | 8/19/2014 | > | 100.00 | cm |
| S008-004 | Transparency, tube with disk | Total | | 9/24/2015 | > | 100.00 | cm |
| S008-004 | Turbidity | Total | MN00006 | 6/3/2014 | | 1.70 | NTRU |
| S008-004 | Vanadium | Total | MN00006 | 8/19/2014 | < | 2.00 | ug/L |
| S008-004 | Volatile suspended solids | Total | MN00006 | 8/19/2014 | | 2.00 | mg/L |
| S008-004 | Volatile suspended solids | Total | MN00006 | 9/24/2015 | | 2.80 | mg/L |
| S008-004 | Zinc | Total | MN00006 | 8/19/2014 | < | 10.00 | ug/L |
| S008-005 | Alkalinity, total as CaCO3 | Total | MN00006 | 2/5/2015 | | 240.00 | mg/L |
| S008-005 | Alkalinity, total as CaCO3 | Total | MN00006 | 2/5/2015 | | 240.00 | mg/L |
| S008-005 | Ammonia-nitrogen as N | Total | MN00006 | 8/19/2014 | < | 0.05 | mg/L |
| S008-005 | Ammonia-nitrogen as N | Total | MN00006 | 2/5/2015 | | 0.06 | mg/L |
| S008-005 | Ammonia-nitrogen as N | Total | MN00006 | 2/5/2015 | | 0.06 | mg/L |
| S008-005 | Ammonia-nitrogen as N | Total | MN00006 | 2/11/2015 | | 0.06 | mg/L |
| S008-005 | Biochemical oxygen demand, standard conditions | Total | MN00006 | 8/19/2014 | | 0.60 | mg/L |
| S008-005 | Bromide | Total | MN00006 | 2/5/2015 | | 0.34 | mg/L |
| S008-005 | Bromide | Total | MN00006 | 2/5/2015 | | 0.34 | mg/L |
| S008-005 | Bromide | Total | MN00006 | 3/2/2015 | | 0.33 | mg/L |
| S008-005 | Calcium | Total | MN00006 | 2/5/2015 | | 24.00 | mg/L |
| S008-005 | Calcium | Total | MN00006 | 2/5/2015 | | 24.00 | mg/L |
| S008-005 | Chloride | Total | MN00006 | 8/19/2014 | | 96.50 | mg/L |
| S008-005 | Chloride | Total | MN00006 | 2/5/2015 | | 111.00 | mg/L |
| S008-005 | Chloride | Total | MN00006 | 2/5/2015 | | 111.00 | mg/L |
| S008-005 | Chloride | Total | MN00006 | 3/2/2015 | | 108.00 | mg/L |
| S008-005 | Dissolved oxygen (DO) | Total | | 8/19/2014 | | 8.88 | mg/L |
| S008-005 | Dissolved oxygen (DO) | Total | | 2/5/2015 | | 14.03 | mg/L |
| S008-005 | Fluoride | Dissolved | MN00006 | 2/5/2015 | | 5.90 | mg/L |
| S008-005 | Fluoride | Dissolved | MN00006 | 2/5/2015 | | 5.90 | mg/L |
| S008-005 | Fluoride | Total | MN00006 | 2/5/2015 | | 5.90 | mg/L |
| S008-005 | Fluoride | Total | MN00006 | 2/5/2015 | | 5.90 | mg/L |
| S008-005 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 8/19/2014 | | 0.83 | mg/L |
| S008-005 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 2/5/2015 | | 1.20 | mg/L |
| S008-005 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 2/5/2015 | | 1.20 | mg/L |
| S008-005 | Iron | Total | MN00006 | 2/5/2015 | | 320.00 | ug/L |
| S008-005 | Iron | Total | MN00006 | 2/5/2015 | | 320.00 | ug/L |
| S008-005 | Magnesium | Total | MN00006 | 2/5/2015 | | 15.40 | mg/L |
| S008-005 | Magnesium | Total | MN00006 | 2/5/2015 | | 15.40 | mg/L |
| S008-005 | Manganese | Total | MN00006 | 2/5/2015 | | 107.00 | ug/L |
| S008-005 | Manganese | Total | MN00006 | 2/5/2015 | | 107.00 | ug/L |
| S008-005 | pH | Total | | 8/19/2014 | | 8.36 | None |
| S008-005 | pH | Total | | 2/5/2015 | | 8.00 | None |
| S008-005 | Phosphorus as P | Total | MN00006 | 8/19/2014 | < | 0.00 | mg/L |
| S008-005 | Phosphorus as P | Total | MN00006 | 2/5/2015 | | 0.01 | mg/L |
| S008-005 | Phosphorus as P | Total | MN00006 | 2/5/2015 | | 0.01 | mg/L |
| S008-005 | Potassium | Total | MN00006 | 2/5/2015 | | 12.30 | mg/L |
| S008-005 | Potassium | Total | MN00006 | 2/5/2015 | | 12.30 | mg/L |
| S008-005 | Sodium | Total | MN00006 | 2/5/2015 | | 150.00 | mg/L |
| S008-005 | Sodium | Total | MN00006 | 2/5/2015 | | 150.00 | mg/L |
| S008-005 | Specific conductance | Total | | 8/19/2014 | | 821.00 | uS/cm |
| S008-005 | Specific conductance | Total | | 2/5/2015 | | 973.00 | uS/cm |
| S008-005 | Strontium | Total | MN00006 | 2/5/2015 | | 178.00 | ug/L |
| S008-005 | Strontium | Total | MN00006 | 2/5/2015 | | 178.00 | ug/L |
| S008-005 | Sulfate as SO4 | Total | MN00006 | 8/19/2014 | | 59.20 | mg/L |
| S008-005 | Sulfate as SO4 | Total | MN00006 | 2/5/2015 | | 66.20 | mg/L |
| S008-005 | Sulfate as SO4 | Total | MN00006 | 2/5/2015 | | 66.20 | mg/L |
| S008-005 | Temperature, water | Total | | 8/19/2014 | | 19.39 | deg C |
| S008-005 | Temperature, water | Total | | 2/5/2015 | | 0.63 | deg C |
| S008-005 | Total suspended solids | Total | MN00006 | 8/19/2014 | | 2.80 | mg/L |
| S008-005 | Total suspended solids | Total | MN00006 | 2/5/2015 | | 6.80 | mg/L |
| S008-005 | Total suspended solids | Total | MN00006 | 2/5/2015 | | 6.80 | mg/L |
| S008-005 | Transparency, tube with disk | Total | | 8/19/2014 | > | 100.00 | cm |
| S008-005 | Volatile suspended solids | Total | MN00006 | 8/19/2014 | | 1.60 | mg/L |
| S008-005 | Volatile suspended solids | Total | MN00006 | 2/5/2015 | | 2.80 | mg/L |
| S008-005 | Volatile suspended solids | Total | MN00006 | 2/5/2015 | | 2.80 | mg/L |
| S014-956 | Chlorophyll a, corrected for pheophytin | Total | MN00006 | 6/25/2014 | | 0.71 | ug/L |
| S014-956 | Chlorophyll a, corrected for pheophytin | Total | MN00006 | 9/2/2014 | | 1.43 | ug/L |

# Appendix A
# Water Quality Dataset

| Station ID | Parameter | Sample Fraction Type | Lab Name Code | Sample Date | Detect Flag | Result | Result Unit |
|---|---|---|---|---|---|---|---|
| S014-956 | Dissolved oxygen (DO) | Total | | 8/20/2015 | | 9.88 | mg/L |
| S014-956 | Dissolved oxygen (DO) | Total | | 10/2/2018 | | 11.39 | mg/L |
| S014-956 | Dissolved oxygen (DO) | Total | | 9/12/2018 | | 8.01 | mg/L |
| S014-956 | Dissolved oxygen (DO) | Total | | 8/23/2018 | | 9.14 | mg/L |
| S014-956 | Dissolved oxygen (DO) | Total | | 5/8/2018 | | 10.59 | mg/L |
| S014-956 | Dissolved oxygen (DO) | Total | | 5/23/2018 | | 9.53 | mg/L |
| S014-956 | Distance from/to | Total | | 5/13/2014 | | 4.64 | ft |
| S014-956 | Distance from/to | Total | | 7/29/2014 | | 9.51 | ft |
| S014-956 | Flow | Total | | 7/15/2014 | | 37.38 | cfs |
| S014-956 | Flow | Total | | 6/9/2014 | | 218.91 | cfs |
| S014-956 | Flow | Total | | 6/17/2014 | | 286.21 | cfs |
| S014-956 | Flow | Total | | 6/25/2014 | | 170.13 | cfs |
| S014-956 | Flow | Total | | 7/9/2014 | | 50.33 | cfs |
| S014-956 | Flow | Total | | 5/13/2014 | | 2054.10 | cfs |
| S014-956 | Flow | Total | | 4/22/2014 | | 1002.20 | cfs |
| S014-956 | Flow | Total | | 4/29/2014 | | 679.97 | cfs |
| S014-956 | Flow | Total | | 5/6/2014 | | 1066.02 | cfs |
| S014-956 | Flow | Total | | 4/23/2014 | | 1230.88 | cfs |
| S014-956 | Flow | Total | | 5/22/2014 | | 677.22 | cfs |
| S014-956 | Flow | Total | | 5/28/2014 | | 156.00 | cfs |
| S014-956 | Flow | Total | | 7/29/2014 | | 26.24 | cfs |
| S014-956 | Flow | Total | | 8/13/2014 | | 32.16 | cfs |
| S014-956 | Flow | Total | | 8/26/2014 | | 42.98 | cfs |
| S014-956 | Flow | Total | | 9/2/2014 | | 47.80 | cfs |
| S014-956 | Flow | Total | | 9/9/2014 | | 16.74 | cfs |
| S014-956 | Flow | Total | | 9/24/2014 | | 12.29 | cfs |
| S014-956 | Flow | Total | | 10/8/2014 | | 50.33 | cfs |
| S014-956 | Flow | Total | | 10/28/2014 | | 31.17 | cfs |
| S014-956 | Flow | Total | | 6/3/2014 | | 673.30 | cfs |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 5/13/2014 | | 0.14 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 4/22/2014 | | 0.41 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 4/23/2014 | | 0.38 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 4/29/2014 | | 0.31 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 5/6/2014 | | 0.23 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 4/15/2014 | | 0.81 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 4/11/2014 | | 1.00 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 5/22/2014 | | 0.07 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 5/28/2014 | | 0.06 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 6/3/2014 | | 0.07 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 6/9/2014 | | 0.06 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 6/17/2014 | | 0.07 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 6/25/2014 | < | 0.05 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 7/9/2014 | | 0.28 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 7/15/2014 | | 0.21 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 7/15/2014 | | 0.21 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 7/29/2014 | | 0.27 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 8/13/2014 | | 0.25 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 8/26/2014 | | 0.17 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 9/2/2014 | | 0.12 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 9/2/2014 | | 0.13 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 9/24/2014 | | 0.29 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 6/17/2014 | | 0.08 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 10/8/2014 | | 0.11 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 10/28/2014 | | 0.23 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 5/19/2015 | | 0.16 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 9/9/2014 | < | 0.05 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 3/16/2015 | | 0.35 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 4/14/2015 | | 0.38 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 4/22/2015 | | 0.49 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 5/6/2015 | | 0.12 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 5/11/2015 | | 0.30 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 5/11/2015 | | 0.28 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 5/12/2015 | | 0.37 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 5/12/2015 | | 0.37 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 4/20/2015 | | 0.59 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 5/14/2015 | | 0.27 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 5/14/2015 | | 0.24 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 5/27/2015 | | 0.08 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 6/10/2015 | | 0.06 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 6/10/2015 | | 0.06 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 6/9/2015 | | 0.07 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 6/23/2015 | | 0.09 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 6/17/2015 | | 0.19 | mg/L |

# Appendix A
# Water Quality Dataset

| Station ID | Parameter | Sample Fraction Type | Lab Name Code | Sample Date | Detect Flag | Result | Result Unit |
|---|---|---|---|---|---|---|---|
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 6/25/2015 | | 0.10 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 8/11/2015 | | 0.54 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 7/29/2015 | | 0.45 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 7/29/2015 | | 0.45 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 7/13/2015 | | 0.22 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 7/13/2015 | | 0.21 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 8/19/2015 | | 0.18 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 8/20/2015 | | 0.12 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 8/25/2015 | < | 0.05 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 9/3/2015 | | 0.06 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 9/8/2015 | < | 0.05 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 9/8/2015 | < | 0.05 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 9/24/2015 | | 0.08 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 9/15/2015 | < | 0.05 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 9/30/2015 | < | 0.05 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 10/5/2015 | < | 0.05 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 10/27/2015 | | 0.11 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 7/1/2015 | | 0.12 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 4/19/2016 | | 0.12 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 4/18/2016 | | 0.12 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 4/27/2016 | | 0.08 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 4/25/2016 | | 0.11 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 5/17/2016 | | 0.07 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 5/17/2016 | | 0.07 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 6/7/2016 | < | 0.05 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 6/16/2016 | | 0.09 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 6/29/2016 | | 0.07 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 7/12/2016 | | 0.06 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 7/14/2016 | < | 0.05 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 5/22/2017 | | 0.08 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 5/22/2017 | < | 0.05 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 7/28/2017 | | 0.19 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 6/28/2018 | | 0.19 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 10/12/2018 | | 0.09 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 3/17/2016 | | 0.21 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 3/15/2016 | | 0.28 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 3/19/2016 | | 0.21 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 3/23/2016 | | 0.17 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 3/14/2016 | | 0.33 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 4/7/2016 | | 0.13 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 8/3/2016 | | 0.11 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 9/8/2016 | < | 0.05 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 10/5/2016 | | 0.11 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 10/5/2016 | | 0.10 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 10/26/2016 | | 0.10 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 4/2/2017 | | 0.18 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 4/4/2017 | | 0.21 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 4/6/2017 | | 0.19 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 5/4/2017 | | 0.07 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 4/12/2017 | < | 0.50 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 4/19/2017 | | 0.13 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 4/21/2017 | | 0.11 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 5/2/2017 | | 0.06 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 5/18/2017 | | 0.05 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 6/13/2017 | | 0.12 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 6/29/2017 | | 0.10 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 8/22/2017 | | 0.13 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 9/18/2017 | < | 0.05 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 8/21/2017 | | 0.11 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 8/10/2017 | | 0.12 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 9/13/2017 | < | 0.05 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 9/27/2017 | | 0.05 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 10/4/2017 | | 0.05 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 10/31/2017 | | 0.10 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 11/13/2017 | | 0.10 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 10/31/2017 | | 0.09 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 5/2/2018 | | 0.23 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 4/20/2018 | | 0.29 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 4/22/2018 | | 0.30 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 5/23/2018 | | 0.07 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 5/23/2018 | | 0.08 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 6/13/2018 | | 0.16 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 5/31/2018 | | 0.16 | mg/L |

# Appendix A
# Water Quality Dataset

| Station ID | Parameter | Sample Fraction Type | Lab Name Code | Sample Date | Detect Flag | Result | Result Unit |
|---|---|---|---|---|---|---|---|
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 6/18/2018 | | 0.07 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 6/17/2018 | | 0.14 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 4/24/2018 | | 0.21 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 4/23/2018 | | 0.24 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 4/30/2018 | | 0.23 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 4/25/2018 | | 0.24 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 4/26/2018 | | 0.23 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 5/8/2018 | | 0.12 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 6/19/2018 | | 0.07 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 6/4/2018 | | 0.07 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 7/2/2018 | | 0.06 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 7/3/2018 | < | 0.05 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 8/7/2018 | | 0.06 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 9/12/2018 | | 0.25 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 8/23/2018 | | 0.26 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 6/7/2018 | < | 0.05 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 7/24/2015 | | 0.22 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 7/24/2015 | | 0.21 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 7/11/2016 | | 0.06 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 8/16/2017 | | 0.13 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 10/3/2017 | | 0.06 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 4/24/2018 | | 0.30 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 5/14/2018 | | 0.12 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 10/9/2018 | | 0.11 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 10/3/2018 | | 0.11 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 10/10/2018 | | 0.11 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 10/31/2018 | | 0.07 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 10/16/2018 | | 0.06 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 10/31/2018 | | 0.07 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 8/21/2017 | < | 0.05 | mg/L |
| S014-956 | Inorganic nitrogen (nitrate and nitrite) as N | Total | MN00006 | 10/8/2018 | | 0.09 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 5/13/2014 | | 0.62 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 4/22/2014 | | 0.69 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 4/23/2014 | | 0.99 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 4/29/2014 | | 0.26 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 5/6/2014 | | 0.55 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 4/11/2014 | | 0.86 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 4/15/2014 | | 0.75 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 5/22/2014 | | 0.44 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 5/28/2014 | | 0.53 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 6/3/2014 | | 0.91 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 6/9/2014 | | 0.74 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 6/17/2014 | | 0.89 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 6/25/2014 | | 0.68 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 7/9/2014 | | 0.63 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 7/15/2014 | | 0.60 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 7/15/2014 | | 0.58 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 7/29/2014 | | 0.49 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 8/13/2014 | | 0.44 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 8/26/2014 | | 0.52 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 9/2/2014 | | 0.63 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 9/2/2014 | | 0.60 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 9/9/2014 | | 0.74 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 9/24/2014 | | 0.31 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 6/17/2014 | | 0.80 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 10/8/2014 | | 0.65 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 10/28/2014 | | 0.49 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 3/16/2015 | | 0.91 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 4/14/2015 | | 0.88 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 4/20/2015 | | 1.31 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 4/22/2015 | | 1.04 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 5/6/2015 | | 0.73 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 5/11/2015 | | 0.86 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 5/11/2015 | | 0.90 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 5/12/2015 | | 0.74 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 5/12/2015 | | 1.02 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 5/19/2015 | | 0.47 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 5/14/2015 | | 0.75 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 5/27/2015 | | 0.68 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 6/10/2015 | | 0.90 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 6/10/2015 | | 0.76 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 6/30/2015 | | 1.01 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 6/9/2015 | | 0.79 | mg/L |

# Appendix A
# Water Quality Dataset

| Station ID | Parameter | Sample Fraction Type | Lab Name Code | Sample Date | Detect Flag | Result | Result Unit |
|---|---|---|---|---|---|---|---|
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 6/23/2015 | | 0.98 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 6/17/2015 | | 0.72 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 6/25/2015 | | 0.84 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 8/11/2015 | | 0.44 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 7/29/2015 | | 0.46 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 7/29/2015 | | 0.41 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 7/20/2015 | | 0.74 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 7/20/2015 | | 0.89 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 7/13/2015 | | 0.72 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 7/13/2015 | | 0.78 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 8/19/2015 | | 0.72 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 8/20/2015 | | 0.66 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 8/25/2015 | | 0.65 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 9/3/2015 | | 0.92 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 9/8/2015 | | 1.05 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 9/8/2015 | | 1.04 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 9/15/2015 | | 0.61 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 9/24/2015 | | 0.98 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 9/30/2015 | | 0.93 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 10/5/2015 | | 0.80 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 3/15/2016 | | 0.53 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 3/17/2016 | | 0.50 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 10/27/2015 | | 0.53 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 7/8/2015 | | 0.93 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 7/1/2015 | | 0.88 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 3/19/2016 | | 0.49 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 3/23/2016 | | 0.49 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 3/14/2016 | | 0.70 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 4/7/2016 | | 0.46 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 4/19/2016 | | 0.64 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 4/18/2016 | | 0.61 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 4/27/2016 | | 0.48 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 4/25/2016 | | 0.84 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 5/24/2016 | | 0.51 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 5/17/2016 | | 0.54 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 5/17/2016 | | 0.44 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 6/7/2016 | | 0.65 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 6/16/2016 | | 0.89 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 6/29/2016 | | 0.69 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 8/3/2016 | | 0.57 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 7/12/2016 | | 1.06 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 7/14/2016 | | 0.84 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 9/8/2016 | | 0.86 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 10/5/2016 | | 0.61 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 10/26/2016 | | 0.54 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 10/5/2016 | | 0.68 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 4/2/2017 | | 0.66 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 4/4/2017 | | 0.69 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 4/6/2017 | | 0.56 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 4/18/2017 | | 0.46 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 4/12/2017 | | 0.53 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 5/4/2017 | | 0.46 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 5/22/2017 | | 0.66 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 5/22/2017 | | 0.63 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 4/19/2017 | | 0.57 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 5/1/2017 | | 0.58 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 4/21/2017 | | 0.60 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 5/2/2017 | | 0.61 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 5/18/2017 | | 1.10 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 6/13/2017 | | 0.58 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 6/29/2017 | | 0.86 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 8/10/2017 | | 0.70 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 8/16/2017 | | 0.68 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 9/18/2017 | | 1.01 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 9/13/2017 | | 0.72 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 10/3/2017 | | 1.18 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 9/27/2017 | | 1.10 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 10/4/2017 | | 1.05 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 7/28/2017 | | 0.47 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 10/31/2017 | | 0.63 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 10/31/2017 | | 0.62 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 5/2/2018 | | 1.32 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 4/20/2018 | | 0.63 | mg/L |

# Appendix A
# Water Quality Dataset

| Station ID | Parameter | Sample Fraction Type | Lab Name Code | Sample Date | Detect Flag | Result | Result Unit |
|---|---|---|---|---|---|---|---|
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 4/22/2018 | | 0.59 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 5/30/2018 | | 0.52 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 5/23/2018 | | 0.46 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 5/23/2018 | | 0.51 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 5/31/2018 | | 0.95 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 6/18/2018 | | 1.04 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 6/17/2018 | | 1.03 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 4/24/2018 | | 0.79 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 4/23/2018 | | 0.78 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 4/25/2018 | | 0.75 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 4/26/2018 | | 0.82 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 5/8/2018 | | 0.57 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 6/19/2018 | | 0.66 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 6/4/2018 | | 0.71 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 6/28/2018 | | 0.51 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 7/2/2018 | | 0.96 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 7/3/2018 | | 0.67 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 8/7/2018 | | 0.61 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 8/23/2018 | | 0.44 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 9/12/2018 | | 0.50 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 6/13/2018 | | 0.61 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 6/7/2018 | | 0.63 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 10/15/2018 | | 0.62 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 10/3/2018 | | 0.61 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 10/10/2018 | | 1.24 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 10/16/2018 | | 0.74 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 10/31/2018 | | 0.59 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 10/31/2018 | | 0.58 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 10/8/2018 | | 0.68 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 9/18/2017 | | 0.73 | mg/L |
| S014-956 | Kjeldahl nitrogen as N | Total | MN00006 | 6/25/2018 | | 1.09 | mg/L |
| S014-956 | Organic carbon | Total | MN00006 | 6/25/2014 | | 16.00 | mg/L |
| S014-956 | Organic carbon | Total | MN00006 | 8/26/2014 | | 10.00 | mg/L |
| S014-956 | Organic carbon | Dissolved | MN00006 | 9/2/2014 | | 12.00 | mg/L |
| S014-956 | Organic carbon | Total | MN00006 | 9/2/2014 | | 12.00 | mg/L |
| S014-956 | Organic carbon | Total | MN00006 | 5/17/2016 | | 11.00 | mg/L |
| S014-956 | Organic carbon | Dissolved | MN00006 | 7/2/2015 | | 14.20 | mg/L |
| S014-956 | Organic carbon | Total | MN00006 | 7/14/2015 | | 15.00 | mg/L |
| S014-956 | Organic carbon | Dissolved | MN00006 | 7/21/2015 | | 20.90 | mg/L |
| S014-956 | Organic carbon | Total | MN00006 | 7/1/2015 | | 22.00 | mg/L |
| S014-956 | Organic carbon | Dissolved | MN00006 | 7/1/2015 | | 20.90 | mg/L |
| S014-956 | Orthophosphate as P | Dissolved | MN00006 | 4/22/2014 | | 0.01 | mg/L |
| S014-956 | Orthophosphate as P | Dissolved | MN00006 | 4/23/2014 | | 0.01 | mg/L |
| S014-956 | Orthophosphate as P | Dissolved | MN00006 | 4/29/2014 | < | 0.01 | mg/L |
| S014-956 | Orthophosphate as P | Dissolved | MN00006 | 5/6/2014 | < | 0.01 | mg/L |
| S014-956 | Orthophosphate as P | Dissolved | MN00006 | 4/11/2014 | | 0.01 | mg/L |
| S014-956 | Orthophosphate as P | Dissolved | MN00006 | 5/22/2014 | < | 0.01 | mg/L |
| S014-956 | Orthophosphate as P | Dissolved | MN00006 | 5/28/2014 | < | 0.01 | mg/L |
| S014-956 | Orthophosphate as P | Dissolved | MN00006 | 6/3/2014 | | 0.01 | mg/L |
| S014-956 | Orthophosphate as P | Dissolved | MN00006 | 6/9/2014 | < | 0.01 | mg/L |
| S014-956 | Orthophosphate as P | Dissolved | MN00006 | 6/17/2014 | < | 0.01 | mg/L |
| S014-956 | Orthophosphate as P | Dissolved | MN00006 | 6/25/2014 | < | 0.01 | mg/L |
| S014-956 | Orthophosphate as P | Dissolved | MN00006 | 7/9/2014 | < | 0.01 | mg/L |
| S014-956 | Orthophosphate as P | Dissolved | MN00006 | 7/15/2014 | | 0.01 | mg/L |
| S014-956 | Orthophosphate as P | Dissolved | MN00006 | 7/15/2014 | | 0.01 | mg/L |
| S014-956 | Orthophosphate as P | Dissolved | MN00006 | 7/29/2014 | < | 0.01 | mg/L |
| S014-956 | Orthophosphate as P | Dissolved | MN00006 | 9/2/2014 | < | 0.01 | mg/L |
| S014-956 | Orthophosphate as P | Dissolved | MN00006 | 9/2/2014 | < | 0.01 | mg/L |
| S014-956 | Orthophosphate as P | Dissolved | MN00006 | 9/24/2014 | < | 0.01 | mg/L |
| S014-956 | Orthophosphate as P | Dissolved | MN00006 | 6/17/2014 | < | 0.01 | mg/L |
| S014-956 | Orthophosphate as P | Dissolved | MN00006 | 10/8/2014 | | 0.01 | mg/L |
| S014-956 | Orthophosphate as P | Dissolved | MN00006 | 10/28/2014 | < | 0.01 | mg/L |
| S014-956 | Orthophosphate as P | Dissolved | MN00006 | 4/15/2014 | | 0.01 | mg/L |
| S014-956 | Orthophosphate as P | Dissolved | MN00006 | 5/13/2014 | < | 0.01 | mg/L |
| S014-956 | Orthophosphate as P | Dissolved | MN00006 | 8/13/2014 | < | 0.01 | mg/L |
| S014-956 | Orthophosphate as P | Dissolved | MN00006 | 7/29/2015 | < | 0.01 | mg/L |
| S014-956 | Orthophosphate as P | Dissolved | MN00006 | 8/25/2015 | | 0.01 | mg/L |
| S014-956 | Orthophosphate as P | Dissolved | MN00006 | 5/17/2016 | < | 0.01 | mg/L |
| S014-956 | Orthophosphate as P | Dissolved | MN00006 | 5/17/2016 | < | 0.01 | mg/L |
| S014-956 | Orthophosphate as P | Dissolved | MN00006 | 6/17/2015 | < | 0.01 | mg/L |
| S014-956 | Orthophosphate as P | Dissolved | MN00006 | 7/1/2015 | < | 0.01 | mg/L |
| S014-956 | Orthophosphate as P | Dissolved | MN00006 | 9/9/2014 | < | 0.01 | mg/L |
| S014-956 | Orthophosphate as P | Dissolved | MN00006 | 3/16/2015 | < | 0.01 | mg/L |

# Appendix A
# Water Quality Dataset

| Station ID | Parameter | Sample Fraction Type | Lab Name Code | Sample Date | Detect Flag | Result | Result Unit |
|---|---|---|---|---|---|---|---|
| S014-956 | Orthophosphate as P | Dissolved | MN00006 | 4/14/2015 | < | 0.01 | mg/L |
| S014-956 | Orthophosphate as P | Dissolved | MN00006 | 4/20/2015 | < | 0.01 | mg/L |
| S014-956 | Orthophosphate as P | Dissolved | MN00006 | 4/22/2015 | < | 0.01 | mg/L |
| S014-956 | Orthophosphate as P | Dissolved | MN00006 | 5/6/2015 | < | 0.01 | mg/L |
| S014-956 | Orthophosphate as P | Dissolved | MN00006 | 5/11/2015 | < | 0.01 | mg/L |
| S014-956 | Orthophosphate as P | Dissolved | MN00006 | 5/11/2015 | | 0.01 | mg/L |
| S014-956 | Orthophosphate as P | Dissolved | MN00006 | 5/12/2015 | < | 0.01 | mg/L |
| S014-956 | Orthophosphate as P | Dissolved | MN00006 | 5/12/2015 | | 0.01 | mg/L |
| S014-956 | Orthophosphate as P | Dissolved | MN00006 | 5/19/2015 | | 0.01 | mg/L |
| S014-956 | Orthophosphate as P | Dissolved | MN00006 | 5/21/2015 | | 0.01 | mg/L |
| S014-956 | Orthophosphate as P | Dissolved | MN00006 | 5/14/2015 | < | 0.01 | mg/L |
| S014-956 | Orthophosphate as P | Dissolved | MN00006 | 5/27/2015 | | 0.01 | mg/L |
| S014-956 | Orthophosphate as P | Dissolved | MN00006 | 6/10/2015 | < | 0.01 | mg/L |
| S014-956 | Orthophosphate as P | Dissolved | MN00006 | 6/10/2015 | < | 0.01 | mg/L |
| S014-956 | Orthophosphate as P | Dissolved | MN00006 | 6/9/2015 | < | 0.01 | mg/L |
| S014-956 | Orthophosphate as P | Dissolved | MN00006 | 6/23/2015 | | 0.01 | mg/L |
| S014-956 | Orthophosphate as P | Dissolved | MN00006 | 6/25/2015 | < | 0.01 | mg/L |
| S014-956 | Orthophosphate as P | Dissolved | MN00006 | 8/11/2015 | < | 0.01 | mg/L |
| S014-956 | Orthophosphate as P | Dissolved | MN00006 | 7/29/2015 | | 0.01 | mg/L |
| S014-956 | Orthophosphate as P | Dissolved | MN00006 | 7/13/2015 | < | 0.01 | mg/L |
| S014-956 | Orthophosphate as P | Dissolved | MN00006 | 7/13/2015 | < | 0.01 | mg/L |
| S014-956 | Orthophosphate as P | Dissolved | MN00006 | 7/17/2015 | < | 0.01 | mg/L |
| S014-956 | Orthophosphate as P | Dissolved | MN00006 | 8/19/2015 | | 0.01 | mg/L |
| S014-956 | Orthophosphate as P | Dissolved | MN00006 | 8/20/2015 | | 0.01 | mg/L |
| S014-956 | Orthophosphate as P | Dissolved | MN00006 | 9/4/2015 | | 0.01 | mg/L |
| S014-956 | Orthophosphate as P | Dissolved | MN00006 | 9/3/2015 | | 0.01 | mg/L |
| S014-956 | Orthophosphate as P | Dissolved | MN00006 | 9/8/2015 | | 0.02 | mg/L |
| S014-956 | Orthophosphate as P | Dissolved | MN00006 | 9/8/2015 | | 0.02 | mg/L |
| S014-956 | Orthophosphate as P | Dissolved | MN00006 | 9/24/2015 | | 0.01 | mg/L |
| S014-956 | Orthophosphate as P | Dissolved | MN00006 | 9/15/2015 | < | 0.01 | mg/L |
| S014-956 | Orthophosphate as P | Dissolved | MN00006 | 9/30/2015 | < | 0.01 | mg/L |
| S014-956 | Orthophosphate as P | Dissolved | MN00006 | 10/5/2015 | < | 0.01 | mg/L |
| S014-956 | Orthophosphate as P | Dissolved | MN00006 | 10/27/2015 | | 0.01 | mg/L |
| S014-956 | Orthophosphate as P | Dissolved | MN00006 | 4/19/2016 | < | 0.01 | mg/L |
| S014-956 | Orthophosphate as P | Dissolved | MN00006 | 4/18/2016 | < | 0.01 | mg/L |
| S014-956 | Orthophosphate as P | Dissolved | MN00006 | 4/27/2016 | < | 0.01 | mg/L |
| S014-956 | Orthophosphate as P | Dissolved | MN00006 | 4/25/2016 | | 0.01 | mg/L |
| S014-956 | Orthophosphate as P | Dissolved | MN00006 | 6/7/2016 | < | 0.01 | mg/L |
| S014-956 | Orthophosphate as P | Dissolved | MN00006 | 6/16/2016 | | 0.01 | mg/L |
| S014-956 | Orthophosphate as P | Dissolved | MN00006 | 6/29/2016 | < | 0.01 | mg/L |
| S014-956 | Orthophosphate as P | Dissolved | MN00006 | 7/12/2016 | | 0.01 | mg/L |
| S014-956 | Orthophosphate as P | Dissolved | MN00006 | 7/14/2016 | | 0.01 | mg/L |
| S014-956 | Orthophosphate as P | Dissolved | MN00006 | 6/28/2018 | | 0.02 | mg/L |
| S014-956 | Orthophosphate as P | Dissolved | MN00006 | 5/15/2015 | | 0.01 | mg/L |
| S014-956 | Orthophosphate as P | Dissolved | MN00006 | 3/17/2016 | < | 0.01 | mg/L |
| S014-956 | Orthophosphate as P | Dissolved | MN00006 | 3/15/2016 | < | 0.01 | mg/L |
| S014-956 | Orthophosphate as P | Dissolved | MN00006 | 3/19/2016 | | 0.01 | mg/L |
| S014-956 | Orthophosphate as P | Dissolved | MN00006 | 3/23/2016 | | 0.01 | mg/L |
| S014-956 | Orthophosphate as P | Dissolved | MN00006 | 3/14/2016 | | 0.01 | mg/L |
| S014-956 | Orthophosphate as P | Dissolved | MN00006 | 4/7/2016 | | 0.01 | mg/L |
| S014-956 | pH | Total | | 7/1/2015 | | 7.58 | None |
| S014-956 | pH | Total | | 7/13/2015 | | 7.88 | None |
| S014-956 | pH | Total | | 8/20/2015 | | 7.90 | None |
| S014-956 | pH | Total | | 10/2/2018 | | 8.03 | None |
| S014-956 | pH | Total | | 9/12/2018 | | 7.98 | None |
| S014-956 | pH | Total | | 8/23/2018 | | 8.16 | None |
| S014-956 | pH | Total | | 5/8/2018 | | 7.86 | None |
| S014-956 | pH | Total | | 5/23/2018 | | 8.04 | None |
| S014-956 | Pheophytin a | Total | MN00006 | 6/25/2014 | | 1.16 | ug/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 4/22/2014 | | 0.06 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 4/23/2014 | | 0.04 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 4/29/2014 | | 0.02 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 5/6/2014 | | 0.02 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 4/11/2014 | | 0.03 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 5/28/2014 | | 0.02 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 6/3/2014 | | 0.02 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 6/9/2014 | | 0.01 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 6/25/2014 | | 0.02 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 7/9/2014 | | 0.01 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 7/15/2014 | | 0.02 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 7/15/2014 | | 0.02 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 7/29/2014 | | 0.01 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 8/26/2014 | | 0.01 | mg/L |

# Appendix A
# Water Quality Dataset

| Station ID | Parameter | Sample Fraction Type | Lab Name Code | Sample Date | Detect Flag | Result | Result Unit |
|---|---|---|---|---|---|---|---|
| S014-956 | Phosphorus as P | Total | MN00006 | 9/2/2014 | | 0.02 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 9/2/2014 | | 0.02 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 9/24/2014 | | 0.01 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 6/17/2014 | | 0.01 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 10/8/2014 | | 0.00 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 10/28/2014 | | 0.00 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 4/15/2014 | | 0.03 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 5/22/2014 | | 0.02 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 6/17/2014 | | 0.01 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 5/13/2014 | | 0.02 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 8/13/2014 | | 0.01 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 7/29/2015 | | 0.02 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 8/25/2015 | | 0.02 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 5/17/2016 | | 0.01 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 5/17/2016 | | 0.01 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 6/17/2015 | | 0.01 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 7/1/2015 | | 0.01 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 9/9/2014 | | 0.02 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 3/16/2015 | | 0.07 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 4/14/2015 | | 0.04 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 4/20/2015 | | 0.05 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 4/22/2015 | | 0.02 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 5/6/2015 | | 0.01 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 5/11/2015 | | 0.03 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 5/11/2015 | | 0.03 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 5/12/2015 | | 0.02 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 5/12/2015 | | 0.02 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 5/19/2015 | | 0.01 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 5/14/2015 | | 0.01 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 5/27/2015 | | 0.01 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 6/10/2015 | | 0.01 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 6/10/2015 | | 0.01 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 6/9/2015 | | 0.02 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 6/23/2015 | | 0.03 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 6/25/2015 | | 0.02 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 8/11/2015 | | 0.01 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 7/29/2015 | | 0.02 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 7/13/2015 | | 0.01 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 7/13/2015 | | 0.01 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 8/19/2015 | | 0.03 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 8/20/2015 | | 0.02 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 9/3/2015 | | 0.02 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 9/8/2015 | | 0.02 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 9/8/2015 | | 0.02 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 9/24/2015 | | 0.03 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 9/15/2015 | | 0.01 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 9/30/2015 | | 0.01 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 10/5/2015 | | 0.01 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 10/27/2015 | | 0.01 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 4/19/2016 | | 0.04 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 4/18/2016 | | 0.05 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 4/27/2016 | | 0.02 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 4/25/2016 | | 0.06 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 6/23/2016 | | 0.02 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 6/7/2016 | | 0.02 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 6/16/2016 | | 0.06 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 6/29/2016 | | 0.02 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 7/12/2016 | | 0.06 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 7/14/2016 | | 0.02 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 6/28/2018 | | 0.05 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 5/6/2016 | | 0.04 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 5/22/2017 | | 0.03 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 5/22/2017 | | 0.03 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 7/28/2017 | | 0.02 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 3/17/2016 | | 0.04 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 3/15/2016 | | 0.04 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 3/19/2016 | | 0.03 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 3/29/2016 | | 0.02 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 3/23/2016 | | 0.02 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 3/14/2016 | | 0.04 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 4/7/2016 | | 0.01 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 8/3/2016 | | 0.02 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 9/8/2016 | | 0.05 | mg/L |

# Appendix A
# Water Quality Dataset

| Station ID | Parameter | Sample Fraction Type | Lab Name Code | Sample Date | Detect Flag | Result | Result Unit |
|---|---|---|---|---|---|---|---|
| S014-956 | Phosphorus as P | Total | MN00006 | 10/5/2016 | | 0.04 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 10/5/2016 | | 0.04 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 10/26/2016 | | 0.01 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 4/2/2017 | | 0.03 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 4/4/2017 | | 0.04 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 4/6/2017 | | 0.04 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 5/4/2017 | | 0.02 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 4/12/2017 | | 0.02 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 4/19/2017 | | 0.04 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 4/21/2017 | | 0.04 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 5/2/2017 | | 0.03 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 5/18/2017 | | 0.05 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 6/13/2017 | | 0.03 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 6/29/2017 | | 0.06 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 8/16/2017 | | 0.02 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 9/18/2017 | | 0.03 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 8/10/2017 | | 0.05 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 9/13/2017 | | 0.02 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 9/27/2017 | | 0.05 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 10/18/2017 | | 0.04 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 10/4/2017 | | 0.04 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 10/3/2017 | | 0.11 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 10/31/2017 | | 0.03 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 10/31/2017 | | 0.03 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 5/2/2018 | | 0.04 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 4/20/2018 | | 0.05 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 4/22/2018 | | 0.04 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 5/23/2018 | | 0.02 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 5/23/2018 | | 0.02 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 6/12/2018 | | 0.02 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 5/31/2018 | | 0.05 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 6/18/2018 | | 0.06 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 6/17/2018 | | 0.10 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 4/24/2018 | | 0.06 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 4/23/2018 | | 0.07 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 4/25/2018 | | 0.05 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 4/26/2018 | | 0.05 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 5/8/2018 | | 0.03 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 6/19/2018 | | 0.03 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 6/4/2018 | | 0.03 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 7/2/2018 | | 0.05 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 7/3/2018 | | 0.04 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 8/7/2018 | | 0.02 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 9/12/2018 | | 0.02 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 8/23/2018 | | 0.02 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 6/7/2018 | | 0.02 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 10/11/2018 | | 0.02 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 10/3/2018 | | 0.02 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 10/8/2018 | | 0.03 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 10/10/2018 | | 0.12 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 11/6/2018 | | 0.03 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 10/16/2018 | | 0.03 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 10/31/2018 | | 0.02 | mg/L |
| S014-956 | Phosphorus as P | Total | MN00006 | 10/31/2018 | | 0.02 | mg/L |
| S014-956 | Precipitation 24hr prior to monitoring event (choice list) | Total | | 4/5/2017 | | NO | |
| S014-956 | Precipitation 24hr prior to monitoring event (choice list) | Total | | 4/13/2017 | | NO | |
| S014-956 | Precipitation 24hr prior to monitoring event (choice list) | Total | | 4/20/2017 | | NO | |
| S014-956 | Precipitation 24hr prior to monitoring event (choice list) | Total | | 4/27/2017 | | NO | |
| S014-956 | Precipitation 24hr prior to monitoring event (choice list) | Total | | 5/3/2017 | | NO | |
| S014-956 | Precipitation 24hr prior to monitoring event (choice list) | Total | | 5/10/2017 | | NO | |
| S014-956 | Precipitation 24hr prior to monitoring event (choice list) | Total | | 5/18/2017 | | NO | |
| S014-956 | Precipitation 24hr prior to monitoring event (choice list) | Total | | 5/27/2017 | | NO | |
| S014-956 | Precipitation 24hr prior to monitoring event (choice list) | Total | | 5/31/2017 | | NO | |
| S014-956 | Precipitation 24hr prior to monitoring event (choice list) | Total | | 6/7/2017 | | NO | |
| S014-956 | Precipitation 24hr prior to monitoring event (choice list) | Total | | 6/16/2017 | | NO | |
| S014-956 | Precipitation 24hr prior to monitoring event (choice list) | Total | | 6/24/2017 | | NO | |
| S014-956 | Precipitation 24hr prior to monitoring event (choice list) | Total | | 7/1/2017 | | NO | |
| S014-956 | Precipitation 24hr prior to monitoring event (choice list) | Total | | 7/6/2017 | | NO | |
| S014-956 | Precipitation 24hr prior to monitoring event (choice list) | Total | | 7/16/2017 | | NO | |
| S014-956 | Precipitation 24hr prior to monitoring event (choice list) | Total | | 7/22/2017 | | NO | |
| S014-956 | Precipitation 24hr prior to monitoring event (choice list) | Total | | 7/29/2017 | | NO | |
| S014-956 | Precipitation 24hr prior to monitoring event (choice list) | Total | | 8/3/2017 | | NO | |
| S014-956 | Precipitation 24hr prior to monitoring event (choice list) | Total | | 8/10/2017 | | NO | |

| Station ID | Parameter | Sample Fraction Type | Lab Name Code | Sample Date | Detect Flag | Result | Result Unit |
|---|---|---|---|---|---|---|---|
| S014-956 | Precipitation 24hr prior to monitoring event (choice list) | Total | | 8/17/2017 | | NO | |
| S014-956 | Precipitation 24hr prior to monitoring event (choice list) | Total | | 8/24/2017 | | NO | |
| S014-956 | Precipitation 24hr prior to monitoring event (choice list) | Total | | 9/13/2017 | | NO | |
| S014-956 | Precipitation 24hr prior to monitoring event (choice list) | Total | | 9/27/2017 | | NO | |
| S014-956 | Precipitation 24hr prior to monitoring event (choice list) | Total | | 10/4/2017 | | YES | |
| S014-956 | Specific conductance | Total | | 5/13/2014 | | 47.00 | uS/cm |
| S014-956 | Specific conductance | Total | | 7/1/2015 | | 106.00 | uS/cm |
| S014-956 | Specific conductance | Total | | 7/13/2015 | | 208.00 | uS/cm |
| S014-956 | Specific conductance | Total | | 8/20/2015 | | 122.00 | uS/cm |
| S014-956 | Specific conductance | Total | | 10/2/2018 | | 224.00 | uS/cm |
| S014-956 | Specific conductance | Total | | 9/12/2018 | | 482.00 | uS/cm |
| S014-956 | Specific conductance | Total | | 8/23/2018 | | 541.00 | uS/cm |
| S014-956 | Specific conductance | Total | | 5/8/2018 | | 89.00 | uS/cm |
| S014-956 | Specific conductance | Total | | 5/23/2018 | | 194.00 | uS/cm |
| S014-956 | Stream condition (text) | Total | | 6/17/2015 | | NSLC | |
| S014-956 | Stream condition (text) | Total | | 6/23/2015 | | HSWC | |
| S014-956 | Stream condition (text) | Total | | 7/29/2015 | | LSLO | |
| S014-956 | Stream condition (text) | Total | | 8/19/2015 | | HSWM | |
| S014-956 | Stream condition (text) | Total | | 3/15/2016 | | HSWO | None |
| S014-956 | Stream condition (text) | Total | | 3/17/2016 | | HSWM | None |
| S014-956 | Stream condition (text) | Total | | 3/19/2016 | | HSWO | None |
| S014-956 | Stream condition (text) | Total | | 3/23/2016 | | NMOC | None |
| S014-956 | Stream condition (text) | Total | | 4/7/2016 | | NMOC | None |
| S014-956 | Stream condition (text) | Total | | 4/18/2016 | | HSWM | None |
| S014-956 | Stream condition (text) | Total | | 10/2/2018 | | LSL | None |
| S014-956 | Stream condition (text) | Total | | 7/2/2018 | | HMO | None |
| S014-956 | Stream condition (text) | Total | | 7/3/2018 | | HSL | None |
| S014-956 | Stream condition (text) | Total | | 6/4/2018 | | HMO | None |
| S014-956 | Stream condition (text) | Total | | 6/7/2018 | | NSL | None |
| S014-956 | Stream condition (text) | Total | | 8/7/2018 | | LSL | None |
| S014-956 | Stream condition (text) | Total | | 10/8/2018 | | NSL | None |
| S014-956 | Stream condition (text) | Total | | 10/10/2018 | | HMO | None |
| S014-956 | Stream condition (text) | Total | | 9/12/2018 | | LSL | None |
| S014-956 | Stream condition (text) | Total | | 10/16/2018 | | HMO | None |
| S014-956 | Stream condition (text) | Total | | 6/18/2018 | | HMO | None |
| S014-956 | Stream condition (text) | Total | | 6/19/2018 | | HMO | None |
| S014-956 | Stream condition (text) | Total | | 8/23/2018 | | LSL | None |
| S014-956 | Stream condition (text) | Total | | 6/17/2018 | | HMO | None |
| S014-956 | Stream condition (text) | Total | | 6/28/2018 | | LSL | None |
| S014-956 | Stream condition (text) | Total | | 5/31/2018 | | HMO | None |
| S014-956 | Stream condition (text) | Total | | 10/31/2018 | | NSL | None |
| S014-956 | Stream condition (text) | Total | | 7/27/2018 | | LSL | None |
| S014-956 | Stream condition (text) | Total | | 5/2/2018 | | HMO | None |
| S014-956 | Stream condition (text) | Total | | 5/8/2018 | | NMO | None |
| S014-956 | Stream condition (text) | Total | | 4/20/2018 | | HMOM | None |
| S014-956 | Stream condition (text) | Total | | 4/22/2018 | | NMOC | None |
| S014-956 | Stream condition (text) | Total | | 4/24/2018 | | HMO | None |
| S014-956 | Stream condition (text) | Total | | 4/25/2018 | | HMO | None |
| S014-956 | Stream condition (text) | Total | | 4/26/2018 | | HMO | None |
| S014-956 | Stream condition (text) | Total | | 4/23/2018 | | HMOM | None |
| S014-956 | Stream condition (text) | Total | | 4/5/2017 | | H | |
| S014-956 | Stream condition (text) | Total | | 4/13/2017 | | H | |
| S014-956 | Stream condition (text) | Total | | 4/20/2017 | | H | |
| S014-956 | Stream condition (text) | Total | | 4/27/2017 | | H | |
| S014-956 | Stream condition (text) | Total | | 5/3/2017 | | H | |
| S014-956 | Stream condition (text) | Total | | 5/10/2017 | | N | |
| S014-956 | Stream condition (text) | Total | | 5/18/2017 | | N | |
| S014-956 | Stream condition (text) | Total | | 5/27/2017 | | N | |
| S014-956 | Stream condition (text) | Total | | 5/31/2017 | | N | |
| S014-956 | Stream condition (text) | Total | | 6/7/2017 | | N | |
| S014-956 | Stream condition (text) | Total | | 6/16/2017 | | N | |
| S014-956 | Stream condition (text) | Total | | 6/24/2017 | | N | |
| S014-956 | Stream condition (text) | Total | | 7/1/2017 | | H | |
| S014-956 | Stream condition (text) | Total | | 7/6/2017 | | N | |
| S014-956 | Stream condition (text) | Total | | 7/16/2017 | | N | |
| S014-956 | Stream condition (text) | Total | | 7/22/2017 | | N | |
| S014-956 | Stream condition (text) | Total | | 7/29/2017 | | N | |
| S014-956 | Stream condition (text) | Total | | 8/3/2017 | | N | |
| S014-956 | Stream condition (text) | Total | | 8/10/2017 | | N | |
| S014-956 | Stream condition (text) | Total | | 8/17/2017 | | H | |
| S014-956 | Stream condition (text) | Total | | 8/24/2017 | | H | |
| S014-956 | Stream condition (text) | Total | | 9/13/2017 | | H | |
| S014-956 | Stream condition (text) | Total | | 9/27/2017 | | H | |

| Station ID | Parameter | Sample Fraction Type | Lab Name Code | Sample Date | Detect Flag | Result | Result Unit |
|---|---|---|---|---|---|---|---|
| S014-956 | Stream condition (text) | Total | | 10/4/2017 | | H | |
| S014-956 | Stream Physical Appearance, Minnesota (choice list) | Total | | 5/13/2014 | | 2.CLOUDY | |
| S014-956 | Stream Physical Appearance, Minnesota (choice list) | Total | | 4/22/2014 | | 2.CLOUDY | |
| S014-956 | Stream Physical Appearance, Minnesota (choice list) | Total | | 4/29/2014 | | 2.CLOUDY | |
| S014-956 | Stream Physical Appearance, Minnesota (choice list) | Total | | 5/6/2014 | | 2.CLOUDY | |
| S014-956 | Stream Physical Appearance, Minnesota (choice list) | Total | | 4/23/2014 | | 3.MUDDY | |
| S014-956 | Stream Physical Appearance, Minnesota (choice list) | Total | | 4/15/2014 | | 2.CLOUDY | |
| S014-956 | Stream Physical Appearance, Minnesota (choice list) | Total | | 5/22/2014 | | 1B.TEA-COLOR | |
| S014-956 | Stream Physical Appearance, Minnesota (choice list) | Total | | 6/9/2014 | | 1B.TEA-COLOR | |
| S014-956 | Stream Physical Appearance, Minnesota (choice list) | Total | | 6/17/2014 | | 1B.TEA-COLOR | |
| S014-956 | Stream Physical Appearance, Minnesota (choice list) | Total | | 6/25/2014 | | 1B.TEA-COLOR | |
| S014-956 | Stream Physical Appearance, Minnesota (choice list) | Total | | 7/9/2014 | | 1B.TEA-COLOR | |
| S014-956 | Stream Physical Appearance, Minnesota (choice list) | Total | | 7/29/2014 | | 2.CLOUDY | |
| S014-956 | Stream Physical Appearance, Minnesota (choice list) | Total | | 8/13/2014 | | 2.CLOUDY | |
| S014-956 | Stream Physical Appearance, Minnesota (choice list) | Total | | 8/26/2014 | | 1B.TEA-COLOR | |
| S014-956 | Stream Physical Appearance, Minnesota (choice list) | Total | | 9/2/2014 | | 2.CLOUDY | |
| S014-956 | Stream Physical Appearance, Minnesota (choice list) | Total | | 9/9/2014 | | 2.CLOUDY | |
| S014-956 | Stream Physical Appearance, Minnesota (choice list) | Total | | 9/24/2014 | | 2.CLOUDY | |
| S014-956 | Stream Physical Appearance, Minnesota (choice list) | Total | | 3/16/2015 | | 2.CLOUDY | |
| S014-956 | Stream Physical Appearance, Minnesota (choice list) | Total | | 4/14/2015 | | 2.CLOUDY | |
| S014-956 | Stream Physical Appearance, Minnesota (choice list) | Total | | 4/20/2015 | | 2.CLOUDY | |
| S014-956 | Stream Physical Appearance, Minnesota (choice list) | Total | | 4/22/2015 | | 1B.TEA-COLOR | |
| S014-956 | Stream Physical Appearance, Minnesota (choice list) | Total | | 5/12/2015 | | 2.CLOUDY | |
| S014-956 | Stream Physical Appearance, Minnesota (choice list) | Total | | 5/6/2015 | | 1B.TEA-COLOR | |
| S014-956 | Stream Physical Appearance, Minnesota (choice list) | Total | | 5/11/2015 | | 2.CLOUDY | |
| S014-956 | Stream Physical Appearance, Minnesota (choice list) | Total | | 5/14/2015 | | 1B.TEA-COLOR | |
| S014-956 | Stream Physical Appearance, Minnesota (choice list) | Total | | 5/27/2015 | | 1B.TEA-COLOR | |
| S014-956 | Stream Physical Appearance, Minnesota (choice list) | Total | | 6/9/2015 | | 1B.TEA-COLOR | |
| S014-956 | Stream Physical Appearance, Minnesota (choice list) | Total | | 6/10/2015 | | 1B.TEA-COLOR | |
| S014-956 | Stream Physical Appearance, Minnesota (choice list) | Total | | 6/25/2015 | | 2.CLOUDY | |
| S014-956 | Stream Physical Appearance, Minnesota (choice list) | Total | | 6/17/2015 | | 1B.TEA-COLOR | |
| S014-956 | Stream Physical Appearance, Minnesota (choice list) | Total | | 6/23/2015 | | 2.CLOUDY | |
| S014-956 | Stream Physical Appearance, Minnesota (choice list) | Total | | 7/1/2015 | | 1B.TEA-COLOR | |
| S014-956 | Stream Physical Appearance, Minnesota (choice list) | Total | | 7/29/2015 | | 2.CLOUDY | |
| S014-956 | Stream Physical Appearance, Minnesota (choice list) | Total | | 8/11/2015 | | 1B.TEA-COLOR | |
| S014-956 | Stream Physical Appearance, Minnesota (choice list) | Total | | 7/13/2015 | | 1B.TEA-COLOR | |
| S014-956 | Stream Physical Appearance, Minnesota (choice list) | Total | | 8/19/2015 | | 3.MUDDY | |
| S014-956 | Stream Physical Appearance, Minnesota (choice list) | Total | | 8/20/2015 | | 3.MUDDY | |
| S014-956 | Stream Physical Appearance, Minnesota (choice list) | Total | | 9/3/2015 | | 2.CLOUDY | |
| S014-956 | Stream Physical Appearance, Minnesota (choice list) | Total | | 9/8/2015 | | 1B.TEA-COLOR | |
| S014-956 | Stream Physical Appearance, Minnesota (choice list) | Total | | 9/15/2015 | | 1B.TEA-COLOR | |
| S014-956 | Stream Physical Appearance, Minnesota (choice list) | Total | | 9/24/2015 | | 2.CLOUDY | |
| S014-956 | Stream Physical Appearance, Minnesota (choice list) | Total | | 10/5/2015 | | 1B.TEA-COLOR | |
| S014-956 | Stream Physical Appearance, Minnesota (choice list) | Total | | 3/15/2016 | | 2.CLOUDY | |
| S014-956 | Stream Physical Appearance, Minnesota (choice list) | Total | | 3/17/2016 | | 3.MUDDY | |
| S014-956 | Stream Physical Appearance, Minnesota (choice list) | Total | | 3/19/2016 | | 1B.TEA-COLOR | |
| S014-956 | Stream Physical Appearance, Minnesota (choice list) | Total | | 3/23/2016 | | 1B.TEA-COLOR | |
| S014-956 | Stream Physical Appearance, Minnesota (choice list) | Total | | 4/7/2016 | | 1B.TEA-COLOR | |
| S014-956 | Stream Physical Appearance, Minnesota (choice list) | Total | | 4/18/2016 | | 3.MUDDY | |
| S014-956 | Stream Physical Appearance, Minnesota (choice list) | Total | | 6/3/2014 | | 3.MUDDY | |
| S014-956 | Stream Physical Appearance, Minnesota (choice list) | Total | | 5/28/2014 | | 1B.TEA-COLOR | |
| S014-956 | Stream Physical Appearance, Minnesota (choice list) | Total | | 7/2/2018 | | 3.MUDDY | None |
| S014-956 | Stream Physical Appearance, Minnesota (choice list) | Total | | 10/2/2018 | | 1A.CLEAR | None |
| S014-956 | Stream Physical Appearance, Minnesota (choice list) | Total | | 7/3/2018 | | 2.CLOUDY | None |
| S014-956 | Stream Physical Appearance, Minnesota (choice list) | Total | | 6/4/2018 | | 3.MUDDY | None |
| S014-956 | Stream Physical Appearance, Minnesota (choice list) | Total | | 6/7/2018 | | 2.CLOUDY | None |
| S014-956 | Stream Physical Appearance, Minnesota (choice list) | Total | | 8/7/2018 | | 2.CLOUDY | None |
| S014-956 | Stream Physical Appearance, Minnesota (choice list) | Total | | 10/8/2018 | | 2.CLOUDY | None |
| S014-956 | Stream Physical Appearance, Minnesota (choice list) | Total | | 10/10/2018 | | 3.MUDDY | None |
| S014-956 | Stream Physical Appearance, Minnesota (choice list) | Total | | 9/12/2018 | | 2.CLOUDY | None |
| S014-956 | Stream Physical Appearance, Minnesota (choice list) | Total | | 10/16/2018 | | 2.CLOUDY | None |
| S014-956 | Stream Physical Appearance, Minnesota (choice list) | Total | | 6/18/2018 | | 3.MUDDY | None |
| S014-956 | Stream Physical Appearance, Minnesota (choice list) | Total | | 6/19/2018 | | 2.CLOUDY | None |
| S014-956 | Stream Physical Appearance, Minnesota (choice list) | Total | | 8/23/2018 | | 2.CLOUDY | None |
| S014-956 | Stream Physical Appearance, Minnesota (choice list) | Total | | 6/17/2018 | | 3.MUDDY | None |
| S014-956 | Stream Physical Appearance, Minnesota (choice list) | Total | | 6/28/2018 | | 2.CLOUDY | None |
| S014-956 | Stream Physical Appearance, Minnesota (choice list) | Total | | 5/31/2018 | | 1A.CLEAR | None |
| S014-956 | Stream Physical Appearance, Minnesota (choice list) | Total | | 10/31/2018 | | 2.CLOUDY | None |
| S014-956 | Stream Physical Appearance, Minnesota (choice list) | Total | | 7/27/2018 | | 1B.TEA-COLOR | None |
| S014-956 | Stream Physical Appearance, Minnesota (choice list) | Total | | 5/2/2018 | | 2.CLOUDY | None |
| S014-956 | Stream Physical Appearance, Minnesota (choice list) | Total | | 5/8/2018 | | 2.CLOUDY | None |
| S014-956 | Stream Physical Appearance, Minnesota (choice list) | Total | | 4/20/2018 | | 1A.CLEAR | None |
| S014-956 | Stream Physical Appearance, Minnesota (choice list) | Total | | 4/22/2018 | | 2.CLOUDY | None |

| Station ID | Parameter | Sample Fraction Type | Lab Name Code | Sample Date | Detect Flag | Result | Result Unit |
|---|---|---|---|---|---|---|---|
| S014-956 | Stream Physical Appearance, Minnesota (choice list) | Total | | 5/23/2018 | | 2.CLOUDY | None |
| S014-956 | Stream Physical Appearance, Minnesota (choice list) | Total | | 4/24/2018 | | 2.CLOUDY | None |
| S014-956 | Stream Physical Appearance, Minnesota (choice list) | Total | | 4/25/2018 | | 3.MUDDY | None |
| S014-956 | Stream Physical Appearance, Minnesota (choice list) | Total | | 4/26/2018 | | 2.CLOUDY | None |
| S014-956 | Stream Physical Appearance, Minnesota (choice list) | Total | | 4/23/2018 | | 3.MUDDY | None |
| S014-956 | Stream Physical Appearance, Minnesota (choice list) | Total | | 4/5/2017 | | 3.MUDDY | |
| S014-956 | Stream Physical Appearance, Minnesota (choice list) | Total | | 4/13/2017 | | 2.CLOUDY | |
| S014-956 | Stream Physical Appearance, Minnesota (choice list) | Total | | 4/20/2017 | | 3.MUDDY | |
| S014-956 | Stream Physical Appearance, Minnesota (choice list) | Total | | 4/27/2017 | | 3.MUDDY | |
| S014-956 | Stream Physical Appearance, Minnesota (choice list) | Total | | 5/3/2017 | | 2.CLOUDY | |
| S014-956 | Stream Physical Appearance, Minnesota (choice list) | Total | | 5/10/2017 | | 2.CLOUDY | |
| S014-956 | Stream Physical Appearance, Minnesota (choice list) | Total | | 5/18/2017 | | 3.MUDDY | |
| S014-956 | Stream Physical Appearance, Minnesota (choice list) | Total | | 5/27/2017 | | 2.CLOUDY | |
| S014-956 | Stream Physical Appearance, Minnesota (choice list) | Total | | 5/31/2017 | | 1B.TEA-COLOR | |
| S014-956 | Stream Physical Appearance, Minnesota (choice list) | Total | | 6/7/2017 | | 1B.TEA-COLOR | |
| S014-956 | Stream Physical Appearance, Minnesota (choice list) | Total | | 6/16/2017 | | 1B.TEA-COLOR | |
| S014-956 | Stream Physical Appearance, Minnesota (choice list) | Total | | 6/24/2017 | | 1B.TEA-COLOR | |
| S014-956 | Stream Physical Appearance, Minnesota (choice list) | Total | | 7/1/2017 | | 2.CLOUDY | |
| S014-956 | Stream Physical Appearance, Minnesota (choice list) | Total | | 7/6/2017 | | 1B.TEA-COLOR | |
| S014-956 | Stream Physical Appearance, Minnesota (choice list) | Total | | 7/16/2017 | | 1B.TEA-COLOR | |
| S014-956 | Stream Physical Appearance, Minnesota (choice list) | Total | | 7/22/2017 | | 1B.TEA-COLOR | |
| S014-956 | Stream Physical Appearance, Minnesota (choice list) | Total | | 7/29/2017 | | 1B.TEA-COLOR | |
| S014-956 | Stream Physical Appearance, Minnesota (choice list) | Total | | 8/3/2017 | | 1B.TEA-COLOR | |
| S014-956 | Stream Physical Appearance, Minnesota (choice list) | Total | | 8/10/2017 | | 2.CLOUDY | |
| S014-956 | Stream Physical Appearance, Minnesota (choice list) | Total | | 8/17/2017 | | 2.CLOUDY | |
| S014-956 | Stream Physical Appearance, Minnesota (choice list) | Total | | 8/24/2017 | | 3.MUDDY | |
| S014-956 | Stream Physical Appearance, Minnesota (choice list) | Total | | 9/13/2017 | | 3.MUDDY | |
| S014-956 | Stream Physical Appearance, Minnesota (choice list) | Total | | 9/27/2017 | | 3.MUDDY | |
| S014-956 | Stream Physical Appearance, Minnesota (choice list) | Total | | 10/4/2017 | | 3.MUDDY | |
| S014-956 | Stream Physical Appearance, Minnesota (choice list) | Total | | 10/8/2014 | | 2.CLOUDY | |
| S014-956 | Stream Physical Appearance, Minnesota (choice list) | Total | | 10/28/2014 | | 1B.TEA-COLOR | |
| S014-956 | Stream recreational suitability (choice list) | Total | | 5/13/2014 | | 4.POOR | |
| S014-956 | Stream recreational suitability (choice list) | Total | | 4/22/2014 | | 4.POOR | |
| S014-956 | Stream recreational suitability (choice list) | Total | | 4/29/2014 | | 4.POOR | |
| S014-956 | Stream recreational suitability (choice list) | Total | | 5/6/2014 | | 4.POOR | |
| S014-956 | Stream recreational suitability (choice list) | Total | | 4/23/2014 | | 4.POOR | |
| S014-956 | Stream recreational suitability (choice list) | Total | | 4/15/2014 | | 4.POOR | |
| S014-956 | Stream recreational suitability (choice list) | Total | | 5/22/2014 | | 2.GOOD | |
| S014-956 | Stream recreational suitability (choice list) | Total | | 5/28/2014 | | 2.GOOD | |
| S014-956 | Stream recreational suitability (choice list) | Total | | 6/9/2014 | | 2.GOOD | |
| S014-956 | Stream recreational suitability (choice list) | Total | | 6/17/2014 | | 2.GOOD | |
| S014-956 | Stream recreational suitability (choice list) | Total | | 6/25/2014 | | 2.GOOD | |
| S014-956 | Stream recreational suitability (choice list) | Total | | 7/9/2014 | | 2.GOOD | |
| S014-956 | Stream recreational suitability (choice list) | Total | | 7/29/2014 | | 1.VERY GOOD | |
| S014-956 | Stream recreational suitability (choice list) | Total | | 8/13/2014 | | 2.GOOD | |
| S014-956 | Stream recreational suitability (choice list) | Total | | 8/26/2014 | | 1.VERY GOOD | |
| S014-956 | Stream recreational suitability (choice list) | Total | | 9/2/2014 | | 2.GOOD | |
| S014-956 | Stream recreational suitability (choice list) | Total | | 9/9/2014 | | 2.GOOD | |
| S014-956 | Stream recreational suitability (choice list) | Total | | 9/24/2014 | | 1.VERY GOOD | |
| S014-956 | Stream recreational suitability (choice list) | Total | | 3/16/2015 | | 4.POOR | |
| S014-956 | Stream recreational suitability (choice list) | Total | | 4/14/2015 | | 4.POOR | |
| S014-956 | Stream recreational suitability (choice list) | Total | | 4/20/2015 | | 4.POOR | |
| S014-956 | Stream recreational suitability (choice list) | Total | | 4/22/2015 | | 3.FAIR | |
| S014-956 | Stream recreational suitability (choice list) | Total | | 5/12/2015 | | 2.GOOD | |
| S014-956 | Stream recreational suitability (choice list) | Total | | 5/6/2015 | | 1.VERY GOOD | |
| S014-956 | Stream recreational suitability (choice list) | Total | | 5/11/2015 | | 2.GOOD | |
| S014-956 | Stream recreational suitability (choice list) | Total | | 5/14/2015 | | 1.VERY GOOD | |
| S014-956 | Stream recreational suitability (choice list) | Total | | 5/27/2015 | | 1.VERY GOOD | |
| S014-956 | Stream recreational suitability (choice list) | Total | | 6/9/2015 | | 1.VERY GOOD | |
| S014-956 | Stream recreational suitability (choice list) | Total | | 6/10/2015 | | 1.VERY GOOD | |
| S014-956 | Stream recreational suitability (choice list) | Total | | 6/25/2015 | | 1.VERY GOOD | |
| S014-956 | Stream recreational suitability (choice list) | Total | | 6/17/2015 | | 1.VERY GOOD | |
| S014-956 | Stream recreational suitability (choice list) | Total | | 6/23/2015 | | 2.GOOD | |
| S014-956 | Stream recreational suitability (choice list) | Total | | 7/1/2015 | | 1.VERY GOOD | |
| S014-956 | Stream recreational suitability (choice list) | Total | | 7/29/2015 | | 1.VERY GOOD | |
| S014-956 | Stream recreational suitability (choice list) | Total | | 8/11/2015 | | 1.VERY GOOD | |
| S014-956 | Stream recreational suitability (choice list) | Total | | 7/13/2015 | | 1.VERY GOOD | |
| S014-956 | Stream recreational suitability (choice list) | Total | | 9/3/2015 | | 2.GOOD | |
| S014-956 | Stream recreational suitability (choice list) | Total | | 9/8/2015 | | 2.GOOD | |
| S014-956 | Stream recreational suitability (choice list) | Total | | 9/15/2015 | | 1.VERY GOOD | |
| S014-956 | Stream recreational suitability (choice list) | Total | | 9/24/2015 | | 2.GOOD | |
| S014-956 | Stream recreational suitability (choice list) | Total | | 10/5/2015 | | 2.GOOD | |
| S014-956 | Stream recreational suitability (choice list) | Total | | 3/15/2016 | | 5.VERY POOR | |

# Appendix A
# Water Quality Dataset

| Station ID | Parameter | Sample Fraction Type | Lab Name Code | Sample Date | Detect Flag | Result | Result Unit |
|---|---|---|---|---|---|---|---|
| S014-956 | Stream recreational suitability (choice list) | Total | | 3/17/2016 | | 5.VERY POOR | |
| S014-956 | Stream recreational suitability (choice list) | Total | | 3/19/2016 | | 2.GOOD | |
| S014-956 | Stream recreational suitability (choice list) | Total | | 3/23/2016 | | 1.VERY GOOD | |
| S014-956 | Stream recreational suitability (choice list) | Total | | 4/7/2016 | | 1.VERY GOOD | |
| S014-956 | Stream recreational suitability (choice list) | Total | | 4/18/2016 | | 3.FAIR | |
| S014-956 | Stream recreational suitability (choice list) | Total | | 6/3/2014 | | 3.FAIR | |
| S014-956 | Stream recreational suitability (choice list) | Total | | 7/2/2018 | | 2.GOOD | None |
| S014-956 | Stream recreational suitability (choice list) | Total | | 10/2/2018 | | 1.VERY GOOD | None |
| S014-956 | Stream recreational suitability (choice list) | Total | | 7/3/2018 | | 1.VERY GOOD | None |
| S014-956 | Stream recreational suitability (choice list) | Total | | 6/4/2018 | | 1.VERY GOOD | None |
| S014-956 | Stream recreational suitability (choice list) | Total | | 6/7/2018 | | 1.VERY GOOD | None |
| S014-956 | Stream recreational suitability (choice list) | Total | | 8/7/2018 | | 1.VERY GOOD | None |
| S014-956 | Stream recreational suitability (choice list) | Total | | 10/8/2018 | | 2.GOOD | None |
| S014-956 | Stream recreational suitability (choice list) | Total | | 10/10/2018 | | 4.POOR | None |
| S014-956 | Stream recreational suitability (choice list) | Total | | 9/12/2018 | | 1.VERY GOOD | None |
| S014-956 | Stream recreational suitability (choice list) | Total | | 10/16/2018 | | 3.FAIR | None |
| S014-956 | Stream recreational suitability (choice list) | Total | | 6/18/2018 | | 3.FAIR | None |
| S014-956 | Stream recreational suitability (choice list) | Total | | 6/19/2018 | | 1.VERY GOOD | None |
| S014-956 | Stream recreational suitability (choice list) | Total | | 8/23/2018 | | 1.VERY GOOD | None |
| S014-956 | Stream recreational suitability (choice list) | Total | | 6/17/2018 | | 2.GOOD | None |
| S014-956 | Stream recreational suitability (choice list) | Total | | 6/28/2018 | | 1.VERY GOOD | None |
| S014-956 | Stream recreational suitability (choice list) | Total | | 5/31/2018 | | 1.VERY GOOD | None |
| S014-956 | Stream recreational suitability (choice list) | Total | | 10/31/2018 | | 3.FAIR | None |
| S014-956 | Stream recreational suitability (choice list) | Total | | 7/27/2018 | | 1.VERY GOOD | None |
| S014-956 | Stream recreational suitability (choice list) | Total | | 5/2/2018 | | 4.POOR | None |
| S014-956 | Stream recreational suitability (choice list) | Total | | 5/8/2018 | | 3.FAIR | None |
| S014-956 | Stream recreational suitability (choice list) | Total | | 4/20/2018 | | 3.FAIR | None |
| S014-956 | Stream recreational suitability (choice list) | Total | | 4/22/2018 | | 1.VERY GOOD | None |
| S014-956 | Stream recreational suitability (choice list) | Total | | 5/23/2018 | | 1.VERY GOOD | None |
| S014-956 | Stream recreational suitability (choice list) | Total | | 4/24/2018 | | 3.FAIR | None |
| S014-956 | Stream recreational suitability (choice list) | Total | | 4/25/2018 | | 4.POOR | None |
| S014-956 | Stream recreational suitability (choice list) | Total | | 4/26/2018 | | 4.POOR | None |
| S014-956 | Stream recreational suitability (choice list) | Total | | 4/23/2018 | | 3.FAIR | None |
| S014-956 | Stream recreational suitability (choice list) | Total | | 4/5/2017 | | 2.GOOD | |
| S014-956 | Stream recreational suitability (choice list) | Total | | 4/13/2017 | | 2.GOOD | |
| S014-956 | Stream recreational suitability (choice list) | Total | | 4/20/2017 | | 3.FAIR | |
| S014-956 | Stream recreational suitability (choice list) | Total | | 4/27/2017 | | 3.FAIR | |
| S014-956 | Stream recreational suitability (choice list) | Total | | 5/3/2017 | | 2.GOOD | |
| S014-956 | Stream recreational suitability (choice list) | Total | | 5/10/2017 | | 2.GOOD | |
| S014-956 | Stream recreational suitability (choice list) | Total | | 5/18/2017 | | 3.FAIR | |
| S014-956 | Stream recreational suitability (choice list) | Total | | 5/27/2017 | | 2.GOOD | |
| S014-956 | Stream recreational suitability (choice list) | Total | | 5/31/2017 | | 2.GOOD | |
| S014-956 | Stream recreational suitability (choice list) | Total | | 6/7/2017 | | 2.GOOD | |
| S014-956 | Stream recreational suitability (choice list) | Total | | 6/16/2017 | | 2.GOOD | |
| S014-956 | Stream recreational suitability (choice list) | Total | | 6/24/2017 | | 2.GOOD | |
| S014-956 | Stream recreational suitability (choice list) | Total | | 7/1/2017 | | 2.GOOD | |
| S014-956 | Stream recreational suitability (choice list) | Total | | 7/6/2017 | | 2.GOOD | |
| S014-956 | Stream recreational suitability (choice list) | Total | | 7/16/2017 | | 2.GOOD | |
| S014-956 | Stream recreational suitability (choice list) | Total | | 7/22/2017 | | 2.GOOD | |
| S014-956 | Stream recreational suitability (choice list) | Total | | 7/29/2017 | | 2.GOOD | |
| S014-956 | Stream recreational suitability (choice list) | Total | | 8/3/2017 | | 2.GOOD | |
| S014-956 | Stream recreational suitability (choice list) | Total | | 8/10/2017 | | 3.FAIR | |
| S014-956 | Stream recreational suitability (choice list) | Total | | 8/17/2017 | | 3.FAIR | |
| S014-956 | Stream recreational suitability (choice list) | Total | | 8/24/2017 | | 3.FAIR | |
| S014-956 | Stream recreational suitability (choice list) | Total | | 9/13/2017 | | 3.FAIR | |
| S014-956 | Stream recreational suitability (choice list) | Total | | 9/27/2017 | | 3.FAIR | |
| S014-956 | Stream recreational suitability (choice list) | Total | | 10/4/2017 | | 4.POOR | |
| S014-956 | Stream recreational suitability (choice list) | Total | | 10/8/2014 | | 1.VERY GOOD | |
| S014-956 | Stream recreational suitability (choice list) | Total | | 10/28/2014 | | 2.GOOD | |
| S014-956 | Stream stage | Total | | 7/9/2014 | | 9.25 | ft |
| S014-956 | Stream stage | Total | | 7/15/2014 | | 10.54 | ft |
| S014-956 | Stream stage | Total | | 7/29/2015 | | 10.45 | ft |
| S014-956 | Stream stage | Total | | 8/20/2015 | | 11.02 | ft |
| S014-956 | Stream stage | Total | | 8/19/2015 | | 10.95 | ft |
| S014-956 | Stream stage | Total | | 4/7/2016 | | 11.42 | ft |
| S014-956 | Stream stage | Total | | 4/19/2016 | | 14.35 | ft |
| S014-956 | Stream stage | Total | | 4/18/2016 | | 14.80 | ft |
| S014-956 | Stream stage | Total | | 4/29/2014 | | 7.21 | ft |
| S014-956 | Stream stage | Total | | 5/6/2014 | | 6.31 | ft |
| S014-956 | Stream stage | Total | | 5/22/2014 | | 7.27 | ft |
| S014-956 | Stream stage | Total | | 6/9/2014 | | 8.61 | ft |
| S014-956 | Stream stage | Total | | 6/17/2014 | | 8.31 | ft |
| S014-956 | Stream stage | Total | | 9/2/2014 | | 9.08 | ft |

# Appendix A
# Water Quality Dataset

| Station ID | Parameter | Sample Fraction Type | Lab Name Code | Sample Date | Detect Flag | Result | Result Unit |
|---|---|---|---|---|---|---|---|
| S014-956 | Stream stage | Total | | 9/9/2014 | | 9.42 | ft |
| S014-956 | Stream stage | Total | | 9/24/2014 | | -9.27 | ft |
| S014-956 | Temperature, water | Total | | 5/13/2014 | | 5.86 | deg C |
| S014-956 | Temperature, water | Total | | 7/1/2015 | | 15.63 | deg C |
| S014-956 | Temperature, water | Total | | 7/13/2015 | | 20.44 | deg C |
| S014-956 | Temperature, water | Total | | 8/20/2015 | | 15.45 | deg C |
| S014-956 | Temperature, water | Total | | 10/2/2018 | | 8.11 | deg C |
| S014-956 | Temperature, water | Total | | 9/12/2018 | | 18.50 | deg C |
| S014-956 | Temperature, water | Total | | 8/23/2018 | | 20.31 | deg C |
| S014-956 | Temperature, water | Total | | 5/8/2018 | | 11.30 | deg C |
| S014-956 | Temperature, water | Total | | 5/23/2018 | | 16.04 | deg C |
| S014-956 | Temperature, water | Total | | 4/13/2017 | | 8.33 | deg C |
| S014-956 | Temperature, water | Total | | 4/20/2017 | | 3.89 | deg C |
| S014-956 | Temperature, water | Total | | 4/27/2017 | | 2.78 | deg C |
| S014-956 | Temperature, water | Total | | 5/3/2017 | | 10.00 | deg C |
| S014-956 | Temperature, water | Total | | 5/10/2017 | | 13.89 | deg C |
| S014-956 | Temperature, water | Total | | 5/27/2017 | | 6.67 | deg C |
| S014-956 | Temperature, water | Total | | 5/31/2017 | | 15.00 | deg C |
| S014-956 | Temperature, water | Total | | 6/7/2017 | | 15.56 | deg C |
| S014-956 | Temperature, water | Total | | 6/16/2017 | | 16.67 | deg C |
| S014-956 | Temperature, water | Total | | 6/24/2017 | | 16.67 | deg C |
| S014-956 | Temperature, water | Total | | 7/1/2017 | | 15.00 | deg C |
| S014-956 | Temperature, water | Total | | 7/6/2017 | | 17.22 | deg C |
| S014-956 | Temperature, water | Total | | 7/16/2017 | | 17.22 | deg C |
| S014-956 | Temperature, water | Total | | 8/10/2017 | | 16.67 | deg C |
| S014-956 | Total suspended solids | Total | MN00006 | 5/13/2014 | | 30.00 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 4/22/2014 | | 38.00 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 4/23/2014 | | 34.00 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 4/29/2014 | | 12.00 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 5/6/2014 | | 10.00 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 4/11/2014 | | 21.00 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 4/15/2014 | | 10.00 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 5/22/2014 | | 6.40 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 5/28/2014 | | 3.60 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 6/3/2014 | | 11.00 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 6/9/2014 | | 3.60 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 6/17/2014 | | 5.20 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 6/25/2014 | | 4.00 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 7/9/2014 | | 2.80 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 7/15/2014 | | 3.20 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 7/15/2014 | | 3.20 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 7/29/2014 | | 10.00 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 8/13/2014 | | 4.80 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 9/2/2014 | | 4.80 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 9/2/2014 | | 4.80 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 9/9/2014 | | 5.60 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 9/24/2014 | | 2.80 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 6/17/2014 | | 5.20 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 10/8/2014 | | 2.00 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 10/28/2014 | | 1.60 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 3/16/2015 | | 8.40 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 4/14/2015 | | 9.20 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 4/20/2015 | | 47.00 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 4/22/2015 | | 5.20 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 5/6/2015 | | 3.20 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 5/15/2015 | | 31.00 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 5/11/2015 | | 29.00 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 5/11/2015 | | 30.00 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 5/12/2015 | | 17.00 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 5/12/2015 | | 19.00 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 5/14/2015 | | 6.40 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 5/19/2015 | | 6.00 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 5/27/2015 | | 10.00 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 6/10/2015 | | 4.80 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 6/10/2015 | | 4.40 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 6/9/2015 | | 8.40 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 6/23/2015 | | 22.00 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 6/17/2015 | | 6.80 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 6/25/2015 | | 7.60 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 8/11/2015 | | 12.00 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 7/29/2015 | | 10.00 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 7/29/2015 | | 9.20 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 7/13/2015 | | 8.00 | mg/L |

# Appendix A
# Water Quality Dataset

| Station ID | Parameter | Sample Fraction Type | Lab Name Code | Sample Date | Detect Flag | Result | Result Unit |
|---|---|---|---|---|---|---|---|
| S014-956 | Total suspended solids | Total | MN00006 | 7/13/2015 | | 6.40 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 8/19/2015 | | 18.00 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 8/20/2015 | | 7.60 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 8/25/2015 | | 4.80 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 9/3/2015 | | 12.00 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 9/8/2015 | | 12.00 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 9/8/2015 | | 12.00 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 9/15/2015 | | 3.20 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 9/24/2015 | | 20.00 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 9/30/2015 | | 3.20 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 10/5/2015 | | 2.40 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 10/27/2015 | | 1.60 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 7/1/2015 | | 6.40 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 3/15/2016 | | 8.00 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 3/17/2016 | | 18.00 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 3/19/2016 | | 6.00 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 3/23/2016 | | 2.80 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 3/14/2016 | | 9.20 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 4/7/2016 | | 1.60 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 4/19/2016 | | 14.00 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 4/18/2016 | | 26.00 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 4/27/2016 | | 5.60 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 4/25/2016 | | 45.00 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 5/17/2016 | | 2.80 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 5/17/2016 | | 2.80 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 6/7/2016 | | 4.80 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 6/16/2016 | | 21.00 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 6/29/2016 | | 4.00 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 8/3/2016 | | 4.00 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 7/12/2016 | | 22.00 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 7/14/2016 | | 5.20 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 9/8/2016 | | 16.00 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 10/5/2016 | | 1.60 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 10/5/2016 | | 1.60 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 10/26/2016 | | 1.20 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 4/2/2017 | | 10.00 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 4/4/2017 | | 17.00 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 4/6/2017 | | 10.00 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 4/12/2017 | | 3.60 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 5/4/2017 | | 4.00 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 5/22/2017 | | 10.00 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 5/22/2017 | | 9.20 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 4/19/2017 | | 11.00 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 4/21/2017 | | 13.00 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 5/2/2017 | | 6.00 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 5/18/2017 | | 12.00 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 6/20/2017 | | 3.60 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 6/13/2017 | | 2.80 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 6/29/2017 | | 25.00 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 8/10/2017 | | 13.00 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 8/16/2017 | | 4.00 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 9/18/2017 | | 4.40 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 9/13/2017 | | 3.60 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 10/3/2017 | | 68.00 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 9/27/2017 | | 16.00 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 10/4/2017 | | 12.00 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 7/28/2017 | | 5.60 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 10/31/2017 | | 1.60 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 10/31/2017 | < | 1.00 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 5/2/2018 | | 11.00 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 4/20/2018 | | 23.00 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 4/22/2018 | | 12.00 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 5/23/2018 | | 3.60 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 5/23/2018 | | 4.40 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 5/31/2018 | | 15.00 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 6/18/2018 | | 16.00 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 6/17/2018 | | 46.00 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 4/24/2018 | | 31.00 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 4/25/2018 | | 20.00 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 4/26/2018 | | 19.00 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 5/8/2018 | | 5.60 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 6/19/2018 | | 8.40 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 6/4/2018 | | 5.60 | mg/L |

# Appendix A
# Water Quality Dataset

| Station ID | Parameter | Sample Fraction Type | Lab Name Code | Sample Date | Detect Flag | Result | Result Unit |
|---|---|---|---|---|---|---|---|
| S014-956 | Total suspended solids | Total | MN00006 | 6/28/2018 | | 6.00 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 7/2/2018 | | 16.00 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 7/3/2018 | | 9.60 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 8/7/2018 | | 5.20 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 8/23/2018 | | 4.80 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 9/12/2018 | | 8.80 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 6/7/2018 | | 3.60 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 10/3/2018 | | 2.80 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 10/10/2018 | | 89.00 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 10/16/2018 | | 9.20 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 10/31/2018 | | 2.80 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 10/31/2018 | | 2.80 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 10/8/2018 | | 6.80 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 6/15/2015 | | 8.80 | mg/L |
| S014-956 | Total suspended solids | Total | MN00006 | 4/23/2018 | | 36.00 | mg/L |
| S014-956 | Transparency, tube with disk | Total | | 5/13/2014 | | 40.00 | cm |
| S014-956 | Transparency, tube with disk | Total | | 4/22/2014 | | 43.00 | cm |
| S014-956 | Transparency, tube with disk | Total | | 4/29/2014 | | 66.00 | cm |
| S014-956 | Transparency, tube with disk | Total | | 4/23/2014 | | 35.00 | cm |
| S014-956 | Transparency, tube with disk | Total | | 5/22/2014 | > | 100.00 | cm |
| S014-956 | Transparency, tube with disk | Total | | 6/9/2014 | > | 100.00 | cm |
| S014-956 | Transparency, tube with disk | Total | | 6/17/2014 | | 95.00 | cm |
| S014-956 | Transparency, tube with disk | Total | | 7/9/2014 | > | 100.00 | cm |
| S014-956 | Transparency, tube with disk | Total | | 7/15/2014 | > | 100.00 | cm |
| S014-956 | Transparency, tube with disk | Total | | 7/29/2014 | | 75.00 | cm |
| S014-956 | Transparency, tube with disk | Total | | 8/26/2014 | | 55.00 | cm |
| S014-956 | Transparency, tube with disk | Total | | 9/2/2014 | | 82.00 | cm |
| S014-956 | Transparency, tube with disk | Total | | 9/9/2014 | | 87.00 | cm |
| S014-956 | Transparency, tube with disk | Total | | 9/24/2014 | | 86.00 | cm |
| S014-956 | Transparency, tube with disk | Total | | 4/15/2014 | | 93.00 | cm |
| S014-956 | Transparency, tube with disk | Total | | 4/11/2014 | | 37.00 | cm |
| S014-956 | Transparency, tube with disk | Total | | 8/13/2014 | > | 100.00 | cm |
| S014-956 | Transparency, tube with disk | Total | | 5/14/2015 | | 87.00 | cm |
| S014-956 | Transparency, tube with disk | Total | | 5/27/2015 | | 90.00 | cm |
| S014-956 | Transparency, tube with disk | Total | | 5/6/2015 | > | 100.00 | cm |
| S014-956 | Transparency, tube with disk | Total | | 5/11/2015 | | 25.00 | cm |
| S014-956 | Transparency, tube with disk | Total | | 6/25/2014 | > | 100.00 | cm |
| S014-956 | Transparency, tube with disk | Total | | 4/20/2015 | | 19.00 | cm |
| S014-956 | Transparency, tube with disk | Total | | 5/12/2015 | | 32.00 | cm |
| S014-956 | Transparency, tube with disk | Total | | 4/22/2015 | | 95.00 | cm |
| S014-956 | Transparency, tube with disk | Total | | 5/19/2015 | | 86.00 | cm |
| S014-956 | Transparency, tube with disk | Total | | 7/1/2015 | > | 100.00 | cm |
| S014-956 | Transparency, tube with disk | Total | | 7/13/2015 | | 75.00 | cm |
| S014-956 | Transparency, tube with disk | Total | | 7/29/2015 | | 65.00 | cm |
| S014-956 | Transparency, tube with disk | Total | | 8/19/2015 | | 15.00 | cm |
| S014-956 | Transparency, tube with disk | Total | | 8/20/2015 | | 59.00 | cm |
| S014-956 | Transparency, tube with disk | Total | | 9/3/2015 | | 36.00 | cm |
| S014-956 | Transparency, tube with disk | Total | | 9/8/2015 | | 67.00 | cm |
| S014-956 | Transparency, tube with disk | Total | | 9/24/2015 | | 33.00 | cm |
| S014-956 | Transparency, tube with disk | Total | | 9/15/2015 | | 87.00 | cm |
| S014-956 | Transparency, tube with disk | Total | | 3/14/2016 | | 38.00 | cm |
| S014-956 | Transparency, tube with disk | Total | | 3/19/2016 | | 95.00 | cm |
| S014-956 | Transparency, tube with disk | Total | | 3/23/2016 | > | 100.00 | cm |
| S014-956 | Transparency, tube with disk | Total | | 4/7/2016 | > | 100.00 | cm |
| S014-956 | Transparency, tube with disk | Total | | 4/18/2016 | | 27.00 | cm |
| S014-956 | Transparency, tube with disk | Total | | 4/19/2016 | | 58.00 | cm |
| S014-956 | Transparency, tube with disk | Total | | 6/9/2015 | > | 100.00 | cm |
| S014-956 | Transparency, tube with disk | Total | | 6/25/2015 | | 90.00 | cm |
| S014-956 | Transparency, tube with disk | Total | | 6/10/2015 | | 88.00 | cm |
| S014-956 | Transparency, tube with disk | Total | | 7/28/2017 | > | 100.00 | cm |
| S014-956 | Transparency, tube with disk | Total | | 5/4/2017 | > | 100.00 | cm |
| S014-956 | Transparency, tube with disk | Total | | 4/2/2017 | | 65.00 | cm |
| S014-956 | Transparency, tube with disk | Total | | 4/4/2017 | | 21.00 | cm |
| S014-956 | Transparency, tube with disk | Total | | 4/6/2017 | | 57.00 | cm |
| S014-956 | Transparency, tube with disk | Total | | 4/12/2017 | > | 100.00 | cm |
| S014-956 | Transparency, tube with disk | Total | | 4/19/2017 | | 45.00 | cm |
| S014-956 | Transparency, tube with disk | Total | | 4/21/2017 | | 41.00 | cm |
| S014-956 | Transparency, tube with disk | Total | | 6/23/2015 | | 40.00 | cm |
| S014-956 | Transparency, tube with disk | Total | | 6/17/2015 | | 93.00 | cm |
| S014-956 | Transparency, tube with disk | Total | | 8/11/2015 | | 47.00 | cm |
| S014-956 | Transparency, tube with disk | Total | | 8/25/2015 | | 86.00 | cm |
| S014-956 | Transparency, tube with disk | Total | | 10/5/2015 | > | 100.00 | cm |
| S014-956 | Transparency, tube with disk | Total | | 10/27/2015 | | 67.00 | cm |

# Appendix A
# Water Quality Dataset

| Station ID | Parameter | Sample Fraction Type | Lab Name Code | Sample Date | Detect Flag | Result | Result Unit |
|---|---|---|---|---|---|---|---|
| S014-956 | Transparency, tube with disk | Total | | 3/17/2016 | | 43.00 | cm |
| S014-956 | Transparency, tube with disk | Total | | 3/15/2016 | | 54.00 | cm |
| S014-956 | Transparency, tube with disk | Total | | 5/18/2017 | | 42.00 | cm |
| S014-956 | Transparency, tube with disk | Total | | 5/22/2017 | | 59.00 | cm |
| S014-956 | Transparency, tube with disk | Total | | 8/16/2017 | > | 100.00 | cm |
| S014-956 | Transparency, tube with disk | Total | | 9/13/2017 | > | 100.00 | cm |
| S014-956 | Transparency, tube with disk | Total | | 9/18/2017 | > | 100.00 | cm |
| S014-956 | Transparency, tube with disk | Total | | 9/27/2017 | | 38.00 | cm |
| S014-956 | Transparency, tube with disk | Total | | 10/3/2017 | | 12.00 | cm |
| S014-956 | Transparency, tube with disk | Total | | 10/4/2017 | | 42.00 | cm |
| S014-956 | Transparency, tube with disk | Total | | 10/30/2017 | | 82.00 | cm |
| S014-956 | Transparency, tube with disk | Total | | 6/29/2017 | | 25.00 | cm |
| S014-956 | Transparency, tube with disk | Total | | 7/3/2018 | | 88.00 | cm |
| S014-956 | Transparency, tube with disk | Total | | 6/4/2018 | | 55.00 | cm |
| S014-956 | Transparency, tube with disk | Total | | 7/2/2018 | | 34.00 | cm |
| S014-956 | Transparency, tube with disk | Total | | 10/2/2018 | | 87.00 | cm |
| S014-956 | Transparency, tube with disk | Total | | 6/7/2018 | | 91.00 | cm |
| S014-956 | Transparency, tube with disk | Total | | 8/7/2018 | > | 100.00 | cm |
| S014-956 | Transparency, tube with disk | Total | | 10/10/2018 | | 12.00 | cm |
| S014-956 | Transparency, tube with disk | Total | | 9/12/2018 | | 60.00 | cm |
| S014-956 | Transparency, tube with disk | Total | | 6/18/2018 | | 24.00 | cm |
| S014-956 | Transparency, tube with disk | Total | | 6/19/2018 | | 40.00 | cm |
| S014-956 | Transparency, tube with disk | Total | | 8/23/2018 | > | 100.00 | cm |
| S014-956 | Transparency, tube with disk | Total | | 6/17/2018 | | 12.00 | cm |
| S014-956 | Transparency, tube with disk | Total | | 6/28/2018 | | 58.00 | cm |
| S014-956 | Transparency, tube with disk | Total | | 5/31/2018 | | 30.00 | cm |
| S014-956 | Transparency, tube with disk | Total | | 7/27/2018 | | 59.00 | cm |
| S014-956 | Transparency, tube with disk | Total | | 10/31/2018 | | 82.00 | cm |
| S014-956 | Transparency, tube with disk | Total | | 5/23/2018 | | 85.00 | cm |
| S014-956 | Transparency, tube with disk | Total | | 4/24/2018 | | 30.00 | cm |
| S014-956 | Transparency, tube with disk | Total | | 5/2/2018 | | 62.00 | cm |
| S014-956 | Transparency, tube with disk | Total | | 4/20/2018 | | 27.00 | cm |
| S014-956 | Transparency, tube with disk | Total | | 4/26/2018 | | 45.00 | cm |
| S014-956 | Transparency, tube with disk | Total | | 4/23/2018 | | 22.00 | cm |
| S014-956 | Transparency, tube with disk | Total | | 5/10/2017 | > | 100.00 | cm |
| S014-956 | Transparency, tube with disk | Total | | 4/27/2017 | > | 100.00 | cm |
| S014-956 | Transparency, tube with disk | Total | | 5/3/2017 | > | 100.00 | cm |
| S014-956 | Transparency, tube with disk | Total | | 4/5/2017 | | 59.00 | cm |
| S014-956 | Transparency, tube with disk | Total | | 4/13/2017 | > | 100.00 | cm |
| S014-956 | Transparency, tube with disk | Total | | 4/20/2017 | | 38.00 | cm |
| S014-956 | Transparency, tube with disk | Total | | 5/18/2017 | | 47.00 | cm |
| S014-956 | Transparency, tube with disk | Total | | 5/27/2017 | > | 100.00 | cm |
| S014-956 | Transparency, tube with disk | Total | | 5/31/2017 | > | 100.00 | cm |
| S014-956 | Transparency, tube with disk | Total | | 6/7/2017 | > | 100.00 | cm |
| S014-956 | Transparency, tube with disk | Total | | 6/16/2017 | > | 100.00 | cm |
| S014-956 | Transparency, tube with disk | Total | | 7/16/2017 | > | 100.00 | cm |
| S014-956 | Transparency, tube with disk | Total | | 6/24/2017 | > | 100.00 | cm |
| S014-956 | Transparency, tube with disk | Total | | 7/1/2017 | | 60.00 | cm |
| S014-956 | Transparency, tube with disk | Total | | 7/6/2017 | > | 100.00 | cm |
| S014-956 | Transparency, tube with disk | Total | | 7/22/2017 | > | 100.00 | cm |
| S014-956 | Transparency, tube with disk | Total | | 7/29/2017 | > | 100.00 | cm |
| S014-956 | Transparency, tube with disk | Total | | 8/3/2017 | > | 100.00 | cm |
| S014-956 | Transparency, tube with disk | Total | | 8/10/2017 | | 42.00 | cm |
| S014-956 | Transparency, tube with disk | Total | | 9/27/2017 | | 40.00 | cm |
| S014-956 | Transparency, tube with disk | Total | | 8/17/2017 | | 39.00 | cm |
| S014-956 | Transparency, tube with disk | Total | | 8/24/2017 | | 41.00 | cm |
| S014-956 | Transparency, tube with disk | Total | | 9/13/2017 | | 42.00 | cm |
| S014-956 | Transparency, tube with disk | Total | | 10/4/2017 | | 31.00 | cm |
| S014-956 | Turbidity | Total | MN00006 | 5/13/2014 | | 35.00 | NTRU |
| S014-956 | Turbidity | Total | MN00006 | 4/22/2014 | | 34.00 | NTRU |
| S014-956 | Turbidity | Total | MN00006 | 4/23/2014 | | 29.00 | NTRU |
| S014-956 | Turbidity | Total | MN00006 | 4/29/2014 | | 13.00 | NTRU |
| S014-956 | Turbidity | Total | MN00006 | 5/6/2014 | | 11.00 | NTRU |
| S014-956 | Turbidity | Total | MN00006 | 4/11/2014 | | 34.00 | NTRU |
| S014-956 | Turbidity | Total | MN00006 | 4/15/2014 | | 16.00 | NTRU |
| S014-956 | Turbidity | Total | MN00006 | 5/22/2014 | | 9.10 | NTRU |
| S014-956 | Turbidity | Total | MN00006 | 5/28/2014 | | 5.00 | NTRU |
| S014-956 | Turbidity | Total | MN00006 | 6/3/2014 | | 15.00 | NTRU |
| S014-956 | Turbidity | Total | MN00006 | 6/9/2014 | | 4.60 | NTRU |
| S014-956 | Turbidity | Total | MN00006 | 6/17/2014 | | 6.80 | NTRU |
| S014-956 | Turbidity | Total | MN00006 | 6/25/2014 | | 5.00 | NTRU |
| S014-956 | Turbidity | Total | MN00006 | 7/9/2014 | | 4.20 | NTRU |
| S014-956 | Turbidity | Total | MN00006 | 7/15/2014 | | 4.20 | NTRU |

# Appendix A
# Water Quality Dataset

| Station ID | Parameter | Sample Fraction Type | Lab Name Code | Sample Date | Detect Flag | Result | Result Unit |
|---|---|---|---|---|---|---|---|
| S014-956 | Turbidity | Total | MN00006 | 7/15/2014 | | 4.10 | NTRU |
| S014-956 | Turbidity | Total | MN00006 | 7/29/2014 | | 6.30 | NTRU |
| S014-956 | Turbidity | Total | MN00006 | 8/13/2014 | | 7.70 | NTRU |
| S014-956 | Turbidity | Total | MN00006 | 9/2/2014 | | 12.00 | NTRU |
| S014-956 | Turbidity | Total | MN00006 | 9/2/2014 | | 12.00 | NTRU |
| S014-956 | Turbidity | Total | MN00006 | 9/9/2014 | | 11.00 | NTRU |
| S014-956 | Turbidity | Total | MN00006 | 9/24/2014 | | 4.30 | NTRU |
| S014-956 | Turbidity | Total | MN00006 | 6/17/2014 | | 6.40 | NTRU |
| S014-956 | Turbidity | Total | MN00006 | 10/8/2014 | | 4.40 | NTRU |
| S014-956 | Turbidity | Total | MN00006 | 10/28/2014 | | 3.70 | NTRU |
| S014-956 | Turbidity | Total | MN00006 | 3/16/2015 | | 10.00 | NTU |
| S014-956 | Turbidity | Total | MN00006 | 4/14/2015 | | 11.00 | NTU |
| S014-956 | Turbidity | Total | MN00006 | 4/20/2015 | | 26.00 | NTU |
| S014-956 | Turbidity | Total | MN00006 | 4/22/2015 | | 6.20 | NTU |
| S014-956 | Turbidity | Total | MN00006 | 5/6/2015 | | 4.90 | NTU |
| S014-956 | Turbidity | Total | MN00006 | 5/11/2015 | | 32.00 | NTU |
| S014-956 | Turbidity | Total | MN00006 | 5/11/2015 | | 32.00 | NTU |
| S014-956 | Turbidity | Total | MN00006 | 5/12/2015 | | 19.00 | NTU |
| S014-956 | Turbidity | Total | MN00006 | 5/12/2015 | | 20.00 | NTU |
| S014-956 | Turbidity | Total | MN00006 | 5/19/2015 | | 7.50 | NTU |
| S014-956 | Turbidity | Total | MN00006 | 5/27/2015 | | 8.30 | NTU |
| S014-956 | Turbidity | Total | MN00006 | 6/10/2015 | | 7.40 | NTU |
| S014-956 | Turbidity | Total | MN00006 | 6/10/2015 | | 7.00 | NTU |
| S014-956 | Turbidity | Total | MN00006 | 6/9/2015 | | 10.00 | NTU |
| S014-956 | Turbidity | Total | MN00006 | 6/17/2015 | | 6.90 | NTU |
| S014-956 | Turbidity | Total | MN00006 | 6/25/2015 | | 7.80 | NTU |
| S014-956 | Turbidity | Total | MN00006 | 7/29/2015 | | 12.00 | NTU |
| S014-956 | Turbidity | Total | MN00006 | 7/29/2015 | | 11.00 | NTU |
| S014-956 | Turbidity | Total | MN00006 | 7/13/2015 | | 9.50 | NTU |
| S014-956 | Turbidity | Total | MN00006 | 7/13/2015 | | 8.00 | NTU |
| S014-956 | Turbidity | Total | MN00006 | 7/1/2015 | | 5.70 | NTU |
| S014-956 | Turbidity | Total | MN00006 | 6/23/2015 | | 25.00 | NTU |
| S014-956 | Turbidity | Total | MN00006 | 5/14/2015 | | 7.60 | NTU |
| S014-956 | UV Absorbance at 254 nm | Total | MN00006 | 8/27/2015 | | 0.58 | units/cm |
| S014-956 | UV Absorbance at 254 nm | Total | MN00006 | 5/17/2016 | | 0.45 | units/cm |
| S014-956 | UV Absorption, relative conc. of organic constituents | Total | MN00006 | 6/25/2014 | | 0.79 | units/cm |
| S014-956 | Volatile suspended solids | Total | MN00006 | 4/14/2015 | | 2.40 | mg/L |
| S014-956 | Volatile suspended solids | Total | MN00006 | 4/20/2015 | | 7.60 | mg/L |
| S014-956 | Volatile suspended solids | Total | MN00006 | 4/22/2015 | < | 1.00 | mg/L |
| S014-956 | Volatile suspended solids | Total | MN00006 | 5/6/2015 | < | 1.00 | mg/L |
| S014-956 | Volatile suspended solids | Total | MN00006 | 5/15/2015 | | 5.00 | mg/L |
| S014-956 | Volatile suspended solids | Total | MN00006 | 5/11/2015 | | 4.00 | mg/L |
| S014-956 | Volatile suspended solids | Total | MN00006 | 5/11/2015 | | 3.60 | mg/L |
| S014-956 | Volatile suspended solids | Total | MN00006 | 5/12/2015 | | 2.80 | mg/L |
| S014-956 | Volatile suspended solids | Total | MN00006 | 5/12/2015 | | 3.20 | mg/L |
| S014-956 | Volatile suspended solids | Total | MN00006 | 5/19/2015 | | 1.60 | mg/L |
| S014-956 | Volatile suspended solids | Total | MN00006 | 5/14/2015 | | 2.40 | mg/L |
| S014-956 | Volatile suspended solids | Total | MN00006 | 5/27/2015 | | 2.00 | mg/L |
| S014-956 | Volatile suspended solids | Total | MN00006 | 6/10/2015 | | 1.20 | mg/L |
| S014-956 | Volatile suspended solids | Total | MN00006 | 6/10/2015 | < | 1.00 | mg/L |
| S014-956 | Volatile suspended solids | Total | MN00006 | 6/9/2015 | | 2.00 | mg/L |
| S014-956 | Volatile suspended solids | Total | MN00006 | 6/23/2015 | | 4.40 | mg/L |
| S014-956 | Volatile suspended solids | Total | MN00006 | 6/17/2015 | | 1.60 | mg/L |
| S014-956 | Volatile suspended solids | Total | MN00006 | 6/25/2015 | | 1.60 | mg/L |
| S014-956 | Volatile suspended solids | Total | MN00006 | 7/29/2015 | | 2.80 | mg/L |
| S014-956 | Volatile suspended solids | Total | MN00006 | 7/29/2015 | | 2.40 | mg/L |
| S014-956 | Volatile suspended solids | Total | MN00006 | 7/13/2015 | | 2.40 | mg/L |
| S014-956 | Volatile suspended solids | Total | MN00006 | 7/13/2015 | | 1.60 | mg/L |
| S014-956 | Volatile suspended solids | Total | MN00006 | 7/1/2015 | | 1.20 | mg/L |
| S014-956 | Volatile suspended solids | Total | MN00006 | 5/13/2014 | | 3.20 | mg/L |
| S014-956 | Volatile suspended solids | Total | MN00006 | 4/22/2014 | | 4.80 | mg/L |
| S014-956 | Volatile suspended solids | Total | MN00006 | 4/23/2014 | | 4.80 | mg/L |
| S014-956 | Volatile suspended solids | Total | MN00006 | 4/29/2014 | | 2.80 | mg/L |
| S014-956 | Volatile suspended solids | Total | MN00006 | 5/6/2014 | | 2.00 | mg/L |
| S014-956 | Volatile suspended solids | Total | MN00006 | 4/11/2014 | | 4.00 | mg/L |
| S014-956 | Volatile suspended solids | Total | MN00006 | 4/15/2014 | | 2.80 | mg/L |
| S014-956 | Volatile suspended solids | Total | MN00006 | 5/22/2014 | | 2.00 | mg/L |
| S014-956 | Volatile suspended solids | Total | MN00006 | 5/28/2014 | | 1.20 | mg/L |
| S014-956 | Volatile suspended solids | Total | MN00006 | 6/3/2014 | | 2.00 | mg/L |
| S014-956 | Volatile suspended solids | Total | MN00006 | 6/9/2014 | | 1.60 | mg/L |
| S014-956 | Volatile suspended solids | Total | MN00006 | 6/17/2014 | | 2.00 | mg/L |
| S014-956 | Volatile suspended solids | Total | MN00006 | 6/25/2014 | | 1.20 | mg/L |
| S014-956 | Volatile suspended solids | Total | MN00006 | 7/9/2014 | < | 1.00 | mg/L |

# Appendix A
# Water Quality Dataset

| Station ID | Parameter | Sample Fraction Type | Lab Name Code | Sample Date | Detect Flag | Result | Result Unit |
|---|---|---|---|---|---|---|---|
| S014-956 | Volatile suspended solids | Total | MN00006 | 7/15/2014 | | 1.60 | mg/L |
| S014-956 | Volatile suspended solids | Total | MN00006 | 7/15/2014 | | 1.20 | mg/L |
| S014-956 | Volatile suspended solids | Total | MN00006 | 7/29/2014 | | 2.40 | mg/L |
| S014-956 | Volatile suspended solids | Total | MN00006 | 8/13/2014 | | 2.00 | mg/L |
| S014-956 | Volatile suspended solids | Total | MN00006 | 9/2/2014 | | 2.80 | mg/L |
| S014-956 | Volatile suspended solids | Total | MN00006 | 9/2/2014 | | 2.80 | mg/L |
| S014-956 | Volatile suspended solids | Total | MN00006 | 9/9/2014 | | 1.60 | mg/L |
| S014-956 | Volatile suspended solids | Total | MN00006 | 9/24/2014 | | 1.60 | mg/L |
| S014-956 | Volatile suspended solids | Total | MN00006 | 6/17/2014 | | 2.40 | mg/L |
| S014-956 | Volatile suspended solids | Total | MN00006 | 10/8/2014 | | 1.20 | mg/L |
| S014-956 | Volatile suspended solids | Total | MN00006 | 10/28/2014 | | 1.60 | mg/L |
| S014-956 | Volatile suspended solids | Total | MN00006 | 3/16/2015 | | 3.60 | mg/L |
| S014-956 | Volatile suspended solids | Total | MN00006 | 6/15/2015 | | 2.40 | mg/L |

# Appendix B

## Cumulative Effects Analysis – Aquatic and Forest Resources – Tailings Basin Progression

# Cumulative Effect Analysis – Aquatic and Forest Resources

## *Tailings Basin Progression*

Prepared for
Northshore Mining Company

October 2019

# Cumulative Effect Analysis – Aquatic and Forest Resources

## *Tailings Basin Progression*

Prepared for
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October 2019

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# Cumulative Effect Analysis – Aquatic and Forest Resources

## October 2019

# Contents


1 Introduction ..... 1
2 Project Description ..... 3
2.1 Proposed Project ..... 3
2.2 No Action ..... 3
3 Cumulative Effects Study Area ..... 4
4 Cumulative Effects Assessment Methods ..... 6
4.1 Human Disturbance Areas ..... 6
4.2 Pre-Settlement Aquatic and Forest Resources ..... 7
4.2.1 Wetlands ..... 7
4.2.2 Lakes and Deepwater Habitats ..... 8
4.2.3 Streams ..... 8
4.2.4 Forest ..... 9
4.3 Existing Aquatic and Forest Resources ..... 9
4.3.1 Wetlands ..... 9
4.3.2 Lakes and Deepwater Habitat ..... 10
4.3.3 Streams ..... 10
4.3.4 Forest ..... 11
4.4 Foreseeable Future Aquatic and Forest Resources ..... 11
4.4.1 Cumulative Actions ..... 11
4.4.2 Wetlands ..... 13
4.4.3 Lakes and Deepwater Habitats ..... 13
4.4.4 Streams ..... 14
4.4.5 Forest ..... 14
5 Cumulative Effects Assessment Results ..... 15
5.1 Pre-settlement Conditions ..... 15
5.2 Existing Conditions ..... 15
5.3 Future Foreseeable Conditions ..... 15
5.3.1 No Action Alternative ..... 15
5.3.2 Proposed Action ..... 16

6 Cumulative Effects Assessment Discussion ..... 18
6.1 Wetlands ..... 18
6.1.1 Cumulative Effects Study Area ..... 18
6.2 Lakes and Deepwater Habitat ..... 18
6.3 Streams ..... 19
6.4 Forests ..... 19
6.5 Conclusions ..... 19
7 References ..... 21

## List of Tables


| | |
|---|---|
| Table 1 | Townships in the study area |
| Table 2 | Changes in wetland, lake and deepwater habitat, stream, and forest resources in the foreseeable future |
| Table 3 | Total wetland area (acres) for pre-settlement, existing, and future conditions |
| Table 4 | Total lake and deepwater habitat area (acres) for pre-settlement, existing, and future conditions |
| Table 5 | Total stream length (miles) for pre-settlement, existing, and future conditions |
| Table 6 | Total forest area (acres) for pre-settlement, existing, and future conditions |
| Table 7 | Summary of future known changes in wetland resources for the study area |
| Table 8 | Summary of future known changes in lake and deepwater habitat resources for the study area |
| Table 9 | Summary of future known changes in stream length for the study area |
| Table 10 | Summary of future known changes in forest area for the study area |


## List of Figures


| | |
|---|---|
| Large Figure 1 | Study Area |
| Large Figure 2 | Human Disturbance Areas |
| Large Figure 3 | Pre-settlement Resources |
| Large Figure 4 | Existing Resources |
| Large Figure 5 | Foreseeable Future Resources |

## Abbreviations

| | |
|---|---|
| Barr | Barr Engineering Co. |
| BWSR | Minnesota Board of Soil and Water Resources |
| CSAH | County State Aid Highway |
| EIS | Environmental Impact Statement |
| GIS | Geographic Information System |
| Northshore | Northshore Mining Company |
| NEPA | National Environmental Policy Act |
| NLCD | National Land Cover Data |
| MNDNR | Minnesota Department of Natural Resources |
| MNTH | Minnesota Trunk Highway |
| MnDOT | Minnesota Department of Transportation |
| NHD | National Hydrography Dataset |
| NWI | National Wetland Inventory |
| proposed Project | proposed West Ridge Railroad Relocation and Tailings Basin Progression project |
| PWI | Public Water Inventory |
| STIP | State of Minnesota State Transportation Improvement Program |
| SWCD | Soil and Water Conservation District |
| USACE | U.S. Army Corps of Engineers |
| USDA-USFS | U.S. Department of Agriculture-U.S. Forest Service |
| USDA-FSA | USDA-Farm Service Agency |
| USGS | United States Geological Survey |

# 1 Introduction

Barr Engineering Co. (Barr) has prepared this Cumulative Effect Analysis on behalf of Northshore Mining Company (Northshore) for its proposed West Ridge Railroad Relocation and Tailings Basin Progression project (proposed Project). The proposed Project area encompasses approximately 1,200 acres and is located about 6 miles west of Silver Bay, in Lake County, Minnesota (Large Figure 1). This analysis is intended to help satisfy the requirements in the letter to Northshore from the U.S. Army Corps of Engineers (USACE; dated May 22, 2019) which will meet National Environmental Policy Act (NEPA) requirements (42 U.S.C. 4321 et seq.). The Council on Environmental Quality, which oversees administration of the NEPA process, has defined cumulative effects in its regulations as:

> [T]he impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency or person undertakes such other actions (40 CFR § 1508.7).

Northshore submitted a wetland permit application June 18, 2018, for a proposed relocation of the West Ridge railroad and progression of the Milepost 7 Tailings Basin. Northshore owns and operates the Peter Mitchell Mine in Babbitt, Minnesota; the EW Davis taconite processing facilities at Silver Bay, Minnesota; and an interconnecting railroad. These facilities have been in operation producing taconite pellets since the 1950s. With the current ore resources and the current rate of mining, production operations at these facilities would continue for approximately 80 years.

The Milepost 7 Tailings Basin at Silver Bay was originally authorized by the Corps after completion of an Environmental Impact Study (EIS) in March 1977, through issuance of the following permits for the life of the Peter Mitchell ore body:

- 76-412B for the construction of Dam 1,
- 76-413B for the construction of Dam 2, and
- 76-422 for the deposition of coarse and fine tails into the tailings basin.

On August 31, 2005, Permit No. 2005-2628-TWP was authorized for deposition of tailings covering an additional 160 acres within the permitted footprint of permit 76-422, expiring on December 31, 2030. That authorization included incorporation of provisions included in permits 76-412B, 76-413B, and 76-422 to accommodate the next 25 years of the basin's use to an elevation of 1252 feet. After reviewing the June 2018 application, the Corps requested the company to complete a watershed assessment, including evaluation of cumulative effects per the guidance in its May 22, 2019 letter to Northshore.

The purpose of this analysis is to consider the aquatic and forest resources available in the past compared to those present currently, and the effects of reasonably foreseeable future actions. The results of this analysis will provide a context for assessing the cumulative effects on wetland, lake and deepwater habitat, stream, and forest resources. The proposed Project, along with the reasonably foreseeable future actions within the study area, will be evaluated to determine the potential for cumulative effects on aquatic and forest resources. The resources evaluated in this analysis include wetlands, lakes and

deepwater habitat, streams, and forests. This analysis also includes the evaluation of the "No Action Alternative" as the baseline against which to compare the cumulative effects on resources, assuming no development of the proposed Project.

# 2 Project Description

## 2.1 Proposed Project

The proposed Project area encompasses approximately 1,200 acres, made up of tailings storage area and supporting infrastructure, and is located about 6 miles west of Silver Bay, in Lake County, Minnesota (Figure 4). Some of the proposed Project area consists of lands disturbed by past activities, including depleted borrow pits and access roads. The proposed Project area utilizes the existing tailings storage facility footprint and land adjacent to it, progressing westerly as contemplated in the EIS and original state and federal permits. Tailings would be stored over the existing, approximately 2,100 acre tailings storage area an additional 113 feet in height above the existing permitted basin and a total height of about 233 feet at its highest point. In addition, tailings would be stored within approximately 850 acres of adjacent tailings storage area to an elevation of 1365 feet as the natural topography allows storage to extend generally northwesterly, but excluding about 1,100 acres of the tailings storage area evaluated in the EIS.

## 2.2 No Action

Under the No Action alternative, the tailings basin could only be operated to the permitted footprint specified by the authorization of permit 2005-2628-TWP, and there would be no progression of the existing tailings basin extents. The No Action alternative would not have adequate tailings storage capacity to meet the project purpose. This alternative would result in no additional wetland impacts beyond those resulting from operation to the existing, permitted tailings basin boundary and railroad alignment.

# 3 Cumulative Effects Study Area

The study area for evaluating cumulative effects to wetland, lake and deepwater habitat, stream, and forest resources is the HUC 10 Beaver River-Frontal Lake Superior watershed. Some of the primary functions performed by these resources are directly related to watershed processes; therefore, a watershed level analysis was completed. The HUC 10 Beaver River-Frontal Lake Superior watershed was used as the spatial boundary for the cumulative effects assessment since the watershed fully encompasses the proposed Project.

The existing Beaver River watershed covers approximately 150 square miles (96,225 acres; Large Figure 4). The historic Beaver River watershed was approximately 225 acres smaller (Figures 2 and 3). Reserve Mining Company added 225 acres to the watershed during its operation. The proposed Project is located within portions of three subwatersheds including: East Branch Beaver River (30.2 square miles), Beaver River (11.1 square miles), and Thirtynine Creek (9.8 square miles), although less than 50 acres of the proposed Project lies within the Thirtynine Creek subwatershed.

The U.S. Department of Agriculture-U.S. Forest Service (USDA-USFS) Superior National Forest covers 42,714 acres in the northwestern portion of the study area, or approximately 44% of the study area (Large Figure 1). Within the study area, Finland State Forest is located within the USDA-USFS Superior National Forest and encompasses 15,395 acres in the northwestern portion of the study area, or approximately 16% of the study area (Large Figure 1).

The United States Geological Survey (USGS) National Land Cover Data (NLCD; 2016) identifies primary land cover types in the study area as forests and wetlands. Other minor land cover types include developed areas, barren land, cultivated crops/hay/pasture land, and open water.

Existing development, other than the proposed Project, is primarily located in the eastern portion of the study area within the cities of Silver Bay and Beaver Bay. There is minimal development in the remainder of the study area. The population of Silver Bay was 2,068 persons in 2000, 1,887 persons in 2010, and estimated to be 1,776 persons in 2018, which indicates a 14 percent decline since the 2000 census (U.S. Census 2019). The population of Beaver Bay was 175 persons in 2000, 181 persons in 2010, and estimated to be 172 persons in 2018, which indicates a two percent decline since the 2010 census (U.S. Census, accessed 2019).

The major highways within the study area include Minnesota Trunk Highway (MNTH) 61 and County State Aid Highways (CSAH) 3, 4, 5, 15, 31, and 32 (Large Figure 1). There are also numerous local streets and forest roads located within the study area.

There are two state parks located within the study area – Tettegouche and Split Rock Lighthouse (Large Figure 1). Tettegouche State Park is located in the northeast portion of the study area, with 5,376 acres of the 9,562 acre park (approximately 56% of the park and encompassing approximately 5.6% of the study area) located within the study area. Split Rock Lighthouse State Park is located in the southeast portion of

the study area, with 1,521 acres of the 2,320 acre park (approximately 66% of the park and encompassing approximately 1.6% of the study area) located within the study area.

Existing aquatic resources (other than wetlands) in the study area include (Large Figure 1):

- One deepwater habitat, Murphy's Pond, which is a non-natural deepwater habitat that has progressively grown in size and depth since before 1980 due to impoundment of a broad valley.
- Two unnamed lakes and eight named lakes including Bean, Bear (2), Drake, Lax, Nicado, Tetagouche, and Water Tank.
- Three constructed ponds that are associated with the Wastewater Treatment Plant in Beaver Bay.
- Six named streams including Beaver River, East Branch Beaver River, West Branch Beaver River, Thirtynine Creek, Big 39 Creek, and Little 39 Creek.
- Many unnamed small ponds, streams, and creeks found throughout the study area.

# 4 Cumulative Effects Assessment Methods

The extents of wetland, lake and deepwater habitat, stream, and forest resources were estimated for three time periods including: pre-settlement, existing, and the foreseeable future. These extents were used to determine the cumulative effects of direct impacts from all past, present, and reasonably foreseeable future projects on the aquatic and forest resources located within the study area in the context of historic and existing aquatic resources.

## 4.1 Human Disturbance Areas

The cumulative effects assessment is based on existing impacts and impacts that will potentially occur in the foreseeable future within the study area. Therefore, as a first step, several data sources were analyzed to create a Geographic Information System (GIS) layer containing polygons signifying existing human disturbance areas within the study area.

The data used and types of human disturbances identified included:

1. *2016 USGS NLCD layer*: Land cover classes included barren land, developed high/medium/low intensity, and developed open space.

2. *MNDNR LiDAR building footprints*: Layer was used to identify the footprints of buildings in the rural parts of the study area.

3. *Minnesota Department of Transportation (MnDOT) street and highway layer*: County State Aid Highways (CSAH) were buffered by 25 feet on each side of the road centerline (50 feet total). All other roads were buffered by 15 feet on each side of the road centerline (30 feet total) to document the disturbance area.

4. *MnDOT Statewide railroad layer*: All railroads were buffered with 25 feet on each side of the railroad centerline (50 feet total).

5. *USDA-USFS roads and trails*: Roads/light duty/unspecified composition were buffered with 15 feet on each side of the roadway (30 feet total). Other roads/trails were buffered 7.5 feet on each side of the roadway (15 feet total). The file was also manually reviewed to remove any roadways that were duplicates of the roadways identified in the *Minnesota Department of Transportation (MnDOT) street and highway layer*.

6. *MNDNR snowmobile trails*: Trails were buffered by 7.5 feet on each side of the road centerline (15 feet total).

7. *MNDNR state trails*: Trails were buffered by 7.5 feet on each side of the road centerline (15 feet total).

8. *2017 USDA-Farm Service Agency (FSA) aerial imagery*: Imagery was reviewed to identify any additional roads/trails/transmission line corridors that were not included in the above layers, but were visible on the aerial imagery. The roads and trails were buffered by 7.5 feet on each side of the road centerline (15 feet total). The transmission line corridors were buffered by 45 feet on each side of the corridor (90 feet).

9. *Historic USGS Quadrangle Maps and Historic Aerial Photos:* The original watershed boundary along the shore of Lake Superior was mapped based on the 1954 USGS Silver Bay quadrangle (scale: 1:62,500), the 1956 USGS Illgen City quadrangle (scale 1:24,000), and 1940 aerial photographs.

10. *Northshore Mining Tailings Basin area*: Existing tailings basin features were identified during the permitting process, including: diversion channels, borrow areas, the landfill, seepage recovery facilities, dams, roads, and ancillary facilities.

There are 15 townships that are completely or partially located within the study area (Large Figure 2). Disturbance within these townships ranged from 0 to 59 percent, with approximately 9 percent of the study area (8,360 acres) impacted by human disturbance since settlement of this area (Table 1).

## 4.2 Pre-Settlement Aquatic and Forest Resources

The pre-settlement time period represents wetland, lake and deepwater habitat, stream, and forest resources as they existed in the late 1800s to early 1900s, prior to mining and urban development. The acreage of aquatic and forest resources estimated for the pre-settlement time period was developed as described in the following sections.

### 4.2.1 Wetlands

The wetlands within the study area were initially identified using the "Existing" wetlands layer (Section 4.3.1). The wetlands were then edited depending on whether they are located outside or within the Human Disturbance Areas (Large Figure 2). Outside of the Human Disturbance Areas, the "Existing" wetlands represent the "Pre-settlement" wetlands.

Within the Human Disturbance Areas, the "Existing" wetlands were edited in the following locations:

1. Southwest of the existing Northshore Tailings Basin – the "Existing" wetlands were removed within this area and replaced with the historic wetlands as identified by analyzing the 1954 USGS quadrangle for Silver Bay (scale 1:62,500), historic aerial photos from 1969 and 1977, and previous wetland studies.
2. Within the existing Northshore Tailings Basin – the "Existing" wetlands were removed and replaced with wetlands digitized using the 1954 USGS quadrangle (scale 1:62,500) for Silver Bay.
3. Northwest of the existing Northshore Tailings Basin – Murphy's Pond and "Existing" wetlands were removed from the file and replaced with wetlands identified by analyzing the 1954 USGS quadrangle (scale 1:62,500) for Silver Bay, and historic aerial photos from 1969 and 1977.

Wetlands in these areas were merged to create the "Pre-settlement" wetlands within the study area. Next, these wetlands were manually reviewed to identify areas where a road/railroad or other feature either split or truncated a "Pre-settlement" wetland. In these cases, wetlands were re-connected to establish "Pre-settlement" conditions. In addition, the "Pre-settlement" wetlands were reviewed to remove any wetlands that appeared to have formed upstream from a road/railroad or other feature and didn't have a wetland feature associated with it on the other side of the road/railroad, etc. These edits were completed to create the "Pre-settlement" wetlands layer (Large Figure 3).

### 4.2.2 Lakes and Deepwater Habitats

Lakes and deepwater habitats were initially identified within the study area by querying the MNDNR Public Water Inventory (PWI) shapefile for "PWI Basins" and the MNDNR Hydrography: Lakes, Ponds, and River Features shapefile for "Lake or Pond". This list of lakes was manually reviewed to determine if any represented recently formed beaver ponds or open water wetlands, which were not considered to be defined as lakes. Several polygons were determined to not be lakes and were removed from the "Pre-settlement" lakes and deepwater habitat layer. These edits were completed to create the "Pre-settlement" lakes and deepwater habitat layer in Large Figure 3.

### 4.2.3 Streams

The streams within the study area were initially identified using the "Existing" streams layer (Section 4.3.1). The streams were then edited depending on whether the stream was located outside or within the Human Disturbance Areas (Large Figure 2). Outside of the Human Disturbance Areas, the "Existing" streams were used as the "Pre-settlement" streams.

Within the Human Disturbance Areas, the "Existing" streams were edited in the following locations:

1. Within the Human Disturbance Areas – streams were digitized using the 1954 USGS quadrangle (scale 1:62,500) for Silver Bay. Streams were classified as perennial or intermittent based on the symbology on the 1954 USGS quadrangle. Only perennial streams were retained in the "Pre-settlement" streams layer.
2. USGS historic quadrangles – Illgen, MN Split Rock Point, and Split Rock Point NE historic quads were reviewed for additional streams, however, none were identified.
3. Within the existing Northshore Tailings Basin – a georeferenced MNDNR 1969 aerial photograph and the 1954 USGS quadrangle map for Silver Bay were used to identify and map streams that previously flowed through the existing tailings basin area.
4. Within the proposed Project area – the PWI versions of Big 39 Creek and Little 39 Creek were used to replace the "Existing" streams.
5. Adjacent to the proposed Project area – the PWI segment for Big Thirtynine Creek was removed between Beaver River and Thirtynine Creek.
6. Adjacent to the proposed Project area – the two diversion ditches were removed.
7. Adjacent to the existing tailings basin – the channel associated with the Northshore Wastewater Treatment Plant was removed.

8. Within the study area – the stream segments intersecting the "Pre-settlement" lakes and deepwater habitat layer were removed from the layer.

These edits were completed to create the "Pre-settlement" streams layer (Large Figure 3).

### 4.2.4 Forest

Forests were assumed to be present throughout the entire study area either as mature or successional forests. Polygons that represent the open water of the "Pre-settlement" lakes and deepwater habitat (Section 4.2.2) were removed to create the "Pre-settlement" forest layer (Large Figure 3).

## 4.3 Existing Aquatic and Forest Resources

The existing time period represents wetland, lake and deepwater habitat, stream, and forest resources as they exist today, prior to the development of the proposed Project. The Beaver River watershed for existing conditions is larger than under Pre-settlement conditions due to additional land area along the shore of Lake Superior at the EW Davis taconite processing facility (Figure 4). The acreage of aquatic and forest resources estimated for the existing time period was developed as described in the following sections.

### 4.3.1 Wetlands

The wetlands within the study area were initially identified using the 2016 MNDNR National Wetland Inventory (NWI) Northeast Update shapefile. The wetlands were then edited depending on whether the wetland was located either outside or within the Human Disturbance Areas (Large Figure 2). The wetlands outside of the Human Disturbance Areas were reviewed to determine if the NWI identified any polygons as a lake; if the polygon was defined as a lake, it was removed.

Within the Human Disturbance Areas, the NWI wetlands were edited in the following locations:

1. Within the proposed Project area – a wetland delineation was conducted in 2015. The extent of the wetland delineation was defined by a "delineated wetland study area". The NWI wetlands within the "delineated wetland study area" were clipped from the layer and replaced with the delineated wetlands.
2. Within the Northshore Bear Lake Outlet project – a wetland delineation was conducted in 2006. The extent of the wetland delineation was defined by a "delineated wetland study area". The NWI wetlands within the "delineated wetland study area" were clipped from the layer and replaced with the delineated wetlands.
3. Within the Silver Bay Business Park – a wetland delineation was conducted in 2013 (Hayes 2013). The extent of the wetland delineation was defined by a "delineated wetland boundary". The NWI wetlands within the "delineated wetland boundary" were clipped from the layer and replaced with the project-specific wetlands (18 acres).
4. Within the study area – the "Existing" lakes and deepwater habitat were clipped out to remove any potential overlap.

These edits were completed to create the "Existing" wetlands layer in the study area (Large Figure 4).

### 4.3.2 Lakes and Deepwater Habitat

The lakes and deepwater habitat within the study area were initially identified using the "Pre-settlement" lakes and deepwater habitat layer (Section 4.2.2). The lakes and deepwater habitat were then edited depending on whether the lake or deepwater habitat was located either outside of or within the Human Disturbance Areas (Large Figure 2). Outside of the Human Disturbance Areas, this layer was used as the "Existing" lakes and deepwater habitat.

Within the Human Disturbance Areas, the lakes and deepwater habitat were edited in the following locations:

1. Within the proposed Project area – Murphy's Pond, a non-natural deepwater habitat, was added using the field mapping data.
2. Beaver Bay Wastewater Treatment ponds – three ponds were added to the layer using the polygons from the NWI.

These edits were completed to generate the "Existing" lakes and deepwater habitat layer (Large Figure 4).

### 4.3.3 Streams

The streams within the study area were initially identified using the MNDNR PWI layer and the flowlines from the USGS National Hydrography Dataset (NHD) within the study area. The NHD file was queried to only show the perennial streams in the study area. The PWI were revised by adding those NHD flowline segments that were not already in the PWI layer, thereby eliminating data redundancy. The streams were then edited depending on whether the stream was located outside or within the Human Disturbance Areas (Large Figure 2). Outside of the Human Disturbance Areas, the revised PWI was used as the "Existing" streams.

Within the Human Disturbance Areas, the PWI streams were edited in the following locations:

1. Within the proposed Project area – the extents of the Big Thirtynine Creek and Little Thirtynine Creek were removed from the PWI layer and the extents were updated using 2017 field mapping of the streams.
2. Within the existing Tailings Basin – the 2005 diversion channel was added using field mapping data.
3. Within the Human Disturbance Areas – the channel associated with the Northshore Wastewater Treatment Plant (Section 4.3.3) was added.
4. Within the study area – the "Existing" stream segments that intersect the "Existing" lakes and deepwater habitat layer were removed.

These edits were completed to generate the "Existing" streams layer (Large Figure 4).

### 4.3.4 Forest

Forests are present throughout the study area outside of the Human Disturbance Areas and lakes and deepwater habitat. Polygons that represent the open water of the "Existing" lakes and deepwater habitat (Section 4.3.2) and the Human Disturbance Areas (Section 4.1) were removed from this layer to create the "Existing" forest layer (Large Figure 4).

## 4.4 Foreseeable Future Aquatic and Forest Resources

The future time period represents wetland, lake and deepwater habitat, stream, and forest resources expected to be present following the conclusion and reclamation of the proposed Project. The acreage of aquatic and forest resources estimated for the future time period was developed as described in the following sections.

### 4.4.1 Cumulative Actions

This assessment included efforts to identify foreseeable future actions as described below. Relevant agencies were contacted to identify any foreseeable future actions within the study area. Agency officials were asked to identify actual or potential development projects that may occur in the study area. Public officials from city, county, state and federal agencies were contacted as follows:

1. City of Silver Bay
    a. City Administrator (contact: Lana Fralich) – identified the following projects:
        i. Black Beach Campground (Large Figure 5) – no wetland impacts but tree clearing will occur.
        ii. Sanitary Trunk Line Improvement Project (Large Figure 5) – less than one acre of temporary wetland impact and some tree clearing anticipated.
        iii. Multimodal Trailhead Center (Large Figure 5) – minor temporary wetland impact and minimal tree clearing anticipated.
        iv. Housing Development Project (Large Figure 5) – located on Penn Avenue with no wetland impacts or tree clearing anticipated.
        v. Silver Bay Business Park (Large Figure 5) – includes water, sewer, utilities, and roadway extension with up to 18 acres of wetland impact and some tree clearing anticipated.
        vi. Highway 61 – looping project for water break with no wetland or tree impacts anticipated.
        vii. MNDNR forestry grant – planting of 200 trees in summer of 2019 anticipated.
        viii. Replacement of all streets with no wetland or tree impacts anticipated.
        ix. Ditch maintenance project with minor temporary wetland impacts anticipated.
2. City of Beaver Bay
    a. City Administrator (contact: Tim Anderson) – no projects identified that would impact wetland, lake and deepwater habitat, stream, or forest resources.
3. Lake County

a. Forestry/Land Department (contact: Nate Eide) – no projects identified that would impact wetland, lakes and deepwater habitat, stream, or forest resources.
b. Highway Department (contact: Krysten Foster) – the Lake County Road and Bridge Five-Year Plan lists several projects occurring in Lake County through 2022. See PDF at https://www.co.lake.mn.us/Highway/2018%205%20year%20plan.pdf. No information on potential impacts to wetland, lake and deepwater habitat, stream, or forest resources is available at this time.
c. Soil and Water Conservation District (SWCD) (contact: Derrick Passe) – identified the following projects:
    i. Several restoration projects have been completed, with the East Branch, Beaver River Restoration Project nearing completion in the summer of 2019 (Large Figure 5), which, according to the associated Environmental Assessment Worksheet , will have approximately 0.3 acres of wetland impact and a gain in 0.6 acres of forest.
    ii. Also mentioned that the Beaver River watershed is a high priority area in the Lake Superior North One Watershed One Plan, which has a reforestation goal of 20 acres of coniferous trees per year in the Lake Superior North watershed (https://www.co.lake.mn.us/document_center/SWCD_Doc_Center/One%20Watershed%20One%20Plan%20Lake%20Superior%20North%201.pdf).

4. Minnesota Board of Soil and Water Resources (BWSR)
    a. Wetland Specialist for Duluth Office (contact: David Demmer) – indicated that there are a few projects in the study area and that most are near Lake Superior and mentioned some of the projects noted above that are occurring in Silver Bay.
        i. Lakeshore Residential Development – a proposed 5-lot residential development within the study area along Lake Superior; indicated that wetland impacts are unlikely but tree clearing may occur (Large Figure 5).
5. MnDOT
    a. State of Minnesota State Transportation Improvement Program (STIP; 2018 https://bwsr.state.mn.us/sites/default/files/2019-01/WCA_WCA_BWSR_Wet_Spec_Work_Areas.pdf) lists several projects occurring in Lake County through 2022 (https://www.co.lake.mn.us/Highway/2018%205%20year%20plan.pdf). No information on potential impacts to wetland, lake and deepwater habitat, stream, and forest resources is available at this time.
6. MNDNR
    a. Lands and Minerals (contact: Margi Coyle) – no information is available at this time regarding potential projects within the study area.
    b. Forestry (contact: Northeast Region office) – no information is available at this time regarding potential projects within the study area.
    c. Waters (contact: Cliff Bentley) – no information is available at this time regarding potential projects within the study area.

d. Tettegouche State Park (contact: Jason Peterson) – identified a few projects, all of which are located outside of the study area.
e. Finland State Forest (contact: Simon Keene) – identified a road project which is located outside of the study area.

7. USDA-USFS
    a. Superior National Forest (Contact: Connie Cummins) – no information is available at this time regarding potential projects within the study area.
8. Northshore Proposed Project
    a. Wetlands
        i. The wetland replacement plan (Barr 2019) identified 267.43 acres of direct impact wetland impacts. In addition, 10.42 acres of wetland will be removed that are not regulated under either the Minnesota Wetland Conservation Act or the Section 404 of the Clean Water Act.
    b. Lakes and deepwater habitat
        i. Murphy's Pond (29.57 acres) will be impacted.
        ii. Two future deepwater habitats (80.29 acres) will be created in the area.
    c. Streams/Channels
        i. The 2005, manmade diversion channel (1.1 miles) will be removed.
        ii. Several future MP7 manmade channels (~2.2 miles) will be created with the proposed Project to ensure continued drainage from existing, unimpacted wetlands adjacent to the Project.
        iii. Within the extent of the proposed Project, remnant segments of Big 39 Creek (5,150 feet) and Little 39 Creek (3,420 feet) will be removed.
        iv. The stream segments that intersected the "Foreseeable Future" lakes and deepwater habitat layer were removed from this layer.
        v. Northshore is currently evaluating several potential stream restoration projects on the Beaver River and East Branch Beaver River as part of planning for the proposed Project, but no details are currently publically available.
    d. Forest
        i. Approximately 235 acres of forest will be cleared for railroad and dam construction and 613 acres of forest will be slowly filled with tailings as the basin expands over the years for a total of 848 acres.

### 4.4.2 Wetlands

Foreseeable future projects identified that may affect wetlands include the proposed Project (277.85 acres), Silver Bay Business Park project (18 acres), East Branch Beaver River Restoration Project (0.3 acres), and some minor temporary wetland impacts (unknown acres), as described in Section 4.4.1.

### 4.4.3 Lakes and Deepwater Habitats

Foreseeable future projects that may affect lakes and deepwater habitat include only the proposed Project, with a loss of 29.57 acres of deepwater habitat and the creation of 80.29 acres of deepwater

habitat for a net gain of 50.72 acres of deepwater habitat. No other foreseeable future projects were identified that would potentially impact lakes or deepwater habitat in the study area.

### 4.4.4 Streams

Foreseeable future projects that may affect streams include only the proposed Project with a loss of 1.6 miles of remnant natural streams, the loss of 1.1 miles of manmade channels, and the creation of 2.2 miles of manmade channel. Northshore is currently evaluating several potential stream restoration projects within the study area, but none are expected to substantially increase stream length. No other foreseeable future projects were identified that would potentially impact streams in the study area.

### 4.4.5 Forest

Foreseeable future projects that may affect forest include the proposed Project with 235 acres of forest physically removed and 613 acres that will slowly be inundated by tailings storage over many years for a total of 848 acres affected. In addition, one project would add 0.6 acres of forest and up to 20 acres could be reforested each year, otherwise no other foreseeable future projects were identified that would substantially impact forest resources in the study area.

# 5 Cumulative Effects Assessment Results

## 5.1 Pre-settlement Conditions

A total of 24,051 acres of wetlands were identified in the 96,000 acre watershed comprising 25.1 percent of the watershed (Table 3; Large Figure 3).

A total of 523 acres of lakes and deepwater habitat were identified in the 96,000 acre watershed comprising 0.5 percent of the watershed (Table 4; Large Figure 3).

A total of 186.6 miles of streams were identified in the 96,000 acre watershed (Table 5; Large Figure 3).

A total of 95,518 acres of forests were identified in the 96,000 acre watershed comprising 99.5 percent of the watershed (Table 6; Large Figure 3).

## 5.2 Existing Conditions

A total of 23,047 acres of wetlands were identified in the 96,225 acre watershed comprising 24.0 percent of the land area (Table 3; Large Figure 4). There has been a decrease of approximately 1,000 acres of wetland, or about a 4 percent decrease in the wetland area compared to pre-settlement conditions (Table 7).

A total of 559 acres of lakes and deepwater habitat were identified in the 96,225 acre watershed comprising 0.6 percent of the land area (Table 4; Large Figure 4). There was an increase of 36 acres of deepwater habitat in the watershed compared to the pre-settlement conditions due to the establishment of Murphy's Pond and the Beaver Bay Wastewater Treatment ponds (Table 8). It should be noted that from pre-settlement to existing conditions, the land area draining to Lake Superior (Beaver River watershed) has increased in size by 225 acres due to operations of Reserve Mining Company (Large Figure 3 and Large Figure 4). That shoreline development resulted in the loss of about 216 acres of Lake Superior, which represents 0.001 percent of the 20,288,000 acre lake.

A total of 182.2 miles of streams were identified in the 96,225 acre watershed (Table 5; Large Figure 4). There has been a decrease of 4.4 miles of streams in the watershed compared to the pre-settlement conditions, representing a 2.4 percent decrease (Table 9).

A total of 87,352 acres of forests were identified in the 96,225 acre watershed comprising 90.8 percent of the land area (Table 6; Large Figure 4). There has been a decrease of approximately 8,165 acres of forest, or an 8.5 percent decrease in the forest area compared to pre-settlement conditions (Table 10).

## 5.3 Future Foreseeable Conditions

### 5.3.1 No Action Alternative

The No Action Alternative assumes no development of the proposed Project. Under this alternative, development of other identified projects would occur under the foreseeable future conditions (Table 2).

Without the proposed Project, there are projected to be approximately 23,027 acres of wetlands in the foreseeable future, which would comprise about 23.9 percent of the watershed (Table 3). Wetland acreage would be reduced by 4.3 percent compared to pre-settlement conditions and reduced by 0.1 percent compared to existing conditions (Table 7).

Without the proposed Project, there are projected to be approximately 559 acres of lakes and deepwater habitat in the foreseeable future, which would comprise about 0.6 percent of the watershed (Table 4). Lake and deepwater habitat acreage would be increased by 6.9 percent compared to pre-settlement conditions and there would be no change compared to existing conditions (Table 8).

Without the proposed Project, there are projected to be approximately 182.2 miles of streams in the foreseeable future (Table 5). Stream length would be reduced by 2.4 percent compared to pre-settlement conditions and there would be no change compared to existing conditions (Table 9).

Without the proposed Project, there are projected to be approximately 87,352 acres of forests in the foreseeable future, which would comprise about 90.8 percent of the watershed (Table 6). Forest acreage would be reduced by 8.5 percent compared to pre-settlement conditions and there would be no change compared to existing conditions (Table 10).

### 5.3.2 Proposed Action

The Proposed Action assumes development of the proposed Project. Under this alternative, development of other projects (including associated wetland and stream impacts in the Beaver River watershed) would occur under the foreseeable future conditions.

A total of approximately 22,749 acres of wetlands are projected to be present in the watershed in the foreseeable future comprising 23.6 percent of the land area (Table 3; Large Figure 5). The change in wetlands, as a proportion of all wetlands within the study area, will be a 5.4 percent reduction from pre-settlement conditions and a 1.3 percent reduction compared to existing conditions (Table 7).

A total of approximately 610 acres of lakes and deepwater habitat are projected to be present in the watershed in the foreseeable future, comprising 0.6 percent of the land area (Table 4; Large Figure 5). The change in lakes and deepwater habitat, as a proportion of the total study area, will be a 16.6 percent increase from pre-settlement conditions and a 9.1 percent increase compared to existing conditions (Table 8).

A total of approximately 181.8 miles of streams and channels are projected to be present in the watershed in the foreseeable future (Table 5; Large Figure 5). The change in stream length, as a proportion of the total study area, will be a 2.6 percent decrease from pre-settlement conditions and a 0.2 percent reduction compared to existing conditions (Table 9).

A total of approximately 86,505 acres of forests are projected to be present in the watershed in the foreseeable future, comprising 89.9 percent of the land area (Table 6; Large Figure 5). The change in

forests, as a proportion of the total study area, will be a 9.4 percent decrease from pre-settlement conditions and a 1.0 percent reduction compared to existing conditions (Table 10).

# 6 Cumulative Effects Assessment Discussion

The study area is unique in contrast to the historical loss of wetlands in the United States. Between the 1780s and the 1980s, the lower 48 states have lost about 53 percent of the pre-settlement wetland habitat (EPA 2019). Minnesota and Wisconsin have lost 42 and 50 percent of their original wetlands, respectively. Relatively few northeastern Minnesota wetlands have been negatively affected or lost compared to wetland loss in the rest of the state or country (Dahl 2011).

## 6.1 Wetlands

### 6.1.1 Cumulative Effects Study Area

Wetlands in the study area are similar in type and function to wetlands found throughout northeastern Minnesota. Most naturally-occurring wetland types in the study area are forested swamp, shrub carr, and alder thicket (MNDNR 2016). Wetlands currently comprise nearly 24 percent of the land area in the study area.

Nearly 99 percent of the existing wetlands in the study area will not be affected by the proposed Project or other foreseeable future development (Table 7).

Compared to pre-settlement conditions, the net decrease in wetland resources under future conditions with all foreseeable future projects in the study area is approximately 1,302 acres or 5.4 percent of the pre-settlement wetlands in the study area (Table 3). Approximately 77 percent of the 1,302-acre decrease is due to past actions in the study area.

Compared to existing conditions, the net decrease in wetland resources associated with all foreseeable future projects in the study area, will be approximately 298 acres, of which the proposed Project would contribute 93 percent (277.8 acres). The net change of wetlands associated with all foreseeable future projects represents 1.3 percent of the existing wetland resources within the study area (Table 7).

## 6.2 Lakes and Deepwater Habitat

Lakes and deepwater habitat currently comprise 0.6 percent of the land area in the study area (Table 4). The existing deepwater habitat that will be impacted by the proposed Project is Murphy's Pond. The rest of the existing lakes in the study area will not be affected by the proposed Project or other foreseeable future development (Table 8).

Compared to pre-settlement conditions, there will be a net increase in lake and deepwater habitat resources under future conditions with all foreseeable future projects in the study area of approximately 87 acres or 17 percent of the pre-settlement lakes and deepwater habitat in the study area (Table 4). Most of the change is due to Northshore operations and all of the changes are due to human-induced deepwater habitats.

Compared to existing conditions, the net increase in lake and deepwater habitat resources associated with all foreseeable future projects in the study area, would be approximately 51 acres, of which the proposed

Project would contribute 100 percent (25.97 acres removed; 80.29 acres created). The net change of lakes and deepwater habitat associated with all foreseeable future projects represents about a 9 percent increase from the existing lake and deepwater habitat resources within the study area (Table 8).

## 6.3 Streams

Streams currently comprise 186.6 miles within the study area (Table 5). Approximately 99 percent of the existing streams in the study area will not be affected by the proposed Project or other foreseeable future development (Table 9).

Compared to pre-settlement conditions, the net decrease in stream resources under future conditions with all foreseeable future projects in the study area is approximately 4.8 miles or 2.6 percent of the pre-settlement streams in the study area (Table 5). Approximately 92 percent of the 4.8 miles is due to past actions in the study area. Compared to existing conditions, the net decrease in stream resources associated with all foreseeable future projects in the study area, would be approximately 0.4 miles, of which the proposed Project would contribute 100 percent. The net change of streams associated with all foreseeable future projects represents less than one percent of the existing stream resources within the study area.

## 6.4 Forests

Forests currently comprise 90.8 percent of the land area in the study area (Table 6). Approximately 99 percent of the existing forests in the study area will not be affected by the proposed Project or other foreseeable future development (Table 10).

Compared to pre-settlement conditions, the net decrease in forest resources under future conditions with all foreseeable future projects in the study area is approximately 9,013 acres or 9 percent of the pre-settlement forests in the study area (Table 6). Over 90 percent of the 9,013 acres is due to past actions in the study area. Compared to existing conditions, the net decrease in forest resources associated with all foreseeable future projects in the study area, would be approximately 848 acres, of which the proposed Project would contribute 100 percent. The net change of forests associated with all foreseeable future projects represents only about 1 percent of the existing forest resources within the study area.

## 6.5 Conclusions

Within the study area:

- More than 98 percent of the existing wetlands in the study area will not be directly impacted by the proposed Project or other foreseeable future projects. Cumulatively, approximately 5 percent of pre-settlement wetlands within the watershed will be impacted when considering all foreseeable future projects, including the Northshore proposed Project.

- Lake and deepwater habitat will increase by about 9 percent from existing conditions in the study area when considering the proposed Project and other foreseeable future projects. Cumulatively, lake and deepwater habitat within the watershed will increase by less than 17 percent compared

to pre-settlement conditions when considering all foreseeable future projects, including the Northshore proposed Project.

- More than 99 percent of the existing streams in the study area will not be directly impacted by the proposed Project or other foreseeable future projects. Cumulatively, less than 3 percent of pre-settlement streams and perennial channels within the watershed will be impacted when considering all foreseeable future projects, including the Northshore proposed Project.

- Approximately 99 percent of the existing forests in the study area will not be directly impacted by the proposed Project or other foreseeable future projects. Cumulatively, approximately 9 percent of pre-settlement forests within the watershed will be impacted when considering all foreseeable future projects, including the Northshore proposed Project.

Based on the effects from the proposed Project and other foreseeable future actions, the cumulative effects on the wetlands, lakes and deepwater habitats, streams, and forest resources in the study area are likely not significant. The cumulative loss of approximately 5 percent of pre-settlement wetlands, or 1.5 percent of the watershed land area comprised by wetlands, will have little to no effect on their functioning for flood storage and maintaining water quality in the watershed. A study conducted in central Minnesota (Johnston et al., 1990) found that when wetland and lake area, as a percent of the watershed, is reduced below 10 percent, flood flows can increase greatly. However, watersheds with 10 to 50 percent wetlands and lakes have nearly the same flood flow per unit area (Johnston et al., 1990). A similar relationship was found for suspended solids as a measure of water quality (Oberts, 1981). Oberts (1981) found that watersheds with 10 to 20 percent wetlands had relatively constant rates of suspended solids generation per unit area of watershed. Therefore, because the HUC 10 Beaver River-Frontal Lake Superior watershed will maintain nearly 24 percent wetlands, by area, with the proposed Project and all reasonably foreseeable future projects, flooding and water quality characteristics will not be adversely affected.

Within the HUC 10 Beaver River-Frontal Lake Superior watershed, approximately 70 percent of the cumulative wetland loss has occurred and will occur proximate to the area of the existing and future Northshore tailings basin. Potential effects of the cumulative wetland loss on flooding and water quality will be minimized by the proposed Project. The proposed tailings basin will provide about 3,000 acres of flood storage and water quality treatment capacity through the collection of rainfall and runoff within the project area and processing of excess water through the Northshore wastewater treatment plant prior to discharge. The wastewater treatment plant has been documented to remove suspended solids consistently to well below water quality standards. In addition, the wastewater treatment plant has documented discharge rates below what would be considered flood flows in the Beaver River. Therefore, with approximately three times more flood storage than was present historically, and proven water quality treatment, the proposed Project and all reasonably foreseeable future projects will not adversely affect flooding or water quality within the Beaver River watershed. Furthermore, the cumulative effects on wetlands in the study area are significantly less than in other parts of the state and country.

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# Tables

Table 1. Townships in the study area.

| Township | Range | Township Area within the Watershed (ac) | Area of Human Disturbance in Township (ac)[1] | Percent of Impacted Area in Township |
|---|---|---|---|---|
| 54N | 8W | 737 | 42 | 5.7% |
| 54N | 9W | 3 | 0 | 0 to % |
| 55N | 7W | 576 | 350 | 60.7% |
| 55N | 8W | 16,373 | 2,599 | 15.9% |
| 55N | 9W | 5,283 | 445 | 8.4% |
| 56N | 7W | 7,791 | 1,185 | 15.2% |
| 56N | 8W | 22,737 | 3,255 | 14.3% |
| 56N | 9W | 20,604 | 261 | 1.3% |
| 56N | 10W | 437 | 7 | 1.6% |
| 57N | 7W | 10 | 0 | 0.0% |
| 57N | 8W | 6,545 | 68 | 1.0% |
| 57N | 9W | 14,080 | 116 | 0.8% |
| 57N | 10W | 50 | 6 | 12.5% |
| 58N | 8W | 13 | 1 | 6.1% |
| 58N | 9W | 985 | 15 | 1.5% |
| Total | | 96,224 | 8,351 | 8.7% |

[1] Human disturbance includes mining features, roads, railroads, barren land, rural and municipal residental, and municipal development.

Table 2. Changes in wetland, lake and deepwater habitat, stream, and forest resources in the foreseeable future.

| Project Name | Wetland (acre) | Lake and Deepwater Habitat (acre)[1] | Stream (miles) | Forest (acre) |
|---|---|---|---|---|
| Proposed Project (Northshore) | -277.9 | 51 | -0.4 | -848 |
| Silver Bay Business Park[2] | -18 | 0 | 0 | NA[4] |
| Miscellaneous projects in the watershed[3] | -2 | 0 | 0 | NA[4] |

[1]As part of Northshore's proposed Project, Murphy's Pond (25.97 acres) will be impacted and two open water areas will be created (80.29 acres), resulting in a net gain in deepwater area.

[2]Assumes worst case scenario where all wetlands identified in the project area would be impacted.

[3]Maximum impact that could occur from additional projects identified in Section 4.4.1.

[4]It is not known how much tree clearing will occur for these small projects; however, tree planting efforts through a MnDNR forestry grant in Silver Bay and reforestation efforts in the Beaver River watershed should offsett forest removal associated with these projects.

Table 3. Total wetland area (acres) for pre-settlement, existing, and future conditions.

| Watershed | Presettlement Conditions | | | Existing Conditions | | | Foreseeable Future Conditions with the Proposed Project | | | Foreseeable Future Conditions without the Proposed Project (No Action Alternative) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total Land Area (ac) | Area (ac) | % of Watershed | Total Land Area | Area (ac) | % of Watershed | Total Land Area | Area (ac) | % of Watershed | Area (ac) | % of Watershed |
| Beaver River | 96,000 | 24,051 | 25.1% | 96,225 | 23,047 | 24.0% | 96,225 | 22,749 | 23.6% | 23,027 | 23.9% |

Table 4. Total lake and deepwater habitat area (acres) for pre-settlement, existing, and future conditions.

| Watershed | Total Land Area (ac) | Presettlement Conditions | | Existing Conditions | | | Foreseeable Future Conditions with the Proposed Project | | | Foreseeable Future Conditions without the Proposed Project (No Action Alternative) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Area (ac) | % of Watershed | | Area (ac) | % of Watershed | | Area (ac) | % of Watershed | Area (ac) | % of Watershed |
| Beaver River | 96,000 | 523 | 0.5% | 96,225 | 559 | 0.6% | 96,225 | 610 | 0.6% | 559 | 0.6% |

Table 5. Total stream length (miles) for pre-settlement, existing, and future conditions.

| Watershed | Total Land Area (ac) | Presettlement Conditions | | Existing Conditions | | | Foreseeable Future Conditions with the Proposed Project | | | Foreseeable Future Conditions without the Proposed Project (No Action Alternative) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Length (mi) | % of Watershed | | Length (mi) | % of Watershed | | Length (mi) | % of Watershed | Length (mi) | % of Watershed |
| Beaver River | 96,000 | 186.6 | NA | 96,225 | 182.2 | NA | 96,225 | 181.8 | NA | 182.2 | NA |

Table 6. Total forest area (acres) for pre-settlement, existing, and future conditions.

| Watershed | Total Land Area (ac) | Presettlement Conditions | | Existing Conditions | | | Foreseeable Future Conditions with the Proposed Project | | | Foreseeable Future Conditions without the Proposed Project (No Action Alternative) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Area (ac) | % of Watershed | | Area (ac) | % of Watershed | | Area (ac) | % of Watershed | Area (ac) | % of Watershed |
| Beaver River | 96,000 | 95,518 | 99.5% | 96,225 | 87,352 | 90.8% | 96,225 | 86,505 | 89.9% | 87,352 | 90.8% |

Table 7. Summary of future known changes in wetland resources for the study area [1].

| Watershed | Pre-settlement Conditions | | Existing Conditions | | % Change from Pre-settlement to Existing Conditions | Forseeable Future Conditions with the Proposed Project | | % Change from Pre-settlement to Future Conditions with the Proposed Project | % Change from Existing to Future Conditions with the Proposed Project | Forseeable Future Conditions with the No Action Alternative | | % Change from Pre-settlement to Future Conditions with the No Action Alternative | % Change from Existing to Future Conditions with the No Action Alternative |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total Land Area (ac) | Wetland Area (ac) | Total Land Area (ac) | Wetland Area (ac) | | Total Land Area (ac) | Wetland Area (ac) | | | Total Land Area (ac) | Wetland Area (ac) | | |
| Beaver River | 96,000 | 24,051 | 96,225 | 23,047 | -4.2% | 96,225 | 22,749 | -5.4% | -1.3% | 96,225 | 23,027 | -4.3% | -0.1% |

[1]The (-) represents a loss of acres and the (+) represents a gain of acres.

Table 8. Summary of future known changes in lake and deepwater habitat resources for the study area [1].

| Watershed | Pre-settlement Conditions | | Existing Conditions | | % Change from Pre-settlement to Existing Conditions | Forseeable Future Conditions with the Proposed Project | | % Change from Pre-settlement to Future Conditions with the Proposed Project | % Change from Existing to Future Conditions with the Proposed Project | Forseeable Future Conditions with the No Action Alternative | | % Change from Pre-settlement to Future Conditions with the No Action Alternative | % Change from Existing to Future Conditions with the No Action Alternative |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total Land Area (ac) | Lake and Deepwater Habitat Area (ac) | Total Land Area (ac) | Lake and Deepwater Habitat Area (ac) | | Total Land Area (ac) | Lake and Deepwater Habitat Area (ac) | | | Total Land Area (ac) | Lake and Deepwater Habitat Area (ac) | | |
| Beaver River | 96,000 | 523 | 96,225 | 559 | 6.9% | 96,225 | 610 | 16.6% | 9.1% | 96,225 | 559 | 6.9% | 0.0% |

[1]The (-) represents a loss of acres and the (+) represents a gain of acres.

Table 9. Summary of future known changes in stream length for the study area [1].

| Watershed | Pre-settlement Conditions | | Existing Conditions | | % Change from Pre-settlement to Existing Conditions | Forseeable Future Conditions with the Proposed Project | | % Change from Pre-settlement to Future Conditions with the Proposed Project | % Change from Existing to Future Conditions with the Proposed Project | Forseeable Future Conditions with the No Action Alternative | | % Change from Pre-settlement to Future Conditions with the No Action Alternative | % Change from Existing to Future Conditions with the No Action Alternative |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total Land Area (ac) | Stream Length (mi) | Total Land Area (ac) | Stream Length (mi) | | Total Land Area (ac) | Stream Length (mi) | | | Total Land Area (ac) | Stream Length (mi) | | |
| Beaver River | 96,000 | 186.6 | 96,225 | 182.2 | -2.4% | 96,225 | 181.8 | -2.6% | -0.2% | 96,225 | 182.2 | -2.4% | 0.0% |

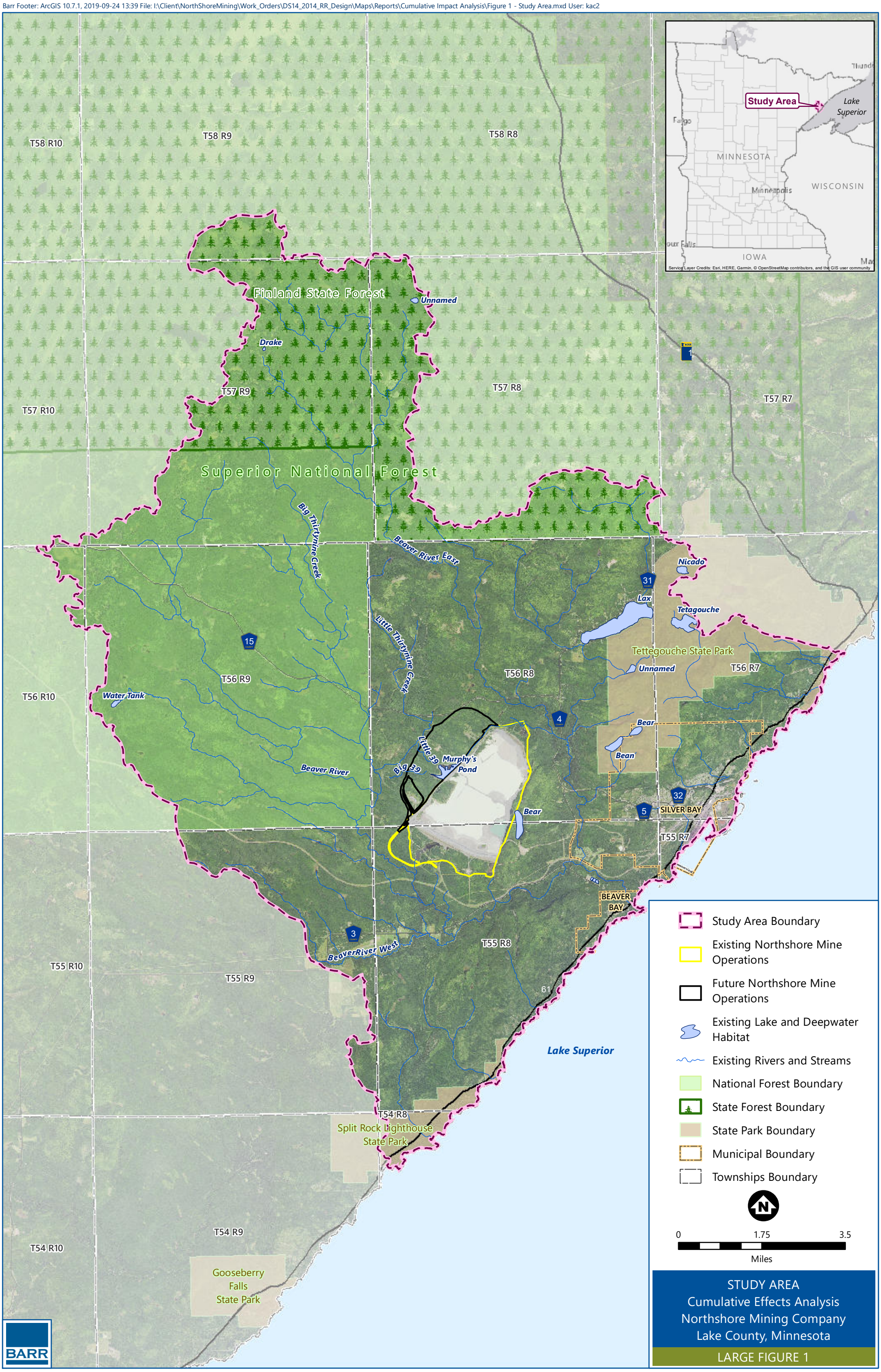
[1] The (-) represents a loss of linear feet and the (+) represents a gain of linear feet.

Table 10. Summary of future known changes in forest area for the study area [1].

| Watershed | Pre-settlement Conditions | | Existing Conditions | | % Change from Pre-settlement to Existing Conditions | Forseeable Future Conditions with the Proposed Project | | % Change from Pre-settlement to Future Conditions with the Proposed Project | % Change from Existing to Future Conditions with the Proposed Project | Forseeable Future Conditions with the No Action Alternative | | % Change from Pre-settlement to Future Conditions with the No Action Alternative | % Change from Existing to Future Conditions with the No Action Alternative |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total Land Area (ac) | Forest Area (ac) | Total Land Area (ac) | Forest Area (ac) | | Total Land Area (ac) | Forest Area (ac) | | | Total Land Area (ac) | Forest Area (ac) | | |
| Beaver River | 96,000 | 95,518 | 96,225 | 87,352 | -8.5% | 96,225 | 86,505 | -9.4% | -1.0% | 96,225 | 87,352 | -8.5% | 0.0% |

[1]The (-) represents a loss of acres and the (+) represents a gain of acres.

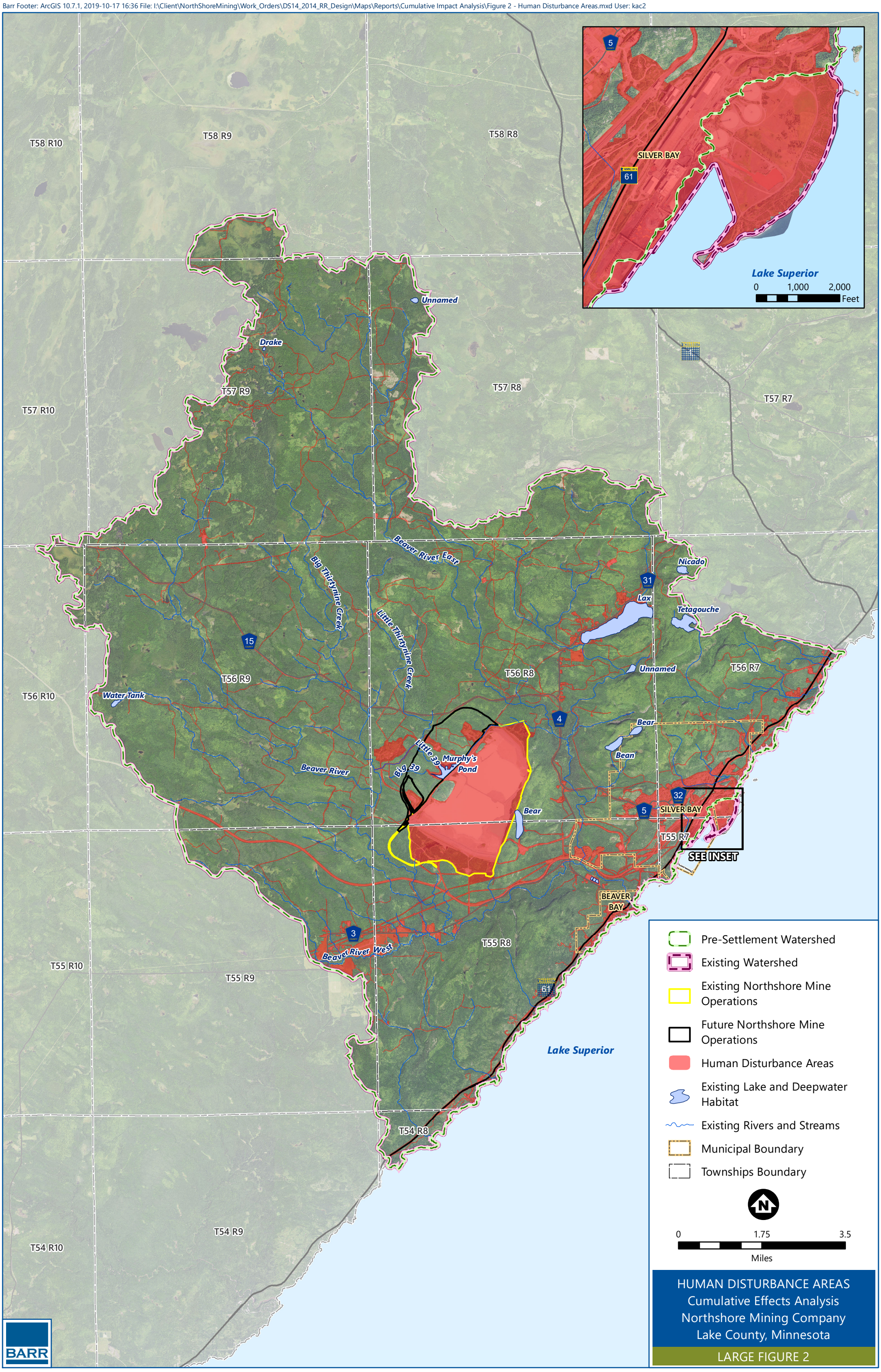
# Large Figures




STUDY AREA
Cumulative Effects Analysis
Northshore Mining Company
Lake County, Minnesota

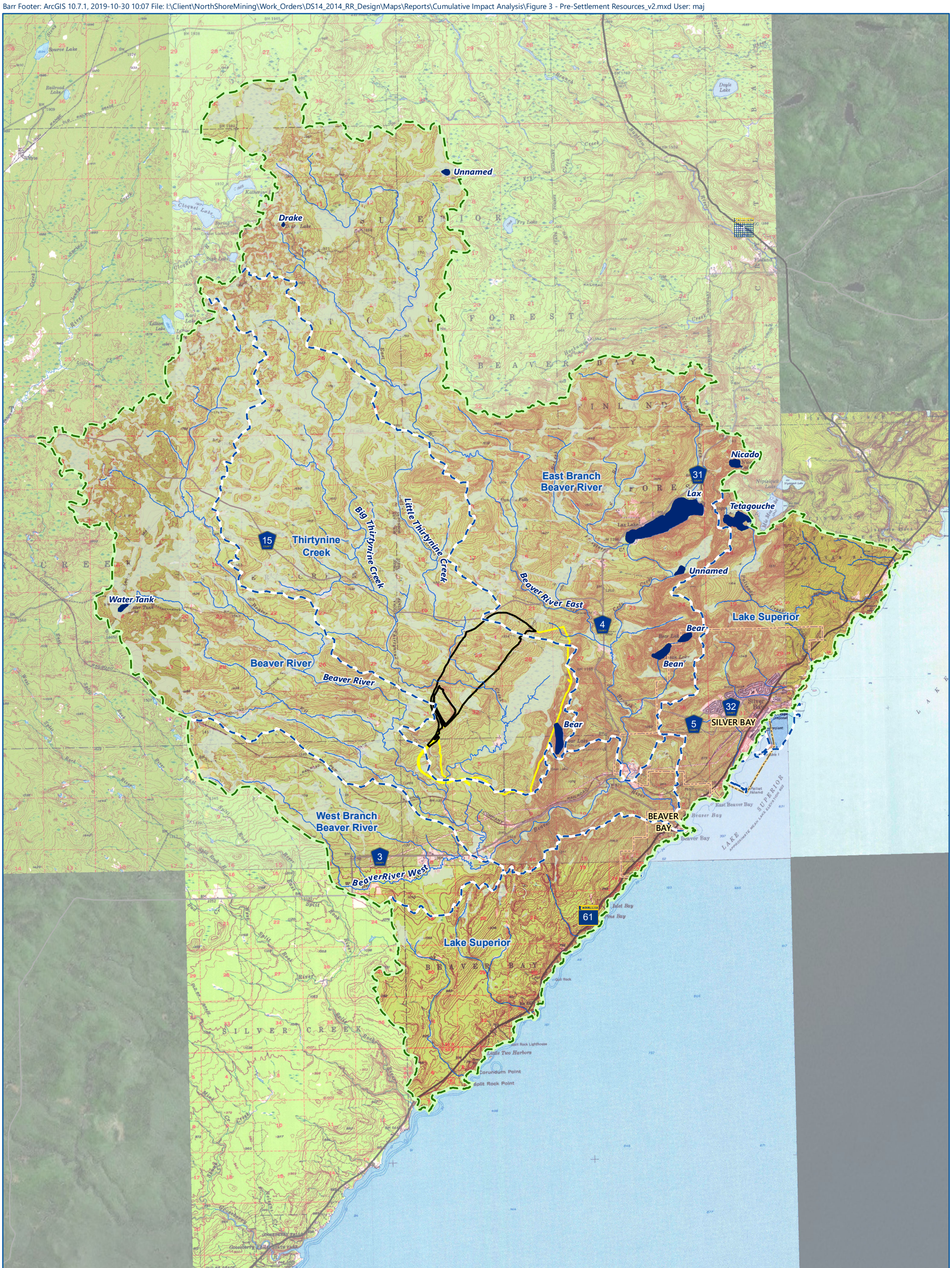
LARGE FIGURE 1

Barr Footer: ArcGIS 10.7.1, 2019-10-17 16:36 File: I:\Client\NorthShoreMining\Work_Orders\DS14_2014_RR_Design\Maps\Reports\Cumulative Impact Analysis\Figure 2 - Human Disturbance Areas.mxd User: kac2




HUMAN DISTURBANCE AREAS
Cumulative Effects Analysis
Northshore Mining Company
Lake County, Minnesota

LARGE FIGURE 2




## Legend

- Pre-Settlement Watershed
- Pre-settlement Subwatersheds
- Pre-Settlement Rivers and Streams
- Pre-Settlement Lakes and Deepwater Habitat
- Future Northshore Mine Operations
- Existing Northshore Mine Operations
- Pre-Settlement Forest Cover
- Municipal Boundary
- Pre-Settlement Wetlands

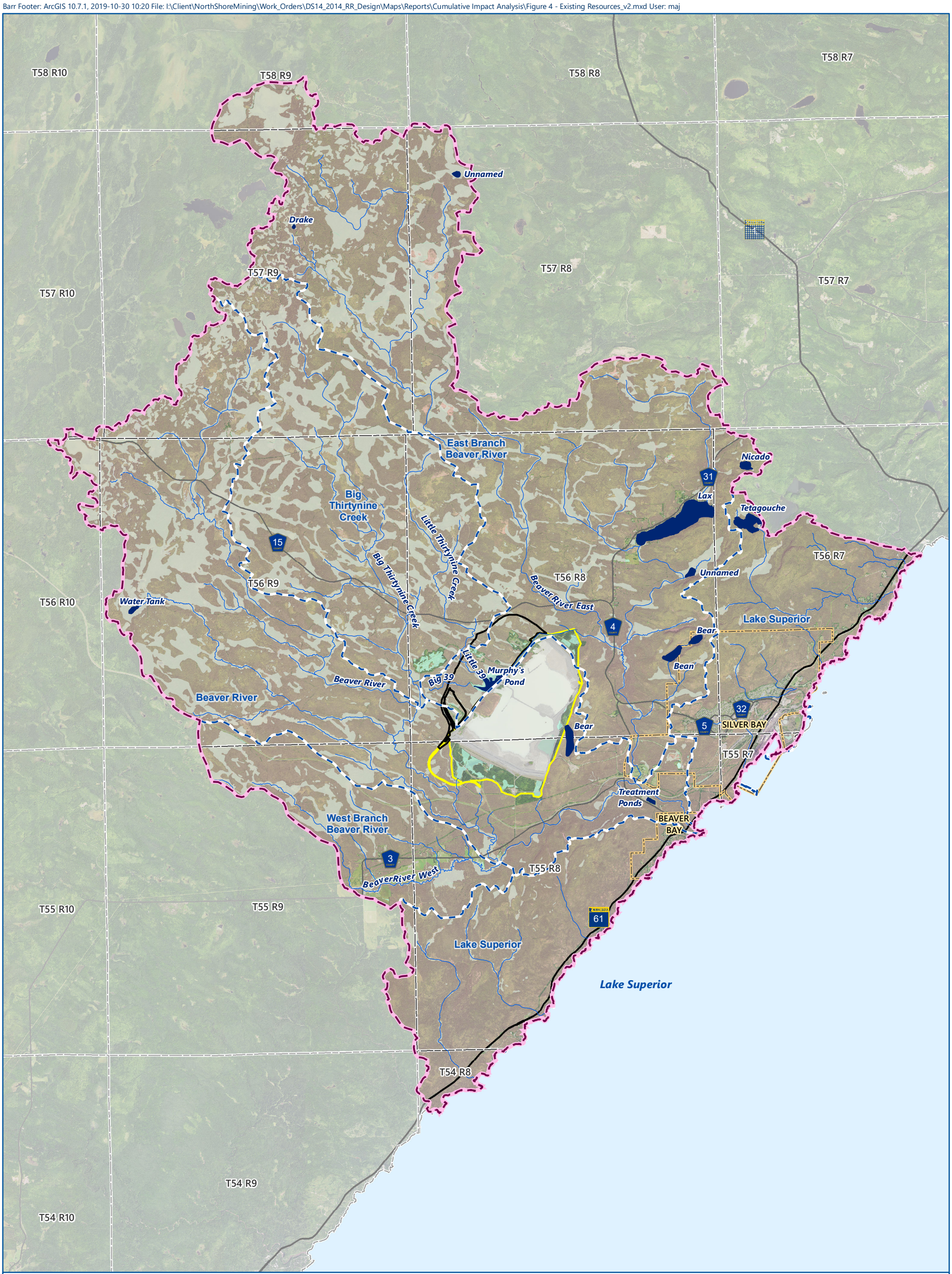
N

0 1.75 3.5
Miles

PRE-SETTLEMENT RESOURCES
Cumulative Effects Analysis
Northshore Mining Company
Lake County, Minnesota

LARGE FIGURE 3

BARR




## Legend

- Existing Watershed
- Existing Subwatersheds
- Existing Rivers and Streams
- Existing Lakes and Deepwater Habitat
- Municipal Boundary
- Future Northshore Mine Operations
- Existing Northshore Mine Operations
- Townships Boundary
- Existing Forest Cover
- Existing Wetlands

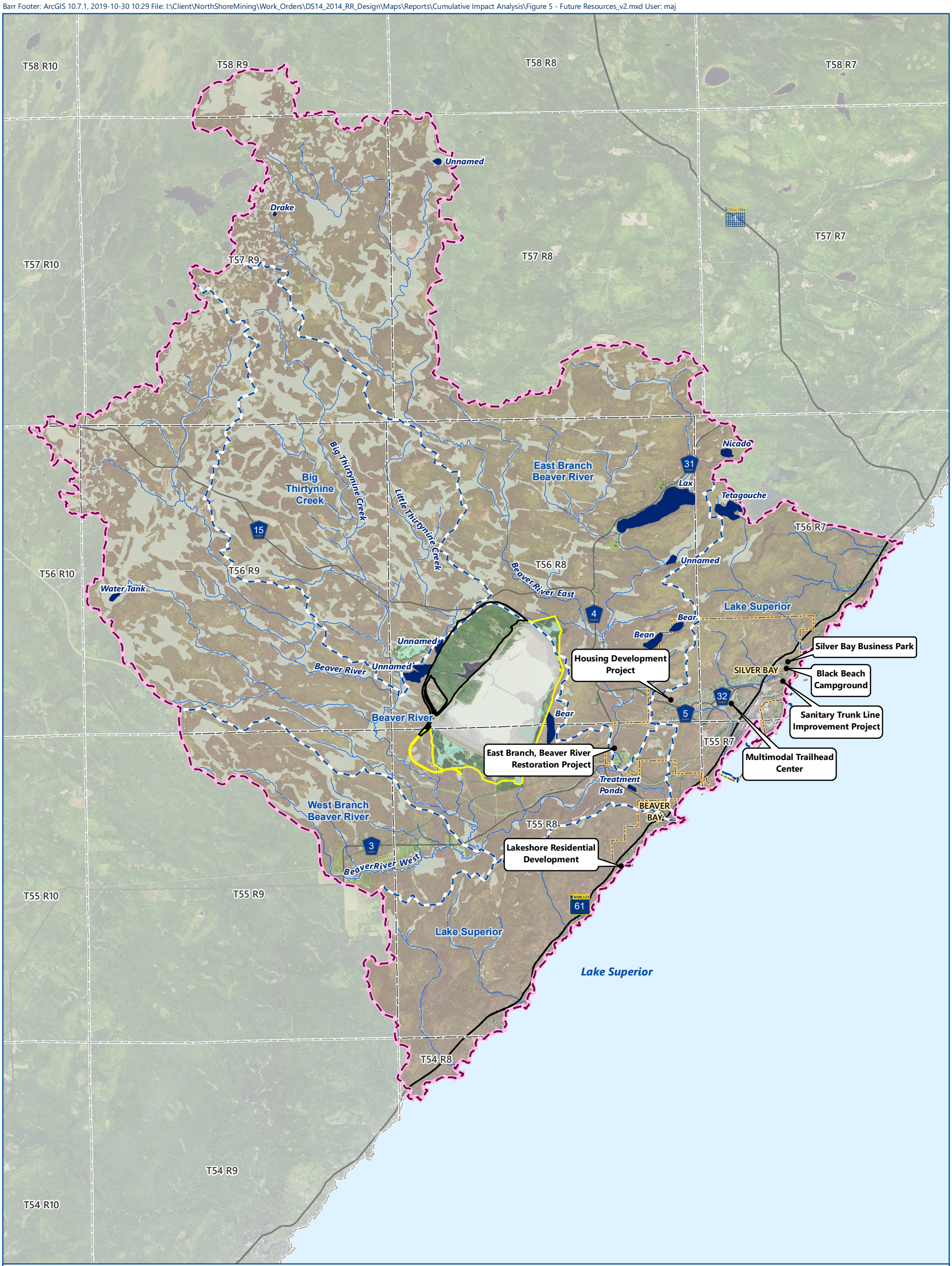
0 1.75 3.5
Miles

EXISTING RESOURCES
Cumulative Effects Analysis
Northshore Mining Company
Lake County, Minnesota

LARGE FIGURE 4

BARR

Barr Footer: ArcGIS 10.7.1, 2019-10-30 10:29 File: I:\Client\NorthShoreMining\Work_Orders\DS14_2014_RR_Design\Maps\Reports\Cumulative Impact Analysis\Figure 5 - Future Resources_v2.mxd User: maj




## Legend

- Foreseeable Future Projects
- Future Watershed
- Future Northshore Mine Operations
- Existing Northshore Mine Operations
- Future Subwatersheds
- Future Rivers and Streams
- Future Lakes and Deepwater Habitat
- Municipal Boundary
- Townships Boundary
- Future Forest Cover
- Future Wetlands

N

0 1.75 3.5
Miles

FORESEEABLE FUTURE RESOURCES
Cumulative Effects Analysis
Northshore Mining Company
Lake County, Minnesota

LARGE FIGURE 5

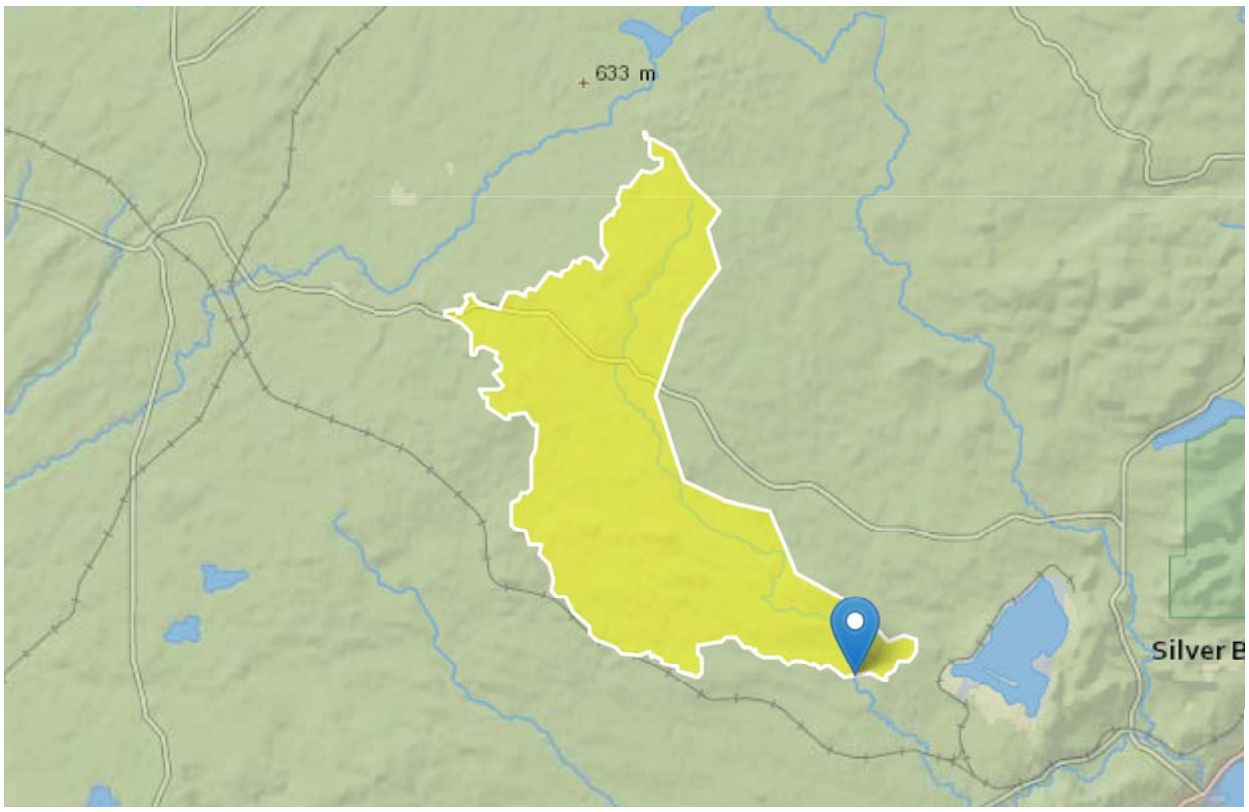
BARR

# Appendix C

## Streamflow and Stream Water Level Modeling Results – Beaver River

# Discharge into Upper Middle Beaver River Subwatershed #11 - Pre-Settlement

**Region ID:** MN
**Workspace ID:** MN20200325230243210000
**Clicked Point (Latitude, Longitude):** 47.28686, -91.41713
**Time:** 2020-03-25 18:02:57 -0500




Basin Characteristics

| Parameter Code | Parameter Description | Value | Unit |
|---|---|---|---|
| DRNAREA | Area that drains to a point on a stream | 24.05 | square miles |
| LAKEAREA | Percentage of Lakes and Ponds | 0.6 | percent |

| Parameter Code | Parameter Description | Value | Unit |
|---|---|---|---|
| STORNWI | Percentage of storage (combined water bodies and wetlands) from the National Wetlands Inventory | 37.98 | percent |
| SSURGOC | Percentage of area of Hydrologic Soil Type C from SSURGO | 21.9 | percent |

General Disclaimers

Parameter values have been edited, computed flows may not apply.

This watershed has been edited, computed flows may not apply.

Peak-Flow Statistics Parameters[100 Percent (24.1 square miles) Region C]

| Parameter Code | Parameter Name | Value | Units | Min Limit | Max Limit |
|---|---|---|---|---|---|
| DRNAREA | Drainage Area | 24.05 | square miles | 0.21 | 607 |
| LAKEAREA | Percent Lakes and Ponds | 0.6 | percent | 0 | 11.8 |

Peak-Flow Statistics Flow Report[100 Percent (24.1 square miles) Region C]

PIl: Prediction Interval-Lower, Plu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

| Statistic | Value | Unit | PIl | Plu | SE | SEp | Equiv. Yrs. |
|---|---|---|---|---|---|---|---|
| 1.5 Year Peak Flood | 509 | ft^3/s | 236 | 950 | 45.2 | 45.2 | 2.8 |
| 2 Year Peak Flood | 653 | ft^3/s | 291 | 1250 | 46.8 | 46.8 | 2.4 |
| 5 Year Peak Flood | 1100 | ft^3/s | 461 | 2200 | 50.4 | 50.4 | 2.8 |
| 10 Year Peak Flood | 1490 | ft^3/s | 600 | 3020 | 52.9 | 52.9 | 3.5 |
| 25 Year Peak Flood | 2070 | ft^3/s | 798 | 4320 | 56.2 | 56.2 | 4.5 |

| Statistic | Value | Unit | PIl | PIu | SE | SEp | Equiv. Yrs. |
|---|---|---|---|---|---|---|---|
| 50 Year Peak Flood | 2600 | ft^3/s | 964 | 5560 | 59.1 | 59.1 | 5.1 |
| 100 Year Peak Flood | 3200 | ft^3/s | 1140 | 7030 | 62.3 | 62.3 | 5.7 |
| 500 Year Peak Flood | 4970 | ft^3/s | 1560 | 11700 | 70.9 | 70.9 | 6.5 |

*Peak-Flow Statistics Citations*

**Lorenz, D.L., Sanocki, C.A., and Kocian, M.J.,2009, Techniques for Estimating the Magnitude and Frequency of Peak Flows on Small Streams in Minnesota Based on Data through Water Year 2005: U.S. Geological Survey Scientific Investigations Report 2009-5250, 54 p. (http://pubs.usgs.gov/sir/2009/5250/pdf/sir2009-5250.pdf)**

Low-Flow Statistics Parameters[Low flow Region BC 2015 5170]

| Parameter Code | Parameter Name | Value | Units | Min Limit | Max Limit |
|---|---|---|---|---|---|
| DRNAREA | Drainage Area | 24.05 | square miles | 2.98 | 2960 |
| STORNWI | Percentage of Storage from NWI | 37.98 | percent | 2.44 | 48 |
| SSURGOC | SSURGO Percent Hydrologic Soil Type C | 21.9 | percent | 2.61 | 100 |

Low-Flow Statistics Flow Report[Low flow Region BC 2015 5170]

| Statistic | Value | Unit |
|---|---|---|
| 7 Day 10 Year Low Flow | 0.614 | ft^3/s |

*Low-Flow Statistics Citations*

**Ziegeweid, J.R., Lorenz, D.L., Sanocki, C.A., and Czuba, C.R.,2015, Methods for estimating flow-duration curve and low-flow frequency statistics for ungaged locations on small streams in Minnesota: U.S. Geological Survey Scientific Investigations Report 2015–5170, 23 p. (http://dx.doi.org/10.3133/sir20155170)**

Seasonal Flow Statistics Parameters[Low flow Region BC 2015 5170]

| Parameter Code | Parameter Name | Value | Units | Min Limit | Max Limit |
|---|---|---|---|---|---|
| DRNAREA | Drainage Area | 24.05 | square miles | 2.98 | 2960 |
| STORNWI | Percentage of Storage from NWI | 37.98 | percent | 2.44 | 48 |
| SSURGOC | SSURGO Percent Hydrologic Soil Type C | 21.9 | percent | 2.61 | 100 |

Seasonal Flow Statistics Flow Report[Low flow Region BC 2015 5170]

| Statistic | Value | Unit |
|---|---|---|
| Oct to Nov 7 Day 10 Year Low Flow | 1.61 | ft^3/s |
| 30_Day_10_Year_Low_Flow_Oct_to_Nov | 2.37 | ft^3/s |
| 7_Day_10_Year_lowflow_Dec_to_Mar | 0.863 | ft^3/s |
| 30_Day_10_Year_Low_Flow_Dec_to_Mar | 1.05 | ft^3/s |
| Apr to May 7 Day 10 Year Low Flow | 3.31 | ft^3/s |
| Apr to May 30 Day 10 Year Low Flow | 12.2 | ft^3/s |
| 7_Day_10_Year_lowflow_Jun_to_Sep | 0.84 | ft^3/s |
| 30_Day_10_Year_Low_Flow_Jun_to_Sep | 1.14 | ft^3/s |
| 122_Day_10_Year_Low_Flow_Jun_to_Sep | 6.95 | ft^3/s |

*Seasonal Flow Statistics Citations*

**Ziegeweid, J.R., Lorenz, D.L., Sanocki, C.A., and Czuba, C.R.,2015, Methods for estimating flow-duration curve and low-flow frequency statistics for ungaged locations on small streams in Minnesota: U.S. Geological Survey Scientific Investigations Report 2015–5170, 23 p. (http://dx.doi.org/10.3133/sir20155170)**

Flow-Duration Statistics Parameters[Flow duration Region BC 2015 5170]

| Parameter Code | Parameter Name | Value | Units | Min Limit | Max Limit |
|---|---|---|---|---|---|

| Parameter Code | Parameter Name | Value | Units | Min Limit | Max Limit |
|---|---|---|---|---|---|
| DRNAREA | Drainage Area | 24.05 | square miles | 2.98 | 2960 |
| STORNWI | Percentage of Storage from NWI | 37.98 | percent | 2.44 | 48 |
| SSURGOC | SSURGO Percent Hydrologic Soil Type C | 21.9 | percent | 2.61 | 100 |

Flow-Duration Statistics Flow Report[Flow duration Region BC 2015 5170]

| Statistic | Value | Unit |
|---|---|---|
| 0.01 Percent Duration | 501 | ft^3/s |
| 0.1 Percent Duration | 319 | ft^3/s |
| 2 Percent Duration | 119 | ft^3/s |
| 5 Percent Duration | 76 | ft^3/s |
| 10 Percent Duration | 38.9 | ft^3/s |
| 25 Percent Duration | 19.1 | ft^3/s |
| 50 Percent Duration | 6.84 | ft^3/s |
| 75 Percent Duration | 3.37 | ft^3/s |
| 90 Percent Duration | 1.86 | ft^3/s |
| 95 Percent Duration | 1.15 | ft^3/s |
| 99 Percent Duration | 0.562 | ft^3/s |
| 99.9 Percent Duration | 0.21 | ft^3/s |
| 99.99 Percent Duration | 0.175 | ft^3/s |

*Flow-Duration Statistics Citations*

**Ziegeweid, J.R., Lorenz, D.L., Sanocki, C.A., and Czuba, C.R.,2015, Methods for estimating flow-duration curve and low-flow frequency statistics for ungaged locations on small streams in Minnesota: U.S. Geological Survey Scientific Investigations Report 2015–5170, 23 p. (http://dx.doi.org/10.3133/sir20155170)**

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Application Version: 4.3.11

NATIONAL WEATHER SERVICE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

# Normal Depth Calculator

Weather.gov > Alaska-Pacific RFC > Normal Depth Calculator

**Alaska-Pacific RFC**
River Forecast Center

River Observations and Forecasts | Weather Observations and Forecasts | Water Supply | Climate and History | Seasonal Interest | Additional Info

## Normal Depth Demonstration Tool

One the most commonly used equations governing Open Channel Flow is known as the Mannings's Equation. It was introduced by the Irish Engineer Robert Manning in 1889 as an alternative to the Chezy Equation. The Mannings equation is an empirical equation that applies to uniform flow in open channels and is a function of the channel velocity, flow area and channel slope.

$$Q = VA = \left(\frac{1.49}{n}\right) AR^{\frac{2}{3}}\sqrt{S} \quad [U.S.]$$

$$Q = VA = \left(\frac{1.00}{n}\right) AR^{\frac{2}{3}}\sqrt{S} \quad [SI]$$

Where:
Q = Flow Rate, ($ft^3/s$)
v = Velocity, (ft/s)
A = Flow Area, ($ft^2$)
n = Manning's Roughness Coefficient
R = Hydraulic Radius, (ft)
S = Channel Slope, (ft/ft)

Under the assumption of uniform flow conditions the bottom slope is the same as the slope of the energy grade line and the water surface slope. The Manning's n is a coefficient which represents the roughness or friction applied to the flow by the channel. Manning's n-values are often selected from tables, but can be back calculated from field measurements. In many flow conditions the selection of a Manning's roughness coefficient can greatly affect computational results.

**Instructions:** Select variable to solve, adjust slider bars, click on graph to modify the cross section. CSV cross section data can be loaded in the input box below. This online calculator is for demonstration and educational purposes only.

Solve For: Water Surface (normal depth)

Slope: 0.0107 (ft/ft)

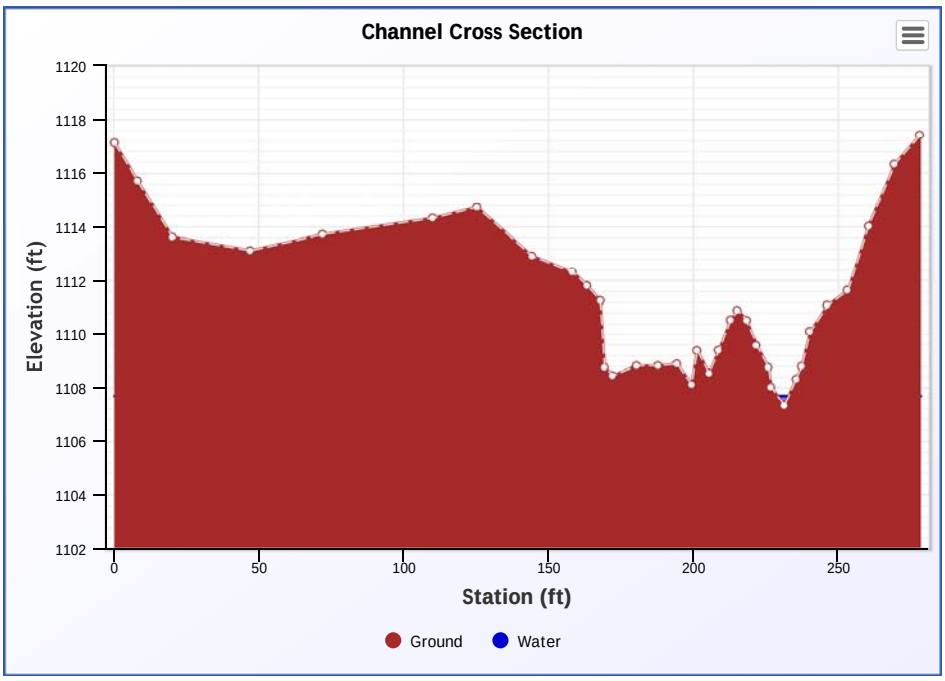
WSE: 1107.67 (ft)

Channel Manning n: 0.040

Flow: 1 ($ft^3/s$)

100 40000

Reset Cross Section




| | |
|---|---|
| Flow Area: | 0.8 ($ft^2$) |
| Wetted Perimeter: | 4.1 (ft) |
| Max Depth: | 0.38 (ft) |
| Average Velocity: | 1.11 (ft/s) |
| Top Width: | 4 (ft) |
| Iterations: | 5001 |
| Froude Number: | 0.45 |

Select HECRAS Geometry: Browse... Load HEC-RAS Data

Load CSV XS Data Below
(station,elevation)

Update Plot

```
0.00,1117.10
8.00,1115.70
20.00,1113.60
47.00,1113.10
72.00,1113.70
110.00,1114.30
125.00,1114.70
144.00,1112.90
158.00,1112.30
163.00,1111.79
167.50,1111.24
169.00,1108.74
172.00,1108.43
180.00,1108.80
187.50,1108.80
194.00,1108.87
199.00,1108.10
201.00,1109.37
205.00,1108.52
208.50,1109.38
212.50,1110.53
215.00,1110.88
218.00,1110.51
221.50,1109.56
225.50,1108.74
226.50,1108.00
231.00,1107.29
235.00,1108.30
237.00,1108.78
240.00,1110.10
246.00,1111.07
253.00,1111.62
260.00,1114.00
269.00,1116.30
278.00,1117.40
```

# Normal Depth Calculator



## Normal Depth Demonstration Tool

One the most commonly used equations governing Open Channel Flow is known as the Mannings's Equation. It was introduced by the Irish Engineer Robert Manning in 1889 as an alternative to the Chezy Equation. The Mannings equation is an empirical equation that applies to uniform flow in open channels and is a function of the channel velocity, flow area and channel slope.

$$Q = VA = \left(\frac{1.49}{n}\right) AR^{\frac{2}{3}} \sqrt{S} \quad [U.S.]$$

$$Q = VA = \left(\frac{1.00}{n}\right) AR^{\frac{2}{3}} \sqrt{S} \quad [SI]$$

Where:
Q = Flow Rate, (ft3/s)
v = Velocity, (ft/s)
A = Flow Area, (ft2)
n = Manning's Roughness Coefficient
R = Hydraulic Radius, (ft)
S = Channel Slope, (ft/ft)

Under the assumption of uniform flow conditions the bottom slope is the same as the slope of the energy grade line and the water surface slope. The Manning's n is a coefficient which represents the roughness or friction applied to the flow by the channel. Manning's n-values are often selected from tables, but can be back calculated from field measurements. In many flow conditions the selection of a Manning's roughness coefficient can greatly affect computational results.

**Instructions:** Select variable to solve, adjust slider bars, click on graph to modify the cross section. CSV cross section data can be loaded in the input box below. This online calculator is for demonstration and educational purposes only.

Select HECRAS Geometry: Choose File No file chosen Load HEC-RAS Data

Solve For: Water Surface (normal depth)

Slope: 0.0107 (ft/ft)

WSE: 1110.3 (ft)

Channel Manning n: 0.040

Flow: 509 (ft3/s)

100 40000

Reset Cross Section

| | |
|---|---|
| Flow Area: | 101.6 (ft2) |
| Wetted Perimeter: | 68.6 (ft) |
| Max Depth: | 3.04 (ft) |
| Average Velocity: | 5.01 (ft/s) |
| Top Width: | 66 (ft) |
| Iterations: | 36 |
| Froude Number: | 0.71 |

Load CSV XS Data Below
(station,elevation)

Update Plot

```
0.00,1117.10
8.00,1115.70
20.00,1113.60
47.00,1113.10
72.00,1113.70
110.00,1114.30
125.00,1114.70
144.00,1112.90
158.00,1112.30
163.00,1111.79
167.50,1111.24
169.00,1108.74
172.00,1108.43
180.00,1108.80
187.50,1108.80
194.00,1108.87
199.00,1108.10
201.00,1109.37
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208.50,1109.38
212.50,1110.53
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221.50,1109.56
225.50,1108.74
226.50,1108.00
231.00,1107.29
235.00,1108.30
237.00,1108.78
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253.00,1111.62
260.00,1114.00
269.00,1116.30
278.00,1117.40
```
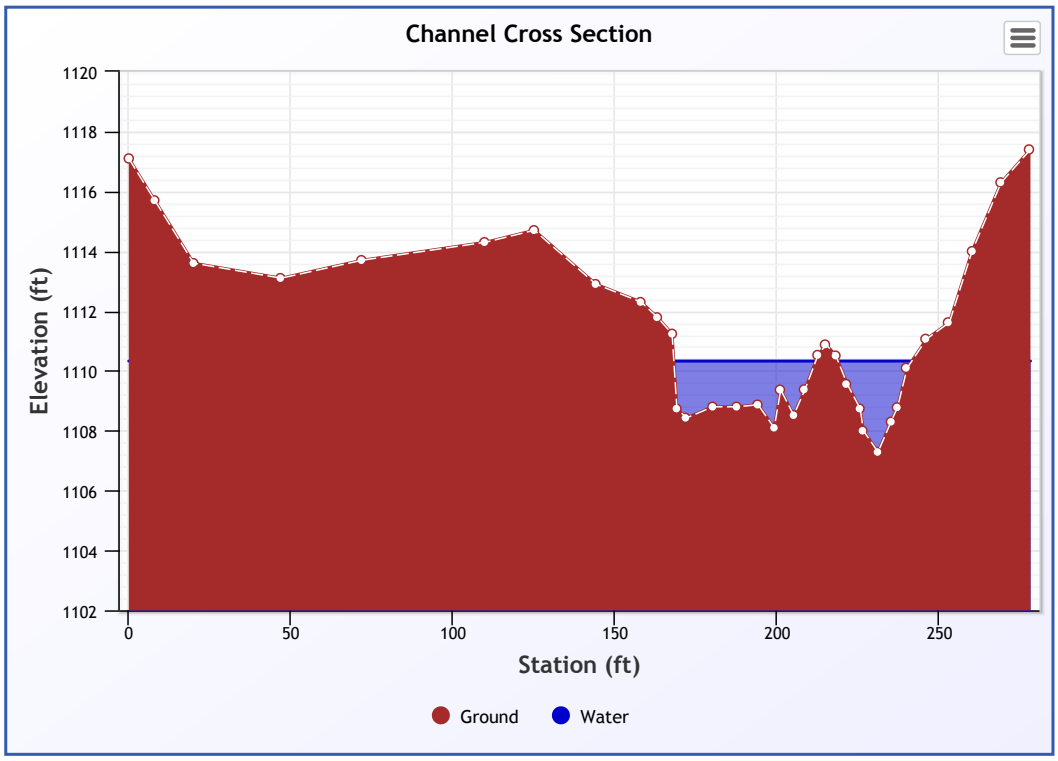



# Normal Depth Calculator



## Normal Depth Demonstration Tool

One the most commonly used equations governing Open Channel Flow is known as the Mannings's Equation. It was introduced by the Irish Engineer Robert Manning in 1889 as an alternative to the Chezy Equation. The Mannings equation is an empirical equation that applies to uniform flow in open channels and is a function of the channel velocity, flow area and channel slope.

$$Q = VA = \left(\frac{1.49}{n}\right) AR^{\frac{2}{3}} \sqrt{S} \quad [U.S.]$$

$$Q = VA = \left(\frac{1.00}{n}\right) AR^{\frac{2}{3}} \sqrt{S} \quad [SI]$$

Where:
Q = Flow Rate, (ft3/s)
v = Velocity, (ft/s)
A = Flow Area, (ft2)
n = Manning's Roughness Coefficient
R = Hydraulic Radius, (ft)
S = Channel Slope, (ft/ft)

Under the assumption of uniform flow conditions the bottom slope is the same as the slope of the energy grade line and the water surface slope. The Manning's n is a coefficient which represents the roughness or friction applied to the flow by the channel. Manning's n-values are often selected from tables, but can be back calculated from field measurements. In many flow conditions the selection of a Manning's roughness coefficient can greatly affect computational results.

**Instructions:** Select variable to solve, adjust slider bars, click on graph to modify the cross section. CSV cross section data can be loaded in the input box below. This online calculator is for demonstration and educational purposes only.

Select HECRAS Geometry: Choose File No file chosen Load HEC-RAS Data

Solve For: Water Surface (normal depth)

Slope: 0.0107 (ft/ft)

WSE: 1113.8 (ft)

Channel Manning n: 0.040

Flow: 3200 (ft3/s)

100 40000

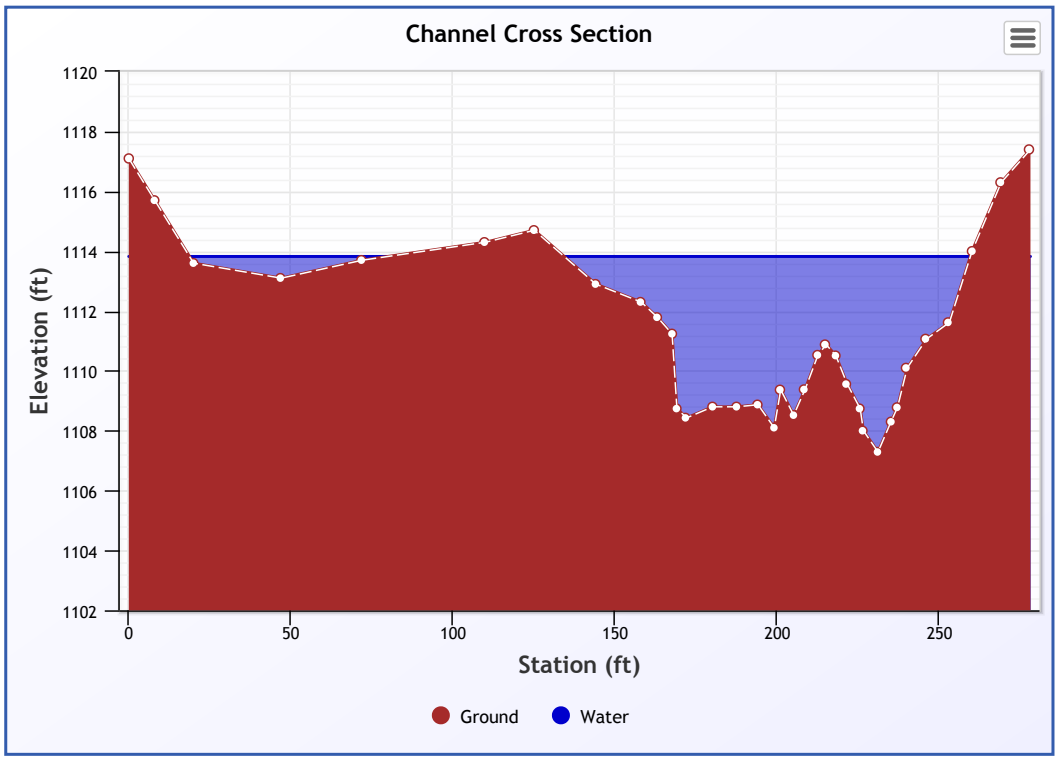
Reset Cross Section

| | |
|---|---|
| Flow Area: | 461.0 (ft2) |
| Wetted Perimeter: | 189.9 (ft) |
| Max Depth: | 6.54 (ft) |
| Average Velocity: | 6.94 (ft/s) |
| Top Width: | 186 (ft) |
| Iterations: | 35 |
| Froude Number: | 0.78 |

Load CSV XS Data Below
(station,elevation)

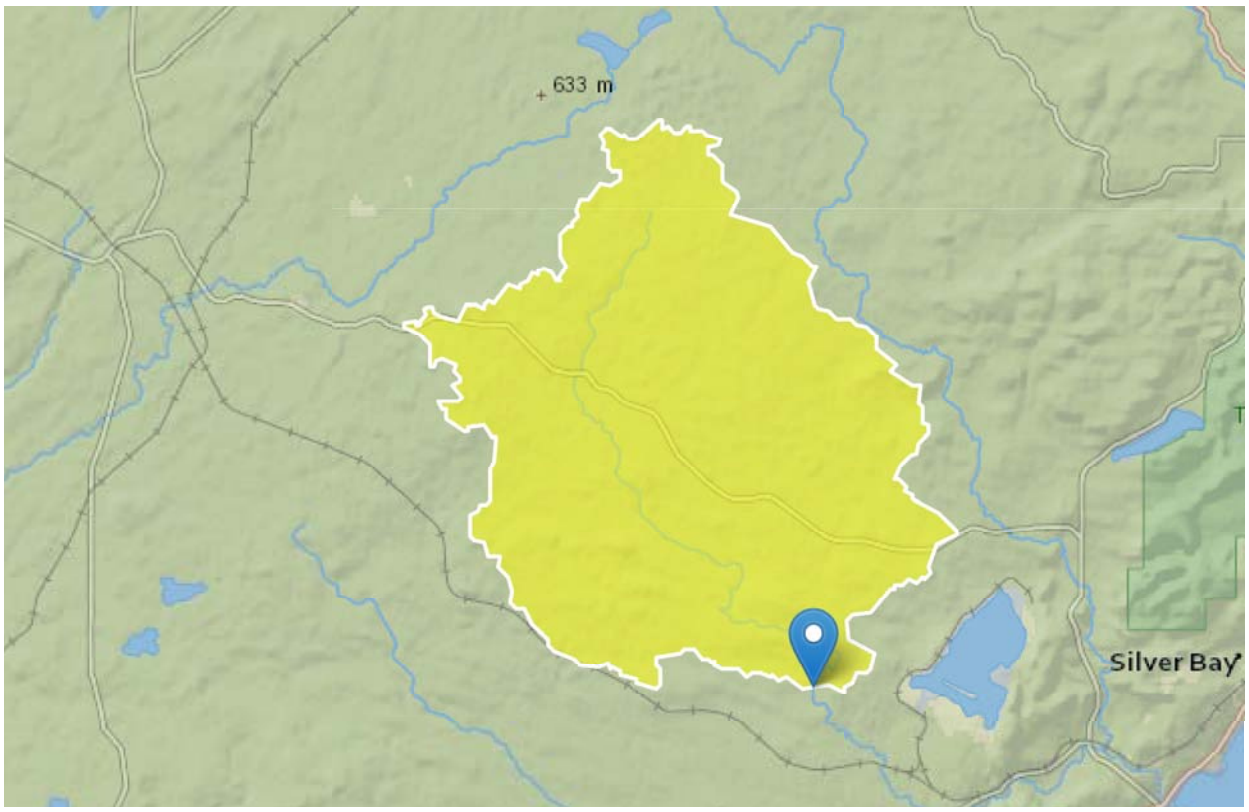
Update Plot

```
0.00,1117.10
8.00,1115.70
20.00,1113.60
47.00,1113.10
72.00,1113.70
110.00,1114.30
125.00,1114.70
144.00,1112.90
158.00,1112.30
163.00,1111.79
167.50,1111.24
169.00,1108.74
172.00,1108.43
180.00,1108.80
187.50,1108.80
194.00,1108.87
199.00,1108.10
201.00,1109.37
205.00,1108.52
208.50,1109.38
212.50,1110.53
215.00,1110.88
218.00,1110.51
221.50,1109.56
225.50,1108.74
226.50,1108.00
231.00,1107.29
235.00,1108.30
237.00,1108.78
240.00,1110.10
246.00,1111.07
253.00,1111.62
260.00,1114.00
269.00,1116.30
278.00,1117.40
```



# Discharge into Upper Middle Beaver River Subwatershed #11 - Existing

**Region ID:** MN
**Workspace ID:** MN20200325205659071000
**Clicked Point (Latitude, Longitude):** 47.28689, -91.41712
**Time:** 2020-03-25 15:57:15 -0500




Basin Characteristics

| Parameter Code | Parameter Description | Value | Unit |
|---|---|---|---|
| DRNAREA | Area that drains to a point on a stream | 47.81 | square miles |
| LAKEAREA | Percentage of Lakes and Ponds | 4.5 | percent |

| Parameter Code | Parameter Description | Value | Unit |
|---|---|---|---|
| STORNWI | Percentage of storage (combined water bodies and wetlands) from the National Wetlands Inventory | 37.78 | percent |
| SSURGOC | Percentage of area of Hydrologic Soil Type C from SSURGO | 21.16 | percent |

General Disclaimers

Parameter values have been edited, computed flows may not apply.

Peak-Flow Statistics Parameters[100 Percent (47.8 square miles) Region C]

| Parameter Code | Parameter Name | Value | Units | Min Limit | Max Limit |
|---|---|---|---|---|---|
| DRNAREA | Drainage Area | 47.81 | square miles | 0.21 | 607 |
| LAKEAREA | Percent Lakes and Ponds | 4.5 | percent | 0 | 11.8 |

Peak-Flow Statistics Flow Report[100 Percent (47.8 square miles) Region C]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

| Statistic | Value | Unit | PIl | PIu | SE | SEp | Equiv. Yrs. |
|---|---|---|---|---|---|---|---|
| 1.5 Year Peak Flood | 473 | ft^3/s | 212 | 913 | 45.2 | 45.2 | 2.8 |
| 2 Year Peak Flood | 587 | ft^3/s | 252 | 1160 | 46.8 | 46.8 | 2.4 |
| 5 Year Peak Flood | 923 | ft^3/s | 371 | 1910 | 50.4 | 50.4 | 2.8 |
| 10 Year Peak Flood | 1190 | ft^3/s | 462 | 2520 | 52.9 | 52.9 | 3.5 |
| 25 Year Peak Flood | 1570 | ft^3/s | 582 | 3430 | 56.2 | 56.2 | 4.5 |
| 50 Year Peak Flood | 1910 | ft^3/s | 676 | 4270 | 59.1 | 59.1 | 5.1 |

| Statistic | Value | Unit | PIl | PIu | SE | SEp | Equiv. Yrs. |
|---|---|---|---|---|---|---|---|
| 100 Year Peak Flood | 2270 | ft^3/s | 769 | 5220 | 62.3 | 62.3 | 5.7 |
| 500 Year Peak Flood | 3250 | ft^3/s | 971 | 8050 | 70.9 | 70.9 | 6.5 |

*Peak-Flow Statistics Citations*

**Lorenz, D.L., Sanocki, C.A., and Kocian, M.J.,2009, Techniques for Estimating the Magnitude and Frequency of Peak Flows on Small Streams in Minnesota Based on Data through Water Year 2005: U.S. Geological Survey Scientific Investigations Report 2009-5250, 54 p. (http://pubs.usgs.gov/sir/2009/5250/pdf/sir2009-5250.pdf)**

Flow-Duration Statistics Parameters[Flow duration Region BC 2015 5170]

| Parameter Code | Parameter Name | Value | Units | Min Limit | Max Limit |
|---|---|---|---|---|---|
| DRNAREA | Drainage Area | 47.81 | square miles | 2.98 | 2960 |
| STORNWI | Percentage of Storage from NWI | 37.78 | percent | 2.44 | 48 |
| SSURGOC | SSURGO Percent Hydrologic Soil Type C | 21.16 | percent | 2.61 | 100 |

Flow-Duration Statistics Flow Report[Flow duration Region BC 2015 5170]

| Statistic | Value | Unit |
|---|---|---|
| 0.01 Percent Duration | 845 | ft^3/s |
| 0.1 Percent Duration | 549 | ft^3/s |
| 2 Percent Duration | 213 | ft^3/s |
| 5 Percent Duration | 138 | ft^3/s |
| 10 Percent Duration | 73.6 | ft^3/s |
| 25 Percent Duration | 36.6 | ft^3/s |
| 50 Percent Duration | 13.7 | ft^3/s |
| 75 Percent Duration | 6.88 | ft^3/s |

| Statistic | Value | Unit |
|---|---|---|
| 90 Percent Duration | 3.92 | ft^3/s |
| 95 Percent Duration | 2.53 | ft^3/s |
| 99 Percent Duration | 1.27 | ft^3/s |
| 99.9 Percent Duration | 0.508 | ft^3/s |
| 99.99 Percent Duration | 0.422 | ft^3/s |

*Flow-Duration Statistics Citations*

**Ziegeweid, J.R., Lorenz, D.L., Sanocki, C.A., and Czuba, C.R.,2015, Methods for estimating flow-duration curve and low-flow frequency statistics for ungaged locations on small streams in Minnesota: U.S. Geological Survey Scientific Investigations Report 2015–5170, 23 p. (http://dx.doi.org/10.3133/sir20155170)**

Low-Flow Statistics Parameters[Low flow Region BC 2015 5170]

| Parameter Code | Parameter Name | Value | Units | Min Limit | Max Limit |
|---|---|---|---|---|---|
| DRNAREA | Drainage Area | 47.81 | square miles | 2.98 | 2960 |
| STORNWI | Percentage of Storage from NWI | 37.78 | percent | 2.44 | 48 |
| SSURGOC | SSURGO Percent Hydrologic Soil Type C | 21.16 | percent | 2.61 | 100 |

Low-Flow Statistics Flow Report[Low flow Region BC 2015 5170]

| Statistic | Value | Unit |
|---|---|---|
| 7 Day 10 Year Low Flow | 1.39 | ft^3/s |

*Low-Flow Statistics Citations*

**Ziegeweid, J.R., Lorenz, D.L., Sanocki, C.A., and Czuba, C.R.,2015, Methods for estimating flow-duration curve and low-flow frequency statistics for ungaged locations on small streams in Minnesota: U.S. Geological Survey Scientific Investigations Report 2015–5170, 23 p. (http://dx.doi.org/10.3133/sir20155170)**

Seasonal Flow Statistics Parameters[Low flow Region BC 2015 5170]

| Parameter Code | Parameter Name | Value | Units | Min Limit | Max Limit |
|---|---|---|---|---|---|
| DRNAREA | Drainage Area | 47.81 | square miles | 2.98 | 2960 |
| STORNWI | Percentage of Storage from NWI | 37.78 | percent | 2.44 | 48 |
| SSURGOC | SSURGO Percent Hydrologic Soil Type C | 21.16 | percent | 2.61 | 100 |

Seasonal Flow Statistics Flow Report[Low flow Region BC 2015 5170]

| Statistic | Value | Unit |
|---|---|---|
| Oct to Nov 7 Day 10 Year Low Flow | 3.41 | ft^3/s |
| 30_Day_10_Year_Low_Flow_Oct_to_Nov | 4.89 | ft^3/s |
| 7_Day_10_Year_lowflow_Dec_to_Mar | 1.92 | ft^3/s |
| 30_Day_10_Year_Low_Flow_Dec_to_Mar | 2.29 | ft^3/s |
| Apr to May 7 Day 10 Year Low Flow | 6.82 | ft^3/s |
| Apr to May 30 Day 10 Year Low Flow | 23 | ft^3/s |
| 7_Day_10_Year_lowflow_Jun_to_Sep | 1.85 | ft^3/s |
| 30_Day_10_Year_Low_Flow_Jun_to_Sep | 2.47 | ft^3/s |
| 122_Day_10_Year_Low_Flow_Jun_to_Sep | 12.9 | ft^3/s |

*Seasonal Flow Statistics Citations*

**Ziegeweid, J.R., Lorenz, D.L., Sanocki, C.A., and Czuba, C.R.,2015, Methods for estimating flow-duration curve and low-flow frequency statistics for ungaged locations on small streams in Minnesota: U.S. Geological Survey Scientific Investigations Report 2015–5170, 23 p. (http://dx.doi.org/10.3133/sir20155170)**

NATIONAL WEATHER SERVICE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

# Normal Depth Calculator

Weather.gov > Alaska-Pacific RFC > Normal Depth Calculator

**Alaska-Pacific RFC**
River Forecast Center

River Observations and Forecasts | Weather Observations and Forecasts | Water Supply | Climate and History | Seasonal Interest | Additional Info

## Normal Depth Demonstration Tool

One the most commonly used equations governing Open Channel Flow is known as the Mannings's Equation. It was introduced by the Irish Engineer Robert Manning in 1889 as an alternative to the Chezy Equation. The Mannings equation is an empirical equation that applies to uniform flow in open channels and is a function of the channel velocity, flow area and channel slope.

$$Q = VA = \left(\frac{1.49}{n}\right) AR^{\frac{2}{3}}\sqrt{S} \quad [U.S.]$$

$$Q = VA = \left(\frac{1.00}{n}\right) AR^{\frac{2}{3}}\sqrt{S} \quad [SI]$$

Where:
Q = Flow Rate, ($ft^3/s$)
v = Velocity, (ft/s)
A = Flow Area, ($ft^2$)
n = Manning's Roughness Coefficient
R = Hydraulic Radius, (ft)
S = Channel Slope, (ft/ft)

Under the assumption of uniform flow conditions the bottom slope is the same as the slope of the energy grade line and the water surface slope. The Manning's n is a coefficient which represents the roughness or friction applied to the flow by the channel. Manning's n-values are often selected from tables, but can be back calculated from field measurements. In many flow conditions the selection of a Manning's roughness coefficient can greatly affect computational results.

**Instructions:** Select variable to solve, adjust slider bars, click on graph to modify the cross section. CSV cross section data can be loaded in the input box below. This online calculator is for demonstration and educational purposes only.

Solve For: Water Surface (normal depth)

Slope: 0.0107 (ft/ft)

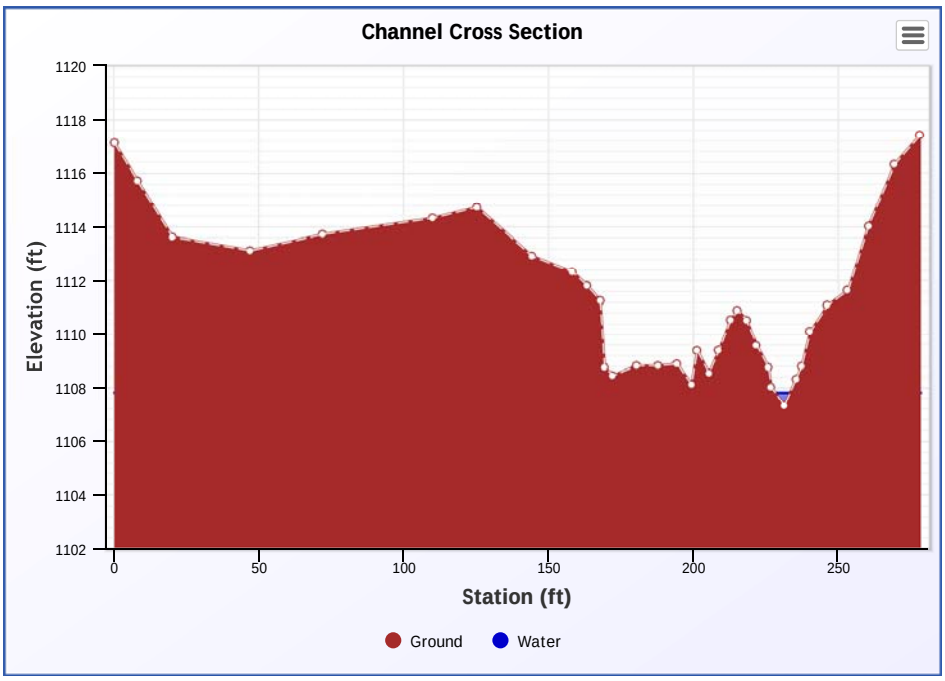
WSE: 1107.79 (ft)

Channel Manning n: 0.040

Flow: 2 ($ft^3/s$)

100 40000

Reset Cross Section




| | |
|---|---|
| Flow Area: | 1.2 ($ft^2$) |
| Wetted Perimeter: | 5.1 (ft) |
| Max Depth: | 0.50 (ft) |
| Average Velocity: | 1.48 (ft/s) |
| Top Width: | 5 (ft) |
| Iterations: | 36 |
| Froude Number: | 0.52 |

Select HECRAS Geometry: Browse... Load HEC-RAS Data

Load CSV XS Data Below
(station,elevation)

Update Plot

```
0.00,1117.10
8.00,1115.70
20.00,1113.60
47.00,1113.10
72.00,1113.70
110.00,1114.30
125.00,1114.70
144.00,1112.90
158.00,1112.30
163.00,1111.79
167.50,1111.24
169.00,1108.74
172.00,1108.43
180.00,1108.80
187.50,1108.80
194.00,1108.87
199.00,1108.10
201.00,1109.37
205.00,1108.52
208.50,1109.38
212.50,1110.53
215.00,1110.88
218.00,1110.51
221.50,1109.56
225.50,1108.74
226.50,1108.00
231.00,1107.29
235.00,1108.30
237.00,1108.78
240.00,1110.10
246.00,1111.07
253.00,1111.62
260.00,1114.00
269.00,1116.30
278.00,1117.40
```

# Normal Depth Calculator



## Normal Depth Demonstration Tool

One the most commonly used equations governing Open Channel Flow is known as the Mannings's Equation. It was introduced by the Irish Engineer Robert Manning in 1889 as an alternative to the Chezy Equation. The Mannings equation is an empirical equation that applies to uniform flow in open channels and is a function of the channel velocity, flow area and channel slope.

$$Q = VA = \left(\frac{1.49}{n}\right) AR^{\frac{2}{3}} \sqrt{S} \quad [U.S.]$$

$$Q = VA = \left(\frac{1.00}{n}\right) AR^{\frac{2}{3}} \sqrt{S} \quad [SI]$$

Where:
Q = Flow Rate, (ft3/s)
v = Velocity, (ft/s)
A = Flow Area, (ft2)
n = Manning's Roughness Coefficient
R = Hydraulic Radius, (ft)
S = Channel Slope, (ft/ft)

Under the assumption of uniform flow conditions the bottom slope is the same as the slope of the energy grade line and the water surface slope. The Manning's n is a coefficient which represents the roughness or friction applied to the flow by the channel. Manning's n-values are often selected from tables, but can be back calculated from field measurements. In many flow conditions the selection of a Manning's roughness coefficient can greatly affect computational results.

**Instructions:** Select variable to solve, adjust slider bars, click on graph to modify the cross section. CSV cross section data can be loaded in the input box below. This online calculator is for demonstration and educational purposes only.

Select HECRAS Geometry: Choose File No file chosen Load HEC-RAS Data

Solve For: Water Surface (normal depth)

Slope: 0.0107 (ft/ft)

WSE: 1110.2 (ft)

Channel Manning n: 0.040

Flow: 473 (ft3/s)

100 40000

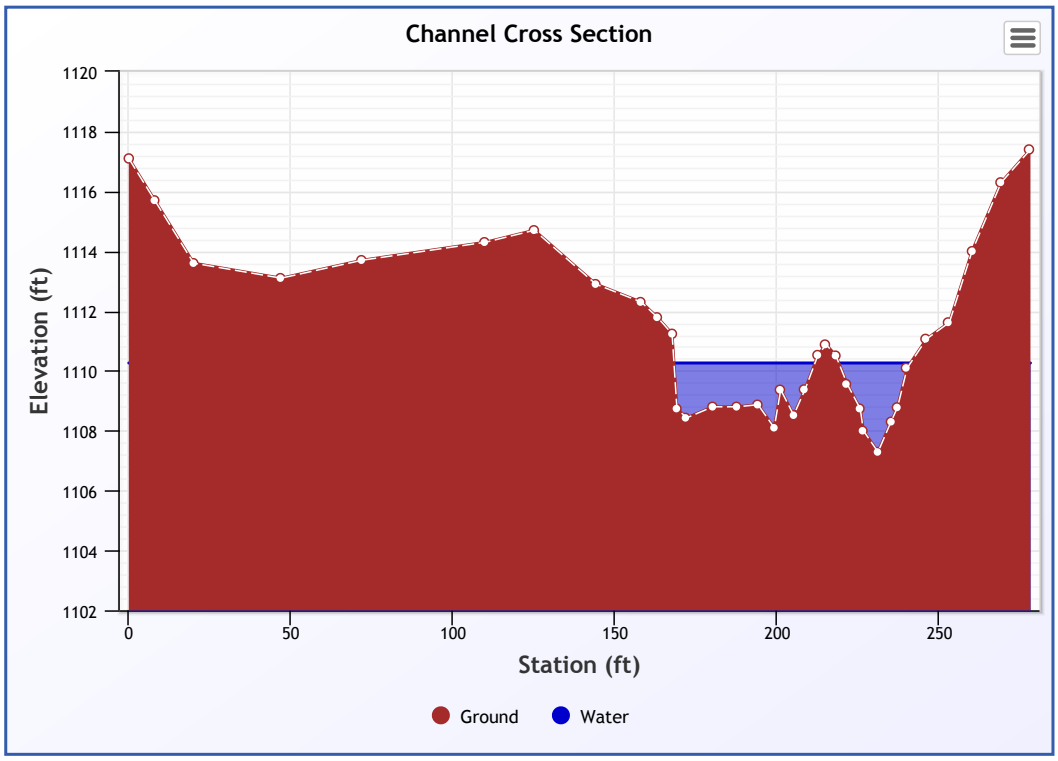
Reset Cross Section

| | |
|---|---|
| Flow Area: | 97.6 (ft2) |
| Wetted Perimeter: | 68.5 (ft) |
| Max Depth: | 2.97 (ft) |
| Average Velocity: | 4.85 (ft/s) |
| Top Width: | 66 (ft) |
| Iterations: | 36 |
| Froude Number: | 0.71 |

Load CSV XS Data Below
(station,elevation)

Update Plot

```
0.00,1117.10
8.00,1115.70
20.00,1113.60
47.00,1113.10
72.00,1113.70
110.00,1114.30
125.00,1114.70
144.00,1112.90
158.00,1112.30
163.00,1111.79
167.50,1111.24
169.00,1108.74
172.00,1108.43
180.00,1108.80
187.50,1108.80
194.00,1108.87
199.00,1108.10
201.00,1109.37
205.00,1108.52
208.50,1109.38
212.50,1110.53
215.00,1110.88
218.00,1110.51
221.50,1109.56
225.50,1108.74
226.50,1108.00
231.00,1107.29
235.00,1108.30
237.00,1108.78
240.00,1110.10
246.00,1111.07
253.00,1111.62
260.00,1114.00
269.00,1116.30
278.00,1117.40
```



# Normal Depth Calculator



## Normal Depth Demonstration Tool

One the most commonly used equations governing Open Channel Flow is known as the Mannings's Equation. It was introduced by the Irish Engineer Robert Manning in 1889 as an alternative to the Chezy Equation. The Mannings equation is an empirical equation that applies to uniform flow in open channels and is a function of the channel velocity, flow area and channel slope.

$$Q = VA = \left(\frac{1.49}{n}\right) AR^{\frac{2}{3}} \sqrt{S} \quad [U.S.]$$

$$Q = VA = \left(\frac{1.00}{n}\right) AR^{\frac{2}{3}} \sqrt{S} \quad [SI]$$

Where:
Q = Flow Rate, (ft3/s)
v = Velocity, (ft/s)
A = Flow Area, (ft2)
n = Manning's Roughness Coefficient
R = Hydraulic Radius, (ft)
S = Channel Slope, (ft/ft)

Under the assumption of uniform flow conditions the bottom slope is the same as the slope of the energy grade line and the water surface slope. The Manning's n is a coefficient which represents the roughness or friction applied to the flow by the channel. Manning's n-values are often selected from tables, but can be back calculated from field measurements. In many flow conditions the selection of a Manning's roughness coefficient can greatly affect computational results.

**Instructions:** Select variable to solve, adjust slider bars, click on graph to modify the cross section. CSV cross section data can be loaded in the input box below. This online calculator is for demonstration and educational purposes only.

Select HECRAS Geometry: Choose File No file chosen Load HEC-RAS Data

Solve For: Water Surface (normal depth)

Slope: 0.0107 (ft/ft)

WSE: 1112.6 (ft)

Channel Manning n: 0.040

Flow: 2270 (ft3/s)

100 40000

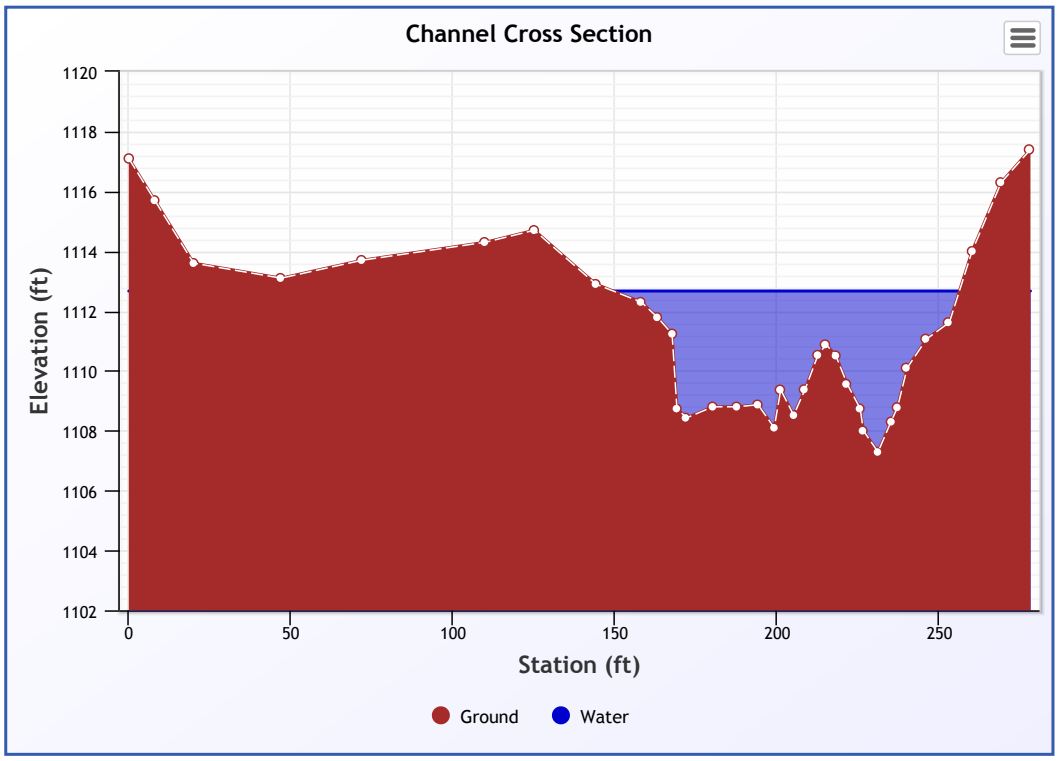
Reset Cross Section

| | |
|---|---|
| Flow Area: | 302.1 (ft2) |
| Wetted Perimeter: | 110.6 (ft) |
| Max Depth: | 5.38 (ft) |
| Average Velocity: | 7.51 (ft/s) |
| Top Width: | 107 (ft) |
| Iterations: | 35 |
| Froude Number: | 0.79 |

Load CSV XS Data Below
(station,elevation)

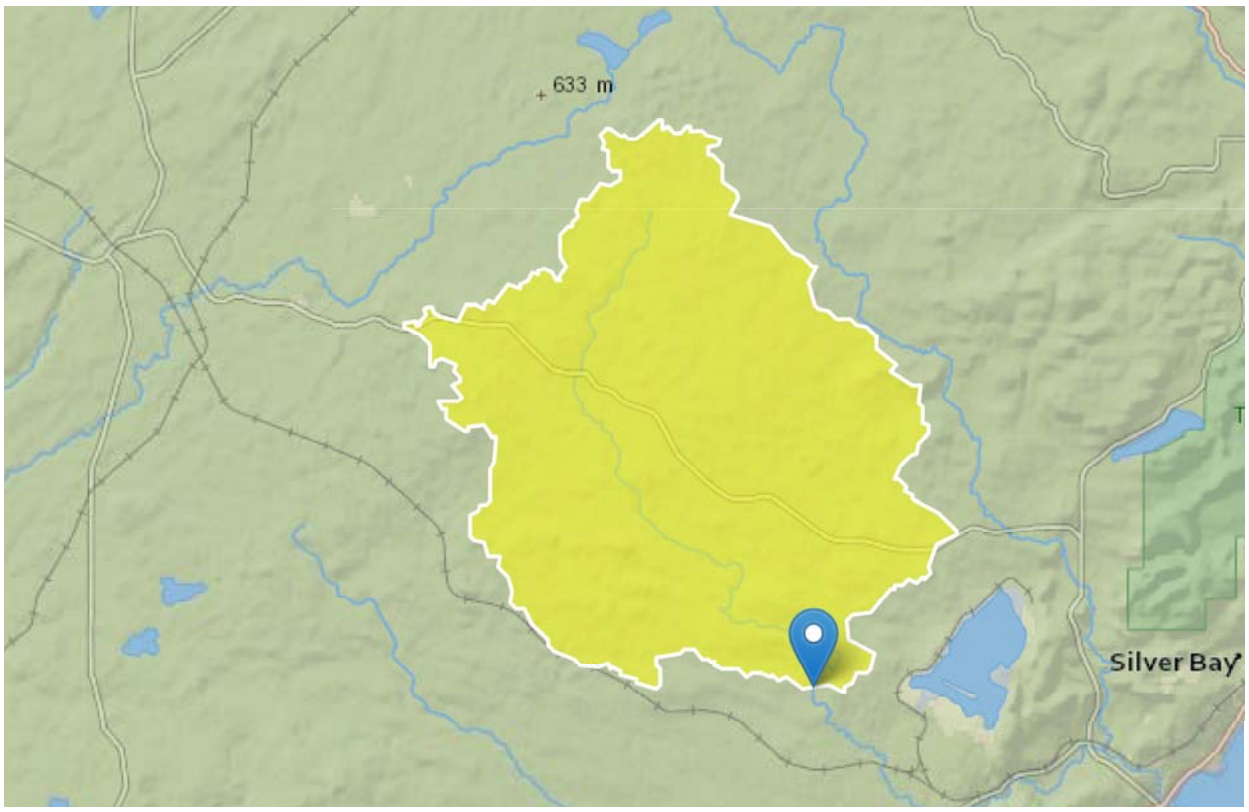
Update Plot

```
0.00,1117.10
8.00,1115.70
20.00,1113.60
47.00,1113.10
72.00,1113.70
110.00,1114.30
125.00,1114.70
144.00,1112.90
158.00,1112.30
163.00,1111.79
167.50,1111.24
169.00,1108.74
172.00,1108.43
180.00,1108.80
187.50,1108.80
194.00,1108.87
199.00,1108.10
201.00,1109.37
205.00,1108.52
208.50,1109.38
212.50,1110.53
215.00,1110.88
218.00,1110.51
221.50,1109.56
225.50,1108.74
226.50,1108.00
231.00,1107.29
235.00,1108.30
237.00,1108.78
240.00,1110.10
246.00,1111.07
253.00,1111.62
260.00,1114.00
269.00,1116.30
278.00,1117.40
```



# Discharge into Upper Middle Beaver River Subwatershed #11 - Future

**Region ID:** MN
**Workspace ID:** MN20200325205659071000
**Clicked Point (Latitude, Longitude):** 47.28689, -91.41712
**Time:** 2020-03-25 15:57:15 -0500




Basin Characteristics

| Parameter Code | Parameter Description | Value | Unit |
|---|---|---|---|
| DRNAREA | Area that drains to a point on a stream | 47.75 | square miles |
| LAKEAREA | Percentage of Lakes and Ponds | 4.5 | percent |

| Parameter Code | Parameter Description | Value | Unit |
|---|---|---|---|
| STORNWI | Percentage of storage (combined water bodies and wetlands) from the National Wetlands Inventory | 37.82 | percent |
| SSURGOC | Percentage of area of Hydrologic Soil Type C from SSURGO | 21.1 | percent |

General Disclaimers

Parameter values have been edited, computed flows may not apply.

Peak-Flow Statistics Parameters[100 Percent (47.8 square miles) Region C]

| Parameter Code | Parameter Name | Value | Units | Min Limit | Max Limit |
|---|---|---|---|---|---|
| DRNAREA | Drainage Area | 47.75 | square miles | 0.21 | 607 |
| LAKEAREA | Percent Lakes and Ponds | 4.5 | percent | 0 | 11.8 |

Peak-Flow Statistics Flow Report[100 Percent (47.8 square miles) Region C]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

| Statistic | Value | Unit | PIl | PIu | SE | SEp | Equiv. Yrs. |
|---|---|---|---|---|---|---|---|
| 1.5 Year Peak Flood | 473 | ft^3/s | 211 | 912 | 45.2 | 45.2 | 2.8 |
| 2 Year Peak Flood | 586 | ft^3/s | 252 | 1160 | 46.8 | 46.8 | 2.4 |
| 5 Year Peak Flood | 922 | ft^3/s | 371 | 1910 | 50.4 | 50.4 | 2.8 |
| 10 Year Peak Flood | 1190 | ft^3/s | 462 | 2520 | 52.9 | 52.9 | 3.5 |
| 25 Year Peak Flood | 1570 | ft^3/s | 581 | 3430 | 56.2 | 56.2 | 4.5 |
| 50 Year Peak Flood | 1900 | ft^3/s | 676 | 4260 | 59.1 | 59.1 | 5.1 |

| Statistic | Value | Unit | PIl | PIu | SE | SEp | Equiv. Yrs. |
|---|---|---|---|---|---|---|---|
| 100 Year Peak Flood | 2260 | ft^3/s | 768 | 5210 | 62.3 | 62.3 | 5.7 |
| 500 Year Peak Flood | 3250 | ft^3/s | 970 | 8040 | 70.9 | 70.9 | 6.5 |

*Peak-Flow Statistics Citations*

**Lorenz, D.L., Sanocki, C.A., and Kocian, M.J.,2009, Techniques for Estimating the Magnitude and Frequency of Peak Flows on Small Streams in Minnesota Based on Data through Water Year 2005: U.S. Geological Survey Scientific Investigations Report 2009-5250, 54 p. (http://pubs.usgs.gov/sir/2009/5250/pdf/sir2009-5250.pdf)**

Flow-Duration Statistics Parameters[Flow duration Region BC 2015 5170]

| Parameter Code | Parameter Name | Value | Units | Min Limit | Max Limit |
|---|---|---|---|---|---|
| DRNAREA | Drainage Area | 47.75 | square miles | 2.98 | 2960 |
| STORNWI | Percentage of Storage from NWI | 37.82 | percent | 2.44 | 48 |
| SSURGOC | SSURGO Percent Hydrologic Soil Type C | 21.1 | percent | 2.61 | 100 |

Flow-Duration Statistics Flow Report[Flow duration Region BC 2015 5170]

| Statistic | Value | Unit |
|---|---|---|
| 0.01 Percent Duration | 843 | ft^3/s |
| 0.1 Percent Duration | 548 | ft^3/s |
| 2 Percent Duration | 213 | ft^3/s |
| 5 Percent Duration | 138 | ft^3/s |
| 10 Percent Duration | 73.5 | ft^3/s |
| 25 Percent Duration | 36.5 | ft^3/s |
| 50 Percent Duration | 13.7 | ft^3/s |
| 75 Percent Duration | 6.87 | ft^3/s |

| Statistic | Value | Unit |
|---|---|---|
| 90 Percent Duration | 3.92 | ft^3/s |
| 95 Percent Duration | 2.53 | ft^3/s |
| 99 Percent Duration | 1.27 | ft^3/s |
| 99.9 Percent Duration | 0.508 | ft^3/s |
| 99.99 Percent Duration | 0.422 | ft^3/s |

*Flow-Duration Statistics Citations*

**Ziegeweid, J.R., Lorenz, D.L., Sanocki, C.A., and Czuba, C.R.,2015, Methods for estimating flow-duration curve and low-flow frequency statistics for ungaged locations on small streams in Minnesota: U.S. Geological Survey Scientific Investigations Report 2015–5170, 23 p. (http://dx.doi.org/10.3133/sir20155170)**

Low-Flow Statistics Parameters[Low flow Region BC 2015 5170]

| Parameter Code | Parameter Name | Value | Units | Min Limit | Max Limit |
|---|---|---|---|---|---|
| DRNAREA | Drainage Area | 47.75 | square miles | 2.98 | 2960 |
| STORNWI | Percentage of Storage from NWI | 37.82 | percent | 2.44 | 48 |
| SSURGOC | SSURGO Percent Hydrologic Soil Type C | 21.1 | percent | 2.61 | 100 |

Low-Flow Statistics Flow Report[Low flow Region BC 2015 5170]

| Statistic | Value | Unit |
|---|---|---|
| 7 Day 10 Year Low Flow | 1.39 | ft^3/s |

*Low-Flow Statistics Citations*

**Ziegeweid, J.R., Lorenz, D.L., Sanocki, C.A., and Czuba, C.R.,2015, Methods for estimating flow-duration curve and low-flow frequency statistics for ungaged locations on small streams in Minnesota: U.S. Geological Survey Scientific Investigations Report 2015–5170, 23 p. (http://dx.doi.org/10.3133/sir20155170)**

Seasonal Flow Statistics Parameters[Low flow Region BC 2015 5170]

| Parameter Code | Parameter Name | Value | Units | Min Limit | Max Limit |
|---|---|---|---|---|---|
| DRNAREA | Drainage Area | 47.75 | square miles | 2.98 | 2960 |
| STORNWI | Percentage of Storage from NWI | 37.82 | percent | 2.44 | 48 |
| SSURGOC | SSURGO Percent Hydrologic Soil Type C | 21.1 | percent | 2.61 | 100 |

Seasonal Flow Statistics Flow Report[Low flow Region BC 2015 5170]

| Statistic | Value | Unit |
|---|---|---|
| Oct to Nov 7 Day 10 Year Low Flow | 3.41 | ft^3/s |
| 30_Day_10_Year_Low_Flow_Oct_to_Nov | 4.89 | ft^3/s |
| 7_Day_10_Year_lowflow_Dec_to_Mar | 1.92 | ft^3/s |
| 30_Day_10_Year_Low_Flow_Dec_to_Mar | 2.29 | ft^3/s |
| Apr to May 7 Day 10 Year Low Flow | 6.82 | ft^3/s |
| Apr to May 30 Day 10 Year Low Flow | 23 | ft^3/s |
| 7_Day_10_Year_lowflow_Jun_to_Sep | 1.85 | ft^3/s |
| 30_Day_10_Year_Low_Flow_Jun_to_Sep | 2.47 | ft^3/s |
| 122_Day_10_Year_Low_Flow_Jun_to_Sep | 12.9 | ft^3/s |

*Seasonal Flow Statistics Citations*

**Ziegeweid, J.R., Lorenz, D.L., Sanocki, C.A., and Czuba, C.R.,2015, Methods for estimating flow-duration curve and low-flow frequency statistics for ungaged locations on small streams in Minnesota: U.S. Geological Survey Scientific Investigations Report 2015–5170, 23 p. (http://dx.doi.org/10.3133/sir20155170)**

NATIONAL WEATHER SERVICE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

# Normal Depth Calculator

Weather.gov > Alaska-Pacific RFC > Normal Depth Calculator

**Alaska-Pacific RFC**
River Forecast Center

River Observations and Forecasts | Weather Observations and Forecasts | Water Supply | Climate and History | Seasonal Interest | Additional Info

## Normal Depth Demonstration Tool

One the most commonly used equations governing Open Channel Flow is known as the Mannings's Equation. It was introduced by the Irish Engineer Robert Manning in 1889 as an alternative to the Chezy Equation. The Mannings equation is an empirical equation that applies to uniform flow in open channels and is a function of the channel velocity, flow area and channel slope.

$$Q = VA = \left(\frac{1.49}{n}\right) AR^{\frac{2}{3}}\sqrt{S} \quad [U.S.]$$

$$Q = VA = \left(\frac{1.00}{n}\right) AR^{\frac{2}{3}}\sqrt{S} \quad [SI]$$

Where:
Q = Flow Rate, ($ft^3/s$)
v = Velocity, (ft/s)
A = Flow Area, ($ft^2$)
n = Manning's Roughness Coefficient
R = Hydraulic Radius, (ft)
S = Channel Slope, (ft/ft)

Under the assumption of uniform flow conditions the bottom slope is the same as the slope of the energy grade line and the water surface slope. The Manning's n is a coefficient which represents the roughness or friction applied to the flow by the channel. Manning's n-values are often selected from tables, but can be back calculated from field measurements. In many flow conditions the selection of a Manning's roughness coefficient can greatly affect computational results.

**Instructions:** Select variable to solve, adjust slider bars, click on graph to modify the cross section. CSV cross section data can be loaded in the input box below. This online calculator is for demonstration and educational purposes only.

Solve For: Water Surface (normal depth)

Slope: 0.0107 (ft/ft)

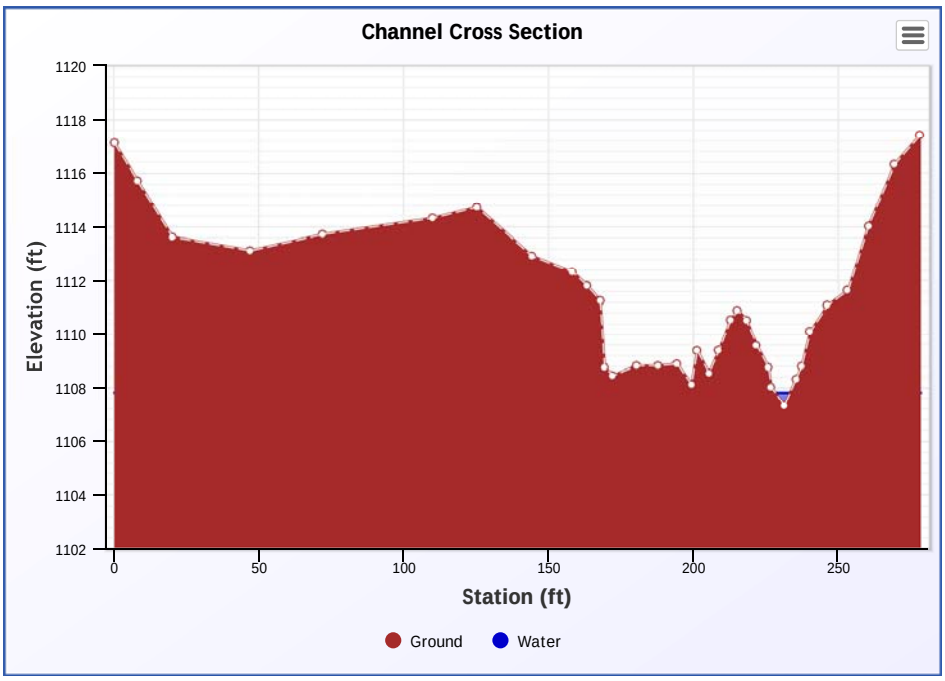
WSE: 1107.79 (ft)

Channel Manning n: 0.040

Flow: 2 ($ft^3/s$)

100 40000

Reset Cross Section




| | |
|---|---|
| Flow Area: | 1.2 ($ft^2$) |
| Wetted Perimeter: | 5.1 (ft) |
| Max Depth: | 0.50 (ft) |
| Average Velocity: | 1.48 (ft/s) |
| Top Width: | 5 (ft) |
| Iterations: | 36 |
| Froude Number: | 0.52 |

Select HECRAS Geometry: Browse... Load HEC-RAS Data

Load CSV XS Data Below
(station,elevation)

Update Plot

```
0.00,1117.10
8.00,1115.70
20.00,1113.60
47.00,1113.10
72.00,1113.70
110.00,1114.30
125.00,1114.70
144.00,1112.90
158.00,1112.30
163.00,1111.79
167.50,1111.24
169.00,1108.74
172.00,1108.43
180.00,1108.80
187.50,1108.80
194.00,1108.87
199.00,1108.10
201.00,1109.37
205.00,1108.52
208.50,1109.38
212.50,1110.53
215.00,1110.88
218.00,1110.51
221.50,1109.56
225.50,1108.74
226.50,1108.00
231.00,1107.29
235.00,1108.30
237.00,1108.78
240.00,1110.10
246.00,1111.07
253.00,1111.62
260.00,1114.00
269.00,1116.30
278.00,1117.40
```

# Normal Depth Calculator



## Normal Depth Demonstration Tool

One the most commonly used equations governing Open Channel Flow is known as the Mannings's Equation. It was introduced by the Irish Engineer Robert Manning in 1889 as an alternative to the Chezy Equation. The Mannings equation is an empirical equation that applies to uniform flow in open channels and is a function of the channel velocity, flow area and channel slope.

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$$Q = VA = \left(\frac{1.00}{n}\right) AR^{\frac{2}{3}} \sqrt{S} \quad [SI]$$

Where:
Q = Flow Rate, (ft3/s)
v = Velocity, (ft/s)
A = Flow Area, (ft2)
n = Manning's Roughness Coefficient
R = Hydraulic Radius, (ft)
S = Channel Slope, (ft/ft)

Under the assumption of uniform flow conditions the bottom slope is the same as the slope of the energy grade line and the water surface slope. The Manning's n is a coefficient which represents the roughness or friction applied to the flow by the channel. Manning's n-values are often selected from tables, but can be back calculated from field measurements. In many flow conditions the selection of a Manning's roughness coefficient can greatly affect computational results.

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Select HECRAS Geometry: Choose File No file chosen Load HEC-RAS Data

Solve For: Water Surface (normal depth)

Slope: 0.0107 (ft/ft)

WSE: 1110.2 (ft)

Channel Manning n: 0.040

Flow: 473 (ft3/s)

100 40000

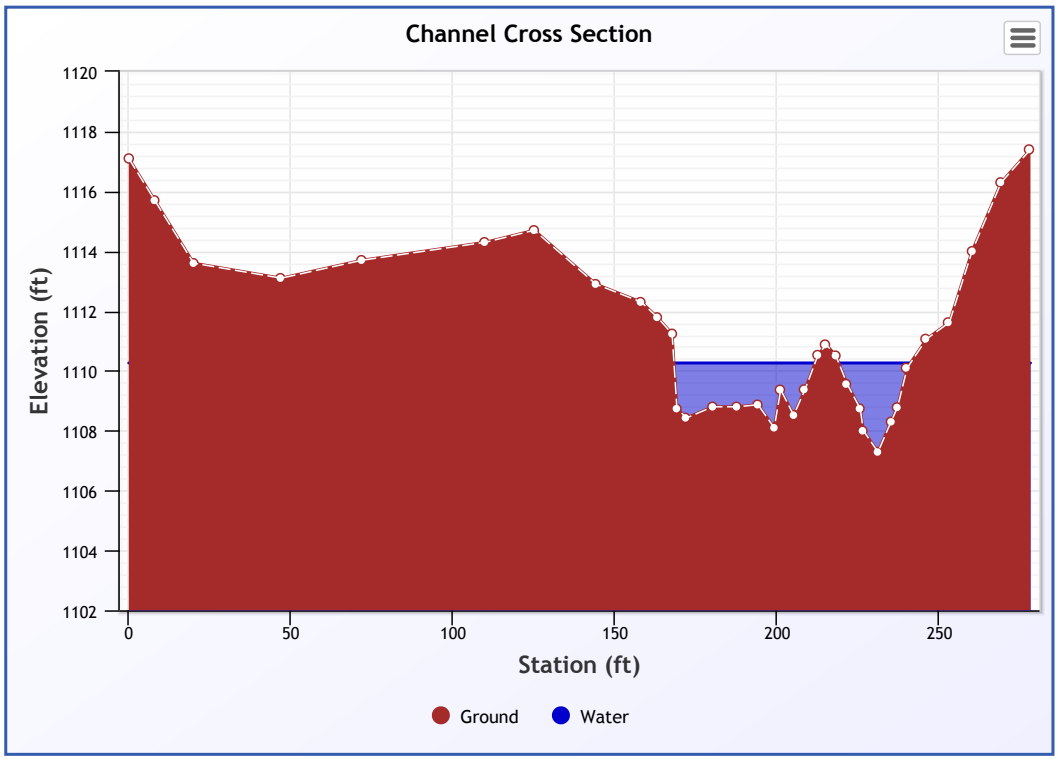
Reset Cross Section

| | |
|---|---|
| Flow Area: | 97.6 (ft2) |
| Wetted Perimeter: | 68.5 (ft) |
| Max Depth: | 2.97 (ft) |
| Average Velocity: | 4.85 (ft/s) |
| Top Width: | 66 (ft) |
| Iterations: | 36 |
| Froude Number: | 0.71 |

Load CSV XS Data Below
(station,elevation)

Update Plot

```
0.00,1117.10
8.00,1115.70
20.00,1113.60
47.00,1113.10
72.00,1113.70
110.00,1114.30
125.00,1114.70
144.00,1112.90
158.00,1112.30
163.00,1111.79
167.50,1111.24
169.00,1108.74
172.00,1108.43
180.00,1108.80
187.50,1108.80
194.00,1108.87
199.00,1108.10
201.00,1109.37
205.00,1108.52
208.50,1109.38
212.50,1110.53
215.00,1110.88
218.00,1110.51
221.50,1109.56
225.50,1108.74
226.50,1108.00
231.00,1107.29
235.00,1108.30
237.00,1108.78
240.00,1110.10
246.00,1111.07
253.00,1111.62
260.00,1114.00
269.00,1116.30
278.00,1117.40
```



# Normal Depth Calculator



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$$Q = VA = \left(\frac{1.00}{n}\right) AR^{\frac{2}{3}} \sqrt{S} \quad [SI]$$

Where:
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v = Velocity, (ft/s)
A = Flow Area, (ft2)
n = Manning's Roughness Coefficient
R = Hydraulic Radius, (ft)
S = Channel Slope, (ft/ft)

Under the assumption of uniform flow conditions the bottom slope is the same as the slope of the energy grade line and the water surface slope. The Manning's n is a coefficient which represents the roughness or friction applied to the flow by the channel. Manning's n-values are often selected from tables, but can be back calculated from field measurements. In many flow conditions the selection of a Manning's roughness coefficient can greatly affect computational results.

**Instructions:** Select variable to solve, adjust slider bars, click on graph to modify the cross section. CSV cross section data can be loaded in the input box below. This online calculator is for demonstration and educational purposes only.

Select HECRAS Geometry: Choose File No file chosen Load HEC-RAS Data

Solve For: Water Surface (normal depth)

Slope: 0.0107 (ft/ft)

WSE: 1112.6 (ft)

Channel Manning n: 0.040

Flow: 2260 (ft3/s)

100 40000

Reset Cross Section

| | |
|---|---|
| Flow Area: | 299.9 (ft2) |
| Wetted Perimeter: | 109.6 (ft) |
| Max Depth: | 5.36 (ft) |
| Average Velocity: | 7.54 (ft/s) |
| Top Width: | 106 (ft) |
| Iterations: | 35 |
| Froude Number: | 0.79 |

Load CSV XS Data Below
(station,elevation)

Update Plot

```
0.00,1117.10
8.00,1115.70
20.00,1113.60
47.00,1113.10
72.00,1113.70
110.00,1114.30
125.00,1114.70
144.00,1112.90
158.00,1112.30
163.00,1111.79
167.50,1111.24
169.00,1108.74
172.00,1108.43
180.00,1108.80
187.50,1108.80
194.00,1108.87
199.00,1108.10
201.00,1109.37
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215.00,1110.88
218.00,1110.51
221.50,1109.56
225.50,1108.74
226.50,1108.00
231.00,1107.29
235.00,1108.30
237.00,1108.78
240.00,1110.10
246.00,1111.07
253.00,1111.62
260.00,1114.00
269.00,1116.30
278.00,1117.40
```
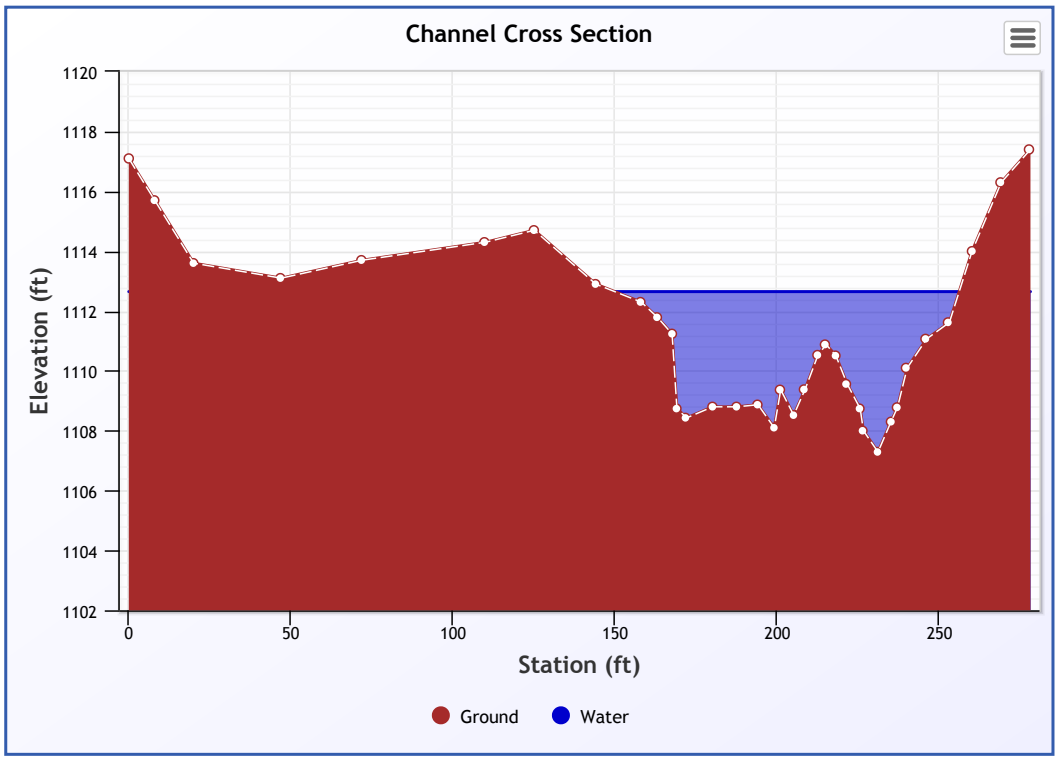
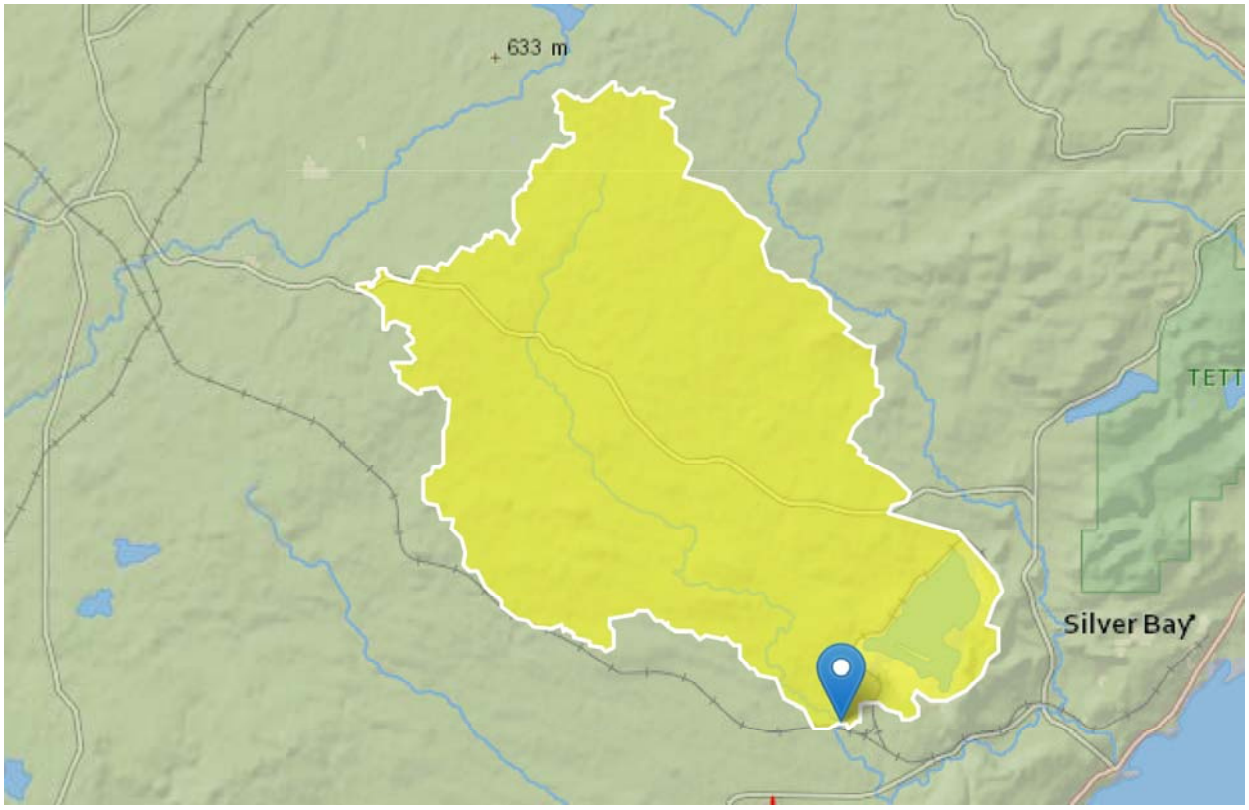



# Discharge into Lower Middle Beaver River Subwatershed #12 - Pre-Settlement

**Region ID:** MN
**Workspace ID:** MN20200325233334914000
**Clicked Point (Latitude, Longitude):** 47.26999, -91.39144
**Time:** 2020-03-25 18:33:59 -0500




Basin Characteristics

| Parameter Code | Parameter Description | Value | Unit |
|---|---|---|---|
| DRNAREA | Area that drains to a point on a stream | 56.34 | square miles |
| LAKEAREA | Percentage of Lakes and Ponds | 0.76 | percent |

| Parameter Code | Parameter Description | Value | Unit |
|---|---|---|---|
| STORNWI | Percentage of storage (combined water bodies and wetlands) from the National Wetlands Inventory | 36.73 | percent |
| SSURGOC | Percentage of area of Hydrologic Soil Type C from SSURGO | 20.1 | percent |

General Disclaimers

Parameter values have been edited, computed flows may not apply.

This watershed has been edited, computed flows may not apply.

Peak-Flow Statistics Parameters[100 Percent (56.4 square miles) Region C]

| Parameter Code | Parameter Name | Value | Units | Min Limit | Max Limit |
|---|---|---|---|---|---|
| DRNAREA | Drainage Area | 56.34 | square miles | 0.21 | 607 |
| LAKEAREA | Percent Lakes and Ponds | 0.76 | percent | 0 | 11.8 |

Peak-Flow Statistics Flow Report[100 Percent (56.4 square miles) Region C]

PIl: Prediction Interval-Lower, Plu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

| Statistic | Value | Unit | PIl | Plu | SE | SEp | Equiv. Yrs. |
|---|---|---|---|---|---|---|---|
| 1.5 Year Peak Flood | 1010 | ft^3/s | 461 | 1900 | 45.2 | 45.2 | 2.8 |
| 2 Year Peak Flood | 1270 | ft^3/s | 558 | 2460 | 46.8 | 46.8 | 2.4 |
| 5 Year Peak Flood | 2060 | ft^3/s | 850 | 4160 | 50.4 | 50.4 | 2.8 |
| 10 Year Peak Flood | 2720 | ft^3/s | 1080 | 5610 | 52.9 | 52.9 | 3.5 |
| 25 Year Peak Flood | 3680 | ft^3/s | 1400 | 7820 | 56.2 | 56.2 | 4.5 |

| Statistic | Value | Unit | PIl | PIu | SE | SEp | Equiv. Yrs. |
|---|---|---|---|---|---|---|---|
| 50 Year Peak Flood | 4560 | ft^3/s | 1660 | 9910 | 59.1 | 59.1 | 5.1 |
| 100 Year Peak Flood | 5530 | ft^3/s | 1930 | 12400 | 62.3 | 62.3 | 5.7 |
| 500 Year Peak Flood | 8300 | ft^3/s | 2560 | 19900 | 70.9 | 70.9 | 6.5 |

*Peak-Flow Statistics Citations*

**Lorenz, D.L., Sanocki, C.A., and Kocian, M.J.,2009, Techniques for Estimating the Magnitude and Frequency of Peak Flows on Small Streams in Minnesota Based on Data through Water Year 2005: U.S. Geological Survey Scientific Investigations Report 2009-5250, 54 p. (http://pubs.usgs.gov/sir/2009/5250/pdf/sir2009-5250.pdf)**

Flow-Duration Statistics Parameters[Flow duration Region BC 2015 5170]

| Parameter Code | Parameter Name | Value | Units | Min Limit | Max Limit |
|---|---|---|---|---|---|
| DRNAREA | Drainage Area | 56.34 | square miles | 2.98 | 2960 |
| STORNWI | Percentage of Storage from NWI | 36.73 | percent | 2.44 | 48 |
| SSURGOC | SSURGO Percent Hydrologic Soil Type C | 20.1 | percent | 2.61 | 100 |

Flow-Duration Statistics Flow Report[Flow duration Region BC 2015 5170]

| Statistic | Value | Unit |
|---|---|---|
| 0.01 Percent Duration | 952 | ft^3/s |
| 0.1 Percent Duration | 620 | ft^3/s |
| 2 Percent Duration | 243 | ft^3/s |
| 5 Percent Duration | 159 | ft^3/s |
| 10 Percent Duration | 85.3 | ft^3/s |
| 25 Percent Duration | 42.9 | ft^3/s |
| 50 Percent Duration | 16.5 | ft^3/s |

| Statistic | Value | Unit |
|---|---|---|
| 75 Percent Duration | 8.41 | ft^3/s |
| 90 Percent Duration | 4.87 | ft^3/s |
| 95 Percent Duration | 3.2 | ft^3/s |
| 99 Percent Duration | 1.63 | ft^3/s |
| 99.9 Percent Duration | 0.674 | ft^3/s |
| 99.99 Percent Duration | 0.561 | ft^3/s |

*Flow-Duration Statistics Citations*

**Ziegeweid, J.R., Lorenz, D.L., Sanocki, C.A., and Czuba, C.R.,2015, Methods for estimating flow-duration curve and low-flow frequency statistics for ungaged locations on small streams in Minnesota: U.S. Geological Survey Scientific Investigations Report 2015–5170, 23 p. (http://dx.doi.org/10.3133/sir20155170)**

Low-Flow Statistics Parameters[Low flow Region BC 2015 5170]

| Parameter Code | Parameter Name | Value | Units | Min Limit | Max Limit |
|---|---|---|---|---|---|
| DRNAREA | Drainage Area | 56.34 | square miles | 2.98 | 2960 |
| STORNWI | Percentage of Storage from NWI | 36.73 | percent | 2.44 | 48 |
| SSURGOC | SSURGO Percent Hydrologic Soil Type C | 20.1 | percent | 2.61 | 100 |

Low-Flow Statistics Flow Report[Low flow Region BC 2015 5170]

| Statistic | Value | Unit |
|---|---|---|
| 7 Day 10 Year Low Flow | 1.78 | ft^3/s |

*Low-Flow Statistics Citations*

**Ziegeweid, J.R., Lorenz, D.L., Sanocki, C.A., and Czuba, C.R.,2015, Methods for estimating flow-duration curve and low-flow frequency statistics for ungaged**

**locations on small streams in Minnesota: U.S. Geological Survey Scientific Investigations Report 2015–5170, 23 p. (http://dx.doi.org/10.3133/sir20155170)**

Seasonal Flow Statistics Parameters[Low flow Region BC 2015 5170]

| Parameter Code | Parameter Name | Value | Units | Min Limit | Max Limit |
|---|---|---|---|---|---|
| DRNAREA | Drainage Area | 56.34 | square miles | 2.98 | 2960 |
| STORNWI | Percentage of Storage from NWI | 36.73 | percent | 2.44 | 48 |
| SSURGOC | SSURGO Percent Hydrologic Soil Type C | 20.1 | percent | 2.61 | 100 |

Seasonal Flow Statistics Flow Report[Low flow Region BC 2015 5170]

| Statistic | Value | Unit |
|---|---|---|
| Oct to Nov 7 Day 10 Year Low Flow | 4.26 | ft^3/s |
| 30_Day_10_Year_Low_Flow_Oct_to_Nov | 6.04 | ft^3/s |
| 7_Day_10_Year_lowflow_Dec_to_Mar | 2.44 | ft^3/s |
| 30_Day_10_Year_Low_Flow_Dec_to_Mar | 2.9 | ft^3/s |
| Apr to May 7 Day 10 Year Low Flow | 8.37 | ft^3/s |
| Apr to May 30 Day 10 Year Low Flow | 27.1 | ft^3/s |
| 7_Day_10_Year_lowflow_Jun_to_Sep | 2.34 | ft^3/s |
| 30_Day_10_Year_Low_Flow_Jun_to_Sep | 3.11 | ft^3/s |
| 122_Day_10_Year_Low_Flow_Jun_to_Sep | 15.2 | ft^3/s |

*Seasonal Flow Statistics Citations*

**Ziegeweid, J.R., Lorenz, D.L., Sanocki, C.A., and Czuba, C.R.,2015, Methods for estimating flow-duration curve and low-flow frequency statistics for ungaged locations on small streams in Minnesota: U.S. Geological Survey Scientific Investigations Report 2015–5170, 23 p. (http://dx.doi.org/10.3133/sir20155170)**

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USGS Product Names Disclaimer: Any use of trade, firm, or product names is for descriptive purposes only and does not imply endorsement by the U.S. Government.

Application Version: 4.3.11

NATIONAL WEATHER SERVICE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

# Normal Depth Calculator

Weather.gov > Alaska-Pacific RFC > Normal Depth Calculator

**Alaska-Pacific RFC**
River Forecast Center

River Observations and Forecasts | Weather Observations and Forecasts | Water Supply | Climate and History | Seasonal Interest | Additional Info

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$$Q = VA = \left(\frac{1.49}{n}\right) AR^{\frac{2}{3}}\sqrt{S} \quad [U.S.]$$

$$Q = VA = \left(\frac{1.00}{n}\right) AR^{\frac{2}{3}}\sqrt{S} \quad [SI]$$

Where:
Q = Flow Rate, ($ft^3/s$)
v = Velocity, (ft/s)
A = Flow Area, ($ft^2$)
n = Manning's Roughness Coefficient
R = Hydraulic Radius, (ft)
S = Channel Slope, (ft/ft)

Under the assumption of uniform flow conditions the bottom slope is the same as the slope of the energy grade line and the water surface slope. The Manning's n is a coefficient which represents the roughness or friction applied to the flow by the channel. Manning's n-values are often selected from tables, but can be back calculated from field measurements. In many flow conditions the selection of a Manning's roughness coefficient can greatly affect computational results.

**Instructions:** Select variable to solve, adjust slider bars, click on graph to modify the cross section. CSV cross section data can be loaded in the input box below. This online calculator is for demonstration and educational purposes only.

Solve For: Water Surface (normal depth)

Slope: 0.0107 (ft/ft)

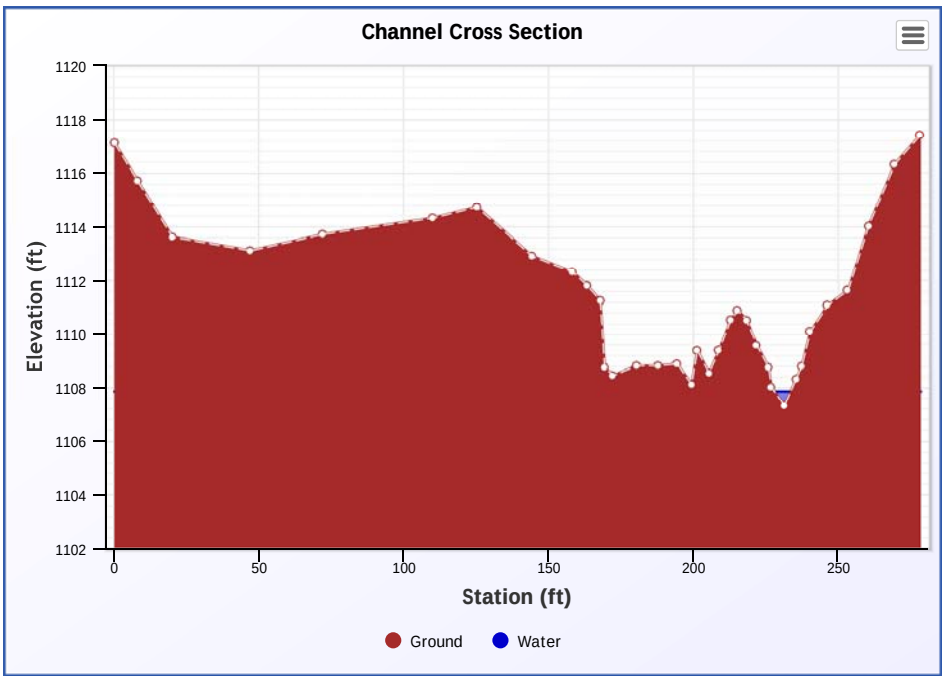
WSE: 1107.84 (ft)

Channel Manning n: 0.040

Flow: 2 ($ft^3/s$)

100 40000

Reset Cross Section




| | |
|---|---|
| Flow Area: | 1.4 ($ft^2$) |
| Wetted Perimeter: | 5.1 (ft) |
| Max Depth: | 0.55 (ft) |
| Average Velocity: | 1.70 (ft/s) |
| Top Width: | 5 (ft) |
| Iterations: | 5001 |
| Froude Number: | 0.57 |

Select HECRAS Geometry: Browse... Load HEC-RAS Data

Load CSV XS Data Below
(station,elevation)

Update Plot

```
0.00,1117.10
8.00,1115.70
20.00,1113.60
47.00,1113.10
72.00,1113.70
110.00,1114.30
125.00,1114.70
144.00,1112.90
158.00,1112.30
163.00,1111.79
167.50,1111.24
169.00,1108.74
172.00,1108.43
180.00,1108.80
187.50,1108.80
194.00,1108.87
199.00,1108.10
201.00,1109.37
205.00,1108.52
208.50,1109.38
212.50,1110.53
215.00,1110.88
218.00,1110.51
221.50,1109.56
225.50,1108.74
226.50,1108.00
231.00,1107.29
235.00,1108.30
237.00,1108.78
240.00,1110.10
246.00,1111.07
253.00,1111.62
260.00,1114.00
269.00,1116.30
278.00,1117.40
```

NATIONAL WEATHER SERVICE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

# Normal Depth Calculator

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**Alaska-Pacific RFC**
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$$Q = VA = \left(\frac{1.49}{n}\right) AR^{\frac{2}{3}}\sqrt{S} \quad [U.S.]$$

$$Q = VA = \left(\frac{1.00}{n}\right) AR^{\frac{2}{3}}\sqrt{S} \quad [SI]$$

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A = Flow Area, ($ft^2$)
n = Manning's Roughness Coefficient
R = Hydraulic Radius, (ft)
S = Channel Slope, (ft/ft)

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**Instructions:** Select variable to solve, adjust slider bars, click on graph to modify the cross section. CSV cross section data can be loaded in the input box below. This online calculator is for demonstration and educational purposes only.

Solve For: Water Surface (normal depth)

Slope: 0.0107 (ft/ft)

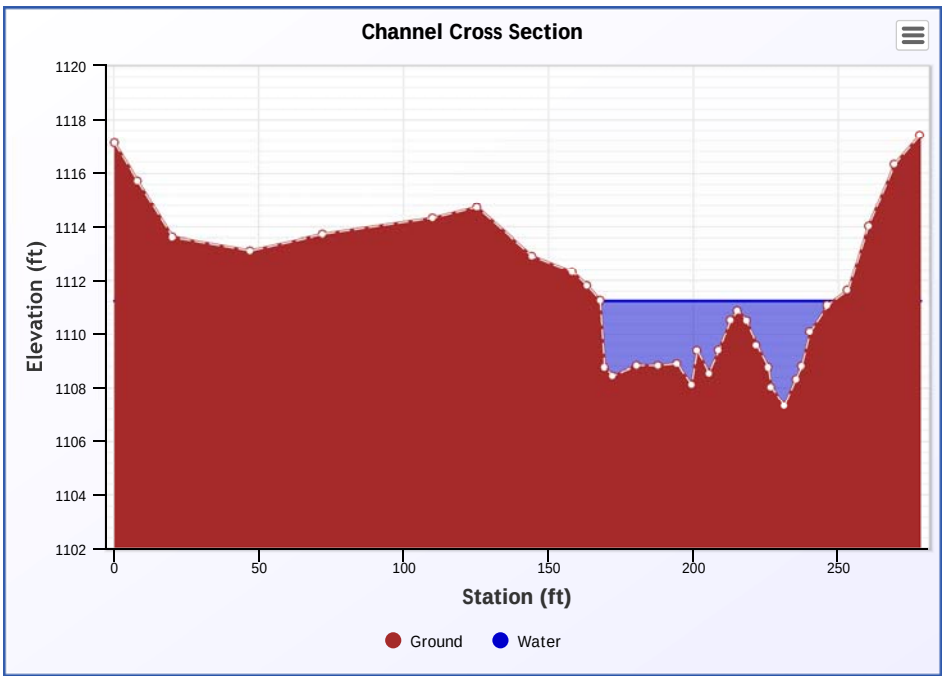
WSE: 1111.21 (ft)

Channel Manning n: 0.040

Flow: 1010 ($ft^3/s$)

100 40000

Reset Cross Section




| | |
|---|---|
| Flow Area: | 166.6 ($ft^2$) |
| Wetted Perimeter: | 83.6 (ft) |
| Max Depth: | 3.92 (ft) |
| Average Velocity: | 6.06 (ft/s) |
| Top Width: | 80 (ft) |
| Iterations: | 36 |
| Froude Number: | 0.74 |

Select HECRAS Geometry: Browse... Load HEC-RAS Data

NATIONAL WEATHER SERVICE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

# Normal Depth Calculator

Weather.gov > Alaska-Pacific RFC > Normal Depth Calculator

**Alaska-Pacific RFC**
River Forecast Center

River Observations and Forecasts | Weather Observations and Forecasts | Water Supply | Climate and History | Seasonal Interest | Additional Info

## Normal Depth Demonstration Tool

One the most commonly used equations governing Open Channel Flow is known as the Mannings's Equation. It was introduced by the Irish Engineer Robert Manning in 1889 as an alternative to the Chezy Equation. The Mannings equation is an empirical equation that applies to uniform flow in open channels and is a function of the channel velocity, flow area and channel slope.

$$Q = VA = \left(\frac{1.49}{n}\right) AR^{\frac{2}{3}}\sqrt{S} \quad [U.S.]$$

$$Q = VA = \left(\frac{1.00}{n}\right) AR^{\frac{2}{3}}\sqrt{S} \quad [SI]$$

Where:
Q = Flow Rate, ($ft^3/s$)
v = Velocity, (ft/s)
A = Flow Area, ($ft^2$)
n = Manning's Roughness Coefficient
R = Hydraulic Radius, (ft)
S = Channel Slope, (ft/ft)

Under the assumption of uniform flow conditions the bottom slope is the same as the slope of the energy grade line and the water surface slope. The Manning's n is a coefficient which represents the roughness or friction applied to the flow by the channel. Manning's n-values are often selected from tables, but can be back calculated from field measurements. In many flow conditions the selection of a Manning's roughness coefficient can greatly affect computational results.

**Instructions:** Select variable to solve, adjust slider bars, click on graph to modify the cross section. CSV cross section data can be loaded in the input box below. This online calculator is for demonstration and educational purposes only.

Solve For: Water Surface (normal depth)

Slope: 0.0107 (ft/ft)

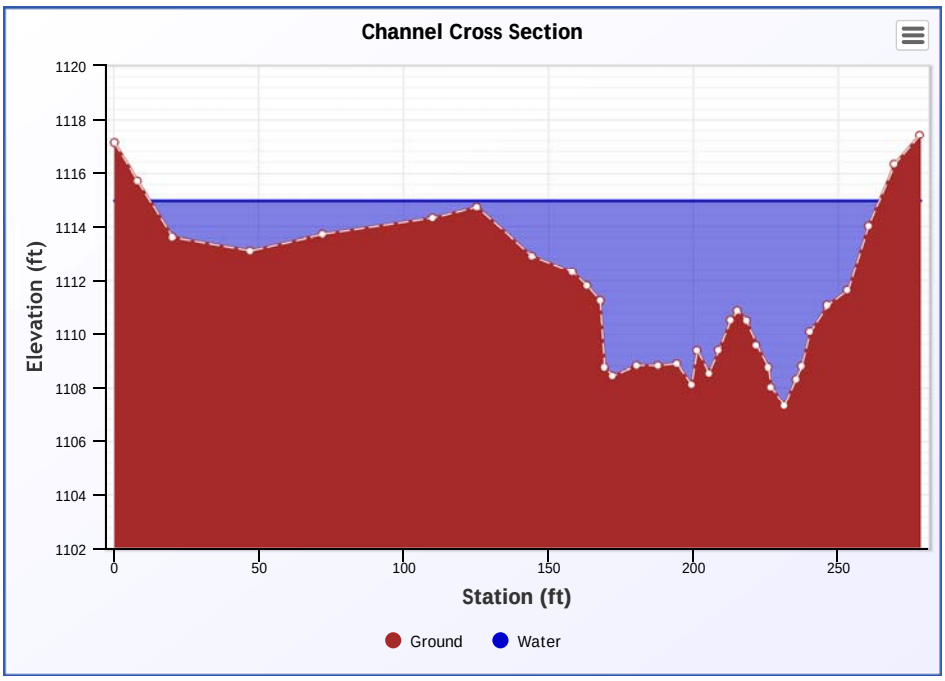
WSE: 1114.97 (ft)

Channel Manning n: 0.040

Flow: 5530 ($ft^3/s$)

100 40000

Reset Cross Section



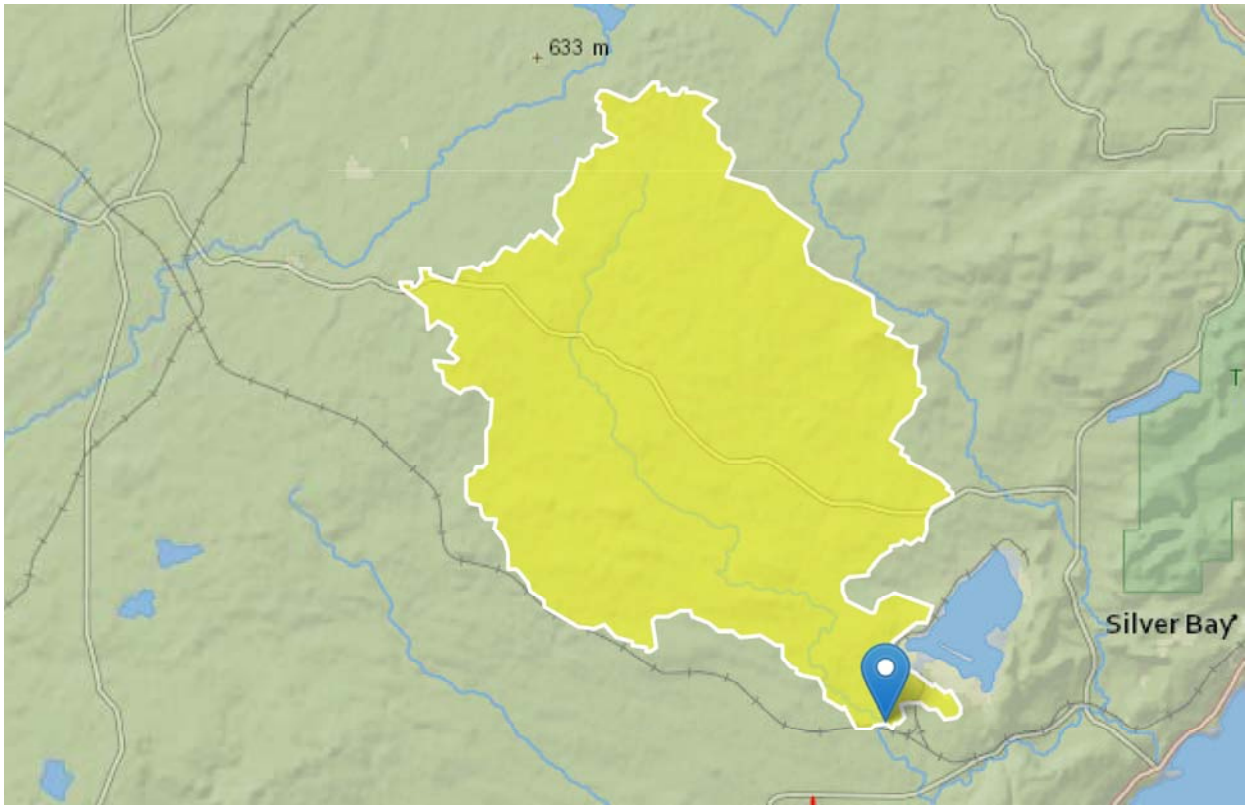

| | |
|---|---|
| Flow Area: | 721.0 ($ft^2$) |
| Wetted Perimeter: | 256.1 (ft) |
| Max Depth: | 7.68 (ft) |
| Average Velocity: | 7.67 (ft/s) |
| Top Width: | 252 (ft) |
| Iterations: | 35 |
| Froude Number: | 0.80 |

Select HECRAS Geometry: Browse... Load HEC-RAS Data

# Discharge into Lower Middle Beaver River Subwatershed #12 - Existing

**Region ID:** MN

**Workspace ID:** MN20200325231149456000
**Clicked Point (Latitude, Longitude):** 47.27006, -91.39147
**Time:** 2020-03-25 18:12:06 -0500




Basin Characteristics

| Parameter Code | Parameter Description | Value | Unit |
|---|---|---|---|
| DRNAREA | Area that drains to a point on a stream | 49.16 | square miles |
| LAKEAREA | Percentage of Lakes and Ponds | 4.38 | percent |

| Parameter Code | Parameter Description | Value | Unit |
|---|---|---|---|
| STORNWI | Percentage of storage (combined water bodies and wetlands) from the National Wetlands Inventory | 37.72 | percent |
| SSURGOC | Percentage of area of Hydrologic Soil Type C from SSURGO | 21.11 | percent |

General Disclaimers

Parameter values have been edited, computed flows may not apply.

Peak-Flow Statistics Parameters[100 Percent (50.6 square miles) Region C]

| Parameter Code | Parameter Name | Value | Units | Min Limit | Max Limit |
|---|---|---|---|---|---|
| DRNAREA | Drainage Area | 49.16 | square miles | 0.21 | 607 |
| LAKEAREA | Percent Lakes and Ponds | 4.38 | percent | 0 | 11.8 |

Peak-Flow Statistics Flow Report[100 Percent (50.6 square miles) Region C]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

| Statistic | Value | Unit | PIl | PIu | SE | SEp | Equiv. Yrs. |
|---|---|---|---|---|---|---|---|
| 1.5 Year Peak Flood | 490 | ft^3/s | 220 | 945 | 45.2 | 45.2 | 2.8 |
| 2 Year Peak Flood | 608 | ft^3/s | 262 | 1200 | 46.8 | 46.8 | 2.4 |
| 5 Year Peak Flood | 957 | ft^3/s | 385 | 1970 | 50.4 | 50.4 | 2.8 |
| 10 Year Peak Flood | 1230 | ft^3/s | 480 | 2610 | 52.9 | 52.9 | 3.5 |
| 25 Year Peak Flood | 1630 | ft^3/s | 604 | 3540 | 56.2 | 56.2 | 4.5 |
| 50 Year Peak Flood | 1970 | ft^3/s | 702 | 4410 | 59.1 | 59.1 | 5.1 |

| Statistic | Value | Unit | PIl | PIu | SE | SEp | Equiv. Yrs. |
|---|---|---|---|---|---|---|---|
| 100 Year Peak Flood | 2350 | ft^3/s | 798 | 5390 | 62.3 | 62.3 | 5.7 |
| 500 Year Peak Flood | 3370 | ft^3/s | 1010 | 8310 | 70.9 | 70.9 | 6.5 |

*Peak-Flow Statistics Citations*

**Lorenz, D.L., Sanocki, C.A., and Kocian, M.J.,2009, Techniques for Estimating the Magnitude and Frequency of Peak Flows on Small Streams in Minnesota Based on Data through Water Year 2005: U.S. Geological Survey Scientific Investigations Report 2009-5250, 54 p. (http://pubs.usgs.gov/sir/2009/5250/pdf/sir2009-5250.pdf)**

Flow-Duration Statistics Parameters[Flow duration Region BC 2015 5170]

| Parameter Code | Parameter Name | Value | Units | Min Limit | Max Limit |
|---|---|---|---|---|---|
| DRNAREA | Drainage Area | 49.16 | square miles | 2.98 | 2960 |
| STORNWI | Percentage of Storage from NWI | 37.72 | percent | 2.44 | 48 |
| SSURGOC | SSURGO Percent Hydrologic Soil Type C | 21.11 | percent | 2.61 | 100 |

Flow-Duration Statistics Flow Report[Flow duration Region BC 2015 5170]

| Statistic | Value | Unit |
|---|---|---|
| 0.01 Percent Duration | 863 | ft^3/s |
| 0.1 Percent Duration | 561 | ft^3/s |
| 2 Percent Duration | 219 | ft^3/s |
| 5 Percent Duration | 142 | ft^3/s |
| 10 Percent Duration | 75.5 | ft^3/s |
| 25 Percent Duration | 37.6 | ft^3/s |
| 50 Percent Duration | 14.1 | ft^3/s |
| 75 Percent Duration | 7.09 | ft^3/s |

| Statistic | Value | Unit |
|---|---|---|
| 90 Percent Duration | 4.05 | ft^3/s |
| 95 Percent Duration | 2.62 | ft^3/s |
| 99 Percent Duration | 1.32 | ft^3/s |
| 99.9 Percent Duration | 0.528 | ft^3/s |
| 99.99 Percent Duration | 0.438 | ft^3/s |

*Flow-Duration Statistics Citations*

**Ziegeweid, J.R., Lorenz, D.L., Sanocki, C.A., and Czuba, C.R.,2015, Methods for estimating flow-duration curve and low-flow frequency statistics for ungaged locations on small streams in Minnesota: U.S. Geological Survey Scientific Investigations Report 2015–5170, 23 p. (http://dx.doi.org/10.3133/sir20155170)**

Low-Flow Statistics Parameters[Low flow Region BC 2015 5170]

| Parameter Code | Parameter Name | Value | Units | Min Limit | Max Limit |
|---|---|---|---|---|---|
| DRNAREA | Drainage Area | 49.16 | square miles | 2.98 | 2960 |
| STORNWI | Percentage of Storage from NWI | 37.72 | percent | 2.44 | 48 |
| SSURGOC | SSURGO Percent Hydrologic Soil Type C | 21.11 | percent | 2.61 | 100 |

Low-Flow Statistics Flow Report[Low flow Region BC 2015 5170]

| Statistic | Value | Unit |
|---|---|---|
| 7 Day 10 Year Low Flow | 1.44 | ft^3/s |

*Low-Flow Statistics Citations*

**Ziegeweid, J.R., Lorenz, D.L., Sanocki, C.A., and Czuba, C.R.,2015, Methods for estimating flow-duration curve and low-flow frequency statistics for ungaged locations on small streams in Minnesota: U.S. Geological Survey Scientific Investigations Report 2015–5170, 23 p. (http://dx.doi.org/10.3133/sir20155170)**

Seasonal Flow Statistics Parameters[Low flow Region BC 2015 5170]

| Parameter Code | Parameter Name | Value | Units | Min Limit | Max Limit |
|---|---|---|---|---|---|
| DRNAREA | Drainage Area | 49.16 | square miles | 2.98 | 2960 |
| STORNWI | Percentage of Storage from NWI | 37.72 | percent | 2.44 | 48 |
| SSURGOC | SSURGO Percent Hydrologic Soil Type C | 21.11 | percent | 2.61 | 100 |

Seasonal Flow Statistics Flow Report[Low flow Region BC 2015 5170]

| Statistic | Value | Unit |
|---|---|---|
| Oct to Nov 7 Day 10 Year Low Flow | 3.53 | ft^3/s |
| 30_Day_10_Year_Low_Flow_Oct_to_Nov | 5.05 | ft^3/s |
| 7_Day_10_Year_lowflow_Dec_to_Mar | 1.99 | ft^3/s |
| 30_Day_10_Year_Low_Flow_Dec_to_Mar | 2.37 | ft^3/s |
| Apr to May 7 Day 10 Year Low Flow | 7.04 | ft^3/s |
| Apr to May 30 Day 10 Year Low Flow | 23.6 | ft^3/s |
| 7_Day_10_Year_lowflow_Jun_to_Sep | 1.91 | ft^3/s |
| 30_Day_10_Year_Low_Flow_Jun_to_Sep | 2.56 | ft^3/s |
| 122_Day_10_Year_Low_Flow_Jun_to_Sep | 13.3 | ft^3/s |

*Seasonal Flow Statistics Citations*

**Ziegeweid, J.R., Lorenz, D.L., Sanocki, C.A., and Czuba, C.R.,2015, Methods for estimating flow-duration curve and low-flow frequency statistics for ungaged locations on small streams in Minnesota: U.S. Geological Survey Scientific Investigations Report 2015–5170, 23 p. (http://dx.doi.org/10.3133/sir20155170)**

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# Normal Depth Calculator

Weather.gov > Alaska-Pacific RFC > Normal Depth Calculator

**Alaska-Pacific RFC**
River Forecast Center

River Observations and Forecasts | Weather Observations and Forecasts | Water Supply | Climate and History | Seasonal Interest | Additional Info

## Normal Depth Demonstration Tool

One the most commonly used equations governing Open Channel Flow is known as the Mannings's Equation. It was introduced by the Irish Engineer Robert Manning in 1889 as an alternative to the Chezy Equation. The Mannings equation is an empirical equation that applies to uniform flow in open channels and is a function of the channel velocity, flow area and channel slope.

$$Q = VA = \left(\frac{1.49}{n}\right) AR^{\frac{2}{3}}\sqrt{S} \quad [U.S.]$$

$$Q = VA = \left(\frac{1.00}{n}\right) AR^{\frac{2}{3}}\sqrt{S} \quad [SI]$$

Where:
Q = Flow Rate, ($ft^3/s$)
v = Velocity, (ft/s)
A = Flow Area, ($ft^2$)
n = Manning's Roughness Coefficient
R = Hydraulic Radius, (ft)
S = Channel Slope, (ft/ft)

Under the assumption of uniform flow conditions the bottom slope is the same as the slope of the energy grade line and the water surface slope. The Manning's n is a coefficient which represents the roughness or friction applied to the flow by the channel. Manning's n-values are often selected from tables, but can be back calculated from field measurements. In many flow conditions the selection of a Manning's roughness coefficient can greatly affect computational results.

**Instructions:** Select variable to solve, adjust slider bars, click on graph to modify the cross section. CSV cross section data can be loaded in the input box below. This online calculator is for demonstration and educational purposes only.

Solve For: Water Surface (normal depth)

Slope: 0.0107 (ft/ft)

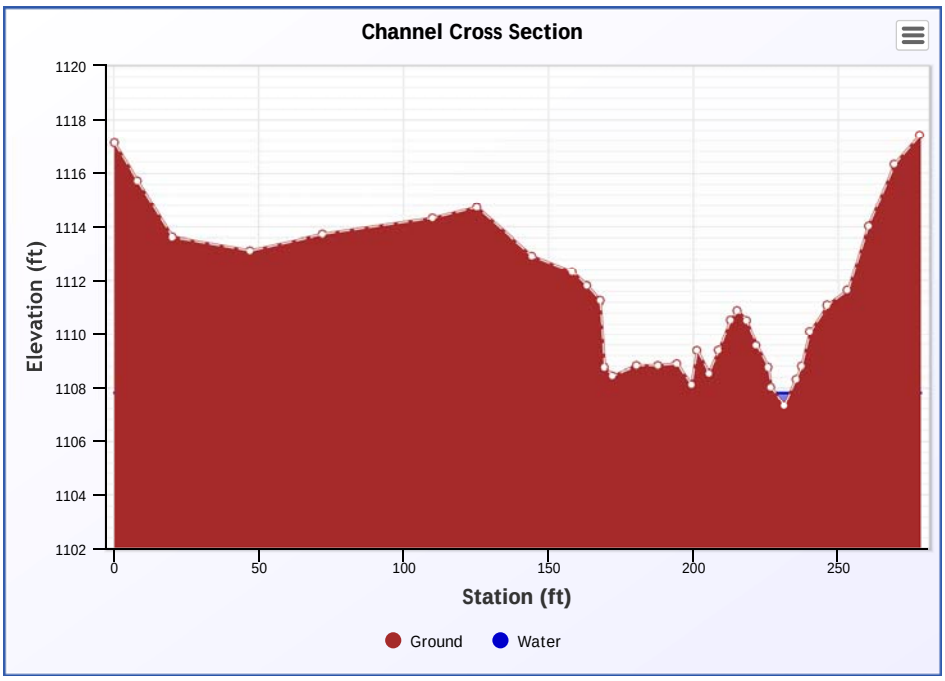
WSE: 1107.79 (ft)

Channel Manning n: 0.040

Flow: 2 ($ft^3/s$)

100 40000

Reset Cross Section




| | |
|---|---|
| Flow Area: | 1.2 ($ft^2$) |
| Wetted Perimeter: | 5.1 (ft) |
| Max Depth: | 0.50 (ft) |
| Average Velocity: | 1.53 (ft/s) |
| Top Width: | 5 (ft) |
| Iterations: | 36 |
| Froude Number: | 0.54 |

Select HECRAS Geometry: Browse... Load HEC-RAS Data

Load CSV XS Data Below
(station,elevation)

Update Plot

```
0.00,1117.10
8.00,1115.70
20.00,1113.60
47.00,1113.10
72.00,1113.70
110.00,1114.30
125.00,1114.70
144.00,1112.90
158.00,1112.30
163.00,1111.79
167.50,1111.24
169.00,1108.74
172.00,1108.43
180.00,1108.80
187.50,1108.80
194.00,1108.87
199.00,1108.10
201.00,1109.37
205.00,1108.52
208.50,1109.38
212.50,1110.53
215.00,1110.88
218.00,1110.51
221.50,1109.56
225.50,1108.74
226.50,1108.00
231.00,1107.29
235.00,1108.30
237.00,1108.78
240.00,1110.10
246.00,1111.07
253.00,1111.62
260.00,1114.00
269.00,1116.30
278.00,1117.40
```

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# Normal Depth Calculator

Weather.gov > Alaska-Pacific RFC > Normal Depth Calculator

**Alaska-Pacific RFC**
River Forecast Center

River Observations and Forecasts | Weather Observations and Forecasts | Water Supply | Climate and History | Seasonal Interest | Additional Info

## Normal Depth Demonstration Tool

One the most commonly used equations governing Open Channel Flow is known as the Mannings's Equation. It was introduced by the Irish Engineer Robert Manning in 1889 as an alternative to the Chezy Equation. The Mannings equation is an empirical equation that applies to uniform flow in open channels and is a function of the channel velocity, flow area and channel slope.

$$Q = VA = \left(\frac{1.49}{n}\right) AR^{\frac{2}{3}}\sqrt{S} \quad [U.S.]$$

$$Q = VA = \left(\frac{1.00}{n}\right) AR^{\frac{2}{3}}\sqrt{S} \quad [SI]$$

Where:
Q = Flow Rate, ($ft^3/s$)
v = Velocity, (ft/s)
A = Flow Area, ($ft^2$)
n = Manning's Roughness Coefficient
R = Hydraulic Radius, (ft)
S = Channel Slope, (ft/ft)

Under the assumption of uniform flow conditions the bottom slope is the same as the slope of the energy grade line and the water surface slope. The Manning's n is a coefficient which represents the roughness or friction applied to the flow by the channel. Manning's n-values are often selected from tables, but can be back calculated from field measurements. In many flow conditions the selection of a Manning's roughness coefficient can greatly affect computational results.

**Instructions:** Select variable to solve, adjust slider bars, click on graph to modify the cross section. CSV cross section data can be loaded in the input box below. This online calculator is for demonstration and educational purposes only.

Solve For: Water Surface (normal depth)

Slope: 0.0107 (ft/ft)

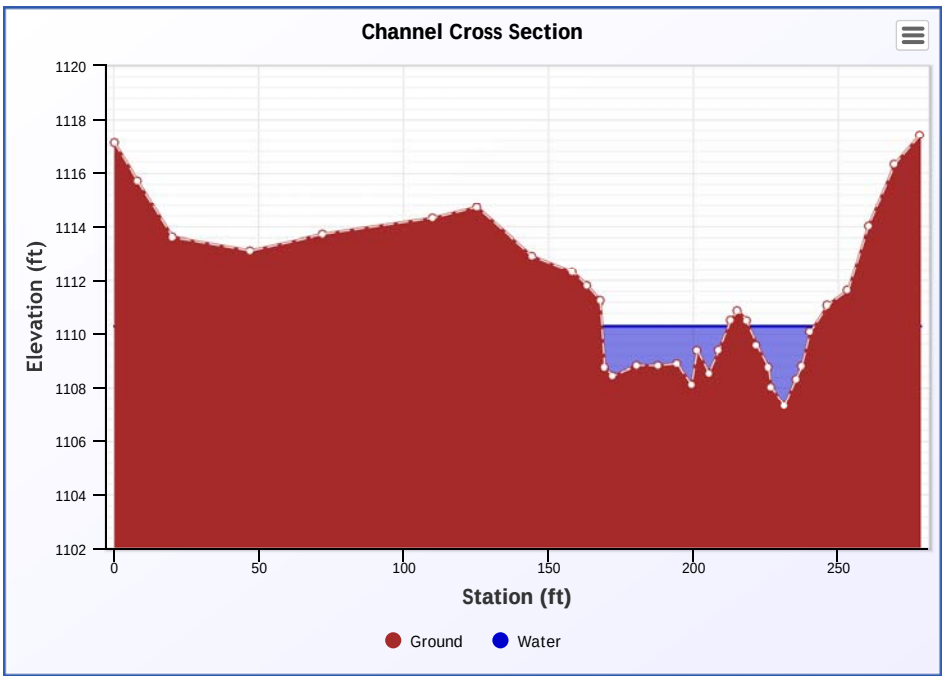
WSE: 1110.30 (ft)

Channel Manning n: 0.040

Flow: 490 ($ft^3/s$)

100 40000

Reset Cross Section




| | |
|---|---|
| Flow Area: | 99.8 ($ft^2$) |
| Wetted Perimeter: | 68.6 (ft) |
| Max Depth: | 3.01 (ft) |
| Average Velocity: | 4.91 (ft/s) |
| Top Width: | 66 (ft) |
| Iterations: | 36 |
| Froude Number: | 0.71 |

Select HECRAS Geometry: Browse... Load HEC-RAS Data

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# Normal Depth Calculator

Weather.gov > Alaska-Pacific RFC > Normal Depth Calculator

**Alaska-Pacific RFC**
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## Normal Depth Demonstration Tool

One the most commonly used equations governing Open Channel Flow is known as the Mannings's Equation. It was introduced by the Irish Engineer Robert Manning in 1889 as an alternative to the Chezy Equation. The Mannings equation is an empirical equation that applies to uniform flow in open channels and is a function of the channel velocity, flow area and channel slope.

$$Q = VA = \left(\frac{1.49}{n}\right) AR^{\frac{2}{3}}\sqrt{S} \quad [U.S.]$$

$$Q = VA = \left(\frac{1.00}{n}\right) AR^{\frac{2}{3}}\sqrt{S} \quad [SI]$$

Where:
Q = Flow Rate, ($ft^3/s$)
v = Velocity, (ft/s)
A = Flow Area, ($ft^2$)
n = Manning's Roughness Coefficient
R = Hydraulic Radius, (ft)
S = Channel Slope, (ft/ft)

Under the assumption of uniform flow conditions the bottom slope is the same as the slope of the energy grade line and the water surface slope. The Manning's n is a coefficient which represents the roughness or friction applied to the flow by the channel. Manning's n-values are often selected from tables, but can be back calculated from field measurements. In many flow conditions the selection of a Manning's roughness coefficient can greatly affect computational results.

**Instructions:** Select variable to solve, adjust slider bars, click on graph to modify the cross section. CSV cross section data can be loaded in the input box below. This online calculator is for demonstration and educational purposes only.

Solve For: Water Surface (normal depth)

Slope: 0.0107 (ft/ft)

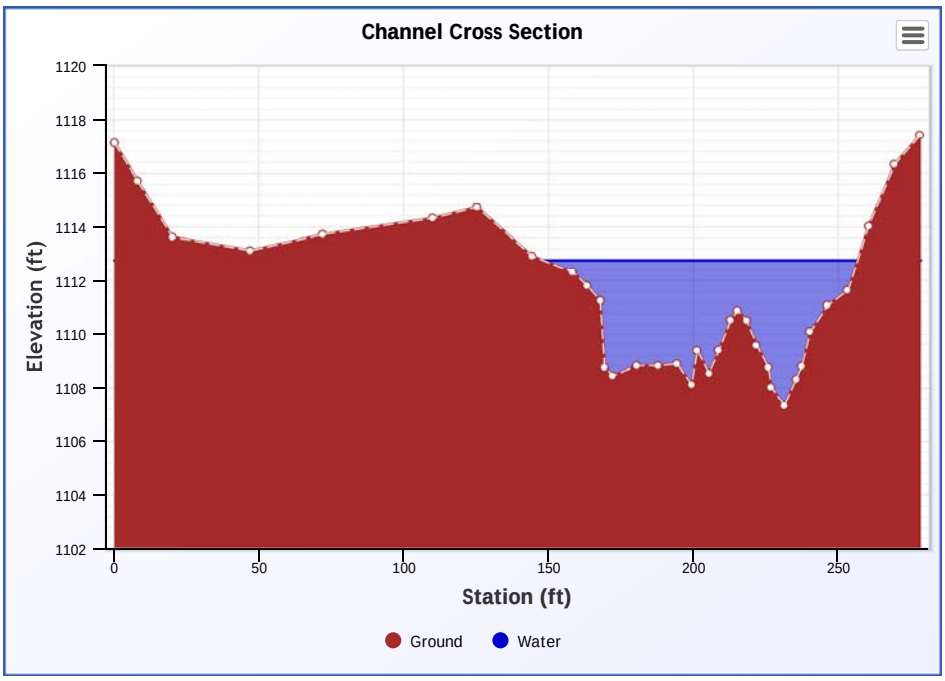
WSE: 1112.74 (ft)

Channel Manning n: 0.040

Flow: 2350 ($ft^3/s$)

100 40000

Reset Cross Section



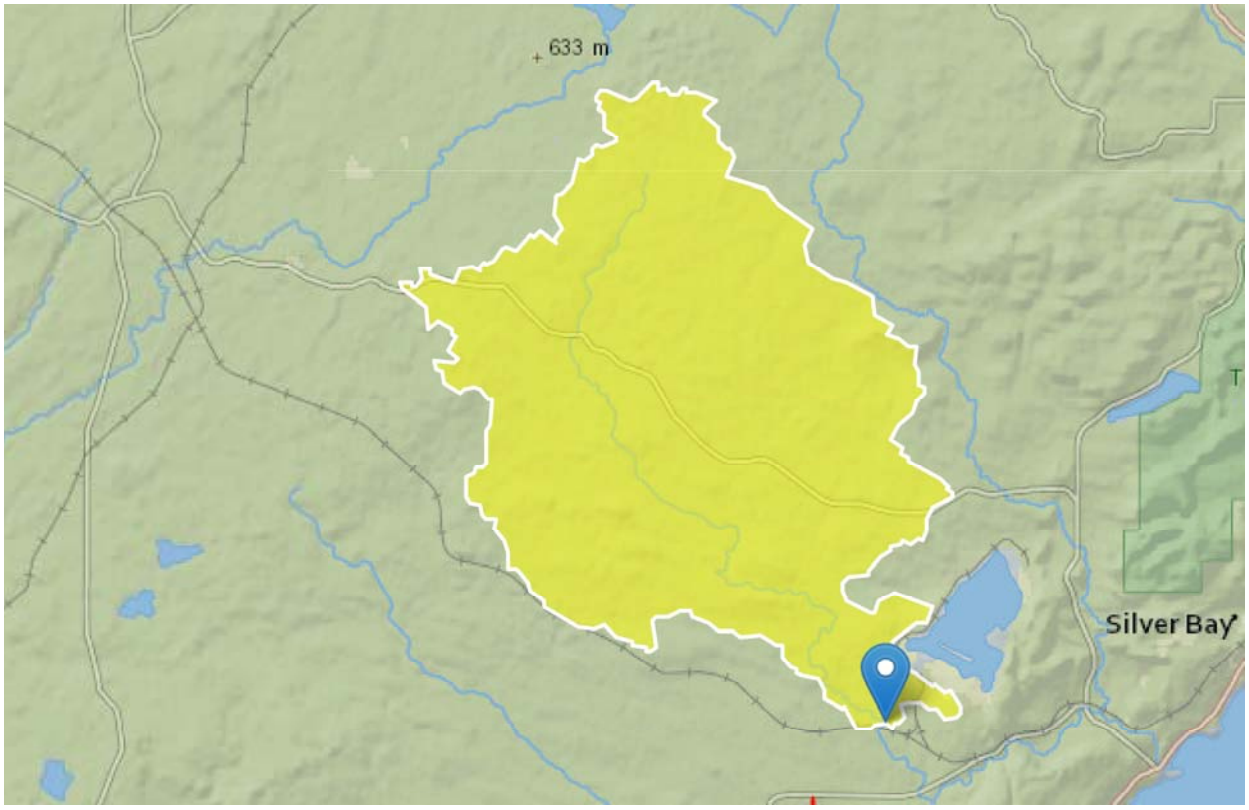

| | |
|---|---|
| Flow Area: | 309.4 ($ft^2$) |
| Wetted Perimeter: | 111.6 (ft) |
| Max Depth: | 5.45 (ft) |
| Average Velocity: | 7.60 (ft/s) |
| Top Width: | 108 (ft) |
| Iterations: | 35 |
| Froude Number: | 0.79 |

Select HECRAS Geometry: Browse... Load HEC-RAS Data

# Discharge into Lower Middle Beaver River Subwatershed #12 - Future

**Region ID:** MN

**Workspace ID:** MN20200325231149456000
**Clicked Point (Latitude, Longitude):** 47.27006, -91.39147
**Time:** 2020-03-25 18:12:06 -0500




Basin Characteristics

| Parameter Code | Parameter Description | Value | Unit |
|---|---|---|---|
| DRNAREA | Area that drains to a point on a stream | 49.1 | square miles |
| LAKEAREA | Percentage of Lakes and Ponds | 4.38 | percent |

| Parameter Code | Parameter Description | Value | Unit |
|---|---|---|---|
| STORNWI | Percentage of storage (combined water bodies and wetlands) from the National Wetlands Inventory | 37.75 | percent |
| SSURGOC | Percentage of area of Hydrologic Soil Type C from SSURGO | 21.0 | percent |

General Disclaimers

Parameter values have been edited, computed flows may not apply.

Peak-Flow Statistics Parameters[100 Percent (50.6 square miles) Region C]

| Parameter Code | Parameter Name | Value | Units | Min Limit | Max Limit |
|---|---|---|---|---|---|
| DRNAREA | Drainage Area | 49.1 | square miles | 0.21 | 607 |
| LAKEAREA | Percent Lakes and Ponds | 4.38 | percent | 0 | 11.8 |

Peak-Flow Statistics Flow Report[100 Percent (50.6 square miles) Region C]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

| Statistic | Value | Unit | PIl | PIu | SE | SEp | Equiv. Yrs. |
|---|---|---|---|---|---|---|---|
| 1.5 Year Peak Flood | 490 | ft^3/s | 220 | 944 | 45.2 | 45.2 | 2.8 |
| 2 Year Peak Flood | 608 | ft^3/s | 261 | 1200 | 46.8 | 46.8 | 2.4 |
| 5 Year Peak Flood | 956 | ft^3/s | 385 | 1970 | 50.4 | 50.4 | 2.8 |
| 10 Year Peak Flood | 1230 | ft^3/s | 479 | 2610 | 52.9 | 52.9 | 3.5 |
| 25 Year Peak Flood | 1630 | ft^3/s | 603 | 3540 | 56.2 | 56.2 | 4.5 |
| 50 Year Peak Flood | 1970 | ft^3/s | 702 | 4400 | 59.1 | 59.1 | 5.1 |

| Statistic | Value | Unit | PIl | PIu | SE | SEp | Equiv. Yrs. |
|---|---|---|---|---|---|---|---|
| 100 Year Peak Flood | 2350 | ft^3/s | 797 | 5380 | 62.3 | 62.3 | 5.7 |
| 500 Year Peak Flood | 3360 | ft^3/s | 1010 | 8300 | 70.9 | 70.9 | 6.5 |

*Peak-Flow Statistics Citations*

**Lorenz, D.L., Sanocki, C.A., and Kocian, M.J.,2009, Techniques for Estimating the Magnitude and Frequency of Peak Flows on Small Streams in Minnesota Based on Data through Water Year 2005: U.S. Geological Survey Scientific Investigations Report 2009-5250, 54 p. (http://pubs.usgs.gov/sir/2009/5250/pdf/sir2009-5250.pdf)**

Flow-Duration Statistics Parameters[Flow duration Region BC 2015 5170]

| Parameter Code | Parameter Name | Value | Units | Min Limit | Max Limit |
|---|---|---|---|---|---|
| DRNAREA | Drainage Area | 49.1 | square miles | 2.98 | 2960 |
| STORNWI | Percentage of Storage from NWI | 37.75 | percent | 2.44 | 48 |
| SSURGOC | SSURGO Percent Hydrologic Soil Type C | 21 | percent | 2.61 | 100 |

Flow-Duration Statistics Flow Report[Flow duration Region BC 2015 5170]

| Statistic | Value | Unit |
|---|---|---|
| 0.01 Percent Duration | 861 | ft^3/s |
| 0.1 Percent Duration | 560 | ft^3/s |
| 2 Percent Duration | 218 | ft^3/s |
| 5 Percent Duration | 141 | ft^3/s |
| 10 Percent Duration | 75.4 | ft^3/s |
| 25 Percent Duration | 37.5 | ft^3/s |
| 50 Percent Duration | 14.1 | ft^3/s |
| 75 Percent Duration | 7.09 | ft^3/s |

| Statistic | Value | Unit |
|---|---|---|
| 90 Percent Duration | 4.05 | ft^3/s |
| 95 Percent Duration | 2.62 | ft^3/s |
| 99 Percent Duration | 1.32 | ft^3/s |
| 99.9 Percent Duration | 0.529 | ft^3/s |
| 99.99 Percent Duration | 0.439 | ft^3/s |

*Flow-Duration Statistics Citations*

**Ziegeweid, J.R., Lorenz, D.L., Sanocki, C.A., and Czuba, C.R.,2015, Methods for estimating flow-duration curve and low-flow frequency statistics for ungaged locations on small streams in Minnesota: U.S. Geological Survey Scientific Investigations Report 2015–5170, 23 p. (http://dx.doi.org/10.3133/sir20155170)**

Low-Flow Statistics Parameters[Low flow Region BC 2015 5170]

| Parameter Code | Parameter Name | Value | Units | Min Limit | Max Limit |
|---|---|---|---|---|---|
| DRNAREA | Drainage Area | 49.1 | square miles | 2.98 | 2960 |
| STORNWI | Percentage of Storage from NWI | 37.75 | percent | 2.44 | 48 |
| SSURGOC | SSURGO Percent Hydrologic Soil Type C | 21 | percent | 2.61 | 100 |

Low-Flow Statistics Flow Report[Low flow Region BC 2015 5170]

| Statistic | Value | Unit |
|---|---|---|
| 7 Day 10 Year Low Flow | 1.44 | ft^3/s |

*Low-Flow Statistics Citations*

**Ziegeweid, J.R., Lorenz, D.L., Sanocki, C.A., and Czuba, C.R.,2015, Methods for estimating flow-duration curve and low-flow frequency statistics for ungaged locations on small streams in Minnesota: U.S. Geological Survey Scientific Investigations Report 2015–5170, 23 p. (http://dx.doi.org/10.3133/sir20155170)**

Seasonal Flow Statistics Parameters[Low flow Region BC 2015 5170]

| Parameter Code | Parameter Name | Value | Units | Min Limit | Max Limit |
|---|---|---|---|---|---|
| DRNAREA | Drainage Area | 49.1 | square miles | 2.98 | 2960 |
| STORNWI | Percentage of Storage from NWI | 37.75 | percent | 2.44 | 48 |
| SSURGOC | SSURGO Percent Hydrologic Soil Type C | 21 | percent | 2.61 | 100 |

Seasonal Flow Statistics Flow Report[Low flow Region BC 2015 5170]

| Statistic | Value | Unit |
|---|---|---|
| Oct to Nov 7 Day 10 Year Low Flow | 3.53 | ft^3/s |
| 30_Day_10_Year_Low_Flow_Oct_to_Nov | 5.05 | ft^3/s |
| 7_Day_10_Year_lowflow_Dec_to_Mar | 1.99 | ft^3/s |
| 30_Day_10_Year_Low_Flow_Dec_to_Mar | 2.37 | ft^3/s |
| Apr to May 7 Day 10 Year Low Flow | 7.04 | ft^3/s |
| Apr to May 30 Day 10 Year Low Flow | 23.6 | ft^3/s |
| 7_Day_10_Year_lowflow_Jun_to_Sep | 1.91 | ft^3/s |
| 30_Day_10_Year_Low_Flow_Jun_to_Sep | 2.56 | ft^3/s |
| 122_Day_10_Year_Low_Flow_Jun_to_Sep | 13.3 | ft^3/s |

*Seasonal Flow Statistics Citations*

**Ziegeweid, J.R., Lorenz, D.L., Sanocki, C.A., and Czuba, C.R.,2015, Methods for estimating flow-duration curve and low-flow frequency statistics for ungaged locations on small streams in Minnesota: U.S. Geological Survey Scientific Investigations Report 2015–5170, 23 p. (http://dx.doi.org/10.3133/sir20155170)**

NATIONAL WEATHER SERVICE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

# Normal Depth Calculator

Weather.gov > Alaska-Pacific RFC > Normal Depth Calculator

**Alaska-Pacific RFC**
River Forecast Center

River Observations and Forecasts | Weather Observations and Forecasts | Water Supply | Climate and History | Seasonal Interest | Additional Info

## Normal Depth Demonstration Tool

One the most commonly used equations governing Open Channel Flow is known as the Mannings's Equation. It was introduced by the Irish Engineer Robert Manning in 1889 as an alternative to the Chezy Equation. The Mannings equation is an empirical equation that applies to uniform flow in open channels and is a function of the channel velocity, flow area and channel slope.

$$Q = VA = \left(\frac{1.49}{n}\right) AR^{\frac{2}{3}}\sqrt{S} \quad [U.S.]$$

$$Q = VA = \left(\frac{1.00}{n}\right) AR^{\frac{2}{3}}\sqrt{S} \quad [SI]$$

Where:
Q = Flow Rate, ($ft^3/s$)
v = Velocity, (ft/s)
A = Flow Area, ($ft^2$)
n = Manning's Roughness Coefficient
R = Hydraulic Radius, (ft)
S = Channel Slope, (ft/ft)

Under the assumption of uniform flow conditions the bottom slope is the same as the slope of the energy grade line and the water surface slope. The Manning's n is a coefficient which represents the roughness or friction applied to the flow by the channel. Manning's n-values are often selected from tables, but can be back calculated from field measurements. In many flow conditions the selection of a Manning's roughness coefficient can greatly affect computational results.

**Instructions:** Select variable to solve, adjust slider bars, click on graph to modify the cross section. CSV cross section data can be loaded in the input box below. This online calculator is for demonstration and educational purposes only.

Solve For: Water Surface (normal depth)

Slope: 0.0107 (ft/ft)

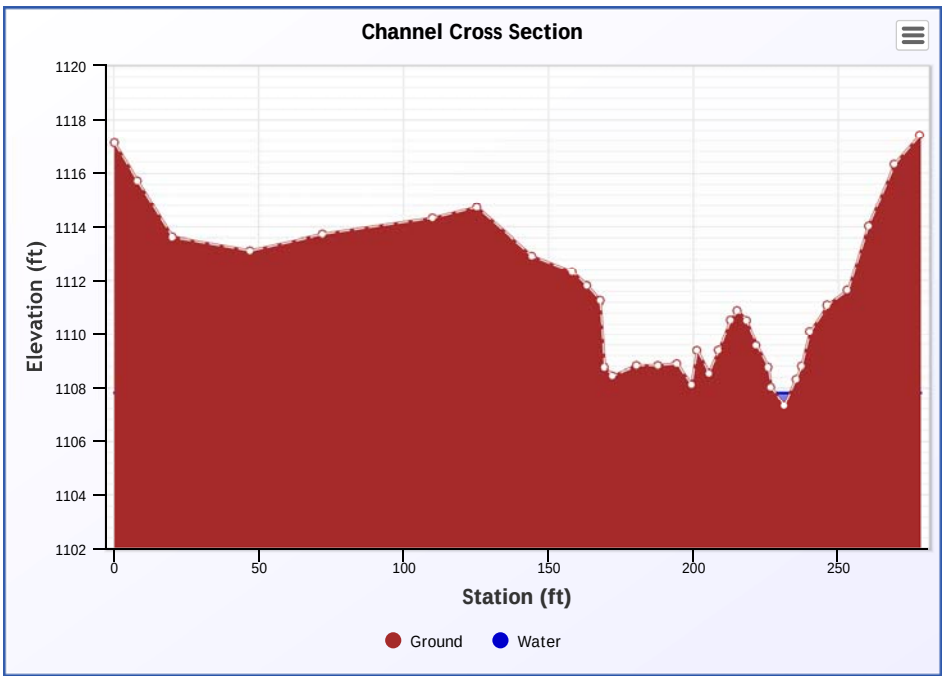
WSE: 1107.79 (ft)

Channel Manning n: 0.040

Flow: 2 ($ft^3/s$)

100 40000

Reset Cross Section




| | |
|---|---|
| Flow Area: | 1.2 ($ft^2$) |
| Wetted Perimeter: | 5.1 (ft) |
| Max Depth: | 0.50 (ft) |
| Average Velocity: | 1.53 (ft/s) |
| Top Width: | 5 (ft) |
| Iterations: | 36 |
| Froude Number: | 0.54 |

Select HECRAS Geometry: Browse... Load HEC-RAS Data

Load CSV XS Data Below
(station,elevation)

Update Plot

```
0.00,1117.10
8.00,1115.70
20.00,1113.60
47.00,1113.10
72.00,1113.70
110.00,1114.30
125.00,1114.70
144.00,1112.90
158.00,1112.30
163.00,1111.79
167.50,1111.24
169.00,1108.74
172.00,1108.43
180.00,1108.80
187.50,1108.80
194.00,1108.87
199.00,1108.10
201.00,1109.37
205.00,1108.52
208.50,1109.38
212.50,1110.53
215.00,1110.88
218.00,1110.51
221.50,1109.56
225.50,1108.74
226.50,1108.00
231.00,1107.29
235.00,1108.30
237.00,1108.78
240.00,1110.10
246.00,1111.07
253.00,1111.62
260.00,1114.00
269.00,1116.30
278.00,1117.40
```

NATIONAL WEATHER SERVICE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

# Normal Depth Calculator

Weather.gov > Alaska-Pacific RFC > Normal Depth Calculator

**Alaska-Pacific RFC**
River Forecast Center

River Observations and Forecasts | Weather Observations and Forecasts | Water Supply | Climate and History | Seasonal Interest | Additional Info

## Normal Depth Demonstration Tool

One the most commonly used equations governing Open Channel Flow is known as the Mannings's Equation. It was introduced by the Irish Engineer Robert Manning in 1889 as an alternative to the Chezy Equation. The Mannings equation is an empirical equation that applies to uniform flow in open channels and is a function of the channel velocity, flow area and channel slope.

$$Q = VA = \left(\frac{1.49}{n}\right) AR^{\frac{2}{3}}\sqrt{S} \quad [U.S.]$$

$$Q = VA = \left(\frac{1.00}{n}\right) AR^{\frac{2}{3}}\sqrt{S} \quad [SI]$$

Where:
Q = Flow Rate, ($ft^3/s$)
v = Velocity, (ft/s)
A = Flow Area, ($ft^2$)
n = Manning's Roughness Coefficient
R = Hydraulic Radius, (ft)
S = Channel Slope, (ft/ft)

Under the assumption of uniform flow conditions the bottom slope is the same as the slope of the energy grade line and the water surface slope. The Manning's n is a coefficient which represents the roughness or friction applied to the flow by the channel. Manning's n-values are often selected from tables, but can be back calculated from field measurements. In many flow conditions the selection of a Manning's roughness coefficient can greatly affect computational results.

**Instructions:** Select variable to solve, adjust slider bars, click on graph to modify the cross section. CSV cross section data can be loaded in the input box below. This online calculator is for demonstration and educational purposes only.

Solve For: Water Surface (normal depth)

Slope: 0.0107 (ft/ft)

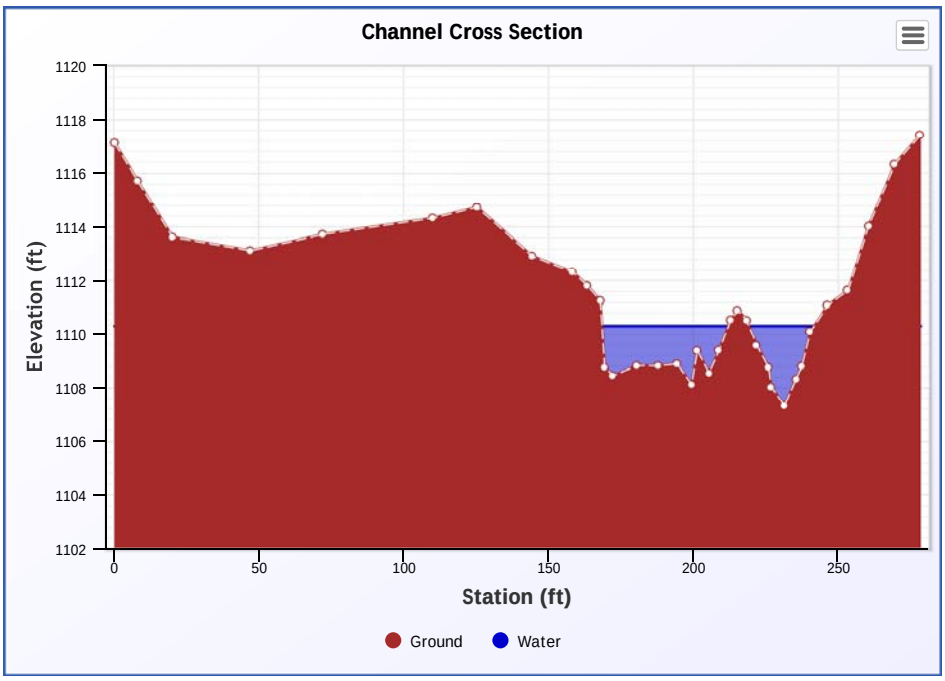
WSE: 1110.30 (ft)

Channel Manning n: 0.040

Flow: 490 ($ft^3/s$)

100 40000

Reset Cross Section




| | |
|---|---|
| Flow Area: | 99.8 ($ft^2$) |
| Wetted Perimeter: | 68.6 (ft) |
| Max Depth: | 3.01 (ft) |
| Average Velocity: | 4.91 (ft/s) |
| Top Width: | 66 (ft) |
| Iterations: | 36 |
| Froude Number: | 0.71 |

Select HECRAS Geometry: Browse... Load HEC-RAS Data

NATIONAL WEATHER SERVICE
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# Normal Depth Calculator

Weather.gov > Alaska-Pacific RFC > Normal Depth Calculator

**Alaska-Pacific RFC**
River Forecast Center

River Observations and Forecasts | Weather Observations and Forecasts | Water Supply | Climate and History | Seasonal Interest | Additional Info

## Normal Depth Demonstration Tool

One the most commonly used equations governing Open Channel Flow is known as the Mannings's Equation. It was introduced by the Irish Engineer Robert Manning in 1889 as an alternative to the Chezy Equation. The Mannings equation is an empirical equation that applies to uniform flow in open channels and is a function of the channel velocity, flow area and channel slope.

$$Q = VA = \left(\frac{1.49}{n}\right) AR^{\frac{2}{3}}\sqrt{S} \quad [U.S.]$$

$$Q = VA = \left(\frac{1.00}{n}\right) AR^{\frac{2}{3}}\sqrt{S} \quad [SI]$$

Where:
Q = Flow Rate, ($ft^3/s$)
v = Velocity, (ft/s)
A = Flow Area, ($ft^2$)
n = Manning's Roughness Coefficient
R = Hydraulic Radius, (ft)
S = Channel Slope, (ft/ft)

Under the assumption of uniform flow conditions the bottom slope is the same as the slope of the energy grade line and the water surface slope. The Manning's n is a coefficient which represents the roughness or friction applied to the flow by the channel. Manning's n-values are often selected from tables, but can be back calculated from field measurements. In many flow conditions the selection of a Manning's roughness coefficient can greatly affect computational results.

**Instructions:** Select variable to solve, adjust slider bars, click on graph to modify the cross section. CSV cross section data can be loaded in the input box below. This online calculator is for demonstration and educational purposes only.

Solve For: Water Surface (normal depth)

Slope: 0.0107 (ft/ft)

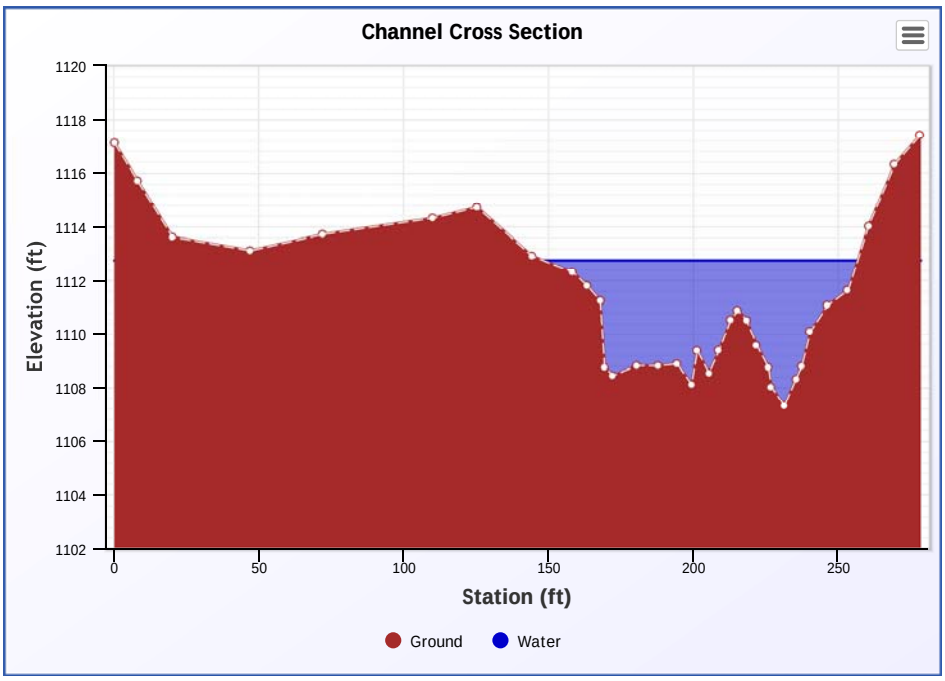
WSE: 1112.74 (ft)

Channel Manning n: 0.040

Flow: 2350 ($ft^3/s$)

100 40000

Reset Cross Section

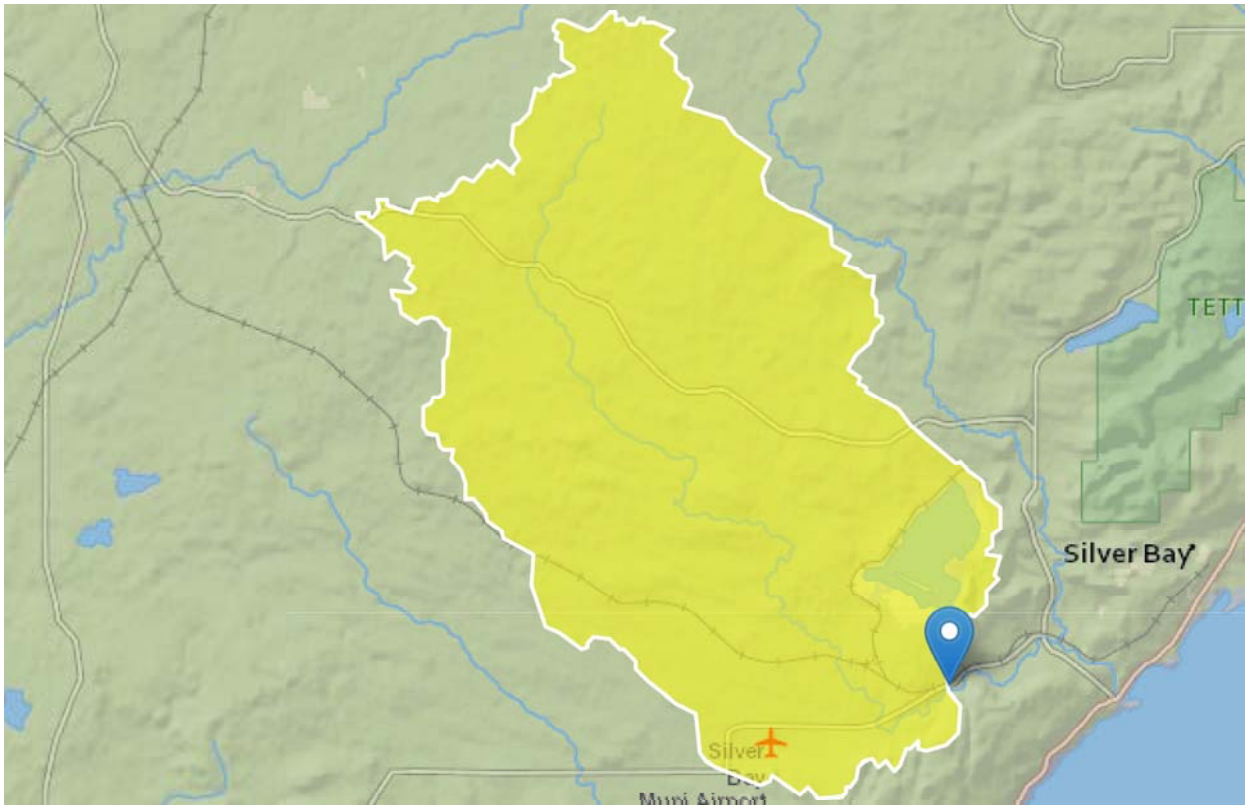



| | |
|---|---|
| Flow Area: | 309.4 ($ft^2$) |
| Wetted Perimeter: | 111.6 (ft) |
| Max Depth: | 5.45 (ft) |
| Average Velocity: | 7.60 (ft/s) |
| Top Width: | 108 (ft) |
| Iterations: | 35 |
| Froude Number: | 0.79 |

Select HECRAS Geometry: Browse... Load HEC-RAS Data

# Flow Into Lower Beaver River Subwatershed 16 - Pre-Settlement

**Region ID:** MN
**Workspace ID:** MN20200401230608120000
**Clicked Point (Latitude, Longitude):** 47.26188, -91.35491
**Time:** 2020-04-01 18:06:32 -0500




Basin Characteristics

| Parameter Code | Parameter Description | Value | Unit |
|---|---|---|---|
| DRNAREA | Area that drains to a point on a stream | 70.57 | square miles |
| LAKEAREA | Percentage of Lakes and Ponds | 0.73 | percent |

| Parameter Code | Parameter Description | Value | Unit |
|---|---|---|---|
| STORNWI | Percentage of storage (combined water bodies and wetlands) from the National Wetlands Inventory | 33.77 | percent |
| SSURGOC | Percentage of area of Hydrologic Soil Type C from SSURGO | 21.6 | percent |

General Disclaimers

Parameter values have been edited, computed flows may not apply.

This watershed has been edited, computed flows may not apply.

Peak-Flow Statistics Parameters[100 Percent (70.8 square miles) Region C]

| Parameter Code | Parameter Name | Value | Units | Min Limit | Max Limit |
|---|---|---|---|---|---|
| DRNAREA | Drainage Area | 70.57 | square miles | 0.21 | 607 |
| LAKEAREA | Percent Lakes and Ponds | 0.73 | percent | 0 | 11.8 |

Peak-Flow Statistics Flow Report[100 Percent (70.8 square miles) Region C]

PIl: Prediction Interval-Lower, Plu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

| Statistic | Value | Unit | PIl | Plu | SE | SEp | Equiv. Yrs. |
|---|---|---|---|---|---|---|---|
| 1.5 Year Peak Flood | 1240 | ft^3/s | 562 | 2350 | 45.2 | 45.2 | 2.8 |
| 2 Year Peak Flood | 1550 | ft^3/s | 677 | 3020 | 46.8 | 46.8 | 2.4 |
| 5 Year Peak Flood | 2500 | ft^3/s | 1020 | 5070 | 50.4 | 50.4 | 2.8 |
| 10 Year Peak Flood | 3280 | ft^3/s | 1290 | 6810 | 52.9 | 52.9 | 3.5 |
| 25 Year Peak Flood | 4410 | ft^3/s | 1660 | 9440 | 56.2 | 56.2 | 4.5 |

| Statistic | Value | Unit | PIl | PIu | SE | SEp | Equiv. Yrs. |
|---|---|---|---|---|---|---|---|
| 50 Year Peak Flood | 5440 | ft^3/s | 1970 | 11900 | 59.1 | 59.1 | 5.1 |
| 100 Year Peak Flood | 6580 | ft^3/s | 2280 | 14800 | 62.3 | 62.3 | 5.7 |
| 500 Year Peak Flood | 9800 | ft^3/s | 3000 | 23700 | 70.9 | 70.9 | 6.5 |

*Peak-Flow Statistics Citations*

**Lorenz, D.L., Sanocki, C.A., and Kocian, M.J.,2009, Techniques for Estimating the Magnitude and Frequency of Peak Flows on Small Streams in Minnesota Based on Data through Water Year 2005: U.S. Geological Survey Scientific Investigations Report 2009-5250, 54 p. (http://pubs.usgs.gov/sir/2009/5250/pdf/sir2009-5250.pdf)**

Flow-Duration Statistics Parameters[Flow duration Region BC 2015 5170]

| Parameter Code | Parameter Name | Value | Units | Min Limit | Max Limit |
|---|---|---|---|---|---|
| DRNAREA | Drainage Area | 70.57 | square miles | 2.98 | 2960 |
| STORNWI | Percentage of Storage from NWI | 33.77 | percent | 2.44 | 48 |
| SSURGOC | SSURGO Percent Hydrologic Soil Type C | 21.6 | percent | 2.61 | 100 |

Flow-Duration Statistics Flow Report[Flow duration Region BC 2015 5170]

| Statistic | Value | Unit |
|---|---|---|
| 0.01 Percent Duration | 1160 | ft^3/s |
| 0.1 Percent Duration | 758 | ft^3/s |
| 2 Percent Duration | 298 | ft^3/s |
| 5 Percent Duration | 194 | ft^3/s |
| 10 Percent Duration | 106 | ft^3/s |
| 25 Percent Duration | 53.6 | ft^3/s |
| 50 Percent Duration | 21.2 | ft^3/s |

| Statistic | Value | Unit |
|---|---|---|
| 75 Percent Duration | 11 | ft^3/s |
| 90 Percent Duration | 6.44 | ft^3/s |
| 95 Percent Duration | 4.29 | ft^3/s |
| 99 Percent Duration | 2.22 | ft^3/s |
| 99.9 Percent Duration | 0.929 | ft^3/s |
| 99.99 Percent Duration | 0.763 | ft^3/s |

*Flow-Duration Statistics Citations*

**Ziegeweid, J.R., Lorenz, D.L., Sanocki, C.A., and Czuba, C.R.,2015, Methods for estimating flow-duration curve and low-flow frequency statistics for ungaged locations on small streams in Minnesota: U.S. Geological Survey Scientific Investigations Report 2015–5170, 23 p. (http://dx.doi.org/10.3133/sir20155170)**

Low-Flow Statistics Parameters[Low flow Region BC 2015 5170]

| Parameter Code | Parameter Name | Value | Units | Min Limit | Max Limit |
|---|---|---|---|---|---|
| DRNAREA | Drainage Area | 70.57 | square miles | 2.98 | 2960 |
| STORNWI | Percentage of Storage from NWI | 33.77 | percent | 2.44 | 48 |
| SSURGOC | SSURGO Percent Hydrologic Soil Type C | 21.6 | percent | 2.61 | 100 |

Low-Flow Statistics Flow Report[Low flow Region BC 2015 5170]

| Statistic | Value | Unit |
|---|---|---|
| 7 Day 10 Year Low Flow | 2.42 | ft^3/s |

*Low-Flow Statistics Citations*

**Ziegeweid, J.R., Lorenz, D.L., Sanocki, C.A., and Czuba, C.R.,2015, Methods for estimating flow-duration curve and low-flow frequency statistics for ungaged**

**locations on small streams in Minnesota: U.S. Geological Survey Scientific Investigations Report 2015–5170, 23 p. (http://dx.doi.org/10.3133/sir20155170)**

Seasonal Flow Statistics Parameters[Low flow Region BC 2015 5170]

| Parameter Code | Parameter Name | Value | Units | Min Limit | Max Limit |
|---|---|---|---|---|---|
| DRNAREA | Drainage Area | 70.57 | square miles | 2.98 | 2960 |
| STORNWI | Percentage of Storage from NWI | 33.77 | percent | 2.44 | 48 |
| SSURGOC | SSURGO Percent Hydrologic Soil Type C | 21.6 | percent | 2.61 | 100 |

Seasonal Flow Statistics Flow Report[Low flow Region BC 2015 5170]

| Statistic | Value | Unit |
|---|---|---|
| Oct to Nov 7 Day 10 Year Low Flow | 5.56 | ft^3/s |
| 30_Day_10_Year_Low_Flow_Oct_to_Nov | 7.8 | ft^3/s |
| 7_Day_10_Year_lowflow_Dec_to_Mar | 3.29 | ft^3/s |
| 30_Day_10_Year_Low_Flow_Dec_to_Mar | 3.89 | ft^3/s |
| Apr to May 7 Day 10 Year Low Flow | 10.8 | ft^3/s |
| Apr to May 30 Day 10 Year Low Flow | 33.3 | ft^3/s |
| 7_Day_10_Year_lowflow_Jun_to_Sep | 3.15 | ft^3/s |
| 30_Day_10_Year_Low_Flow_Jun_to_Sep | 4.15 | ft^3/s |
| 122_Day_10_Year_Low_Flow_Jun_to_Sep | 19.1 | ft^3/s |

*Seasonal Flow Statistics Citations*

**Ziegeweid, J.R., Lorenz, D.L., Sanocki, C.A., and Czuba, C.R.,2015, Methods for estimating flow-duration curve and low-flow frequency statistics for ungaged locations on small streams in Minnesota: U.S. Geological Survey Scientific Investigations Report 2015–5170, 23 p. (http://dx.doi.org/10.3133/sir20155170)**

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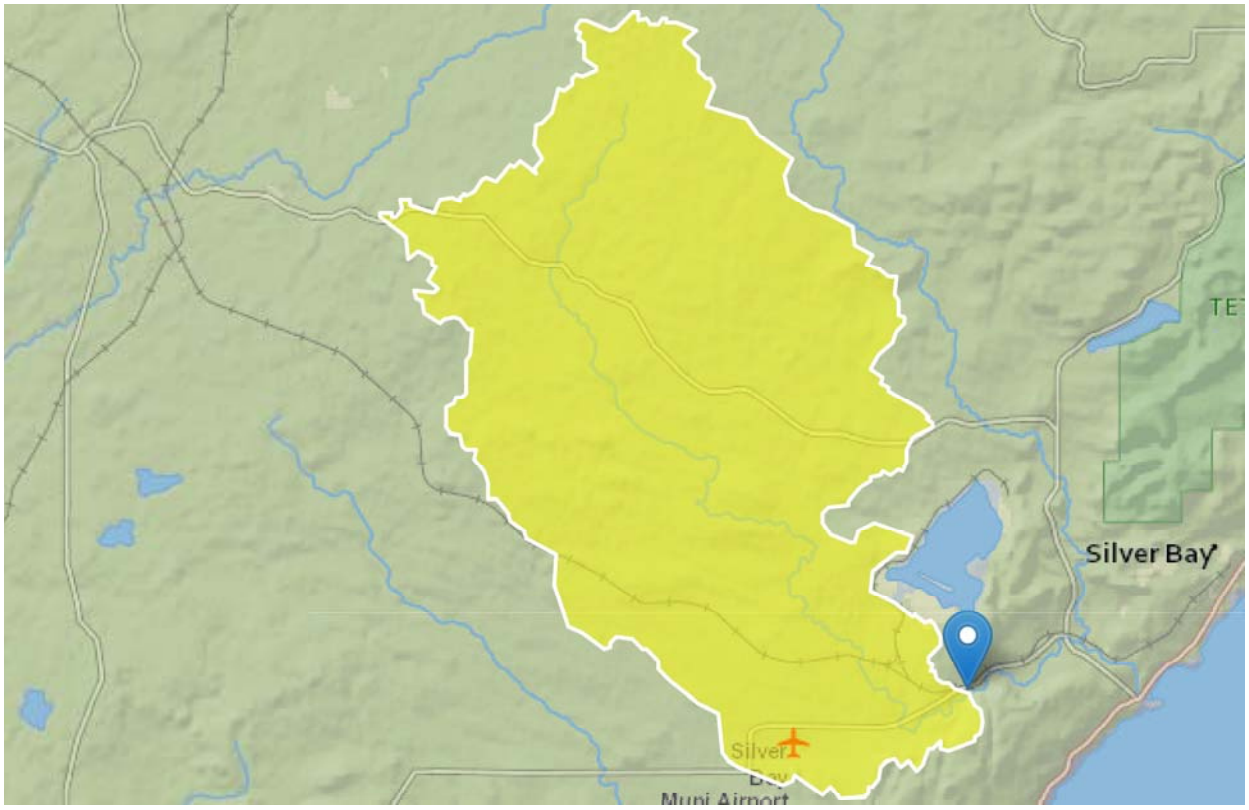
USGS Product Names Disclaimer: Any use of trade, firm, or product names is for descriptive purposes only and does not imply endorsement by the U.S. Government.

Application Version: 4.3.11

# Flow Into Lower Beaver River Subwatershed 16 - Existing

**Region ID:** MN
**Workspace ID:** MN20200401224329308000
**Clicked Point (Latitude, Longitude):** 47.26084, -91.35582
**Time:** 2020-04-01 17:43:46 -0500




Basin Characteristics

| Parameter Code | Parameter Description | Value | Unit |
|---|---|---|---|
| DRNAREA | Area that drains to a point on a stream | 63.27 | square miles |
| LAKEAREA | Percentage of Lakes and Ponds | 3.97 | percent |

| Parameter Code | Parameter Description | Value | Unit |
|---|---|---|---|
| STORNWI | Percentage of storage (combined water bodies and wetlands) from the National Wetlands Inventory | 34.09 | percent |
| SSURGOC | Percentage of area of Hydrologic Soil Type C from SSURGO | 22.5 | percent |

General Disclaimers

Parameter values have been edited, computed flows may not apply.

Peak-Flow Statistics Parameters[100 Percent (64.1 square miles) Region C]

| Parameter Code | Parameter Name | Value | Units | Min Limit | Max Limit |
|---|---|---|---|---|---|
| DRNAREA | Drainage Area | 63.27 | square miles | 0.21 | 607 |
| LAKEAREA | Percent Lakes and Ponds | 3.97 | percent | 0 | 11.8 |

Peak-Flow Statistics Flow Report[100 Percent (64.1 square miles) Region C]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

| Statistic | Value | Unit | PIl | PIu | SE | SEp | Equiv. Yrs. |
|---|---|---|---|---|---|---|---|
| 1.5 Year Peak Flood | 636 | ft^3/s | 287 | 1220 | 45.2 | 45.2 | 2.8 |
| 2 Year Peak Flood | 787 | ft^3/s | 341 | 1550 | 46.8 | 46.8 | 2.4 |
| 5 Year Peak Flood | 1230 | ft^3/s | 498 | 2510 | 50.4 | 50.4 | 2.8 |
| 10 Year Peak Flood | 1580 | ft^3/s | 617 | 3310 | 52.9 | 52.9 | 3.5 |
| 25 Year Peak Flood | 2070 | ft^3/s | 774 | 4470 | 56.2 | 56.2 | 4.5 |
| 50 Year Peak Flood | 2500 | ft^3/s | 898 | 5540 | 59.1 | 59.1 | 5.1 |

| Statistic | Value | Unit | PIl | PIu | SE | SEp | Equiv. Yrs. |
|---|---|---|---|---|---|---|---|
| 100 Year Peak Flood | 2970 | ft^3/s | 1020 | 6750 | 62.3 | 62.3 | 5.7 |
| 500 Year Peak Flood | 4240 | ft^3/s | 1280 | 10400 | 70.9 | 70.9 | 6.5 |

*Peak-Flow Statistics Citations*

**Lorenz, D.L., Sanocki, C.A., and Kocian, M.J.,2009, Techniques for Estimating the Magnitude and Frequency of Peak Flows on Small Streams in Minnesota Based on Data through Water Year 2005: U.S. Geological Survey Scientific Investigations Report 2009-5250, 54 p. (http://pubs.usgs.gov/sir/2009/5250/pdf/sir2009-5250.pdf)**

Flow-Duration Statistics Parameters[Flow duration Region BC 2015 5170]

| Parameter Code | Parameter Name | Value | Units | Min Limit | Max Limit |
|---|---|---|---|---|---|
| DRNAREA | Drainage Area | 63.27 | square miles | 2.98 | 2960 |
| STORNWI | Percentage of Storage from NWI | 34.09 | percent | 2.44 | 48 |
| SSURGOC | SSURGO Percent Hydrologic Soil Type C | 22.5 | percent | 2.61 | 100 |

Flow-Duration Statistics Flow Report[Flow duration Region BC 2015 5170]

| Statistic | Value | Unit |
|---|---|---|
| 0.01 Percent Duration | 1080 | ft^3/s |
| 0.1 Percent Duration | 700 | ft^3/s |
| 2 Percent Duration | 273 | ft^3/s |
| 5 Percent Duration | 177 | ft^3/s |
| 10 Percent Duration | 96 | ft^3/s |
| 25 Percent Duration | 48.3 | ft^3/s |
| 50 Percent Duration | 18.8 | ft^3/s |
| 75 Percent Duration | 9.65 | ft^3/s |

| Statistic | Value | Unit |
|---|---|---|
| 90 Percent Duration | 5.6 | ft^3/s |
| 95 Percent Duration | 3.69 | ft^3/s |
| 99 Percent Duration | 1.89 | ft^3/s |
| 99.9 Percent Duration | 0.774 | ft^3/s |
| 99.99 Percent Duration | 0.634 | ft^3/s |

*Flow-Duration Statistics Citations*

**Ziegeweid, J.R., Lorenz, D.L., Sanocki, C.A., and Czuba, C.R.,2015, Methods for estimating flow-duration curve and low-flow frequency statistics for ungaged locations on small streams in Minnesota: U.S. Geological Survey Scientific Investigations Report 2015–5170, 23 p. (http://dx.doi.org/10.3133/sir20155170)**

Low-Flow Statistics Parameters[Low flow Region BC 2015 5170]

| Parameter Code | Parameter Name | Value | Units | Min Limit | Max Limit |
|---|---|---|---|---|---|
| DRNAREA | Drainage Area | 63.27 | square miles | 2.98 | 2960 |
| STORNWI | Percentage of Storage from NWI | 34.09 | percent | 2.44 | 48 |
| SSURGOC | SSURGO Percent Hydrologic Soil Type C | 22.5 | percent | 2.61 | 100 |

Low-Flow Statistics Flow Report[Low flow Region BC 2015 5170]

| Statistic | Value | Unit |
|---|---|---|
| 7 Day 10 Year Low Flow | 2.07 | ft^3/s |

*Low-Flow Statistics Citations*

**Ziegeweid, J.R., Lorenz, D.L., Sanocki, C.A., and Czuba, C.R.,2015, Methods for estimating flow-duration curve and low-flow frequency statistics for ungaged locations on small streams in Minnesota: U.S. Geological Survey Scientific Investigations Report 2015–5170, 23 p. (http://dx.doi.org/10.3133/sir20155170)**

Seasonal Flow Statistics Parameters[Low flow Region BC 2015 5170]

| Parameter Code | Parameter Name | Value | Units | Min Limit | Max Limit |
|---|---|---|---|---|---|
| DRNAREA | Drainage Area | 63.27 | square miles | 2.98 | 2960 |
| STORNWI | Percentage of Storage from NWI | 34.09 | percent | 2.44 | 48 |
| SSURGOC | SSURGO Percent Hydrologic Soil Type C | 22.5 | percent | 2.61 | 100 |

Seasonal Flow Statistics Flow Report[Low flow Region BC 2015 5170]

| Statistic | Value | Unit |
|---|---|---|
| Oct to Nov 7 Day 10 Year Low Flow | 4.81 | ft^3/s |
| 30_Day_10_Year_Low_Flow_Oct_to_Nov | 6.8 | ft^3/s |
| 7_Day_10_Year_lowflow_Dec_to_Mar | 2.82 | ft^3/s |
| 30_Day_10_Year_Low_Flow_Dec_to_Mar | 3.35 | ft^3/s |
| Apr to May 7 Day 10 Year Low Flow | 9.51 | ft^3/s |
| Apr to May 30 Day 10 Year Low Flow | 29.9 | ft^3/s |
| 7_Day_10_Year_lowflow_Jun_to_Sep | 2.71 | ft^3/s |
| 30_Day_10_Year_Low_Flow_Jun_to_Sep | 3.58 | ft^3/s |
| 122_Day_10_Year_Low_Flow_Jun_to_Sep | 17.2 | ft^3/s |

*Seasonal Flow Statistics Citations*

**Ziegeweid, J.R., Lorenz, D.L., Sanocki, C.A., and Czuba, C.R.,2015, Methods for estimating flow-duration curve and low-flow frequency statistics for ungaged locations on small streams in Minnesota: U.S. Geological Survey Scientific Investigations Report 2015–5170, 23 p. (http://dx.doi.org/10.3133/sir20155170)**

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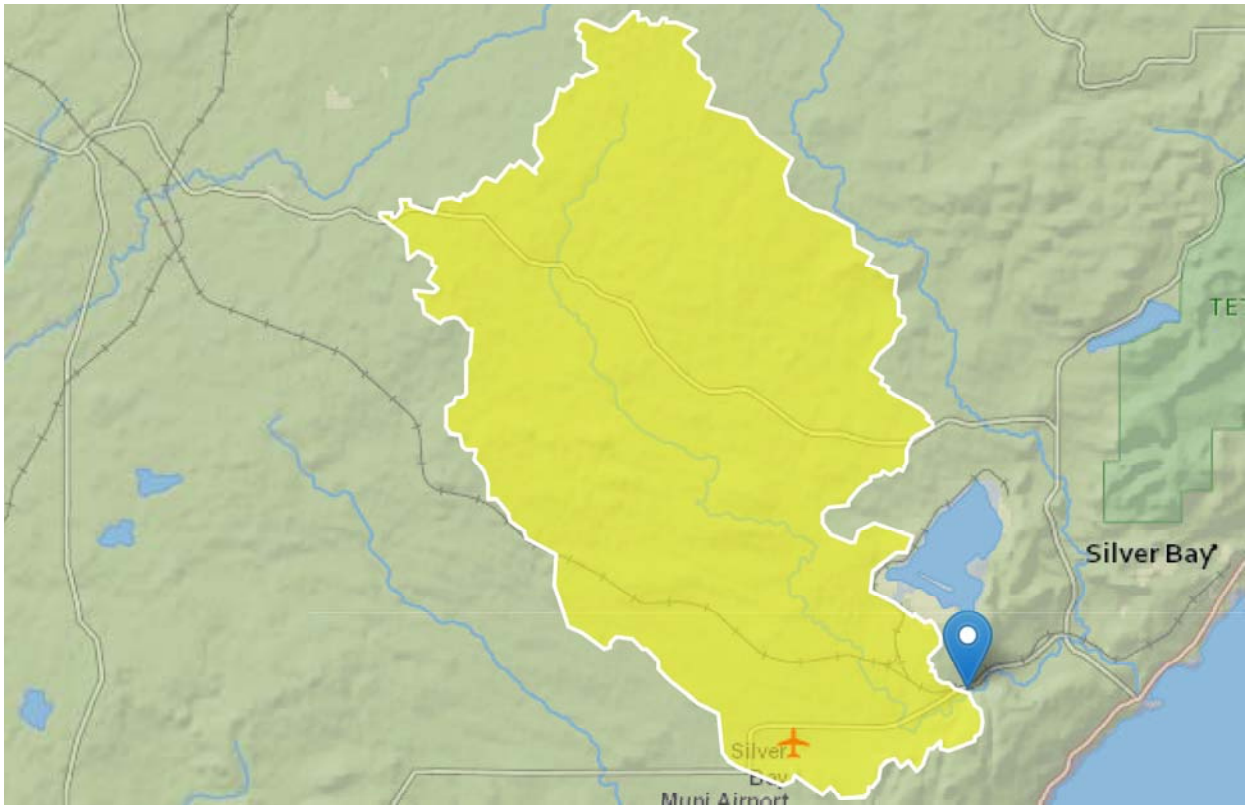
Application Version: 4.3.11

# Flow Into Lower Beaver River Subwatershed 16 - Future

**Region ID:** MN
**Workspace ID:** MN20200401224329308000
**Clicked Point (Latitude, Longitude):** 47.26084, -91.35582
**Time:** 2020-04-01 17:43:46 -0500




Basin Characteristics

| Parameter Code | Parameter Description | Value | Unit |
|---|---|---|---|
| DRNAREA | Area that drains to a point on a stream | 63.21 | square miles |
| LAKEAREA | Percentage of Lakes and Ponds | 3.97 | percent |

| Parameter Code | Parameter Description | Value | Unit |
|---|---|---|---|
| STORNWI | Percentage of storage (combined water bodies and wetlands) from the National Wetlands Inventory | 34.1 | percent |
| SSURGOC | Percentage of area of Hydrologic Soil Type C from SSURGO | 21.6 | percent |

General Disclaimers

Parameter values have been edited, computed flows may not apply.

Peak-Flow Statistics Parameters[100 Percent (64.1 square miles) Region C]

| Parameter Code | Parameter Name | Value | Units | Min Limit | Max Limit |
|---|---|---|---|---|---|
| DRNAREA | Drainage Area | 63.21 | square miles | 0.21 | 607 |
| LAKEAREA | Percent Lakes and Ponds | 3.97 | percent | 0 | 11.8 |

Peak-Flow Statistics Flow Report[100 Percent (64.1 square miles) Region C]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

| Statistic | Value | Unit | PIl | PIu | SE | SEp | Equiv. Yrs. |
|---|---|---|---|---|---|---|---|
| 1.5 Year Peak Flood | 636 | ft^3/s | 287 | 1220 | 45.2 | 45.2 | 2.8 |
| 2 Year Peak Flood | 786 | ft^3/s | 340 | 1540 | 46.8 | 46.8 | 2.4 |
| 5 Year Peak Flood | 1230 | ft^3/s | 497 | 2510 | 50.4 | 50.4 | 2.8 |
| 10 Year Peak Flood | 1580 | ft^3/s | 617 | 3300 | 52.9 | 52.9 | 3.5 |
| 25 Year Peak Flood | 2070 | ft^3/s | 773 | 4470 | 56.2 | 56.2 | 4.5 |
| 50 Year Peak Flood | 2500 | ft^3/s | 898 | 5540 | 59.1 | 59.1 | 5.1 |

| Statistic | Value | Unit | PIl | PIu | SE | SEp | Equiv. Yrs. |
|---|---|---|---|---|---|---|---|
| 100 Year Peak Flood | 2970 | ft^3/s | 1020 | 6750 | 62.3 | 62.3 | 5.7 |
| 500 Year Peak Flood | 4230 | ft^3/s | 1280 | 10300 | 70.9 | 70.9 | 6.5 |

*Peak-Flow Statistics Citations*

**Lorenz, D.L., Sanocki, C.A., and Kocian, M.J.,2009, Techniques for Estimating the Magnitude and Frequency of Peak Flows on Small Streams in Minnesota Based on Data through Water Year 2005: U.S. Geological Survey Scientific Investigations Report 2009-5250, 54 p. (http://pubs.usgs.gov/sir/2009/5250/pdf/sir2009-5250.pdf)**

Flow-Duration Statistics Parameters[Flow duration Region BC 2015 5170]

| Parameter Code | Parameter Name | Value | Units | Min Limit | Max Limit |
|---|---|---|---|---|---|
| DRNAREA | Drainage Area | 63.21 | square miles | 2.98 | 2960 |
| STORNWI | Percentage of Storage from NWI | 34.1 | percent | 2.44 | 48 |
| SSURGOC | SSURGO Percent Hydrologic Soil Type C | 21.6 | percent | 2.61 | 100 |

Flow-Duration Statistics Flow Report[Flow duration Region BC 2015 5170]

| Statistic | Value | Unit |
|---|---|---|
| 0.01 Percent Duration | 1070 | ft^3/s |
| 0.1 Percent Duration | 693 | ft^3/s |
| 2 Percent Duration | 271 | ft^3/s |
| 5 Percent Duration | 176 | ft^3/s |
| 10 Percent Duration | 95.4 | ft^3/s |
| 25 Percent Duration | 48.3 | ft^3/s |
| 50 Percent Duration | 18.9 | ft^3/s |
| 75 Percent Duration | 9.75 | ft^3/s |

| Statistic | Value | Unit |
|---|---|---|
| 90 Percent Duration | 5.69 | ft^3/s |
| 95 Percent Duration | 3.76 | ft^3/s |
| 99 Percent Duration | 1.93 | ft^3/s |
| 99.9 Percent Duration | 0.801 | ft^3/s |
| 99.99 Percent Duration | 0.659 | ft^3/s |

*Flow-Duration Statistics Citations*

**Ziegeweid, J.R., Lorenz, D.L., Sanocki, C.A., and Czuba, C.R.,2015, Methods for estimating flow-duration curve and low-flow frequency statistics for ungaged locations on small streams in Minnesota: U.S. Geological Survey Scientific Investigations Report 2015–5170, 23 p. (http://dx.doi.org/10.3133/sir20155170)**

Low-Flow Statistics Parameters[Low flow Region BC 2015 5170]

| Parameter Code | Parameter Name | Value | Units | Min Limit | Max Limit |
|---|---|---|---|---|---|
| DRNAREA | Drainage Area | 63.21 | square miles | 2.98 | 2960 |
| STORNWI | Percentage of Storage from NWI | 34.1 | percent | 2.44 | 48 |
| SSURGOC | SSURGO Percent Hydrologic Soil Type C | 21.6 | percent | 2.61 | 100 |

Low-Flow Statistics Flow Report[Low flow Region BC 2015 5170]

| Statistic | Value | Unit |
|---|---|---|
| 7 Day 10 Year Low Flow | 2.11 | ft^3/s |

*Low-Flow Statistics Citations*

**Ziegeweid, J.R., Lorenz, D.L., Sanocki, C.A., and Czuba, C.R.,2015, Methods for estimating flow-duration curve and low-flow frequency statistics for ungaged locations on small streams in Minnesota: U.S. Geological Survey Scientific Investigations Report 2015–5170, 23 p. (http://dx.doi.org/10.3133/sir20155170)**

Seasonal Flow Statistics Parameters[Low flow Region BC 2015 5170]

| Parameter Code | Parameter Name | Value | Units | Min Limit | Max Limit |
|---|---|---|---|---|---|
| DRNAREA | Drainage Area | 63.21 | square miles | 2.98 | 2960 |
| STORNWI | Percentage of Storage from NWI | 34.1 | percent | 2.44 | 48 |
| SSURGOC | SSURGO Percent Hydrologic Soil Type C | 21.6 | percent | 2.61 | 100 |

Seasonal Flow Statistics Flow Report[Low flow Region BC 2015 5170]

| Statistic | Value | Unit |
|---|---|---|
| Oct to Nov 7 Day 10 Year Low Flow | 4.91 | ft^3/s |
| 30_Day_10_Year_Low_Flow_Oct_to_Nov | 6.92 | ft^3/s |
| 7_Day_10_Year_lowflow_Dec_to_Mar | 2.88 | ft^3/s |
| 30_Day_10_Year_Low_Flow_Dec_to_Mar | 3.41 | ft^3/s |
| Apr to May 7 Day 10 Year Low Flow | 9.62 | ft^3/s |
| Apr to May 30 Day 10 Year Low Flow | 30.1 | ft^3/s |
| 7_Day_10_Year_lowflow_Jun_to_Sep | 2.76 | ft^3/s |
| 30_Day_10_Year_Low_Flow_Jun_to_Sep | 3.64 | ft^3/s |
| 122_Day_10_Year_Low_Flow_Jun_to_Sep | 17.2 | ft^3/s |

*Seasonal Flow Statistics Citations*

**Ziegeweid, J.R., Lorenz, D.L., Sanocki, C.A., and Czuba, C.R.,2015, Methods for estimating flow-duration curve and low-flow frequency statistics for ungaged locations on small streams in Minnesota: U.S. Geological Survey Scientific Investigations Report 2015–5170, 23 p. (http://dx.doi.org/10.3133/sir20155170)**

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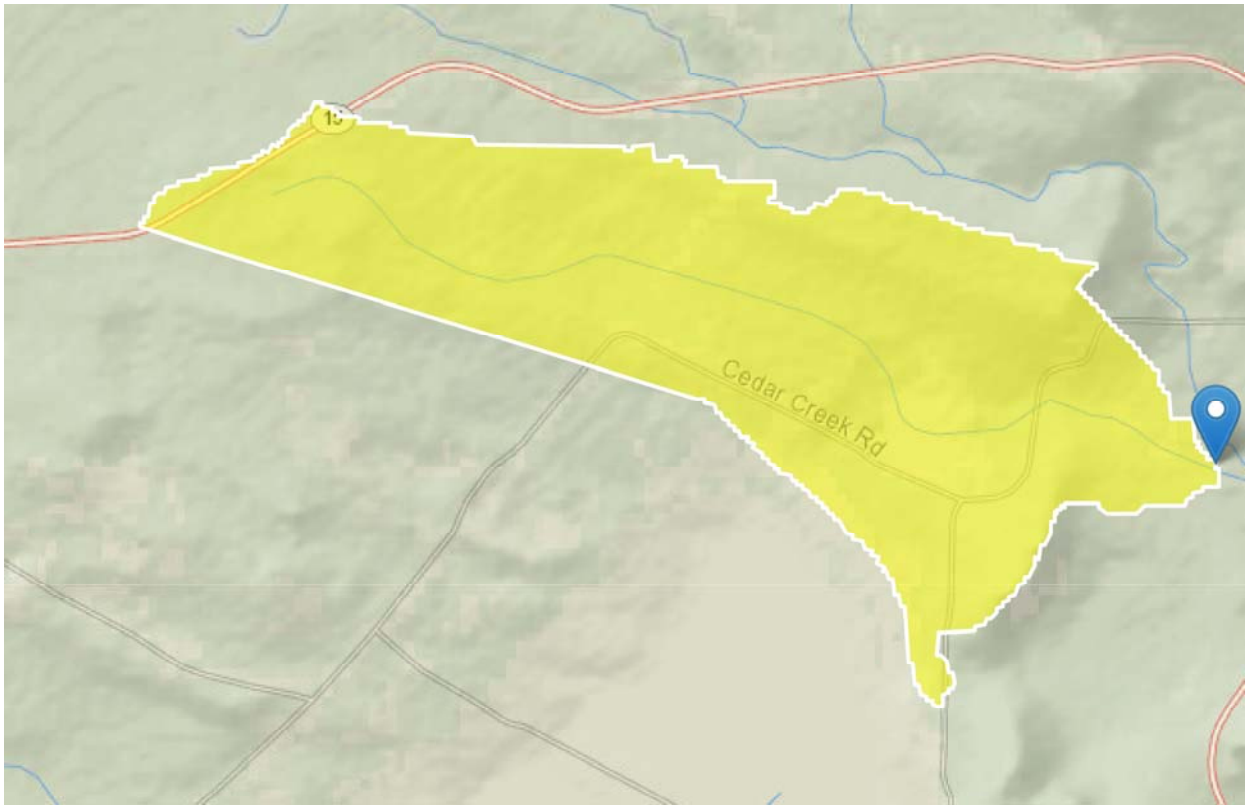
Application Version: 4.3.11

# Appendix D

## Streamflow and Stream Water Level Modeling Results
## West Unnamed Creek

# West Unnamed Creek Subwatershed #4 - Pre-Settlement

**Region ID:** MN
**Workspace ID:** MN20200326180213878000
**Clicked Point (Latitude, Longitude):** 47.31244, -91.32890
**Time:** 2020-03-26 13:02:30 -0500




Basin Characteristics

| Parameter Code | Parameter Description | Value | Unit |
|---|---|---|---|
| DRNAREA | Area that drains to a point on a stream | 1.04 | square miles |
| LAKEAREA | Percentage of Lakes and Ponds | 0.12 | percent |

| Parameter Code | Parameter Description | Value | Unit |
|---|---|---|---|
| STORNWI | Percentage of storage (combined water bodies and wetlands) from the National Wetlands Inventory | 13.26 | percent |
| SSURGOC | Percentage of area of Hydrologic Soil Type C from SSURGO | 14.0 | percent |

General Disclaimers

Parameter values have been edited, computed flows may not apply.

This watershed has been edited, computed flows may not apply.

Peak-Flow Statistics Parameters[Region C]

| Parameter Code | Parameter Name | Value | Units | Min Limit | Max Limit |
|---|---|---|---|---|---|
| DRNAREA | Drainage Area | 1.04 | square miles | 0.21 | 607 |
| LAKEAREA | Percent Lakes and Ponds | 0.12 | percent | 0 | 11.8 |

Peak-Flow Statistics Flow Report[Region C]

PIl: Prediction Interval-Lower, Plu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

| Statistic | Value | Unit | PIl | Plu | SE | SEp | Equiv. Yrs. |
|---|---|---|---|---|---|---|---|
| 1.5 Year Peak Flood | 41.1 | ft^3/s | 18.7 | 77.8 | 45.2 | 45.2 | 2.8 |
| 2 Year Peak Flood | 56.2 | ft^3/s | 24.6 | 109 | 46.8 | 46.8 | 2.4 |
| 5 Year Peak Flood | 110 | ft^3/s | 45.2 | 223 | 50.4 | 50.4 | 2.8 |
| 10 Year Peak Flood | 161 | ft^3/s | 63.7 | 332 | 52.9 | 52.9 | 3.5 |
| 25 Year Peak Flood | 245 | ft^3/s | 92.9 | 522 | 56.2 | 56.2 | 4.5 |

| Statistic | Value | Unit | PIl | Plu | SE | SEp | Equiv. Yrs. |
|---|---|---|---|---|---|---|---|
| 50 Year Peak Flood | 328 | ft^3/s | 119 | 715 | 59.1 | 59.1 | 5.1 |
| 100 Year Peak Flood | 428 | ft^3/s | 149 | 959 | 62.3 | 62.3 | 5.7 |
| 500 Year Peak Flood | 750 | ft^3/s | 231 | 1800 | 70.9 | 70.9 | 6.5 |

*Peak-Flow Statistics Citations*

**Lorenz, D.L., Sanocki, C.A., and Kocian, M.J.,2009, Techniques for Estimating the Magnitude and Frequency of Peak Flows on Small Streams in Minnesota Based on Data through Water Year 2005: U.S. Geological Survey Scientific Investigations Report 2009-5250, 54 p. (http://pubs.usgs.gov/sir/2009/5250/pdf/sir2009-5250.pdf)**

Flow-Duration Statistics Parameters[Flow duration Region BC 2015 5170]

| Parameter Code | Parameter Name | Value | Units | Min Limit | Max Limit |
|---|---|---|---|---|---|
| DRNAREA | Drainage Area | 1.04 | square miles | 2.98 | 2960 |
| STORNWI | Percentage of Storage from NWI | 13.26 | percent | 2.44 | 48 |
| SSURGOC | SSURGO Percent Hydrologic Soil Type C | 14 | percent | 2.61 | 100 |

Flow-Duration Statistics Disclaimers[Flow duration Region BC 2015 5170]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors

Flow-Duration Statistics Flow Report[Flow duration Region BC 2015 5170]

| Statistic | Value | Unit |
|---|---|---|
| 0.01 Percent Duration | 47.1 | ft^3/s |
| 0.1 Percent Duration | 25.4 | ft^3/s |
| 2 Percent Duration | 7.35 | ft^3/s |
| 5 Percent Duration | 4.28 | ft^3/s |

| Statistic | Value | Unit |
|---|---|---|
| 10 Percent Duration | 1.91 | ft^3/s |
| 25 Percent Duration | 1.13 | ft^3/s |
| 50 Percent Duration | 0.496 | ft^3/s |
| 75 Percent Duration | 0.306 | ft^3/s |
| 90 Percent Duration | 0.182 | ft^3/s |
| 95 Percent Duration | 0.112 | ft^3/s |
| 99 Percent Duration | 0.0634 | ft^3/s |
| 99.9 Percent Duration | 0.0241 | ft^3/s |
| 99.99 Percent Duration | 0.0213 | ft^3/s |

*Flow-Duration Statistics Citations*

**Ziegeweid, J.R., Lorenz, D.L., Sanocki, C.A., and Czuba, C.R.,2015, Methods for estimating flow-duration curve and low-flow frequency statistics for ungaged locations on small streams in Minnesota: U.S. Geological Survey Scientific Investigations Report 2015–5170, 23 p. (http://dx.doi.org/10.3133/sir20155170)**

Low-Flow Statistics Parameters[Low flow Region BC 2015 5170]

| Parameter Code | Parameter Name | Value | Units | Min Limit | Max Limit |
|---|---|---|---|---|---|
| DRNAREA | Drainage Area | 1.04 | square miles | 2.98 | 2960 |
| STORNWI | Percentage of Storage from NWI | 13.26 | percent | 2.44 | 48 |
| SSURGOC | SSURGO Percent Hydrologic Soil Type C | 14 | percent | 2.61 | 100 |

Low-Flow Statistics Disclaimers[Low flow Region BC 2015 5170]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors

Low-Flow Statistics Flow Report[Low flow Region BC 2015 5170]

| Statistic | Value | Unit |
|---|---|---|
| 7 Day 10 Year Low Flow | 0.0639 | ft^3/s |

*Low-Flow Statistics Citations*

**Ziegeweid, J.R., Lorenz, D.L., Sanocki, C.A., and Czuba, C.R.,2015, Methods for estimating flow-duration curve and low-flow frequency statistics for ungaged locations on small streams in Minnesota: U.S. Geological Survey Scientific Investigations Report 2015–5170, 23 p. (http://dx.doi.org/10.3133/sir20155170)**

Seasonal Flow Statistics Parameters[Low flow Region BC 2015 5170]

| Parameter Code | Parameter Name | Value | Units | Min Limit | Max Limit |
|---|---|---|---|---|---|
| DRNAREA | Drainage Area | 1.04 | square miles | 2.98 | 2960 |
| STORNWI | Percentage of Storage from NWI | 13.26 | percent | 2.44 | 48 |
| SSURGOC | SSURGO Percent Hydrologic Soil Type C | 14 | percent | 2.61 | 100 |

Seasonal Flow Statistics Disclaimers[Low flow Region BC 2015 5170]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors

Seasonal Flow Statistics Flow Report[Low flow Region BC 2015 5170]

| Statistic | Value | Unit |
|---|---|---|
| Oct to Nov 7 Day 10 Year Low Flow | 0.153 | ft^3/s |
| 30_Day_10_Year_Low_Flow_Oct_to_Nov | 0.231 | ft^3/s |
| 7_Day_10_Year_lowflow_Dec_to_Mar | 0.0866 | ft^3/s |
| 30_Day_10_Year_Low_Flow_Dec_to_Mar | 0.112 | ft^3/s |
| Apr to May 7 Day 10 Year Low Flow | 0.284 | ft^3/s |
| Apr to May 30 Day 10 Year Low Flow | 0.822 | ft^3/s |
| 7_Day_10_Year_lowflow_Jun_to_Sep | 0.0837 | ft^3/s |

| Statistic | Value | Unit |
|---|---|---|
| 30_Day_10_Year_Low_Flow_Jun_to_Sep | 0.114 | ft^3/s |
| 122_Day_10_Year_Low_Flow_Jun_to_Sep | 0.664 | ft^3/s |

*Seasonal Flow Statistics Citations*

**Ziegeweid, J.R., Lorenz, D.L., Sanocki, C.A., and Czuba, C.R.,2015, Methods for estimating flow-duration curve and low-flow frequency statistics for ungaged locations on small streams in Minnesota: U.S. Geological Survey Scientific Investigations Report 2015–5170, 23 p. (http://dx.doi.org/10.3133/sir20155170)**

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Application Version: 4.3.11

NATIONAL WEATHER SERVICE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

# Normal Depth Calculator

Weather.gov > Alaska-Pacific RFC > Normal Depth Calculator

**Alaska-Pacific RFC**
River Forecast Center

River Observations and Forecasts | Weather Observations and Forecasts | Water Supply | Climate and History | Seasonal Interest | Additional Info

## Normal Depth Demonstration Tool

One the most commonly used equations governing Open Channel Flow is known as the Mannings's Equation. It was introduced by the Irish Engineer Robert Manning in 1889 as an alternative to the Chezy Equation. The Mannings equation is an empirical equation that applies to uniform flow in open channels and is a function of the channel velocity, flow area and channel slope.

**7Q10**

$$Q = VA = \left(\frac{1.49}{n}\right) AR^{\frac{2}{3}}\sqrt{S} \quad [U.S.]$$

$$Q = VA = \left(\frac{1.00}{n}\right) AR^{\frac{2}{3}}\sqrt{S} \quad [SI]$$

Where:
Q = Flow Rate, ($ft^3/s$)
v = Velocity, (ft/s)
A = Flow Area, ($ft^2$)
n = Manning's Roughness Coefficient
R = Hydraulic Radius, (ft)
S = Channel Slope, (ft/ft)

Under the assumption of uniform flow conditions the bottom slope is the same as the slope of the energy grade line and the water surface slope. The Manning's n is a coefficient which represents the roughness or friction applied to the flow by the channel. Manning's n-values are often selected from tables, but can be back calculated from field measurements. In many flow conditions the selection of a Manning's roughness coefficient can greatly affect computational results.

**Instructions:** Select variable to solve, adjust slider bars, click on graph to modify the cross section. CSV cross section data can be loaded in the input box below. This online calculator is for demonstration and educational purposes only.

Solve For: Water Surface (normal depth)

Slope: 0.042 (ft/ft)

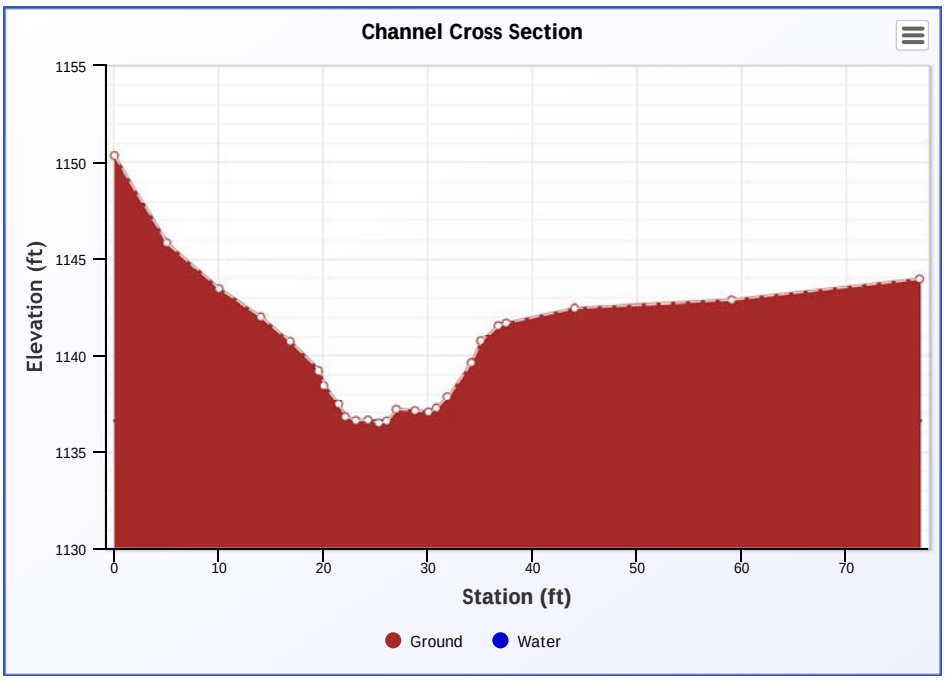
WSE: 1136.56 (ft)

Channel Manning n: 0.055

Flow: 0 ($ft^3/s$)

100 40000

Reset Cross Section




| | |
|---|---|
| Flow Area: | 0.1 ($ft^2$) |
| Wetted Perimeter: | 1.2 (ft) |
| Max Depth: | 0.12 (ft) |
| Average Velocity: | 1.14 (ft/s) |
| Top Width: | 1 (ft) |
| Iterations: | 5001 |
| Froude Number: | 0.74 |

Select HECRAS Geometry: Browse... Load HEC-RAS Data

Load CSV XS Data Below
(station,elevation)

Update Plot

```
0.00,1150.30
5.00,1145.83
10.00,1143.43
14.00,1142.01
16.80,1140.70
19.60,1139.18
20.10,1138.42
21.40,1137.43
22.10,1136.77
23.10,1136.57
24.30,1136.60
25.30,1136.44
26.10,1136.55
27.00,1137.15
28.70,1137.08
30.10,1137.01
30.80,1137.22
31.90,1137.84
34.10,1139.59
35.10,1140.74
36.70,1141.56
37.50,1141.69
44.00,1142.45
59.00,1142.85
77.00,1143.93
```

NATIONAL WEATHER SERVICE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

# Normal Depth Calculator

Weather.gov > Alaska-Pacific RFC > Normal Depth Calculator

**Alaska-Pacific RFC**
River Forecast Center

River Observations and Forecasts | Weather Observations and Forecasts | Water Supply | Climate and History | Seasonal Interest | Additional Info

## Normal Depth Demonstration Tool

One the most commonly used equations governing Open Channel Flow is known as the Mannings's Equation. It was introduced by the Irish Engineer Robert Manning in 1889 as an alternative to the Chezy Equation. The Mannings equation is an empirical equation that applies to uniform flow in open channels and is a function of the channel velocity, flow area and channel slope.

**Q1.5**

$$Q = VA = \left(\frac{1.49}{n}\right) AR^{\frac{2}{3}}\sqrt{S} \quad [U.S.]$$

$$Q = VA = \left(\frac{1.00}{n}\right) AR^{\frac{2}{3}}\sqrt{S} \quad [SI]$$

Where:
Q = Flow Rate, ($ft^3/s$)
v = Velocity, (ft/s)
A = Flow Area, ($ft^2$)
n = Manning's Roughness Coefficient
R = Hydraulic Radius, (ft)
S = Channel Slope, (ft/ft)

Under the assumption of uniform flow conditions the bottom slope is the same as the slope of the energy grade line and the water surface slope. The Manning's n is a coefficient which represents the roughness or friction applied to the flow by the channel. Manning's n-values are often selected from tables, but can be back calculated from field measurements. In many flow conditions the selection of a Manning's roughness coefficient can greatly affect computational results.

**Instructions:** Select variable to solve, adjust slider bars, click on graph to modify the cross section. CSV cross section data can be loaded in the input box below. This online calculator is for demonstration and educational purposes only.

Solve For: Water Surface (normal depth)

Slope: 0.042 (ft/ft)

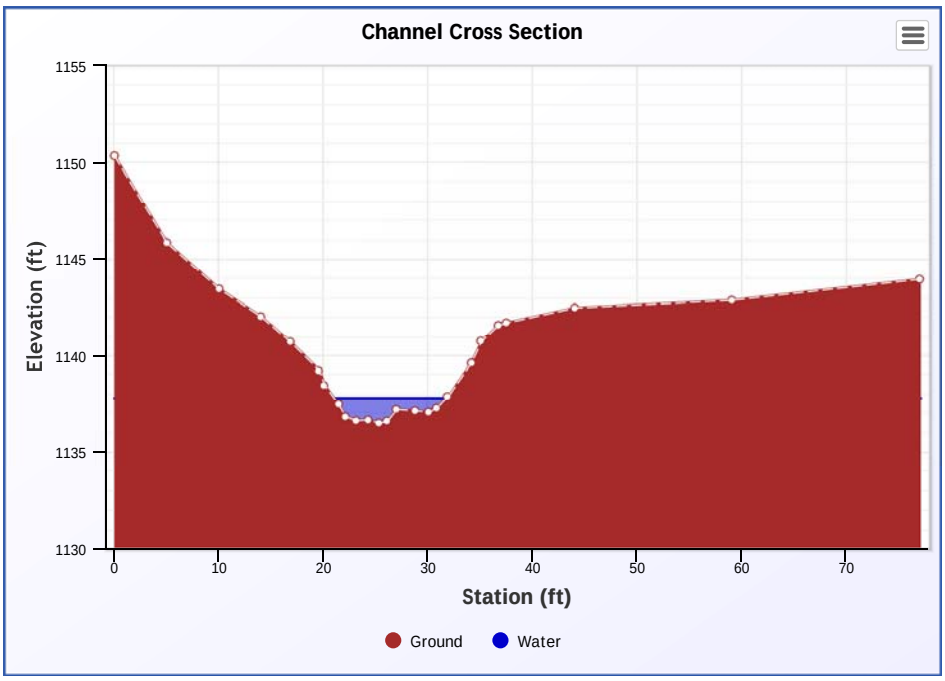
WSE: 1137.75 (ft)

Channel Manning n: 0.055

Flow: 41 ($ft^3/s$)

100 40000

Reset Cross Section




| | |
|---|---|
| Flow Area: | 8.9 ($ft^2$) |
| Wetted Perimeter: | 11.7 (ft) |
| Max Depth: | 1.31 (ft) |
| Average Velocity: | 4.63 (ft/s) |
| Top Width: | 11 (ft) |
| Iterations: | 26 |
| Froude Number: | 0.91 |

Select HECRAS Geometry: Browse... Load HEC-RAS Data

NATIONAL WEATHER SERVICE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

# Normal Depth Calculator

Weather.gov > Alaska-Pacific RFC > Normal Depth Calculator

**Alaska-Pacific RFC**
River Forecast Center

River Observations and Forecasts | Weather Observations and Forecasts | Water Supply | Climate and History | Seasonal Interest | Additional Info

## Normal Depth Demonstration Tool

One the most commonly used equations governing Open Channel Flow is known as the Mannings's Equation. It was introduced by the Irish Engineer Robert Manning in 1889 as an alternative to the Chezy Equation. The Mannings equation is an empirical equation that applies to uniform flow in open channels and is a function of the channel velocity, flow area and channel slope.

**Q100**

$$Q = VA = \left(\frac{1.49}{n}\right) AR^{\frac{2}{3}}\sqrt{S} \quad [U.S.]$$

$$Q = VA = \left(\frac{1.00}{n}\right) AR^{\frac{2}{3}}\sqrt{S} \quad [SI]$$

Where:
Q = Flow Rate, ($ft^3/s$)
v = Velocity, (ft/s)
A = Flow Area, ($ft^2$)
n = Manning's Roughness Coefficient
R = Hydraulic Radius, (ft)
S = Channel Slope, (ft/ft)

Under the assumption of uniform flow conditions the bottom slope is the same as the slope of the energy grade line and the water surface slope. The Manning's n is a coefficient which represents the roughness or friction applied to the flow by the channel. Manning's n-values are often selected from tables, but can be back calculated from field measurements. In many flow conditions the selection of a Manning's roughness coefficient can greatly affect computational results.

**Instructions:** Select variable to solve, adjust slider bars, click on graph to modify the cross section. CSV cross section data can be loaded in the input box below. This online calculator is for demonstration and educational purposes only.

Solve For: Water Surface (normal depth)

Slope: 0.042 (ft/ft)

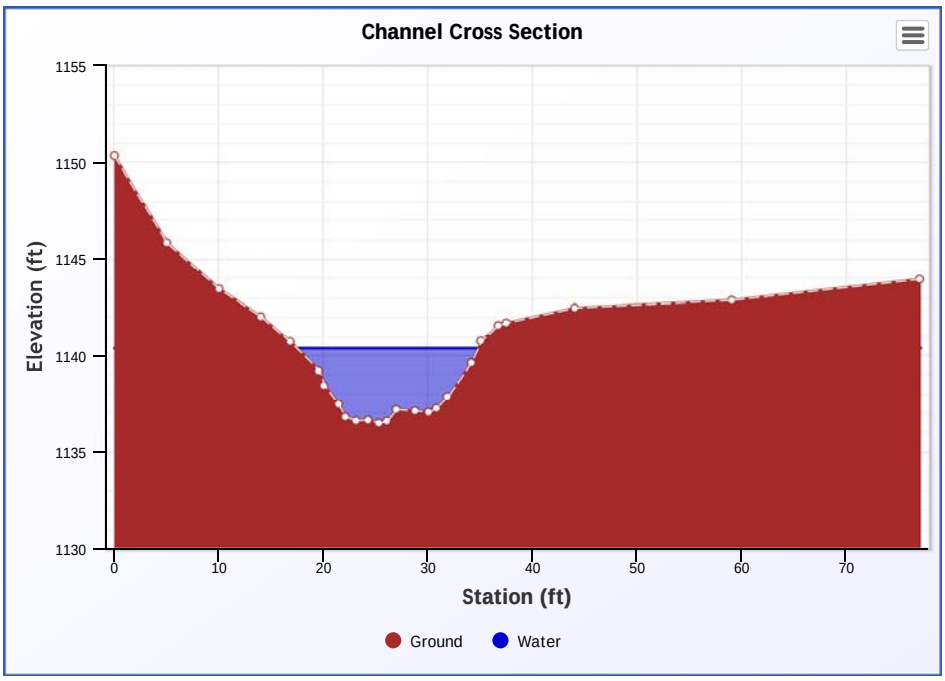
WSE: 1140.35 (ft)

Channel Manning n: 0.055

Flow: 428 ($ft^3/s$)

100 40000

Reset Cross Section

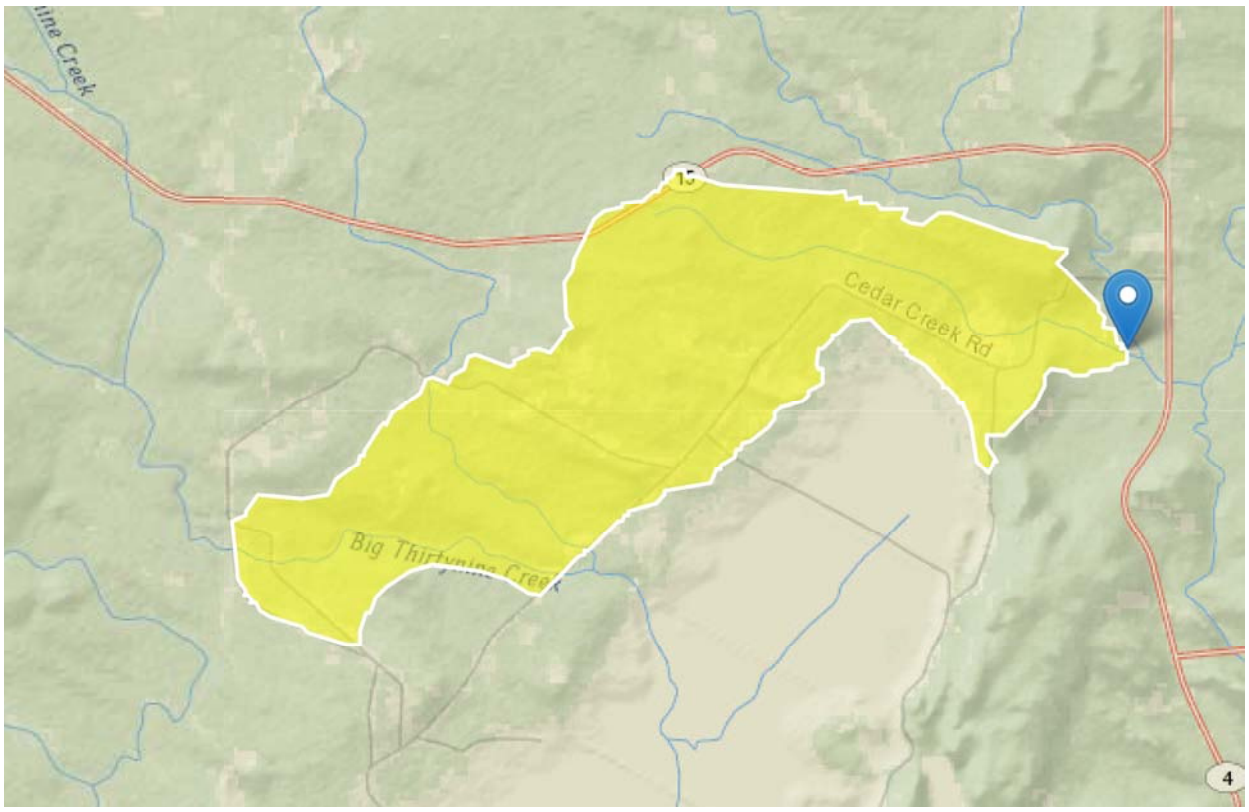



| | |
|---|---|
| Flow Area: | 45.5 ($ft^2$) |
| Wetted Perimeter: | 20.6 (ft) |
| Max Depth: | 3.91 (ft) |
| Average Velocity: | 9.41 (ft/s) |
| Top Width: | 18 (ft) |
| Iterations: | 25 |
| Froude Number: | 1.05 |

Select HECRAS Geometry: Browse... Load HEC-RAS Data

# West Unnamed Creek Subwatershed #4 - Existing

**Region ID:** MN
**Workspace ID:** MN20200326175515214000
**Clicked Point (Latitude, Longitude):** 47.31246, -91.32884
**Time:** 2020-03-26 12:55:31 -0500




Basin Characteristics

| Parameter Code | Parameter Description | Value | Unit |
|---|---|---|---|
| DRNAREA | Area that drains to a point on a stream | 3.02 | square miles |
| LAKEAREA | Percentage of Lakes and Ponds | 6.0 | percent |

| Parameter Code | Parameter Description | Value | Unit |
|---|---|---|---|
| STORNWI | Percentage of storage (combined water bodies and wetlands) from the National Wetlands Inventory | 18.84 | percent |
| SSURGOC | Percentage of area of Hydrologic Soil Type C from SSURGO | 18.4 | percent |

General Disclaimers

Parameter values have been edited, computed flows may not apply.

Peak-Flow Statistics Parameters[Region C]

| Parameter Code | Parameter Name | Value | Units | Min Limit | Max Limit |
|---|---|---|---|---|---|
| DRNAREA | Drainage Area | 3.02 | square miles | 0.21 | 607 |
| LAKEAREA | Percent Lakes and Ponds | 6 | percent | 0 | 11.8 |

Peak-Flow Statistics Flow Report[Region C]

PIl: Prediction Interval-Lower, Plu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

| Statistic | Value | Unit | PIl | Plu | SE | SEp | Equiv. Yrs. |
|---|---|---|---|---|---|---|---|
| 1.5 Year Peak Flood | 38.3 | ft^3/s | 15.4 | 82.1 | 45.2 | 45.2 | 2.8 |
| 2 Year Peak Flood | 49.9 | ft^3/s | 19.2 | 110 | 46.8 | 46.8 | 2.4 |
| 5 Year Peak Flood | 87.7 | ft^3/s | 31.3 | 204 | 50.4 | 50.4 | 2.8 |
| 10 Year Peak Flood | 120 | ft^3/s | 41.1 | 287 | 52.9 | 52.9 | 3.5 |
| 25 Year Peak Flood | 169 | ft^3/s | 54.9 | 422 | 56.2 | 56.2 | 4.5 |
| 50 Year Peak Flood | 214 | ft^3/s | 66.1 | 551 | 59.1 | 59.1 | 5.1 |

| Statistic | Value | Unit | PIl | Plu | SE | SEp | Equiv. Yrs. |
|---|---|---|---|---|---|---|---|
| 100 Year Peak Flood | 265 | ft^3/s | 77.6 | 706 | 62.3 | 62.3 | 5.7 |
| 500 Year Peak Flood | 413 | ft^3/s | 105 | 1200 | 70.9 | 70.9 | 6.5 |

*Peak-Flow Statistics Citations*

**Lorenz, D.L., Sanocki, C.A., and Kocian, M.J.,2009, Techniques for Estimating the Magnitude and Frequency of Peak Flows on Small Streams in Minnesota Based on Data through Water Year 2005: U.S. Geological Survey Scientific Investigations Report 2009-5250, 54 p. (http://pubs.usgs.gov/sir/2009/5250/pdf/sir2009-5250.pdf)**

Flow-Duration Statistics Parameters[Flow duration Region BC 2015 5170]

| Parameter Code | Parameter Name | Value | Units | Min Limit | Max Limit |
|---|---|---|---|---|---|
| DRNAREA | Drainage Area | 3.02 | square miles | 2.98 | 2960 |
| STORNWI | Percentage of Storage from NWI | 18.84 | percent | 2.44 | 48 |
| SSURGOC | SSURGO Percent Hydrologic Soil Type C | 18.4 | percent | 2.61 | 100 |

Flow-Duration Statistics Flow Report[Flow duration Region BC 2015 5170]

| Statistic | Value | Unit |
|---|---|---|
| 0.01 Percent Duration | 108 | ft^3/s |
| 0.1 Percent Duration | 61.4 | ft^3/s |
| 2 Percent Duration | 19.3 | ft^3/s |
| 5 Percent Duration | 11.5 | ft^3/s |
| 10 Percent Duration | 5.38 | ft^3/s |
| 25 Percent Duration | 2.95 | ft^3/s |
| 50 Percent Duration | 1.19 | ft^3/s |
| 75 Percent Duration | 0.675 | ft^3/s |

| Statistic | Value | Unit |
|---|---|---|
| 90 Percent Duration | 0.386 | ft^3/s |
| 95 Percent Duration | 0.236 | ft^3/s |
| 99 Percent Duration | 0.125 | ft^3/s |
| 99.9 Percent Duration | 0.0459 | ft^3/s |
| 99.99 Percent Duration | 0.0393 | ft^3/s |

*Flow-Duration Statistics Citations*

**Ziegeweid, J.R., Lorenz, D.L., Sanocki, C.A., and Czuba, C.R.,2015, Methods for estimating flow-duration curve and low-flow frequency statistics for ungaged locations on small streams in Minnesota: U.S. Geological Survey Scientific Investigations Report 2015–5170, 23 p. (http://dx.doi.org/10.3133/sir20155170)**

Low-Flow Statistics Parameters[Low flow Region BC 2015 5170]

| Parameter Code | Parameter Name | Value | Units | Min Limit | Max Limit |
|---|---|---|---|---|---|
| DRNAREA | Drainage Area | 3.02 | square miles | 2.98 | 2960 |
| STORNWI | Percentage of Storage from NWI | 18.84 | percent | 2.44 | 48 |
| SSURGOC | SSURGO Percent Hydrologic Soil Type C | 18.4 | percent | 2.61 | 100 |

Low-Flow Statistics Flow Report[Low flow Region BC 2015 5170]

| Statistic | Value | Unit |
|---|---|---|
| 7 Day 10 Year Low Flow | 0.131 | ft^3/s |

*Low-Flow Statistics Citations*

**Ziegeweid, J.R., Lorenz, D.L., Sanocki, C.A., and Czuba, C.R.,2015, Methods for estimating flow-duration curve and low-flow frequency statistics for ungaged locations on small streams in Minnesota: U.S. Geological Survey Scientific Investigations Report 2015–5170, 23 p. (http://dx.doi.org/10.3133/sir20155170)**

Seasonal Flow Statistics Parameters[Low flow Region BC 2015 5170]

| Parameter Code | Parameter Name | Value | Units | Min Limit | Max Limit |
|---|---|---|---|---|---|
| DRNAREA | Drainage Area | 3.02 | square miles | 2.98 | 2960 |
| STORNWI | Percentage of Storage from NWI | 18.84 | percent | 2.44 | 48 |
| SSURGOC | SSURGO Percent Hydrologic Soil Type C | 18.4 | percent | 2.61 | 100 |

Seasonal Flow Statistics Flow Report[Low flow Region BC 2015 5170]

| Statistic | Value | Unit |
|---|---|---|
| Oct to Nov 7 Day 10 Year Low Flow | 0.322 | ft^3/s |
| 30_Day_10_Year_Low_Flow_Oct_to_Nov | 0.486 | ft^3/s |
| 7_Day_10_Year_lowflow_Dec_to_Mar | 0.18 | ft^3/s |
| 30_Day_10_Year_Low_Flow_Dec_to_Mar | 0.229 | ft^3/s |
| Apr to May 7 Day 10 Year Low Flow | 0.632 | ft^3/s |
| Apr to May 30 Day 10 Year Low Flow | 2.01 | ft^3/s |
| 7_Day_10_Year_lowflow_Jun_to_Sep | 0.175 | ft^3/s |
| 30_Day_10_Year_Low_Flow_Jun_to_Sep | 0.238 | ft^3/s |
| 122_Day_10_Year_Low_Flow_Jun_to_Sep | 1.46 | ft^3/s |

*Seasonal Flow Statistics Citations*

**Ziegeweid, J.R., Lorenz, D.L., Sanocki, C.A., and Czuba, C.R.,2015, Methods for estimating flow-duration curve and low-flow frequency statistics for ungaged locations on small streams in Minnesota: U.S. Geological Survey Scientific Investigations Report 2015–5170, 23 p. (http://dx.doi.org/10.3133/sir20155170)**

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# Normal Depth Calculator

Weather.gov > Alaska-Pacific RFC > Normal Depth Calculator

**Alaska-Pacific RFC**
River Forecast Center

River Observations and Forecasts | Weather Observations and Forecasts | Water Supply | Climate and History | Seasonal Interest | Additional Info

## Normal Depth Demonstration Tool

One the most commonly used equations governing Open Channel Flow is known as the Mannings's Equation. It was introduced by the Irish Engineer Robert Manning in 1889 as an alternative to the Chezy Equation. The Mannings equation is an empirical equation that applies to uniform flow in open channels and is a function of the channel velocity, flow area and channel slope.

**7Q10**

$$Q = VA = \left(\frac{1.49}{n}\right) AR^{\frac{2}{3}}\sqrt{S} \quad [U.S.]$$

$$Q = VA = \left(\frac{1.00}{n}\right) AR^{\frac{2}{3}}\sqrt{S} \quad [SI]$$

Where:
Q = Flow Rate, ($ft^3/s$)
v = Velocity, (ft/s)
A = Flow Area, ($ft^2$)
n = Manning's Roughness Coefficient
R = Hydraulic Radius, (ft)
S = Channel Slope, (ft/ft)

Under the assumption of uniform flow conditions the bottom slope is the same as the slope of the energy grade line and the water surface slope. The Manning's n is a coefficient which represents the roughness or friction applied to the flow by the channel. Manning's n-values are often selected from tables, but can be back calculated from field measurements. In many flow conditions the selection of a Manning's roughness coefficient can greatly affect computational results.

**Instructions:** Select variable to solve, adjust slider bars, click on graph to modify the cross section. CSV cross section data can be loaded in the input box below. This online calculator is for demonstration and educational purposes only.

Solve For: Water Surface (normal depth)

Slope: 0.042 (ft/ft)

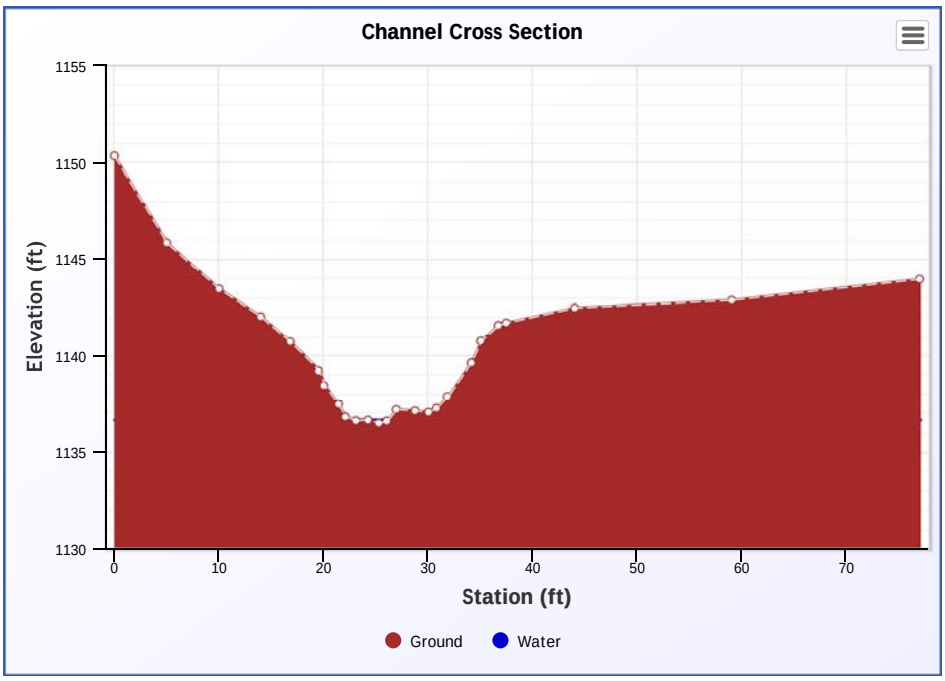
WSE: 1136.60 (ft)

Channel Manning n: 0.055

Flow: 0 ($ft^3/s$)

100 40000

Reset Cross Section




| | |
|---|---|
| Flow Area: | 0.2 ($ft^2$) |
| Wetted Perimeter: | 3.2 (ft) |
| Max Depth: | 0.16 (ft) |
| Average Velocity: | 0.89 (ft/s) |
| Top Width: | 3 (ft) |
| Iterations: | 5001 |
| Froude Number: | 0.62 |

Select HECRAS Geometry: Browse... Load HEC-RAS Data

Load CSV XS Data Below
(station,elevation)

Update Plot

```
0.00,1150.30
5.00,1145.83
10.00,1143.43
14.00,1142.01
16.80,1140.70
19.60,1139.18
20.10,1138.42
21.40,1137.43
22.10,1136.77
23.10,1136.57
24.30,1136.60
25.30,1136.44
26.10,1136.55
27.00,1137.15
28.70,1137.08
30.10,1137.01
30.80,1137.22
31.90,1137.84
34.10,1139.59
35.10,1140.74
36.70,1141.56
37.50,1141.69
44.00,1142.45
59.00,1142.85
77.00,1143.93
```

NATIONAL WEATHER SERVICE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

# Normal Depth Calculator

Weather.gov > Alaska-Pacific RFC > Normal Depth Calculator

**Alaska-Pacific RFC**
River Forecast Center

River Observations and Forecasts | Weather Observations and Forecasts | Water Supply | Climate and History | Seasonal Interest | Additional Info

## Normal Depth Demonstration Tool

One the most commonly used equations governing Open Channel Flow is known as the Mannings's Equation. It was introduced by the Irish Engineer Robert Manning in 1889 as an alternative to the Chezy Equation. The Mannings equation is an empirical equation that applies to uniform flow in open channels and is a function of the channel velocity, flow area and channel slope.

**Q1.5**

$$Q = VA = \left(\frac{1.49}{n}\right) AR^{\frac{2}{3}}\sqrt{S} \quad [U.S.]$$

$$Q = VA = \left(\frac{1.00}{n}\right) AR^{\frac{2}{3}}\sqrt{S} \quad [SI]$$

Where:
Q = Flow Rate, ($ft^3/s$)
v = Velocity, (ft/s)
A = Flow Area, ($ft^2$)
n = Manning's Roughness Coefficient
R = Hydraulic Radius, (ft)
S = Channel Slope, (ft/ft)

Under the assumption of uniform flow conditions the bottom slope is the same as the slope of the energy grade line and the water surface slope. The Manning's n is a coefficient which represents the roughness or friction applied to the flow by the channel. Manning's n-values are often selected from tables, but can be back calculated from field measurements. In many flow conditions the selection of a Manning's roughness coefficient can greatly affect computational results.

**Instructions:** Select variable to solve, adjust slider bars, click on graph to modify the cross section. CSV cross section data can be loaded in the input box below. This online calculator is for demonstration and educational purposes only.

Solve For: Water Surface (normal depth)

Slope: 0.042 (ft/ft)

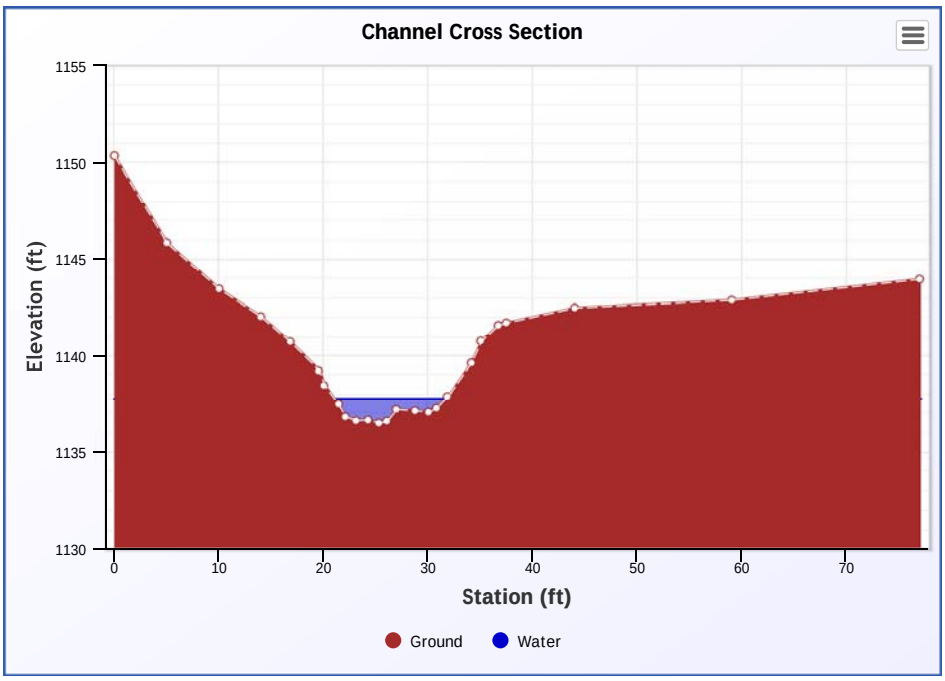
WSE: 1137.71 (ft)

Channel Manning n: 0.055

Flow: 38 ($ft^3/s$)

100 40000

Reset Cross Section




| | |
|---|---|
| Flow Area: | 8.5 ($ft^2$) |
| Wetted Perimeter: | 11.7 (ft) |
| Max Depth: | 1.27 (ft) |
| Average Velocity: | 4.49 (ft/s) |
| Top Width: | 11 (ft) |
| Iterations: | 5001 |
| Froude Number: | 0.90 |

Select HECRAS Geometry: Browse... Load HEC-RAS Data

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# Normal Depth Calculator

Weather.gov > Alaska-Pacific RFC > Normal Depth Calculator

**Alaska-Pacific RFC**
River Forecast Center

River Observations and Forecasts | Weather Observations and Forecasts | Water Supply | Climate and History | Seasonal Interest | Additional Info

## Normal Depth Demonstration Tool

One the most commonly used equations governing Open Channel Flow is known as the Mannings's Equation. It was introduced by the Irish Engineer Robert Manning in 1889 as an alternative to the Chezy Equation. The Mannings equation is an empirical equation that applies to uniform flow in open channels and is a function of the channel velocity, flow area and channel slope.

**Q100**

$$Q = VA = \left(\frac{1.49}{n}\right) AR^{\frac{2}{3}}\sqrt{S} \quad [U.S.]$$

$$Q = VA = \left(\frac{1.00}{n}\right) AR^{\frac{2}{3}}\sqrt{S} \quad [SI]$$

Where:
Q = Flow Rate, ($ft^3/s$)
v = Velocity, (ft/s)
A = Flow Area, ($ft^2$)
n = Manning's Roughness Coefficient
R = Hydraulic Radius, (ft)
S = Channel Slope, (ft/ft)

Under the assumption of uniform flow conditions the bottom slope is the same as the slope of the energy grade line and the water surface slope. The Manning's n is a coefficient which represents the roughness or friction applied to the flow by the channel. Manning's n-values are often selected from tables, but can be back calculated from field measurements. In many flow conditions the selection of a Manning's roughness coefficient can greatly affect computational results.

**Instructions:** Select variable to solve, adjust slider bars, click on graph to modify the cross section. CSV cross section data can be loaded in the input box below. This online calculator is for demonstration and educational purposes only.

Solve For: Water Surface (normal depth)

Slope: 0.042 (ft/ft)

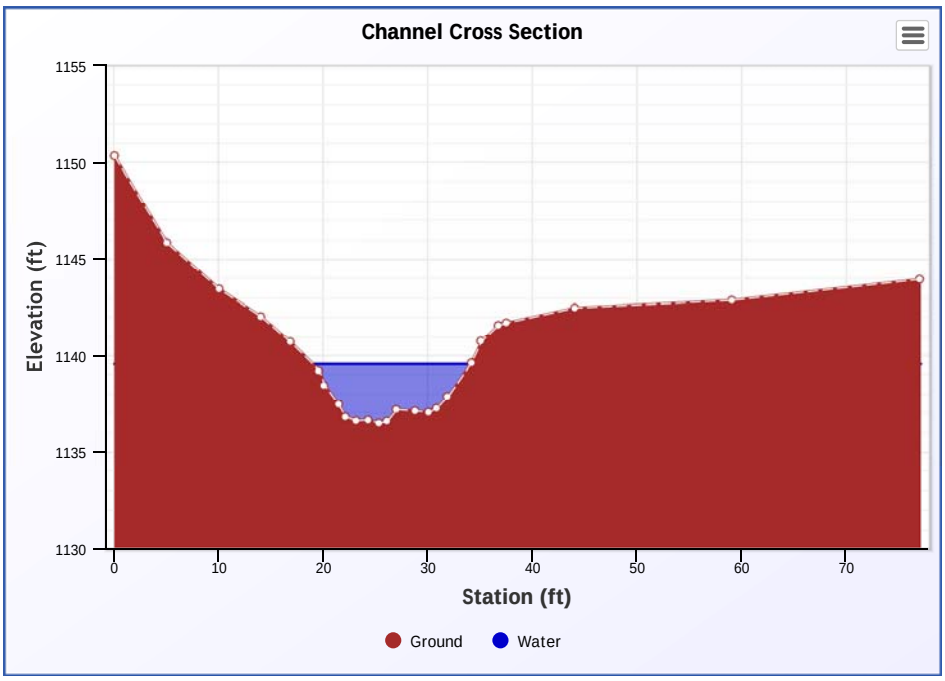
WSE: 1139.53 (ft)

Channel Manning n: 0.055

Flow: 265 ($ft^3/s$)

100 40000

Reset Cross Section

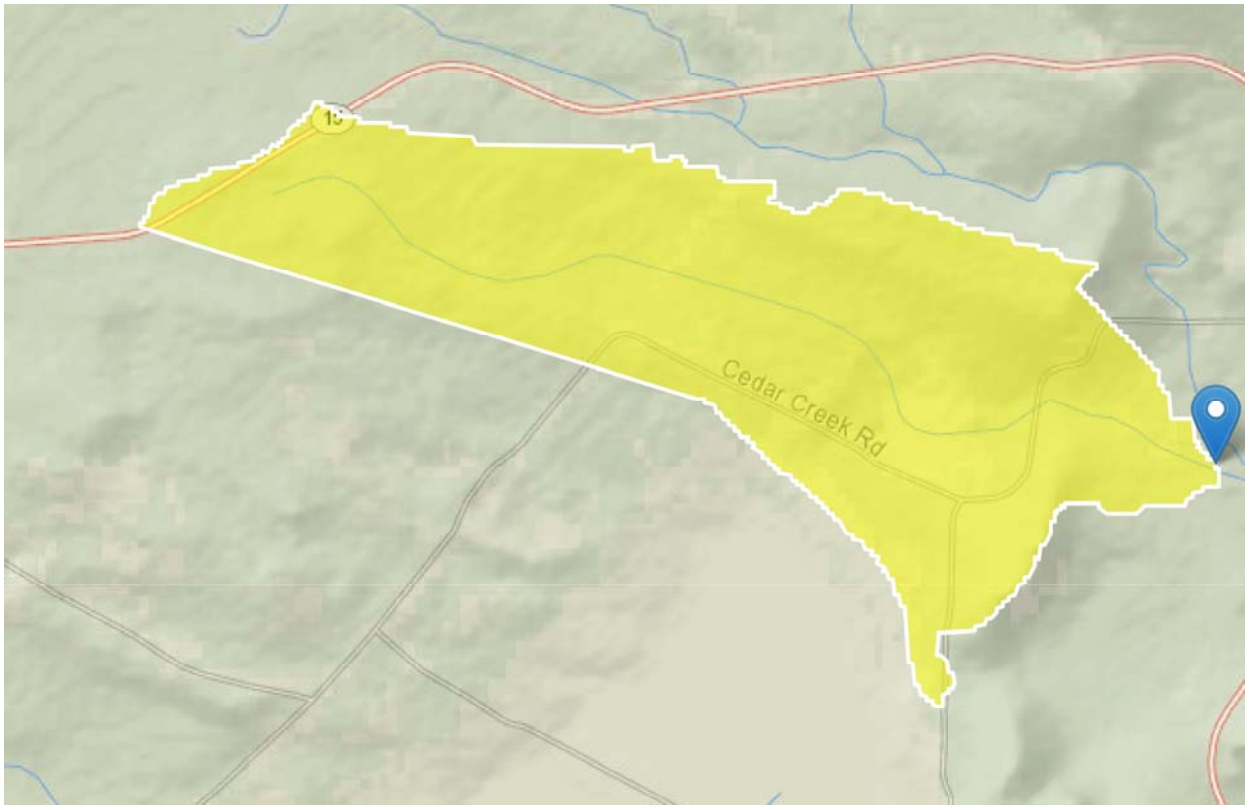



| | |
|---|---|
| Flow Area: | 31.8 ($ft^2$) |
| Wetted Perimeter: | 17.1 (ft) |
| Max Depth: | 3.09 (ft) |
| Average Velocity: | 8.35 (ft/s) |
| Top Width: | 15 (ft) |
| Iterations: | 25 |
| Froude Number: | 1.01 |

Select HECRAS Geometry: Browse... Load HEC-RAS Data

# West Unnamed Creek Subwatershed #4 - Future

**Region ID:** MN
**Workspace ID:** MN20200326180213878000
**Clicked Point (Latitude, Longitude):** 47.31244, -91.32890
**Time:** 2020-03-26 13:02:30 -0500




Basin Characteristics

| Parameter Code | Parameter Description | Value | Unit |
|---|---|---|---|
| DRNAREA | Area that drains to a point on a stream | 0.95 | square miles |
| LAKEAREA | Percentage of Lakes and Ponds | 3.47 | percent |

| Parameter Code | Parameter Description | Value | Unit |
|---|---|---|---|
| STORNWI | Percentage of storage (combined water bodies and wetlands) from the National Wetlands Inventory | 13.83 | percent |
| SSURGOC | Percentage of area of Hydrologic Soil Type C from SSURGO | 15.2 | percent |

General Disclaimers

Parameter values have been edited, computed flows may not apply.

This watershed has been edited, computed flows may not apply.

Peak-Flow Statistics Parameters[Region C]

| Parameter Code | Parameter Name | Value | Units | Min Limit | Max Limit |
|---|---|---|---|---|---|
| DRNAREA | Drainage Area | 0.95 | square miles | 0.21 | 607 |
| LAKEAREA | Percent Lakes and Ponds | 3.47 | percent | 0 | 11.8 |

Peak-Flow Statistics Flow Report[Region C]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

| Statistic | Value | Unit | PIl | PIu | SE | SEp | Equiv. Yrs. |
|---|---|---|---|---|---|---|---|
| 1.5 Year Peak Flood | 18 | ft^3/s | 7.31 | 38.2 | 45.2 | 45.2 | 2.8 |
| 2 Year Peak Flood | 24.1 | ft^3/s | 9.38 | 52.8 | 46.8 | 46.8 | 2.4 |
| 5 Year Peak Flood | 45.2 | ft^3/s | 16.3 | 104 | 50.4 | 50.4 | 2.8 |
| 10 Year Peak Flood | 64.2 | ft^3/s | 22.2 | 152 | 52.9 | 52.9 | 3.5 |
| 25 Year Peak Flood | 94.6 | ft^3/s | 31 | 233 | 56.2 | 56.2 | 4.5 |

| Statistic | Value | Unit | PIl | PIu | SE | SEp | Equiv. Yrs. |
|---|---|---|---|---|---|---|---|
| 50 Year Peak Flood | 123 | ft^3/s | 38.4 | 313 | 59.1 | 59.1 | 5.1 |
| 100 Year Peak Flood | 157 | ft^3/s | 46.4 | 412 | 62.3 | 62.3 | 5.7 |
| 500 Year Peak Flood | 259 | ft^3/s | 66.4 | 746 | 70.9 | 70.9 | 6.5 |

*Peak-Flow Statistics Citations*

**Lorenz, D.L., Sanocki, C.A., and Kocian, M.J.,2009, Techniques for Estimating the Magnitude and Frequency of Peak Flows on Small Streams in Minnesota Based on Data through Water Year 2005: U.S. Geological Survey Scientific Investigations Report 2009-5250, 54 p. (http://pubs.usgs.gov/sir/2009/5250/pdf/sir2009-5250.pdf)**

Flow-Duration Statistics Parameters[Flow duration Region BC 2015 5170]

| Parameter Code | Parameter Name | Value | Units | Min Limit | Max Limit |
|---|---|---|---|---|---|
| DRNAREA | Drainage Area | 0.95 | square miles | 2.98 | 2960 |
| STORNWI | Percentage of Storage from NWI | 13.83 | percent | 2.44 | 48 |
| SSURGOC | SSURGO Percent Hydrologic Soil Type C | 15.2 | percent | 2.61 | 100 |

Flow-Duration Statistics Disclaimers[Flow duration Region BC 2015 5170]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errorsOne or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors

Flow-Duration Statistics Flow Report[Flow duration Region BC 2015 5170]

| Statistic | Value | Unit |
|---|---|---|
| 0.01 Percent Duration | 44.3 | ft^3/s |
| 0.1 Percent Duration | 23.9 | ft^3/s |
| 2 Percent Duration | 6.91 | ft^3/s |

| Statistic | Value | Unit |
|---|---|---|
| 5 Percent Duration | 4 | ft^3/s |
| 10 Percent Duration | 1.77 | ft^3/s |
| 25 Percent Duration | 1.03 | ft^3/s |
| 50 Percent Duration | 0.439 | ft^3/s |
| 75 Percent Duration | 0.266 | ft^3/s |
| 90 Percent Duration | 0.155 | ft^3/s |
| 95 Percent Duration | 0.0939 | ft^3/s |
| 99 Percent Duration | 0.0519 | ft^3/s |
| 99.9 Percent Duration | 0.0191 | ft^3/s |
| 99.99 Percent Duration | 0.0167 | ft^3/s |

*Flow-Duration Statistics Citations*

**Ziegeweid, J.R., Lorenz, D.L., Sanocki, C.A., and Czuba, C.R.,2015, Methods for estimating flow-duration curve and low-flow frequency statistics for ungaged locations on small streams in Minnesota: U.S. Geological Survey Scientific Investigations Report 2015–5170, 23 p. (http://dx.doi.org/10.3133/sir20155170)**

Low-Flow Statistics Parameters[Low flow Region BC 2015 5170]

| Parameter Code | Parameter Name | Value | Units | Min Limit | Max Limit |
|---|---|---|---|---|---|
| DRNAREA | Drainage Area | 0.95 | square miles | 2.98 | 2960 |
| STORNWI | Percentage of Storage from NWI | 13.83 | percent | 2.44 | 48 |
| SSURGOC | SSURGO Percent Hydrologic Soil Type C | 15.2 | percent | 2.61 | 100 |

Low-Flow Statistics Disclaimers[Low flow Region BC 2015 5170]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errorsOne or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors

Low-Flow Statistics Flow Report[Low flow Region BC 2015 5170]

| Statistic | Value | Unit |
|---|---|---|
| 7 Day 10 Year Low Flow | 0.0527 | ft^3/s |

*Low-Flow Statistics Citations*

**Ziegeweid, J.R., Lorenz, D.L., Sanocki, C.A., and Czuba, C.R.,2015, Methods for estimating flow-duration curve and low-flow frequency statistics for ungaged locations on small streams in Minnesota: U.S. Geological Survey Scientific Investigations Report 2015–5170, 23 p. (http://dx.doi.org/10.3133/sir20155170)**

Seasonal Flow Statistics Parameters[Low flow Region BC 2015 5170]

| Parameter Code | Parameter Name | Value | Units | Min Limit | Max Limit |
|---|---|---|---|---|---|
| DRNAREA | Drainage Area | 0.95 | square miles | 2.98 | 2960 |
| STORNWI | Percentage of Storage from NWI | 13.83 | percent | 2.44 | 48 |
| SSURGOC | SSURGO Percent Hydrologic Soil Type C | 15.2 | percent | 2.61 | 100 |

Seasonal Flow Statistics Disclaimers[Low flow Region BC 2015 5170]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errorsOne or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors

Seasonal Flow Statistics Flow Report[Low flow Region BC 2015 5170]

| Statistic | Value | Unit |
|---|---|---|
| Oct to Nov 7 Day 10 Year Low Flow | 0.129 | ft^3/s |
| 30_Day_10_Year_Low_Flow_Oct_to_Nov | 0.197 | ft^3/s |
| 7_Day_10_Year_lowflow_Dec_to_Mar | 0.0721 | ft^3/s |
| 30_Day_10_Year_Low_Flow_Dec_to_Mar | 0.0941 | ft^3/s |

| Statistic | Value | Unit |
|---|---|---|
| Apr to May 7 Day 10 Year Low Flow | 0.246 | ft^3/s |
| Apr to May 30 Day 10 Year Low Flow | 0.742 | ft^3/s |
| 7_Day_10_Year_lowflow_Jun_to_Sep | 0.07 | ft^3/s |
| 30_Day_10_Year_Low_Flow_Jun_to_Sep | 0.0959 | ft^3/s |
| 122_Day_10_Year_Low_Flow_Jun_to_Sep | 0.597 | ft^3/s |

*Seasonal Flow Statistics Citations*

**Ziegeweid, J.R., Lorenz, D.L., Sanocki, C.A., and Czuba, C.R.,2015, Methods for estimating flow-duration curve and low-flow frequency statistics for ungaged locations on small streams in Minnesota: U.S. Geological Survey Scientific Investigations Report 2015–5170, 23 p. (http://dx.doi.org/10.3133/sir20155170)**

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Application Version: 4.3.11

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# Normal Depth Calculator

Weather.gov > Alaska-Pacific RFC > Normal Depth Calculator

**Alaska-Pacific RFC**
River Forecast Center

River Observations and Forecasts | Weather Observations and Forecasts | Water Supply | Climate and History | Seasonal Interest | Additional Info

## Normal Depth Demonstration Tool

One the most commonly used equations governing Open Channel Flow is known as the Mannings's Equation. It was introduced by the Irish Engineer Robert Manning in 1889 as an alternative to the Chezy Equation. The Mannings equation is an empirical equation that applies to uniform flow in open channels and is a function of the channel velocity, flow area and channel slope.

**7Q10**

$$Q = VA = \left(\frac{1.49}{n}\right) AR^{\frac{2}{3}}\sqrt{S} \quad [U.S.]$$

$$Q = VA = \left(\frac{1.00}{n}\right) AR^{\frac{2}{3}}\sqrt{S} \quad [SI]$$

Where:
Q = Flow Rate, ($ft^3/s$)
v = Velocity, (ft/s)
A = Flow Area, ($ft^2$)
n = Manning's Roughness Coefficient
R = Hydraulic Radius, (ft)
S = Channel Slope, (ft/ft)

Under the assumption of uniform flow conditions the bottom slope is the same as the slope of the energy grade line and the water surface slope. The Manning's n is a coefficient which represents the roughness or friction applied to the flow by the channel. Manning's n-values are often selected from tables, but can be back calculated from field measurements. In many flow conditions the selection of a Manning's roughness coefficient can greatly affect computational results.

**Instructions:** Select variable to solve, adjust slider bars, click on graph to modify the cross section. CSV cross section data can be loaded in the input box below. This online calculator is for demonstration and educational purposes only.

Solve For: Water Surface (normal depth)

Slope: 0.042 (ft/ft)

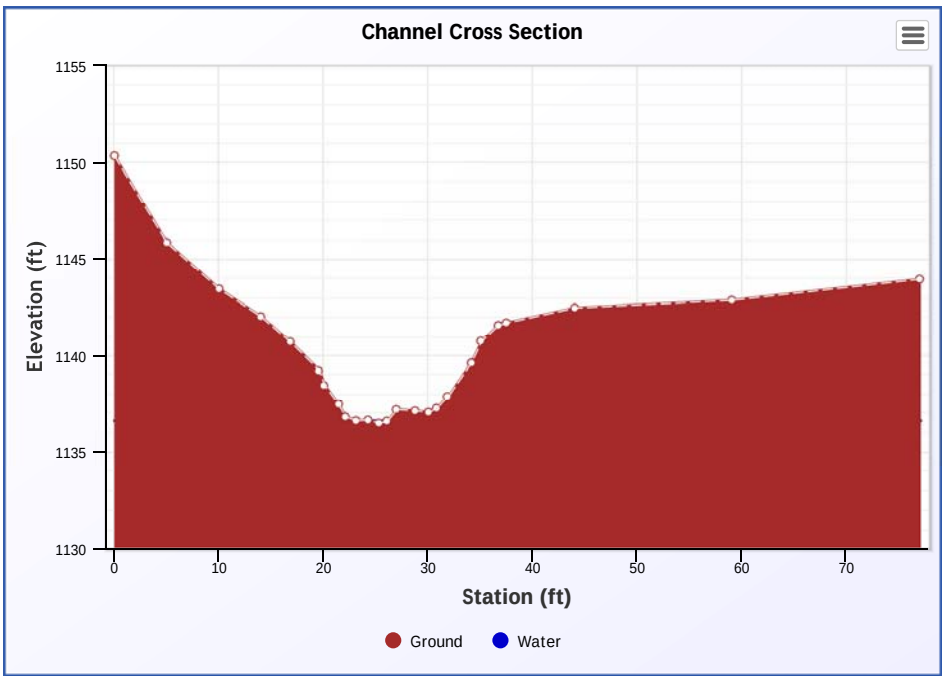
WSE: 1136.56 (ft)

Channel Manning n: 0.055

Flow: 0 ($ft^3/s$)

100 40000

Reset Cross Section




| | |
|---|---|
| Flow Area: | 0.1 ($ft^2$) |
| Wetted Perimeter: | 1.2 (ft) |
| Max Depth: | 0.12 (ft) |
| Average Velocity: | 0.95 (ft/s) |
| Top Width: | 1 (ft) |
| Iterations: | 5001 |
| Froude Number: | 0.62 |

Select HECRAS Geometry: Browse... Load HEC-RAS Data

Load CSV XS Data Below
(station,elevation)

Update Plot

```
0.00,1150.30
5.00,1145.83
10.00,1143.43
14.00,1142.01
16.80,1140.70
19.60,1139.18
20.10,1138.42
21.40,1137.43
22.10,1136.77
23.10,1136.57
24.30,1136.60
25.30,1136.44
26.10,1136.55
27.00,1137.15
28.70,1137.08
30.10,1137.01
30.80,1137.22
31.90,1137.84
34.10,1139.59
35.10,1140.74
36.70,1141.56
37.50,1141.69
44.00,1142.45
59.00,1142.85
77.00,1143.93
```

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**Q1.5**

$$Q = VA = \left(\frac{1.49}{n}\right) AR^{\frac{2}{3}}\sqrt{S} \quad [U.S.]$$

$$Q = VA = \left(\frac{1.00}{n}\right) AR^{\frac{2}{3}}\sqrt{S} \quad [SI]$$

Where:
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A = Flow Area, ($ft^2$)
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S = Channel Slope, (ft/ft)

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**Instructions:** Select variable to solve, adjust slider bars, click on graph to modify the cross section. CSV cross section data can be loaded in the input box below. This online calculator is for demonstration and educational purposes only.

Solve For: Water Surface (normal depth)

Slope: 0.042 (ft/ft)

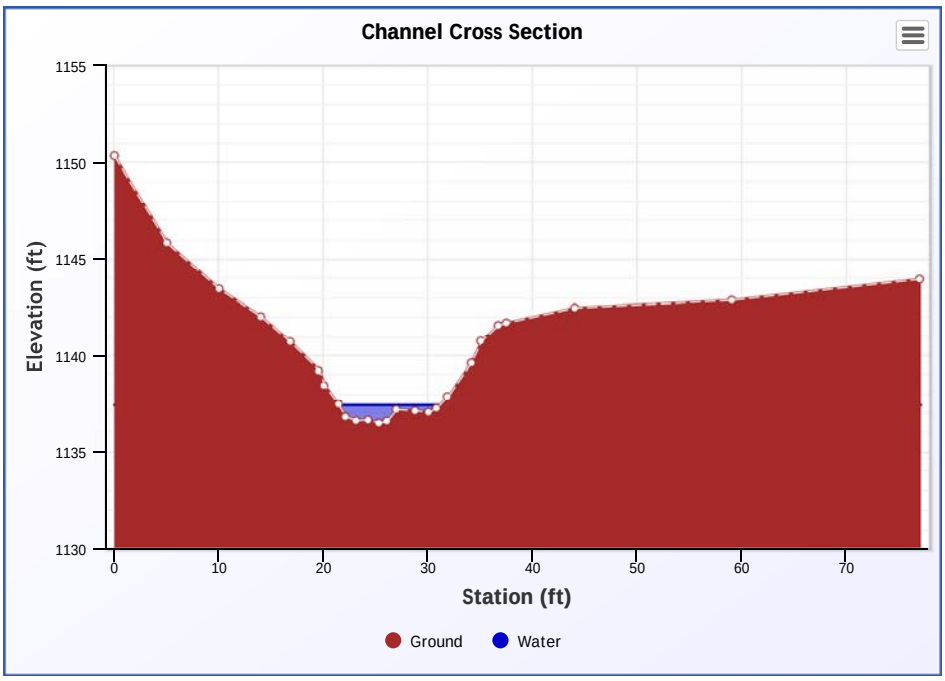
WSE: 1137.38 (ft)

Channel Manning n: 0.055

Flow: 18 ($ft^3/s$)

100 40000

Reset Cross Section




| | |
|---|---|
| Flow Area: | 5.2 ($ft^2$) |
| Wetted Perimeter: | 10.5 (ft) |
| Max Depth: | 0.94 (ft) |
| Average Velocity: | 3.43 (ft/s) |
| Top Width: | 10 (ft) |
| Iterations: | 26 |
| Froude Number: | 0.84 |

Select HECRAS Geometry: Browse... Load HEC-RAS Data

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# Normal Depth Calculator

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## Normal Depth Demonstration Tool

One the most commonly used equations governing Open Channel Flow is known as the Mannings's Equation. It was introduced by the Irish Engineer Robert Manning in 1889 as an alternative to the Chezy Equation. The Mannings equation is an empirical equation that applies to uniform flow in open channels and is a function of the channel velocity, flow area and channel slope.

**Q100**

$$Q = VA = \left(\frac{1.49}{n}\right) AR^{\frac{2}{3}}\sqrt{S} \quad [U.S.]$$

$$Q = VA = \left(\frac{1.00}{n}\right) AR^{\frac{2}{3}}\sqrt{S} \quad [SI]$$

Where:
Q = Flow Rate, ($ft^3/s$)
v = Velocity, (ft/s)
A = Flow Area, ($ft^2$)
n = Manning's Roughness Coefficient
R = Hydraulic Radius, (ft)
S = Channel Slope, (ft/ft)

Under the assumption of uniform flow conditions the bottom slope is the same as the slope of the energy grade line and the water surface slope. The Manning's n is a coefficient which represents the roughness or friction applied to the flow by the channel. Manning's n-values are often selected from tables, but can be back calculated from field measurements. In many flow conditions the selection of a Manning's roughness coefficient can greatly affect computational results.

**Instructions:** Select variable to solve, adjust slider bars, click on graph to modify the cross section. CSV cross section data can be loaded in the input box below. This online calculator is for demonstration and educational purposes only.

Solve For: Water Surface (normal depth)

Slope: 0.042 (ft/ft)

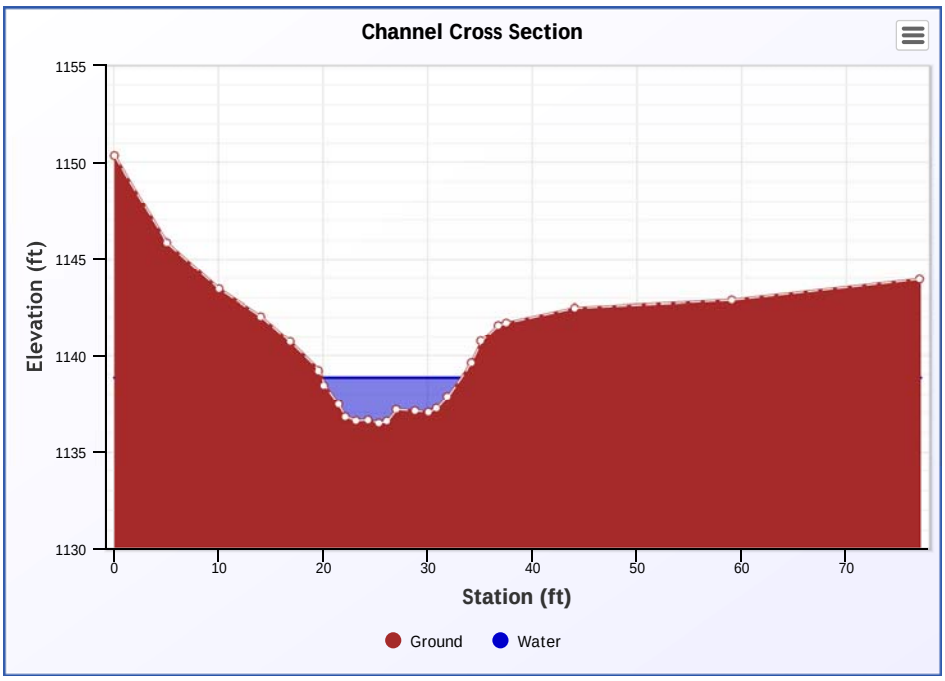
WSE: 1138.83 (ft)

Channel Manning n: 0.055

Flow: 157 ($ft^3/s$)

100 40000

Reset Cross Section




| | |
|---|---|
| Flow Area: | 21.9 ($ft^2$) |
| Wetted Perimeter: | 14.7 (ft) |
| Max Depth: | 2.39 (ft) |
| Average Velocity: | 7.18 (ft/s) |
| Top Width: | 13 (ft) |
| Iterations: | 26 |
| Froude Number: | 0.98 |

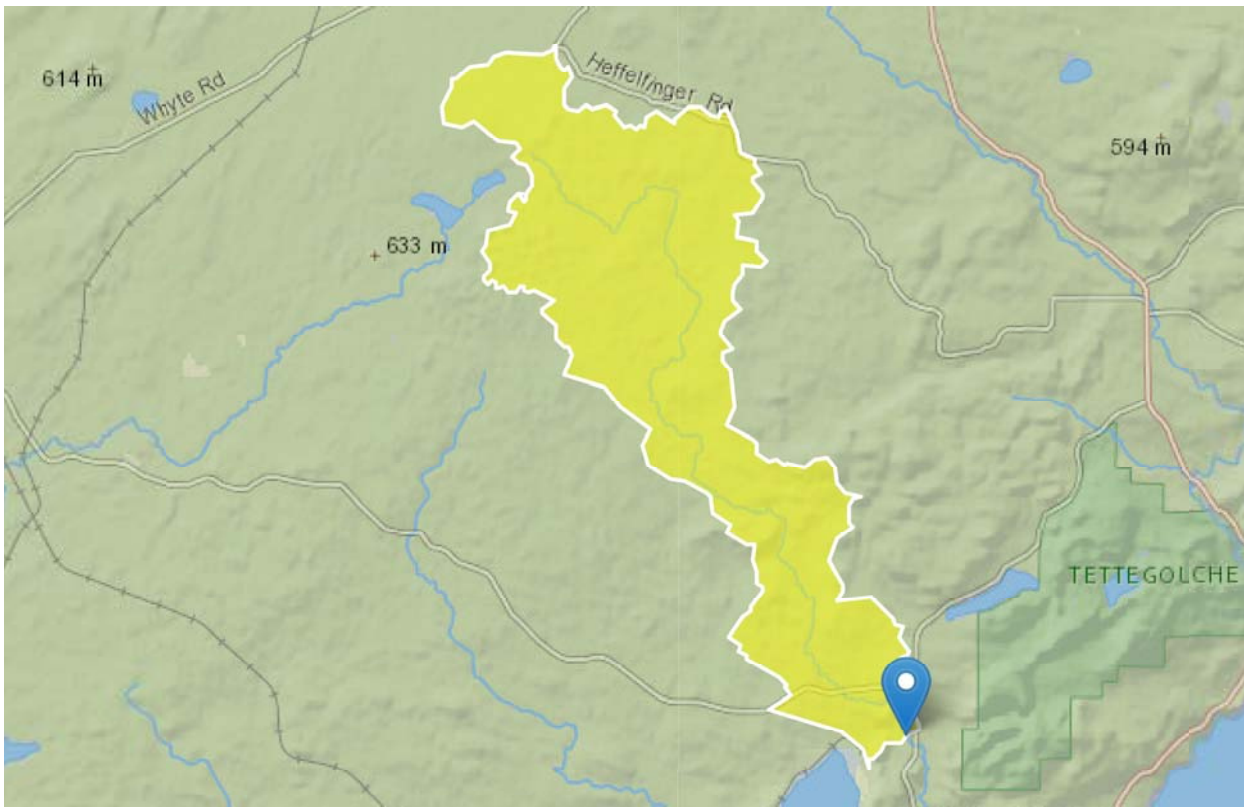
Select HECRAS Geometry: Browse... Load HEC-RAS Data

# Appendix E

## Streamflow and Stream Water Level Modeling Results
## East Branch Beaver River

# East Branch Beaver River Downstream of West Unnamed Creek - Pre-Settlement

**Region ID:** MN
**Workspace ID:** MN20200326165942158000
**Clicked Point (Latitude, Longitude):** 47.31248, -91.32839
**Time:** 2020-03-26 11:59:56 -0500




Basin Characteristics

| Parameter Code | Parameter Description | Value | Unit |
|---|---|---|---|
| DRNAREA | Area that drains to a point on a stream | 28 | square miles |
| LAKEAREA | Percentage of Lakes and Ponds | 0.73 | percent |

| Parameter Code | Parameter Description | Value | Unit |
|---|---|---|---|
| STORNWI | Percentage of storage (combined water bodies and wetlands) from the National Wetlands Inventory | 35.2 | percent |
| SSURGOC | Percentage of area of Hydrologic Soil Type C from SSURGO | 40.2 | percent |

General Disclaimers

Parameter values have been edited, computed flows may not apply.

This watershed has been edited, computed flows may not apply.

Peak-Flow Statistics Parameters[100 Percent (28.1 square miles) Region C]

| Parameter Code | Parameter Name | Value | Units | Min Limit | Max Limit |
|---|---|---|---|---|---|
| DRNAREA | Drainage Area | 28 | square miles | 0.21 | 607 |
| LAKEAREA | Percent Lakes and Ponds | 0.73 | percent | 0 | 11.8 |

Peak-Flow Statistics Flow Report[100 Percent (28.1 square miles) Region C]

PIl: Prediction Interval-Lower, Plu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

| Statistic | Value | Unit | PIl | Plu | SE | SEp | Equiv. Yrs. |
|---|---|---|---|---|---|---|---|
| 1.5 Year Peak Flood | 557 | ft^3/s | 258 | 1040 | 45.2 | 45.2 | 2.8 |
| 2 Year Peak Flood | 711 | ft^3/s | 316 | 1360 | 46.8 | 46.8 | 2.4 |
| 5 Year Peak Flood | 1190 | ft^3/s | 497 | 2370 | 50.4 | 50.4 | 2.8 |
| 10 Year Peak Flood | 1600 | ft^3/s | 644 | 3240 | 52.9 | 52.9 | 3.5 |
| 25 Year Peak Flood | 2200 | ft^3/s | 851 | 4600 | 56.2 | 56.2 | 4.5 |

| Statistic | Value | Unit | PIl | PIu | SE | SEp | Equiv. Yrs. |
|---|---|---|---|---|---|---|---|
| 50 Year Peak Flood | 2760 | ft^3/s | 1020 | 5900 | 59.1 | 59.1 | 5.1 |
| 100 Year Peak Flood | 3390 | ft^3/s | 1200 | 7430 | 62.3 | 62.3 | 5.7 |
| 500 Year Peak Flood | 5210 | ft^3/s | 1640 | 12200 | 70.9 | 70.9 | 6.5 |

*Peak-Flow Statistics Citations*

**Lorenz, D.L., Sanocki, C.A., and Kocian, M.J.,2009, Techniques for Estimating the Magnitude and Frequency of Peak Flows on Small Streams in Minnesota Based on Data through Water Year 2005: U.S. Geological Survey Scientific Investigations Report 2009-5250, 54 p. (http://pubs.usgs.gov/sir/2009/5250/pdf/sir2009-5250.pdf)**

Flow-Duration Statistics Parameters[Flow duration Region BC 2015 5170]

| Parameter Code | Parameter Name | Value | Units | Min Limit | Max Limit |
|---|---|---|---|---|---|
| DRNAREA | Drainage Area | 28 | square miles | 2.98 | 2960 |
| STORNWI | Percentage of Storage from NWI | 35.2 | percent | 2.44 | 48 |
| SSURGOC | SSURGO Percent Hydrologic Soil Type C | 40.2 | percent | 2.61 | 100 |

Flow-Duration Statistics Flow Report[Flow duration Region BC 2015 5170]

| Statistic | Value | Unit |
|---|---|---|
| 0.01 Percent Duration | 642 | ft^3/s |
| 0.1 Percent Duration | 410 | ft^3/s |
| 2 Percent Duration | 151 | ft^3/s |
| 5 Percent Duration | 93.3 | ft^3/s |
| 10 Percent Duration | 47.9 | ft^3/s |
| 25 Percent Duration | 22 | ft^3/s |
| 50 Percent Duration | 7.48 | ft^3/s |

| Statistic | Value | Unit |
|---|---|---|
| 75 Percent Duration | 3.51 | ft^3/s |
| 90 Percent Duration | 1.83 | ft^3/s |
| 95 Percent Duration | 1.09 | ft^3/s |
| 99 Percent Duration | 0.492 | ft^3/s |
| 99.9 Percent Duration | 0.162 | ft^3/s |
| 99.99 Percent Duration | 0.126 | ft^3/s |

*Flow-Duration Statistics Citations*

**Ziegeweid, J.R., Lorenz, D.L., Sanocki, C.A., and Czuba, C.R.,2015, Methods for estimating flow-duration curve and low-flow frequency statistics for ungaged locations on small streams in Minnesota: U.S. Geological Survey Scientific Investigations Report 2015–5170, 23 p. (http://dx.doi.org/10.3133/sir20155170)**

Low-Flow Statistics Parameters[Low flow Region BC 2015 5170]

| Parameter Code | Parameter Name | Value | Units | Min Limit | Max Limit |
|---|---|---|---|---|---|
| DRNAREA | Drainage Area | 28 | square miles | 2.98 | 2960 |
| STORNWI | Percentage of Storage from NWI | 35.2 | percent | 2.44 | 48 |
| SSURGOC | SSURGO Percent Hydrologic Soil Type C | 40.2 | percent | 2.61 | 100 |

Low-Flow Statistics Flow Report[Low flow Region BC 2015 5170]

| Statistic | Value | Unit |
|---|---|---|
| 7 Day 10 Year Low Flow | 0.566 | ft^3/s |

*Low-Flow Statistics Citations*

**Ziegeweid, J.R., Lorenz, D.L., Sanocki, C.A., and Czuba, C.R.,2015, Methods for estimating flow-duration curve and low-flow frequency statistics for ungaged**

**locations on small streams in Minnesota: U.S. Geological Survey Scientific Investigations Report 2015–5170, 23 p. (http://dx.doi.org/10.3133/sir20155170)**

Seasonal Flow Statistics Parameters[Low flow Region BC 2015 5170]

| Parameter Code | Parameter Name | Value | Units | Min Limit | Max Limit |
|---|---|---|---|---|---|
| DRNAREA | Drainage Area | 28 | square miles | 2.98 | 2960 |
| STORNWI | Percentage of Storage from NWI | 35.2 | percent | 2.44 | 48 |
| SSURGOC | SSURGO Percent Hydrologic Soil Type C | 40.2 | percent | 2.61 | 100 |

Seasonal Flow Statistics Flow Report[Low flow Region BC 2015 5170]

| Statistic | Value | Unit |
|---|---|---|
| Oct to Nov 7 Day 10 Year Low Flow | 1.45 | ft^3/s |
| 30_Day_10_Year_Low_Flow_Oct_to_Nov | 2.21 | ft^3/s |
| 7_Day_10_Year_lowflow_Dec_to_Mar | 0.806 | ft^3/s |
| 30_Day_10_Year_Low_Flow_Dec_to_Mar | 0.995 | ft^3/s |
| Apr to May 7 Day 10 Year Low Flow | 3.31 | ft^3/s |
| Apr to May 30 Day 10 Year Low Flow | 12.8 | ft^3/s |
| 7_Day_10_Year_lowflow_Jun_to_Sep | 0.792 | ft^3/s |
| 30_Day_10_Year_Low_Flow_Jun_to_Sep | 1.1 | ft^3/s |
| 122_Day_10_Year_Low_Flow_Jun_to_Sep | 7.62 | ft^3/s |

*Seasonal Flow Statistics Citations*

**Ziegeweid, J.R., Lorenz, D.L., Sanocki, C.A., and Czuba, C.R.,2015, Methods for estimating flow-duration curve and low-flow frequency statistics for ungaged locations on small streams in Minnesota: U.S. Geological Survey Scientific Investigations Report 2015–5170, 23 p. (http://dx.doi.org/10.3133/sir20155170)**

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Application Version: 4.3.11

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$$Q = VA = \left(\frac{1.49}{n}\right) AR^{\frac{2}{3}}\sqrt{S} \quad [U.S.]$$

$$Q = VA = \left(\frac{1.00}{n}\right) AR^{\frac{2}{3}}\sqrt{S} \quad [SI]$$

Where:
Q = Flow Rate, ($ft^3/s$)
v = Velocity, (ft/s)
A = Flow Area, ($ft^2$)
n = Manning's Roughness Coefficient
R = Hydraulic Radius, (ft)
S = Channel Slope, (ft/ft)

Under the assumption of uniform flow conditions the bottom slope is the same as the slope of the energy grade line and the water surface slope. The Manning's n is a coefficient which represents the roughness or friction applied to the flow by the channel. Manning's n-values are often selected from tables, but can be back calculated from field measurements. In many flow conditions the selection of a Manning's roughness coefficient can greatly affect computational results.

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Solve For: Water Surface (normal depth)

Slope: 0.005 (ft/ft)

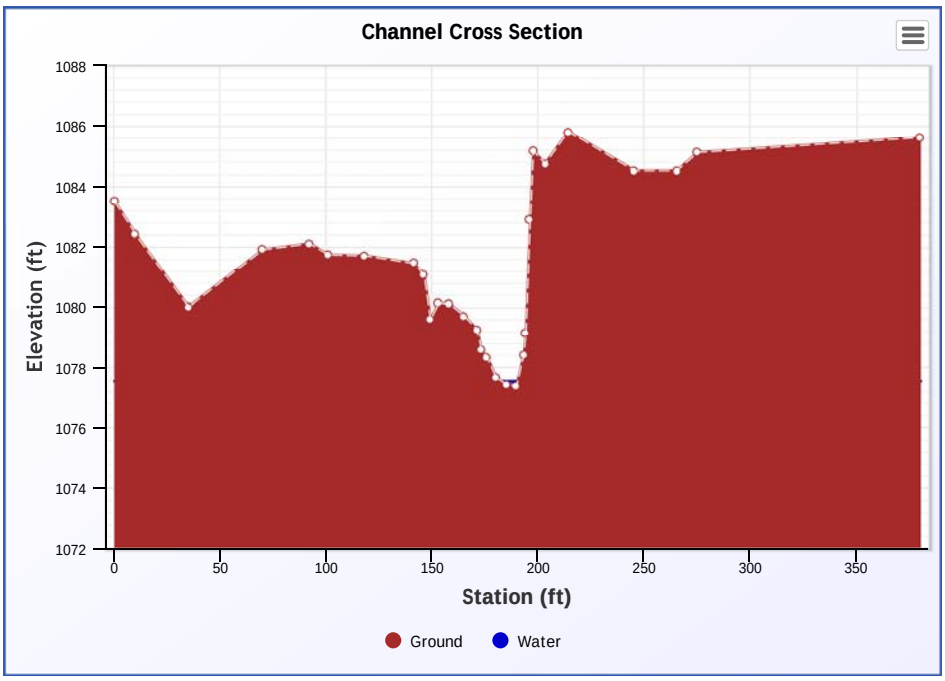
WSE: 1077.54 (ft)

Channel Manning n: 0.028

Flow: 1 ($ft^3/s$)

100 40000

Reset Cross Section




| | |
|---|---|
| Flow Area: | 0.8 ($ft^2$) |
| Wetted Perimeter: | 7.0 (ft) |
| Max Depth: | 0.16 (ft) |
| Average Velocity: | 0.94 (ft/s) |
| Top Width: | 7 (ft) |
| Iterations: | 5001 |
| Froude Number: | 0.49 |

Select HECRAS Geometry: Browse... Load HEC-RAS Data

Load CSV XS Data Below
(station,elevation)

Update Plot

```
0.00,1083.50
10.00,1082.40
35.00,1080.00
70.00,1081.90
92.00,1082.10
101.00,1081.73
118.00,1081.70
141.00,1081.45
146.00,1081.05
149.00,1079.58
153.00,1080.14
158.00,1080.10
165.00,1079.71
171.00,1079.24
173.00,1078.57
175.50,1078.33
180.00,1077.66
185.00,1077.42
189.50,1077.38
193.00,1078.40
194.00,1079.14
196.00,1082.87
197.50,1085.14
203.00,1084.73
214.00,1085.80
245.00,1084.50
265.00,1084.50
275.00,1085.10
380.00,1085.60
```

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**Instructions:** Select variable to solve, adjust slider bars, click on graph to modify the cross section. CSV cross section data can be loaded in the input box below. This online calculator is for demonstration and educational purposes only.

Solve For: Water Surface (normal depth)

Slope: 0.005 (ft/ft)

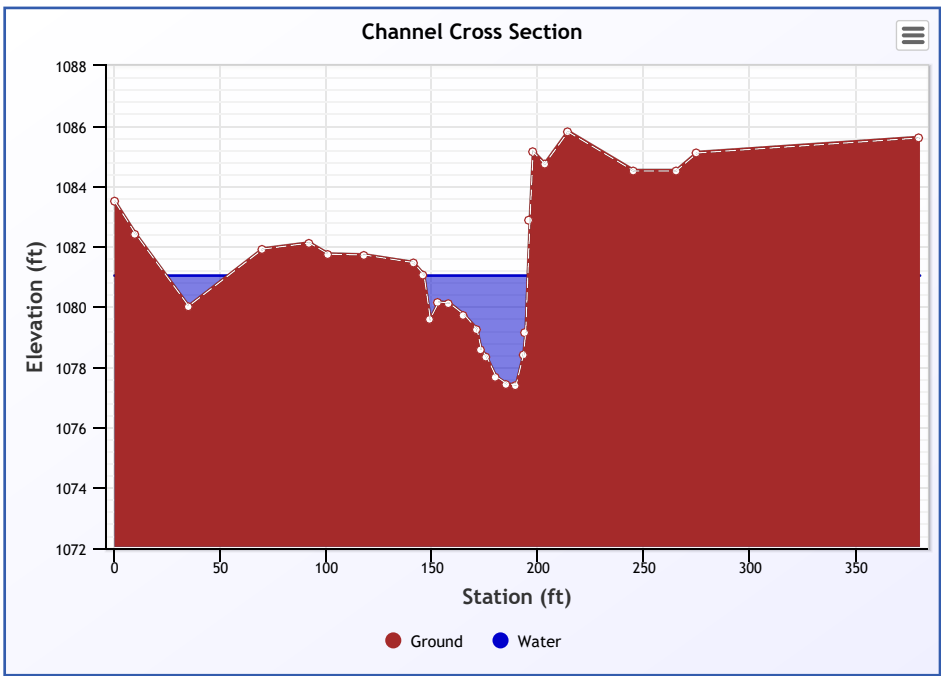
WSE: 1081.03 (ft)

Channel Manning n: 0.028

Flow: 557 ($ft^3/s$)

100 40000

Reset Cross Section




| | |
|---|---|
| Flow Area: | 116.7 ($ft^2$) |
| Wetted Perimeter: | 81.2 (ft) |
| Max Depth: | 3.65 (ft) |
| Average Velocity: | 4.77 (ft/s) |
| Top Width: | 79 (ft) |
| Iterations: | 29 |
| Froude Number: | 0.69 |

Select HECRAS Geometry: Browse... Load HEC-RAS Data

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$$Q = VA = \left(\frac{1.00}{n}\right) AR^{\frac{2}{3}}\sqrt{S} \quad [SI]$$

Where:
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A = Flow Area, ($ft^2$)
n = Manning's Roughness Coefficient
R = Hydraulic Radius, (ft)
S = Channel Slope, (ft/ft)

Under the assumption of uniform flow conditions the bottom slope is the same as the slope of the energy grade line and the water surface slope. The Manning's n is a coefficient which represents the roughness or friction applied to the flow by the channel. Manning's n-values are often selected from tables, but can be back calculated from field measurements. In many flow conditions the selection of a Manning's roughness coefficient can greatly affect computational results.

**Instructions:** Select variable to solve, adjust slider bars, click on graph to modify the cross section. CSV cross section data can be loaded in the input box below. This online calculator is for demonstration and educational purposes only.

Solve For: Water Surface (normal depth)

Slope: 0.005 (ft/ft)

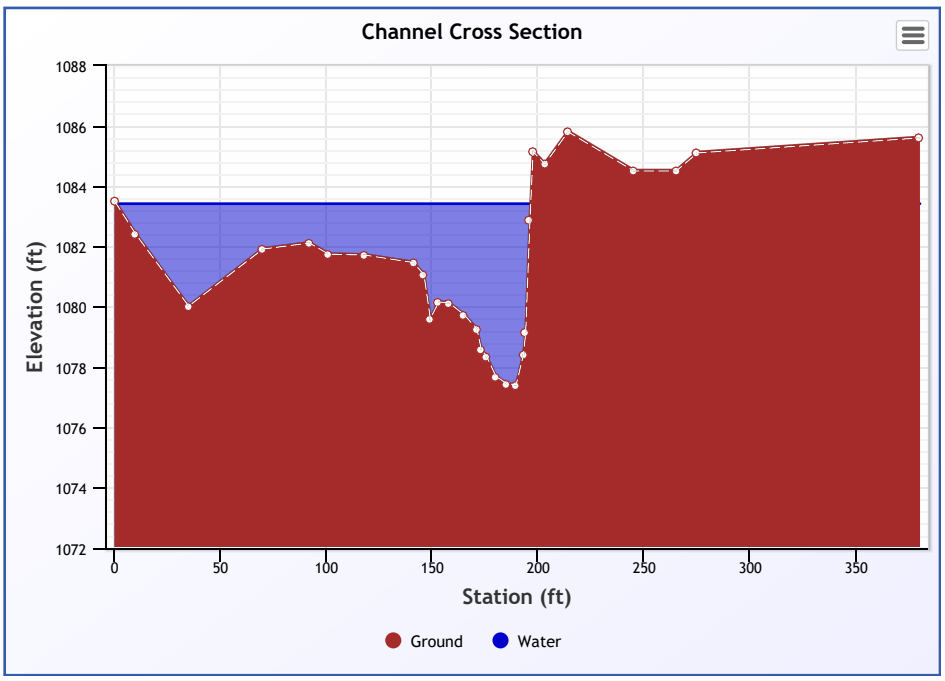
WSE: 1083.42 (ft)

Channel Manning n: 0.028

Flow: 3390 ($ft^3/s$)

100 40000

Reset Cross Section

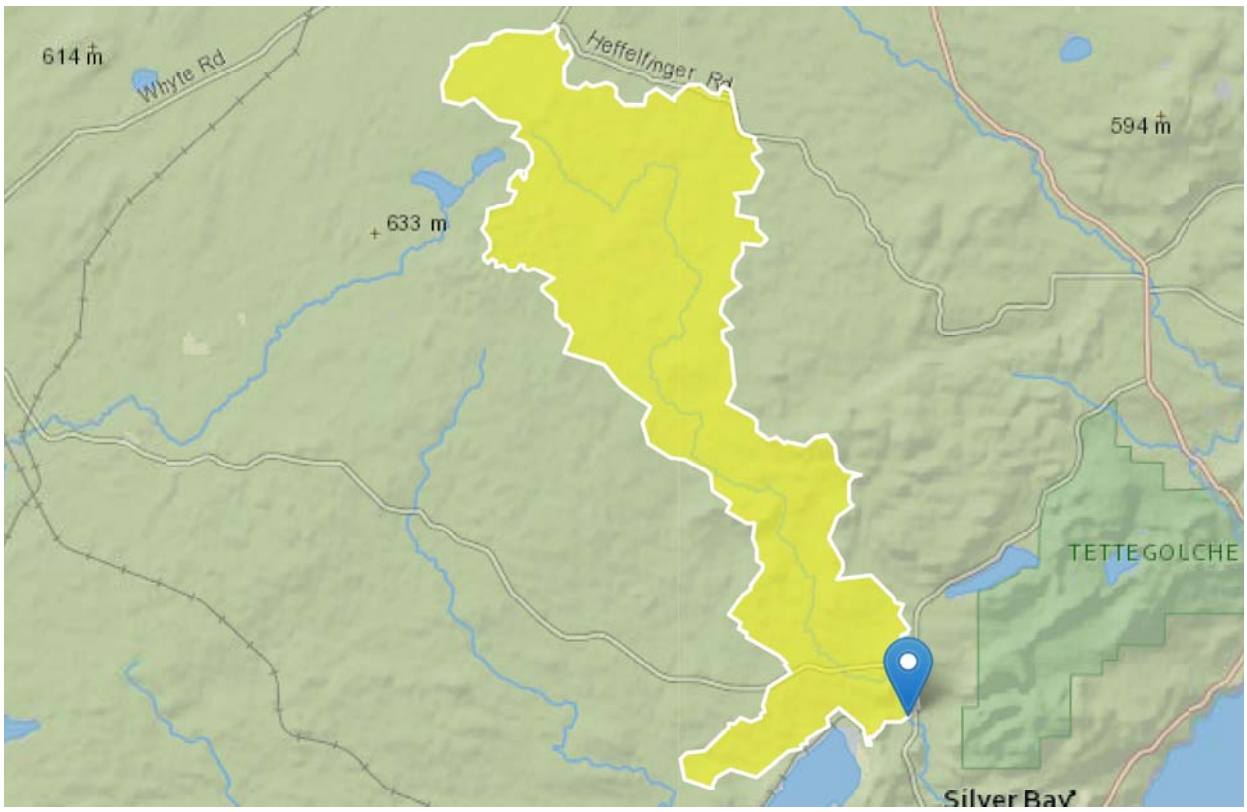



| | |
|---|---|
| Flow Area: | 493.1 ($ft^2$) |
| Wetted Perimeter: | 199.0 (ft) |
| Max Depth: | 6.04 (ft) |
| Average Velocity: | 6.87 (ft/s) |
| Top Width: | 195 (ft) |
| Iterations: | 29 |
| Froude Number: | 0.76 |

Select HECRAS Geometry: Browse... Load HEC-RAS Data

# East Branch Beaver River Downstream of West Unnamed Creek - Existing

**Region ID:** MN
**Workspace ID:** MN20200326165248260000
**Clicked Point (Latitude, Longitude):** 47.31244, -91.32839
**Time:** 2020-03-26 11:53:08 -0500




Basin Characteristics

| Parameter Code | Parameter Description | Value | Unit |
|---|---|---|---|
| DRNAREA | Area that drains to a point on a stream | 29.98 | square miles |
| LAKEAREA | Percentage of Lakes and Ponds | 3.78 | percent |

| Parameter Code | Parameter Description | Value | Unit |
|---|---|---|---|
| STORNWI | Percentage of storage (combined water bodies and wetlands) from the National Wetlands Inventory | 34.16 | percent |
| SSURGOC | Percentage of area of Hydrologic Soil Type C from SSURGO | 38.63 | percent |

General Disclaimers

Parameter values have been edited, computed flows may not apply.

Peak-Flow Statistics Parameters[100 Percent (29.9 square miles) Region C]

| Parameter Code | Parameter Name | Value | Units | Min Limit | Max Limit |
|---|---|---|---|---|---|
| DRNAREA | Drainage Area | 29.98 | square miles | 0.21 | 607 |
| LAKEAREA | Percent Lakes and Ponds | 3.78 | percent | 0 | 11.8 |

Peak-Flow Statistics Flow Report[100 Percent (29.9 square miles) Region C]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

| Statistic | Value | Unit | PIl | PIu | SE | SEp | Equiv. Yrs. |
|---|---|---|---|---|---|---|---|
| 1.5 Year Peak Flood | 341 | ft^3/s | 154 | 654 | 45.2 | 45.2 | 2.8 |
| 2 Year Peak Flood | 428 | ft^3/s | 185 | 843 | 46.8 | 46.8 | 2.4 |
| 5 Year Peak Flood | 690 | ft^3/s | 279 | 1420 | 50.4 | 50.4 | 2.8 |
| 10 Year Peak Flood | 903 | ft^3/s | 353 | 1900 | 52.9 | 52.9 | 3.5 |
| 25 Year Peak Flood | 1210 | ft^3/s | 452 | 2620 | 56.2 | 56.2 | 4.5 |
| 50 Year Peak Flood | 1480 | ft^3/s | 531 | 3300 | 59.1 | 59.1 | 5.1 |

| Statistic | Value | Unit | PIl | PIu | SE | SEp | Equiv. Yrs. |
|---|---|---|---|---|---|---|---|
| 100 Year Peak Flood | 1780 | ft^3/s | 610 | 4070 | 62.3 | 62.3 | 5.7 |
| 500 Year Peak Flood | 2620 | ft^3/s | 789 | 6410 | 70.9 | 70.9 | 6.5 |

*Peak-Flow Statistics Citations*

**Lorenz, D.L., Sanocki, C.A., and Kocian, M.J.,2009, Techniques for Estimating the Magnitude and Frequency of Peak Flows on Small Streams in Minnesota Based on Data through Water Year 2005: U.S. Geological Survey Scientific Investigations Report 2009-5250, 54 p. (http://pubs.usgs.gov/sir/2009/5250/pdf/sir2009-5250.pdf)**

Flow-Duration Statistics Parameters[Flow duration Region BC 2015 5170]

| Parameter Code | Parameter Name | Value | Units | Min Limit | Max Limit |
|---|---|---|---|---|---|
| DRNAREA | Drainage Area | 29.98 | square miles | 2.98 | 2960 |
| STORNWI | Percentage of Storage from NWI | 34.16 | percent | 2.44 | 48 |
| SSURGOC | SSURGO Percent Hydrologic Soil Type C | 38.63 | percent | 2.61 | 100 |

Flow-Duration Statistics Flow Report[Flow duration Region BC 2015 5170]

| Statistic | Value | Unit |
|---|---|---|
| 0.01 Percent Duration | 674 | ft^3/s |
| 0.1 Percent Duration | 430 | ft^3/s |
| 2 Percent Duration | 159 | ft^3/s |
| 5 Percent Duration | 98.4 | ft^3/s |
| 10 Percent Duration | 50.8 | ft^3/s |
| 25 Percent Duration | 23.5 | ft^3/s |
| 50 Percent Duration | 8.17 | ft^3/s |
| 75 Percent Duration | 3.88 | ft^3/s |

| Statistic | Value | Unit |
|---|---|---|
| 90 Percent Duration | 2.05 | ft^3/s |
| 95 Percent Duration | 1.23 | ft^3/s |
| 99 Percent Duration | 0.564 | ft^3/s |
| 99.9 Percent Duration | 0.19 | ft^3/s |
| 99.99 Percent Duration | 0.148 | ft^3/s |

*Flow-Duration Statistics Citations*

**Ziegeweid, J.R., Lorenz, D.L., Sanocki, C.A., and Czuba, C.R.,2015, Methods for estimating flow-duration curve and low-flow frequency statistics for ungaged locations on small streams in Minnesota: U.S. Geological Survey Scientific Investigations Report 2015–5170, 23 p. (http://dx.doi.org/10.3133/sir20155170)**

Low-Flow Statistics Parameters[Low flow Region BC 2015 5170]

| Parameter Code | Parameter Name | Value | Units | Min Limit | Max Limit |
|---|---|---|---|---|---|
| DRNAREA | Drainage Area | 29.98 | square miles | 2.98 | 2960 |
| STORNWI | Percentage of Storage from NWI | 34.16 | percent | 2.44 | 48 |
| SSURGOC | SSURGO Percent Hydrologic Soil Type C | 38.63 | percent | 2.61 | 100 |

Low-Flow Statistics Flow Report[Low flow Region BC 2015 5170]

| Statistic | Value | Unit |
|---|---|---|
| 7 Day 10 Year Low Flow | 0.646 | ft^3/s |

*Low-Flow Statistics Citations*

**Ziegeweid, J.R., Lorenz, D.L., Sanocki, C.A., and Czuba, C.R.,2015, Methods for estimating flow-duration curve and low-flow frequency statistics for ungaged locations on small streams in Minnesota: U.S. Geological Survey Scientific Investigations Report 2015–5170, 23 p. (http://dx.doi.org/10.3133/sir20155170)**

Seasonal Flow Statistics Parameters[Low flow Region BC 2015 5170]

| Parameter Code | Parameter Name | Value | Units | Min Limit | Max Limit |
|---|---|---|---|---|---|
| DRNAREA | Drainage Area | 29.98 | square miles | 2.98 | 2960 |
| STORNWI | Percentage of Storage from NWI | 34.16 | percent | 2.44 | 48 |
| SSURGOC | SSURGO Percent Hydrologic Soil Type C | 38.63 | percent | 2.61 | 100 |

Seasonal Flow Statistics Flow Report[Low flow Region BC 2015 5170]

| Statistic | Value | Unit |
|---|---|---|
| Oct to Nov 7 Day 10 Year Low Flow | 1.63 | ft^3/s |
| 30_Day_10_Year_Low_Flow_Oct_to_Nov | 2.47 | ft^3/s |
| 7_Day_10_Year_lowflow_Dec_to_Mar | 0.916 | ft^3/s |
| 30_Day_10_Year_Low_Flow_Dec_to_Mar | 1.13 | ft^3/s |
| Apr to May 7 Day 10 Year Low Flow | 3.66 | ft^3/s |
| Apr to May 30 Day 10 Year Low Flow | 13.7 | ft^3/s |
| 7_Day_10_Year_lowflow_Jun_to_Sep | 0.897 | ft^3/s |
| 30_Day_10_Year_Low_Flow_Jun_to_Sep | 1.24 | ft^3/s |
| 122_Day_10_Year_Low_Flow_Jun_to_Sep | 8.23 | ft^3/s |

*Seasonal Flow Statistics Citations*

**Ziegeweid, J.R., Lorenz, D.L., Sanocki, C.A., and Czuba, C.R.,2015, Methods for estimating flow-duration curve and low-flow frequency statistics for ungaged locations on small streams in Minnesota: U.S. Geological Survey Scientific Investigations Report 2015–5170, 23 p. (http://dx.doi.org/10.3133/sir20155170)**

NATIONAL WEATHER SERVICE
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# Normal Depth Calculator

Weather.gov > Alaska-Pacific RFC > Normal Depth Calculator

**Alaska-Pacific RFC**
River Forecast Center

River Observations and Forecasts | Weather Observations and Forecasts | Water Supply | Climate and History | Seasonal Interest | Additional Info

## Normal Depth Demonstration Tool

One the most commonly used equations governing Open Channel Flow is known as the Mannings's Equation. It was introduced by the Irish Engineer Robert Manning in 1889 as an alternative to the Chezy Equation. The Mannings equation is an empirical equation that applies to uniform flow in open channels and is a function of the channel velocity, flow area and channel slope.

$$Q = VA = \left(\frac{1.49}{n}\right) AR^{\frac{2}{3}}\sqrt{S} \quad [U.S.]$$

$$Q = VA = \left(\frac{1.00}{n}\right) AR^{\frac{2}{3}}\sqrt{S} \quad [SI]$$

Where:
Q = Flow Rate, ($ft^3/s$)
v = Velocity, (ft/s)
A = Flow Area, ($ft^2$)
n = Manning's Roughness Coefficient
R = Hydraulic Radius, (ft)
S = Channel Slope, (ft/ft)

Under the assumption of uniform flow conditions the bottom slope is the same as the slope of the energy grade line and the water surface slope. The Manning's n is a coefficient which represents the roughness or friction applied to the flow by the channel. Manning's n-values are often selected from tables, but can be back calculated from field measurements. In many flow conditions the selection of a Manning's roughness coefficient can greatly affect computational results.

**Instructions:** Select variable to solve, adjust slider bars, click on graph to modify the cross section. CSV cross section data can be loaded in the input box below. This online calculator is for demonstration and educational purposes only.

Solve For: Water Surface (normal depth)

Slope: 0.005 (ft/ft)

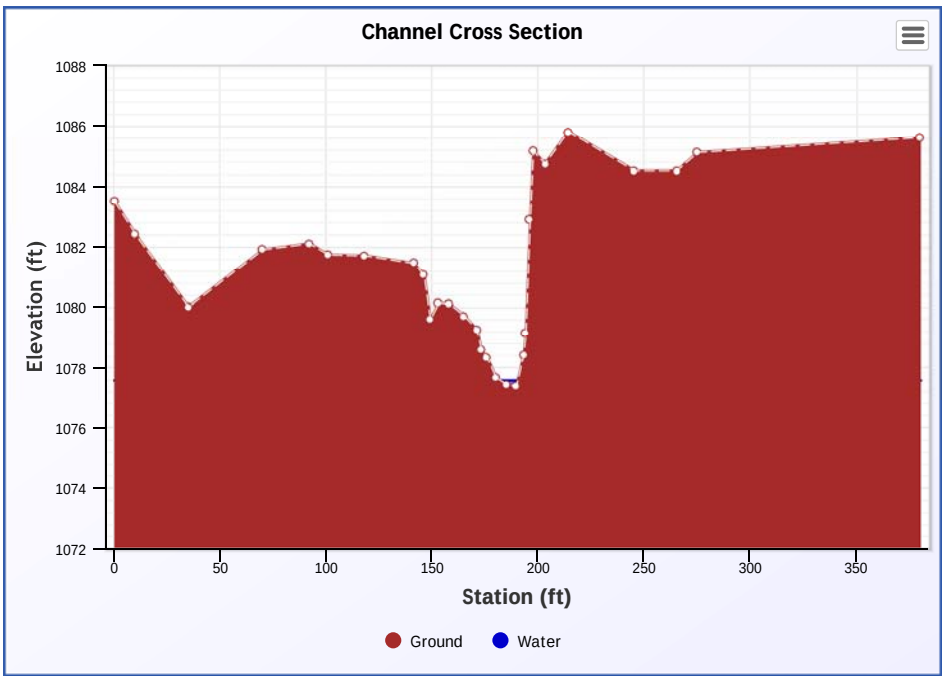
WSE: 1077.56 (ft)

Channel Manning n: 0.028

Flow: 1 ($ft^3/s$)

100 40000

Reset Cross Section




| | |
|---|---|
| Flow Area: | 1.0 ($ft^2$) |
| Wetted Perimeter: | 8.0 (ft) |
| Max Depth: | 0.18 (ft) |
| Average Velocity: | 0.89 (ft/s) |
| Top Width: | 8 (ft) |
| Iterations: | 5001 |
| Froude Number: | 0.44 |

Select HECRAS Geometry: Browse... Load HEC-RAS Data

Load CSV XS Data Below
(station,elevation)

Update Plot

```
0.00,1083.50
10.00,1082.40
35.00,1080.00
70.00,1081.90
92.00,1082.10
101.00,1081.73
118.00,1081.70
141.00,1081.45
146.00,1081.05
149.00,1079.58
153.00,1080.14
158.00,1080.10
165.00,1079.71
171.00,1079.24
173.00,1078.57
175.50,1078.33
180.00,1077.66
185.00,1077.42
189.50,1077.38
193.00,1078.40
194.00,1079.14
196.00,1082.87
197.50,1085.14
203.00,1084.73
214.00,1085.80
245.00,1084.50
265.00,1084.50
275.00,1085.10
380.00,1085.60
```

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# Normal Depth Calculator

Weather.gov > Alaska-Pacific RFC > Normal Depth Calculator

**Alaska-Pacific RFC**
River Forecast Center

River Observations and Forecasts | Weather Observations and Forecasts | Water Supply | Climate and History | Seasonal Interest | Additional Info

## Normal Depth Demonstration Tool

One the most commonly used equations governing Open Channel Flow is known as the Mannings's Equation. It was introduced by the Irish Engineer Robert Manning in 1889 as an alternative to the Chezy Equation. The Mannings equation is an empirical equation that applies to uniform flow in open channels and is a function of the channel velocity, flow area and channel slope.

$$Q = VA = \left(\frac{1.49}{n}\right) AR^{\frac{2}{3}}\sqrt{S} \quad [U.S.]$$

$$Q = VA = \left(\frac{1.00}{n}\right) AR^{\frac{2}{3}}\sqrt{S} \quad [SI]$$

Where:
Q = Flow Rate, ($ft^3/s$)
v = Velocity, (ft/s)
A = Flow Area, ($ft^2$)
n = Manning's Roughness Coefficient
R = Hydraulic Radius, (ft)
S = Channel Slope, (ft/ft)

Under the assumption of uniform flow conditions the bottom slope is the same as the slope of the energy grade line and the water surface slope. The Manning's n is a coefficient which represents the roughness or friction applied to the flow by the channel. Manning's n-values are often selected from tables, but can be back calculated from field measurements. In many flow conditions the selection of a Manning's roughness coefficient can greatly affect computational results.

**Instructions:** Select variable to solve, adjust slider bars, click on graph to modify the cross section. CSV cross section data can be loaded in the input box below. This online calculator is for demonstration and educational purposes only.

Solve For: Water Surface (normal depth)

Slope: 0.005 (ft/ft)

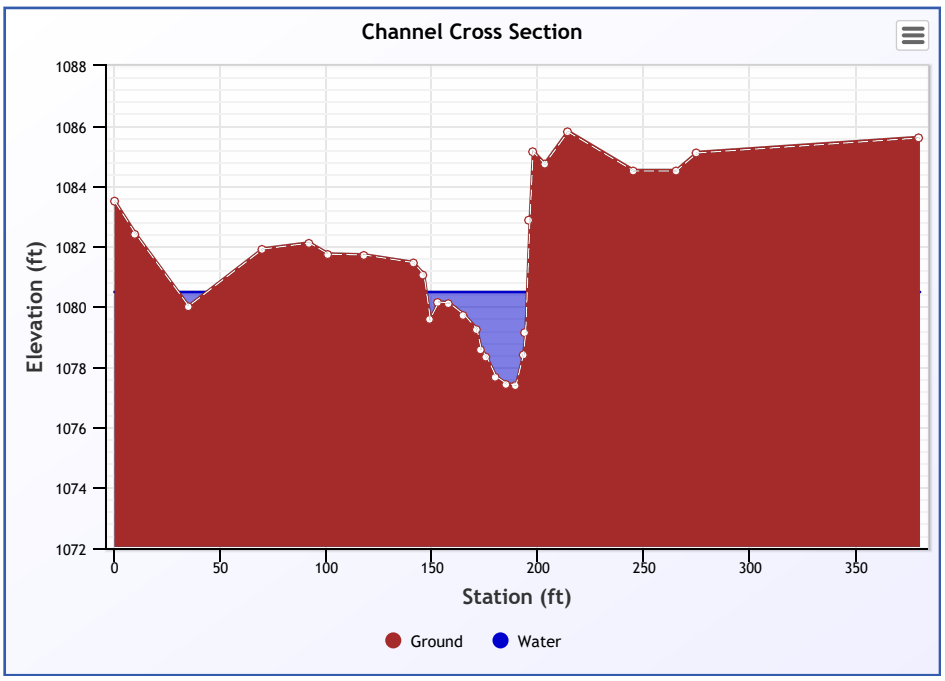
WSE: 1080.49 (ft)

Channel Manning n: 0.028

Flow: 341 ($ft^3/s$)

100 40000

Reset Cross Section




| | |
|---|---|
| Flow Area: | 78.5 ($ft^2$) |
| Wetted Perimeter: | 63.5 (ft) |
| Max Depth: | 3.11 (ft) |
| Average Velocity: | 4.34 (ft/s) |
| Top Width: | 62 (ft) |
| Iterations: | 30 |
| Froude Number: | 0.68 |

Select HECRAS Geometry: Browse... Load HEC-RAS Data

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# Normal Depth Calculator

Weather.gov > Alaska-Pacific RFC > Normal Depth Calculator

**Alaska-Pacific RFC**
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River Observations and Forecasts | Weather Observations and Forecasts | Water Supply | Climate and History | Seasonal Interest | Additional Info

## Normal Depth Demonstration Tool

One the most commonly used equations governing Open Channel Flow is known as the Mannings's Equation. It was introduced by the Irish Engineer Robert Manning in 1889 as an alternative to the Chezy Equation. The Mannings equation is an empirical equation that applies to uniform flow in open channels and is a function of the channel velocity, flow area and channel slope.

$$Q = VA = \left(\frac{1.49}{n}\right) AR^{\frac{2}{3}}\sqrt{S} \quad [U.S.]$$

$$Q = VA = \left(\frac{1.00}{n}\right) AR^{\frac{2}{3}}\sqrt{S} \quad [SI]$$

Where:
Q = Flow Rate, ($ft^3/s$)
v = Velocity, (ft/s)
A = Flow Area, ($ft^2$)
n = Manning's Roughness Coefficient
R = Hydraulic Radius, (ft)
S = Channel Slope, (ft/ft)

Under the assumption of uniform flow conditions the bottom slope is the same as the slope of the energy grade line and the water surface slope. The Manning's n is a coefficient which represents the roughness or friction applied to the flow by the channel. Manning's n-values are often selected from tables, but can be back calculated from field measurements. In many flow conditions the selection of a Manning's roughness coefficient can greatly affect computational results.

**Instructions:** Select variable to solve, adjust slider bars, click on graph to modify the cross section. CSV cross section data can be loaded in the input box below. This online calculator is for demonstration and educational purposes only.

Solve For: Water Surface (normal depth)

Slope: 0.005 (ft/ft)

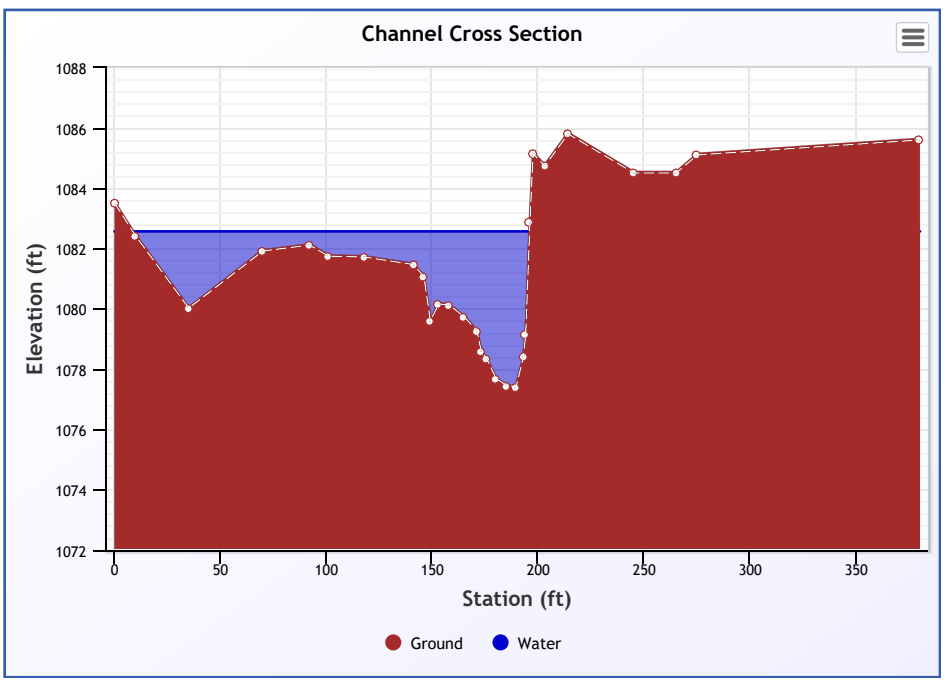
WSE: 1082.56 (ft)

Channel Manning n: 0.028

Flow: 1780 ($ft^3/s$)

100 40000

Reset Cross Section

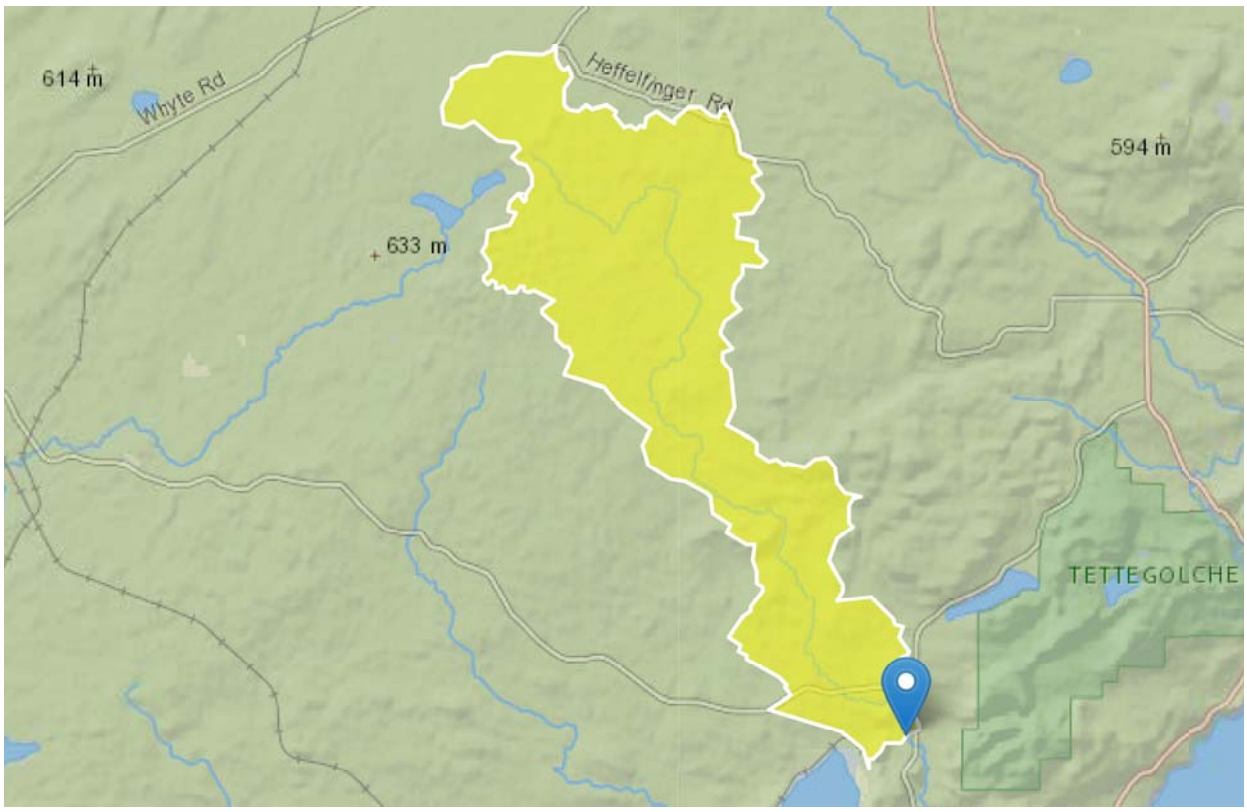



| | |
|---|---|
| Flow Area: | 329.0 ($ft^2$) |
| Wetted Perimeter: | 190.1 (ft) |
| Max Depth: | 5.18 (ft) |
| Average Velocity: | 5.41 (ft/s) |
| Top Width: | 187 (ft) |
| Iterations: | 29 |
| Froude Number: | 0.72 |

Select HECRAS Geometry: Browse... Load HEC-RAS Data

# East Branch Beaver River Downstream of West Unnamed Creek - Future

**Region ID:** MN
**Workspace ID:** MN20200326165942158000
**Clicked Point (Latitude, Longitude):** 47.31248, -91.32839
**Time:** 2020-03-26 11:59:56 -0500




Basin Characteristics

| Parameter Code | Parameter Description | Value | Unit |
|---|---|---|---|
| DRNAREA | Area that drains to a point on a stream | 27.91 | square miles |
| LAKEAREA | Percentage of Lakes and Ponds | 3.53 | percent |

| Parameter Code | Parameter Description | Value | Unit |
|---|---|---|---|
| STORNWI | Percentage of storage (combined water bodies and wetlands) from the National Wetlands Inventory | 35.12 | percent |
| SSURGOC | Percentage of area of Hydrologic Soil Type C from SSURGO | 40.4 | percent |

General Disclaimers

Parameter values have been edited, computed flows may not apply.

This watershed has been edited, computed flows may not apply.

Peak-Flow Statistics Parameters[100 Percent (28.1 square miles) Region C]

| Parameter Code | Parameter Name | Value | Units | Min Limit | Max Limit |
|---|---|---|---|---|---|
| DRNAREA | Drainage Area | 27.91 | square miles | 0.21 | 607 |
| LAKEAREA | Percent Lakes and Ponds | 3.53 | percent | 0 | 11.8 |

Peak-Flow Statistics Flow Report[100 Percent (28.1 square miles) Region C]

PIl: Prediction Interval-Lower, Plu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

| Statistic | Value | Unit | PIl | Plu | SE | SEp | Equiv. Yrs. |
|---|---|---|---|---|---|---|---|
| 1.5 Year Peak Flood | 330 | ft^3/s | 149 | 631 | 45.2 | 45.2 | 2.8 |
| 2 Year Peak Flood | 415 | ft^3/s | 180 | 815 | 46.8 | 46.8 | 2.4 |
| 5 Year Peak Flood | 673 | ft^3/s | 273 | 1380 | 50.4 | 50.4 | 2.8 |
| 10 Year Peak Flood | 883 | ft^3/s | 346 | 1850 | 52.9 | 52.9 | 3.5 |
| 25 Year Peak Flood | 1190 | ft^3/s | 445 | 2560 | 56.2 | 56.2 | 4.5 |

| Statistic | Value | Unit | PIl | PIu | SE | SEp | Equiv. Yrs. |
|---|---|---|---|---|---|---|---|
| 50 Year Peak Flood | 1460 | ft^3/s | 524 | 3230 | 59.1 | 59.1 | 5.1 |
| 100 Year Peak Flood | 1760 | ft^3/s | 604 | 3990 | 62.3 | 62.3 | 5.7 |
| 500 Year Peak Flood | 2590 | ft^3/s | 785 | 6320 | 70.9 | 70.9 | 6.5 |

*Peak-Flow Statistics Citations*

**Lorenz, D.L., Sanocki, C.A., and Kocian, M.J.,2009, Techniques for Estimating the Magnitude and Frequency of Peak Flows on Small Streams in Minnesota Based on Data through Water Year 2005: U.S. Geological Survey Scientific Investigations Report 2009-5250, 54 p. (http://pubs.usgs.gov/sir/2009/5250/pdf/sir2009-5250.pdf)**

Flow-Duration Statistics Parameters[Flow duration Region BC 2015 5170]

| Parameter Code | Parameter Name | Value | Units | Min Limit | Max Limit |
|---|---|---|---|---|---|
| DRNAREA | Drainage Area | 27.91 | square miles | 2.98 | 2960 |
| STORNWI | Percentage of Storage from NWI | 35.12 | percent | 2.44 | 48 |
| SSURGOC | SSURGO Percent Hydrologic Soil Type C | 40.4 | percent | 2.61 | 100 |

Flow-Duration Statistics Flow Report[Flow duration Region BC 2015 5170]

| Statistic | Value | Unit |
|---|---|---|
| 0.01 Percent Duration | 641 | ft^3/s |
| 0.1 Percent Duration | 409 | ft^3/s |
| 2 Percent Duration | 151 | ft^3/s |
| 5 Percent Duration | 93.1 | ft^3/s |
| 10 Percent Duration | 47.8 | ft^3/s |
| 25 Percent Duration | 21.9 | ft^3/s |
| 50 Percent Duration | 7.46 | ft^3/s |

| Statistic | Value | Unit |
|---|---|---|
| 75 Percent Duration | 3.5 | ft^3/s |
| 90 Percent Duration | 1.83 | ft^3/s |
| 95 Percent Duration | 1.08 | ft^3/s |
| 99 Percent Duration | 0.489 | ft^3/s |
| 99.9 Percent Duration | 0.161 | ft^3/s |
| 99.99 Percent Duration | 0.125 | ft^3/s |

*Flow-Duration Statistics Citations*

**Ziegeweid, J.R., Lorenz, D.L., Sanocki, C.A., and Czuba, C.R.,2015, Methods for estimating flow-duration curve and low-flow frequency statistics for ungaged locations on small streams in Minnesota: U.S. Geological Survey Scientific Investigations Report 2015–5170, 23 p. (http://dx.doi.org/10.3133/sir20155170)**

Low-Flow Statistics Parameters[Low flow Region BC 2015 5170]

| Parameter Code | Parameter Name | Value | Units | Min Limit | Max Limit |
|---|---|---|---|---|---|
| DRNAREA | Drainage Area | 27.91 | square miles | 2.98 | 2960 |
| STORNWI | Percentage of Storage from NWI | 35.12 | percent | 2.44 | 48 |
| SSURGOC | SSURGO Percent Hydrologic Soil Type C | 40.4 | percent | 2.61 | 100 |

Low-Flow Statistics Flow Report[Low flow Region BC 2015 5170]

| Statistic | Value | Unit |
|---|---|---|
| 7 Day 10 Year Low Flow | 0.563 | ft^3/s |

*Low-Flow Statistics Citations*

**Ziegeweid, J.R., Lorenz, D.L., Sanocki, C.A., and Czuba, C.R.,2015, Methods for estimating flow-duration curve and low-flow frequency statistics for ungaged**

**locations on small streams in Minnesota: U.S. Geological Survey Scientific Investigations Report 2015–5170, 23 p. (http://dx.doi.org/10.3133/sir20155170)**

Seasonal Flow Statistics Parameters[Low flow Region BC 2015 5170]

| Parameter Code | Parameter Name | Value | Units | Min Limit | Max Limit |
|---|---|---|---|---|---|
| DRNAREA | Drainage Area | 27.91 | square miles | 2.98 | 2960 |
| STORNWI | Percentage of Storage from NWI | 35.12 | percent | 2.44 | 48 |
| SSURGOC | SSURGO Percent Hydrologic Soil Type C | 40.4 | percent | 2.61 | 100 |

Seasonal Flow Statistics Flow Report[Low flow Region BC 2015 5170]

| Statistic | Value | Unit |
|---|---|---|
| Oct to Nov 7 Day 10 Year Low Flow | 1.44 | ft^3/s |
| 30_Day_10_Year_Low_Flow_Oct_to_Nov | 2.21 | ft^3/s |
| 7_Day_10_Year_lowflow_Dec_to_Mar | 0.803 | ft^3/s |
| 30_Day_10_Year_Low_Flow_Dec_to_Mar | 0.991 | ft^3/s |
| Apr to May 7 Day 10 Year Low Flow | 3.3 | ft^3/s |
| Apr to May 30 Day 10 Year Low Flow | 12.7 | ft^3/s |
| 7_Day_10_Year_lowflow_Jun_to_Sep | 0.789 | ft^3/s |
| 30_Day_10_Year_Low_Flow_Jun_to_Sep | 1.09 | ft^3/s |
| 122_Day_10_Year_Low_Flow_Jun_to_Sep | 7.6 | ft^3/s |

*Seasonal Flow Statistics Citations*

**Ziegeweid, J.R., Lorenz, D.L., Sanocki, C.A., and Czuba, C.R.,2015, Methods for estimating flow-duration curve and low-flow frequency statistics for ungaged locations on small streams in Minnesota: U.S. Geological Survey Scientific Investigations Report 2015–5170, 23 p. (http://dx.doi.org/10.3133/sir20155170)**

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# Normal Depth Calculator

Weather.gov > Alaska-Pacific RFC > Normal Depth Calculator

**Alaska-Pacific RFC**
River Forecast Center

River Observations and Forecasts | Weather Observations and Forecasts | Water Supply | Climate and History | Seasonal Interest | Additional Info

## Normal Depth Demonstration Tool

One the most commonly used equations governing Open Channel Flow is known as the Mannings's Equation. It was introduced by the Irish Engineer Robert Manning in 1889 as an alternative to the Chezy Equation. The Mannings equation is an empirical equation that applies to uniform flow in open channels and is a function of the channel velocity, flow area and channel slope.

$$Q = VA = \left(\frac{1.49}{n}\right) AR^{\frac{2}{3}}\sqrt{S} \quad [U.S.]$$

$$Q = VA = \left(\frac{1.00}{n}\right) AR^{\frac{2}{3}}\sqrt{S} \quad [SI]$$

Where:
Q = Flow Rate, ($ft^3/s$)
v = Velocity, (ft/s)
A = Flow Area, ($ft^2$)
n = Manning's Roughness Coefficient
R = Hydraulic Radius, (ft)
S = Channel Slope, (ft/ft)

Under the assumption of uniform flow conditions the bottom slope is the same as the slope of the energy grade line and the water surface slope. The Manning's n is a coefficient which represents the roughness or friction applied to the flow by the channel. Manning's n-values are often selected from tables, but can be back calculated from field measurements. In many flow conditions the selection of a Manning's roughness coefficient can greatly affect computational results.

**Instructions:** Select variable to solve, adjust slider bars, click on graph to modify the cross section. CSV cross section data can be loaded in the input box below. This online calculator is for demonstration and educational purposes only.

Solve For: Water Surface (normal depth)

Slope: 0.005 (ft/ft)

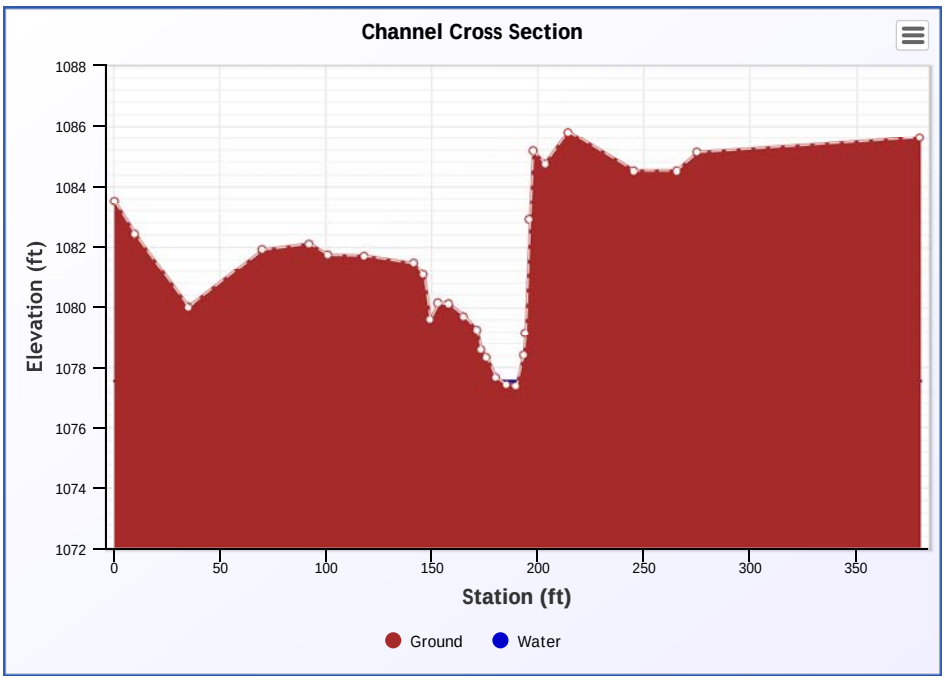
WSE: 1077.54 (ft)

Channel Manning n: 0.028

Flow: 1 ($ft^3/s$)

100 40000

Reset Cross Section




| | |
|---|---|
| Flow Area: | 0.9 ($ft^2$) |
| Wetted Perimeter: | 8.0 (ft) |
| Max Depth: | 0.16 (ft) |
| Average Velocity: | 0.90 (ft/s) |
| Top Width: | 8 (ft) |
| Iterations: | 5001 |
| Froude Number: | 0.48 |

Select HECRAS Geometry: Browse... Load HEC-RAS Data

Load CSV XS Data Below
(station,elevation)

Update Plot

```
0.00,1083.50
10.00,1082.40
35.00,1080.00
70.00,1081.90
92.00,1082.10
101.00,1081.73
118.00,1081.70
141.00,1081.45
146.00,1081.05
149.00,1079.58
153.00,1080.14
158.00,1080.10
165.00,1079.71
171.00,1079.24
173.00,1078.57
175.50,1078.33
180.00,1077.66
185.00,1077.42
189.50,1077.38
193.00,1078.40
194.00,1079.14
196.00,1082.87
197.50,1085.14
203.00,1084.73
214.00,1085.80
245.00,1084.50
265.00,1084.50
275.00,1085.10
380.00,1085.60
```

NATIONAL WEATHER SERVICE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

# Normal Depth Calculator

Weather.gov > Alaska-Pacific RFC > Normal Depth Calculator

**Alaska-Pacific RFC**
River Forecast Center

River Observations and Forecasts | Weather Observations and Forecasts | Water Supply | Climate and History | Seasonal Interest | Additional Info

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$$Q = VA = \left(\frac{1.00}{n}\right) AR^{\frac{2}{3}}\sqrt{S} \quad [SI]$$

Where:
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Solve For: Water Surface (normal depth)

Slope: 0.005 (ft/ft)

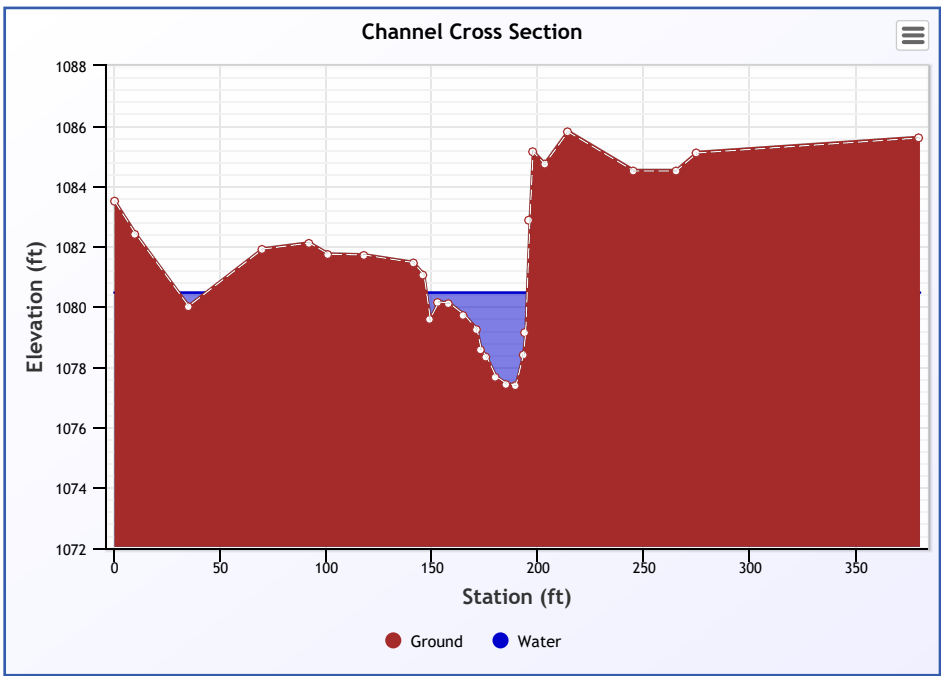
WSE: 1080.47 (ft)

Channel Manning n: 0.028

Flow: 330 ($ft^3/s$)

100 40000

Reset Cross Section




| | |
|---|---|
| Flow Area: | 77.5 ($ft^2$) |
| Wetted Perimeter: | 63.5 (ft) |
| Max Depth: | 3.09 (ft) |
| Average Velocity: | 4.26 (ft/s) |
| Top Width: | 62 (ft) |
| Iterations: | 30 |
| Froude Number: | 0.67 |

Select HECRAS Geometry: Browse... Load HEC-RAS Data

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# Normal Depth Calculator

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**Alaska-Pacific RFC**
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$$Q = VA = \left(\frac{1.00}{n}\right) AR^{\frac{2}{3}}\sqrt{S} \quad [SI]$$

Where:
Q = Flow Rate, ($ft^3/s$)
v = Velocity, (ft/s)
A = Flow Area, ($ft^2$)
n = Manning's Roughness Coefficient
R = Hydraulic Radius, (ft)
S = Channel Slope, (ft/ft)

Under the assumption of uniform flow conditions the bottom slope is the same as the slope of the energy grade line and the water surface slope. The Manning's n is a coefficient which represents the roughness or friction applied to the flow by the channel. Manning's n-values are often selected from tables, but can be back calculated from field measurements. In many flow conditions the selection of a Manning's roughness coefficient can greatly affect computational results.

**Instructions:** Select variable to solve, adjust slider bars, click on graph to modify the cross section. CSV cross section data can be loaded in the input box below. This online calculator is for demonstration and educational purposes only.

Solve For: Water Surface (normal depth)

Slope: 0.005 (ft/ft)

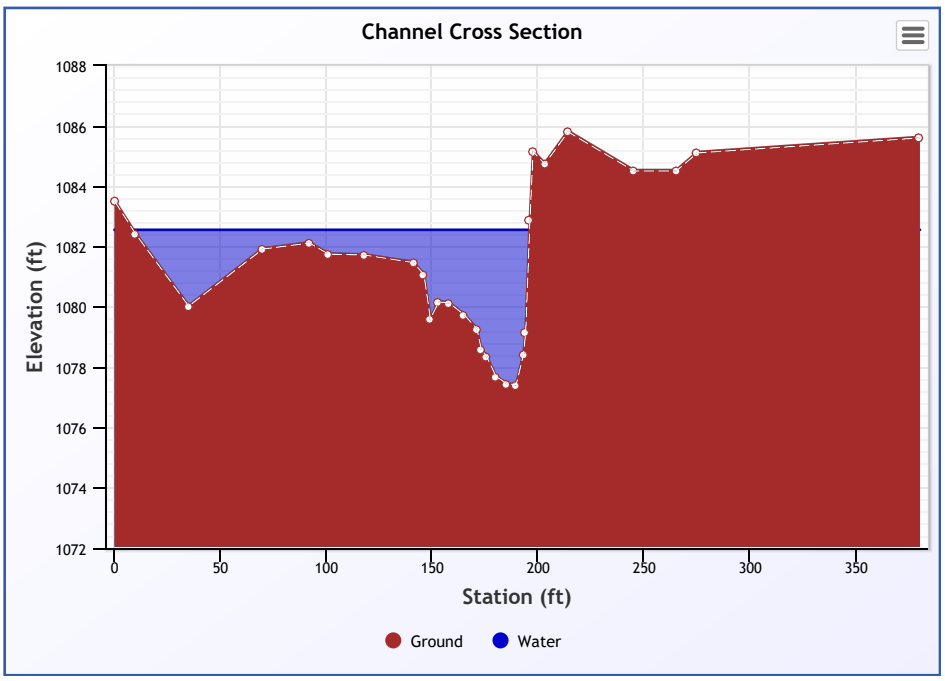
WSE: 1082.55 (ft)

Channel Manning n: 0.028

Flow: 1760 ($ft^3/s$)

100 40000

Reset Cross Section

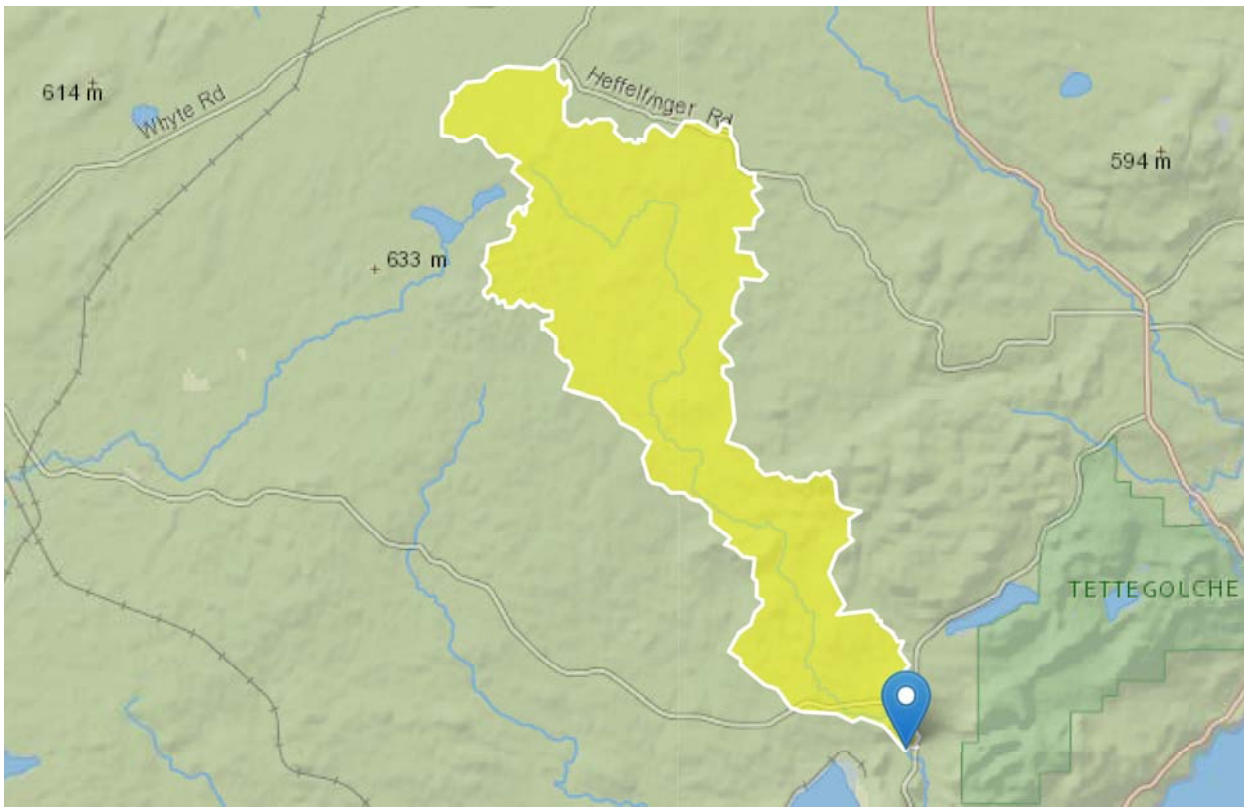



| | |
|---|---|
| Flow Area: | 326.2 ($ft^2$) |
| Wetted Perimeter: | 190.1 (ft) |
| Max Depth: | 5.17 (ft) |
| Average Velocity: | 5.40 (ft/s) |
| Top Width: | 187 (ft) |
| Iterations: | 30 |
| Froude Number: | 0.72 |

Select HECRAS Geometry: Browse... Load HEC-RAS Data

# East Branch Beaver River Headwaters Subwatershed #1 - Pre-Settlement

**Region ID:** MN
**Workspace ID:** MN20200326172704646000
**Clicked Point (Latitude, Longitude):** 47.31272, -91.32867
**Time:** 2020-03-26 12:27:24 -0500




Basin Characteristics

| Parameter Code | Parameter Description | Value | Unit |
|---|---|---|---|
| DRNAREA | Area that drains to a point on a stream | 26.96 | square miles |
| LAKEAREA | Percentage of Lakes and Ponds | 0.75 | percent |

| Parameter Code | Parameter Description | Value | Unit |
|---|---|---|---|
| STORNWI | Percentage of storage (combined water bodies and wetlands) from the National Wetlands Inventory | 36.05 | percent |
| SSURGOC | Percentage of area of Hydrologic Soil Type C from SSURGO | 42.1 | percent |

General Disclaimers

Parameter values have been edited, computed flows may not apply.

Peak-Flow Statistics Parameters[100 Percent (27.1 square miles) Region C]

| Parameter Code | Parameter Name | Value | Units | Min Limit | Max Limit |
|---|---|---|---|---|---|
| DRNAREA | Drainage Area | 26.96 | square miles | 0.21 | 607 |
| LAKEAREA | Percent Lakes and Ponds | 0.75 | percent | 0 | 11.8 |

Peak-Flow Statistics Flow Report[100 Percent (27.1 square miles) Region C]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

| Statistic | Value | Unit | PIl | PIu | SE | SEp | Equiv. Yrs. |
|---|---|---|---|---|---|---|---|
| 1.5 Year Peak Flood | 536 | ft^3/s | 248 | 998 | 45.2 | 45.2 | 2.8 |
| 2 Year Peak Flood | 684 | ft^3/s | 305 | 1310 | 46.8 | 46.8 | 2.4 |
| 5 Year Peak Flood | 1150 | ft^3/s | 479 | 2280 | 50.4 | 50.4 | 2.8 |
| 10 Year Peak Flood | 1540 | ft^3/s | 621 | 3120 | 52.9 | 52.9 | 3.5 |
| 25 Year Peak Flood | 2130 | ft^3/s | 821 | 4440 | 56.2 | 56.2 | 4.5 |
| 50 Year Peak Flood | 2660 | ft^3/s | 989 | 5690 | 59.1 | 59.1 | 5.1 |

| Statistic | Value | Unit | PIl | PIu | SE | SEp | Equiv. Yrs. |
|---|---|---|---|---|---|---|---|
| 100 Year Peak Flood | 3270 | ft^3/s | 1160 | 7170 | 62.3 | 62.3 | 5.7 |
| 500 Year Peak Flood | 5030 | ft^3/s | 1590 | 11800 | 70.9 | 70.9 | 6.5 |

*Peak-Flow Statistics Citations*

**Lorenz, D.L., Sanocki, C.A., and Kocian, M.J.,2009, Techniques for Estimating the Magnitude and Frequency of Peak Flows on Small Streams in Minnesota Based on Data through Water Year 2005: U.S. Geological Survey Scientific Investigations Report 2009-5250, 54 p. (http://pubs.usgs.gov/sir/2009/5250/pdf/sir2009-5250.pdf)**

Flow-Duration Statistics Parameters[Flow duration Region BC 2015 5170]

| Parameter Code | Parameter Name | Value | Units | Min Limit | Max Limit |
|---|---|---|---|---|---|
| DRNAREA | Drainage Area | 26.96 | square miles | 2.98 | 2960 |
| STORNWI | Percentage of Storage from NWI | 36.05 | percent | 2.44 | 48 |
| SSURGOC | SSURGO Percent Hydrologic Soil Type C | 42.1 | percent | 2.61 | 100 |

Flow-Duration Statistics Flow Report[Flow duration Region BC 2015 5170]

| Statistic | Value | Unit |
|---|---|---|
| 0.01 Percent Duration | 628 | ft^3/s |
| 0.1 Percent Duration | 401 | ft^3/s |
| 2 Percent Duration | 147 | ft^3/s |
| 5 Percent Duration | 91 | ft^3/s |
| 10 Percent Duration | 46.5 | ft^3/s |
| 25 Percent Duration | 21.1 | ft^3/s |
| 50 Percent Duration | 7.08 | ft^3/s |
| 75 Percent Duration | 3.28 | ft^3/s |

| Statistic | Value | Unit |
|---|---|---|
| 90 Percent Duration | 1.7 | ft^3/s |
| 95 Percent Duration | 0.996 | ft^3/s |
| 99 Percent Duration | 0.445 | ft^3/s |
| 99.9 Percent Duration | 0.144 | ft^3/s |
| 99.99 Percent Duration | 0.112 | ft^3/s |

*Flow-Duration Statistics Citations*

**Ziegeweid, J.R., Lorenz, D.L., Sanocki, C.A., and Czuba, C.R.,2015, Methods for estimating flow-duration curve and low-flow frequency statistics for ungaged locations on small streams in Minnesota: U.S. Geological Survey Scientific Investigations Report 2015–5170, 23 p. (http://dx.doi.org/10.3133/sir20155170)**

Low-Flow Statistics Parameters[Low flow Region BC 2015 5170]

| Parameter Code | Parameter Name | Value | Units | Min Limit | Max Limit |
|---|---|---|---|---|---|
| DRNAREA | Drainage Area | 26.96 | square miles | 2.98 | 2960 |
| STORNWI | Percentage of Storage from NWI | 36.05 | percent | 2.44 | 48 |
| SSURGOC | SSURGO Percent Hydrologic Soil Type C | 42.1 | percent | 2.61 | 100 |

Low-Flow Statistics Flow Report[Low flow Region BC 2015 5170]

| Statistic | Value | Unit |
|---|---|---|
| 7 Day 10 Year Low Flow | 0.514 | ft^3/s |

*Low-Flow Statistics Citations*

**Ziegeweid, J.R., Lorenz, D.L., Sanocki, C.A., and Czuba, C.R.,2015, Methods for estimating flow-duration curve and low-flow frequency statistics for ungaged locations on small streams in Minnesota: U.S. Geological Survey Scientific Investigations Report 2015–5170, 23 p. (http://dx.doi.org/10.3133/sir20155170)**

Seasonal Flow Statistics Parameters[Low flow Region BC 2015 5170]

| Parameter Code | Parameter Name | Value | Units | Min Limit | Max Limit |
|---|---|---|---|---|---|
| DRNAREA | Drainage Area | 26.96 | square miles | 2.98 | 2960 |
| STORNWI | Percentage of Storage from NWI | 36.05 | percent | 2.44 | 48 |
| SSURGOC | SSURGO Percent Hydrologic Soil Type C | 42.1 | percent | 2.61 | 100 |

Seasonal Flow Statistics Flow Report[Low flow Region BC 2015 5170]

| Statistic | Value | Unit |
|---|---|---|
| Oct to Nov 7 Day 10 Year Low Flow | 1.34 | ft^3/s |
| 30_Day_10_Year_Low_Flow_Oct_to_Nov | 2.05 | ft^3/s |
| 7_Day_10_Year_lowflow_Dec_to_Mar | 0.736 | ft^3/s |
| 30_Day_10_Year_Low_Flow_Dec_to_Mar | 0.911 | ft^3/s |
| Apr to May 7 Day 10 Year Low Flow | 3.09 | ft^3/s |
| Apr to May 30 Day 10 Year Low Flow | 12.2 | ft^3/s |
| 7_Day_10_Year_lowflow_Jun_to_Sep | 0.725 | ft^3/s |
| 30_Day_10_Year_Low_Flow_Jun_to_Sep | 1.01 | ft^3/s |
| 122_Day_10_Year_Low_Flow_Jun_to_Sep | 7.25 | ft^3/s |

*Seasonal Flow Statistics Citations*

**Ziegeweid, J.R., Lorenz, D.L., Sanocki, C.A., and Czuba, C.R.,2015, Methods for estimating flow-duration curve and low-flow frequency statistics for ungaged locations on small streams in Minnesota: U.S. Geological Survey Scientific Investigations Report 2015–5170, 23 p. (http://dx.doi.org/10.3133/sir20155170)**

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USGS Product Names Disclaimer: Any use of trade, firm, or product names is for descriptive purposes only and does not imply endorsement by the U.S. Government.

Application Version: 4.3.11

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Weather.gov > Alaska-Pacific RFC > Normal Depth Calculator

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$$Q = VA = \left(\frac{1.00}{n}\right) AR^{\frac{2}{3}}\sqrt{S} \quad [SI]$$

## 7Q10 Jun-Sept

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S = Channel Slope, (ft/ft)

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Solve For: Water Surface (normal depth)

Slope: 0.005 (ft/ft)

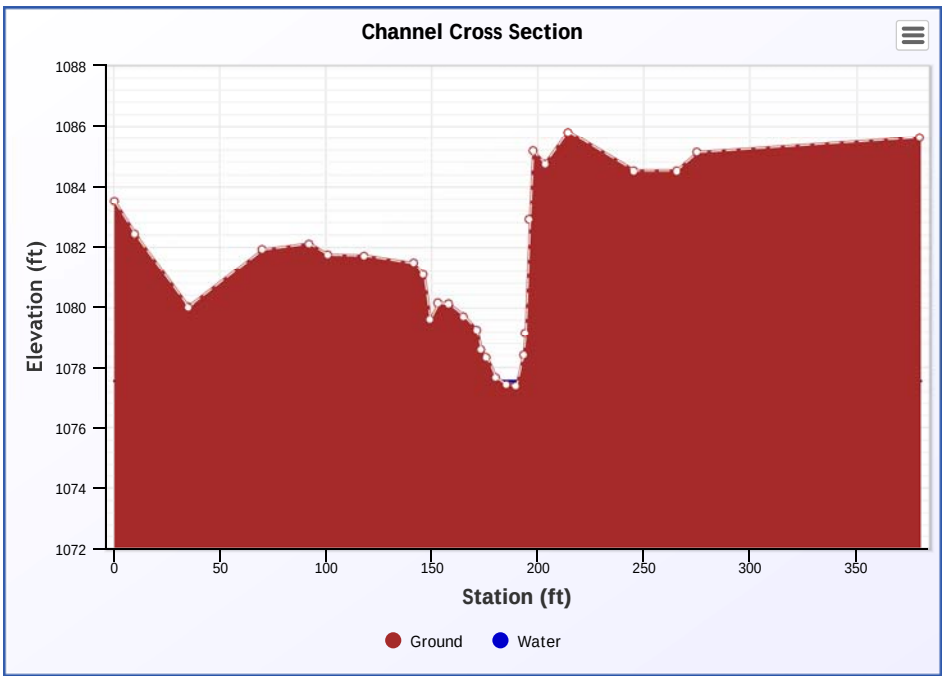
WSE: 1077.54 (ft)

Channel Manning n: 0.028

Flow: 1 ($ft^3/s$)

100 40000

Reset Cross Section




| | |
|---|---|
| Flow Area: | 0.9 ($ft^2$) |
| Wetted Perimeter: | 8.0 (ft) |
| Max Depth: | 0.16 (ft) |
| Average Velocity: | 0.83 (ft/s) |
| Top Width: | 8 (ft) |
| Iterations: | 5001 |
| Froude Number: | 0.44 |

Select HECRAS Geometry: Browse... Load HEC-RAS Data

Load CSV XS Data Below
(station,elevation)

Update Plot

```
0.00,1083.50
10.00,1082.40
35.00,1080.00
70.00,1081.90
92.00,1082.10
101.00,1081.73
118.00,1081.70
141.00,1081.45
146.00,1081.05
149.00,1079.58
153.00,1080.14
158.00,1080.10
165.00,1079.71
171.00,1079.24
173.00,1078.57
175.50,1078.33
180.00,1077.66
185.00,1077.42
189.50,1077.38
193.00,1078.40
194.00,1079.14
196.00,1082.87
197.50,1085.14
203.00,1084.73
214.00,1085.80
245.00,1084.50
265.00,1084.50
275.00,1085.10
380.00,1085.60
```

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**Q1.5**

$$Q = VA = \left(\frac{1.49}{n}\right) AR^{\frac{2}{3}}\sqrt{S} \quad [U.S.]$$

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Solve For: Water Surface (normal depth)

Slope: 0.005 (ft/ft)

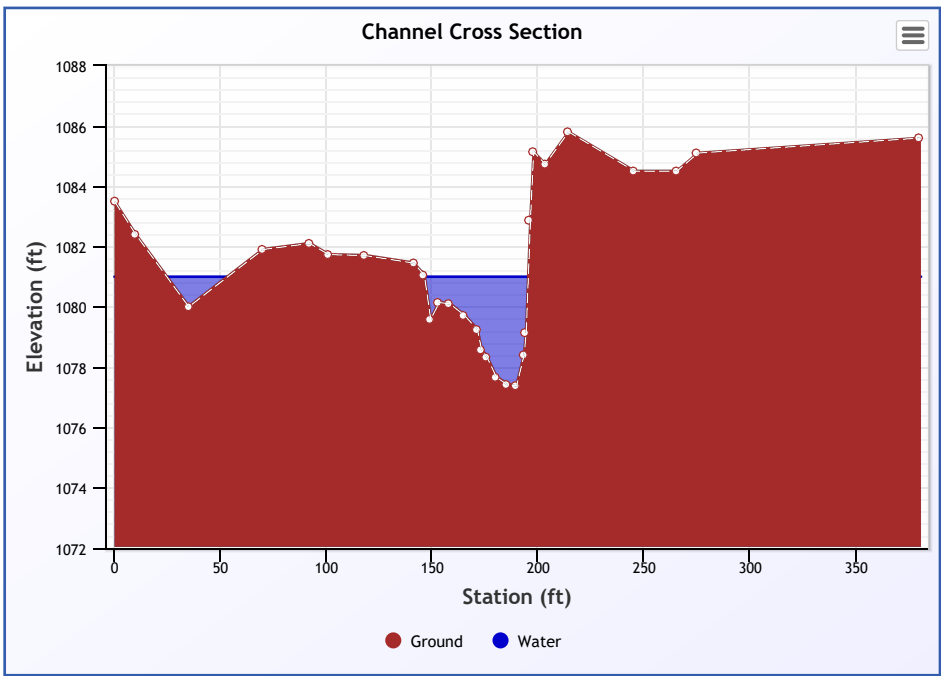
WSE: 1080.99 (ft)

Channel Manning n: 0.028

Flow: 536 ($ft^3/s$)

100 40000

Reset Cross Section




| | |
|---|---|
| Flow Area: | 112.9 ($ft^2$) |
| Wetted Perimeter: | 79.1 (ft) |
| Max Depth: | 3.61 (ft) |
| Average Velocity: | 4.75 (ft/s) |
| Top Width: | 77 (ft) |
| Iterations: | 29 |
| Froude Number: | 0.69 |

Select HECRAS Geometry: Browse... Load HEC-RAS Data

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**Q100**

$$Q = VA = \left(\frac{1.49}{n}\right) AR^{\frac{2}{3}}\sqrt{S} \quad [U.S.]$$

$$Q = VA = \left(\frac{1.00}{n}\right) AR^{\frac{2}{3}}\sqrt{S} \quad [SI]$$

Where:
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v = Velocity, (ft/s)
A = Flow Area, ($ft^2$)
n = Manning's Roughness Coefficient
R = Hydraulic Radius, (ft)
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Under the assumption of uniform flow conditions the bottom slope is the same as the slope of the energy grade line and the water surface slope. The Manning's n is a coefficient which represents the roughness or friction applied to the flow by the channel. Manning's n-values are often selected from tables, but can be back calculated from field measurements. In many flow conditions the selection of a Manning's roughness coefficient can greatly affect computational results.

**Instructions:** Select variable to solve, adjust slider bars, click on graph to modify the cross section. CSV cross section data can be loaded in the input box below. This online calculator is for demonstration and educational purposes only.

Solve For: Water Surface (normal depth)

Slope: 0.005 (ft/ft)

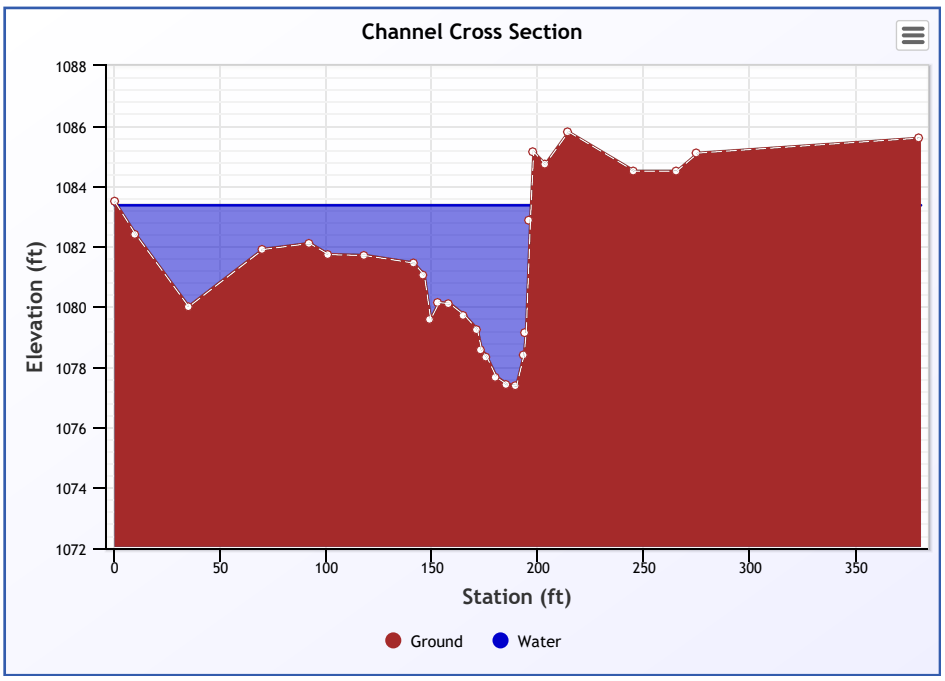
WSE: 1083.36 (ft)

Channel Manning n: 0.028

Flow: 3270 ($ft^3/s$)

100 40000

Reset Cross Section



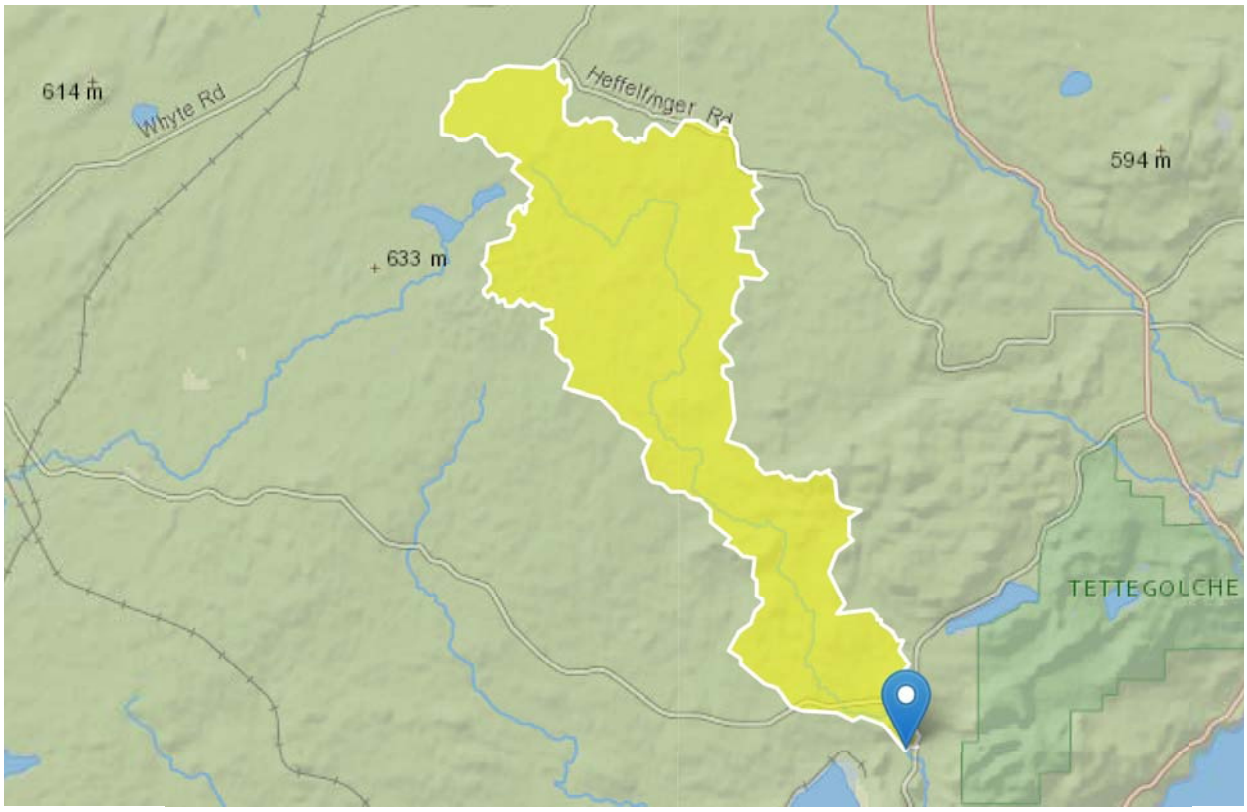

| | |
|---|---|
| Flow Area: | 481.7 ($ft^2$) |
| Wetted Perimeter: | 198.9 (ft) |
| Max Depth: | 5.98 (ft) |
| Average Velocity: | 6.79 (ft/s) |
| Top Width: | 195 (ft) |
| Iterations: | 30 |
| Froude Number: | 0.76 |

Select HECRAS Geometry: Browse... Load HEC-RAS Data

# East Branch Beaver River Headwaters

# Subwatershed #1 - Existing and Future

**Region ID:** MN
**Workspace ID:** MN20200326172704646000
**Clicked Point (Latitude, Longitude):** 47.31272, -91.32867
**Time:** 2020-03-26 12:27:24 -0500




Basin Characteristics

| Parameter Code | Parameter Description | Value | Unit |
|---|---|---|---|
| DRNAREA | Area that drains to a point on a stream | 26.96 | square miles |
| LAKEAREA | Percentage of Lakes and Ponds | 3.53 | percent |
| STORNWI | Percentage of storage (combined water bodies and wetlands) from the National Wetlands Inventory | 35.87 | percent |

| Parameter Code | Parameter Description | Value | Unit |
|---|---|---|---|
| SSURGOC | Percentage of area of Hydrologic Soil Type C from SSURGO | 42.1 | percent |

General Disclaimers

Parameter values have been edited, computed flows may not apply.

Peak-Flow Statistics Parameters[100 Percent (27.1 square miles) Region C]

| Parameter Code | Parameter Name | Value | Units | Min Limit | Max Limit |
|---|---|---|---|---|---|
| DRNAREA | Drainage Area | 26.96 | square miles | 0.21 | 607 |
| LAKEAREA | Percent Lakes and Ponds | 3.53 | percent | 0 | 11.8 |

Peak-Flow Statistics Flow Report[100 Percent (27.1 square miles) Region C]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

| Statistic | Value | Unit | PIl | PIu | SE | SEp | Equiv. Yrs. |
|---|---|---|---|---|---|---|---|
| 1.5 Year Peak Flood | 320 | ft^3/s | 145 | 613 | 45.2 | 45.2 | 2.8 |
| 2 Year Peak Flood | 403 | ft^3/s | 175 | 791 | 46.8 | 46.8 | 2.4 |
| 5 Year Peak Flood | 654 | ft^3/s | 266 | 1340 | 50.4 | 50.4 | 2.8 |
| 10 Year Peak Flood | 860 | ft^3/s | 337 | 1800 | 52.9 | 52.9 | 3.5 |
| 25 Year Peak Flood | 1160 | ft^3/s | 433 | 2500 | 56.2 | 56.2 | 4.5 |
| 50 Year Peak Flood | 1420 | ft^3/s | 511 | 3150 | 59.1 | 59.1 | 5.1 |
| 100 Year Peak Flood | 1710 | ft^3/s | 589 | 3900 | 62.3 | 62.3 | 5.7 |
| 500 Year Peak Flood | 2530 | ft^3/s | 766 | 6170 | 70.9 | 70.9 | 6.5 |

*Peak-Flow Statistics Citations*

**Lorenz, D.L., Sanocki, C.A., and Kocian, M.J.,2009, Techniques for Estimating the Magnitude and Frequency of Peak Flows on Small Streams in Minnesota Based on Data through Water Year 2005: U.S. Geological Survey Scientific Investigations Report 2009-5250, 54 p. (http://pubs.usgs.gov/sir/2009/5250/pdf/sir2009-5250.pdf)**

Flow-Duration Statistics Parameters[Flow duration Region BC 2015 5170]

| Parameter Code | Parameter Name | Value | Units | Min Limit | Max Limit |
|---|---|---|---|---|---|
| DRNAREA | Drainage Area | 26.96 | square miles | 2.98 | 2960 |
| STORNWI | Percentage of Storage from NWI | 35.87 | percent | 2.44 | 48 |
| SSURGOC | SSURGO Percent Hydrologic Soil Type C | 42.1 | percent | 2.61 | 100 |

Flow-Duration Statistics Flow Report[Flow duration Region BC 2015 5170]

| Statistic | Value | Unit |
|---|---|---|
| 0.01 Percent Duration | 628 | ft^3/s |
| 0.1 Percent Duration | 401 | ft^3/s |
| 2 Percent Duration | 147 | ft^3/s |
| 5 Percent Duration | 90.9 | ft^3/s |
| 10 Percent Duration | 46.5 | ft^3/s |
| 25 Percent Duration | 21.1 | ft^3/s |
| 50 Percent Duration | 7.09 | ft^3/s |
| 75 Percent Duration | 3.29 | ft^3/s |
| 90 Percent Duration | 1.7 | ft^3/s |
| 95 Percent Duration | 1 | ft^3/s |
| 99 Percent Duration | 0.447 | ft^3/s |
| 99.9 Percent Duration | 0.145 | ft^3/s |

| Statistic | Value | Unit |
|---|---|---|
| 99.99 Percent Duration | 0.112 | ft^3/s |

*Flow-Duration Statistics Citations*

**Ziegeweid, J.R., Lorenz, D.L., Sanocki, C.A., and Czuba, C.R.,2015, Methods for estimating flow-duration curve and low-flow frequency statistics for ungaged locations on small streams in Minnesota: U.S. Geological Survey Scientific Investigations Report 2015–5170, 23 p. (http://dx.doi.org/10.3133/sir20155170)**

Low-Flow Statistics Parameters[Low flow Region BC 2015 5170]

| Parameter Code | Parameter Name | Value | Units | Min Limit | Max Limit |
|---|---|---|---|---|---|
| DRNAREA | Drainage Area | 26.96 | square miles | 2.98 | 2960 |
| STORNWI | Percentage of Storage from NWI | 35.87 | percent | 2.44 | 48 |
| SSURGOC | SSURGO Percent Hydrologic Soil Type C | 42.1 | percent | 2.61 | 100 |

Low-Flow Statistics Flow Report[Low flow Region BC 2015 5170]

| Statistic | Value | Unit |
|---|---|---|
| 7 Day 10 Year Low Flow | 0.517 | ft^3/s |

*Low-Flow Statistics Citations*

**Ziegeweid, J.R., Lorenz, D.L., Sanocki, C.A., and Czuba, C.R.,2015, Methods for estimating flow-duration curve and low-flow frequency statistics for ungaged locations on small streams in Minnesota: U.S. Geological Survey Scientific Investigations Report 2015–5170, 23 p. (http://dx.doi.org/10.3133/sir20155170)**

Seasonal Flow Statistics Parameters[Low flow Region BC 2015 5170]

| Parameter Code | Parameter Name | Value | Units | Min Limit | Max Limit |
|---|---|---|---|---|---|

| Parameter Code | Parameter Name | Value | Units | Min Limit | Max Limit |
|---|---|---|---|---|---|
| DRNAREA | Drainage Area | 26.96 | square miles | 2.98 | 2960 |
| STORNWI | Percentage of Storage from NWI | 35.87 | percent | 2.44 | 48 |
| SSURGOC | SSURGO Percent Hydrologic Soil Type C | 42.1 | percent | 2.61 | 100 |

Seasonal Flow Statistics Flow Report[Low flow Region BC 2015 5170]

| Statistic | Value | Unit |
|---|---|---|
| Oct to Nov 7 Day 10 Year Low Flow | 1.34 | ft^3/s |
| 30_Day_10_Year_Low_Flow_Oct_to_Nov | 2.06 | ft^3/s |
| 7_Day_10_Year_lowflow_Dec_to_Mar | 0.74 | ft^3/s |
| 30_Day_10_Year_Low_Flow_Dec_to_Mar | 0.916 | ft^3/s |
| Apr to May 7 Day 10 Year Low Flow | 3.09 | ft^3/s |
| Apr to May 30 Day 10 Year Low Flow | 12.2 | ft^3/s |
| 7_Day_10_Year_lowflow_Jun_to_Sep | 0.728 | ft^3/s |
| 30_Day_10_Year_Low_Flow_Jun_to_Sep | 1.01 | ft^3/s |
| 122_Day_10_Year_Low_Flow_Jun_to_Sep | 7.27 | ft^3/s |

*Seasonal Flow Statistics Citations*

**Ziegeweid, J.R., Lorenz, D.L., Sanocki, C.A., and Czuba, C.R.,2015, Methods for estimating flow-duration curve and low-flow frequency statistics for ungaged locations on small streams in Minnesota: U.S. Geological Survey Scientific Investigations Report 2015–5170, 23 p. (http://dx.doi.org/10.3133/sir20155170)**

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NATIONAL WEATHER SERVICE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

# Normal Depth Calculator

Weather.gov > Alaska-Pacific RFC > Normal Depth Calculator

**Alaska-Pacific RFC**
River Forecast Center

River Observations and Forecasts | Weather Observations and Forecasts | Water Supply | Climate and History | Seasonal Interest | Additional Info

## Normal Depth Demonstration Tool

One the most commonly used equations governing Open Channel Flow is known as the Mannings's Equation. It was introduced by the Irish Engineer Robert Manning in 1889 as an alternative to the Chezy Equation. The Mannings equation is an empirical equation that applies to uniform flow in open channels and is a function of the channel velocity, flow area and channel slope.

**7Q10 Jun-Sept**

$$Q = VA = \left(\frac{1.49}{n}\right) AR^{\frac{2}{3}}\sqrt{S} \quad [U.S.]$$

$$Q = VA = \left(\frac{1.00}{n}\right) AR^{\frac{2}{3}}\sqrt{S} \quad [SI]$$

Where:
Q = Flow Rate, ($ft^3/s$)
v = Velocity, (ft/s)
A = Flow Area, ($ft^2$)
n = Manning's Roughness Coefficient
R = Hydraulic Radius, (ft)
S = Channel Slope, (ft/ft)

Under the assumption of uniform flow conditions the bottom slope is the same as the slope of the energy grade line and the water surface slope. The Manning's n is a coefficient which represents the roughness or friction applied to the flow by the channel. Manning's n-values are often selected from tables, but can be back calculated from field measurements. In many flow conditions the selection of a Manning's roughness coefficient can greatly affect computational results.

**Instructions:** Select variable to solve, adjust slider bars, click on graph to modify the cross section. CSV cross section data can be loaded in the input box below. This online calculator is for demonstration and educational purposes only.

Solve For: Water Surface (normal depth)

Slope: 0.005 (ft/ft)

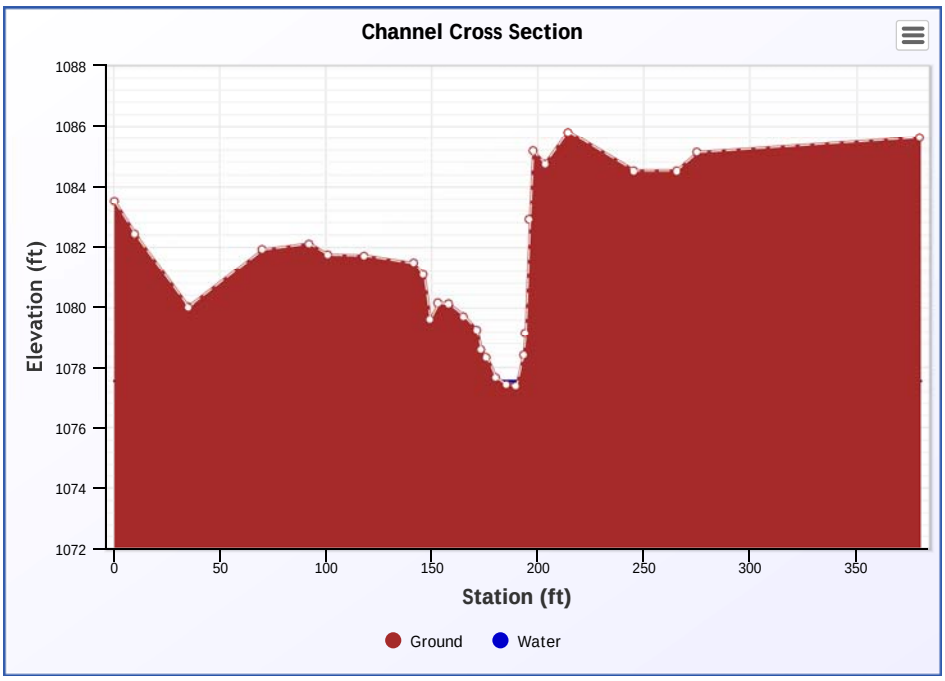
WSE: 1077.54 (ft)

Channel Manning n: 0.028

Flow: 1 ($ft^3/s$)

100 40000

Reset Cross Section




| | |
|---|---|
| Flow Area: | 0.9 ($ft^2$) |
| Wetted Perimeter: | 8.0 (ft) |
| Max Depth: | 0.16 (ft) |
| Average Velocity: | 0.83 (ft/s) |
| Top Width: | 8 (ft) |
| Iterations: | 5001 |
| Froude Number: | 0.44 |

Select HECRAS Geometry: Browse... Load HEC-RAS Data

Load CSV XS Data Below
(station,elevation)

Update Plot

```
0.00,1083.50
10.00,1082.40
35.00,1080.00
70.00,1081.90
92.00,1082.10
101.00,1081.73
118.00,1081.70
141.00,1081.45
146.00,1081.05
149.00,1079.58
153.00,1080.14
158.00,1080.10
165.00,1079.71
171.00,1079.24
173.00,1078.57
175.50,1078.33
180.00,1077.66
185.00,1077.42
189.50,1077.38
193.00,1078.40
194.00,1079.14
196.00,1082.87
197.50,1085.14
203.00,1084.73
214.00,1085.80
245.00,1084.50
265.00,1084.50
275.00,1085.10
380.00,1085.60
```

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# Normal Depth Calculator

Weather.gov > Alaska-Pacific RFC > Normal Depth Calculator

**Alaska-Pacific RFC**
River Forecast Center

River Observations and Forecasts | Weather Observations and Forecasts | Water Supply | Climate and History | Seasonal Interest | Additional Info

## Normal Depth Demonstration Tool

One the most commonly used equations governing Open Channel Flow is known as the Mannings's Equation. It was introduced by the Irish Engineer Robert Manning in 1889 as an alternative to the Chezy Equation. The Mannings equation is an empirical equation that applies to uniform flow in open channels and is a function of the channel velocity, flow area and channel slope.

**Q1.5**

$$Q = VA = \left(\frac{1.49}{n}\right) AR^{\frac{2}{3}}\sqrt{S} \quad [U.S.]$$

$$Q = VA = \left(\frac{1.00}{n}\right) AR^{\frac{2}{3}}\sqrt{S} \quad [SI]$$

Where:
Q = Flow Rate, ($ft^3/s$)
v = Velocity, (ft/s)
A = Flow Area, ($ft^2$)
n = Manning's Roughness Coefficient
R = Hydraulic Radius, (ft)
S = Channel Slope, (ft/ft)

Under the assumption of uniform flow conditions the bottom slope is the same as the slope of the energy grade line and the water surface slope. The Manning's n is a coefficient which represents the roughness or friction applied to the flow by the channel. Manning's n-values are often selected from tables, but can be back calculated from field measurements. In many flow conditions the selection of a Manning's roughness coefficient can greatly affect computational results.

**Instructions:** Select variable to solve, adjust slider bars, click on graph to modify the cross section. CSV cross section data can be loaded in the input box below. This online calculator is for demonstration and educational purposes only.

Solve For: Water Surface (normal depth)

Slope: 0.005 (ft/ft)

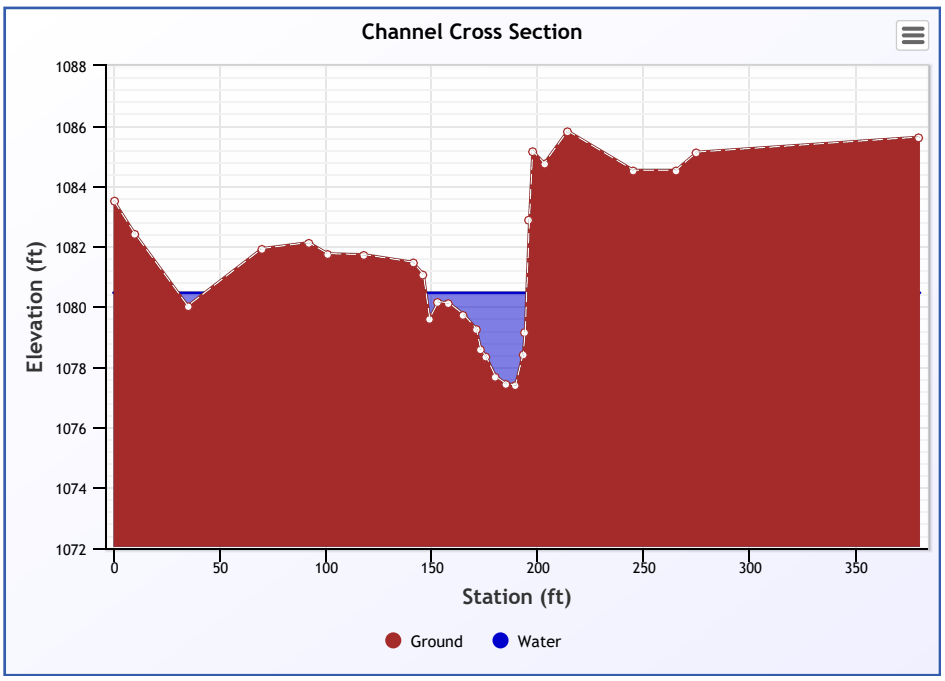
WSE: 1080.42 (ft)

Channel Manning n: 0.028

Flow: 320 ($ft^3/s$)

100 — 40000

Reset Cross Section




| | |
|---|---|
| Flow Area: | 74.6 ($ft^2$) |
| Wetted Perimeter: | 61.5 (ft) |
| Max Depth: | 3.04 (ft) |
| Average Velocity: | 4.29 (ft/s) |
| Top Width: | 60 (ft) |
| Iterations: | 29 |
| Froude Number: | 0.68 |

Select HECRAS Geometry: Browse... Load HEC-RAS Data

NATIONAL WEATHER SERVICE
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# Normal Depth Calculator

Weather.gov > Alaska-Pacific RFC > Normal Depth Calculator

**Alaska-Pacific RFC**
River Forecast Center

River Observations and Forecasts | Weather Observations and Forecasts | Water Supply | Climate and History | Seasonal Interest | Additional Info

## Normal Depth Demonstration Tool

One the most commonly used equations governing Open Channel Flow is known as the Mannings's Equation. It was introduced by the Irish Engineer Robert Manning in 1889 as an alternative to the Chezy Equation. The Mannings equation is an empirical equation that applies to uniform flow in open channels and is a function of the channel velocity, flow area and channel slope.

**Q100**

$$Q = VA = \left(\frac{1.49}{n}\right) AR^{\frac{2}{3}}\sqrt{S} \quad [U.S.]$$

$$Q = VA = \left(\frac{1.00}{n}\right) AR^{\frac{2}{3}}\sqrt{S} \quad [SI]$$

Where:
Q = Flow Rate, ($ft^3/s$)
v = Velocity, (ft/s)
A = Flow Area, ($ft^2$)
n = Manning's Roughness Coefficient
R = Hydraulic Radius, (ft)
S = Channel Slope, (ft/ft)

Under the assumption of uniform flow conditions the bottom slope is the same as the slope of the energy grade line and the water surface slope. The Manning's n is a coefficient which represents the roughness or friction applied to the flow by the channel. Manning's n-values are often selected from tables, but can be back calculated from field measurements. In many flow conditions the selection of a Manning's roughness coefficient can greatly affect computational results.

**Instructions:** Select variable to solve, adjust slider bars, click on graph to modify the cross section. CSV cross section data can be loaded in the input box below. This online calculator is for demonstration and educational purposes only.

Solve For: Water Surface (normal depth)

Slope: 0.005 (ft/ft)

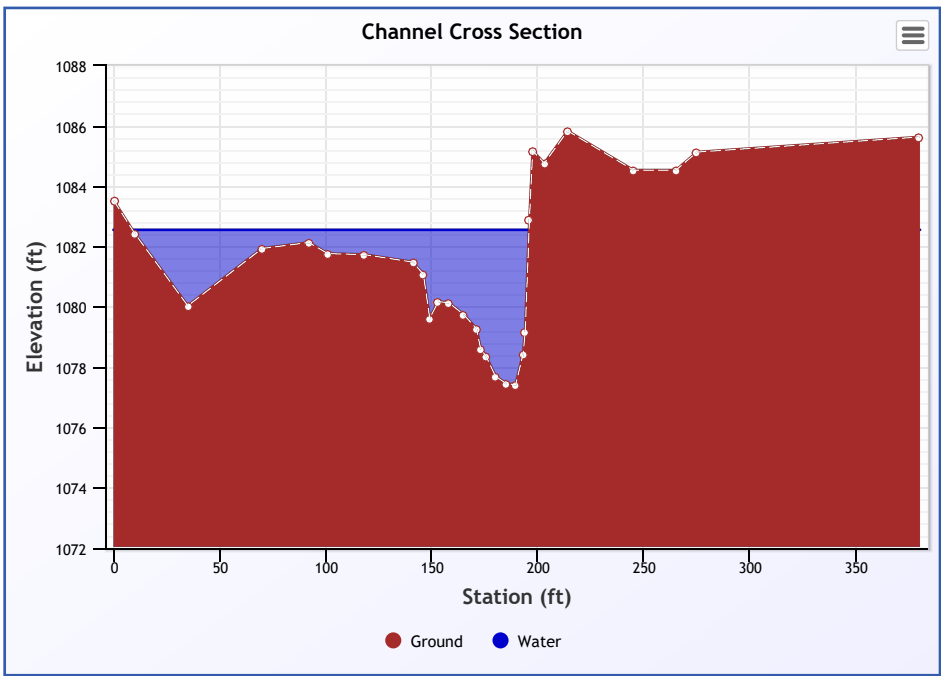
WSE: 1082.52 (ft)

Channel Manning n: 0.028

Flow: 1710 ($ft^3/s$)

100 40000

Reset Cross Section




| | |
|---|---|
| Flow Area: | 320.6 ($ft^2$) |
| Wetted Perimeter: | 190.1 (ft) |
| Max Depth: | 5.14 (ft) |
| Average Velocity: | 5.33 (ft/s) |
| Top Width: | 187 (ft) |
| Iterations: | 30 |
| Froude Number: | 0.72 |

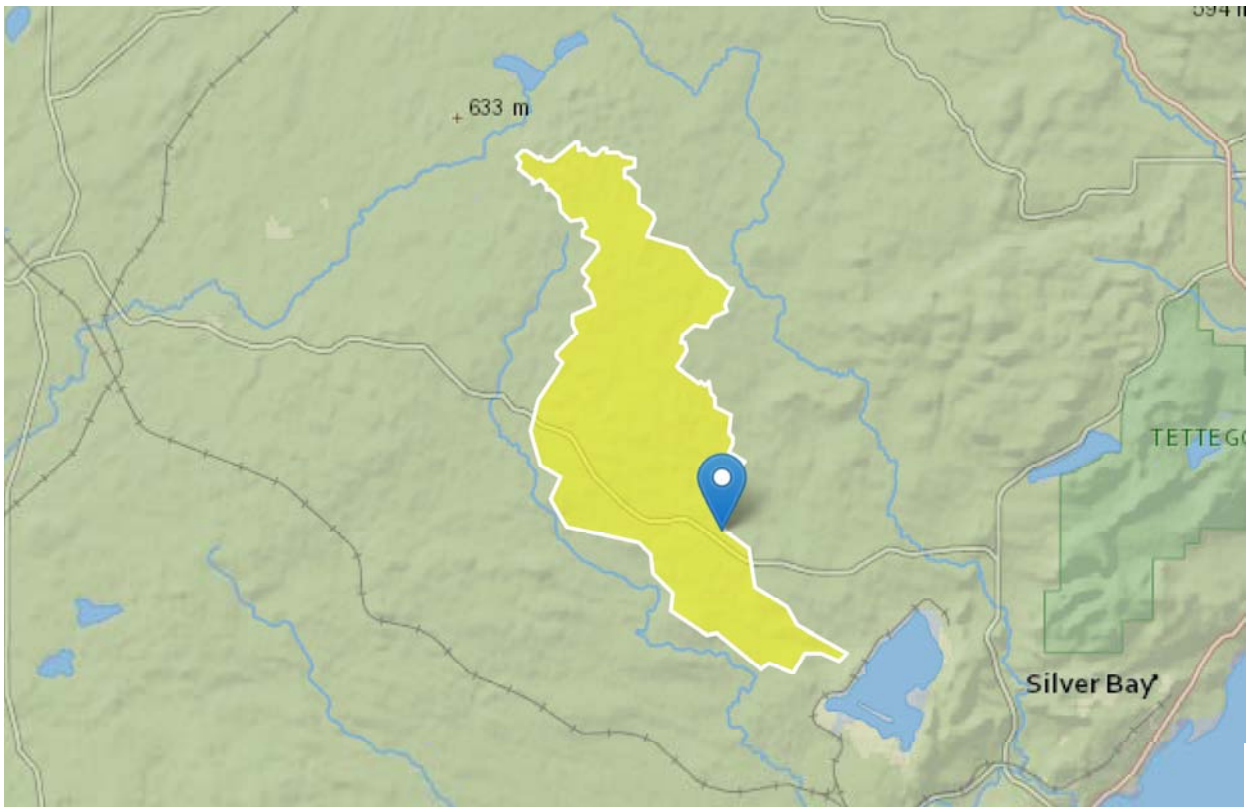
Select HECRAS Geometry: Browse... Load HEC-RAS Data

# Appendix F

## Streamflow and Stream Water Level Modeling Results – Other

# Big Thirtynine Creek Subwatershed #18 - Pre-Settlement

**Region ID:** MN
**Workspace ID:** MN20200327174847161000
**Clicked Point (Latitude, Longitude):** 47.32788, -91.41965
**Time:** 2020-03-27 12:49:16 -0500




Basin Characteristics

| Parameter Code | Parameter Description | Value | Unit |
|---|---|---|---|
| DRNAREA | Area that drains to a point on a stream | 17.7 | square miles |
| LAKEAREA | Percentage of Lakes and Ponds | 0.54 | percent |

| Parameter Code | Parameter Description | Value | Unit |
|---|---|---|---|
| STORNWI | Percentage of storage (combined water bodies and wetlands) from the National Wetlands Inventory | 38.75 | percent |
| SSURGOC | Percentage of area of Hydrologic Soil Type C from SSURGO | 21.9 | percent |

General Disclaimers

Parameter values have been edited, computed flows may not apply.

This watershed has been edited, computed flows may not apply.

Peak-Flow Statistics Parameters[Region C]

| Parameter Code | Parameter Name | Value | Units | Min Limit | Max Limit |
|---|---|---|---|---|---|
| DRNAREA | Drainage Area | 17.7 | square miles | 0.21 | 607 |
| LAKEAREA | Percent Lakes and Ponds | 0.54 | percent | 0 | 11.8 |

Peak-Flow Statistics Flow Report[Region C]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

| Statistic | Value | Unit | PIl | PIu | SE | SEp | Equiv. Yrs. |
|---|---|---|---|---|---|---|---|
| 1.5 Year Peak Flood | 399 | ft^3/s | 185 | 742 | 45.2 | 45.2 | 2.8 |
| 2 Year Peak Flood | 515 | ft^3/s | 230 | 982 | 46.8 | 46.8 | 2.4 |
| 5 Year Peak Flood | 883 | ft^3/s | 370 | 1750 | 50.4 | 50.4 | 2.8 |
| 10 Year Peak Flood | 1200 | ft^3/s | 486 | 2430 | 52.9 | 52.9 | 3.5 |
| 25 Year Peak Flood | 1680 | ft^3/s | 652 | 3500 | 56.2 | 56.2 | 4.5 |

| Statistic | Value | Unit | PIl | PIu | SE | SEp | Equiv. Yrs. |
|---|---|---|---|---|---|---|---|
| 50 Year Peak Flood | 2130 | ft^3/s | 792 | 4530 | 59.1 | 59.1 | 5.1 |
| 100 Year Peak Flood | 2640 | ft^3/s | 941 | 5760 | 62.3 | 62.3 | 5.7 |
| 500 Year Peak Flood | 4140 | ft^3/s | 1310 | 9680 | 70.9 | 70.9 | 6.5 |

*Peak-Flow Statistics Citations*

**Lorenz, D.L., Sanocki, C.A., and Kocian, M.J.,2009, Techniques for Estimating the Magnitude and Frequency of Peak Flows on Small Streams in Minnesota Based on Data through Water Year 2005: U.S. Geological Survey Scientific Investigations Report 2009-5250, 54 p. (http://pubs.usgs.gov/sir/2009/5250/pdf/sir2009-5250.pdf)**

Flow-Duration Statistics Parameters[Flow duration Region BC 2015 5170]

| Parameter Code | Parameter Name | Value | Units | Min Limit | Max Limit |
|---|---|---|---|---|---|
| DRNAREA | Drainage Area | 17.7 | square miles | 2.98 | 2960 |
| STORNWI | Percentage of Storage from NWI | 38.75 | percent | 2.44 | 48 |
| SSURGOC | SSURGO Percent Hydrologic Soil Type C | 21.9 | percent | 2.61 | 100 |

Flow-Duration Statistics Flow Report[Flow duration Region BC 2015 5170]

| Statistic | Value | Unit |
|---|---|---|
| 0.01 Percent Duration | 394 | ft^3/s |
| 0.1 Percent Duration | 250 | ft^3/s |
| 2 Percent Duration | 91.9 | ft^3/s |
| 5 Percent Duration | 58.1 | ft^3/s |
| 10 Percent Duration | 29.3 | ft^3/s |
| 25 Percent Duration | 14.2 | ft^3/s |
| 50 Percent Duration | 4.99 | ft^3/s |

| Statistic | Value | Unit |
|---|---|---|
| 75 Percent Duration | 2.43 | ft^3/s |
| 90 Percent Duration | 1.32 | ft^3/s |
| 95 Percent Duration | 0.805 | ft^3/s |
| 99 Percent Duration | 0.387 | ft^3/s |
| 99.9 Percent Duration | 0.14 | ft^3/s |
| 99.99 Percent Duration | 0.118 | ft^3/s |

*Flow-Duration Statistics Citations*

**Ziegeweid, J.R., Lorenz, D.L., Sanocki, C.A., and Czuba, C.R.,2015, Methods for estimating flow-duration curve and low-flow frequency statistics for ungaged locations on small streams in Minnesota: U.S. Geological Survey Scientific Investigations Report 2015–5170, 23 p. (http://dx.doi.org/10.3133/sir20155170)**

Low-Flow Statistics Parameters[Low flow Region BC 2015 5170]

| Parameter Code | Parameter Name | Value | Units | Min Limit | Max Limit |
|---|---|---|---|---|---|
| DRNAREA | Drainage Area | 17.7 | square miles | 2.98 | 2960 |
| STORNWI | Percentage of Storage from NWI | 38.75 | percent | 2.44 | 48 |
| SSURGOC | SSURGO Percent Hydrologic Soil Type C | 21.9 | percent | 2.61 | 100 |

Low-Flow Statistics Flow Report[Low flow Region BC 2015 5170]

| Statistic | Value | Unit |
|---|---|---|
| 7 Day 10 Year Low Flow | 0.422 | ft^3/s |

*Low-Flow Statistics Citations*

**Ziegeweid, J.R., Lorenz, D.L., Sanocki, C.A., and Czuba, C.R.,2015, Methods for estimating flow-duration curve and low-flow frequency statistics for ungaged**

**locations on small streams in Minnesota: U.S. Geological Survey Scientific Investigations Report 2015–5170, 23 p. (http://dx.doi.org/10.3133/sir20155170)**

Seasonal Flow Statistics Parameters[Low flow Region BC 2015 5170]

| Parameter Code | Parameter Name | Value | Units | Min Limit | Max Limit |
|---|---|---|---|---|---|
| DRNAREA | Drainage Area | 17.7 | square miles | 2.98 | 2960 |
| STORNWI | Percentage of Storage from NWI | 38.75 | percent | 2.44 | 48 |
| SSURGOC | SSURGO Percent Hydrologic Soil Type C | 21.9 | percent | 2.61 | 100 |

Seasonal Flow Statistics Flow Report[Low flow Region BC 2015 5170]

| Statistic | Value | Unit |
|---|---|---|
| Oct to Nov 7 Day 10 Year Low Flow | 1.14 | ft^3/s |
| 30_Day_10_Year_Low_Flow_Oct_to_Nov | 1.71 | ft^3/s |
| 7_Day_10_Year_lowflow_Dec_to_Mar | 0.598 | ft^3/s |
| 30_Day_10_Year_Low_Flow_Dec_to_Mar | 0.737 | ft^3/s |
| Apr to May 7 Day 10 Year Low Flow | 2.38 | ft^3/s |
| Apr to May 30 Day 10 Year Low Flow | 9.14 | ft^3/s |
| 7_Day_10_Year_lowflow_Jun_to_Sep | 0.585 | ft^3/s |
| 30_Day_10_Year_Low_Flow_Jun_to_Sep | 0.803 | ft^3/s |
| 122_Day_10_Year_Low_Flow_Jun_to_Sep | 5.24 | ft^3/s |

*Seasonal Flow Statistics Citations*

**Ziegeweid, J.R., Lorenz, D.L., Sanocki, C.A., and Czuba, C.R.,2015, Methods for estimating flow-duration curve and low-flow frequency statistics for ungaged locations on small streams in Minnesota: U.S. Geological Survey Scientific Investigations Report 2015–5170, 23 p. (http://dx.doi.org/10.3133/sir20155170)**

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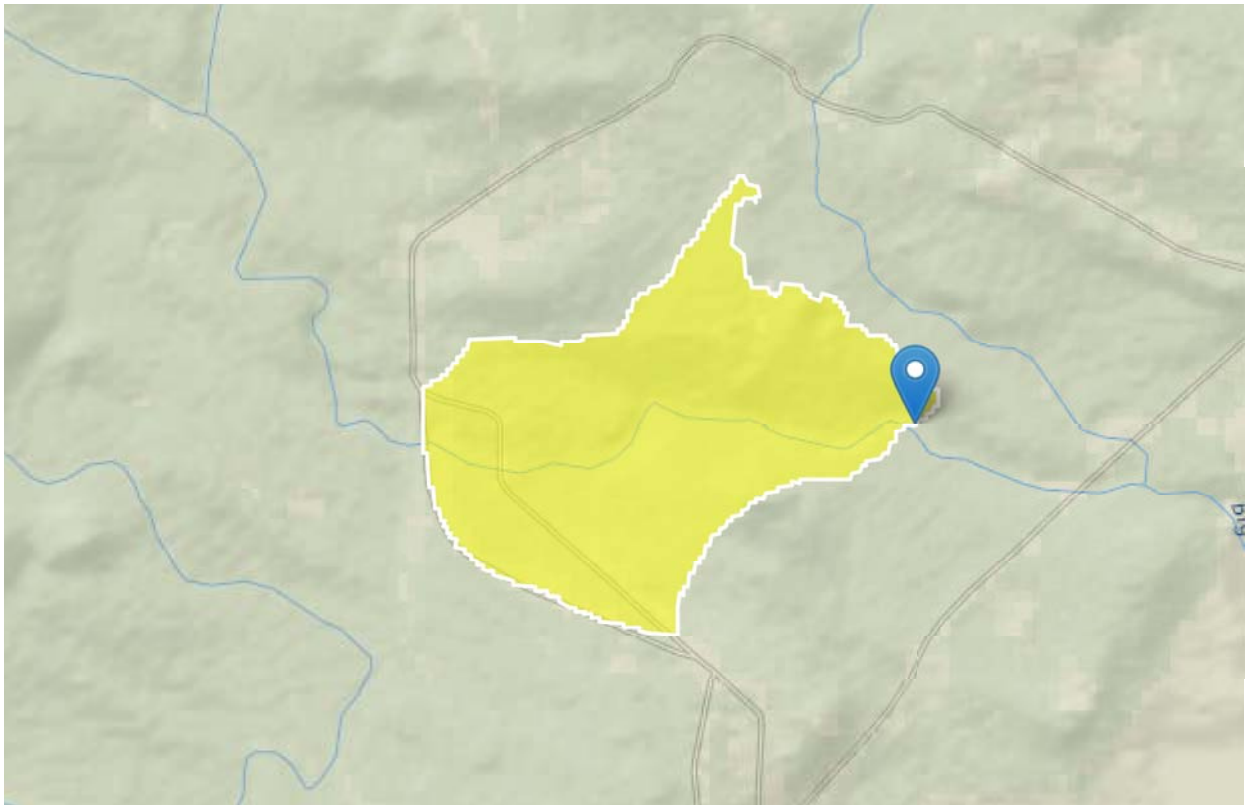
USGS Software Disclaimer: This software has been approved for release by the U.S. Geological Survey (USGS). Although the software has been subjected to rigorous review, the USGS reserves the right to update the software as needed pursuant to further analysis and review. No warranty, expressed or implied, is made by the USGS or the U.S. Government as to the functionality of the software and related material nor shall the fact of release constitute any such warranty. Furthermore, the software is released on condition that neither the USGS nor the U.S. Government shall be held liable for any damages resulting from its authorized or unauthorized use.

USGS Product Names Disclaimer: Any use of trade, firm, or product names is for descriptive purposes only and does not imply endorsement by the U.S. Government.

Application Version: 4.3.11

# Big Thirtynine Creek Subwatershed #2 - Existing

**Region ID:** MN
**Workspace ID:** MN20200327170452857000
**Clicked Point (Latitude, Longitude):** 47.30150, -91.38445
**Time:** 2020-03-27 12:05:08 -0500



Basin Characteristics

| Parameter Code | Parameter Description | Value | Unit |
|---|---|---|---|
| DRNAREA | Area that drains to a point on a stream | 0.46 | square miles |
| LAKEAREA | Percentage of Lakes and Ponds | 1.87 | percent |

| Parameter Code | Parameter Description | Value | Unit |
|---|---|---|---|
| STORNWI | Percentage of storage (combined water bodies and wetlands) from the National Wetlands Inventory | 17.56 | percent |
| SSURGOC | Percentage of area of Hydrologic Soil Type C from SSURGO | 18.4 | percent |

General Disclaimers

Parameter values have been edited, computed flows may not apply.

Peak-Flow Statistics Parameters[Region C]

| Parameter Code | Parameter Name | Value | Units | Min Limit | Max Limit |
|---|---|---|---|---|---|
| DRNAREA | Drainage Area | 0.46 | square miles | 0.21 | 607 |
| LAKEAREA | Percent Lakes and Ponds | 1.87 | percent | 0 | 11.8 |

Peak-Flow Statistics Flow Report[Region C]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

| Statistic | Value | Unit | PIl | PIu | SE | SEp | Equiv. Yrs. |
|---|---|---|---|---|---|---|---|
| 1.5 Year Peak Flood | 12.2 | ft^3/s | 5.06 | 25.5 | 45.2 | 45.2 | 2.8 |
| 2 Year Peak Flood | 16.7 | ft^3/s | 6.64 | 35.9 | 46.8 | 46.8 | 2.4 |
| 5 Year Peak Flood | 32.9 | ft^3/s | 12.1 | 74 | 50.4 | 50.4 | 2.8 |
| 10 Year Peak Flood | 47.9 | ft^3/s | 17 | 111 | 52.9 | 52.9 | 3.5 |
| 25 Year Peak Flood | 72.8 | ft^3/s | 24.5 | 175 | 56.2 | 56.2 | 4.5 |
| 50 Year Peak Flood | 96.8 | ft^3/s | 31 | 240 | 59.1 | 59.1 | 5.1 |

| Statistic | Value | Unit | PIl | PIu | SE | SEp | Equiv. Yrs. |
|---|---|---|---|---|---|---|---|
| 100 Year Peak Flood | 126 | ft^3/s | 38.2 | 322 | 62.3 | 62.3 | 5.7 |
| 500 Year Peak Flood | 217 | ft^3/s | 57.4 | 608 | 70.9 | 70.9 | 6.5 |

*Peak-Flow Statistics Citations*

**Lorenz, D.L., Sanocki, C.A., and Kocian, M.J.,2009, Techniques for Estimating the Magnitude and Frequency of Peak Flows on Small Streams in Minnesota Based on Data through Water Year 2005: U.S. Geological Survey Scientific Investigations Report 2009-5250, 54 p. (http://pubs.usgs.gov/sir/2009/5250/pdf/sir2009-5250.pdf)**

Flow-Duration Statistics Parameters[Flow duration Region BC 2015 5170]

| Parameter Code | Parameter Name | Value | Units | Min Limit | Max Limit |
|---|---|---|---|---|---|
| DRNAREA | Drainage Area | 0.46 | square miles | 2.98 | 2960 |
| STORNWI | Percentage of Storage from NWI | 17.56 | percent | 2.44 | 48 |
| SSURGOC | SSURGO Percent Hydrologic Soil Type C | 18.4 | percent | 2.61 | 100 |

Flow-Duration Statistics Disclaimers[Flow duration Region BC 2015 5170]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors

Flow-Duration Statistics Flow Report[Flow duration Region BC 2015 5170]

| Statistic | Value | Unit |
|---|---|---|
| 0.01 Percent Duration | 25.5 | ft^3/s |
| 0.1 Percent Duration | 13.7 | ft^3/s |
| 2 Percent Duration | 3.86 | ft^3/s |
| 5 Percent Duration | 2.2 | ft^3/s |
| 10 Percent Duration | 0.927 | ft^3/s |

| Statistic | Value | Unit |
|---|---|---|
| 25 Percent Duration | 0.503 | ft^3/s |
| 50 Percent Duration | 0.187 | ft^3/s |
| 75 Percent Duration | 0.103 | ft^3/s |
| 90 Percent Duration | 0.0554 | ft^3/s |
| 95 Percent Duration | 0.0309 | ft^3/s |
| 99 Percent Duration | 0.0155 | ft^3/s |
| 99.9 Percent Duration | 0.00494 | ft^3/s |
| 99.99 Percent Duration | 0.00432 | ft^3/s |

*Flow-Duration Statistics Citations*

**Ziegeweid, J.R., Lorenz, D.L., Sanocki, C.A., and Czuba, C.R.,2015, Methods for estimating flow-duration curve and low-flow frequency statistics for ungaged locations on small streams in Minnesota: U.S. Geological Survey Scientific Investigations Report 2015–5170, 23 p. (http://dx.doi.org/10.3133/sir20155170)**

Low-Flow Statistics Parameters[Low flow Region BC 2015 5170]

| Parameter Code | Parameter Name | Value | Units | Min Limit | Max Limit |
|---|---|---|---|---|---|
| DRNAREA | Drainage Area | 0.46 | square miles | 2.98 | 2960 |
| STORNWI | Percentage of Storage from NWI | 17.56 | percent | 2.44 | 48 |
| SSURGOC | SSURGO Percent Hydrologic Soil Type C | 18.4 | percent | 2.61 | 100 |

Low-Flow Statistics Disclaimers[Low flow Region BC 2015 5170]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors

Low-Flow Statistics Flow Report[Low flow Region BC 2015 5170]

| Statistic | Value | Unit |
|---|---|---|

| Statistic | Value | Unit |
|---|---|---|
| 7 Day 10 Year Low Flow | 0.0161 | ft^3/s |

*Low-Flow Statistics Citations*

**Ziegeweid, J.R., Lorenz, D.L., Sanocki, C.A., and Czuba, C.R.,2015, Methods for estimating flow-duration curve and low-flow frequency statistics for ungaged locations on small streams in Minnesota: U.S. Geological Survey Scientific Investigations Report 2015–5170, 23 p. (http://dx.doi.org/10.3133/sir20155170)**

Seasonal Flow Statistics Parameters[Low flow Region BC 2015 5170]

| Parameter Code | Parameter Name | Value | Units | Min Limit | Max Limit |
|---|---|---|---|---|---|
| DRNAREA | Drainage Area | 0.46 | square miles | 2.98 | 2960 |
| STORNWI | Percentage of Storage from NWI | 17.56 | percent | 2.44 | 48 |
| SSURGOC | SSURGO Percent Hydrologic Soil Type C | 18.4 | percent | 2.61 | 100 |

Seasonal Flow Statistics Disclaimers[Low flow Region BC 2015 5170]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors

Seasonal Flow Statistics Flow Report[Low flow Region BC 2015 5170]

| Statistic | Value | Unit |
|---|---|---|
| Oct to Nov 7 Day 10 Year Low Flow | 0.0455 | ft^3/s |
| 30_Day_10_Year_Low_Flow_Oct_to_Nov | 0.0737 | ft^3/s |
| 7_Day_10_Year_lowflow_Dec_to_Mar | 0.0229 | ft^3/s |
| 30_Day_10_Year_Low_Flow_Dec_to_Mar | 0.0309 | ft^3/s |
| Apr to May 7 Day 10 Year Low Flow | 0.0948 | ft^3/s |
| Apr to May 30 Day 10 Year Low Flow | 0.359 | ft^3/s |
| 7_Day_10_Year_lowflow_Jun_to_Sep | 0.0227 | ft^3/s |

| Statistic | Value | Unit |
|---|---|---|
| 30_Day_10_Year_Low_Flow_Jun_to_Sep | 0.0324 | ft^3/s |
| 122_Day_10_Year_Low_Flow_Jun_to_Sep | 0.279 | ft^3/s |

*Seasonal Flow Statistics Citations*

**Ziegeweid, J.R., Lorenz, D.L., Sanocki, C.A., and Czuba, C.R.,2015, Methods for estimating flow-duration curve and low-flow frequency statistics for ungaged locations on small streams in Minnesota: U.S. Geological Survey Scientific Investigations Report 2015–5170, 23 p. (http://dx.doi.org/10.3133/sir20155170)**

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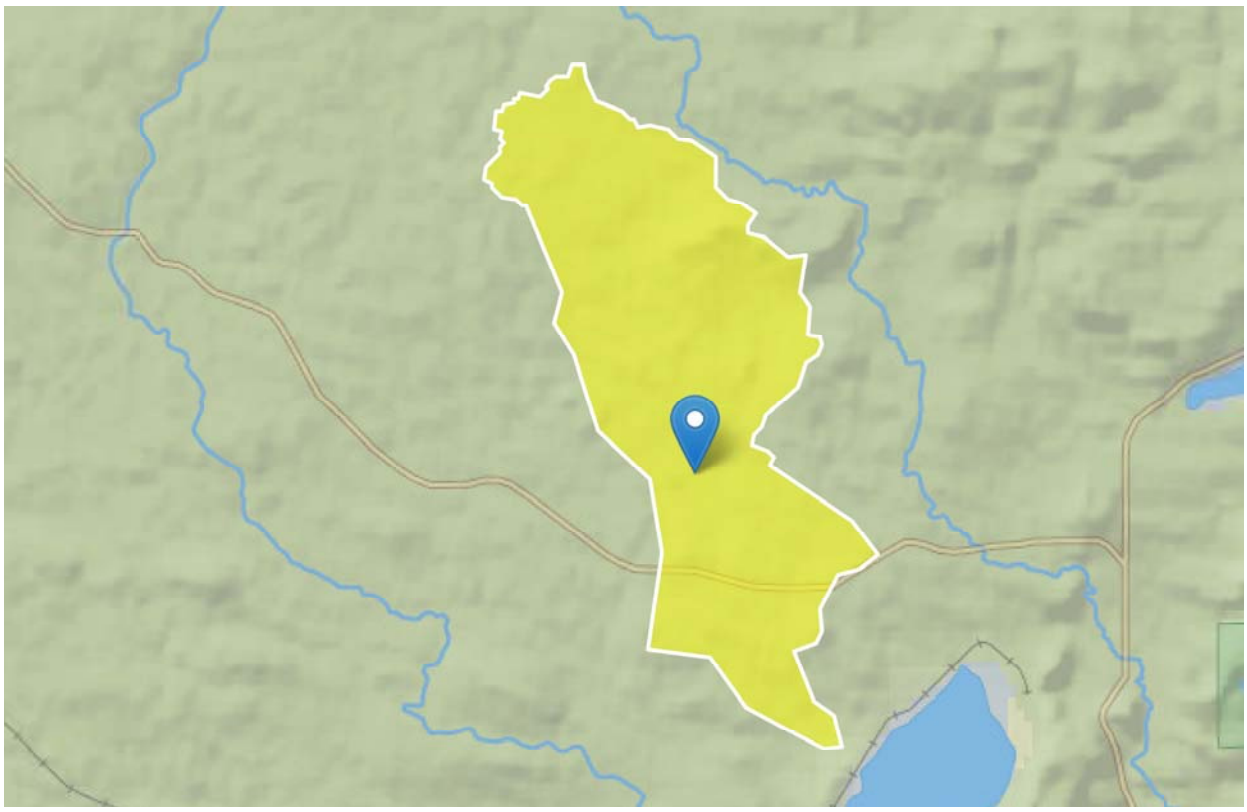
Application Version: 4.3.11

# Little Thirtynine Creek Subwatershed #17 - Pre-Settlement

**Region ID:** MN
**Workspace ID:** MN20200327173309050000
**Clicked Point (Latitude, Longitude):** 47.33203, -91.39914
**Time:** 2020-03-27 12:33:33 -0500



Basin Characteristics

| Parameter Code | Parameter Description | Value | Unit |
|---|---|---|---|
| DRNAREA | Area that drains to a point on a stream | 6.94 | square miles |
| LAKEAREA | Percentage of Lakes and Ponds | 0.8 | percent |

| Parameter Code | Parameter Description | Value | Unit |
|---|---|---|---|
| STORNWI | Percentage of storage (combined water bodies and wetlands) from the National Wetlands Inventory | 34.48 | percent |
| SSURGOC | Percentage of area of Hydrologic Soil Type C from SSURGO | 21.9 | percent |

General Disclaimers

Parameter values have been edited, computed flows may not apply.

This watershed has been edited, computed flows may not apply.

Peak-Flow Statistics Parameters[Region C]

| Parameter Code | Parameter Name | Value | Units | Min Limit | Max Limit |
|---|---|---|---|---|---|
| DRNAREA | Drainage Area | 6.94 | square miles | 0.21 | 607 |
| LAKEAREA | Percent Lakes and Ponds | 0.8 | percent | 0 | 11.8 |

Peak-Flow Statistics Flow Report[Region C]

PIl: Prediction Interval-Lower, Plu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

| Statistic | Value | Unit | PIl | Plu | SE | SEp | Equiv. Yrs. |
|---|---|---|---|---|---|---|---|
| 1.5 Year Peak Flood | 164 | ft^3/s | 76 | 304 | 45.2 | 45.2 | 2.8 |
| 2 Year Peak Flood | 214 | ft^3/s | 95.8 | 408 | 46.8 | 46.8 | 2.4 |
| 5 Year Peak Flood | 380 | ft^3/s | 160 | 753 | 50.4 | 50.4 | 2.8 |
| 10 Year Peak Flood | 526 | ft^3/s | 213 | 1060 | 52.9 | 52.9 | 3.5 |
| 25 Year Peak Flood | 753 | ft^3/s | 293 | 1570 | 56.2 | 56.2 | 4.5 |

| Statistic | Value | Unit | PIl | Plu | SE | SEp | Equiv. Yrs. |
|---|---|---|---|---|---|---|---|
| 50 Year Peak Flood | 965 | ft^3/s | 361 | 2050 | 59.1 | 59.1 | 5.1 |
| 100 Year Peak Flood | 1210 | ft^3/s | 433 | 2640 | 62.3 | 62.3 | 5.7 |
| 500 Year Peak Flood | 1950 | ft^3/s | 618 | 4540 | 70.9 | 70.9 | 6.5 |

*Peak-Flow Statistics Citations*

**Lorenz, D.L., Sanocki, C.A., and Kocian, M.J.,2009, Techniques for Estimating the Magnitude and Frequency of Peak Flows on Small Streams in Minnesota Based on Data through Water Year 2005: U.S. Geological Survey Scientific Investigations Report 2009-5250, 54 p. (http://pubs.usgs.gov/sir/2009/5250/pdf/sir2009-5250.pdf)**

Flow-Duration Statistics Parameters[Flow duration Region BC 2015 5170]

| Parameter Code | Parameter Name | Value | Units | Min Limit | Max Limit |
|---|---|---|---|---|---|
| DRNAREA | Drainage Area | 6.94 | square miles | 2.98 | 2960 |
| STORNWI | Percentage of Storage from NWI | 34.48 | percent | 2.44 | 48 |
| SSURGOC | SSURGO Percent Hydrologic Soil Type C | 21.9 | percent | 2.61 | 100 |

Flow-Duration Statistics Flow Report[Flow duration Region BC 2015 5170]

| Statistic | Value | Unit |
|---|---|---|
| 0.01 Percent Duration | 195 | ft^3/s |
| 0.1 Percent Duration | 119 | ft^3/s |
| 2 Percent Duration | 41.2 | ft^3/s |
| 5 Percent Duration | 25.4 | ft^3/s |
| 10 Percent Duration | 12.2 | ft^3/s |
| 25 Percent Duration | 5.97 | ft^3/s |
| 50 Percent Duration | 2.06 | ft^3/s |

| Statistic | Value | Unit |
|---|---|---|
| 75 Percent Duration | 1.01 | ft^3/s |
| 90 Percent Duration | 0.538 | ft^3/s |
| 95 Percent Duration | 0.316 | ft^3/s |
| 99 Percent Duration | 0.15 | ft^3/s |
| 99.9 Percent Duration | 0.0514 | ft^3/s |
| 99.99 Percent Duration | 0.0435 | ft^3/s |

*Flow-Duration Statistics Citations*

**Ziegeweid, J.R., Lorenz, D.L., Sanocki, C.A., and Czuba, C.R.,2015, Methods for estimating flow-duration curve and low-flow frequency statistics for ungaged locations on small streams in Minnesota: U.S. Geological Survey Scientific Investigations Report 2015–5170, 23 p. (http://dx.doi.org/10.3133/sir20155170)**

Low-Flow Statistics Parameters[Low flow Region BC 2015 5170]

| Parameter Code | Parameter Name | Value | Units | Min Limit | Max Limit |
|---|---|---|---|---|---|
| DRNAREA | Drainage Area | 6.94 | square miles | 2.98 | 2960 |
| STORNWI | Percentage of Storage from NWI | 34.48 | percent | 2.44 | 48 |
| SSURGOC | SSURGO Percent Hydrologic Soil Type C | 21.9 | percent | 2.61 | 100 |

Low-Flow Statistics Flow Report[Low flow Region BC 2015 5170]

| Statistic | Value | Unit |
|---|---|---|
| 7 Day 10 Year Low Flow | 0.163 | ft^3/s |

*Low-Flow Statistics Citations*

**Ziegeweid, J.R., Lorenz, D.L., Sanocki, C.A., and Czuba, C.R.,2015, Methods for estimating flow-duration curve and low-flow frequency statistics for ungaged**

**locations on small streams in Minnesota: U.S. Geological Survey Scientific Investigations Report 2015–5170, 23 p. (http://dx.doi.org/10.3133/sir20155170)**

Seasonal Flow Statistics Parameters[Low flow Region BC 2015 5170]

| Parameter Code | Parameter Name | Value | Units | Min Limit | Max Limit |
|---|---|---|---|---|---|
| DRNAREA | Drainage Area | 6.94 | square miles | 2.98 | 2960 |
| STORNWI | Percentage of Storage from NWI | 34.48 | percent | 2.44 | 48 |
| SSURGOC | SSURGO Percent Hydrologic Soil Type C | 21.9 | percent | 2.61 | 100 |

Seasonal Flow Statistics Flow Report[Low flow Region BC 2015 5170]

| Statistic | Value | Unit |
|---|---|---|
| Oct to Nov 7 Day 10 Year Low Flow | 0.459 | ft^3/s |
| 30_Day_10_Year_Low_Flow_Oct_to_Nov | 0.706 | ft^3/s |
| 7_Day_10_Year_lowflow_Dec_to_Mar | 0.233 | ft^3/s |
| 30_Day_10_Year_Low_Flow_Dec_to_Mar | 0.294 | ft^3/s |
| Apr to May 7 Day 10 Year Low Flow | 0.976 | ft^3/s |
| Apr to May 30 Day 10 Year Low Flow | 3.91 | ft^3/s |
| 7_Day_10_Year_lowflow_Jun_to_Sep | 0.23 | ft^3/s |
| 30_Day_10_Year_Low_Flow_Jun_to_Sep | 0.321 | ft^3/s |
| 122_Day_10_Year_Low_Flow_Jun_to_Sep | 2.38 | ft^3/s |

*Seasonal Flow Statistics Citations*

**Ziegeweid, J.R., Lorenz, D.L., Sanocki, C.A., and Czuba, C.R.,2015, Methods for estimating flow-duration curve and low-flow frequency statistics for ungaged locations on small streams in Minnesota: U.S. Geological Survey Scientific Investigations Report 2015–5170, 23 p. (http://dx.doi.org/10.3133/sir20155170)**

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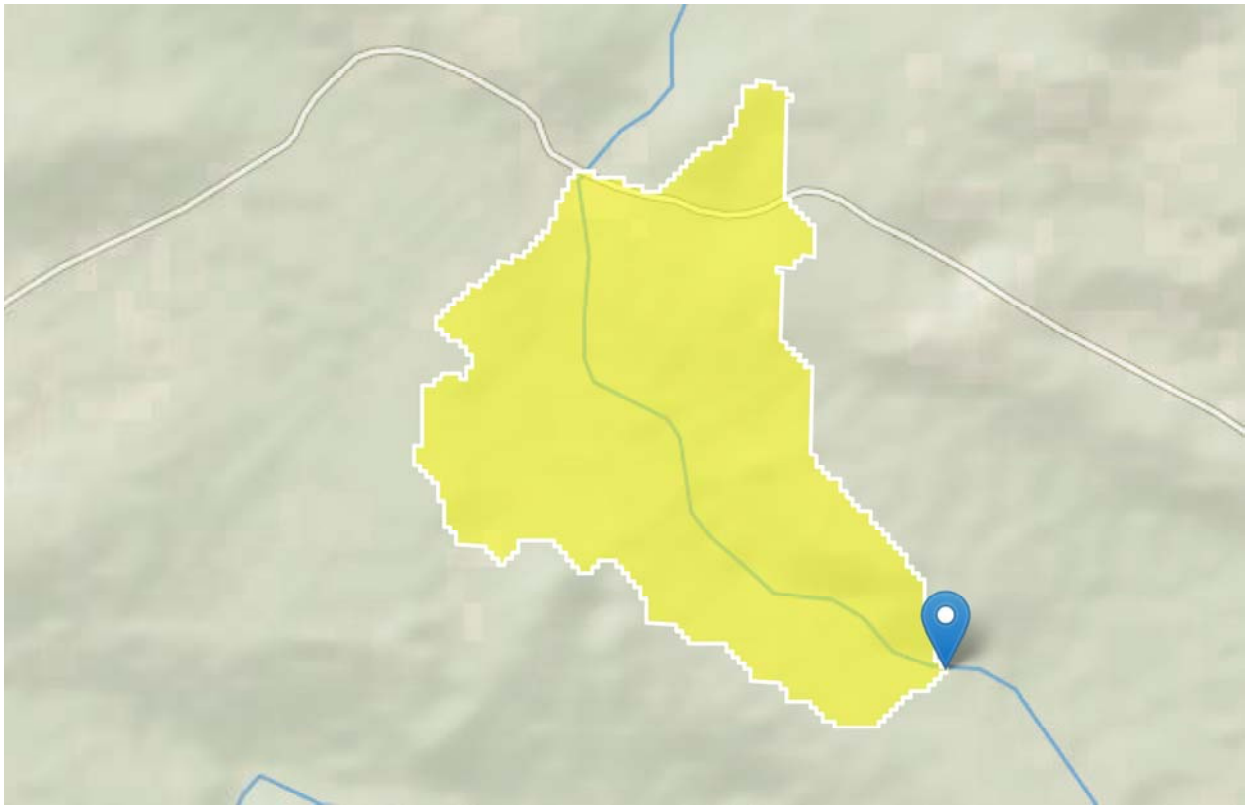
Application Version: 4.3.11

# Little Thirtynine Creek Subwatershed #3 - Existing

**Region ID:** MN
**Workspace ID:** MN20200327165823925000
**Clicked Point (Latitude, Longitude):** 47.30370, -91.38090
**Time:** 2020-03-27 11:58:42 -0500



Basin Characteristics

| Parameter Code | Parameter Description | Value | Unit |
|---|---|---|---|
| DRNAREA | Area that drains to a point on a stream | 0.11 | square miles |
| LAKEAREA | Percentage of Lakes and Ponds | 4.06 | percent |

| Parameter Code | Parameter Description | Value | Unit |
|---|---|---|---|
| STORNWI | Percentage of storage (combined water bodies and wetlands) from the National Wetlands Inventory | 27.76 | percent |
| SSURGOC | Percentage of area of Hydrologic Soil Type C from SSURGO | 18.4 | percent |

General Disclaimers

Parameter values have been edited, computed flows may not apply.

Peak-Flow Statistics Parameters[Region C]

| Parameter Code | Parameter Name | Value | Units | Min Limit | Max Limit |
|---|---|---|---|---|---|
| DRNAREA | Drainage Area | 0.11 | square miles | 0.21 | 607 |
| LAKEAREA | Percent Lakes and Ponds | 4.06 | percent | 0 | 11.8 |

Peak-Flow Statistics Disclaimers[Region C]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors

Peak-Flow Statistics Flow Report[Region C]

| Statistic | Value | Unit |
|---|---|---|
| 1.5 Year Peak Flood | 2.62 | ft^3/s |
| 2 Year Peak Flood | 3.65 | ft^3/s |
| 5 Year Peak Flood | 7.48 | ft^3/s |
| 10 Year Peak Flood | 11.1 | ft^3/s |

| Statistic | Value | Unit |
|---|---|---|
| 25 Year Peak Flood | 17.3 | ft^3/s |
| 50 Year Peak Flood | 23.3 | ft^3/s |
| 100 Year Peak Flood | 30.6 | ft^3/s |
| 500 Year Peak Flood | 54.2 | ft^3/s |

*Peak-Flow Statistics Citations*

**Lorenz, D.L., Sanocki, C.A., and Kocian, M.J.,2009, Techniques for Estimating the Magnitude and Frequency of Peak Flows on Small Streams in Minnesota Based on Data through Water Year 2005: U.S. Geological Survey Scientific Investigations Report 2009-5250, 54 p. (http://pubs.usgs.gov/sir/2009/5250/pdf/sir2009-5250.pdf)**

Flow-Duration Statistics Parameters[Flow duration Region BC 2015 5170]

| Parameter Code | Parameter Name | Value | Units | Min Limit | Max Limit |
|---|---|---|---|---|---|
| DRNAREA | Drainage Area | 0.11 | square miles | 2.98 | 2960 |
| STORNWI | Percentage of Storage from NWI | 27.76 | percent | 2.44 | 48 |
| SSURGOC | SSURGO Percent Hydrologic Soil Type C | 18.4 | percent | 2.61 | 100 |

Flow-Duration Statistics Disclaimers[Flow duration Region BC 2015 5170]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors

Flow-Duration Statistics Flow Report[Flow duration Region BC 2015 5170]

| Statistic | Value | Unit |
|---|---|---|
| 0.01 Percent Duration | 7.97 | ft^3/s |
| 0.1 Percent Duration | 4.26 | ft^3/s |
| 2 Percent Duration | 1.15 | ft^3/s |

| Statistic | Value | Unit |
|---|---|---|
| 5 Percent Duration | 0.642 | ft^3/s |
| 10 Percent Duration | 0.248 | ft^3/s |
| 25 Percent Duration | 0.122 | ft^3/s |
| 50 Percent Duration | 0.0366 | ft^3/s |
| 75 Percent Duration | 0.0178 | ft^3/s |
| 90 Percent Duration | 0.00843 | ft^3/s |
| 95 Percent Duration | 0.00416 | ft^3/s |
| 99 Percent Duration | 0.00183 | ft^3/s |
| 99.9 Percent Duration | 0.00048 | ft^3/s |
| 99.99 Percent Duration | 0.000433 | ft^3/s |

*Flow-Duration Statistics Citations*

**Ziegeweid, J.R., Lorenz, D.L., Sanocki, C.A., and Czuba, C.R.,2015, Methods for estimating flow-duration curve and low-flow frequency statistics for ungaged locations on small streams in Minnesota: U.S. Geological Survey Scientific Investigations Report 2015–5170, 23 p. (http://dx.doi.org/10.3133/sir20155170)**

Low-Flow Statistics Parameters[Low flow Region BC 2015 5170]

| Parameter Code | Parameter Name | Value | Units | Min Limit | Max Limit |
|---|---|---|---|---|---|
| DRNAREA | Drainage Area | 0.11 | square miles | 2.98 | 2960 |
| STORNWI | Percentage of Storage from NWI | 27.76 | percent | 2.44 | 48 |
| SSURGOC | SSURGO Percent Hydrologic Soil Type C | 18.4 | percent | 2.61 | 100 |

Low-Flow Statistics Disclaimers[Low flow Region BC 2015 5170]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors

Low-Flow Statistics Flow Report[Low flow Region BC 2015 5170]

| Statistic | Value | Unit |
|---|---|---|
| 7 Day 10 Year Low Flow | 0.00191 | ft^3/s |

*Low-Flow Statistics Citations*

**Ziegeweid, J.R., Lorenz, D.L., Sanocki, C.A., and Czuba, C.R.,2015, Methods for estimating flow-duration curve and low-flow frequency statistics for ungaged locations on small streams in Minnesota: U.S. Geological Survey Scientific Investigations Report 2015–5170, 23 p. (http://dx.doi.org/10.3133/sir20155170)**

Seasonal Flow Statistics Parameters[Low flow Region BC 2015 5170]

| Parameter Code | Parameter Name | Value | Units | Min Limit | Max Limit |
|---|---|---|---|---|---|
| DRNAREA | Drainage Area | 0.11 | square miles | 2.98 | 2960 |
| STORNWI | Percentage of Storage from NWI | 27.76 | percent | 2.44 | 48 |
| SSURGOC | SSURGO Percent Hydrologic Soil Type C | 18.4 | percent | 2.61 | 100 |

Seasonal Flow Statistics Disclaimers[Low flow Region BC 2015 5170]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors

Seasonal Flow Statistics Flow Report[Low flow Region BC 2015 5170]

| Statistic | Value | Unit |
|---|---|---|
| Oct to Nov 7 Day 10 Year Low Flow | 0.0071 | ft^3/s |
| 30_Day_10_Year_Low_Flow_Oct_to_Nov | 0.0125 | ft^3/s |
| 7_Day_10_Year_lowflow_Dec_to_Mar | 0.00292 | ft^3/s |
| 30_Day_10_Year_Low_Flow_Dec_to_Mar | 0.00412 | ft^3/s |
| Apr to May 7 Day 10 Year Low Flow | 0.0164 | ft^3/s |

| Statistic | Value | Unit |
|---|---|---|
| Apr to May 30 Day 10 Year Low Flow | 0.0908 | ft^3/s |
| 7_Day_10_Year_lowflow_Jun_to_Sep | 0.00299 | ft^3/s |
| 30_Day_10_Year_Low_Flow_Jun_to_Sep | 0.00453 | ft^3/s |
| 122_Day_10_Year_Low_Flow_Jun_to_Sep | 0.0649 | ft^3/s |

*Seasonal Flow Statistics Citations*

**Ziegeweid, J.R., Lorenz, D.L., Sanocki, C.A., and Czuba, C.R.,2015, Methods for estimating flow-duration curve and low-flow frequency statistics for ungaged locations on small streams in Minnesota: U.S. Geological Survey Scientific Investigations Report 2015–5170, 23 p. (http://dx.doi.org/10.3133/sir20155170)**

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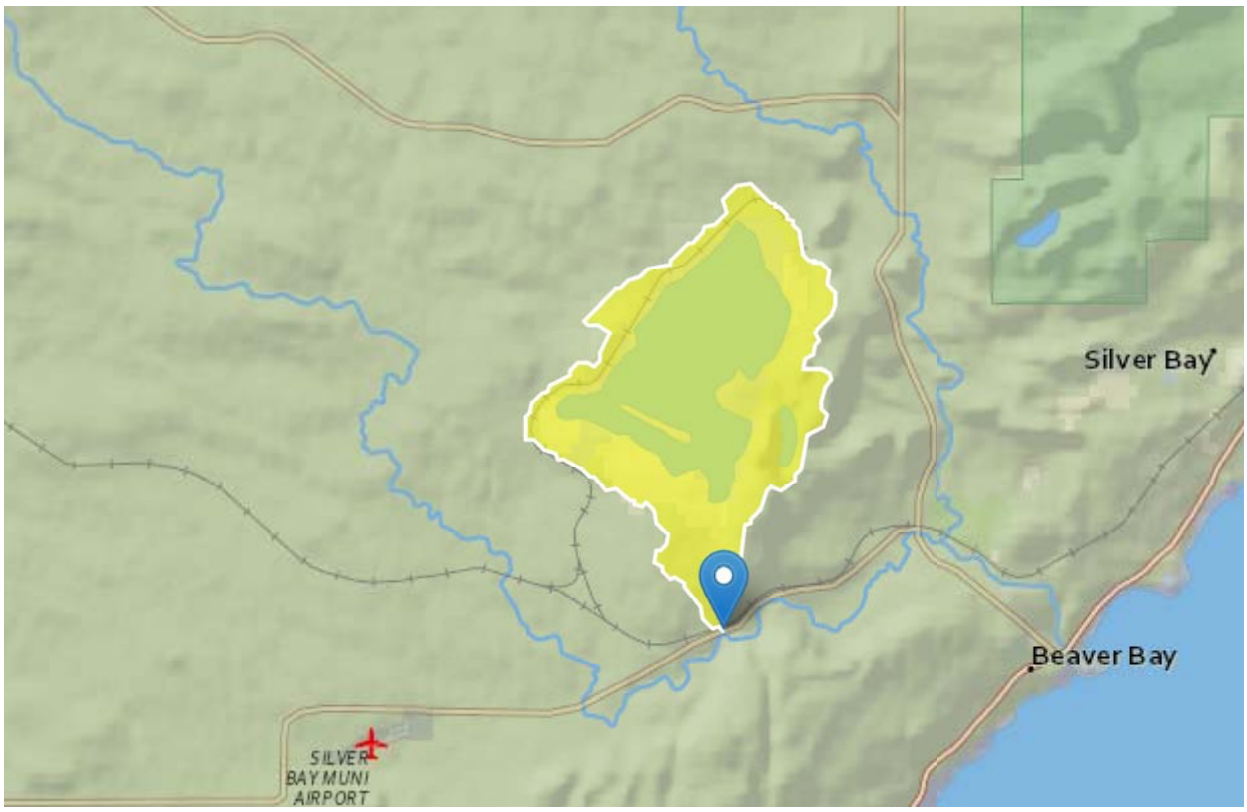
Application Version: 4.3.11

# MilePost 7 Subwatershed #14 - Theoretical Existing Discharge

**Region ID:** MN
**Workspace ID:** MN20200401200539604000
**Clicked Point (Latitude, Longitude):** 47.26228, -91.35534
**Time:** 2020-04-01 15:05:57 -0500




Basin Characteristics

| Parameter Code | Parameter Description | Value | Unit |
|---|---|---|---|
| DRNAREA | Area that drains to a point on a stream | 5 | square miles |
| LAKEAREA | Percentage of Lakes and Ponds | 2.46 | percent |

| Parameter Code | Parameter Description | Value | Unit |
|---|---|---|---|
| STORNWI | Percentage of storage (combined water bodies and wetlands) from the National Wetlands Inventory | 5.42 | percent |
| SSURGOC | Percentage of area of Hydrologic Soil Type C from SSURGO | 12.0 | percent |

General Disclaimers

Parameter values have been edited, computed flows may not apply.

Peak-Flow Statistics Parameters[Region C]

| Parameter Code | Parameter Name | Value | Units | Min Limit | Max Limit |
|---|---|---|---|---|---|
| DRNAREA | Drainage Area | 5 | square miles | 0.21 | 607 |
| LAKEAREA | Percent Lakes and Ponds | 2.46 | percent | 0 | 11.8 |

Peak-Flow Statistics Flow Report[Region C]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

| Statistic | Value | Unit | PIl | PIu | SE | SEp | Equiv. Yrs. |
|---|---|---|---|---|---|---|---|
| 1.5 Year Peak Flood | 86.6 | ft^3/s | 38.7 | 167 | 45.2 | 45.2 | 2.8 |
| 2 Year Peak Flood | 113 | ft^3/s | 48.4 | 224 | 46.8 | 46.8 | 2.4 |
| 5 Year Peak Flood | 199 | ft^3/s | 79.8 | 412 | 50.4 | 50.4 | 2.8 |
| 10 Year Peak Flood | 273 | ft^3/s | 106 | 580 | 52.9 | 52.9 | 3.5 |
| 25 Year Peak Flood | 388 | ft^3/s | 143 | 849 | 56.2 | 56.2 | 4.5 |
| 50 Year Peak Flood | 493 | ft^3/s | 175 | 1110 | 59.1 | 59.1 | 5.1 |

| Statistic | Value | Unit | PIl | Plu | SE | SEp | Equiv. Yrs. |
|---|---|---|---|---|---|---|---|
| 100 Year Peak Flood | 614 | ft^3/s | 207 | 1420 | 62.3 | 62.3 | 5.7 |
| 500 Year Peak Flood | 971 | ft^3/s | 289 | 2410 | 70.9 | 70.9 | 6.5 |

*Peak-Flow Statistics Citations*

**Lorenz, D.L., Sanocki, C.A., and Kocian, M.J.,2009, Techniques for Estimating the Magnitude and Frequency of Peak Flows on Small Streams in Minnesota Based on Data through Water Year 2005: U.S. Geological Survey Scientific Investigations Report 2009-5250, 54 p. (http://pubs.usgs.gov/sir/2009/5250/pdf/sir2009-5250.pdf)**

Flow-Duration Statistics Parameters[Flow duration Region BC 2015 5170]

| Parameter Code | Parameter Name | Value | Units | Min Limit | Max Limit |
|---|---|---|---|---|---|
| DRNAREA | Drainage Area | 5 | square miles | 2.98 | 2960 |
| STORNWI | Percentage of Storage from NWI | 5.42 | percent | 2.44 | 48 |
| SSURGOC | SSURGO Percent Hydrologic Soil Type C | 12 | percent | 2.61 | 100 |

Flow-Duration Statistics Flow Report[Flow duration Region BC 2015 5170]

| Statistic | Value | Unit |
|---|---|---|
| 0.01 Percent Duration | 171 | ft^3/s |
| 0.1 Percent Duration | 90.9 | ft^3/s |
| 2 Percent Duration | 26.9 | ft^3/s |
| 5 Percent Duration | 15.9 | ft^3/s |
| 10 Percent Duration | 7.91 | ft^3/s |
| 25 Percent Duration | 5.6 | ft^3/s |
| 50 Percent Duration | 3.49 | ft^3/s |
| 75 Percent Duration | 2.74 | ft^3/s |

| Statistic | Value | Unit |
|---|---|---|
| 90 Percent Duration | 1.98 | ft^3/s |
| 95 Percent Duration | 1.47 | ft^3/s |
| 99 Percent Duration | 1.04 | ft^3/s |
| 99.9 Percent Duration | 0.538 | ft^3/s |
| 99.99 Percent Duration | 0.461 | ft^3/s |

*Flow-Duration Statistics Citations*

**Ziegeweid, J.R., Lorenz, D.L., Sanocki, C.A., and Czuba, C.R.,2015, Methods for estimating flow-duration curve and low-flow frequency statistics for ungaged locations on small streams in Minnesota: U.S. Geological Survey Scientific Investigations Report 2015–5170, 23 p. (http://dx.doi.org/10.3133/sir20155170)**

Low-Flow Statistics Parameters[Low flow Region BC 2015 5170]

| Parameter Code | Parameter Name | Value | Units | Min Limit | Max Limit |
|---|---|---|---|---|---|
| DRNAREA | Drainage Area | 5 | square miles | 2.98 | 2960 |
| STORNWI | Percentage of Storage from NWI | 5.42 | percent | 2.44 | 48 |
| SSURGOC | SSURGO Percent Hydrologic Soil Type C | 12 | percent | 2.61 | 100 |

Low-Flow Statistics Flow Report[Low flow Region BC 2015 5170]

| Statistic | Value | Unit |
|---|---|---|
| 7 Day 10 Year Low Flow | 1.02 | ft^3/s |

*Low-Flow Statistics Citations*

**Ziegeweid, J.R., Lorenz, D.L., Sanocki, C.A., and Czuba, C.R.,2015, Methods for estimating flow-duration curve and low-flow frequency statistics for ungaged locations on small streams in Minnesota: U.S. Geological Survey Scientific Investigations Report 2015–5170, 23 p. (http://dx.doi.org/10.3133/sir20155170)**

Seasonal Flow Statistics Parameters[Low flow Region BC 2015 5170]

| Parameter Code | Parameter Name | Value | Units | Min Limit | Max Limit |
|---|---|---|---|---|---|
| DRNAREA | Drainage Area | 5 | square miles | 2.98 | 2960 |
| STORNWI | Percentage of Storage from NWI | 5.42 | percent | 2.44 | 48 |
| SSURGOC | SSURGO Percent Hydrologic Soil Type C | 12 | percent | 2.61 | 100 |

Seasonal Flow Statistics Flow Report[Low flow Region BC 2015 5170]

| Statistic | Value | Unit |
|---|---|---|
| Oct to Nov 7 Day 10 Year Low Flow | 1.61 | ft^3/s |
| 30_Day_10_Year_Low_Flow_Oct_to_Nov | 2.15 | ft^3/s |
| 7_Day_10_Year_lowflow_Dec_to_Mar | 1.24 | ft^3/s |
| 30_Day_10_Year_Low_Flow_Dec_to_Mar | 1.51 | ft^3/s |
| Apr to May 7 Day 10 Year Low Flow | 2.49 | ft^3/s |
| Apr to May 30 Day 10 Year Low Flow | 3.96 | ft^3/s |
| 7_Day_10_Year_lowflow_Jun_to_Sep | 1.14 | ft^3/s |
| 30_Day_10_Year_Low_Flow_Jun_to_Sep | 1.41 | ft^3/s |
| 122_Day_10_Year_Low_Flow_Jun_to_Sep | 3.8 | ft^3/s |

*Seasonal Flow Statistics Citations*

**Ziegeweid, J.R., Lorenz, D.L., Sanocki, C.A., and Czuba, C.R.,2015, Methods for estimating flow-duration curve and low-flow frequency statistics for ungaged locations on small streams in Minnesota: U.S. Geological Survey Scientific Investigations Report 2015–5170, 23 p. (http://dx.doi.org/10.3133/sir20155170)**

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Application Version: 4.3.11

# Appendix G

## Wetland Monitoring Plan

# Indirect Wetland Impact Monitoring Plan

## *West Ridge Railroad and Tailings Basin Progression*

Prepared for
Northshore Mining Company

April 30, 2020

# Indirect Wetland Impact Monitoring Plan

## *West Ridge Railroad and Tailings Basin Progression*

Prepared for
Northshore Mining Company

April 30, 2020

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# Indirect Wetland Impact Monitoring Plan

## West Ridge Railroad and Tailings Basin Progression

## April 30, 2020

# Contents


1.0 Introduction ..... 1
2.0 Potential Indirect Wetland Impact Assessment ..... 2
2.1 Wetland 34 ..... 2
2.2 Wetland 35 ..... 2
2.3 Reference Wetland ..... 3
3.0 Wetland Hydrology Monitoring ..... 5
3.1 Monitoring Locations ..... 5
3.2 Well Construction and Placement ..... 6
3.3 Monitoring Schedule ..... 6
4.0 Vegetation Monitoring ..... 8
4.1 Vegetation Monitoring ..... 8
4.2 Vegetation Metrics ..... 8
5.0 Wetland Boundary Monitoring ..... 10
6.0 Indirect Wetland Impact Criteria ..... 11
6.1 Regulatory Impact Thresholds ..... 11
7.0 Reporting ..... 12
8.0 References ..... 13

## List of Tables

Table 1 Summary of Wetland and Watershed Modifications....4
Table 2 Monitoring Well Location Characteristics....5
Table 3 Wetland Monitoring Vegetation Communities....6

## List of Figures

Figure 1 Existing Conditions Watersheds and Wetland
Figure 2 Proposed Condition Watersheds and Potential Indirect Wetland Impacts
Figure 3 Wetlands 34 and 35 Proposed Monitoring Locations
Figure 4 Proposed Reference Wetland Monitoring Locations

# 1.0 Introduction

The purpose of this report is to present a proposed indirect wetland impact monitoring work plan (Plan) for the Northshore Mining Company West Ridge Railroad and Tailings Basin Progression project (Project). The Plan is intended to describe a monitoring program that will allow for determining whether or not indirect wetland impacts result from the permitted project and if so, the extent of those impacts. In order to document whether or not indirect wetland impacts occur and to verify the extent of the potential impacts; hydrologic monitoring, vegetation monitoring, and wetland boundary documentation are proposed.

# 2.0 Potential Indirect Wetland Impact Assessment

An assessment of the potential for indirect wetland impacts was included in the April 2019 *Joint Application and Wetland Replacement Plan – West Ridge Railroad Relocation and Tailings Basin Progression* report (Barr 2019). Further analysis is included here regarding Wetlands 34 and 35 based on subsequent discussions with the U.S. Army Corps of Engineers (USACE).

## 2.1 Wetland 34

Wetland 34 is an 18.24 acre hardwood swamp that currently spans a watershed divide (Watersheds 2B and 3B, Figure 1) with 7.66 acres in the northwest Watershed 2B and 10.58 acres in the southeast Watershed 3B, discharging towards the tailings basin. The railroad and Dam 1 extension embankments will directly impact 3.59 acres of Wetland 34. Approximately 9.0 acres of Wetland 34 will remain between the two embankments within the landfill isolation area, of which 1.47 acres is on the north side of the watershed divide and will be impounded by the railroad embankment (Figure 2). The remaining 7.53 acres of unimpacted Wetland 34 lies in Watershed 1B (Figure 2), draining to the south.

Under existing conditions, the south part of Wetland 34 is 10.59 acres in size and has a 52.3 acre watershed, resulting in a watershed to wetland ratio of 4.9:1 (Table 1, Figure 1). With the project, 7.53 acres of Wetland 34 will remain with an immediate watershed area of 32.9 acres and a watershed to wetland ratio of 4.4:1 (Table 1, Figure 2). While the watershed ratio is reduced by 10 percent, the effective drainage area to the remaining portion of the wetland is virtually the same as in existing conditions (compare Watershed 3B in Figure 1 to Watershed 1B in Figure 2) and the wetland will be allowed to discharge to the south at the wetland boundary elevation, preventing potential impoundment impacts. Since a portion of the wetland will be filled by the project, the original wetland watershed will be altered slightly with a 10 percent reduction in watershed ratio for the south part of the wetland overall; there is some potential for indirect impacts and monitoring is proposed.

## 2.2 Wetland 35

Wetland 35 is a 4.27 acre hardwood swamp wetland, which also crosses a watershed divide (Watersheds 2A and 3C, Figure 1) with 1.71 acres in the northern Watershed 2A and discharging to the south, while 2.56 acres is located in the southern Watershed 3C discharging to the east. The railroad and Dam 1 extension embankments will directly impact 1.54 acres of Wetland 35. Approximately 2.73 acres of Wetland 35 will remain between the two embankments within the landfill isolation area. Of the unimpacted 2.73 acres of wetland, 1.53 acres will remain on the north side of the watershed divide (Watershed 2A, Figure 2) and will continue to drain freely to Wetland 34. The other 1.2 acres of unimpacted Wetland 35 lies in Watershed 1A, draining to the southeast (Figure 2).

Under existing conditions, the north part of Wetland 35 is 1.71 acres in size and has a 5.1 acre watershed, resulting in a watershed to wetland ratio of 3.0:1 (Table 1, Figure 1). With the Project, 1.53 acres of Wetland 35 will remain in the northern part with a watershed area of 14.7 acres and a watershed to wetland ratio of 9.6:1, an increase of 220 percent (Table 1, Figure 2). Because the outlet from the wetland will not be impacted, the additional watershed will provide sustainable hydrology. Under existing

conditions, the south part of Wetland 35 is 2.56 acres in size and has a 13.4 acre watershed, resulting in a watershed to wetland ratio of 5.2:1 (Table 1, Figure 1). With the Project, 1.2 acres of Wetland 35 will remain with a watershed area of 8.5 acres and a watershed to wetland ratio of 7.1:1, an increase of 37 percent (Table 1, Figure 2). Because the wetland will be allowed to discharge to the south at the wetland boundary elevation the additional watershed will provide sustainable hydrology. Since a portion of Wetland 35 will be filled by the project, the original wetland watershed will be altered slightly, and additional watershed area will be added; there is some potential for indirect impacts and monitoring is proposed.

**Table 1 Summary of Wetland and Watershed Modifications**

| Wetland ID | Existing Conditions | | | Future Conditions | | | Percent Watershed Change | Percent Change in Ratio |
|---|---|---|---|---|---|---|---|---|
| | Wetland (acres) | Watershed[1] (acres) | Ratio | Wetland (acres) | Watershed[1] (acres) | Ratio | | |
| Wetland 34 | 18.24 | 85.6 | 4.7 | NA | NA | NA | NA | NA |
| North Wetland 34 | 7.66 | 33.3 | 4.3 | 1.47 | 10.9 | 7.4 | -67% | 72% |
| South Wetland 34 | 10.58 | 52.3 | 4.9 | 7.53 | 32.9 | 4.4 | -37% | -10% |
| South Wetland 34 (including Wetland 35 Watershed) | NA | NA | NA | 7.53 | 41.4 | 5.5 | NA | NA |
| Wetland 35 | 4.27 | 18.5 | 4.3 | 2.73 | 23.0 | 8.4 | 24% | 94% |
| North Wetland 35 | 1.71 | 5.1 | 3.0 | 1.53 | 14.7 | 9.6 | 188% | 220% |
| South Wetland 35 | 2.56 | 13.4 | 5.2 | 1.2 | 8.5 | 7.1 | -37% | 37% |

[1] watershed area includes the wetland area (i.e., total watershed area)

## 2.3 Reference Wetland

Two reference wetlands have been identified to track hydrologic and vegetative wetland characteristics within undisturbed wetlands located outside of the influence of the project (Figure 4). The reference wetlands will be used to understand hydrologic conditions and vegetative changes that may occur naturally due to climate and other factors for comparison to the monitored wetlands. The reference wetlands are located approximately 1-1.5 miles north of the wetlands proposed for monitoring. Both reference wetlands are classified as hardwood swamps in the National Wetland Inventory, the same as the monitored wetlands. The reference wetlands are both in headwater watersheds, similar to the monitored wetlands with wetland to watershed ratios of 4:1 and 7.9:1; within the range of the monitored wetlands (Table 2). The reference wetlands compare favorably to the monitored wetlands in watershed characteristics, landscape position, slope, and vegetation communities while having intact watersheds with only minor disturbances.

**Table 2 Monitoring Well Location Characteristics**

| Well ID | Community Type | Slope (%) | Assessment Area (acres) | Watershed to Wetland Ratio |
|---|---|---|---|---|
| 34-1 | Hardwood Swamp | 0.6 | 1.0 | 4.4 |
| 34-2 | Hardwood Swamp | 3.2 | 1.0 | 4.4 |
| 35-1 | Hardwood Swamp | 1.0 | 1.0 | 9.6 |
| 35-2 | Hardwood Swamp | 2.2 | 0.4 | 7.1 |
| Ref-1 | Hardwood Swamp | 3.0 | 1.7 | 4.0 |
| Ref-2 | Hardwood Swamp | 0.6 | 1.0 | 7.9 |

# 3.0 Wetland Hydrology Monitoring

The purpose of the monitoring wells is to document the presence or absence of wetland hydrology. To do so, the *Water Table Monitoring Project Design* (Noble, 2006) will be followed. This document provides the minimum standard for installation, collection, and interpretation of groundwater monitoring data in cases where direct hydrologic measurements are needed to document the presence or absence of wetland hydrology.

The USACE (2012) has adopted a wetland hydrology standard of inundation or water table within 12 inches of the ground surface for at least 14 consecutive days during the growing season in at least five of ten years. In southern Lake County, the statistical growing season extends from May 1 to October 8, a total of 161 days, based on the closest weather station with adequate temperature data, Wolf Ridge E.L.C. However, the growing season is further defined by field observations of active vegetation growth. The beginning of the growing season is indicated by the emergence and growth of non-evergreen vascular vegetation. The end of the growing season is indicated when deciduous trees have lost their leaves or when the last vascular herbaceous vegetation has turned brown and stopped flowering.

To evaluate and understand the wetland hydrology monitoring data; precipitation data prior to and during the monitoring period will be collected and analyzed. The Natural Resources Conservation Service (NRCS) has established standardized statistical methods (WETS Tables) for evaluating precipitation data for use in evaluating climatic normalcy consistent with the USACE (2005). The WETS precipitation statistics from the Lake County Soil and Water Conservation District (SWCD) weather station will be collected for the historic normal period 1981 to 2010 and used to determine precipitation normalcy during the study period. Daily precipitation data will be collected from the Lake County SWCD weather station or nearest available site and compared to the WETS precipitation averages to determine climate normalcy during each water year throughout the monitoring period (defined as October 1 through September 30). The precipitation will be analyzed on a monthly basis as well as the cumulative 30-day precipitation for direct analysis of the wetland hydrology monitoring data (USACE, 2005).

Baseline wetland hydroperiod data for each monitoring location will be established by conducting two years of monitoring prior to starting construction of the railroad and dam embankments. The hydroperiod is defined as the cumulative number of consecutive days during the growing season in which water levels are within 12 inches of the ground surface or above the ground surface, including only those periods with a minimum of 14 consecutive days. The wetland hydrology monitoring data will be evaluated in the context of the precipitation conditions during and prior to monitoring along with a comparison of the data to the reference wetlands. The wetland hydroperiod data collected during project operations will be compared to the baseline hydroperiod to determine if indirect wetland drainage is occurring.

## 3.1 Monitoring Locations

Northshore proposes to monitor the remaining portions of Wetlands 34 and 35 that lie within the landfill isolation area (Figure 3). Two shallow monitoring well locations will be established within each monitored wetland, approximately as shown on Figure 3. Well 34-1 is located within the northern, headwaters

portion of Wetland 34 where slopes are relatively flat, approximately 0.6 percent (Table 2). Well 34-2 is located in the southern part of Wetland 34 where slopes are steeper at 3 percent (Table 2). Well 35-1, is located in the northern headwaters of Wetland 35 with land slopes of about 1 percent (Table 2). Well 35-2 is in the southern part of Wetland 35 where slopes are slightly steeper at 2.2 percent (Table 2).

One well will be installed within each reference wetland located outside the influence of the project (Figure 4). The reference wetlands were chosen to ensure that there would be no hydrologic effects from the project, but still be located within the same climatic and ecological region, and of the same wetland community types. In addition, the reference wetlands were selected to represent the range of land slopes and watershed to wetland ratios present in the monitored wetlands. Reference Wetland 1 (Ref-1) is a classified as a hardwood swamp by the NWI, has a watershed ratio of 4:1 and land slopes of about 3 percent (Table 2). Reference Wetland 2 (Ref-2) is located in a headwater, hardwood swamp with a watershed ratio of 7.9:1, and land slopes of 0.6 percent (Table 2). Given the similar landscape characteristics to the monitored wetlands and being located upstream in the watershed from the project, the reference wetlands were deemed suitable.

## 3.2 Well Construction and Placement

Monitoring wells will be installed in the approximate locations shown on Figures 3 and 4, consistent with the *Technical Standard for Water-Table Monitoring of Potential Wetland Sites* (USACE, 2005). Wells will be installed to a depth of at least 18 inches with approximately an 18-30 inch length of 1.25-inch diameter, 0.01-inch slot PVC commercial well screen. Where a confining soil layer is encountered, the wells will be installed down to, but not through the confining layer. All wells will be fitted with a filter sock to prevent clogging of the screen. Wells installed in peat or muck soils will be driven into the soil by hand, where possible. At monitoring locations where mineral soils are present, wells will be installed by auguring a bore hole, placing the well, installing a silica sand filter pack, and sealing the upper 4 inches with bentonite to prevent the infiltration of surface water along the well casing. A loose fitting slip cap will cover each well and a breather hole will be drilled near the top of the well casing to equalize pressure and to ensure accurate readings. The location of each well will be documented with a Geographic Positioning System (GPS) unit after installation.

Each monitoring well will be fitted with a data logger designed to automatically record pressure, which is converted to water level by correcting for barometric pressure. The water level data loggers (i.e., Rugged Troll® 100) are manufactured by In-Situ, Inc. The loggers are non-vented pressure transducers and will be programmed to record pressure at least every four hours. The pressure data from Rugged Troll® 100 data loggers will be corrected for atmospheric barometric pressure recorded by a similar device, which will be exposed to the air for the duration of the growing season.

## 3.3 Monitoring Schedule

Wetland hydrology monitoring will be conducted throughout the growing season during baseline monitoring and during project operation. Water levels will be recorded every 4 hours from about late April until approximately October 30 (or until field observations suggest that the growing season has ended). Field visits will be conducted four times during the baseline data growing seasons (approximately

monthly) to download monitoring data and ensure the proper functioning of the wells and a fifth time to remove the data loggers after the end of the growing season. During project operations, field visits will be conducted two times during the growing season. During each field visit, water levels will be recorded in the wetland monitoring wells and the reference wetland wells and checked against the water levels computed from the data loggers to verify accuracy, well data will be downloaded, and photographs will be taken. Should any data logger malfunction, it will be replaced within one month and manual water level measurements will be recorded weekly prior to replacement.

Monitoring will be conducted for a minimum of two years prior to construction of the railroad and Dam 1 embankments to establish baseline conditions. After construction of the railroad and Dam 1 embankments that will isolate Wetlands 34 and 35, monitoring will resume to evaluate potential indirect impacts. Monitoring will continue through during operation of the railroad and dam embankments until the hydrology data have shown stabilized conditions for at least two consecutive years.

# 4.0 Vegetation Monitoring

## 4.1 Vegetation Monitoring

Vegetation monitoring will also be conducted as part of the evaluation of potential indirect wetland impacts. In wetlands, when hydrologic conditions change, vegetation will typically change in response to the hydrology over much longer time periods. However, it is important to establish baseline vegetation conditions prior to the start of the project activities, so comparisons can be made to data collected during project operations. Vegetation monitoring will be completed before construction activities are started to document baseline conditions to which future data will be compared. After construction of the railroad and Dam 1 embankments that isolate Wetlands 34 and 35, vegetation monitoring will be conducted every five years until the hydrology data have shown stabilized conditions for at least two consecutive years. Vegetation will be monitored within defined assessment areas located near each well, including the reference wetlands (Figures 3 and 4), using the timed meander sampling approach following the protocols in the Rapid Floristic Quality Assessment Manual (Rapid FQA) (MPCA, 2014). The assessment areas are mostly 1 acre in size with the exception of 35-2 and Ref-1 (Table 2).

A botanist will inventory vegetation during July or August when most plant species will be identifiable. The botanist will walk within the assessment area and record each new plant species as it is observed. Each assessment area will be surveyed for at least 30 minutes if a single wetland community is present within the area, otherwise 20 minutes will be added for each additional community present. After the first 20 minutes, the botanist will make a note and begin a separate list to record each new species observed; if ≥3 new species are observed in the last 10 minutes of the survey, then the survey will continue for an additional 10 minutes (extended to 40 minutes total). The survey within each assessment area will end after 3 or fewer species are observed in the last 10 minutes of survey. For species that cannot be identified immediately, the ecologist will stop timing to identify it or to collect it for later identification; each species not identified in the field will be coded for reference throughout the survey effort. At least 90 percent of the plant taxa will be inventoried and the cover classes estimated within each assessment area. All unidentified taxa will be enumerated so that their cover can be recorded and specimens will be collected to assist in later identification. When each timed meander survey is completed, the cover of each species observed will be estimated within the assessment area. The cover will be based on an estimate of absolute cover for the entire assessment area. The total of the cover estimates may not equal 100 percent.

## 4.2 Vegetation Metrics

The vegetation species cover estimates will be used to calculate the abundance-weighted Coefficient of Conservatism (*wC.*) following MPCA protocols (MPCA, 2014). The Rapid FQA relies on a general model of biological response to anthropogenic impacts called the Biological Condition Gradient (BCG; US EPA, 2005) as an underlying theoretical framework for the assessment criteria (Bourdaghs, 2012). A five level BCG model specific to wetland vegetation has been developed for the Rapid FQA (Bourdaghs, 2012), of which four levels are typically used (the fifth level represents the absence of a viable vegetation community). The four BCG tiers are described generally as fair, poor, good, and exceptional with exceptional representing pre-European settlement conditions before stressors were present. Ranges of

numeric values of *wC* have been established for each of the 14 wetland community types present in Minnesota as defined by Eggers and Reed (2011) for each BCG tier (MPCA, 2014).

Using the Rapid FQA and *wC* to evaluate vegetation changes within a wetland community incorporates a myriad of potential anthropogenic stressors as potential causes. For example, invasive wetland plant seeds can be transported to wetlands by wildlife, wind, or other natural mechanisms and can become established without hydrologic stressors added to a wetland. In order to more specifically evaluate the tendency for the plant community to be suited to wetland conditions and to determine whether or not the vegetative composition is trending toward non-hydrophytes (as a result of reduced hydrology), the prevalence index will also be calculated for each assessment area (also known as hydrophytic indicator 3) (USACE, 2012). The prevalence index ranges from 1 to 5, and a prevalence index of ≤3.0 indicates that hydrophytic vegetation is present. The prevalence index is a weighted-average wetland indicator status of all plant species in the assessment area sampling (USACE, 2012). All plants are given a numeric value based on indicator status, and their abundance is used to calculate the prevalence index.

# 5.0 Wetland Boundary Monitoring

The wetland boundaries within the wetland areas identified for hydrology monitoring and within the reference wetlands will be delineated before construction is started to establish the pre-project, baseline wetland extents. Starting after construction of the railroad and Dam 1 embankments is complete and continuing every 5 years during construction operations, the wetland boundaries will be re-delineated until the hydrology data has shown stabilized conditions for at least two consecutive years. Approximately 25 percent of wetland boundaries will be field-delineated and located with a GPS with approximately one foot accuracy to document whether or not wetland drainage occurs. If hydrology data indicate potential wetland drainage, wetland boundaries will be delineated within each entire wetland during the following year. Wetland delineation data will be compiled to map each boundary and the results will be reported with the applicable annual monitoring report. A loss of wetland area from the baseline wetland extent will be considered an impact.

# 6.0 Indirect Wetland Impact Criteria

## 6.1 Regulatory Impact Thresholds

Regulatory criteria that may indicate an adverse, indirect wetland impact are as follows:

1. **A 50% reduction of the baseline wetland hydroperiod.** Antecedent moisture conditions based on precipitation data and reference wetland hydrology data will be considered in the evaluation of the wetland hydroperiod. The hydroperiod of a wetland is equal to the length of time and portion of the year the wetland holds ponded water or saturation within 12 inches of the soil surface. This period of time generally varies from year-to-year based on climatic conditions. Therefore, the judgment of surpassing this threshold will be evaluated considering the baseline pre-project monitoring data for each wetland, climatic conditions, and reference wetland hydroperiod.

2. **Change in vegetation species composition and/or cover as described below, inconsistent with vegetation changes in the reference wetland.**

    - Reduction of wC by one or more BCG tiers, and
    - ≥25% increase in the prevalence index

3. **A change in wetland community type coincident with a reduction in wetland hydroperiod that is not consistent with wetland community type change documented within the reference wetland.**

4. **Changes in monitored wetland boundaries inconsistent with changes in boundaries of reference wetlands.**

# 7.0 Reporting

The data for hydrology, vegetation, and wetland boundary monitoring will be compiled into annual reports to be submitted to the USACE, MNDNR, and MPCA. Annual reports will include methods, results, and evaluation of potential adverse indirect wetland impacts. Hydrology data from throughout the growing season will be presented as hydrographs showing the depth to water aligned with the corresponding 30-day cumulative precipitation data compared to the normal range. The individual water level measurements will be presented in tabular format from throughout each growing season along with an electronic file containing the water level measurements. The hydrology monitoring locations will be presented graphically along with a shapefile of the locations. Vegetation monitoring data will only be included in years in which that monitoring was conducted. Wetland boundaries will be presented graphically along with a shapefile of the locations during the years in which that monitoring is conducted. Northshore will discuss the results of monitoring on an annual basis with the agencies and will determine if there is a need to modify this monitoring plan.

# 8.0 References

**Barr Engineering Company.** 2019. *Joint Permit Application and Wetland Replacement Plan – West Ridge Railroad Relocation and Tailings Basin Progression*. April 2019.

**Bourdaghs, M.** 2012. Development of a Rapid Floristic Quality Assessment. wq-bwm-02a. Minnesota Pollution Control Agency, St. Paul, MN.

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# Figures

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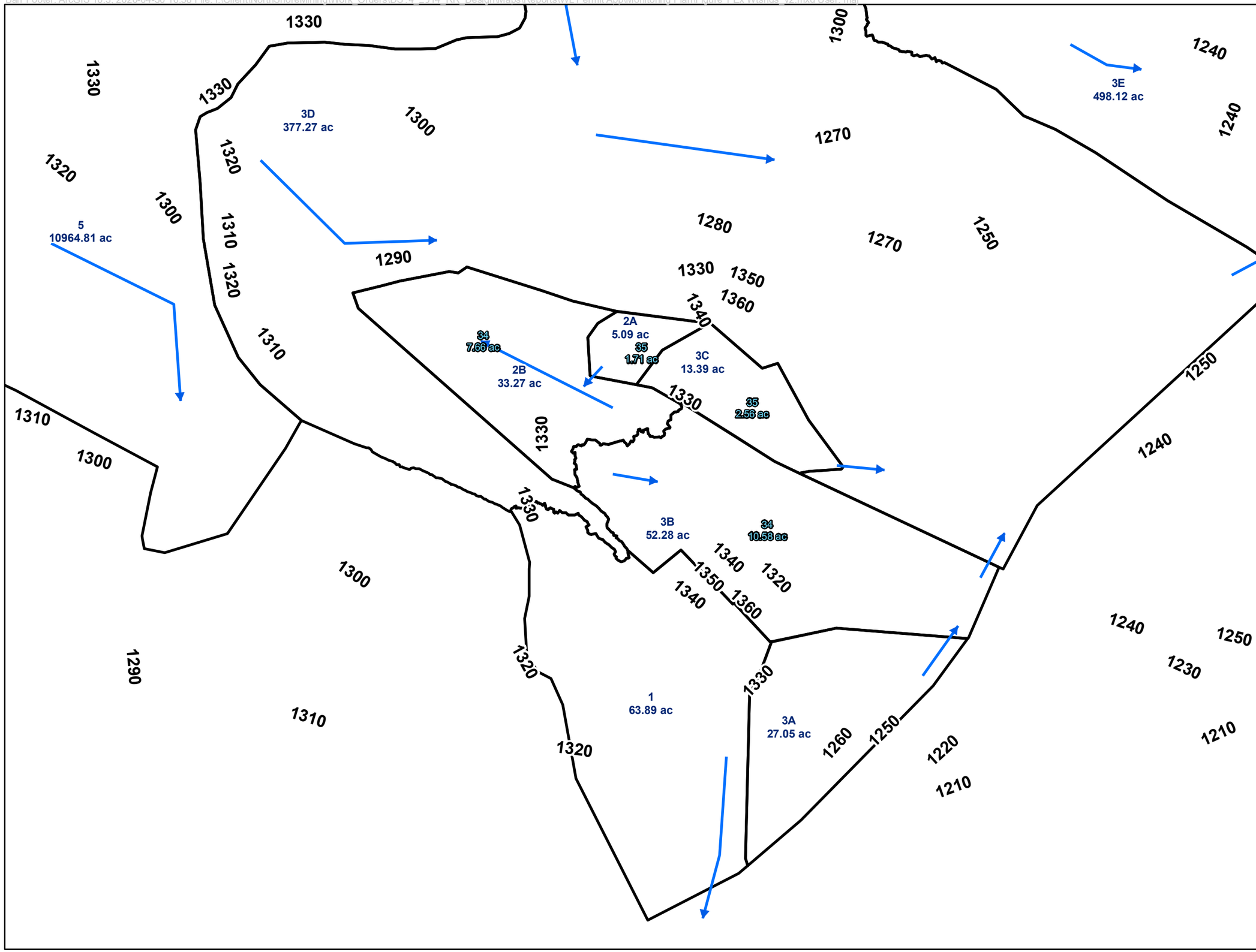



**Legend**

- Existing Flow
- Existing Watersheds
- Deepwater
- Wetlands
- 10 ft Contours

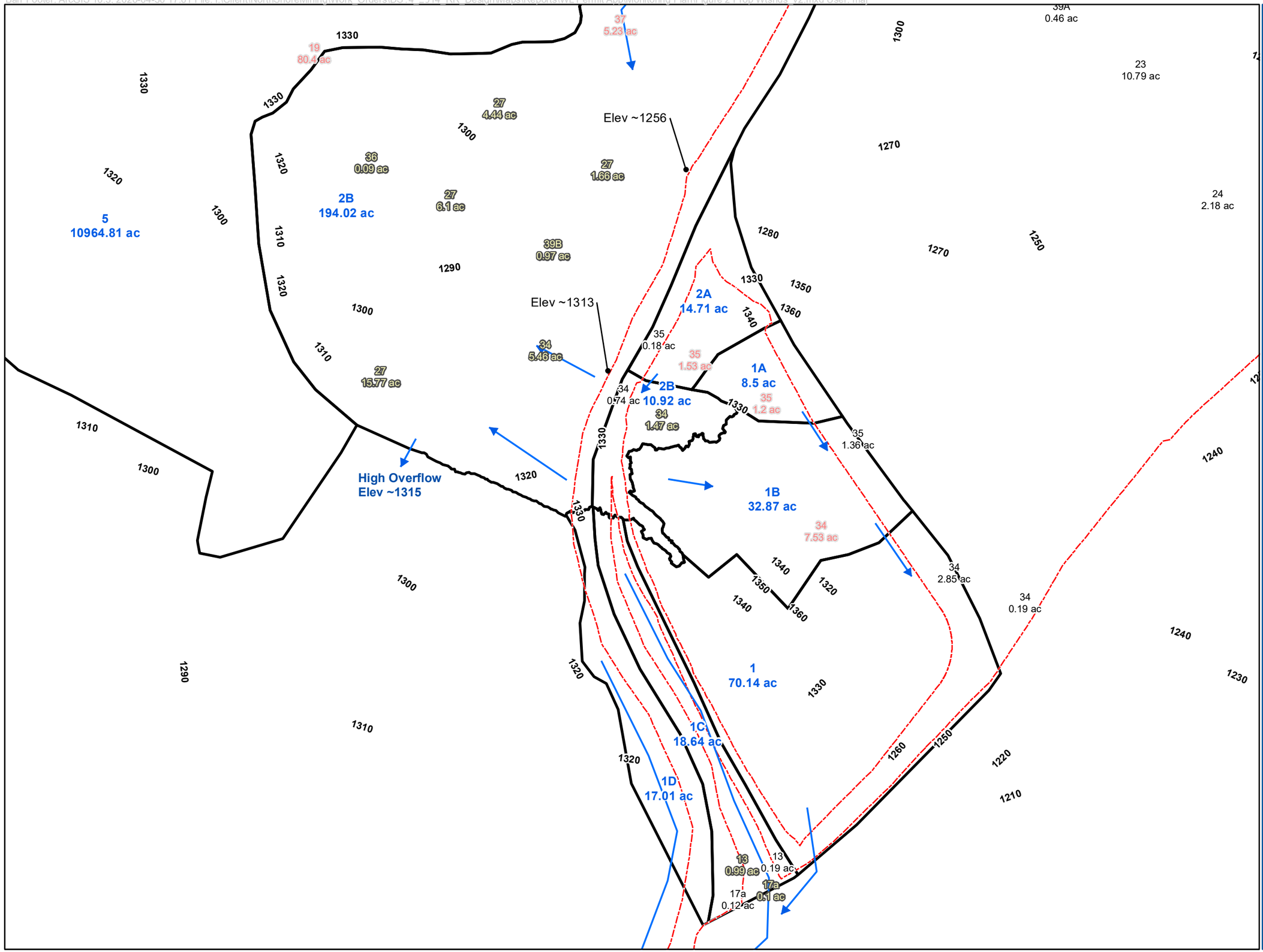
0 600 1,200
Feet

Source: 2017 FSA aerial photo

EXISTING WATERSHEDS
WETLANDS 34 AND 35
Northshore Mining Company
Lake County, Minnesota

FIGURE 1

Barr Footer: ArcGIS 10.3, 2020-04-30 17:01 File: I:\Client\NorthShoreMining\Work_Orders\DS_4_2014_RR_Design\Maps\Reports\WL Permit App\Monitoring Plan\Figure 2 Prop Wtshds_v2.mxd User: maj




## Legend

- Proposed Flow
- Project Area
- Proposed Watersheds
- Remaining Wetlands
- Deepwater Impacts
- Nonjurisdictional Wetlands

**Indirect Wetland Impacts**

- Impoundment
- Fragmentation

**Direct Wetland Impacts**

- Railroad and Dams
- Tailings Basin Progression

**Project Features**

- Dam 1 Extension
- Dam 1 Rail Switchback
- Railroad Embankment
- Tailings Basin Progression
- 10 ft Contours

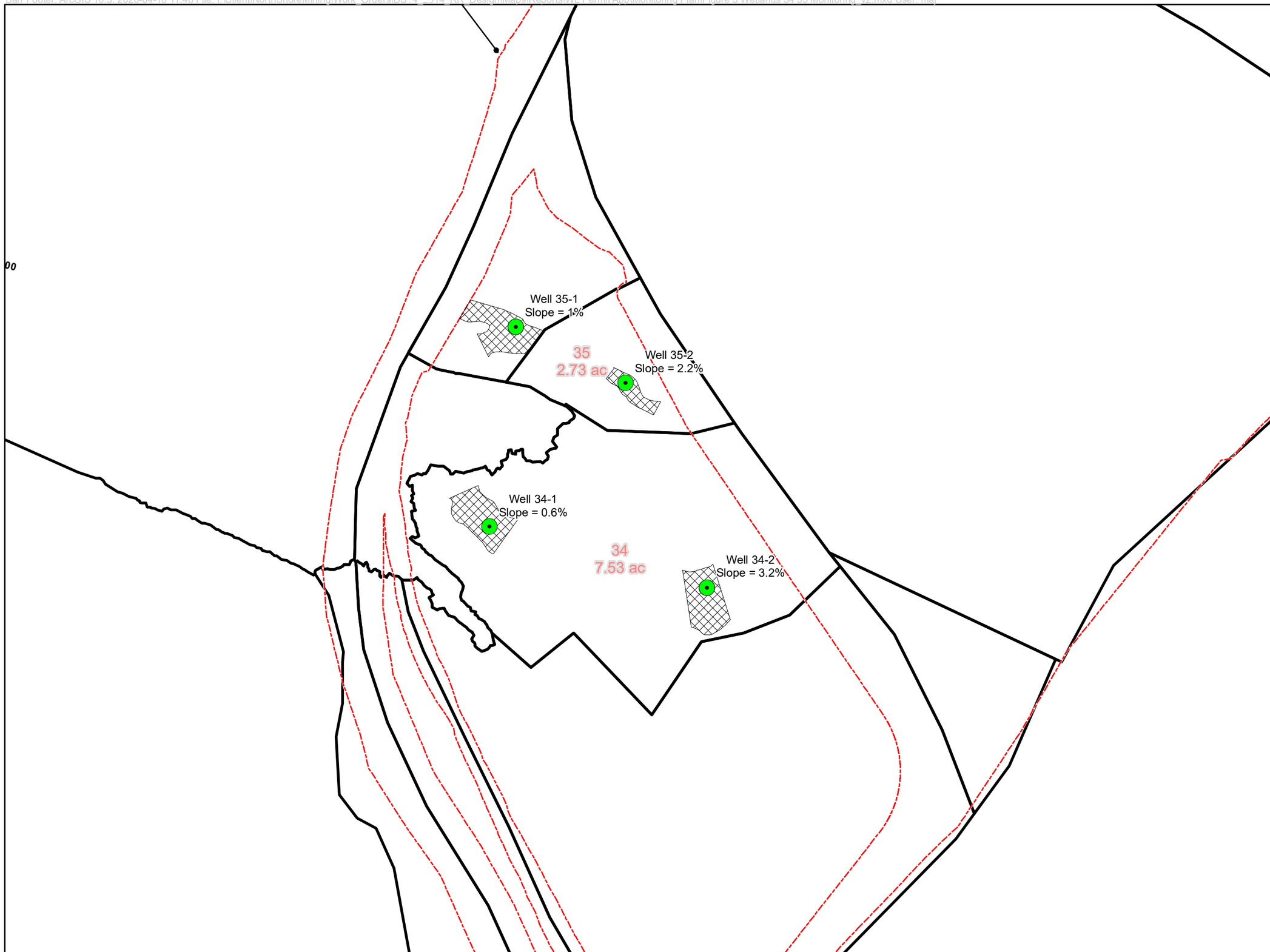
0 600 1,200
Feet

Source: 2017 FSA aerial photo

FUTURE WATERSHEDS
WETLANDS 34 AND 35
Northshore Mining Company
Lake County, Minnesota

FIGURE 2

Barr Footer: ArcGIS 10.3, 2020-04-10 11:48 File: I:\Client\NorthShoreMining\Work_Orders\DS14_2014_RR_Design\Maps\Reports\WL Permit App\Monitoring Plan\Figure 3 Wetlands 34 35 Monitoring_v2.mxd User: maj




**Legend**

- Proposed Monitoring Wells
- Assessment Areas
- Project Area
- Proposed Watersheds
- Unaffected Wetlands
- Nonjurisdictional Wetlands

**Project Features**

- Dam 1 Extension
- Dam 1 Rail Switchback
- Railroad Embankment
- Tailings Basin Progression

**LiDAR Topography**

- 10-ft contours
- 2-ft contours

**Predominant Wetland Type**

- Alder Thicket
- Coniferous Swamp
- Wet/Sedge Meadow
- Hardwood Swamp
- Shallow Marsh

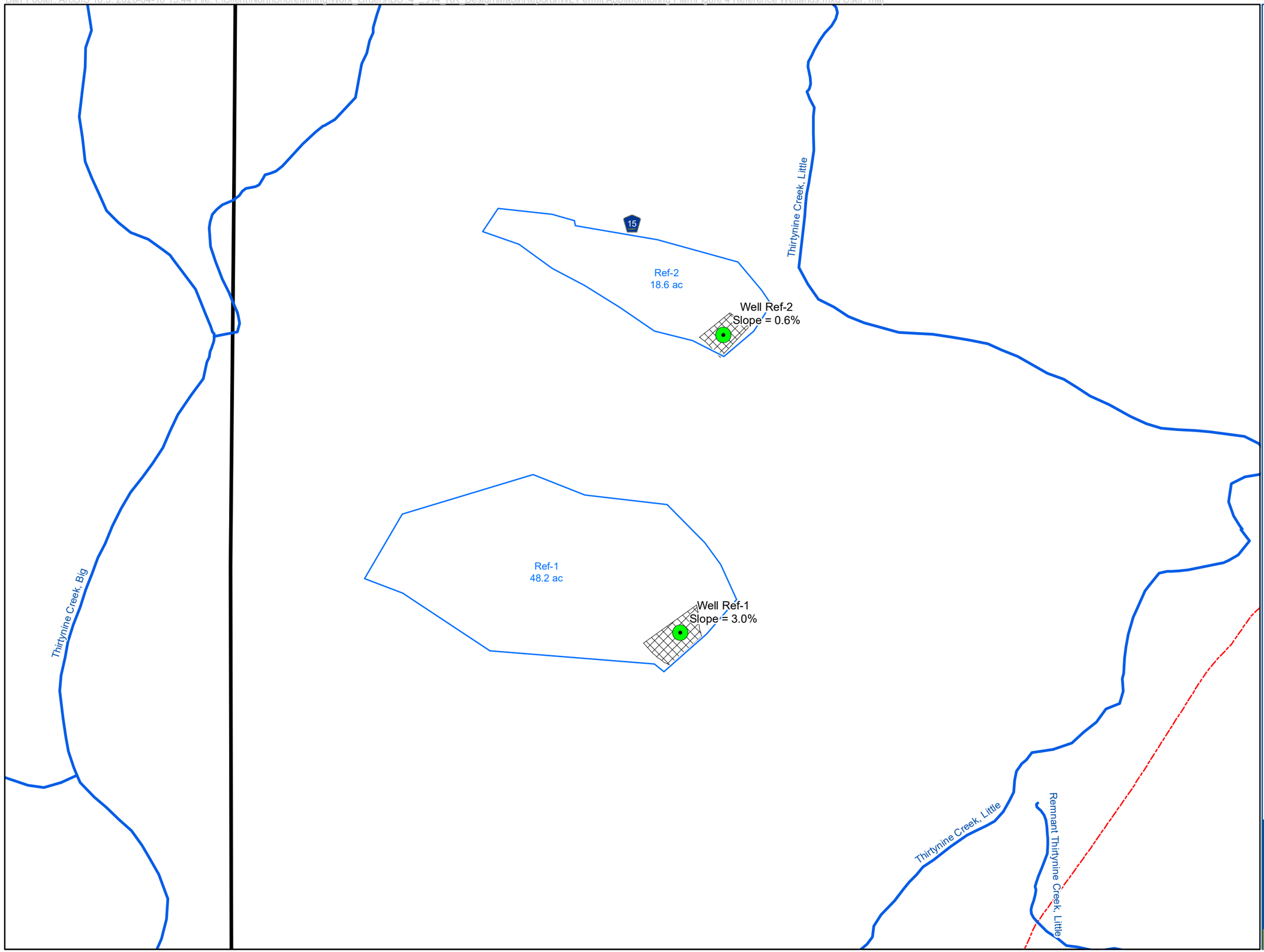
0 400 800
Feet

Source: 2017 FSA aerial photo

WETLANDS 34 and 35
PROPOSED MONITORING
LOCATIONS
Northshore Mining Company
Lake County, Minnesota

FIGURE 3

Barr Footer: ArcGIS 10.3, 2020-04-10 13:44 File: I:\Client\NorthShoreMining\Work_Orders\DS_4_2014_RR_Design\Maps\Reports\WL Permit App\Monitoring Plan\Figure 4 Reference Wetlands.mxd User: maj




## Legend

- Proposed Monitoring Wells
- Reference Wetland Watersheds
- Assessment Areas
- Northshore Property
- Project Area
- Public Water Watercourses

**Project Features**

- Dam 1 Extension
- Dam 1 Rail Switchback
- Railroad Embankment
- Tailings Basin Progression

**LiDAR Topography**

- 10-ft contours
- 2-ft contours

**Wetlands**

- Shrub Swamps
- Shallow Marsh
- Open Water Community
- Hardwood Swamp
- Wet/Sedge Meadow
- Coniferous Wetland
- Deep Marsh
- Seasonally Flooded Basin
- Bog

0 600 1,200
Feet

Source: 2015 FSA CIR aerial photo

PROPOSED REFERENCE WETLAND MONITORING LOCATIONS
Northshore Mining Company
Lake County, Minnesota

FIGURE 4

# Appendix H

## MNRAM Wetland Assessments

# MNRAM Wetland Assessments

## *Tailings Basin Progression Project*

Prepared for
Northshore Mining Company

February 2020

# MNRAM Wetland Assessments

## *Tailings Basin Progression Project*

Prepared for
Northshore Mining Company

February 2020

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MNRAM Wetland Assessments

February 2020

# Contents


1 Introduction ..... 1
2 Representative Sample of Project Wetlands ..... 2
3 Comparison of MnRAM Evaluations ..... 3
3.1 MnRAM 3.4 ..... 3
3.2 Barr Mine MnRAM ..... 3
3.3 MnRAM Method Comparison ..... 3
3.3.1 Hydrologic and Water Quality Functions ..... 3
3.4 Wildlife Habitat ..... 4
3.4.1 Functions Not Considered in Barr Mine MnRAM ..... 4
3.4.2 MnRAM 3.4 Values ..... 5
3.4.3 MnRAM 3.4 Groundwater Interaction ..... 5
3.4.4 MnRAM 3.4 Planning Tools ..... 5
4 Methods ..... 6
4.1 Barr Mine MnRAM ..... 6
4.2 MnRAM 3.4 ..... 6
5 Results ..... 7
5.1 Wetland 2 ..... 7
5.2 Wetland 6 ..... 8
5.3 Wetland 8 ..... 8
5.4 Wetland 11a ..... 8
5.5 Wetland 11c ..... 9
5.6 Wetland 13 ..... 9
5.7 Wetland 15 ..... 9
5.8 Wetland 17b ..... 10
5.9 Wetland 18 ..... 10
5.10 Wetland 20 ..... 12
5.11 Wetland 23 ..... 12
5.12 Wetland 27 ..... 13

6 Conclusions ..... 15
7 References ..... 16

## List of Tables


Table 1 Summary of Ratings for Jurisdictional Wetlands Using Barr Mine MnRAM
Table 2 Summary of Wetlands Selected for Full MnRAM 3.4 Evaluation
Table 3 Comparison of Functions/Values and Variables for the Barr Mine MnRAM and MnRAM 3.4


## List of Figures


Figure 1 MNRAM Evaluations


## List of Appendices


Appendix A Barr Mine MnRAM Wetland Functional Assessment Results
Appendix B Barr Mine MnRAM – Summary of Field Methodology
Appendix C U.S. Army Corps of Engineers Comments Dated July 17, 2019
Appendix D MnRAM 3.4 Response Records and Wetland Functional Assessment Summaries
Appendix E Comparison of MnRAM Evaluations
Appendix F MnRAM 3.4 Guidance, Section 6 – Functional Rating Formulas

# 1 Introduction

Barr Engineering Co. (Barr) evaluated the condition and functions of the Northshore West Ridge Railroad Project (Project) wetlands during the field wetland delineations in July and August 2015 (Appendix A). This evaluation was based on using a subset of the functions and values in the Minnesota Routine Assessment Method for Evaluating Wetland Functions, Version 3.4 (MnRAM 3.4; BWSR 2010). Appendix B provides a summary of the field methodology for this subset of 9 considerations - the Barr Mine MnRAM (Barr 2015a).

A summary of the field methodology for the Barr Mine MnRAM was provided to the U.S. Army Corps of Engineers (Corps), St. Paul District on May 31, 2019, via e-mail from Andrea Hayden (Appendix B). The Corps responded with comments on July 17, 2019 (Appendix C) which requested:

1. *In order to have a true understanding of Barr's abbreviated assessment, we ask that you pick a representative sample of wetlands from the project area with a range of vegetative quality (high, medium, and low) and each wetland plant community and run the full MNRAM analysis on them.*
2. *Please provide the rationale behind why specific factors of MNRAM were opted out of and why the selected factors were considered.*

Therefore, the purpose of this technical memorandum is to provide responses to the Corps' request for further information about the Barr Mine MnRAM evaluation that was conducted for the Project. Full MnRAM 3.4 evaluations were completed for a representative sample of wetland types in the Project area in order to evaluate the effectiveness of the Barr Mine MnRAM methodology, which was used for this Project.

# 2 Representative Sample of Project Wetlands

There were 64 wetlands that were evaluated for this Project, including six wetland community types: fresh (wet) meadow, sedge meadow, shallow marsh, alder thicket, hardwood swamp, and coniferous swamp (Appendix A). A total of 18 of those wetlands were determined to be non-jurisdictional and one wetland had no proposed impacts (Wetland 37); so those wetlands were eliminated from consideration. A summary of the remaining 39 wetlands is provided in Table 1, categorized by wetland type and vegetative diversity ratings. Since 85 percent of the Project wetlands were rated high for vegetative diversity, we also evaluated their overall wetland condition (Table 1, lower part) in order to select a wider range of overall wetland functioning.

Based on this criteria, 12 wetlands were selected, upon which a full MnRAM 3.4 evaluation was completed (Table 2 and Figure 1). At least one wetland of each community type was selected and wetlands were selected from all of the various vegetative diversity ratings (Table 2), representing the full range of wetlands present at the Project. These wetlands included sedge meadow (Wetlands 6, 11a, and 11c), fresh (wet) meadow (Wetland 8), shallow marsh (Wetlands 17b and 18), alder thicket (Wetlands 13 and 15), hardwood swamp (Wetlands 2, 23, and 27), and coniferous swamp (Wetland 20). The vegetative diversity of these wetlands ranged from moderate to exceptional using the Barr Mine MnRAM (based on the sensitive plant species survey results, 2 wetlands would rate Exceptional for vegetative diversity based on special features item in MnRAM 3.4) (BWSR 2010). In addition, human disturbance ranged from low to high, with some Project wetlands located within or adjacent to disturbance areas including ditches, borrow areas, tree clearing, 2006 railroad construction, and roadway construction associated with the permitted operation of the tailings basin (Appendix B).

# 3 Comparison of MnRAM Evaluations

## 3.1 MnRAM 3.4

The MnRAM was originally developed by an interagency workgroup in 1991, shortly after the Minnesota Wetland Conservation Act (WCA) was initiated. The MnRAM was developed as a practical assessment tool to help local authorities to make wetland management decisions when regulating wetland impacts. Since 1991, there have been updates resulting in the current version of MnRAM 3.4. The majority of the considerations in MnRAM 3.4 are function-related, however, there are two value-related considerations (aesthetics/recreational/educational/cultural and commercial uses), and one consideration that characterizes the most likely groundwater interaction within wetlands. In addition, there are three planning tools incorporated in the MnRAM 3.4 methodology: wetland restoration potential, additional stormwater treatment needs, and wetland sensitivity to stormwater and urban development (BWSR 2010). The formulas for computing ratings in MnRAM 3.4 are included in Appendix F.

## 3.2 Barr Mine MnRAM

The Barr Mine MnRAM was developed in about 2005 with the intent of incorporating evaluation of the most common wetland functions in northern Minnesota wetlands that could be reasonably applied to large mining projects containing many wetlands per project. The Barr Mine MnRAM incorporates the majority of wetland and watershed characteristics evaluated in the MnRAM 3.4 wetland functions. Barr has utilized the Barr Mine MnRAM for many mining projects in northern Minnesota during the last 15 years. Notable are four projects authorized between 2007 and 2019 with wetland impacts of 123 acres, 629 acres, 765 acres, and 930 acres, respectively. All of those projects were evaluated through Environmental Impact Statements, and wetland functions were evaluated using the Barr Mine MnRAM, which was determined to provide adequate assessment of lost wetland functions as documented in the decision documents and permit authorizations. The Barr Mine MnRAM has been utilized for numerous other mining projects for which Corps authorizations were issued.

## 3.3 MnRAM Method Comparison

The wetland functions and values defined in MnRAM 3.4 that were incorporated into the Barr Mine MnRAM are shown in Table 3. These considerations are used to allow for an evaluation of potential direct and indirect wetland impacts resulting from the development of mining projects.

Table 3 identifies the 15 wetland functions, values, characteristics, and planning tools that can be evaluated using MnRAM 3.4. The MnRAM 3.4 variables associated with determining ratings for each function/value/characteristic are summarized in Table 3 along with the corresponding variables evaluated using the Barr Mine MnRAM method. The rationale for why specific factors were selected for the Barr Mine MnRAM method are described below.

### 3.3.1 Hydrologic and Water Quality Functions

There are several common characteristics of wetlands and surrounding areas that are factored into evaluating the four hydrologic and water quality wetland functions in MnRAM 3.4:

- Outlet characteristics
- Upland land use/upland buffer
- Stormwater runoff
- Soil disturbance/erosion
- Emergent vegetation

The intent of the Barr Mine MnRAM methodology was to develop wetland assessment variables that encompassed these critical characteristics. Each of these most common MnRAM 3.4 characteristics related to hydrology and water quality are considered in the Barr Mine MnRAM (Appendix B) as described below and as shown in Table 3.

- Outlet characteristics - #4 Wetland Outlet Configuration
- Upland land use/upland buffer – #5 Upland Conditions/Land Uses
- Stormwater runoff - #8 Human Disturbance
- Soil disturbance/erosion - #8 Human Disturbance and #5 Upland Conditions/Land Uses
- Emergent vegetation - #5 Upland Conditions/Land Uses

## 3.4 Wildlife Habitat

In MnRAM 3.4, the maintenance of characteristic wildlife habitat structure function evaluates the value of a wetland for wildlife generally, not for specific species, because a wetland's ability to support specific wildlife species is difficult to determine (BWSR 2010). Therefore, the evaluation of wildlife habitat in MnRAM 3.4 considers barriers, vegetative diversity, wetland detritus, upland buffer, outlet characteristics, stormwater runoff, and habitat interspersion (vegetation types, communities, and wetlands), most of which are also evaluated in the Barr Mine MnRAM method (as described below and in Table 3):

- Barriers - #6 Wildlife habitat
- Vegetative diversity - #3 Vegetative Diversity
- Upland buffer - #5 Upland Condition/Land Uses
- Outlet Characteristics - #4 Wetland Outlet Configuration
- Stormwater runoff - #8 Human Disturbance
- Habitat Interspersion - #6 Wildlife Habitat
- Wetland Interspersion – Not evaluated by Barr Mine MnRAM
- Wetland Detritus – Not evaluated by Barr Mine MnRAM

### 3.4.1 Functions Not Considered in Barr Mine MnRAM

The shoreline protection function of MnRAM 3.4 is not considered in the Barr Mine MnRAM, because stream and lake impacts within Minnesota mining projects have been rare.

The fish habitat function of MnRAM 3.4 is described as a wetland's ability to support native fish, which is determined by structural wetland factors and water quality contributions, but is only present in wetlands inundated during most of the growing season (BWSR 2010). MnRAM 3.4 also includes a method for evaluating the value of wetlands for amphibians in general, but not for specific species, and amphibian

habitat is only present in wetlands typically inundated in the spring through about mid-June (BWSR 2010). The MnRAM 3.4 evaluation of fish and amphibian habitat, if present, focus on upland land use/buffer, stormwater, erosion, nutrient loading, and barriers; all of which are considered in the overall Barr Mine MnRAM method (Table 3). However, the Barr Mine MnRAM method does not consider whether wetlands have the appropriate hydroperiod or connectivity to other waters supporting fish to adequately characterize amphibian or fish habitat. Because there are three wetlands within the Project area that do have suitable fish and amphibian habitats, those wetlands have been evaluated utilizing the MnRAM 3.4 to capture those functions.

### 3.4.2 MnRAM 3.4 Values

The aesthetics/recreation/education/cultural value of wetlands in MnRAM 3.4 considers specific educational and recreational values of wetlands, visibility, proximity to public lands, ownership, access, human disturbance, and spatial buffering, with the qualifier that wetlands on private lands are not likely to provide benefits to the general public (BWSR 2010). Barr Mine MnRAM question #7 considers predominantly accessibility and recreational value. Because the Project is entirely planned on private land, the lack of public accessibility is the controlling factor.

The commercial uses value in MnRAM 3.4 is another one that is rarely a component of wetlands within mining projects and therefore, was not included in the Barr Mine MnRAM. No wetlands within the Project area were determined to have existing commercial uses.

### 3.4.3 MnRAM 3.4 Groundwater Interaction

The groundwater interaction function is the most difficult to assess and the most likely type of interaction is determined using MnRAM 3.4 (i.e., recharge, discharge, or a combination) (BWSR 2010). Because this function is difficult to accurately determine without large quantities of detailed hydrologic and geologic information, and because the goal of evaluating this function is to help guide future management (BWSR 2010); it was not included in the Barr Mine MnRAM.

### 3.4.4 MnRAM 3.4 Planning Tools

The three planning tools included in MnRAM 3.4: wetland restoration potential, additional stormwater treatment needs, and wetland sensitivity to stormwater are included in MnRAM 3.4 to assist with planning level inventory and assessment projects. For instance, watershed districts in Minnesota commonly use these tools to guide development, protect wetland resources from secondary effects, and plan for wetland restoration activities. Because this Project is not a planning project, these tools were not included in the Barr Mine MnRAM and are not included in the full MnRAM 3.4 assessments presented here.

# 4 Methods

## 4.1 Barr Mine MnRAM

Wetland information was collected for the Barr Mine MnRAM during fieldwork in July and August 2015 (Barr 2015b). Based on the fieldwork, the Barr Mine MnRAM considerations were evaluated using the guidance in Appendix B. The ratings for the Barr Mine MnRAM assessment have been updated to account for the subsequent identification of State-listed species and the updated results are provided in Appendix A, including the recalculation of overall wetland condition to not include public value. In order to evaluate how well the Barr Mine MnRAM method characterizes MnRAM 3.4 wetland functions and values, the wetland and landscape factors evaluated using the Barr Mine MnRAM method, applicable to each MnRAM 3.4 function, were combined and averaged based on the descriptions in Section 2.0 to arrive at a comparable rating for each function. The relationship of the Barr questions/factors to the MnRAM 3.4 functional formulas is summarized in Table 3 and the individual question ratings and computed comparisons for each MnRAM 3.4 function are included in Appendix E.

For example, the Maintenance of Hydrologic Regime function in MnRAM 3.4 is characterized by: outlet characteristics, upland land use, soil disturbance, and stormwater runoff. Barr Question #4 characterizes the wetland outlet, Barr Questions #5 and #8 address upland land use, Barr Question #8 evaluates soil disturbance, and Barr Question #8 gets at stormwater characteristics. Therefore, the average of Barr Questions #4, #5, and #8 are used as a check on how well the Barr methodology characterizes the Maintenance of Hydrologic Regime function.

An additional check used to compare the Barr Mine MnRAM method against MnRAM 3.4, is comparing overall condition scores. For the Barr method, an overall condition score was determined for each wetland by taking the average of each of the six applicable MnRAM 3.4 wetland function ratings (Table E-2). To determine average scores comparable to MnRAM 3.4, the values for individual Barr method questions were based on MnRAM 3.4 (BWSR 2010, pg 3): Low=0.1, Medium=0.5, High=1.0, and Exceptional=2.0. The rating for overall condition scores was determined based on MnRAM 3.4 (BWSR 2010, pg 3) function score ranges: Low=0.01-0.32, Medium=0.33-0.65, High=0.66-1.0, and Exceptional=1.01-2.0 (Tables E-1).

## 4.2 MnRAM 3.4

Wetland information was evaluated using the field information collected in 2015 (Barr 2015b) as well as supplementing this information in 2019 using ArcMap 10.7.1 to review more current aerial photography and publically-available information. Based on this information, the MnRAM 3.4 functions and values were evaluated following the comprehensive guidance document and Microsoft Access database (BWSR 2010). The MnRAM 3.4 results for each wetland are provided in Appendix D. The ratings for the MnRAM 3.4 functions and values are provided in Appendix E compared to the Barr Mine MnRAM ratings. Based on the ratings for each function, an overall condition score was determined for each wetland by taking the average of each of the nine applicable MnRAM 3.4 wetland function ratings (Table E-2). The rating for overall condition score is also based on MnRAM 3.4 (BWSR 2010, pg 3) (Low=0.01-0.32, Medium=0.33-0.65, High=0.66-1.0, Exceptional=1.01-2.0) (Table E-1).

# 5 Results

Table E-1 in Appendix E provides a comparison of the all the results for the Barr Mine MnRAM and MnRAM 3.4 considerations. The ratings for the MnRAM 3.4 functions and values compared to Barr Mine MnRAM surrogates as described in Table 3 are shown in Tables E-1 (ratings) and E-2 (numeric scores) (Appendix E).

Following is a summary of how the Barr method compared to MnRAM 3.4 functions and values:

- Vegetative diversity/integrity – all wetlands rated the same
- Maintenance of hydrologic regime - the Barr method rated one wetland lower than MnRAM 3.4 by one rating category
- Flood and stormwater storage/attenuation - the Barr method rated one wetland higher than MnRAM 3.4 by one rating category and one wetland lower by one category
- Downstream water quality protection - the Barr method rated four wetlands higher than MnRAM 3.4, each by one rating category
- Maintenance of wetland water quality - the Barr method rated two wetlands lower than MnRAM 3.4 by one rating category
- Maintenance of Characteristic Wildlife Habitat Structure - the Barr method rated one wetland higher than MnRAM 3.4 by one rating category
- Shoreline habitat, fish habitat, and amphibian habitat - do not have surrogate measures in the Barr method
- Overall condition – the Barr method rated one wetland lower than MnRAM 3.4 by one rating category, except all individual functions were rated the same
- Aesthetics/recreational - all wetlands rated the same

More detailed descriptions are provided in the following sections for each wetland selected for this evaluation.

## 5.1 Wetland 2

Wetland 2 is identified as a hardwood swamp, with small areas of fresh (wet) meadow and shrub-carr (Eggers and Reed 2011). It is a natural wetland that is partially disturbed by a ditch at the downstream end. This 8.3-acre wetland is located on a slope draining towards the tailings basin with over 50 feet of fall from northwest to southeast.

Ratings for the MnRAM 3.4 functions and the Barr Mine MnRAM in Wetland 2 are the same except for wildlife habitat, which is rated “high” for the Barr Mine MnRAM and “moderate” for MnRAM 3.4 (Table E-1). The actual difference in scores for wildlife habitat is 0.06 points and falls across the dividing line between moderate and high ratings (0.70 for Barr method compared to 0.64 for MnRAM 3.4 with the dividing line at 0.65-0.66) (Table E-2). The community types and hydroperiod present in Wetland 2 are not adequate for supporting fish or amphibian habitat. The overall condition rating and the

aesthetics/recreational value were both rated the same using the Barr method as using the MnRAM 3.4 method (Table E-1).

## 5.2 Wetland 6

Wetland 6 is identified as primarily a sedge meadow wetland with an alder thicket component (Eggers and Reed 2011). The wetland was created from excavation activities to obtain borrow materials, is adjacent to a roadway, and the upland area around the southeast end of the wetland is generally devoid of vegetation or has sparse vegetation. This wetland appears to intermittently overflow into a roadway ditch. This 1.25-acre, slope wetland has over 20 feet of relief from the northwest end to the southeast end.

Ratings for the MnRAM functions in Wetland 6 are all the same for both MnRAM 3.4 and the Barr Mine MnRAM, except for downstream water quality (Table E-1). The rating for downstream water quality is "moderate" for the Barr Mine MnRAM and "low" for MnRAM 3.4. The primary reasons for the "moderate" rating using the Barr method are that due to the significant landscape disturbance from historic borrow activities, the wetland has an opportunity to treat runoff and protect downstream resources, but that is offset by the constructed outlet. The MnRAM 3.4 "low" rating results from degraded upland conditions, sparse emergent vegetation, and the proximity of downstream water resources being more than 2 miles away. The MnRAM 3.4 assessment considers more factors, which may be more representative in this case. The community types and hydroperiod present in Wetland 6 are not adequate for supporting fish or amphibian habitat. The overall condition rating and the aesthetics/recreational value were both rated the same using the Barr method as using the MnRAM 3.4 method (Table E-1).

## 5.3 Wetland 8

Wetland 8 is identified as a fresh (wet) meadow, with a small area of shrub-carr (Eggers and Reed 2011). The wetland was created by excavation activities to obtain borrow materials, is adjacent to a roadway, and the upland area around the majority of the wetland is generally devoid of vegetation or has sparse vegetation. This wetland appears to intermittently overflow into a roadway ditch. This 2.66-acre, slope wetland has approximately 48 feet of fall from west to east (Figure 1).

Ratings for the MnRAM functions in Wetland 8 are all the same for both MnRAM 3.4 and the Barr Mine MnRAM (Table E-1). The community types and hydroperiod present in Wetland 8 are not adequate for supporting fish or amphibian habitat. The overall condition rating and the aesthetics/recreational value were both rated the same using the Barr method as using the MnRAM 3.4 method (Table E-1).

## 5.4 Wetland 11a

Wetland 11a is identified as a sedge meadow, with a small area of hardwood swamp (Eggers and Reed 2011). It is a natural wetland that is depressional with no apparent surface water outlet. The wetland encompasses 0.04 acres and is surrounded by naturally vegetated uplands.

Ratings for the MnRAM functions in Wetland 11a are all the same for both MnRAM 3.4 and the Barr Mine MnRAM (Table E-1). The community types and hydroperiod present in Wetland 11a are not adequate for

supporting fish or amphibian habitat. The overall condition rating and the aesthetics/recreational value were both rated the same using the Barr method as using the MnRAM 3.4 method.

## 5.5 Wetland 11c

Wetland 11c is identified as a sedge meadow, with a small area of seasonally flooded basin (Eggers and Reed 2011). It is a natural wetland that is depressional with no apparent surface water outlet. The wetland encompasses 0.13 acres, surrounded by vegetated uplands.

Ratings for the MnRAM functions in Wetland 11c are all the same for both MnRAM 3.4 and the Barr Mine MnRAM (Table E-1). The community types and hydroperiod present in Wetland 11c are not adequate for supporting fish or amphibian habitat. The overall condition rating and the aesthetics/recreational value were both rated the same using the Barr method as using the MnRAM 3.4 method.

## 5.6 Wetland 13

Wetland 13 is identified as an alder thicket, with a small area of hardwood swamp (Eggers and Reed 2011). This 11.93-acre, slope wetland has over 60 feet of fall from the north to south ends. It is a natural wetland with no defined surface water outlet, however, this wetland appears to intermittently overflow into a roadway ditch. This wetland is split into two parts by a roadway. There are also multiple roadways, a roadway ditch, railroad, a trail, and upland areas with sparse vegetation around the southeast end of this wetland. The northwest area of the wetland is generally adjacent to upland forest.

Ratings for the MnRAM functions in Wetland 13 are the same for both MnRAM 3.4 and the Barr Mine MnRAM (Table E-1). The community types and hydroperiod present in Wetland 13 are not adequate for supporting fish or amphibian habitat. Despite the fact that all individual functions were scored the same by the Barr method as MnRAM 3.4, the overall condition rating is “moderate” for Barr and “high” for MnRAM 3.4. This difference occurred because the overall condition scores fell on either side of the dividing line between “moderate” and “high” with a score of 0.63 for the Barr method and a score of 0.68 for the MnRAM 3.4 method, while the break between categories is 0.65-0.66. Therefore, there is no effective difference in overall condition ratings. The aesthetics/recreational value were both rated the same using the Barr method as using the MnRAM 3.4 method.

## 5.7 Wetland 15

Wetland 15 is identified as an alder thicket, with a component of coniferous swamp (Eggers and Reed 2011). Wetland 15 is a natural, 31.3 acre, depressional/tributary wetland that discharges east to “Murphy’s Pond”. The south side of this wetland is adjacent to a wide road and railroad. The remainder of the wetland is generally adjacent to either upland forest or wetland. . Ratings for the MnRAM functions in Wetland 15 are all the same for both MnRAM 3.4 and the Barr Mine MnRAM (Table E-1). The community types and hydroperiod present in Wetland 15 are not adequate for supporting fish or amphibian habitat. The overall condition rating and the aesthetics/recreational value were both rated the same using the Barr method as using the MnRAM 3.4 method.

## 5.8 Wetland 17b

Wetland 17b is identified as a shallow marsh wetland (Eggers and Reed 2011). It is a constructed ditch, which carries occasional discharge from Wetland 18 and Murphy's Pond and flows from the Project area through the constructed ditch cross-section to the East Branch Beaver River over 2 miles downstream. The wetland encompasses 3.32 acres, surrounded by steep, vegetated uplands resulting from the ditch construction in about 2006. Ratings for the MnRAM functions in Wetland 17b are all the same for both MnRAM 3.4 and the Barr Mine MnRAM (Table E-1).

Using MnRAM 3.4, Wetland 17b was determined to have fish and amphibian habitats present. Fish habitat in Wetland 17b is rated "high" due to its connection to Murphy's Pond, the presence of vegetated uplands, and adequate wetland vegetation. With its connection to Wetland 18 (Murphy's Pond), Wetland 17b is also hydraulically connected to the remnant Little 39 and Big 39 Creeks. Detailed fish surveys were completed for the remnant Little 39 and Big 39 Creeks, which drain into Wetland 18. Therefore, those fish surveys may be representative of the fish within the hydraulically connected Wetland 17b, which is the connecting feature to the downstream fishery in the East Branch Beaver River. The fish surveys resulted in FIBI (MPCA 2014a) scores of 16 and 19 out of 100, respectively. The Minnesota Stream Quantification Tool and Debit Calculator User Manual (MNSQT), Version 1.0 (Minnesota Stream Quantification Tool Steering Committee (MNSQT SC) 2019) classifies both streams as not functioning regarding their fishery, based on the FIBI scores. Therefore, the more detailed fish survey provides a clearer picture of how the wetland may actually be functioning in regards to supporting fish. Amphibian habitat in Wetland 17b is rated "low" due to poor overwintering conditions and the potential presence of predatory fish. The overall condition rating and the aesthetics/recreational value were both rated the same using the Barr method as using the MnRAM 3.4 method.

## 5.9 Wetland 18

Wetland 18 is identified as a shallow marsh and deep marsh located around Murphy's Pond (Eggers and Reed 2011). This wetland is on the edge of a deep water habitat that was created by impounding Thirty-nine Creek. The south side of this wetland is adjacent to a wide roadway, railroad, and roadway ditch. The wetland connects with the roadway ditch (Wetland 17b) and flows in this ditch to the northeast where it discharges to the East Branch Beaver River. The wetland is a 42.74 acre, depressional/flow-through wetland. Ratings for the MnRAM functions in Wetland 18 are all the same for both MnRAM 3.4 and the Barr Mine MnRAM, except for hydrologic regime, flood storage, downstream water quality, and wetland water quality (Table E-1).

The Barr method rated hydrologic regime "moderate" while the MnRAM 3.4 rated it "high." The lower Barr rating was primarily influenced by the constructed outlet that has impounded the wetland. Whereas, the MnRAM 3.4 formula for hydrologic regime equally weights the outlet characteristics, upland land use, wetland soil condition, and the extent of stormwater runoff. While the constructed outlet results in a low rating; upland land use, wetland soils, and stormwater runoff are all rated "high," therefore, the hydrologic regime function is rated "high" based on the MnRAM 3.4 formula. Given the fact that the altered outlet has changed the hydrologic regime from the natural condition as a primarily forested wetland, to a

deepwater habitat surrounded by deep and shallow marsh communities; the MnRAM 3.4 rating does not represent an accurate assessment of the natural hydrologic regime.

The Barr method rated flood storage "moderate" while the MnRAM 3.4 rated it "low." The "moderate" Barr method rating is primarily a result of the human disturbance rating, which has resulted in impoundment of the wetland, and as far as flood storage goes, that disturbance has improved water storage with over 80 acres of water storage area. The "low" rating for MnRAM 3.4 is primarily a result of the limited opportunity for the wetland to treat stormwater. The MnRAM 3.4 method for flood storage includes three measures of opportunity; instances where degrading conditions in the wetland result in a higher flood storage rating. Those opportunities include:

1. Wetlands receiving high volumes of untreated stormwater,
2. Wetlands in highly modified watersheds with a lot of impervious surfaces, and
3. Wetlands in watersheds with a lower overall wetland density.

All of those opportunities are rated "low" for Wetland 18 based on MnRAM 3.4 methods, along with limited vegetative cover and a connected flow path contributing to the "low" flood storage rating.

The Barr method rated downstream water quality "high" while MnRAM 3.4 rated it "moderate." The "high" Barr rating stems from the majority of the contributing watershed remaining intact and the impoundment providing water storage, despite the presence of a constructed ditch outlet. The lower MnRAM 3.4 rating stems primarily from the constructed outlet, proximity of downstream water resources being more than 2 miles away, and the lack of emergent vegetation in the wetland. Given the unique circumstances in Wetland 18, the Barr method appears to better characterize the wetland functioning to protect downstream waters.

The Barr method rated wetland water quality "moderate" while the MnRAM 3.4 rated it "high." The lower Barr rating is partly because the wetland has been significantly altered by the impoundment, including the resulting change in the wetland vegetation. The MnRAM 3.4 rating is "high" because of an intact watershed, an intact upland buffer around most of the wetland, the lack of stormwater runoff, and limited evidence of nutrient loading.

Using MnRAM 3.4, fish habitat in Wetland 18 is rated high. The wetland surrounds the deepwater habitat of Murphy's Pond and an occasional hydraulic connection to the East Branch Beaver River over two miles downstream contributes to the "high" rating. The limited stormwater runoff, limited disturbances, and presence of naturally vegetated buffer areas; also contribute to the high rating. Detailed fish surveys were completed for the remnant Little 39 and Big 39 Creeks, which drain into Wetland 18. Therefore, those fish surveys may be representative of the fish within the hydraulically connected Wetland 18. The fish surveys resulted in FIBI (MPCA 2014a) scores of 16 and 19 out of 100, respectively. The MNSQT (MNSQT SC 2019) classifies both streams as not functioning regarding their fishery, based on the FIBI scores. Therefore, the more detailed fish survey provides a clearer picture of how the wetland may actually be functioning in regards to supporting fish.

Using MnRAM 3.4, amphibian habitat in Wetland 18 is rated moderate. The primary factors contributing to that rating are poor overwintering conditions, and the potential for some predatory fish. The overall condition rating and the aesthetics/recreational value were both rated the same using the Barr method as using the MnRAM 3.4 method.

## 5.10 Wetland 20

Wetland 20 is identified predominantly as a coniferous swamp, with hardwood swamp and alder thicket communities also present (Eggers and Reed 2011). It is a natural wetland that drains east to the East Branch Beaver River, nearly two miles downstream. CSAH 15 runs parallel to the northwestern side of this wetland and intercepts the wetland in two locations. There is a southwest to northeast trail that bisects this wetland, however the wetland is generally surrounded by forested upland. The wetland is a 21.14-acre, depressional, isolated wetland.

Ratings for the MnRAM functions are all the same for both MnRAM 3.4 and the Barr Mine MnRAM (Table E-1). The community types and hydroperiod present in Wetland 20 are not adequate for supporting fish or amphibian habitat. The overall condition rating and the aesthetics/recreational value were both rated the same using the Barr method as using the MnRAM 3.4 method.

## 5.11 Wetland 23

Wetland 23 is identified as a hardwood swamp, with small areas of fresh (wet) meadow and shallow marsh (Eggers and Reed 2011). It is a natural wetland that drains southeast to Wetland 18 ("Murphy's Pond"). This 19.9-acre, floodplain wetland is located within and adjacent to the remnant valley of Little 39 Creek.

Ratings for the MnRAM functions are all the same for both MnRAM 3.4 and the Barr Mine MnRAM, except for downstream water quality (Table E-1). The rating for downstream water quality is "high" for the Barr Mine MnRAM and "moderate" for MnRAM 3.4 (Table E-1). The Barr method rates downstream water quality "high" because the upland areas are generally intact, the outlet has not been modified, and there is relatively little landscape disturbance affecting the wetland. From the perspective of protecting downstream water quality, the wetland is functioning close to natural conditions. The primary reason that MnRAM 3.4 rates downstream water quality lower than the Barr method is that the closest fishery or recreational water is more than 2 miles downstream, so the wetland has limited opportunity to protect water quality in downstream waters.

Using MnRAM 3.4, fish habitat in Wetland 23 is rated high. The wetland connection to the remnant Little 39 Creek contributes to that rating along with the lack of stormwater runoff, limited landscape disturbances, and the presence of naturally vegetated buffer areas. However, the MnRAM 3.4 method doesn't take into account specific hydrologic characteristics, which can affect the fishery, namely the loss of much of its historic watershed. A detailed fish survey was completed for the remnant Little 39 Creek, which is representative of the fish within the hydraulically connected Wetland 23. The fish survey identified 4 species of fish with a resulting FIBI (MPCA 2014a) score of 16 out of 100. The MNSQT (MNSQT SC 2019) classifies the stream as not functioning regarding the fishery, based on the FIBI score. Therefore, the actual functioning of Wetland 23 in regards to supporting fish is "low."

Using MnRAM 3.4, amphibian habitat in Wetland 23 is rated moderate. The primary factors contributing to that rating are poor overwintering conditions, and the potential for some predatory fish. Wetland 23 is connected to the remnant Little 39 Creek, along which most of the suitable amphibian habitat lies. A detailed macroinvertebrate survey was completed for the remnant Little 39 Creek. Because macroinvertebrates are an important food source for many amphibians (Breckenridge 1944), this survey provides additional information to help assess amphibian habitat. The macroinvertebrate survey resulted in an MIBI (MPCA 2014b) score of 25 out of 100, which is classified as not functioning for macroinvertebrates according to the MNSQT (MNSQT SC 2019). The MIBI score may not directly indicate a diminished food source for many amphibians, but indicates that the macroinvertebrates are not indicative of a high quality stream environment. The overall condition rating and the aesthetics/recreational value were both rated the same using the Barr method as using the MnRAM 3.4 method.

## 5.12 Wetland 27

Wetland 27 is identified predominantly as a hardwood swamp, with areas of sedge meadow and alder thicket (Eggers and Reed 2011). It is a natural wetland that drains northeast and east to Wetland 18 ("Murphy's Pond"). The west side of this wetland is bounded by roads, but the majority of the contributing watershed remains intact. This 33.03-acre, floodplain wetland is located within and adjacent to the remnant valley of Big 39 Creek.

Ratings for the MnRAM functions are all the same for both MnRAM 3.4 and the Barr Mine MnRAM, except flood storage and downstream water quality (Table E-1). The rating for flood storage is "moderate" for the Barr Mine MnRAM and "high" for MnRAM 3.4. The "moderate" Barr rating stems primarily from the lack of opportunity to store flood waters. By following the MnRAM 3.4 formula, the presence of an intact watershed and lack of untreated stormwater runoff are both considered low ratings for flood storage, because the wetland doesn't have an opportunity to store flood waters, despite the presence of a natural outlet condition. The higher MnRAM 3.4 rating stems from intact soils and emergent vegetation within the wetland and the lack of erosion, despite the limited opportunity for flood storage.

The rating for downstream water quality is "high" for the Barr Mine MnRAM and "moderate" for MnRAM 3.4 (Table E-1). The Barr method rates downstream water quality "high" because the upland areas are generally intact, the outlet has not been modified, and there is relatively little landscape disturbance affecting the wetlands, so from a downstream water quality protection perspective, Wetland 27 is functioning close to natural conditions. The primary reason that MnRAM 3.4 rates downstream water quality lower than the Barr method is that the closest fishery or recreational water is more than 2 miles downstream, so the wetland has limited opportunity to protect water quality in downstream waters.

Using MnRAM 3.4, fish habitat in Wetland 27 is rated high. The wetland connection to the remnant Big 39 Creek contributes to that rating along with the lack of stormwater runoff, limited landscape disturbances, and the presence of naturally vegetated buffer areas. However, the MnRAM 3.4 method doesn't take into account specific hydrologic characteristics, which can affect the fishery, namely the loss of much of its historic watershed. A detailed fish survey was completed for the remnant Big 39 Creek, which is

representative of the fish within the hydraulically connected Wetland 27. The fish survey identified 3 species of fish with a resulting FIBI (MPCA 2014a) score of 19 out of 100. The Minnesota Stream Quantification Tool and Debit Calculator User Manual (MNSQT), Version 1.0 (Minnesota Stream Quantification Tool Steering Committee (MNSQT SC) 2019) classifies the stream as not functioning regarding the fishery, based on the FIBI score. Therefore, the actual functioning of the wetland in regards to supporting fish is "low."

Using MnRAM 3.4, amphibian habitat in Wetland 27 is rated moderate. The primary factors contributing to that rating are poor overwintering conditions, and the potential for some predatory fish. Wetland 27 is connected to Big 39 Creek, along which most of the suitable amphibian habitat lies. A detailed macroinvertebrate survey was completed for the remnant Big 39 Creek. Because macroinvertebrates are an important food source for many amphibians (Breckenridge 1944), this survey provides additional information to help assess amphibian habitat. The macroinvertebrate survey resulted in an MIBI (MPCA 2014b) score of 29 out of 100, which is classified as not functioning for macroinvertebrates according to the MNSQT (MNSQT SC 2019). The MIBI score may not directly indicate a diminished food source for many amphibians, but indicates that the macroinvertebrates are not indicative of a high quality stream environment. The overall condition rating and the aesthetics/recreational value were both rated the same using the Barr method as using the MnRAM 3.4 method.

# 6 Conclusions

Complete wetland functional assessments were completed for 12 wetlands or approximately 30 percent of the Project area wetlands (Appendix D) using MnRAM 3.4 (BWSR 2010) to evaluate the effectiveness of the Barr Mine MnRAM method (Appendix B). Six individual wetland functions (vegetative diversity/integrity, hydrologic regime, flood storage, downstream water quality, wetland water quality, and wildlife habitat) and one public wetland value (aesthetics/recreation) were evaluated for each of the 12 wetlands (84 total) using the MnRAM 3.4 method and also using comparable factors evaluated with the Barr Mine MnRAM method. Three MnRAM 3.4 wetland functions do not have comparable measures in the Barr method (shoreline protection, fish habitat, and amphibian habitat), but those particular functions only applied to four wetlands within the Project area (Wetlands 17b, 18, 23, and 27). Therefore, full MnRAM 3.4 assessments were completed for those three functions on the four Project wetlands. When wetlands are present within mining projects that have characteristics in which shoreline wetlands are present and/or where fish and amphibian habitats are present, the MnRAM 3.4 methodology should be utilized to evaluate those wetland functions, as done in this assessment for Wetlands 17b, 18, 23, and 27.

Of the 84 total function/value assessments completed, nine ratings differed between the MnRAM 3.4 method and the Barr method, as described in the summary bullets in Section 5. Overall, the two MnRAM methods provided similar functional assessments for the selected wetlands. As previously determined by the Corps in decision documents and permit authorizations for numerous past projects, this evaluation helps support the conclusion that wetlands in a mining landscape are adequately characterized using the Barr Mine MnRAM method.

# 7 References


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# Tables

Table 1
Summary of Ratings for Jurisdictional Wetlands Using Barr Mine MnRAM

| Wetland Community Type/Rating | Number of Wetlands | | | | |
|---|---|---|---|---|---|
| | Low | Medium | High | Exceptional | Total |
| **Vegetative Diversity Rating** | | | | | |
| Fresh (Wet) Meadow | 0 | 0 | 0 | 1 | 1 |
| Sedge Meadow | 0 | 0 | 5 | 0 | 5 |
| Shallow Marsh | 0 | 2 | 1 | 0 | 3 |
| Alder Thicket | 0 | 1 | 3 | 0 | 4 |
| Hardwood Swamp | 0 | 1 | 22 | 1 | 24 |
| Coniferous Swamp | 0 | 0 | 2 | 0 | 2 |
| **TOTAL** | **0** | **4** | **33** | **2** | **39** |
| **Overall Condition Rating** | | | | | |
| Fresh (Wet) Meadow | 0 | 0 | 1 | 0 | 1 |
| Sedge Meadow | 0 | 2 | 3 | 0 | 5 |
| Shallow Marsh | 0 | 3 | 0 | 0 | 3 |
| Alder Thicket | 0 | 2 | 2 | 0 | 4 |
| Hardwood Swamp | 0 | 7 | 17 | 0 | 24 |
| Coniferous Swamp | 0 | 0 | 2 | 0 | 2 |
| **TOTAL** | **0** | **14** | **25** | **0** | **39** |

Table 2
Summary of Wetlands Selected for Full MnRAM 3.4 Evaluation

| Wetland Community Type/Rating | Wetland ID[1] | | | | |
|---|---|---|---|---|---|
| | Low | Medium | High | Exceptional | Total |
| **Vegetative Diversity Rating** | | | | | |
| Fresh (Wet) Meadow | | | | 8 | 1 |
| Sedge Meadow | | | 6, 11a, 11b, 11c, 17a | | 5 |
| Shallow Marsh | | 16b, 18 | 17b | | 3 |
| Alder Thicket | | 15 | 13, 29, 32 | | 4 |
| Hardwood Swamp | | 2 | 1a, 1b, 3a, 3b, 3c, 4, 5, 9, 10, 12, 19, 21, 22, 23, 24, 26, 27, 28, 33, 34, 35, 36 | 14 | 24 |
| Coniferous Swamp | | | 20 , 25 | | 2 |
| **TOTAL** | **0** | **4** | **33** | **2** | **39** |
| **Overall Condition Rating** | | | | | |
| Fresh (Wet) Meadow | | | 8 | | 1 |
| Sedge Meadow | | 6 , 17a | 11a, 11b, 11c | | 5 |
| Shallow Marsh | | 16b, 17b, 18 | | | 3 |
| Alder Thicket | | 13, 15 | 29, 32 | | 4 |
| Hardwood Swamp | | 2 ,3a, 3b, 3c, 4, 9, 12 | 1a, 1b, 5, 10, 14, 19, 21, 22, 23, 24, 26, 27, 28, 33, 34, 35, 36 | | 24 |
| Coniferous Swamp | | | 20, 25 | | 2 |
| **TOTAL** | **0** | **14** | **25** | **0** | **39** |

[1]Underlined wetland IDs were selected for the full MnRAM 3.4 evaluation.

Table 3
Comparison of Functions/Values and Variables for the Barr Mine MnRAM and MnRAM 3.4

| MnRAM 3.4 Functions and Values | MnRAM 3.4 Variables | Barr Mine MnRAM Functions/Values | Barr Mine MnRAM Variables |
|---|---|---|---|
| Vegetative diversity/integrity | Diversity and invasive species | Vegetative Diversity | Diversity and invasive species |
| Maintenance of hydrologic regime | Outlet, upland land use (imperviousness), soil disturbance, stormwater runoff | Outlet Condition | Outlet |
| | | Upland Condition | Upland land use, upland buffer, emergent vegetation |
| | | Human Disturbance | Upland land use, soil condition, nutrient loading, stormwater |
| Flood/stormwater/ attenuation | Outlet, upland land use (imperviousness), soil type and disturbance, erosion, wetland density, emergent vegetation, channels | Outlet Condition | Outlet |
| | | Upland Condition | Upland land use, upland buffer, emergent vegetation |
| | | Human Disturbance | Upland land use, soil condition, nutrient loading, stormwater |
| Downstream water quality | Outlet, upland land use (imperviousness), stormwater runoff, erosion, upland buffer, emergent vegetation, downstream water sensitivity | Outlet Condition | Outlet |
| | | Upland Condition | Upland land use, upland buffer, emergent vegetation |
| | | Human Disturbance | Upland land use, soil condition, nutrient loading, stormwater |
| Maintenance of wetland water quality | Vegetative diversity, upland land use (imperviousness), stormwater runoff, erosion, upland buffer, nutrient loading | Vegetative Diversity | Vegetative Diversity |
| | | Upland Condition | Upland land use, upland buffer, emergent vegetation |
| | | Human Disturbance | Upland land use, soil condition, nutrient loading, stormwater |
| Shoreline protection | Emergent vegetation, wetland width, erosion potential, bank stability | NE | NE |
| Maintenance of characteristic wildlife habitat structure | Barriers, vegetative diversity, wetland detritus, upland buffer, outlet, stormwater runoff, vegetation and community interspersion, wetland interspersion | Wildlife Habitat | Barriers, community interspersion |
| | | Outlet Condition | Outlet |
| | | Upland Condition | Upland land use, upland buffer, emergent vegetation |
| | | Human Disturbance | Upland land use, soil condition, nutrient loading, stormwater |
| | | Vegetative Diversity | Vegetative Diversity |
| Maintenance of characteristic fish habitat | Fish habitat, upland buffer, erosion, stormwater runoff, nutrient loading, shoreline vegetation | Upland Condition | Upland land use, upland buffer, emergent vegetation |
| | | Human Disturbance | Upland land use, soil condition, nutrient loading, stormwater |
| Maintenance of characteristic amphibian habitat | Hydroperiod, fish presence, upland buffer, barriers, upland land use, stormwater runoff | Wildlife Habitat | Barriers, community interspersion |
| | | Upland Condition | Upland land use, upland buffer, emergent vegetation |
| | | Human Disturbance | Upland land use, soil condition, nutrient loading, stormwater |
| **Considerations not included in Overall Condition Rating** | | | |
| Aesthetics/recreational/ educational/cultural | Education, visibility, public proximity, ownership, access, human disturbance, spatial buffer, recreation | Public Values | Access and recreation |
| Commercial uses | Commercial products and hydrologic alteration | NE | |
| Groundwater interaction | Soils, upland land use (imperviousness), wetland size, hydrologic regime, outlet, topography | NE | |
| **Planning tools** | | | |
| Wetland restoration potential | Planning tool to identify potential wetland restoration opportunities | NE | |
| Additional stormwater treatment needs | Planning tool to identify additional stormwater treatment needs to sustain wetland functions | NE | |
| Wetland sensitivity to stormwater and urban development | Planning tool to assist in protecting wetlands from future stormwater impacts | NE | |

# Figure

Existing Watercourses

MnRAM Evaluated Wetlands

- Alder Thicket
- Coniferous Swamp
- Fresh (Wet) Meadow
- Hardwood Swamp
- Sedge Meadow
- Shallow Marsh
- Deepwater Habitat
- Additional Site Wetlands
- Project Area

**Surface Topography**

- 10-ft Contours
- 2-ft Contours

0 750 1,500 3,000

Feet

Aerial Imagery: Lake County CIR (2015)

Figure 1

MnRAM EVALUATION
West Ridge Railroad Relocation
Northshore Mining Company
Lake County, Minnesota

Barr Footer: ArcGIS 10.7.1, 2020-02-07 11:49 File: I:\Client\NorthShoreMining\Work_Orders\DS14_2014_RR_Design\Maps\Reports\MnRAM_Evaluation\Figure 1 - MnRAM Evaluation.mxd User: maj

# Appendix A

## Barr Mine MnRAM Wetland Functional Assessment Results

**Updated Barr Mine MnRAM Wetland Function Assessment Results**
**Northshore West Ridge RR Realignment and Tailings Basin Progression**

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Federal Jurisdiction** | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| **Wetland ID** | 1a | 1b | 2 | 3a | 3b | 3c | 4 | 5 | 6 | 8 | 9 | 10 |
| **Date** | 7/22/2015 | 7/22/2015 | 7/22/2015 | 7/22/2015 | 7/22/2015 | 7/22/2015 | 7/23/2015 | 7/23/2015 | 7/23/2015 | 7/23/2015 | 7/24/2015 | 7/24/2015 |
| **Field Team** | KSW & JTK | KSW & JTK | KSW & JTK | KSW & JTK | KSW & JTK | KSW & JTK | KSW & JTK | KSW & JTK | KSW & JTK | KSW & JTK | KSW & JTK | KSW & JTK |
| **Community 1 Eggers and Reed** | Hardwood Swamp | Hardwood Swamp | Hardwood Swamp | Hardwood Swamp | Hardwood Swamp | Hardwood Swamp | Hardwood Swamp | Hardwood Swamp | Sedge Meadow | Fresh (Wet) Meadow | Hardwood Swamp | Hardwood Swamp |
| **Community 1 %** | 70% | 100% | 80% | 100% | 100% | 100% | 90% | 100% | 80% | 90% | 100% | 90% |
| **Wetland Plot ID** | 1a-W | 1a-W | 2-W | 3a-W | 3a-W | 3a-W | 4-W | 5-W | 6-W | 8-W | 9-W | 10-W |
| **Upland Plot ID** | 1a-U | 1a-U | 2-U | 3a-U | 3a-U | 3a-U | 4-U | 5-U | 6-U | 8-U | 9-U | 10-U |
| **Community 2 Eggers and Reed** | Fresh (Wet) Meadow | | Fresh (Wet) Meadow | - | - | - | Fresh (Wet) Meadow | - | Alder Thicket | Shrub-carr | - | Alder Thicket |
| **Community 2 %** | 30% | | 10% | - | - | - | 10% | - | 20% | 10% | - | 10% |
| **Wetland Plot ID** | - | - | - | - | - | - | - | - | - | - | - | - |
| **Upland Plot ID** | - | - | - | - | - | - | - | - | - | - | - | - |
| **Community 3 Eggers and Reed** | - | - | Shrub-carr | - | - | - | - | - | - | - | - | - |
| **Community 3 %** | - | - | 10% | - | - | - | - | - | - | - | - | - |
| **Community 4 Eggers and Reed** | - | - | - | - | - | - | - | - | - | - | - | - |
| **Community 4 %** | - | - | - | - | - | - | - | - | - | - | - | - |
| **Native Plant Community (NPC)** | WFn55 & WMn82 | WFn55 | WFn55 | WFn55 | WFn55 | WFn55 | WFn55 | WFn55 | - | WMn82 | WFn55 | WFn55 & FPn73 |
| **Topographic Setting** | Depressional-no inlet/outlet | Depressional-no inlet/outlet | Slope | Depressional-no inlet/outlet | Depressional-no inlet/outlet | Depressional-no inlet/outlet | Slope | Slope | Slope | Slope | Slope | Depressional-no inlet/outlet |
| **Vegetative Diversity** | H (1.0) | H (1.0) | M (0.5) | H (1.0) | H (1.0) | H (1.0) | H (1.0) | H (1.0) | H (1.0) | **E (2.0)** | H (1.0) | H (1.0) |
| **Outlet Configuration** | H (1.0) | H (1.0) | H (1.0) | L (0.1) | H(1.0) | H(1.0) | H(1.0) | H (1.0) | L (0.1) | L (0.1) | L (0.1) | H (1.0) |
| **Upland Condition** | M (0.5) | M (0.5) | M (0.5) | H (1.0) | H (1.0) | H (1.0) | H (1.0) | M (0.5) | M (0.5) | M (0.5) | M (0.5) | H (1.0) |
| **Wildlife Habitat** | H (1.0) | H (1.0) | H (1.0) | H (1.0) | H (1.0) | H (1.0) | H (1.0) | H (1.0) | H (1.0) | H (1.0) | H (1.0) | H (1.0) |
| **Average Value** | **0.88** | **0.88** | **0.75** | **0.78** | **1.00** | **1.00** | **1.00** | **0.88** | **0.65** | **0.9** | **0.65** | **1.00** |
| **Overall Condition[1]** | H | H | **H** | **H** | **H** | **H** | **H** | H | M | **H** | M | H |
| **Public Value** | L (0.1) | L (0.1) | L (0.1) | L (0.1) | L (0.1) | L (0.1) | L (0.1) | L (0.1) | L (0.1) | L (0.1) | L (0.1) | L (0.1) |
| **Human Disturbance** | M | M | M | L | L | L | L | L | H | H | L | L |
| **Comments on history, origin, and connectivity** | Natural wetland partially disturbed by trail | Natural wetland, appears topographically-enclosed wetland with no apparent surface water outlet | Natural wetland, partially disturbed by ditch | Natural wetland, topographically-enclosed wetland with no apparent surface water outlet | Natural wetland, topographically-enclosed wetland with no apparent surface water outlet | Natural wetland, topographically-enclosed wetland with no apparent surface water outlet | Natural wetland, connected to diversion ditch | Natural wetland, intermittently connected with Wetland 10, which is intermittently connected with diversion ditch | Wetland appears incidental due to excavation possibly for borrow soil. Intermittently overflows along roadway channel and into diversion ditch during flooded conditions. | This wetland is a seepage wetland that starts higher in the landscape with narrow drainageway then empties into large, broad, open depression. Wetland appears incidental due to surface scraping. Intermittently overflows into diversion ditch during flooded conditions. | Natural wetland. Wetland intermittently overflows into diversion ditch during flooded conditions. | Natural wetland, topographically-enclosed wetland with no apparent surface water outlet |

[1]Average value of vegetative diversity, outlet configuration, upland condition, and wildlife habitat

[2]Based on average value using MnRAM rating categories: Low=0.01-0.32, Medium=0.33-0.65, High=0.66-1.0, Exceptional=1.01-2.0

Shaded columns represent wetlands for which full MnRAM 3.4 assessment completed

**Bold** = values revised from 2015 wetland delineation report

## Updated Barr Mine MnRAM Wetland Function Assessment Results
## Northshore West Ridge RR Realignment and Tailings Basin Progression

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Federal Jurisdiction** | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| **Wetland ID** | 11a | 11b | 11c | 12 | 13 | 14 | 15 | 16a | 16b | 16c | 16d | 17a |
| **Date** | 7/24/2015 | 7/24/2015 | 7/24/2015 | 7/24/2015 | 7/23/2015 | 7/23/2015 | 7/23/2015 | 7/24/2015 | 7/23/2015 | 7/24/2015 | 7/24/2015 | 7/24/2015 |
| **Field Team** | KSW & JTK | KSW & JTK | KSW & JTK | KSW & JTK | LBN & KMS2 | LBN & KMS2 | LBN & KMS2 | LBN & KMS2 | LBN & KMS2 | LBN & KMS2 | LBN & KMS2 | LBN & KMS2 |
| **Community 1 Eggers and Reed** | Sedge Meadow | Sedge Meadow | Sedge Meadow | Hardwood Swamp | Alder Thicket | Hardwood Swamp | Alder Thicket | Shallow Marsh | Shallow Marsh | Sedge Meadow | Sedge Meadow | Sedge Meadow |
| **Community 1 %** | 90% | 90% | 90% | 100% | 80% | 100% | 75% | 75% | 75% | 100% | 100% | 100% |
| **Wetland Plot ID** | 11a-W | 11a-W | 11a-W | 12-W | 13-W | 14-W | 15-W | 16a-W | 16a-W | 16a-W | 16a-W | 17a-W |
| **Upland Plot ID** | 10-U | 10-U | 10-U | 12-U | 13-U | 14-U | 15-U | 16a-U | 16a-U | 16a-U | 16a-U | 17a-U |
| **Community 2 Eggers and Reed** | Hardwood Swamp | Shrub-carr | Seasonally Flooded Basin | - | Hardwood Swamp | - | Coniferous Swamp | Shallow, Open Water | Alder Thicket | - | - | - |
| **Community 2 %** | 10% | 10% | 10% | - | 20% | - | 25% | 25% | 25% | - | - | - |
| **Wetland Plot ID** | - | - | - | - | 101-W | - | 104a-W | 105-W | - | - | - | - |
| **Upland Plot ID** | - | - | - | - | 101-U | - | 104a-U | 105-U | - | - | - | - |
| **Community 3 Eggers and Reed** | - | - | - | - | - | - | - | - | - | - | - | - |
| **Community 3 %** | - | - | - | - | - | - | - | - | - | - | - | - |
| **Community 4 Eggers and Reed** | - | - | - | - | - | - | - | - | - | - | - | - |
| **Community 4 %** | - | - | - | - | - | - | - | - | - | - | - | - |
| **Native Plant Community (NPC)** | WMn82 & WFn55 | WMn82 | WMn82 | WFn55 | FPn73 & WFn55 | WFn55 | FPn73 & FPn62 | MRn83 | WMn82 & FPn73 | - | - | - |
| **Topographic Setting** | Depressional-no inlet/outlet | Depressional-no inlet/outlet | Depressional-no inlet/outlet | Depressional-tributary | Slope | Depressional-tributary | Depressional-tributary | Depressional with a culvert at the inlet | Depressional-no inlet/outlet | Depressional-no inlet/outlet | Depressional-no inlet/outlet | Depressional-tributary |
| **Vegetative Diversity** | H (1.0) | H (1.0) | H (1.0) | H (1.0) | H (1.0) | **E (2.0)** | M (0.5) | H (1.0) | M (0.5) | M (0.5) | M (0.5) | H (1.0) |
| **Outlet Configuration** | H (1.0) | H (1.0) | H (1.0) | M (0.5) | M (0.5) | M (0.5) | L (0.1) | L (0.1) | L (0.1) | M (0.5) | M (0.5) | L (0.1) |
| **Upland Condition** | H (1.0) | H (1.0) | H (1.0) | M (0.5) | M (0.5) | M (0.5) | M (0.5) | L (0.1) | M (0.5) | L (0.1) | L (0.1) | M (0.5) |
| **Wildlife Habitat** | H (1.0) | H (1.0) | H (1.0) | H (1.0) | **M (0.5)** | H (1.0) | H (1.0) | M (0.5) | H (1.0) | M (0.5) | M (0.5) | L (0.1) |
| **Average Value** | **1.00** | **1.00** | **1.00** | **0.75** | **0.62** | **1.00** | **0.53** | **0.43** | **0.53** | **0.4** | **0.4** | **0.43** |
| **Overall Condition[1]** | H | H | H | **H** | **M** | **H** | M | M | M | M | M | M |
| **Public Value** | L (0.1) | L (0.1) | L (0.1) | L (0.1) | L (0.1) | L (0.1) | L (0.1) | L (0.1) | L (0.1) | L (0.1) | L (0.1) | L (0.1) |
| **Human Disturbance** | L (0.1) | L (0.1) | L (0.1) | L | M | M | M | H | M | H | H | M |
| **Comments on history, origin, and connectivity** | Natural wetland, topographically-enclosed wetland with no apparent surface water outlet. | Natural wetland, topographically-enclosed wetland with no apparent surface water outlet. | Natural wetland, topographically-enclosed wetland with no apparent surface water outlet. | Natural wetland. Wetland intermittently overflows to channel which intermittently overflows into diversion ditch during flooded conditions. | Natural wetland, which is topographically-enclosed wetland with no apparent surface water outlet. | Part natural wetland, part excavated ditch. Wetland connects via culvert that crosses under RR grade. Appears to connect to waterway at the south end. Cut off from water source at the north end by a large berm. | Wetland flows to "Murphy's Pond", which is connected to road ditches that flow northeast to E. Beaver River. | Topographically-enclosed wetland with no apparent surface water outlet - but receives water via a culvert. Source of water/ culvert was not apparent. Most likely an incidental wetland - this area was completely re-worked in 2011. | Topographically-enclosed wetland with no apparent surface water outlet. 2006 RR installation cut off this wetland from stream and other wetlands in the area. | Topographically-enclosed wetland with no apparent surface water outlet. 2003-2004 this area was impacted by clearing, and then in 2006 by the RR construction. | Topographically-enclosed wetland with no apparent surface water outlet. 2003-2004 this area was impacted by clearing, and then in 2006 by the RR construction. | Ditch wetland constructed during original basin development. Follows roadway, connects with the E. Beaver River. |

[1]Average value of vegetative diversity, outlet configuration, upland condition, and wildlife habitat

[2]Based on average value using MnRAM rating categories: Low=0.01-0.32, Medium=0.33-0.65, High=0.66-1.0, Exceptional=1.01-2.0

Shaded columns represent wetlands for which full MnRAM 3.4 assessment completed

**Bold** = values revised from 2015 wetland delineation report

## Updated Barr Mine MnRAM Wetland Function Assessment Results
## Northshore West Ridge RR Realignment and Tailings Basin Progression

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Federal Jurisdiction** | Yes | No | No | No | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| **Wetland ID** | 17b | 17c | 17d | 17e | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 |
| **Date** | 7/24/2015 | 7/24/2015 | 7/24/2015 | 7/24/2015 | 7/24/2015 | 8/10/2015 | 8/10/2015 | 8/10/2015 | 8/11/2015 | 8/11/2015 | 8/11/2015 | 8/11/2015 |
| **Field Team** | LBN & KMS2 | LBN & KMS2 | LBN & KMS2 | LBN & KMS2 | LBN & KMS2 | JTK & DRD | JTK & DRD | JTK & DRD | JTK & DRD | JTK & DRD | JTK & DRD | JTK & DRD |
| **Community 1 Eggers and Reed** | Shallow Marsh | Sedge Meadow | Sedge Meadow | Sedge Meadow | Shallow Marsh | Hardwood Swamp | Coniferous Swamp | Hardwood Swamp | Hardwood Swamp | Hardwood Swamp | Hardwood Swamp | Coniferous Swamp |
| **Community 1 %** | 100% | 100% | 100% | 100% | 85% | 100% | 60% | 100% | 100% | 80% | 100% | 75% |
| **Wetland Plot ID** | 17a-W | 17a-W | 17a-W | 17a-W | 18-W | 19-W | 20-W | 21-W | 22-W | 23-W | 24-W | 25-W |
| **Upland Plot ID** | 17a-U | 17a-U | 17a-U | 17a-U | 18-U | 19-U | 19-U | 21-U | 23-U | 23-U | 24-U | 23-U |
| **Community 2 Eggers and Reed** | - | - | - | - | Shallow, Open Water | - | Hardwood Swamp | - | - | Fresh (Wet) Meadow | - | Hardwood Swamp |
| **Community 2 %** | - | - | - | - | 10% | - | 30% | - | - | 10% | - | 25% |
| **Wetland Plot ID** | - | - | - | - | - | - | - | - | - | - | - | - |
| **Upland Plot ID** | - | - | - | - | - | - | - | - | - | - | - | - |
| **Community 3 Eggers and Reed** | - | - | - | - | Deep Marsh | - | Alder Thicket | - | - | Shallow Marsh | - | - |
| **Community 3 %** | - | - | - | - | 5% | - | 10% | - | - | 10% | - | - |
| **Community 4 Eggers and Reed** | - | - | - | - | - | - | | - | - | - | - | - |
| **Community 4 %** | - | - | - | - | - | - | | - | - | - | - | - |
| **Native Plant Community (NPC)** | - | - | - | - | MRn83 | WFn55 | FPn73, FPn62, & WFn55 | WFn55 | WFn55 | FFn57 | WFn55 | WFn53 & WFn55 |
| **Topographic Setting** | Depressional-flow-through | Depressional-no inlet/outlet | Depressional-no inlet/outlet | Depressional-tributary | Depressional-flow-through | Depressional-no inlet/outlet | Depressional-no inlet/outlet | Depressional-tributary | Depressional-no inlet/outlet | Floodplain | Lacustrine fringe | Slope |
| **Vegetative Diversity** | **M (0.5)** | H (1.0) | H (1.0) | H (1.0) | M (0.5) | H (1.0) | H (1.0) | H (1.0) | H (1.0) | H (1.0) | H (1.0) | H (1.0) |
| **Outlet Configuration** | L (0.1) | L (0.1) | L (0.1) | M (0.5) | **L (0.1)** | H (1.0) | H (1.0) | H (1.0) | H (1.0) | H (1.0) | M (0.5) | H (1.0) |
| **Upland Condition** | M (0.5) | M (0.5) | M (0.5) | M (0.5) | **H (1.0)** | H (1.0) | H (1.0) | H (1.0) | H (1.0) | H (1.0) | H (1.0) | H (1.0) |
| **Wildlife Habitat** | L (0.1) | L (0.1) | L (0.1) | L (0.1) | H (1.0) | H (1.0) | H (1.0) | H (1.0) | H (1.0) | H (1.0) | H (1.0) | H (1.0) |
| **Average Value** | **0.30** | **0.43** | **0.43** | **0.53** | **0.75** | **1.00** | **1.00** | **1.00** | **1.00** | **1.00** | **0.88** | **1.00** |
| **Overall Condition[1]** | **L** | M | M | M | M | H | H | H | H | H | H | H |
| **Public Value** | L (0.1) | L (0.1) | L (0.1) | L (0.1) | L (0.1) | L (0.1) | L (0.1) | L (0.1) | L (0.1) | L (0.1) | L (0.1) | L (0.1) |
| **Human Disturbance** | M | M | M | M | **H** | L | L | L | L | L | L | L |
| **Comments on history, origin, and connectivity** | Ditch wetland constructed during original basin development. Follows roadway, connects with the E. Beaver River. | Ditch constructed as part of 2006 Corps authorization to relocate diversion ditch and railroad and expand tailings storage. | Ditch constructed as part of 2006 Corps authorization to relocate diversion ditch and railroad and expand tailings storage. | Ditch constructed as part of 2006 Corps authorization to relocate diversion ditch and railroad and expand tailings storage. | "Murphy's Pond" connects with roadside ditches and water flow continues to the northeast to E. Beaver River. Impounded on the southeast side by roadway and RR. | Natural wetland that drains to the Beaver River. | Natural wetland that drains to East Beaver River. | Natural wetland, connected to diversion ditch. | Natural wetland that drains to Murphy's Pond. | Natural wetland that drains to Murphy's Pond. | Natural wetland that drains to Murphy's Pond. | Natural wetland that drains to Murphy's Pond. |

[1]Average value of vegetative diversity, outlet configuration, upland condition, and wildlife habitat

[2]Based on average value using MnRAM rating categories: Low=0.01-0.32, Medium=0.33-0.65, High=0.66-1.0, Exceptional=1.01-2.0

Shaded columns represent wetlands for which full MnRAM 3.4 assessment completed

**Bold** = values revised from 2015 wetland delineation report

## Updated Barr Mine MnRAM Wetland Function Assessment Results
## Northshore West Ridge RR Realignment and Tailings Basin Progression

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Federal Jurisdiction** | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| **Wetland ID** | 26 | 27 | 28 | 29 | 32 | 33 | 34 | 35 | 36 | 37 |
| **Date** | 8/12/2015 | 8/12/2015 | 8/12/2015 | 8/12/2015 | 8/13/2015 | 8/13/2015 | 8/13/2015 | 8/14/2015 | 8/14/2015 | - |
| **Field Team** | JTK & DRD | JTK & DRD | JTK & DRD | JTK & DRD | JTK & DRD | JTK & DRD | JTK & DRD | JTK & DRD | JTK & DRD | - |
| **Community 1 Eggers and Reed** | Hardwood Swamp | Hardwood Swamp | Hardwood Swamp | Alder Thicket | Alder Thicket | Hardwood Swamp | Hardwood Swamp | Hardwood Swamp | Hardwood Swamp | Hardwood Swamp |
| **Community 1 %** | 100% | 60% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% |
| **Wetland Plot ID** | 26-W | 27-W | 28-W | 29-W | 32-W | 33-W | 34-W | 35-W | 36-W | **-** |
| **Upland Plot ID** | 26-U | 27-U | 28-U | 28-U | 32-U | 32-U | 34-U | 35-U | 27-U | **-** |
| **Community 2 Eggers and Reed** | - | Sedge Meadow | - | - | - | - | - | - | - | - |
| **Community 2 %** | - | 20% | - | - | - | - | - | - | - | - |
| **Wetland Plot ID** | - | - | - | - | - | - | - | - | - | - |
| **Upland Plot ID** | - | - | - | - | - | - | - | - | - | - |
| **Community 3 Eggers and Reed** | - | Alder Thicket | - | - | - | - | - | - | - | - |
| **Community 3 %** | - | 20% | - | - | - | - | - | - | - | - |
| **Community 4 Eggers and Reed** | - | - | - | - | - | - | - | - | - | - |
| **Community 4 %** | - | - | - | - | - | - | - | - | - | - |
| **Native Plant Community (NPC)** | WFn55 | WFn55 , FPn73, & WMn82 | WFn55 | FPn73 | FPn73 | WFn55 | WFn55 | WFn55 | WFn55 | WFn55 |
| **Topographic Setting** | Depressional-no inlet/outlet | Floodplain | Depressional-no inlet/outlet | Depressional-no inlet/outlet | Depressional-no inlet/outlet | Depressional-no inlet/outlet | Depressional-no inlet/outlet | Depressional-no inlet/outlet | Depressional-flow through | Depressional-no inlet/outlet |
| **Vegetative Diversity** | H (1.0) | H (1.0) | H (1.0) | H (1.0) | H (1.0) | H (1.0) | H (1.0) | H (1.0) | H (1.0) | H (1.0) |
| **Outlet Configuration** | H (1.0) | H (1.0) | H (1.0) | H (1.0) | H (1.0) | H (1.0) | H (1.0) | H (1.0) | M (0.5) | H (1.0) |
| **Upland Condition** | H (1.0) | H (1.0) | H (1.0) | H (1.0) | H (1.0) | H (1.0) | H (1.0) | H (1.0) | H (1.0) | H (1.0) |
| **Wildlife Habitat** | H (1.0) | H (1.0) | H (1.0) | H (1.0) | H (1.0) | H (1.0) | H (1.0) | H (1.0) | H (1.0) | H (1.0) |
| **Average Value** | **1.00** | **1.00** | **1.00** | **1.00** | **1.00** | **1.00** | **1.00** | **1.00** | **0.88** | **1.00** |
| **Overall Condition[1]** | H | H | H | H | H | H | H | H | H | H |
| **Public Value** | L (0.1) | L (0.1) | L (0.1) | L (0.1) | L (0.1) | L (0.1) | L (0.1) | L (0.1) | L (0.1) | L (0.1) |
| **Human Disturbance** | L | L | L | L | L | L | L | L | L | L |
| **Comments on history, origin, and connectivity** | Natural wetland that drains to wetland 205 to Murphy's Pond. | Natural wetland that drains to Murphy's Pond. | Natural wetland that drains to the Beaver River. | Natural wetland that drains to the Beaver River. | Natural wetland, topographically-enclosed wetland with no apparent surface water outlet. | Natural wetland, topographically-enclosed wetland with no apparent surface water outlet. | Natural wetland, connected to diversion ditch. | Connection is uncertain. Wetland may be topographically-enclosed wetland with no apparent surface water outlet. | Natural wetland that drains to Murphy's Pond. | Desktop Delineated, Natural wetland, topographically-enclosed wetland with no apparent surface water outlet. |

[1]Average value of vegetative diversity, outlet configuration, upland condition, and wildlife habitat

[2]Based on average value using MnRAM rating categories: Low=0.01-0.32, Medium=0.33-0.65, High=0.66-1.0, Exceptional=1.01-2.0

Shaded columns represent wetlands for which full MnRAM 3.4 assessment completed

**Bold** = values revised from 2015 wetland delineation report

# Appendix B

## Barr Mine MnRAM

## Summary of Field Methodology

**Select Wetland Functional Assessment Field Guidance**
**For Mining Project Permitting**
**Barr Engineering Company**
**June 2015**

## 1.0 Field Functional Assessments

The objective of the field functional assessment is to collect data to allow for an evaluation of potential direct and indirect impacts from project development. Therefore, documentation of functional condition is needed to be able to determine impacts resulting from project development. This project will follow guidance for evaluation of wetland functions from the *Minnesota Routine Assessment Method for Evaluating Wetland Functions, Version 3.4* (MnRAM); however, a full MnRAM evaluation will not be completed. Select MnRAM functions will be used to evaluate the wetland functions for this project based on MnRAM 3.4 guidance. Wetland information should be collected in the field, as described below.

1. Wetland Community Classification – Follow Eggers and Reed classification system (17 communities as described in MnRAM) to identify the major (at least 10 percent of the wetland), distinct communities within each wetland and approximate percentage of each.

2. Topographic setting, which is used to define outlet characteristics
   - Depressional – no obvious inlets or outlets
   - Depressional – Flow-through (defined inflow and outflow)
   - Depressional – Tributary (no inlet, defined outflow)
   - Riverine (within the river/stream banks)
   - Lacustrine fringe (edge of deepwater areas) / shoreland
   - Extensive peatland / organic flat – noting percent cover of sphagnum moss and vegetation exemptions with percent cover if not true bog (therefore minerotrophic, not ombrotrophic)
   - Slope
   - Floodplain (outside waterbody banks)

3. Vegetative Diversity / Integrity (question 1 of MnRAM; carry full guidance in the field)
   - High – generally <20% invasive/non-native vegetation, inundated wetlands dominated by 3 or more native species, 5-10+native species present in other communities
   - Medium – generally 20-50% invasive/non-native vegetation, inundated wetlands dominated by 2 species, <5-9 species present in other communities
   - Low – generally >50% invasive/non-native vegetation, inundated wetlands dominated by 1 species, 50% or more of the trees are dead

4. Wetland Outlet Configuration
   - High – natural outlet condition
   - Medium – constructed outlet that is located close to historic wetland boundary (i.e., culvert, weir, permeable rock, ditch, etc.)
   - Low – constructed ditch outlet causing drainage or impounded wetland with no outlet or higher than the natural outlet

5. Upland Conditions / Land Uses
    - High – unaltered; full grass, shrub, or forest cover, natural slopes, no evidence of erosion
    - Medium – moderate vegetative cover, some artificial slopes, some evidence of erosion affecting wetland
    - Low – significant disturbance; intensive mining activities affecting wetland, limited vegetative cover, clear evidence of erosion

6. Wildlife Habitat
    - High – natural habitats surrounding wetland and connecting to other natural communities, no barriers to access from the wetland
    - Medium – moderate access to other natural communities, limited barriers to access from the wetland
    - Low – isolated from other natural communities or difficult access to other natural habitats (i.e., stockpiles, mine pits, roads, steep slopes, buildings, infrastructure, etc.)

7. Public Value
    - High – accessible to the public and provides recreational value
    - Medium – cumbersome public access with some recreational value
    - Low – no public access or no recreational value

8. Human Disturbance
    - High – significant alterations; roads stockpiles, mine pits, soil removal or disturbance, invasive species have significantly affected wetland
    - Medium – moderate alterations; roads stockpiles, mine pits, soil removal or disturbance, invasive species have affected wetland
    - Low – Unaltered; little evidence of human disturbances affecting wetland

Ratings for each of these characteristics will be utilized to develop a functional quality rating for each wetland. Ratings for items 3 through 7 will be given a score, as follows:

Low = 0.1, Medium = 0.5, High = 1.0

Based on these ratings for items 3 through 7, an average value will be calculated. An overall wetland functional assessment rating would then be given to the wetland based on the average value, as follows:

0 to 0.32 = Low, 0.33 to 0.65 = Medium, 0.66 to 1.0 = High

Item 8, human disturbance, would also be given a separate rating for each wetland.

# Appendix C

## U.S. Army Corps of Engineers Comments Dated July 17, 2019

Barr Functional Assessment Methodology Comments
July 17, 2019

Please provide the following revisions to your functional assessment:

1. In order to have a true understanding of Barr's abbreviated assessment, we ask that you pick a representative sample of wetlands from the project area with a range of vegetative quality (high, medium, and low) and each wetland plant community and run the full MNRAM analysis on them.
2. Please provide the rationale behind why specific factors of MNRAM were opted out of and why the selected factors were considered.

| MNRAM 3.4 | BARR |
|---|---|
| Veg diversity/integrity | Vegetative Diversity |
| Maintenance of characteristic hydrologic regime | Outlet Condition |
| Flood/stormwater/attenuation | Upland Condition |
| Downstream water quality | Wildlife Habitat |
| Maintenance of wetland water quality | Public Values |
| Shoreline protection | |
| Maintenance of characteristic wildlife habitat structure | |
| Maintenance of characteristic fish habitat | |
| Maintenance of characteristic amphibian habitat | |
| Aesthetics/recreational/educational/cultural | |
| Commercial uses | |
| Groundwater interaction | |
| Wetland restoration potential | |
| Sensitivity to stormwater and urban development | |
| Additional stormwater treatment needs | |

3. Remove the public value when calculating the overall wetland condition rating
    a. MNRAM and SAMP do consider public value in their ratings but they are kept separate
    b. the "Public Value" rating should not be mixed with functional ratings and certainly should not be given the same weight as vegetative diversity, wildlife habitat, outlet condition, etc.
4. MNRAM ratings are function by function; we won't put emphasis on average value
5. Special concern plant species: MNRAM guidance is to rate the vegetative diversity/integrity function as "exceptional" if SC, THR or END species are documented, therefore wetlands where they are documented should be rated exceptional for diversity/integrity

# Appendix D

## MnRAM Response Records and Wetland Functional Assessment Summaries

# MnRAM: Site Response Record

For Wetland: 2

Location: 38-056-08-21-002

## Northshore West Ridge Railroad

**Plant Community: Shrub Carr**

| Cowardin Classification: | Circular 39: |
|---|---|
| PSS1B | Type 6 |

**Plant Community: Fresh (Wet) Meadow**

| Cowardin Classification: | Circular 39: |
|---|---|
| PEMB | Type 2 |

**Plant Community: Hardwood Swamp**

| Cowardin Classification: | Circular 39: |
|---|---|
| PFO1B | Type 7 |

| | | |
|---|---|---|
| 4 | *Listed, rare, special species?* | No |
| 5 | *Rare community or habitat?* | No |
| 6 | *Pre-European-settlement condition?* | No |

***Hydrogeomorphology / topography:***

| | | |
|---|---|---|
| 7 | | Slope |
| 8-1 | *Maximum water depth* | 0 inches |
| 8-2 | *% inundated* | 0% |
| 9 | *Immediate drainage--local WS* | 52 acres |
| 10 | *Esimated size/existing site:* | *(see #66)* |
| 11-Upland Soil | | |
| 11-Wetland Soil | | |

| | | |
|---|---|---|
| 12 | *Outlet for flood control* | NA |
| 13 | *Outlet for hydro regime* | A |
| 14 | *Dominant upland land use* | B |
| 15 | *Wetland soil condition* | A |
| 16 | *Vegetation (% cover)* | 100% |
| 17 | *Emerg. veg flood resistance* | A |
| 18 | *Sediment delivery* | A |
| 19 | *Upland soils (soil group)* | B |
| 20 | *Stormwater runoff* | B |
| 21 | *Subwatershed wetland density* | C |
| 22 | *Channels/sheet flow* | B |
| 23 | *Adjacent buffer width* | 490 feet |

***Adjacent area management***

| | | |
|---|---|---|
| 24-A | *Full* | 100% |
| 24-B | *Manicured* | 0% |
| 24-C | *Bare* | 0% |

***Adjacent area diversity/structure***

| | | |
|---|---|---|
| 25-A | *Native* | 50% |
| 25-B | *Mixed* | 0% |
| 25-C | *Sparse* | 50% |

***Adjacent area slope***

| | | |
|---|---|---|
| 26-A | *Gentle* | 100% |
| 26-B | *Moderate* | 0% |
| 26-C | *Steep* | 0% |

| | | |
|---|---|---|
| 27 | *Downstream sens./WQ protect.* | B |
| 28 | *Nutrient loading* | B |
| 29 | *Shoreline wetland?* | No |

***Shoreline Wetland***

| | | |
|---|---|---|
| 30 | *Rooted veg., % cover* | 0% |
| 31 | *Wetland in-water width* | 0 feet |
| 32 | *Emerg. veg. erosion resistance* | |
| 33 | *Erosion potential of site* | |
| 34 | *Upslope veg./bank protection* | |
| 35 | *Rare wildlife?* | No |
| 36 | *Scare/Rare/S1/S2 community* | No |
| 37 | *Vegetative cover* | NA |
| 38 | *Veg. community interspersion* | B |
| 39 | *Wetland detritus* | B |
| 40 | *Interspersion on landscape* | A |
| 41 | *Wildlife barriers* | B |

***Amphibian-breeding potential***

| | | |
|---|---|---|
| 42 | *Hydroperiod adequacy* | Inadequate |
| 43 | *Fish presence* | A |
| 44 | *Overwintering habitat* | |
| 45 | *Wildlife species (list)* | |
| 46 | *Fish habitat quality* | NA |
| 47 | *Fish species (list)* | |
| 48 | *Unique/rare opportunity* | No |
| 49 | *Wetland visibility* | C |
| 50 | *Proximity to population* | No |
| 51 | *Public ownership* | C |
| 52 | *Public access* | C |
| 53 | *Human influence on wetland* | A |
| 54 | *Human influence on viewshed* | B |

| | | |
|---|---|---|
| 55 | *Spatial buffer* | C |
| 56 | *Recreational activity potential* | C |
| 57 | *Commercial crop--hydro impact* | NA |

***Groundwater-specific questions***

| | | |
|---|---|---|
| 58 | *Wetland soils* | Recharge |
| 59 | *Subwatershed land use* | Discharge |
| 60 | *Wetland size/soil group* | Recharge |
| 61 | *Wetland hydroperiod* | Recharge |
| 62 | *Inlet/Outlet configuration* | Recharge |
| 63 | *Upland topo relief* | Recharge |

***Additional information***

| | | |
|---|---|---|
| 64 | *Restoration potential* | |
| 65 | *LO affected by restoration* | |
| 66 | *Existing size* | 8.3 |
| | *Restorable size* | 0 |
| | *Potential new wetland* | 0 |
| 67 | *Average width of pot. buffer* | 0 feet |
| 68 | *Ease of potential restoration* | |
| 69 | *Hydrologic alterations* | 0 |
| 70 | *Potential wetland type* | 0 |
| 71 | *Stormwater sensitivity* | |
| 72 | *Additional treatment needs* | |

Watershed Lake Superior (South)

WS# 2 Service Area: 1

For functional ratings, please run the Summary tab report.

This report printed on: 2/14/2020

# Wetland Functional Assessment Summary

| Wetland Name | Hydrogeomorphology | Maintenance of Hydrologic Regime | Flood/ Stormwater/ Attenuation | Downstream Water Quality | Maintenance of Wetland Water Quality | Shoreline Protection |
|---|---|---|---|---|---|---|
| 2 | Slope | 0.75 | 0.66 | 0.75 | 0.63 | 0.00 |
| | | High | Moderate | High | Moderate | Not Applicable |

| | | | | | | | Additional Information | | |
|---|---|---|---|---|---|---|---|---|---|
| Wetland Name | Maintenance of Characteristic Wildlife Habitat Structure | Maintenance of Characteristic Fish Habitat | Maintenance of Characteristic Amphibian Habitat | Aesthetics/ Recreation/ Education/ Cultural | Commercial Uses | Ground-Water Interaction | Wetland Restoration Potential | Wetland Sensitivity to Stormwater and Urban Development | Additional Stormwater Treatment Needs |
| 2 | 0.64 | 0.00 | 0.00 | 0.26 | 0.00 | Recharge | 0.00 | 0.50 | 0.63 |
| | Moderate | Not Applicable | Not Applicable | Low | Not Applicable | | Not Applicable | High | Moderate |

# Wetland Community Summary

| | | Vegetative Diversity/Integrity | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Community | | | | | | | | |
| Wetland Name | Location | Cowardin Classification | Circular 39 | Plant Community | Wetland Proportion | Individual Community Rating | Highest Wetland Rating | Average Wetland Rating | Weighted Average Wetland Rating | |
| 2 | 38-056-08-21-002 | PSS1B | Type 6 | Shrub Carr | 10 | 0.5 | 0.50 | 0.37 | 0.46 | |
| | | | | | | | Moderate | Moderate | Moderate | |
| | | PEMB | Type 2 | Fresh (Wet) Meadow | 10 | 0.1 | 0.50 | 0.37 | 0.46 | |
| | | | | | | | Moderate | Moderate | Moderate | |
| | | PFO1B | Type 7 | Hardwood Swamp | 80 | 0.5 | 0.50 | 0.37 | 0.46 | |
| | | | | | | | Moderate | Moderate | Moderate | |
| | | | | | 100 | | 0.50 | 0.37 | 0.46 | ☐ |

☑ *Denotes incomplete calculation data.*

# MnRAM: Site Response Record

For Wetland: 6

Location: 38-056-08-28-006

## Northshore West Ridge Railroad

**Plant Community: Sedge Meadow**

Cowardin Classification: PEMB — Circular 39: Type 2

**Plant Community: Alder Thicket**

Cowardin Classification: PSS1B — Circular 39: Type 6

| | | |
|---|---|---|
| 4 | *Listed, rare, special species?* | No |
| 5 | *Rare community or habitat?* | No |
| 6 | *Pre-European-settlement condition?* | No |

***Hydrogeomorphology / topography:***

| | | |
|---|---|---|
| 7 | | Slope |
| 8-1 | *Maximum water depth* | 0 inches |
| 8-2 | *% inundated* | 0% |
| 9 | *Immediate drainage--local WS* | 5 acres |
| 10 | *Esimated size/existing site:* | *(see #66)* |
| 11-Upland Soil | | |
| 11-Wetland Soil | | |

| | | |
|---|---|---|
| 12 | *Outlet for flood control* | NA |
| 13 | *Outlet for hydro regime* | C |
| 14 | *Dominant upland land use* | C |
| 15 | *Wetland soil condition* | C |
| 16 | *Vegetation (% cover)* | 25% |
| 17 | *Emerg. veg flood resistance* | C |
| 18 | *Sediment delivery* | B |
| 19 | *Upland soils (soil group)* | B |
| 20 | *Stormwater runoff* | B |
| 21 | *Subwatershed wetland density* | C |
| 22 | *Channels/sheet flow* | B |
| 23 | *Adjacent buffer width* | 50 feet |

***Adjacent area management***

| | | |
|---|---|---|
| 24-A | *Full* | 30% |
| 24-B | *Manicured* | 0% |
| 24-C | *Bare* | 70% |

***Adjacent area diversity/structure***

| | | |
|---|---|---|
| 25-A | *Native* | 0% |
| 25-B | *Mixed* | 30% |
| 25-C | *Sparse* | 70% |

***Adjacent area slope***

| | | |
|---|---|---|
| 26-A | *Gentle* | 0% |
| 26-B | *Moderate* | 50% |
| 26-C | *Steep* | 50% |

| | | |
|---|---|---|
| 27 | *Downstream sens./WQ protect.* | C |
| 28 | *Nutrient loading* | A |
| 29 | *Shoreline wetland?* | No |

***Shoreline Wetland***

| | | |
|---|---|---|
| 30 | *Rooted veg., % cover* | 0% |
| 31 | *Wetland in-water width* | 0 feet |
| 32 | *Emerg. veg. erosion resistance* | |
| 33 | *Erosion potential of site* | |
| 34 | *Upslope veg./bank protection* | |
| 35 | *Rare wildlife?* | No |
| 36 | *Scare/Rare/S1/S2 community* | No |
| 37 | *Vegetative cover* | NA |
| 38 | *Veg. community interspersion* | C |
| 39 | *Wetland detritus* | B |
| 40 | *Interspersion on landscape* | A |
| 41 | *Wildlife barriers* | C |

***Amphibian-breeding potential***

| | | |
|---|---|---|
| 42 | *Hydroperiod adequacy* | Inadequate |
| 43 | *Fish presence* | A |
| 44 | *Overwintering habitat* | |
| 45 | *Wildlife species (list)* | |
| 46 | *Fish habitat quality* | NA |
| 47 | *Fish species (list)* | |
| 48 | *Unique/rare opportunity* | No |
| 49 | *Wetland visibility* | C |
| 50 | *Proximity to population* | No |
| 51 | *Public ownership* | C |
| 52 | *Public access* | C |
| 53 | *Human influence on wetland* | C |
| 54 | *Human influence on viewshed* | B |
| 55 | *Spatial buffer* | C |
| 56 | *Recreational activity potential* | C |

| | | |
|---|---|---|
| 57 | *Commercial crop--hydro impact* | NA |

***Groundwater-specific questions***

| | | |
|---|---|---|
| 58 | *Wetland soils* | Recharge |
| 59 | *Subwatershed land use* | Discharge |
| 60 | *Wetland size/soil group* | Recharge |
| 61 | *Wetland hydroperiod* | Recharge |
| 62 | *Inlet/Outlet configuration* | Discharge |
| 63 | *Upland topo relief* | Recharge |

***Additional information***

| | | |
|---|---|---|
| 64 | *Restoration potential* | |
| 65 | *LO affected by restoration* | |
| 66 | *Existing size* | 1.25 |
| | *Restorable size* | 0 |
| | *Potential new wetland* | 0 |
| 67 | *Average width of pot. buffer* | 0 feet |
| 68 | *Ease of potential restoration* | |
| 69 | *Hydrologic alterations* | 0 |
| 70 | *Potential wetland type* | 0 |
| 71 | *Stormwater sensitivity* | |
| 72 | *Additional treatment needs* | |

Watershed Lake Superior (South)

WS# 2 Service Area: 1

For functional ratings, please run the Summary tab report.

This report printed on: 2/14/2020

# Wetland Functional Assessment Summary

| Wetland Name | Hydrogeomorphology | Maintenance of Hydrologic Regime | Flood/ Stormwater/ Attenuation | Downstream Water Quality | Maintenance of Wetland Water Quality | Shoreline Protection |
|---|---|---|---|---|---|---|
| 6 | Slope | 0.20 | 0.43 | 0.31 | 0.61 | 0.00 |
| | | Low | Moderate | Low | Moderate | Not Applicable |

| | | | | | | | Additional Information | | |
|---|---|---|---|---|---|---|---|---|---|
| Wetland Name | Maintenance of Characteristic Wildlife Habitat Structure | Maintenance of Characteristic Fish Habitat | Maintenance of Characteristic Amphibian Habitat | Aesthetics/ Recreation/ Education/ Cultural | Commercial Uses | Ground-Water Interaction | Wetland Restoration Potential | Wetland Sensitivity to Stormwater and Urban Development | Additional Stormwater Treatment Needs |
| 6 | 0.50 | 0.00 | 0.00 | 0.15 | 0.00 | Combination Discharge, Recharge | 0.00 | 1.00 | 0.61 |
| | Moderate | Not Applicable | Not Applicable | Low | Not Applicable | | Not Applicable | Exceptional | Moderate |

# Wetland Community Summary

| | | Vegetative Diversity/Integrity | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Community | | | | | | | | |
| Wetland Name | Location | Cowardin Classification | Circular 39 | Plant Community | Wetland Proportion | Individual Community Rating | Highest Wetland Rating | Average Wetland Rating | Weighted Average Wetland Rating | |
| 6 | 38-056-08-28-006 | PEMB | Type 2 | Sedge Meadow | 80 | 1 | 1.00 | 0.75 | 0.90 | |
| | | | | | | | High | High | High | |
| | | PSS1B | Type 6 | Alder Thicket | 20 | 0.5 | 1.00 | 0.75 | 0.90 | |
| | | | | | | | High | High | High | |
| | | | | | 100 | | 1.00 | 0.75 | 0.90 | ☐ |

☑ *Denotes incomplete calculation data.*

# MnRAM: Site Response Record

For Wetland: 8

Location: 38-056-08-28-008

## Northshore West Ridge Railroad

**Plant Community: Fresh (Wet) Meadow**

Cowardin Classification: PEMB — Circular 39: Type 2

**Plant Community: Shrub Carr**

Cowardin Classification: PSS1B — Circular 39: Type 6

| | | |
|---|---|---|
| 4 | *Listed, rare, special species?* | Yes |
| 5 | *Rare community or habitat?* | No |
| 6 | *Pre-European-settlement condition?* | No |

***Hydrogeomorphology / topography:***

| | | |
|---|---|---|
| 7 | | Slope |
| 8-1 | *Maximum water depth* | 0 inches |
| 8-2 | *% inundated* | 0% |
| 9 | *Immediate drainage--local WS* | 12 acres |
| 10 | *Esimated size/existing site:* | *(see #66)* |
| 11-Upland Soil | | |
| 11-Wetland Soil | | |

| | | |
|---|---|---|
| 12 | *Outlet for flood control* | NA |
| 13 | *Outlet for hydro regime* | C |
| 14 | *Dominant upland land use* | C |
| 15 | *Wetland soil condition* | C |
| 16 | *Vegetation (% cover)* | 25% |
| 17 | *Emerg. veg flood resistance* | C |
| 18 | *Sediment delivery* | B |
| 19 | *Upland soils (soil group)* | B |
| 20 | *Stormwater runoff* | B |
| 21 | *Subwatershed wetland density* | C |
| 22 | *Channels/sheet flow* | B |
| 23 | *Adjacent buffer width* | 50 feet |

***Adjacent area management***

| | | |
|---|---|---|
| 24-A | *Full* | 20% |
| 24-B | *Manicured* | 10% |
| 24-C | *Bare* | 70% |

***Adjacent area diversity/structure***

| | | |
|---|---|---|
| 25-A | *Native* | 0% |
| 25-B | *Mixed* | 30% |
| 25-C | *Sparse* | 70% |

***Adjacent area slope***

| | | |
|---|---|---|
| 26-A | *Gentle* | 50% |
| 26-B | *Moderate* | 50% |
| 26-C | *Steep* | 0% |

| | | |
|---|---|---|
| 27 | *Downstream sens./WQ protect.* | B |
| 28 | *Nutrient loading* | B |
| 29 | *Shoreline wetland?* | No |

***Shoreline Wetland***

| | | |
|---|---|---|
| 30 | *Rooted veg., % cover* | 0% |
| 31 | *Wetland in-water width* | 0 feet |
| 32 | *Emerg. veg. erosion resistance* | |
| 33 | *Erosion potential of site* | |
| 34 | *Upslope veg./bank protection* | |
| 35 | *Rare wildlife?* | No |
| 36 | *Scare/Rare/S1/S2 community* | No |
| 37 | *Vegetative cover* | NA |
| 38 | *Veg. community interspersion* | C |
| 39 | *Wetland detritus* | B |
| 40 | *Interspersion on landscape* | A |
| 41 | *Wildlife barriers* | C |

***Amphibian-breeding potential***

| | | |
|---|---|---|
| 42 | *Hydroperiod adequacy* | Inadequate |
| 43 | *Fish presence* | A |
| 44 | *Overwintering habitat* | |
| 45 | *Wildlife species (list)* | |
| 46 | *Fish habitat quality* | NA |
| 47 | *Fish species (list)* | |
| 48 | *Unique/rare opportunity* | No |
| 49 | *Wetland visibility* | C |
| 50 | *Proximity to population* | No |
| 51 | *Public ownership* | C |
| 52 | *Public access* | C |
| 53 | *Human influence on wetland* | C |
| 54 | *Human influence on viewshed* | B |
| 55 | *Spatial buffer* | C |
| 56 | *Recreational activity potential* | C |
| 57 | *Commercial crop--hydro impact* | NA |

***Groundwater-specific questions***

| | | |
|---|---|---|
| 58 | *Wetland soils* | Recharge |
| 59 | *Subwatershed land use* | Discharge |
| 60 | *Wetland size/soil group* | Recharge |
| 61 | *Wetland hydroperiod* | Recharge |
| 62 | *Inlet/Outlet configuration* | Recharge |
| 63 | *Upland topo relief* | Recharge |

***Additional information***

| | | |
|---|---|---|
| 64 | *Restoration potential* | |
| 65 | *LO affected by restoration* | |
| 66 | *Existing size* | 2.66 |
| | *Restorable size* | 0 |
| | *Potential new wetland* | 0 |
| 67 | *Average width of pot. buffer* | 0 feet |
| 68 | *Ease of potential restoration* | |
| 69 | *Hydrologic alterations* | 0 |
| 70 | *Potential wetland type* | 0 |
| 71 | *Stormwater sensitivity* | |
| 72 | *Additional treatment needs* | |

Watershed Lake Superior (South)

WS# 2 Service Area: 1

For functional ratings, please run the Summary tab report.

This report printed on: 2/14/2020

# Wetland Functional Assessment Summary

| Wetland Name | Hydrogeomorphology | Maintenance of Hydrologic Regime | Flood/ Stormwater/ Attenuation | Downstream Water Quality | Maintenance of Wetland Water Quality | Shoreline Protection |
|---|---|---|---|---|---|---|
| 8 | Slope | 0.20 | 0.43 | 0.40 | 0.87 | 0.00 |
| | | Low | Moderate | Moderate | High | Not Applicable |

| | | | | | | | Additional Information | | |
|---|---|---|---|---|---|---|---|---|---|
| Wetland Name | Maintenance of Characteristic Wildlife Habitat Structure | Maintenance of Characteristic Fish Habitat | Maintenance of Characteristic Amphibian Habitat | Aesthetics/ Recreation/ Education/ Cultural | Commercial Uses | Ground-Water Interaction | Wetland Restoration Potential | Wetland Sensitivity to Stormwater and Urban Development | Additional Stormwater Treatment Needs |
| 8 | 0.74 | 0.00 | 0.00 | 0.15 | 0.00 | Recharge | 0.00 | 1.00 | 0.87 |
| | High | Not Applicable | Not Applicable | Low | Not Applicable | | Not Applicable | High | High |

# Wetland Community Summary

| | | Vegetative Diversity/Integrity | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Community | | | | | | | | |
| Wetland Name | Location | Cowardin Classification | Circular 39 | Plant Community | Wetland Proportion | Individual Community Rating | Highest Wetland Rating | Average Wetland Rating | Weighted Average Wetland Rating | |
| 8 | 38-056-08-28-008 | PEMB | Type 2 | Fresh (Wet) Meadow | 90 | 1 | 2.00 | 2.00 | 2.00 | |
| | | | | | | | Exceptional | Exceptional | Exceptional | |
| | | PSS1B | Type 6 | Shrub Carr | 10 | 1 | 2.00 | 2.00 | 2.00 | |
| | | | | | | | Exceptional | Exceptional | Exceptional | |
| | | | | | 100 | | 2.00 | 2.00 | 2.00 | ☐ |

☑ *Denotes incomplete calculation data.*

# MnRAM: Site Response Record

For Wetland: 11a

Location: 38-056-08-29-011

## Northshore West Ridge Railroad

**Plant Community: Sedge Meadow**

Cowardin Classification: PEMB — Circular 39: Type 2

**Plant Community: Hardwood Swamp**

Cowardin Classification: PFO1A — Circular 39: Type 7

| | | |
|---|---|---|
| 4 | *Listed, rare, special species?* | No |
| 5 | *Rare community or habitat?* | No |
| 6 | *Pre-European-settlement condition?* | No |

***Hydrogeomorphology / topography:***

| | | |
|---|---|---|
| 7 | | Depressional/Isolated |
| 8-1 | *Maximum water depth* | 0 inches |
| 8-2 | *% inundated* | 0% |
| 9 | *Immediate drainage--local WS* | 10 acres |
| 10 | *Esimated size/existing site:* | *(see #66)* |
| 11-Upland Soil | | |
| 11-Wetland Soil | | |

| | | |
|---|---|---|
| 12 | *Outlet for flood control* | A |
| 13 | *Outlet for hydro regime* | A |
| 14 | *Dominant upland land use* | A |
| 15 | *Wetland soil condition* | B |
| 16 | *Vegetation (% cover)* | 100% |
| 17 | *Emerg. veg flood resistance* | NA |
| 18 | *Sediment delivery* | A |
| 19 | *Upland soils (soil group)* | B |
| 20 | *Stormwater runoff* | C |
| 21 | *Subwatershed wetland density* | C |
| 22 | *Channels/sheet flow* | A |
| 23 | *Adjacent buffer width* | 500 feet |

***Adjacent area management***

| | | |
|---|---|---|
| 24-A | *Full* | 100% |
| 24-B | *Manicured* | 0% |
| 24-C | *Bare* | 0% |

***Adjacent area diversity/structure***

| | | |
|---|---|---|
| 25-A | *Native* | 100% |
| 25-B | *Mixed* | 0% |
| 25-C | *Sparse* | 0% |

***Adjacent area slope***

| | | |
|---|---|---|
| 26-A | *Gentle* | 100% |
| 26-B | *Moderate* | 0% |
| 26-C | *Steep* | 0% |

| | | |
|---|---|---|
| 27 | *Downstream sens./WQ protect.* | C |
| 28 | *Nutrient loading* | A |
| 29 | *Shoreline wetland?* | No |

***Shoreline Wetland***

| | | |
|---|---|---|
| 30 | *Rooted veg., % cover* | 0% |
| 31 | *Wetland in-water width* | 0 feet |
| 32 | *Emerg. veg. erosion resistance* | |
| 33 | *Erosion potential of site* | |
| 34 | *Upslope veg./bank protection* | |
| 35 | *Rare wildlife?* | No |
| 36 | *Scare/Rare/S1/S2 community* | No |
| 37 | *Vegetative cover* | NA |
| 38 | *Veg. community interspersion* | C |
| 39 | *Wetland detritus* | A |
| 40 | *Interspersion on landscape* | A |
| 41 | *Wildlife barriers* | B |

***Amphibian-breeding potential***

| | | |
|---|---|---|
| 42 | *Hydroperiod adequacy* | Inadequate |
| 43 | *Fish presence* | A |
| 44 | *Overwintering habitat* | |
| 45 | *Wildlife species (list)* | |
| 46 | *Fish habitat quality* | NA |
| 47 | *Fish species (list)* | |
| 48 | *Unique/rare opportunity* | No |
| 49 | *Wetland visibility* | C |
| 50 | *Proximity to population* | No |
| 51 | *Public ownership* | C |
| 52 | *Public access* | C |
| 53 | *Human influence on wetland* | B |
| 54 | *Human influence on viewshed* | B |
| 55 | *Spatial buffer* | B |
| 56 | *Recreational activity potential* | C |

| | | |
|---|---|---|
| 57 | *Commercial crop--hydro impact* | NA |

***Groundwater-specific questions***

| | | |
|---|---|---|
| 58 | *Wetland soils* | Discharge |
| 59 | *Subwatershed land use* | Discharge |
| 60 | *Wetland size/soil group* | Recharge |
| 61 | *Wetland hydroperiod* | Recharge |
| 62 | *Inlet/Outlet configuration* | Recharge |
| 63 | *Upland topo relief* | Recharge |

***Additional information***

| | | |
|---|---|---|
| 64 | *Restoration potential* | |
| 65 | *LO affected by restoration* | |
| 66 | *Existing size* | 0.04 |
| | *Restorable size* | 0 |
| | *Potential new wetland* | 0 |
| 67 | *Average width of pot. buffer* | 0 feet |
| 68 | *Ease of potential restoration* | |
| 69 | *Hydrologic alterations* | 0 |
| 70 | *Potential wetland type* | 0 |
| 71 | *Stormwater sensitivity* | |
| 72 | *Additional treatment needs* | |

Watershed Lake Superior (South)

WS# 2 Service Area: 1

For functional ratings, please run the Summary tab report.

This report printed on: 2/14/2020

# Wetland Functional Assessment Summary

| Wetland Name | Hydrogeomorphology | Maintenance of Hydrologic Regime | Flood/ Stormwater/ Attenuation | Downstream Water Quality | Maintenance of Wetland Water Quality | Shoreline Protection |
|---|---|---|---|---|---|---|
| 11a | Depressional/Isolated (no discernable inlets or outlets) | 0.88 | 0.56 | 0.67 | 1.00 | 0.00 |
| | | High | Moderate | High | High | Not Applicable |

| | | | | | | | Additional Information | | |
|---|---|---|---|---|---|---|---|---|---|
| Wetland Name | Maintenance of Characteristic Wildlife Habitat Structure | Maintenance of Characteristic Fish Habitat | Maintenance of Characteristic Amphibian Habitat | Aesthetics/ Recreation/ Education/ Cultural | Commercial Uses | Ground-Water Interaction | Wetland Restoration Potential | Wetland Sensitivity to Stormwater and Urban Development | Additional Stormwater Treatment Needs |
| 11a | 0.84 | 0.00 | 0.00 | 0.25 | 0.00 | Combination Discharge, Recharge | 0.00 | 1.00 | 1.00 |
| | High | Not Applicable | Not Applicable | Low | Not Applicable | | Not Applicable | Exceptional | High |

# Wetland Community Summary

| | | Vegetative Diversity/Integrity | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Community | | | | | | | | |
| Wetland Name | Location | Cowardin Classification | Circular 39 | Plant Community | Wetland Proportion | Individual Community Rating | Highest Wetland Rating | Average Wetland Rating | Weighted Average Wetland Rating | |
| 11a | 38-056-08-29-011 | PEMB | Type 2 | Sedge Meadow | 90 | 1 | 1.00 | 1.00 | 1.00 | |
| | | | | | | | High | High | High | |
| | | PFO1A | Type 7 | Hardwood Swamp | 10 | 1 | 1.00 | 1.00 | 1.00 | |
| | | | | | | | High | High | High | |
| | | | | | 100 | | 1.00 | 1.00 | 1.00 | ☐ |

☑ *Denotes incomplete calculation data.*

# MnRAM: Site Response Record

For Wetland: 11c

Location: 38-056-08-29-011

## Northshore West Ridge Railroad

**Plant Community: Sedge Meadow**

Cowardin Classification: PEMB — Circular 39: Type 2

**Plant Community: Seasonally Flooded Ba**

Cowardin Classification: PEMA — Circular 39: Type 1

| | | |
|---|---|---|
| 4 | *Listed, rare, special species?* | No |
| 5 | *Rare community or habitat?* | No |
| 6 | *Pre-European-settlement condition?* | No |

***Hydrogeomorphology / topography:***

7 Depressional/Isolated

| | | |
|---|---|---|
| 8-1 | *Maximum water depth* | 0 inches |
| 8-2 | *% inundated* | 0% |
| 9 | *Immediate drainage--local WS* | 10 acres |
| 10 | *Esimated size/existing site:* | *(see #66)* |

*11-Upland Soil*

*11-Wetland Soil*

| | | |
|---|---|---|
| 12 | *Outlet for flood control* | A |
| 13 | *Outlet for hydro regime* | A |
| 14 | *Dominant upland land use* | A |
| 15 | *Wetland soil condition* | B |
| 16 | *Vegetation (% cover)* | 100% |
| 17 | *Emerg. veg flood resistance* | NA |
| 18 | *Sediment delivery* | A |
| 19 | *Upland soils (soil group)* | B |
| 20 | *Stormwater runoff* | C |
| 21 | *Subwatershed wetland density* | C |
| 22 | *Channels/sheet flow* | A |
| 23 | *Adjacent buffer width* | 500 feet |

***Adjacent area management***

| | | |
|---|---|---|
| 24-A | *Full* | 100% |
| 24-B | *Manicured* | 0% |
| 24-C | *Bare* | 0% |

***Adjacent area diversity/structure***

| | | |
|---|---|---|
| 25-A | *Native* | 100% |
| 25-B | *Mixed* | 0% |
| 25-C | *Sparse* | 0% |

***Adjacent area slope***

| | | |
|---|---|---|
| 26-A | *Gentle* | 100% |
| 26-B | *Moderate* | 0% |
| 26-C | *Steep* | 0% |

| | | |
|---|---|---|
| 27 | *Downstream sens./WQ protect.* | C |
| 28 | *Nutrient loading* | A |
| 29 | *Shoreline wetland?* | No |

***Shoreline Wetland***

| | | |
|---|---|---|
| 30 | *Rooted veg., % cover* | 0% |
| 31 | *Wetland in-water width* | 0 feet |
| 32 | *Emerg. veg. erosion resistance* | |
| 33 | *Erosion potential of site* | |
| 34 | *Upslope veg./bank protection* | |
| 35 | *Rare wildlife?* | No |
| 36 | *Scare/Rare/S1/S2 community* | No |
| 37 | *Vegetative cover* | NA |
| 38 | *Veg. community interspersion* | C |
| 39 | *Wetland detritus* | A |
| 40 | *Interspersion on landscape* | A |
| 41 | *Wildlife barriers* | B |

***Amphibian-breeding potential***

| | | |
|---|---|---|
| 42 | *Hydroperiod adequacy* | Inadequate |
| 43 | *Fish presence* | A |
| 44 | *Overwintering habitat* | |
| 45 | *Wildlife species (list)* | |
| 46 | *Fish habitat quality* | NA |
| 47 | *Fish species (list)* | |
| 48 | *Unique/rare opportunity* | No |
| 49 | *Wetland visibility* | C |
| 50 | *Proximity to population* | No |
| 51 | *Public ownership* | C |
| 52 | *Public access* | C |
| 53 | *Human influence on wetland* | B |
| 54 | *Human influence on viewshed* | B |
| 55 | *Spatial buffer* | B |
| 56 | *Recreational activity potential* | C |

| | | |
|---|---|---|
| 57 | *Commercial crop--hydro impact* | NA |

***Groundwater-specific questions***

| | | |
|---|---|---|
| 58 | *Wetland soils* | Discharge |
| 59 | *Subwatershed land use* | Discharge |
| 60 | *Wetland size/soil group* | Recharge |
| 61 | *Wetland hydroperiod* | Recharge |
| 62 | *Inlet/Outlet configuration* | Recharge |
| 63 | *Upland topo relief* | Recharge |

***Additional information***

| | | |
|---|---|---|
| 64 | *Restoration potential* | |
| 65 | *LO affected by restoration* | |
| 66 | *Existing size* | 0.13 |
| | *Restorable size* | 0 |
| | *Potential new wetland* | 0 |
| 67 | *Average width of pot. buffer* | 0 feet |
| 68 | *Ease of potential restoration* | |
| 69 | *Hydrologic alterations* | 0 |
| 70 | *Potential wetland type* | 0 |
| 71 | *Stormwater sensitivity* | |
| 72 | *Additional treatment needs* | |

Watershed Lake Superior (South)

WS# 2 Service Area: 1

For functional ratings, please run the Summary tab report.

This report printed on: 2/14/2020

# Wetland Functional Assessment Summary

| Wetland Name | Hydrogeomorphology | Maintenance of Hydrologic Regime | Flood/ Stormwater/ Attenuation | Downstream Water Quality | Maintenance of Wetland Water Quality | Shoreline Protection |
|---|---|---|---|---|---|---|
| 11c | Depressional/Isolated (no discernable inlets or outlets) | 0.88 | 0.56 | 0.67 | 1.00 | 0.00 |
| | | High | Moderate | High | High | Not Applicable |

| | | | | | | | Additional Information | | |
|---|---|---|---|---|---|---|---|---|---|
| Wetland Name | Maintenance of Characteristic Wildlife Habitat Structure | Maintenance of Characteristic Fish Habitat | Maintenance of Characteristic Amphibian Habitat | Aesthetics/ Recreation/ Education/ Cultural | Commercial Uses | Ground-Water Interaction | Wetland Restoration Potential | Wetland Sensitivity to Stormwater and Urban Development | Additional Stormwater Treatment Needs |
| 11c | 0.84 | 0.00 | 0.00 | 0.25 | 0.00 | Combination Discharge, Recharge | 0.00 | 1.00 | 1.00 |
| | High | Not Applicable | Not Applicable | Low | Not Applicable | | Not Applicable | Exceptional | High |

# Wetland Community Summary

| | | Vegetative Diversity/Integrity | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Community | | | | | | | | |
| Wetland Name | Location | Cowardin Classification | Circular 39 | Plant Community | Wetland Proportion | Individual Community Rating | Highest Wetland Rating | Average Wetland Rating | Weighted Average Wetland Rating | |
| 11c | 38-056-08-29-011 | PEMB | Type 2 | Sedge Meadow | 90 | 1 | 1.00 | 1.00 | 1.00 | |
| | | | | | | | High | High | High | |
| | | PEMA | Type 1 | Seasonally Flooded Basin | 10 | 1 | 1.00 | 1.00 | 1.00 | |
| | | | | | | | High | High | High | |
| | | | | | 100 | | 1.00 | 1.00 | 1.00 | ☐ |

☑ *Denotes incomplete calculation data.*

# MnRAM: Site Response Record

For Wetland: 13

Location: 38-056-08-31-013

## Northshore West Ridge Railroad

**Plant Community: Alder Thicket**

Cowardin Classification: PSS1B — Circular 39: Type 6

**Plant Community: Hardwood Swamp**

Cowardin Classification: PFO1B — Circular 39: Type 7

| | | |
|---|---|---|
| 4 | *Listed, rare, special species?* | No |
| 5 | *Rare community or habitat?* | No |
| 6 | *Pre-European-settlement condition?* | No |

***Hydrogeomorphology / topography:***

| | | |
|---|---|---|
| 7 | | Slope |
| 8-1 | *Maximum water depth* | 0 inches |
| 8-2 | *% inundated* | 0% |
| 9 | *Immediate drainage--local WS* | 43 acres |
| 10 | *Esimated size/existing site:* | *(see #66)* |
| 11-Upland Soil | | |
| 11-Wetland Soil | | |

| | | |
|---|---|---|
| 12 | *Outlet for flood control* | NA |
| 13 | *Outlet for hydro regime* | B |
| 14 | *Dominant upland land use* | B |
| 15 | *Wetland soil condition* | A |
| 16 | *Vegetation (% cover)* | 100% |
| 17 | *Emerg. veg flood resistance* | A |
| 18 | *Sediment delivery* | B |
| 19 | *Upland soils (soil group)* | B |
| 20 | *Stormwater runoff* | B |
| 21 | *Subwatershed wetland density* | C |
| 22 | *Channels/sheet flow* | B |
| 23 | *Adjacent buffer width* | 50 feet |

***Adjacent area management***

| | | |
|---|---|---|
| 24-A | *Full* | 30% |
| 24-B | *Manicured* | 10% |
| 24-C | *Bare* | 60% |

***Adjacent area diversity/structure***

| | | |
|---|---|---|
| 25-A | *Native* | 50% |
| 25-B | *Mixed* | 0% |
| 25-C | *Sparse* | 50% |

***Adjacent area slope***

| | | |
|---|---|---|
| 26-A | *Gentle* | 80% |
| 26-B | *Moderate* | 10% |
| 26-C | *Steep* | 10% |

| | | |
|---|---|---|
| 27 | *Downstream sens./WQ protect.* | B |
| 28 | *Nutrient loading* | A |
| 29 | *Shoreline wetland?* | No |

***Shoreline Wetland***

| | | |
|---|---|---|
| 30 | *Rooted veg., % cover* | 0% |
| 31 | *Wetland in-water width* | 0 feet |
| 32 | *Emerg. veg. erosion resistance* | |
| 33 | *Erosion potential of site* | |
| 34 | *Upslope veg./bank protection* | |
| 35 | *Rare wildlife?* | No |
| 36 | *Scare/Rare/S1/S2 community* | No |
| 37 | *Vegetative cover* | NA |
| 38 | *Veg. community interspersion* | C |
| 39 | *Wetland detritus* | A |
| 40 | *Interspersion on landscape* | A |
| 41 | *Wildlife barriers* | B |

***Amphibian-breeding potential***

| | | |
|---|---|---|
| 42 | *Hydroperiod adequacy* | Inadequate |
| 43 | *Fish presence* | A |
| 44 | *Overwintering habitat* | |
| 45 | *Wildlife species (list)* | |
| 46 | *Fish habitat quality* | NA |
| 47 | *Fish species (list)* | |
| 48 | *Unique/rare opportunity* | No |
| 49 | *Wetland visibility* | C |
| 50 | *Proximity to population* | No |
| 51 | *Public ownership* | C |
| 52 | *Public access* | C |
| 53 | *Human influence on wetland* | B |
| 54 | *Human influence on viewshed* | C |
| 55 | *Spatial buffer* | C |
| 56 | *Recreational activity potential* | C |

| | | |
|---|---|---|
| 57 | *Commercial crop--hydro impact* | NA |

***Groundwater-specific questions***

| | | |
|---|---|---|
| 58 | *Wetland soils* | Recharge |
| 59 | *Subwatershed land use* | Discharge |
| 60 | *Wetland size/soil group* | Recharge |
| 61 | *Wetland hydroperiod* | Recharge |
| 62 | *Inlet/Outlet configuration* | Recharge |
| 63 | *Upland topo relief* | Recharge |

***Additional information***

| | | |
|---|---|---|
| 64 | *Restoration potential* | |
| 65 | *LO affected by restoration* | |
| 66 | *Existing size* | 11.93 |
| | *Restorable size* | 0 |
| | *Potential new wetland* | 0 |
| 67 | *Average width of pot. buffer* | 0 feet |
| 68 | *Ease of potential restoration* | |
| 69 | *Hydrologic alterations* | 0 |
| 70 | *Potential wetland type* | 0 |
| 71 | *Stormwater sensitivity* | |
| 72 | *Additional treatment needs* | |

Watershed Lake Superior (South)

WS# 2 Service Area: 1

For functional ratings, please run the Summary tab report.

This report printed on: 2/18/2020

# Wetland Functional Assessment Summary

| Wetland Name | Hydrogeomorphology | Maintenance of Hydrologic Regime | Flood/ Stormwater/ Attenuation | Downstream Water Quality | Maintenance of Wetland Water Quality | Shoreline Protection |
|---|---|---|---|---|---|---|
| 13 | Slope | 0.63 | 0.60 | 0.60 | 0.70 | 0.00 |
| | | Moderate | Moderate | Moderate | High | Not Applicable |

| | | | | | | | Additional Information | | |
|---|---|---|---|---|---|---|---|---|---|
| Wetland Name | Maintenance of Characteristic Wildlife Habitat Structure | Maintenance of Characteristic Fish Habitat | Maintenance of Characteristic Amphibian Habitat | Aesthetics/ Recreation/ Education/ Cultural | Commercial Uses | Ground-Water Interaction | Wetland Restoration Potential | Wetland Sensitivity to Stormwater and Urban Development | Additional Stormwater Treatment Needs |
| 13 | 0.65 | 0.00 | 0.00 | 0.15 | 0.00 | Recharge | 0.00 | 1.00 | 0.70 |
| | Moderate | Not Applicable | Not Applicable | Low | Not Applicable | | Not Applicable | High | High |

# Wetland Community Summary

| | | Vegetative Diversity/Integrity | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Community | | | | | | | | |
| Wetland Name | Location | Cowardin Classification | Circular 39 | Plant Community | Wetland Proportion | Individual Community Rating | Highest Wetland Rating | Average Wetland Rating | Weighted Average Wetland Rating | |
| 13 | 38-056-08-31-013 | PSS1B | Type 6 | Alder Thicket | 80 | 1 | 1.00 | 0.75 | 0.90 | |
| | | | | | | | High | High | High | |
| | | PFO1B | Type 7 | Hardwood Swamp | 20 | 0.5 | 1.00 | 0.75 | 0.90 | |
| | | | | | | | High | High | High | |
| | | | | | 100 | | 1.00 | 0.75 | 0.90 | ☐ |

☑ *Denotes incomplete calculation data.*

# MnRAM: Site Response Record

For Wetland: 15

Location: 38-056-08-32-015

## Northshore West Ridge Railroad

**Plant Community: Alder Thicket**

Cowardin Classification: PSS1B — Circular 39: Type 6

**Plant Community: Coniferous Swamp**

Cowardin Classification: PFO4B — Circular 39: Type 7

| | | |
|---|---|---|
| 4 | *Listed, rare, special species?* | No |
| 5 | *Rare community or habitat?* | No |
| 6 | *Pre-European-settlement condition?* | No |

***Hydrogeomorphology / topography:***

| | | |
|---|---|---|
| 7 | | Depressional/Tributary |
| 8-1 | *Maximum water depth* | 0 inches |
| 8-2 | *% inundated* | 0% |
| 9 | *Immediate drainage--local WS* | 64 acres |
| 10 | *Esimated size/existing site:* | *(see #66)* |
| 11-Upland Soil | | |
| 11-Wetland Soil | | |
| 12 | *Outlet for flood control* | C |
| 13 | *Outlet for hydro regime* | C |
| 14 | *Dominant upland land use* | B |
| 15 | *Wetland soil condition* | A |
| 16 | *Vegetation (% cover)* | 100% |
| 17 | *Emerg. veg flood resistance* | A |
| 18 | *Sediment delivery* | B |
| 19 | *Upland soils (soil group)* | B |
| 20 | *Stormwater runoff* | B |
| 21 | *Subwatershed wetland density* | C |
| 22 | *Channels/sheet flow* | B |
| 23 | *Adjacent buffer width* | 350 feet |

***Adjacent area management***

| | | |
|---|---|---|
| 24-A | *Full* | 50% |
| 24-B | *Manicured* | 0% |
| 24-C | *Bare* | 50% |

***Adjacent area diversity/structure***

| | | |
|---|---|---|
| 25-A | *Native* | 60% |
| 25-B | *Mixed* | 0% |
| 25-C | *Sparse* | 40% |

***Adjacent area slope***

| | | |
|---|---|---|
| 26-A | *Gentle* | 100% |
| 26-B | *Moderate* | 0% |
| 26-C | *Steep* | 0% |
| 27 | *Downstream sens./WQ protect.* | C |
| 28 | *Nutrient loading* | A |
| 29 | *Shoreline wetland?* | No |

***Shoreline Wetland***

| | | |
|---|---|---|
| 30 | *Rooted veg., % cover* | 0% |
| 31 | *Wetland in-water width* | 0 feet |
| 32 | *Emerg. veg. erosion resistance* | |
| 33 | *Erosion potential of site* | |
| 34 | *Upslope veg./bank protection* | |
| 35 | *Rare wildlife?* | No |
| 36 | *Scare/Rare/S1/S2 community* | No |
| 37 | *Vegetative cover* | NA |
| 38 | *Veg. community interspersion* | C |
| 39 | *Wetland detritus* | A |
| 40 | *Interspersion on landscape* | A |
| 41 | *Wildlife barriers* | B |

***Amphibian-breeding potential***

| | | |
|---|---|---|
| 42 | *Hydroperiod adequacy* | Inadequate |
| 43 | *Fish presence* | B |
| 44 | *Overwintering habitat* | |
| 45 | *Wildlife species (list)* | |
| 46 | *Fish habitat quality* | NA |
| 47 | *Fish species (list)* | |
| 48 | *Unique/rare opportunity* | No |
| 49 | *Wetland visibility* | C |
| 50 | *Proximity to population* | No |
| 51 | *Public ownership* | C |
| 52 | *Public access* | C |
| 53 | *Human influence on wetland* | B |
| 54 | *Human influence on viewshed* | C |
| 55 | *Spatial buffer* | C |
| 56 | *Recreational activity potential* | C |
| 57 | *Commercial crop--hydro impact* | NA |

***Groundwater-specific questions***

| | | |
|---|---|---|
| 58 | *Wetland soils* | Discharge |
| 59 | *Subwatershed land use* | Discharge |
| 60 | *Wetland size/soil group* | Recharge |
| 61 | *Wetland hydroperiod* | Recharge |
| 62 | *Inlet/Outlet configuration* | Recharge |
| 63 | *Upland topo relief* | Recharge |

***Additional information***

| | | |
|---|---|---|
| 64 | *Restoration potential* | |
| 65 | *LO affected by restoration* | |
| 66 | *Existing size* | 31.28 |
| | *Restorable size* | 0 |
| | *Potential new wetland* | 0 |
| 67 | *Average width of pot. buffer* | 0 feet |
| 68 | *Ease of potential restoration* | |
| 69 | *Hydrologic alterations* | 0 |
| 70 | *Potential wetland type* | 0 |
| 71 | *Stormwater sensitivity* | |
| 72 | *Additional treatment needs* | |

Watershed Lake Superior (South)

WS# 2 Service Area: 1

For functional ratings, please run the Summary tab report.

This report printed on: 2/14/2020

# Wetland Functional Assessment Summary

| Wetland Name | Hydrogeomorphology | Maintenance of Hydrologic Regime | Flood/ Stormwater/ Attenuation | Downstream Water Quality | Maintenance of Wetland Water Quality | Shoreline Protection |
|---|---|---|---|---|---|---|
| 15 | Depressional/Tributary (outlet but no perennial inlet or drainage entering from upstream subwatershed) | 0.52 | 0.50 | 0.51 | 0.62 | 0.00 |
| | | Moderate | Moderate | Moderate | Moderate | Not Applicable |

| Wetland Name | Maintenance of Characteristic Wildlife Habitat Structure | Maintenance of Characteristic Fish Habitat | Maintenance of Characteristic Amphibian Habitat | Aesthetics/ Recreation/ Education/ Cultural | Commercial Uses | Ground-Water Interaction | Additional Information: Wetland Restoration Potential | Additional Information: Wetland Sensitivity to Stormwater and Urban Development | Additional Information: Additional Stormwater Treatment Needs |
|---|---|---|---|---|---|---|---|---|---|
| 15 | 0.55 | 0.00 | 0.00 | 0.15 | 0.00 | Combination Discharge, Recharge | 0.00 | 0.50 | 0.62 |
| | Moderate | Not Applicable | Not Applicable | Low | Not Applicable | | Not Applicable | High | Moderate |

# Wetland Community Summary

| Wetland Name | Location | Vegetative Diversity/Integrity: Community: Cowardin Classification | Circular 39 | Plant Community | Wetland Proportion | Individual Community Rating | Highest Wetland Rating | Average Wetland Rating | Weighted Average Wetland Rating | |
|---|---|---|---|---|---|---|---|---|---|---|
| 15 | 38-056-08-32-015 | PSS1B | Type 6 | Alder Thicket | 75 | 0.5 | 0.50 | 0.50 | 0.50 | |
| | | | | | | | Moderate | Moderate | Moderate | |
| | | PFO4B | Type 7 | Coniferous Swamp | 25 | 0.5 | 0.50 | 0.50 | 0.50 | |
| | | | | | | | Moderate | Moderate | Moderate | |
| | | | | | 100 | | 0.50 | 0.50 | 0.50 | ☐ |

☑ *Denotes incomplete calculation data.*

# MnRAM: Site Response Record

For Wetland: 17b

Location: 38-056-08-31-017

## Northshore West Ridge Railroad

**Plant Community: Shallow Marsh**

Cowardin Classification: PEM1C

Circular 39: Type 3

| | | |
|---|---|---|
| 4 | *Listed, rare, special species?* | No |
| 5 | *Rare community or habitat?* | No |
| 6 | *Pre-European-settlement condition?* | No |

***Hydrogeomorphology / topography:***

| | | |
|---|---|---|
| 7 | | Depressional/FlowThru |
| 8-1 | *Maximum water depth* | 12 inches |
| 8-2 | *% inundated* | 100% |
| 9 | *Immediate drainage--local WS* | 1400 acre |
| 10 | *Esimated size/existing site:* | *(see #66)* |
| 11-Upland Soil | | |
| 11-Wetland Soil | | |
| 12 | *Outlet for flood control* | B |
| 13 | *Outlet for hydro regime* | B |
| 14 | *Dominant upland land use* | B |
| 15 | *Wetland soil condition* | C |
| 16 | *Vegetation (% cover)* | 80% |
| 17 | *Emerg. veg flood resistance* | B |
| 18 | *Sediment delivery* | B |
| 19 | *Upland soils (soil group)* | B |
| 20 | *Stormwater runoff* | C |
| 21 | *Subwatershed wetland density* | C |
| 22 | *Channels/sheet flow* | C |
| 23 | *Adjacent buffer width* | 50 feet |

***Adjacent area management***

| | | |
|---|---|---|
| 24-A | *Full* | 100% |
| 24-B | *Manicured* | 0% |
| 24-C | *Bare* | 0% |

***Adjacent area diversity/structure***

| | | |
|---|---|---|
| 25-A | *Native* | 0% |
| 25-B | *Mixed* | 100% |
| 25-C | *Sparse* | 0% |

***Adjacent area slope***

| | | |
|---|---|---|
| 26-A | *Gentle* | 0% |
| 26-B | *Moderate* | 0% |
| 26-C | *Steep* | 100% |
| 27 | *Downstream sens./WQ protect.* | B |
| 28 | *Nutrient loading* | B |
| 29 | *Shoreline wetland?* | Yes |

***Shoreline Wetland***

| | | |
|---|---|---|
| 30 | *Rooted veg., % cover* | 80% |
| 31 | *Wetland in-water width* | 20 feet |
| 32 | *Emerg. veg. erosion resistance* | A |
| 33 | *Erosion potential of site* | C |
| 34 | *Upslope veg./bank protection* | B |
| 35 | *Rare wildlife?* | No |
| 36 | *Scare/Rare/S1/S2 community* | No |
| 37 | *Vegetative cover* | B |
| 38 | *Veg. community interspersion* | NA |
| 39 | *Wetland detritus* | B |
| 40 | *Interspersion on landscape* | A |
| 41 | *Wildlife barriers* | B |

***Amphibian-breeding potential***

| | | |
|---|---|---|
| 42 | *Hydroperiod adequacy* | Adequate |
| 43 | *Fish presence* | B |
| 44 | *Overwintering habitat* | C |
| 45 | *Wildlife species (list)* | |
| 46 | *Fish habitat quality* | A |
| 47 | *Fish species (list)* | |
| 48 | *Unique/rare opportunity* | No |
| 49 | *Wetland visibility* | C |
| 50 | *Proximity to population* | No |
| 51 | *Public ownership* | C |
| 52 | *Public access* | C |
| 53 | *Human influence on wetland* | B |
| 54 | *Human influence on viewshed* | B |
| 55 | *Spatial buffer* | C |
| 56 | *Recreational activity potential* | C |
| 57 | *Commercial crop--hydro impact* | NA |

***Groundwater-specific questions***

| | | |
|---|---|---|
| 58 | *Wetland soils* | Recharge |
| 59 | *Subwatershed land use* | Discharge |
| 60 | *Wetland size/soil group* | Recharge |
| 61 | *Wetland hydroperiod* | Recharge |
| 62 | *Inlet/Outlet configuration* | Discharge |
| 63 | *Upland topo relief* | Discharge |

***Additional information***

| | | |
|---|---|---|
| 64 | *Restoration potential* | |
| 65 | *LO affected by restoration* | |
| 66 | *Existing size* | 5.83 |
| | *Restorable size* | 0 |
| | *Potential new wetland* | 0 |
| 67 | *Average width of pot. buffer* | 0 feet |
| 68 | *Ease of potential restoration* | |
| 69 | *Hydrologic alterations* | 0 |
| 70 | *Potential wetland type* | 0 |
| 71 | *Stormwater sensitivity* | |
| 72 | *Additional treatment needs* | |

Watershed Lake Superior (South)

WS# 2 Service Area: 1

For functional ratings, please run the Summary tab report.

This report printed on: 2/19/2020

# Wetland Functional Assessment Summary

| Wetland Name | Hydrogeomorphology | Maintenance of Hydrologic Regime | Flood/ Stormwater/ Attenuation | Downstream Water Quality | Maintenance of Wetland Water Quality | Shoreline Protection |
|---|---|---|---|---|---|---|
| 17b | Depressional/Flow-through (apparent inlet and outlet), Depressional/Flow-through (apparent inlet and outlet) | 0.52 | 0.39 | 0.48 | 0.58 | 0.62 |
| | | Moderate | Moderate | Moderate | Moderate | Moderate |

| Wetland Name | Maintenance of Characteristic Wildlife Habitat Structure | Maintenance of Characteristic Fish Habitat | Maintenance of Characteristic Amphibian Habitat | Aesthetics/ Recreation/ Education/ Cultural | Commercial Uses | Ground-Water Interaction | Additional Information: Wetland Restoration Potential | Additional Information: Wetland Sensitivity to Stormwater and Urban Development | Additional Information: Additional Stormwater Treatment Needs |
|---|---|---|---|---|---|---|---|---|---|
| 17b | 0.63 | 0.83 | 0.26 | 0.20 | 0.00 | Combination Discharge, Recharge | 0.00 | 0.50 | 0.58 |
| | Moderate | High | Low | Low | Not Applicable | | Not Applicable | Moderate | Moderate |

# Wetland Community Summary

| Wetland Name | Location | Vegetative Diversity/Integrity: Community: Cowardin Classification | Circular 39 | Plant Community | Wetland Proportion | Individual Community Rating | Highest Wetland Rating | Average Wetland Rating | Weighted Average Wetland Rating | |
|---|---|---|---|---|---|---|---|---|---|---|
| 17b | 38-056-08-31-017 | PEM1C | Type 3 | Shallow Marsh | 100 | 0.5 | 0.50 | 0.50 | 0.50 | |
| | | | | | | | Moderate | Moderate | Moderate | |
| | | | | | 100 | | 0.50 | 0.50 | 0.50 | ☐ |

☑ *Denotes incomplete calculation data.*

# MnRAM: Site Response Record

For Wetland: 18

Location: 38-056-08-29-018

## Northshore West Ridge Railroad

**Plant Community: Shallow Marsh**

Cowardin Classification: PEMC — Circular 39: Type 3

**Plant Community: Deep Marsh**

Cowardin Classification: PAB4H — Circular 39: Type 4

| | | |
|---|---|---|
| 4 | *Listed, rare, special species?* | No |
| 5 | *Rare community or habitat?* | No |
| 6 | *Pre-European-settlement condition?* | No |

***Hydrogeomorphology / topography:***

| | | |
|---|---|---|
| 7 | | Depressional/FlowThru |
| 8-1 | *Maximum water depth* | 48 inches |
| 8-2 | *% inundated* | 90% |
| 9 | *Immediate drainage--local WS* | 102 acres |
| 10 | *Esimated size/existing site:* | *(see #66)* |
| 11-Upland Soil | | |
| 11-Wetland Soil | | |
| 12 | *Outlet for flood control* | C |
| 13 | *Outlet for hydro regime* | C |
| 14 | *Dominant upland land use* | A |
| 15 | *Wetland soil condition* | A |
| 16 | *Vegetation (% cover)* | 20% |
| 17 | *Emerg. veg flood resistance* | B |
| 18 | *Sediment delivery* | B |
| 19 | *Upland soils (soil group)* | B |
| 20 | *Stormwater runoff* | C |
| 21 | *Subwatershed wetland density* | C |
| 22 | *Channels/sheet flow* | C |
| 23 | *Adjacent buffer width* | 325 feet |

***Adjacent area management***

| | | |
|---|---|---|
| 24-A | *Full* | 60% |
| 24-B | *Manicured* | 0% |
| 24-C | *Bare* | 40% |

***Adjacent area diversity/structure***

| | | |
|---|---|---|
| 25-A | *Native* | 60% |
| 25-B | *Mixed* | 0% |
| 25-C | *Sparse* | 40% |

***Adjacent area slope***

| | | |
|---|---|---|
| 26-A | *Gentle* | 90% |
| 26-B | *Moderate* | 10% |
| 26-C | *Steep* | 0% |
| 27 | *Downstream sens./WQ protect.* | C |
| 28 | *Nutrient loading* | A |
| 29 | *Shoreline wetland?* | Yes |

***Shoreline Wetland***

| | | |
|---|---|---|
| 30 | *Rooted veg., % cover* | 40% |
| 31 | *Wetland in-water width* | 10 feet |
| 32 | *Emerg. veg. erosion resistance* | B |
| 33 | *Erosion potential of site* | B |
| 34 | *Upslope veg./bank protection* | C |
| 35 | *Rare wildlife?* | No |
| 36 | *Scare/Rare/S1/S2 community* | No |
| 37 | *Vegetative cover* | B |
| 38 | *Veg. community interspersion* | C |
| 39 | *Wetland detritus* | NA |
| 40 | *Interspersion on landscape* | A |
| 41 | *Wildlife barriers* | A |

***Amphibian-breeding potential***

| | | |
|---|---|---|
| 42 | *Hydroperiod adequacy* | Adequate |
| 43 | *Fish presence* | B |
| 44 | *Overwintering habitat* | C |
| 45 | *Wildlife species (list)* | |
| 46 | *Fish habitat quality* | A |
| 47 | *Fish species (list)* | |
| 48 | *Unique/rare opportunity* | No |
| 49 | *Wetland visibility* | C |
| 50 | *Proximity to population* | No |
| 51 | *Public ownership* | C |
| 52 | *Public access* | C |
| 53 | *Human influence on wetland* | B |
| 54 | *Human influence on viewshed* | C |
| 55 | *Spatial buffer* | C |
| 56 | *Recreational activity potential* | C |
| 57 | *Commercial crop--hydro impact* | NA |

***Groundwater-specific questions***

| | | |
|---|---|---|
| 58 | *Wetland soils* | Discharge |
| 59 | *Subwatershed land use* | Discharge |
| 60 | *Wetland size/soil group* | Recharge |
| 61 | *Wetland hydroperiod* | Discharge |
| 62 | *Inlet/Outlet configuration* | Discharge |
| 63 | *Upland topo relief* | Recharge |

***Additional information***

| | | |
|---|---|---|
| 64 | *Restoration potential* | |
| 65 | *LO affected by restoration* | |
| 66 | *Existing size* | 42.74 |
| | *Restorable size* | 0 |
| | *Potential new wetland* | 0 |
| 67 | *Average width of pot. buffer* | 0 feet |
| 68 | *Ease of potential restoration* | |
| 69 | *Hydrologic alterations* | 0 |
| 70 | *Potential wetland type* | 0 |
| 71 | *Stormwater sensitivity* | |
| 72 | *Additional treatment needs* | |

Watershed Lake Superior (South)

WS# 2 Service Area: 1

For functional ratings, please run the Summary tab report.

This report printed on: 2/18/2020

# Wetland Functional Assessment Summary

| Wetland Name | Hydrogeomorphology | Maintenance of Hydrologic Regime | Flood/ Stormwater/ Attenuation | Downstream Water Quality | Maintenance of Wetland Water Quality | Shoreline Protection |
|---|---|---|---|---|---|---|
| 18 | Depressional/Flow-through (apparent inlet and outlet), Depressional/Flow-through (apparent inlet and outlet) | 0.77 | 0.30 | 0.42 | 0.77 | 0.34 |
| | | High | Low | Moderate | High | Moderate |

| | | | | | | | Additional Information | | |
|---|---|---|---|---|---|---|---|---|---|
| Wetland Name | Maintenance of Characteristic Wildlife Habitat Structure | Maintenance of Characteristic Fish Habitat | Maintenance of Characteristic Amphibian Habitat | Aesthetics/ Recreation/ Education/ Cultural | Commercial Uses | Ground-Water Interaction | Wetland Restoration Potential | Wetland Sensitivity to Stormwater and Urban Development | Additional Stormwater Treatment Needs |
| 18 | 0.61 | 0.69 | 0.42 | 0.15 | 0.00 | Combination Discharge, Recharge | 0.00 | 0.50 | 0.77 |
| | Moderate | High | Moderate | Low | Not Applicable | | Not Applicable | Moderate | High |

# Wetland Community Summary

| | | Vegetative Diversity/Integrity | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Community | | | | | | | | |
| Wetland Name | Location | Cowardin Classification | Circular 39 | Plant Community | Wetland Proportion | Individual Community Rating | Highest Wetland Rating | Average Wetland Rating | Weighted Average Wetland Rating | |
| 18 | 38-056-08-29-018 | PEMC | Type 3 | Shallow Marsh | 85 | 0.5 | 0.50 | 0.50 | 0.50 | |
| | | | | | | | Moderate | Moderate | Moderate | |
| | | PAB4H | Type 4 | Deep Marsh | 15 | 0.5 | 0.50 | 0.50 | 0.50 | |
| | | | | | | | Moderate | Moderate | Moderate | |
| | | | | | 100 | | 0.50 | 0.50 | 0.50 | ☐ |

☑ *Denotes incomplete calculation data.*

# MnRAM: Site Response Record

For Wetland: 20

Location: 38-056-08-20-020

## Northshore West Ridge Railroad

**Plant Community: Coniferous Swamp**

| Cowardin Classification: | Circular 39: |
|---|---|
| PFO4B | Type 7 |

**Plant Community: Hardwood Swamp**

| Cowardin Classification: | Circular 39: |
|---|---|
| PFO1B | Type 7 |

**Plant Community: Alder Thicket**

| Cowardin Classification: | Circular 39: |
|---|---|
| PSS1B | Type 6 |

| | | |
|---|---|---|
| 4 | *Listed, rare, special species?* | No |
| 5 | *Rare community or habitat?* | No |
| 6 | *Pre-European-settlement condition?* | No |

***Hydrogeomorphology / topography:***

| | | |
|---|---|---|
| 7 | | Depressional/Isolated |
| 8-1 | *Maximum water depth* | 0 inches |
| 8-2 | *% inundated* | 0% |
| 9 | *Immediate drainage--local WS* | 36 acres |
| 10 | *Esimated size/existing site:* | *(see #66)* |
| 11-Upland Soil | | |
| 11-Wetland Soil | | |

| | | |
|---|---|---|
| 12 | *Outlet for flood control* | A |
| 13 | *Outlet for hydro regime* | A |
| 14 | *Dominant upland land use* | A |
| 15 | *Wetland soil condition* | A |
| 16 | *Vegetation (% cover)* | 100% |
| 17 | *Emerg. veg flood resistance* | NA |
| 18 | *Sediment delivery* | A |
| 19 | *Upland soils (soil group)* | B |
| 20 | *Stormwater runoff* | C |
| 21 | *Subwatershed wetland density* | C |
| 22 | *Channels/sheet flow* | B |
| 23 | *Adjacent buffer width* | 300 feet |

***Adjacent area management***

| | | |
|---|---|---|
| 24-A | *Full* | 90% |
| 24-B | *Manicured* | 0% |
| 24-C | *Bare* | 10% |

***Adjacent area diversity/structure***

| | | |
|---|---|---|
| 25-A | *Native* | 90% |
| 25-B | *Mixed* | 0% |
| 25-C | *Sparse* | 10% |

***Adjacent area slope***

| | | |
|---|---|---|
| 26-A | *Gentle* | 100% |
| 26-B | *Moderate* | 0% |
| 26-C | *Steep* | 0% |

| | | |
|---|---|---|
| 27 | *Downstream sens./WQ protect.* | B |
| 28 | *Nutrient loading* | A |
| 29 | *Shoreline wetland?* | No |

***Shoreline Wetland***

| | | |
|---|---|---|
| 30 | *Rooted veg., % cover* | 0% |
| 31 | *Wetland in-water width* | 0 feet |
| 32 | *Emerg. veg. erosion resistance* | |
| 33 | *Erosion potential of site* | |
| 34 | *Upslope veg./bank protection* | |
| 35 | *Rare wildlife?* | No |
| 36 | *Scare/Rare/S1/S2 community* | No |
| 37 | *Vegetative cover* | NA |
| 38 | *Veg. community interspersion* | B |
| 39 | *Wetland detritus* | A |
| 40 | *Interspersion on landscape* | A |
| 41 | *Wildlife barriers* | B |

***Amphibian-breeding potential***

| | | |
|---|---|---|
| 42 | *Hydroperiod adequacy* | Inadequate |
| 43 | *Fish presence* | A |
| 44 | *Overwintering habitat* | C |
| 45 | *Wildlife species (list)* | |
| 46 | *Fish habitat quality* | NA |
| 47 | *Fish species (list)* | |
| 48 | *Unique/rare opportunity* | No |
| 49 | *Wetland visibility* | B |
| 50 | *Proximity to population* | No |
| 51 | *Public ownership* | C |
| 52 | *Public access* | C |
| 53 | *Human influence on wetland* | A |
| 54 | *Human influence on viewshed* | B |

| | | |
|---|---|---|
| 55 | *Spatial buffer* | C |
| 56 | *Recreational activity potential* | C |
| 57 | *Commercial crop--hydro impact* | NA |

***Groundwater-specific questions***

| | | |
|---|---|---|
| 58 | *Wetland soils* | Discharge |
| 59 | *Subwatershed land use* | Discharge |
| 60 | *Wetland size/soil group* | Recharge |
| 61 | *Wetland hydroperiod* | Recharge |
| 62 | *Inlet/Outlet configuration* | Recharge |
| 63 | *Upland topo relief* | Recharge |

***Additional information***

| | | |
|---|---|---|
| 64 | *Restoration potential* | |
| 65 | *LO affected by restoration* | |
| 66 | *Existing size* | 21.14 |
| | *Restorable size* | 0 |
| | *Potential new wetland* | 0 |
| 67 | *Average width of pot. buffer* | 0 feet |
| 68 | *Ease of potential restoration* | |
| 69 | *Hydrologic alterations* | 0 |
| 70 | *Potential wetland type* | 0 |
| 71 | *Stormwater sensitivity* | |
| 72 | *Additional treatment needs* | |

Watershed Lake Superior (South)

WS# 2 Service Area: 1

For functional ratings, please run the Summary tab report.

This report printed on: 2/14/2020

# Wetland Functional Assessment Summary

| Wetland Name | Hydrogeomorphology | Maintenance of Hydrologic Regime | Flood/ Stormwater/ Attenuation | Downstream Water Quality | Maintenance of Wetland Water Quality | Shoreline Protection |
|---|---|---|---|---|---|---|
| 20 | Depressional/Isolated (no discernable inlets or outlets) | 1.00 | 0.58 | 0.72 | 1.00 | 0.00 |
| | | High | Moderate | High | High | Not Applicable |

| | | | | | | | Additional Information | | |
|---|---|---|---|---|---|---|---|---|---|
| Wetland Name | Maintenance of Characteristic Wildlife Habitat Structure | Maintenance of Characteristic Fish Habitat | Maintenance of Characteristic Amphibian Habitat | Aesthetics/ Recreation/ Education/ Cultural | Commercial Uses | Ground-Water Interaction | Wetland Restoration Potential | Wetland Sensitivity to Stormwater and Urban Development | Additional Stormwater Treatment Needs |
| 20 | 0.86 | 0.00 | 0.00 | 0.31 | 0.00 | Combination Discharge, Recharge | 0.00 | 1.00 | 1.00 |
| | High | Not Applicable | Not Applicable | Low | Not Applicable | | Not Applicable | Exceptional | High |

# Wetland Community Summary

| | | Vegetative Diversity/Integrity | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Community | | | | | | | | |
| Wetland Name | Location | Cowardin Classification | Circular 39 | Plant Community | Wetland Proportion | Individual Community Rating | Highest Wetland Rating | Average Wetland Rating | Weighted Average Wetland Rating | |
| 20 | 38-056-08-20-020 | PFO4B | Type 7 | Coniferous Swamp | 60 | 1 | 1.00 | 1.00 | 1.00 | |
| | | | | | | | High | High | High | |
| | | PFO1B | Type 7 | Hardwood Swamp | 30 | 1 | 1.00 | 1.00 | 1.00 | |
| | | | | | | | High | High | High | |
| | | PSS1B | Type 6 | Alder Thicket | 10 | 1 | 1.00 | 1.00 | 1.00 | |
| | | | | | | | High | High | High | |
| | | | | | 100 | | 1.00 | 1.00 | 1.00 | ☐ |

☑ *Denotes incomplete calculation data.*

# MnRAM: Site Response Record

For Wetland: 23

Location: 38-056-08-29-023

## Northshore West Ridge Railroad

**Plant Community: Hardwood Swamp**

Cowardin Classification: PFO1A — Circular 39: Type 7

**Plant Community: Fresh (Wet) Meadow**

Cowardin Classification: PEMB — Circular 39: Type 2

**Plant Community: Shallow Marsh**

Cowardin Classification: PEMC — Circular 39: Type 3

| | | |
|---|---|---|
| 4 | *Listed, rare, special species?* | No |
| 5 | *Rare community or habitat?* | No |
| 6 | *Pre-European-settlement condition?* | No |

***Hydrogeomorphology / topography:***

| | | |
|---|---|---|
| 7 | | Floodplain |
| 8-1 | *Maximum water depth* | 20 inches |
| 8-2 | *% inundated* | 5% |
| 9 | *Immediate drainage--local WS* | 45 acres |
| 10 | *Esimated size/existing site:* | *(see #66)* |
| 11-Upland Soil | | |
| 11-Wetland Soil | | |

| | | |
|---|---|---|
| 12 | *Outlet for flood control* | NA |
| 13 | *Outlet for hydro regime* | A |
| 14 | *Dominant upland land use* | B |
| 15 | *Wetland soil condition* | A |
| 16 | *Vegetation (% cover)* | 100% |
| 17 | *Emerg. veg flood resistance* | A |
| 18 | *Sediment delivery* | A |
| 19 | *Upland soils (soil group)* | B |
| 20 | *Stormwater runoff* | C |
| 21 | *Subwatershed wetland density* | C |
| 22 | *Channels/sheet flow* | B |
| 23 | *Adjacent buffer width* | 500 feet |

***Adjacent area management***

| | | |
|---|---|---|
| 24-A | *Full* | 90% |
| 24-B | *Manicured* | 10% |
| 24-C | *Bare* | 0% |

***Adjacent area diversity/structure***

| | | |
|---|---|---|
| 25-A | *Native* | 90% |
| 25-B | *Mixed* | 10% |
| 25-C | *Sparse* | 0% |

***Adjacent area slope***

| | | |
|---|---|---|
| 26-A | *Gentle* | 100% |
| 26-B | *Moderate* | 0% |
| 26-C | *Steep* | 0% |

| | | |
|---|---|---|
| 27 | *Downstream sens./WQ protect.* | C |
| 28 | *Nutrient loading* | A |
| 29 | *Shoreline wetland?* | Yes |

***Shoreline Wetland***

| | | |
|---|---|---|
| 30 | *Rooted veg., % cover* | 70% |
| 31 | *Wetland in-water width* | 2 feet |
| 32 | *Emerg. veg. erosion resistance* | B |
| 33 | *Erosion potential of site* | C |
| 34 | *Upslope veg./bank protection* | C |
| 35 | *Rare wildlife?* | No |
| 36 | *Scare/Rare/S1/S2 community* | No |
| 37 | *Vegetative cover* | NA |
| 38 | *Veg. community interspersion* | B |
| 39 | *Wetland detritus* | A |
| 40 | *Interspersion on landscape* | A |
| 41 | *Wildlife barriers* | B |

***Amphibian-breeding potential***

| | | |
|---|---|---|
| 42 | *Hydroperiod adequacy* | Adequate |
| 43 | *Fish presence* | B |
| 44 | *Overwintering habitat* | C |
| 45 | *Wildlife species (list)* | |
| 46 | *Fish habitat quality* | A |
| 47 | *Fish species (list)* | |
| 48 | *Unique/rare opportunity* | No |
| 49 | *Wetland visibility* | C |
| 50 | *Proximity to population* | No |
| 51 | *Public ownership* | C |
| 52 | *Public access* | C |
| 53 | *Human influence on wetland* | B |
| 54 | *Human influence on viewshed* | B |

| | | |
|---|---|---|
| 55 | *Spatial buffer* | C |
| 56 | *Recreational activity potential* | C |
| 57 | *Commercial crop--hydro impact* | NA |

***Groundwater-specific questions***

| | | |
|---|---|---|
| 58 | *Wetland soils* | Recharge |
| 59 | *Subwatershed land use* | Discharge |
| 60 | *Wetland size/soil group* | Recharge |
| 61 | *Wetland hydroperiod* | Recharge |
| 62 | *Inlet/Outlet configuration* | Recharge |
| 63 | *Upland topo relief* | Recharge |

***Additional information***

| | | |
|---|---|---|
| 64 | *Restoration potential* | |
| 65 | *LO affected by restoration* | |
| 66 | *Existing size* | 19.9 |
| | *Restorable size* | 0 |
| | *Potential new wetland* | 0 |
| 67 | *Average width of pot. buffer* | 0 feet |
| 68 | *Ease of potential restoration* | |
| 69 | *Hydrologic alterations* | 0 |
| 70 | *Potential wetland type* | 0 |
| 71 | *Stormwater sensitivity* | |
| 72 | *Additional treatment needs* | |

Watershed Lake Superior (South)

WS# 2 Service Area: 1

For functional ratings, please run the Summary tab report.

This report printed on: 2/14/2020

# Wetland Functional Assessment Summary

| Wetland Name | Hydrogeomorphology | Maintenance of Hydrologic Regime | Flood/ Stormwater/ Attenuation | Downstream Water Quality | Maintenance of Wetland Water Quality | Shoreline Protection |
|---|---|---|---|---|---|---|
| 23 | Floodplain (outside waterbody banks) | 0.88 | 0.61 | 0.61 | 0.93 | 0.36 |
| | | High | Moderate | Moderate | High | Moderate |

| | | | | | | | Additional Information | | |
|---|---|---|---|---|---|---|---|---|---|
| Wetland Name | Maintenance of Characteristic Wildlife Habitat Structure | Maintenance of Characteristic Fish Habitat | Maintenance of Characteristic Amphibian Habitat | Aesthetics/ Recreation/ Education/ Cultural | Commercial Uses | Ground-Water Interaction | Wetland Restoration Potential | Wetland Sensitivity to Stormwater and Urban Development | Additional Stormwater Treatment Needs |
| 23 | 0.89 | 0.89 | 0.34 | 0.20 | 0.00 | Recharge | 0.00 | 1.00 | 0.93 |
| | High | High | Moderate | Low | Not Applicable | | Not Applicable | Exceptional | High |

# Wetland Community Summary

| | | Vegetative Diversity/Integrity | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Community | | | | | | | | |
| Wetland Name | Location | Cowardin Classification | Circular 39 | Plant Community | Wetland Proportion | Individual Community Rating | Highest Wetland Rating | Average Wetland Rating | Weighted Average Wetland Rating | |
| 23 | 38-056-08-29-023 | PFO1A | Type 7 | Hardwood Swamp | 80 | 1 | 1.00 | 1.00 | 1.00 | |
| | | | | | | | High | High | High | |
| | | PEMB | Type 2 | Fresh (Wet) Meadow | 10 | 1 | 1.00 | 1.00 | 1.00 | |
| | | | | | | | High | High | High | |
| | | PEMC | Type 3 | Shallow Marsh | 10 | 1 | 1.00 | 1.00 | 1.00 | |
| | | | | | | | High | High | High | |
| | | | | | 100 | | 1.00 | 1.00 | 1.00 | ☐ |

☑ *Denotes incomplete calculation data.*

# MnRAM: Site Response Record

For Wetland: 27

Location: 38-056-08-30-027

## Northshore West Ridge Railroad

**Plant Community: Hardwood Swamp**

| Cowardin Classification: | Circular 39: |
|---|---|
| PFO1B | Type 7 |

**Plant Community: Alder Thicket**

| Cowardin Classification: | Circular 39: |
|---|---|
| PSS1B | Type 6 |

**Plant Community: Sedge Meadow**

| Cowardin Classification: | Circular 39: |
|---|---|
| PEMB | Type 2 |

| | | |
|---|---|---|
| 4 | *Listed, rare, special species?* | No |
| 5 | *Rare community or habitat?* | No |
| 6 | *Pre-European-settlement condition?* | No |

***Hydrogeomorphology / topography:***

| | | |
|---|---|---|
| 7 | | Floodplain |
| 8-1 | *Maximum water depth* | 28 inches |
| 8-2 | *% inundated* | 3% |
| 9 | *Immediate drainage--local WS* | 102 acres |
| 10 | *Esimated size/existing site:* | *(see #66)* |
| 11-Upland Soil | | |
| 11-Wetland Soil | | |

| | | |
|---|---|---|
| 12 | *Outlet for flood control* | NA |
| 13 | *Outlet for hydro regime* | A |
| 14 | *Dominant upland land use* | B |
| 15 | *Wetland soil condition* | A |
| 16 | *Vegetation (% cover)* | 90% |
| 17 | *Emerg. veg flood resistance* | A |
| 18 | *Sediment delivery* | A |
| 19 | *Upland soils (soil group)* | C |
| 20 | *Stormwater runoff* | C |
| 21 | *Subwatershed wetland density* | C |
| 22 | *Channels/sheet flow* | B |
| 23 | *Adjacent buffer width* | 450 feet |

***Adjacent area management***

| | | |
|---|---|---|
| 24-A | *Full* | 80% |
| 24-B | *Manicured* | 10% |
| 24-C | *Bare* | 10% |

***Adjacent area diversity/structure***

| | | |
|---|---|---|
| 25-A | *Native* | 80% |
| 25-B | *Mixed* | 10% |
| 25-C | *Sparse* | 10% |

***Adjacent area slope***

| | | |
|---|---|---|
| 26-A | *Gentle* | 100% |
| 26-B | *Moderate* | 0% |
| 26-C | *Steep* | 0% |

| | | |
|---|---|---|
| 27 | *Downstream sens./WQ protect.* | C |
| 28 | *Nutrient loading* | A |
| 29 | *Shoreline wetland?* | Yes |

***Shoreline Wetland***

| | | |
|---|---|---|
| 30 | *Rooted veg., % cover* | 70% |
| 31 | *Wetland in-water width* | 5 feet |
| 32 | *Emerg. veg. erosion resistance* | B |
| 33 | *Erosion potential of site* | C |
| 34 | *Upslope veg./bank protection* | C |
| 35 | *Rare wildlife?* | No |
| 36 | *Scare/Rare/S1/S2 community* | No |
| 37 | *Vegetative cover* | NA |
| 38 | *Veg. community interspersion* | B |
| 39 | *Wetland detritus* | A |
| 40 | *Interspersion on landscape* | A |
| 41 | *Wildlife barriers* | B |

***Amphibian-breeding potential***

| | | |
|---|---|---|
| 42 | *Hydroperiod adequacy* | Adequate |
| 43 | *Fish presence* | B |
| 44 | *Overwintering habitat* | C |
| 45 | *Wildlife species (list)* | |
| 46 | *Fish habitat quality* | A |
| 47 | *Fish species (list)* | |
| 48 | *Unique/rare opportunity* | No |
| 49 | *Wetland visibility* | C |
| 50 | *Proximity to population* | No |
| 51 | *Public ownership* | C |
| 52 | *Public access* | C |
| 53 | *Human influence on wetland* | B |
| 54 | *Human influence on viewshed* | C |

| | | |
|---|---|---|
| 55 | *Spatial buffer* | C |
| 56 | *Recreational activity potential* | C |
| 57 | *Commercial crop--hydro impact* | NA |

***Groundwater-specific questions***

| | | |
|---|---|---|
| 58 | *Wetland soils* | Discharge |
| 59 | *Subwatershed land use* | Discharge |
| 60 | *Wetland size/soil group* | Recharge |
| 61 | *Wetland hydroperiod* | Discharge |
| 62 | *Inlet/Outlet configuration* | Discharge |
| 63 | *Upland topo relief* | Recharge |

***Additional information***

| | | |
|---|---|---|
| 64 | *Restoration potential* | |
| 65 | *LO affected by restoration* | |
| 66 | *Existing size* | 33.03 |
| | *Restorable size* | 0 |
| | *Potential new wetland* | 0 |
| 67 | *Average width of pot. buffer* | 0 feet |
| 68 | *Ease of potential restoration* | |
| 69 | *Hydrologic alterations* | 0 |
| 70 | *Potential wetland type* | 0 |
| 71 | *Stormwater sensitivity* | |
| 72 | *Additional treatment needs* | |

Watershed Lake Superior (South)

WS# 2 Service Area: 1

For functional ratings, please run the Summary tab report.

This report printed on: 2/14/2020

# Wetland Functional Assessment Summary

| Wetland Name | Hydrogeomorphology | Maintenance of Hydrologic Regime | Flood/ Stormwater/ Attenuation | Downstream Water Quality | Maintenance of Wetland Water Quality | Shoreline Protection |
|---|---|---|---|---|---|---|
| 27 | Floodplain (outside waterbody banks) | 0.88 | 0.67 | 0.61 | 0.89 | 0.36 |
| | | High | High | Moderate | High | Moderate |

| | | | | | | | Additional Information | | |
|---|---|---|---|---|---|---|---|---|---|
| Wetland Name | Maintenance of Characteristic Wildlife Habitat Structure | Maintenance of Characteristic Fish Habitat | Maintenance of Characteristic Amphibian Habitat | Aesthetics/ Recreation/ Education/ Cultural | Commercial Uses | Ground-Water Interaction | Wetland Restoration Potential | Wetland Sensitivity to Stormwater and Urban Development | Additional Stormwater Treatment Needs |
| 27 | 0.86 | 0.88 | 0.34 | 0.15 | 0.00 | Combination Discharge, Recharge | 0.00 | 1.00 | 0.89 |
| | High | High | Moderate | Low | Not Applicable | | Not Applicable | Exceptional | High |

# Wetland Community Summary

| | | Vegetative Diversity/Integrity | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Community | | | | | | | | |
| Wetland Name | Location | Cowardin Classification | Circular 39 | Plant Community | Wetland Proportion | Individual Community Rating | Highest Wetland Rating | Average Wetland Rating | Weighted Average Wetland Rating | |
| 27 | 38-056-08-30-027 | PFO1B | Type 7 | Hardwood Swamp | 60 | 1 | 1.00 | 0.83 | 0.90 | |
| | | | | | | | High | High | High | |
| | | PSS1B | Type 6 | Alder Thicket | 20 | 0.5 | 1.00 | 0.83 | 0.90 | |
| | | | | | | | High | High | High | |
| | | PEMB | Type 2 | Sedge Meadow | 20 | 1 | 1.00 | 0.83 | 0.90 | |
| | | | | | | | High | High | High | |
| | | | | | 100 | | 1.00 | 0.83 | 0.90 | ☐ |

☑ *Denotes incomplete calculation data.*

# Appendix E

## Comparison of MnRAM Evaluations

Table E-1. Comparison of ratings for MnRAM 3.4 and Barr Mine MnRAM

| MnRAM 3.4 Functions and Values | Barr Mine MnRAM Functions/Values | Ratings for Barr Mine MnRAM and MnRAM 3.4[1] | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Wetland 2 hardwood swamp | | Wetland 6 sedge meadow | | Wetland 8 fresh (wet) meadow | | Wetland 11a sedge meadow | | Wetland 11c sedge meadow | | Wetland 13 alder thicket | | Wetland 15 alder thicket | | Wetland 17b shallow marsh | | Wetland 18 shallow marsh | | Wetland 20 coniferous swamp | | Wetland 23 hardwood swamp | | Wetland 27 hardwood swamp | |
| | | Barr | MnRAM 3.4 | Barr | MnRAM 3.4 | Barr | MnRAM 3.4 | Barr | MnRAM 3.4 | Barr | MnRAM 3.4 | Barr | MnRAM 3.4 | Barr | MnRAM 3.4 | Barr | MnRAM 3.4 | Barr | MnRAM 3.4 | Barr | MnRAM 3.4 | Barr | MnRAM 3.4 | Barr | MnRAM 3.4 |
| ***Vegetative diversity/integrity*** | | **moderate** | moderate | **high** | high | **exceptional[2]** | exceptional | **high** | high | **high** | high | **high** | high | **moderate** | moderate | **moderate** | moderate | **moderate** | moderate | **high** | high | **high** | high | **high** | high |
| *Maintenance of hydrologic regime* | **Outlet Condition** | **high** | | **low** | | **low** | | **high** | | **high** | | **moderate** | | **low** | | **low** | | **low** | | **high** | | **high** | | **high** | |
| | **Upland Condition** | **moderate** | | **moderate** | | **moderate** | | **high** | | **high** | | **moderate** | | **moderate** | | **moderate** | | **high** | | **high** | | **high** | | **high** | |
| | **Human Disturbance[3]** | **moderate** | | **high** | | **high** | | **low** | | **low** | | **moderate** | | **moderate** | | **moderate** | | **high** | | **low** | | **low** | | **low** | |
| ***Maintenance of Hydrologic Regime*** | | **high** | high | **low** | low | **low** | low | **high** | high | **high** | high | **moderate** | moderate | **moderate** | moderate | **moderate** | moderate | **moderate** | high | **high** | high | **high** | high | **high** | high |
| *Flood/stormwater/attenuation* | **Outlet Condition** | **high** | | **low** | | **low** | | **high** | | **high** | | **moderate** | | **low** | | **low** | | **low** | | **high** | | **high** | | **high** | |
| | **Upland Condition[4]** | **moderate** | | **moderate** | | **moderate** | | **high** | | **high** | | **moderate** | | **moderate** | | **moderate** | | **high** | | **high** | | **high** | | **high** | |
| | **Human Disturbance** | **moderate** | | **high** | | **high** | | **low** | | **low** | | **moderate** | | **moderate** | | **moderate** | | **high** | | **low** | | **low** | | **low** | |
| ***Flood/Stormwater/Attenuation*** | | **high** | high | **moderate** | moderate | **moderate** | moderate | **moderate** | moderate | **moderate** | moderate | **moderate** | moderate | **moderate** | moderate | **moderate** | moderate | **moderate** | low | **moderate** | moderate | **moderate** | moderate | **moderate** | high |
| *Downstream water quality* | **Outlet Condition** | **high** | | **low** | | **low** | | **high** | | **high** | | **moderate** | | **low** | | **low** | | **low** | | **high** | | **high** | | **high** | |
| | **Upland Condition** | **moderate** | | **moderate** | | **moderate** | | **high** | | **high** | | **moderate** | | **moderate** | | **moderate** | | **high** | | **high** | | **high** | | **high** | |
| | **Human Disturbance** | **moderate** | | **high** | | **high** | | **low** | | **low** | | **moderate** | | **moderate** | | **moderate** | | **high** | | **low** | | **low** | | **low** | |
| ***Downstream water quality*** | | **high** | high | **moderate** | low | **moderate** | moderate | **high** | high | **high** | high | **moderate** | moderate | **moderate** | moderate | **moderate** | moderate | **high** | moderate | **high** | high | **high** | moderate | **high** | moderate |
| *Maintenance of wetland water quality* | **Vegetative Diversity** | **moderate** | | **high** | | **exceptional[2]** | | **high** | | **high** | | **high** | | **moderate** | | **moderate** | | **moderate** | | **high** | | **high** | | **high** | |
| | **Upland Condition** | **moderate** | | **moderate** | | **moderate** | | **high** | | **high** | | **moderate** | | **moderate** | | **moderate** | | **high** | | **high** | | **high** | | **high** | |
| | **Human Disturbance[3]** | **moderate** | | **high** | | **high** | | **low** | | **low** | | **moderate** | | **moderate** | | **moderate** | | **high** | | **low** | | **low** | | **low** | |
| ***Maintenance of wetland water quality*** | | **moderate** | moderate | **moderate** | moderate | **high** | high | **high** | high | **high** | high | **high** | high | **moderate** | moderate | **moderate** | moderate | **moderate** | high | **high** | high | **high** | high | **high** | high |
| ***Shoreline protection*** | | **NE** | NA | **NE** | NA | **NE** | NA | **NE** | NA | **NE** | NA | **NE** | NA | **NE** | NA | **NE** | moderate | **NE** | moderate | **NE** | NA | **NE** | moderate | **NE** | moderate |
| *Maintenance of characteristic wildlife habitat structure* | **Wildlife Habitat** | **high** | | **high** | | **high** | | **high** | | **high** | | **moderate** | | **high** | | **low** | | **high** | | **high** | | **high** | | **high** | |
| | **Outlet Condition** | **high** | | **low** | | **low** | | **high** | | **high** | | **moderate** | | **low** | | **low** | | **low** | | **high** | | **high** | | **high** | |
| | **Upland Condition** | **moderate** | | **moderate** | | **moderate** | | **high** | | **high** | | **moderate** | | **moderate** | | **moderate** | | **high** | | **high** | | **high** | | **high** | |
| | **Human Disturbance[3]** | **moderate** | | **high** | | **high** | | **low** | | **low** | | **moderate** | | **moderate** | | **moderate** | | **high** | | **low** | | **low** | | **low** | |
| | **Vegetative Diversity** | **moderate** | | **high** | | **exceptional[2]** | | **high** | | **high** | | **high** | | **moderate** | | **moderate** | | **moderate** | | **high** | | **high** | | **high** | |
| ***Maintenance of characteristic wildlife habitat structure*** | | **high** | moderate | **moderate** | moderate | **high** | high | **high** | high | **high** | high | **moderate** | moderate | **moderate** | moderate | **moderate** | moderate | **moderate** | moderate | **high** | high | **high** | high | **high** | high |
| *Maintenance of characteristic fish habitat* | **Upland Condition** | **moderate** | | **moderate** | | **moderate** | | **high** | | **high** | | **moderate** | | **moderate** | | **moderate** | | **high** | | **high** | | **high** | | **high** | |
| | **Human Disturbance[3]** | **moderate** | | **high** | | **high** | | **low** | | **low** | | **moderate** | | **moderate** | | **moderate** | | **high** | | **low** | | **low** | | **low** | |
| ***Maintenance of characteristic fish habitat*** | | **NA** | NA | **NA** | NA | **NA** | NA | **NA** | NA | **NA** | NA | **NA** | NA | **NA** | NA | **NA** | high | **NA** | high | **NA** | NA | **NA** | high | **NA** | high |
| *Maintenance of characteristic amphibian habitat* | **Wildlife Habitat** | **high** | | **high** | | **high** | | **high** | | **high** | | **moderate** | | **high** | | **low** | | **high** | | **high** | | **high** | | **high** | |
| | **Upland Condition** | **moderate** | | **moderate** | | **moderate** | | **high** | | **high** | | **moderate** | | **moderate** | | **moderate** | | **high** | | **high** | | **high** | | **high** | |
| | **Human Disturbance[3]** | **moderate** | | **high** | | **high** | | **low** | | **low** | | **moderate** | | **moderate** | | **moderate** | | **high** | | **low** | | **low** | | **low** | |
| ***Maintenance of characteristic amphibian habitat*** | | **NA** | NA | **NA** | NA | **NA** | NA | **NA** | NA | **NA** | NA | **NA** | NA | **NA** | NA | **NA** | low | **NA** | moderate | **NA** | NA | **NA** | moderate | **NA** | moderate |
| **OVERALL CONDITION RATING[5]** | | **moderate** | moderate | **moderate** | moderate | **high** | high | **high** | high | **high** | high | **moderate** | high | **moderate** | moderate | **moderate** | moderate | **moderate** | moderate | **high** | high | **high** | high | **high** | high |
| **CONSIDERATIONS NOT INCLUDED IN OVERALL CONDITION RATING** | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Aesthetics/recreational/educational/cultural* | **Public Values** | **low** | low | **low** | low | **low** | low | **low** | low | **low** | low | **low** | low | **low** | low | **low** | low | **low** | low | **low** | low | **low** | low | **low** | low |
| *Commercial uses* | **NE** | **NE** | NA | **NE** | NA | **NE** | NA | **NE** | NA | **NE** | NA | **NE** | NA | **NE** | NA | **NE** | NA | **NE** | NA | **NE** | NA | **NE** | NA | **NE** | NA |
| *Groundwater interaction* | **NE** | **NE** | R | **NE** | R/D | **NE** | R | **NE** | R/D | **NE** | R/D | **NE** | R | **NE** | R/D | **NE** | R/D | **NE** | R/D | **NE** | R/D | **NE** | R | **NE** | R/D |

[1]Ratings for the MnRAMs include: NA=not applicable; low; moderate; high; exceptional; and NE=no equivalent. For the groundwater interaction, the ratings include recharge (R), discharge (D), or a combination of recharge and discharge (R/D).

[2]Rating for the Barr Mine MnRAM for the Vegetative Diversity consideration was modified from High in the 2015 evaluation to Exceptional in the 2019 evaluation based on the presence of *Eleochris nitidia*, a state-listed special concern species.

[3]Rating for the Barr Mine MnRAM for the Human Disturbance consideration has score values that are opposite of those described in Footnote 5; for instance a Human Disturbance rating of High equates to significant disturbance and negative effects, therefore has a score of 0.1 while a rating of Low equates to little disturbance and a score of 1.0. To be consistent with MnRAM 3.4 formulas, this applies to Hydrologic Regime, Wetland Water Quality, and Wildlife Habitat.

[4]Rating for the Barr Mine MnRAM for Upland Condition uses reversed score values (i.e., High rating = 0.1 value) to match the MnRAM 3.4 formula, which uses the reverse value for Question 14 - Dominant Upland Land Use.

[5]The Overall Condition Rating is an average of the numeric values for each consideration (Low=0.1, Moderate=0.5, High=1.0, Exceptional=2.0) following values in MnRAM 3.4 (BWSR 2010, pg 3). The overall condition rating is based on the Functional Index Scores in MnRAM 3.4 (BWSR 2010, pg 3), which include: Low=0.01-0.32, Moderate=0.33-0.65, High=0.66-1.00, and Exceptional=1.01-2.00. Per Corps guidance (Attachment C), Public Values and Aesthetics/recreational/educational/cultural are not included in the Overall Condition Rating.

Table E-2. Comparison of numeric values and overall condition score for MnRAM 3.4 and Barr Mine MnRAM

| MnRAM 3.4 Functions and Values | Barr Mine MnRAM Functions/Values | Ratings for Barr Mine MnRAM and MnRAM 3.4[1] | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Wetland 2 hardwood swamp | | Wetland 6 sedge meadow | | Wetland 8 fresh (wet) meadow | | Wetland 11a sedge meadow | | Wetland 11c sedge meadow | | Wetland 13 alder thicket | | Wetland 15 alder thicket | | Wetland 17b shallow marsh | | Wetland 18 shallow marsh | | Wetland 20 coniferous swamp | | Wetland 23 hardwood swamp | | Wetland 27 hardwood swamp | |
| | | Barr | MnRAM 3.4 | Barr | MnRAM 3.4 | Barr | MnRAM 3.4 | Barr | MnRAM 3.4 | Barr | MnRAM 3.4 | Barr | MnRAM 3.4 | Barr | MnRAM 3.4 | Barr | MnRAM 3.4 | Barr | MnRAM 3.4 | Barr | MnRAM 3.4 | Barr | MnRAM 3.4 | Barr | MnRAM 3.4 |
| ***Vegetative Diversity/Integrity*** | | **0.5** | 0.46 | **1.0** | 0.90 | **2.0**[2] | 2.00 | **1.0** | 1.00 | **1.0** | 1.00 | **1.0** | 0.90 | **0.5** | 0.50 | **0.5** | 0.50 | **0.5** | 0.5 | **1.0** | 1.00 | **1.0** | 1.00 | **1.0** | 0.90 |
| *Maintenance of hydrologic regime* | **Outlet condition** | **1.0** | | **0.1** | | **0.1** | | **1.0** | | **1.0** | | **0.5** | | **0.1** | | **0.1** | | **0.1** | | **1.0** | | **1.0** | | **1.0** | |
| | **Upland condition** | **0.5** | | **0.5** | | **0.5** | | **1.0** | | **1.0** | | **0.5** | | **0.5** | | **0.5** | | **1.0** | | **1.0** | | **1.0** | | **1.0** | |
| | **Human disturbance**[3] | **0.5** | | **0.1** | | **0.1** | | **1.0** | | **1.0** | | **0.5** | | **0.5** | | **0.5** | | **0.1** | | **1.0** | | **1.0** | | **1.0** | |
| ***Maintenance of Hydrologic Regime*** | | **0.67** | 0.75 | **0.23** | 0.20 | **0.23** | 0.20 | **1.00** | 0.88 | **1.00** | 0.88 | **0.50** | 0.63 | **0.37** | 0.52 | **0.37** | 0.52 | **0.40** | 0.77 | **1.00** | 1.00 | **1.00** | 0.88 | **1.00** | 0.88 |
| *Flood/stormwater/ attenuation* | **Outlet condition** | **1.0** | | **0.1** | | **0.1** | | **1.0** | | **1.0** | | **0.5** | | **0.1** | | **0.1** | | **0.1** | | **1.0** | | **1.0** | | **1.0** | |
| | **Upland condition**[4] | **0.5** | | **0.5** | | **0.5** | | **0.1** | | **0.1** | | **0.5** | | **0.5** | | **0.5** | | **0.1** | | **0.1** | | **0.1** | | **0.1** | |
| | **Human disturbance** | **0.5** | | **1.0** | | **1.0** | | **0.1** | | **0.1** | | **0.5** | | **0.5** | | **0.5** | | **1.0** | | **0.1** | | **0.1** | | **0.1** | |
| ***Flood/Stormwater/Attenuation*** | | **0.67** | 0.66 | **0.53** | 0.43 | **0.53** | 0.43 | **0.40** | 0.56 | **0.40** | 0.56 | **0.50** | 0.60 | **0.37** | 0.50 | **0.37** | 0.39 | **0.40** | 0.3 | **0.40** | 0.58 | **0.40** | 0.61 | **0.40** | 0.67 |
| *Downstream water quality* | **Outlet condition** | **1.0** | | **0.1** | | **0.1** | | **1.0** | | **1.0** | | **0.5** | | **0.1** | | **0.1** | | **0.1** | | **1.0** | | **1.0** | | **1.0** | |
| | **Upland condition** | **0.5** | | **0.5** | | **0.5** | | **1.0** | | **1.0** | | **0.5** | | **0.5** | | **0.5** | | **1.0** | | **1.0** | | **1.0** | | **1.0** | |
| | **Human disturbance** | **0.5** | | **1.0** | | **1.0** | | **0.1** | | **0.1** | | **0.5** | | **0.5** | | **0.5** | | **1.0** | | **0.1** | | **0.1** | | **0.1** | |
| ***Downstream Water Quality*** | | **0.67** | 0.75 | **0.53** | 0.31 | **0.53** | 0.40 | **0.70** | 0.67 | **0.70** | 0.67 | **0.50** | 0.60 | **0.37** | 0.51 | **0.37** | 0.48 | **0.70** | 0.42 | **0.70** | 0.72 | **0.70** | 0.61 | **0.70** | 0.61 |
| *Maintenance of wetland water quality* | **Vegetative diversity** | **0.5** | | **1.0** | | **2.0**[2] | | **1.0** | | **1.0** | | **1.0** | | **0.5** | | **0.5** | | **0.5** | | **1.0** | | **1.0** | | **1.0** | |
| | **Upland condition** | **0.5** | | **0.1** | | **0.5** | | **1.0** | | **1.0** | | **0.5** | | **0.5** | | **0.5** | | **1.0** | | **1.0** | | **1.0** | | **1.0** | |
| | **Human disturbance**[3] | **0.5** | | **0.1** | | **0.1** | | **1.0** | | **1.0** | | **0.5** | | **0.5** | | **0.5** | | **0.1** | | **1.0** | | **1.0** | | **1.0** | |
| ***Maintenance of Wetland Water Quality*** | | **0.50** | 0.63 | **0.40** | 0.61 | **0.9** | 0.87 | **1.00** | 1.0 | **1.00** | 1.0 | **0.67** | 0.70 | **0.50** | 0.62 | **0.50** | 0.58 | **0.53** | 0.77 | **1.00** | 1.00 | **1.00** | 0.93 | **1.00** | 0.89 |
| ***Shoreline protection*** | | **NE** | NA | **NE** | NA | **NE** | NA | **NE** | NA | **NE** | NA | **NE** | NA | **NE** | NA | **NE** | 0.62 | **NE** | 0.34 | **NE** | NA | **NE** | 0.36 | **NE** | 0.36 |
| *Maintenance of characteristic wildlife habitat structure* | **Wildlife habitat** | **1.0** | | **1.0** | | **1.0** | | **1.0** | | **1.0** | | **0.5** | | **1.0** | | **0.1** | | **1.0** | | **1.0** | | **1.0** | | **1.0** | |
| | **Outlet condition** | **1.0** | | **0.1** | | **0.1** | | **1.0** | | **1.0** | | **0.5** | | **0.1** | | **0.1** | | **0.1** | | **1.0** | | **1.0** | | **1.0** | |
| | **Upland condition** | **0.5** | | **0.5** | | **0.5** | | **1.0** | | **1.0** | | **0.5** | | **0.5** | | **0.5** | | **1.0** | | **1.0** | | **1.0** | | **1.0** | |
| | **Human disturbance**[3] | **0.5** | | **0.1** | | **0.1** | | **1.0** | | **1.0** | | **0.5** | | **0.5** | | **0.5** | | **0.1** | | **1.0** | | **1.0** | | **1.0** | |
| | **Vegetative diversity** | **0.5** | | **1.0** | | **2.0**[2] | | **1.0** | | **1.0** | | **1.0** | | **0.5** | | **0.5** | | **0.5** | | **1.0** | | **1.0** | | **1.0** | |
| ***Maintenance of Characteristic Wildlife Habitat Structure*** | | **0.70** | 0.64 | **0.54** | 0.50 | **0.74** | 0.74 | **1.00** | 0.84 | **1.00** | 0.84 | **0.60** | 0.65 | **0.52** | 0.55 | **0.34** | 0.63 | **0.54** | 0.61 | **1.00** | 0.86 | **1.00** | 0.89 | **1.00** | 0.86 |
| *Maintenance of characteristic fish habitat* | **Upland condition** | **0.5** | | **0.5** | | **0.5** | | **1.0** | | **1.0** | | **0.5** | | **0.5** | | **0.5** | | **1.0** | | **1.0** | | **1.0** | | **1.0** | |
| | **Human disturbance**[3] | **0.5** | | **0.1** | | **0.1** | | **1.0** | | **1.0** | | **0.5** | | **0.5** | | **0.5** | | **0.1** | | **1.0** | | **1.0** | | **1.0** | |
| ***Maintenance of Characteristic Fish Habitat*** | | **NA** | NA | **NA** | NA | **NA** | NA | **NA** | NA | **NA** | NA | **NA** | NA | **NA** | NA | **NA** | 0.83 | **NA** | 0.69 | **NA** | NA | **NA** | 0.89 | **NA** | 0.88 |
| *Maintenance of characteristic amphibian habitat* | **Wildlife habitat** | **1.0** | | **1.0** | | **1.0** | | **1.0** | | **1.0** | | **0.5** | | **1.0** | | **0.1** | | **1.0** | | **1.0** | | **1.0** | | **1.0** | |
| | **Upland condition** | **0.5** | | **0.5** | | **0.5** | | **1.0** | | **1.0** | | **0.5** | | **0.5** | | **0.5** | | **1.0** | | **1.0** | | **1.0** | | **1.0** | |
| | **Human disturbance**[3] | **0.5** | | **0.1** | | **0.1** | | **1.0** | | **1.0** | | **0.5** | | **0.5** | | **0.5** | | **0.1** | | **1.0** | | **1.0** | | **1.0** | |
| ***Maintenance of Characteristic Amphibian Habitat*** | | **NA** | NA | **NA** | NA | **NA** | NA | **NA** | NA | **NA** | NA | **NA** | NA | **NA** | NA | **NA** | 0.26 | **NA** | 0.42 | **NA** | NA | **NA** | 0.34 | **NA** | 0.34 |
| **OVERALL CONDITION RATING**[5] | | **0.62** | 0.65 | **0.54** | 0.49 | **0.58** | 0.77 | **0.85** | 0.83 | **0.85** | 0.83 | **0.63** | 0.68 | **0.44** | 0.53 | **0.41** | 0.53 | **0.51** | 0.54 | **0.85** | 0.86 | **0.85** | 0.72 | **0.85** | 0.71 |
| **CONSIDERATIONS NOT INCLUDED IN OVERALL CONDITION RATING** | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Aesthetics/recreational/educational/cultural* | **Public values** | **0.1** | 0.26 | **0.1** | 0.15 | **0.1** | 0.15 | **0.1** | 0.25 | **0.1** | 0.25 | **0.1** | 0.15 | **0.1** | 0.15 | **0.1** | 0.20 | **0.1** | 0.15 | **0.1** | 0.31 | **0.1** | 0.20 | **0.1** | 0.15 |
| *Commercial uses* | **NE** | **NE** | NA | **NE** | NA | **NE** | NA | **NE** | NA | **NE** | NA | **NE** | NA | **NE** | NA | **NE** | NA | **NE** | NA | **NE** | NA | **NE** | NA | **NE** | NA |
| *Groundwater interaction* | **NE** | **NE** | R | **NE** | R/D | **NE** | R | **NE** | R/D | **NE** | R/D | **NE** | R | **NE** | R/D | **NE** | R/D | **NE** | R/D | **NE** | R/D | **NE** | R | **NE** | R/D |

[1]Ratings for the MnRAMs include: NA=not applicable; low; moderate; high; exceptional; and NE=no equivalent. For the groundwater interaction, the ratings include recharge (R), discharge (D), or a combination of recharge and discharge (R/D).

[2]Rating for the Barr Mine MnRAM for the Vegetative Diversity consideration was modified from High in the 2015 evaluation to Exceptional in the 2019 evaluation based on the presence of *Eleochris nitidia,* a state-listed special concern species.

[3]Rating for the Barr Mine MnRAM for the Human Disturbance consideration has score values that are opposite of those described in Footnote 5; for instance a Human Disturbance rating of High equates to significant disturbance and negative effects, therefore has a score of 0.1 while a rating of Low equates to little disturbance and a score of 1.0. To be consistent with MnRAM 3.4 formulas, this applies to Hydrologic Regime, Wetland Water Quality, and Wildlife Habitat.

[4]Rating for the Barr Mine MnRAM for Upland Condition uses reversed score values (i.e., High rating = 0.1 value) to match the MnRAM 3.4 formula, which uses the reverse value for Question 14 - Dominant Upland Land Use.

[5]The Overall Condition Rating is an average of the numeric values for each consideration (Low=0.1, Moderate=0.5, High=1.0, Exceptional=2.0) following values in MnRAM 3.4 (BWSR 2010, pg 3). The overall condition rating is based on the Functional Index Scores in MnRAM 3.4 (BWSR 2010, pg 3), which include: Low=0.01-0.32, Moderate=0.33-0.65, High=0.66-1.00, and Exceptional=1.01-2.00. Per Corps guidance (Attachment C), Public Values and Aesthetics/recreational/educational/cultural are not included in the Overall Condition Rating.

# Appendix F

## MnRAM 3.4 Guidance, Section 6.0 – Functional Rating Formulas

# Comprehensive General Guidance

**for**

**Minnesota Routine Assessment Method (MnRAM)**
**Evaluating Wetland Function, Version 3.4 (beta)**

*9/15/2010*

# 6.0 Functional Rating Formulas

GENERAL NOTE: Some questions are not applicable to particular wetlands and will be scored N/A. In these cases, rather than count N/A as zero, an alternate equation is provided that eliminates the question from the formula altogether. Because not every question has N/A as an option, formulas that do not include N/A-option questions have only one configuration.

Formulas with a "reverse rating" (marked as "R") take the actual response and "flip" its value for the calculation, so that a question response of "A" high (value of 1.0) will be calculated as low (value of 0.1). In such a formula, medium ratings stay medium.

## *6.1 VEGETATIVE DIVERSITY/INTEGRITY*

**Table 3: Vegetative Diversity/Integrity Summary**

The functional rating is based primarily on the diversity of vegetation within the wetland in comparison to an undisturbed condition for that wetland type. An exceptional rating results from one of the following conditions: 1) highly diverse wetlands with virtually no non-native species, 2) rare or critically impaired wetland communities in the watershed, or 3) the presence or previous sighting of rare, threatened, or endangered plant species. A high rating indicates the presence of diverse, native wetland species and a lack of non-native or invasive species. Wetlands that rate low are primarily dominated by non-native and/or invasive species.

This table may be used when calculating Vegetative Diversity/Integrity Functional Index manually. It shows four options for calculating and presenting floristic data. If you are entering data directly into the MnRAM database, this table does not apply.

| | 3A Proportion of Wetland | 3B Individual Community Scores | 3C Highest Quality | 3D Non-Weighted Average | 3E Weighted Average |
|---|---|---|---|---|---|
| **Community #1** | **T** | **A** | | **A** | **A** |
| **Community #2** | **U** | **B** | | **B** | **B** |
| **Community #3** | **V** | **C** | | **C** | **C** |
| **Community #4** | **W** | **D** | | **D** | **D** |
| **Community #5** | **X** | **E** | | **E** | **E** |
| **Community #6** | **Y** | **F** | | **F** | **F** |
| **Community #7** | **Z** | **G** | | **G** | **G** |
| **Wetland Rating Value** | **1.0** | | **Highest Value** | **(A+B+C+D+E+F+G)/7 = Ave.** | **(A*T)+(B*U)+(C*V)+(D*W)+(E*X)+(F*Y)+(G*Z) = Wt. Ave.** |

If any questions #4-6 are answered yes and/or if any of the Special Features b, d, or i have been selected, enter Exceptional for the functional index. If not, compute the contribution to vegetative diversity and integrity by each plant community by doing the following: multiply the ranking for each community

(Question #3b) by its total proportion in Question 3a (percent of total). Then, the functional index for the entire wetland can be calculated four ways (as follows) and should be utilized according to the scope of the project:

**3b) Individual Community Scores:** maintain raw data as recorded.

**3c) Highest Quality Community:** report the highest-functioning community.

**3d) Non-Weighted Average Quality of all Communities:** straight average

**3e) Weighted Average Quality Based on Percentage of Each Community:** multiply each community rating by its percentage, then add all together.

| **Vegetative Diversity/ Integrity** | | | | | |
|---|---|---|---|---|---|
| | **3a. Proportion of Wetland** | **3b. Individual Community Scores** | **3c. Highest Rated Community Quality** | **3d. Non-Weighted Average** | **3e. Weighted Average** |
| **Community #1** | **T** | **A** | **If Spec. Features b, d or i are checked then rate Exceptional (2); if either question 4, 5, or 6 are Yes, then rate Exceptional (2); else:** | | |
| **Community #2** | **U** | **B** | | | |
| **Community #3** | **V** | **C** | | | |
| **Community #4** | **W** | **D** | | | |
| **Community #5** | **X** | **E** | | | |
| **Community #6** | **Y** | **F** | | | |
| **Community #7** | **Z** | **G** | | | |
| **Overall Wetland Value Rating** | **1.0** | | **: Highest Value of A-G** | **: (A+B+C+D+E+F+G)/7 = Ave.** | **:(A*T)+(B*U)+(C*V)+(D*W)+(E*X)+(F*Y)+(G*Z) = Wt. Ave.** |

### 6.2 MAINTENANCE OF CHARACTERISTIC HYDROLOGIC REGIME

A wetland's hydrologic regime or hydroperiod is the seasonal pattern of the wetland water level that is like a hydrologic signature of each wetland type. It defines the rise and fall of a wetland's surface and subsurface water. The constancy of the seasonal patterns from year to year ensures a reasonable stability for the wetland[24]. The ability of the wetland to maintain a hydrologic regime characteristic of the wetland type is evaluated based upon wetland soil and vegetation characteristics, land use within the wetland, land use within the upland watershed contributing to the wetland, and wetland outlet configuration. Maintenance of the hydrologic regime is important for maintaining a characteristic vegetative community, and is closely associated with other functions including flood attenuation, water quality and groundwater interaction.

Measures the degree of human alteration of the wetland hydrology, either by outlet control or by altering immediate watershed conditions. Each parameter is weighted equally.

| MnRAM # | Excel # | Variable Description | Type of Interaction |
|---|---|---|---|
| 13 | E17 | Outlet—natural hydrologic regime | Controlling |
| 14 | E18 | Dominant upland land use | Compensatory |
| 15 | E19 | Soil condition/wetland | Compensatory |
| 20 R | F24 | Stormwater runoff/pretreatment-Reversed | Compensatory |

Hydrologic Regime Index = $(13+14+15+20_{reverse})/4$

### 6.3 FLOOD AND STORMWATER STORAGE/ATTENUATION

A wetland's ability to provide flood storage and/or flood wave attenuation is dependent on many characteristics of the wetland and contributing watershed. Characteristics of the subwatershed that affect the wetlands ability to provide flood storage and attenuation include: soil types, land use and resulting stormwater runoff volume, sediment delivery from the subwatershed, and the abundance of wetlands and waterbodies in the subwatershed. Wetland characteristics which affect the wetland's ability to store and or attenuate stormwater include: condition of wetland soils; presence, extent, and type of wetland vegetation; presence and connectivity of channels; and most importantly outlet configuration. Higher rated wetlands will have an unaltered or restricted outlet, undisturbed wetland soils, dense emergent vegetation without channels, a high proportion of impervious surfaces in the subwatershed, large runoff volumes, clayey upland soils, and few wetlands present within the subwatershed.

This formula is based on the Surface Water Storage Functional Capacity Index scoring concept and equation[25]. The formula was altered with the addition of three surface flow characteristics and two stormwater runoff parameters (Stormwater Runoff Quality/Quantity and Subwatershed Wetland Density) along with the removal of two parameters (Soil Porosity and Subsurface Outlet, which is already characterized in another parameter). This index is comprised of 5 primary processes, which are weighted equally; included in each major process are one to three characteristics that equally contribute to that process.

[24] Mitsch and Gosselink, 2000
[25] Lee et al., 1997

1. **Outlet Characteristics**: Outlet characteristics
2. **Upland Watershed**: Upland land use, Upland soils,
3. **Wetland Condition/Land Use**: Wetland land use, sediment delivery
4. **Runoff Characteristics:** Stormwater runoff quality/quantity, subwatershed wetland density
5. **Surface Flow Characteristics**: Flow-through emergent vegetation density, surface flow characteristics

**Flood and Stormwater Storage Index Computation:**

**Entire Formula:** Outlet for flood retention{12} + (Dominant upland use{$14_{reversed}$}+ Upland soils{19})/2 + (Soil condition{15} + Sediment delivery{18})/2 + Stormwater runoff pretreat&det{20} + Subwatershed wetland density{21})/2 + (Percent emergent vegetative cover{16} + Flow-through emergent vegetative roughness{17} + Channels/sheet flow{22})/3)/5.

**1**. If 12=0, then: ((14 $_{reversed}$ +19)/2+(15+18)/2+(20+21)/2+(16+17+22)/3)/4

**2**. If 12>0, then: (12+(14 $_{reversed}$ +19)/2+(15+18)/2+(20+21)/2+(16+17+22)/3)/5

No changes to the formula are necessary if 16=0.

Flood and Stormwater Storage/Attenuation Variables

| MnRAM # | Excel # | Variable Description | Type of Interaction |
|---|---|---|---|
| 12 | E16 | Outlet—flood attenuation | Controlling—optional |
| 14-R | F18 | Dominant upland land use—reversed | Compensatory |
| 19 | E23 | Upland soils | Compensatory |
| 15 | E19 | Soil condition | Compensatory |
| 18 | E22 | Sediment delivery | Compensatory |
| 20 | E24 | Stormwater pretreatment &detention | Compensatory |
| 21 | E25 | Subwatershed wetland density | Compensatory |
| 16 | F20 | Emergent vegetation % cover | Comp.—optional |
| 17 | E21 | Emergent vegetation flood resistance | Comp.—optional |
| 22 | E26 | Channels/sheet flow | Compensatory |

### *6.4 DOWNSTREAM WATER QUALITY PROTECTION*

This rates the wetland's ability and opportunity to protect valuable downstream resources. Valuable downstream resources include recreational waters (i.e. lakes, streams, rivers, creeks, etc) and potable water supplies. The level of functioning is determined based on runoff characteristics, sedimentation processes, nutrient cycling, and the presence and location of significant downstream water resources. Runoff characteristics that are evaluated include: land use and soils in the upstream watershed, the stormwater delivery system to the wetland, and sediment delivery characteristics. The ability of the wetland to remove sediment from stormwater is determined by emergent vegetation and overland flow characteristics. A high nutrient removal rating indicates dense vegetation and sheet flow to maximize nutrient uptake and residence time within the wetland. The opportunity for a wetland to protect a valuable water resource diminishes with distance from the wetland so wetlands with valuable waters within 0.5 miles downstream have the greatest opportunity to provide protection, as do those that receive more (and less-treated) runoff.

Compute Functional Index for Downstream Water Quality Protection

This functional index computation was derived from a combination of Nutrient Cycling and Retention of Particulates functions in the HGM Prairie Pothole draft guidebook[54] with the downstream sensitivity concept from *The Minnesota Wetland Evaluation Methodology.* Three major processes make up equal portions of the Downstream Water Quality Protection function[26] with a measure of opportunity to protect downstream resources; each process is comprised of two to four observable parameters.

1. **Rate, Quantity, and Quality of Runoff to the Wetland**: this is characterized by the conditions in the upstream watershed; both land use and soils, that affect the sediment and nutrient loads to the wetland, and by the existing storm water delivery system to the wetland (Upland watershed conditions, storm water runoff, evidence of sediment delivery, and upland buffer each comprise 1/16 of the entire downstream water quality functional index based on their contribution to sediment removal).
2. **Sedimentation**: this is characterized by the presence of flow-through emergent vegetation density and by the overland flow characteristics within the wetland. A wetland with primarily sheet flow through the wetland and dense emergent vegetation density will allow sediment to drop out more effectively than a wetland with channel flow and no vegetation (When all parameters are applicable; emergent vegetative density and overland flow characteristics each make up 1/8 of the total downstream water quality functional index based on their contribution to sediment removal).
3. **Nutrient Uptake**: this is characterized by the outlet configuration and vegetative characteristics. A wetland with long water retention times has more capacity to remove nutrients from the water column via physical and biological processes. Vegetation slows floodwaters by creating frictional drag in proportion to stem density which allows sediment particles to settle out, thereby improving the water quality for downstream uses (Outlet characteristics and vegetative density each make up 1/8 of the total downstream water quality functional index based on their contribution to nutrient uptake).
4. **Downstream Sensitivity**: if the wetland contributes to the maintenance of water quality within one-half mile of a recreational water body or potable water supply source downstream, it operates at a higher functioning level than a similar wetland farther from or without significant

[26] Derived from a combination of Nutrient Cycling and Retention of Particulates functions in the HGM Prairie Pothole draft guidebook (Lee et al., 1997) with the downstream sensitivity concept from *The Minnesota Wetland Evaluation Methodology.*

downstream water resources (This factor accounts for ¼ of the total downstream water quality functional index).

**Downstream Water Quality Functional Index Computations:**

**1**. If 12=0, then: (14+20+18+(**23+24+26**)/3+(**16**+17)/2+27)/6

**2**. If 12>0, then: (14+20+18+(**23+24+26**)/3+(**16**+17)/2+27+12)/7

No changes to the formula are necessary if 16=0.

**Entire Formula:**
(Dominant upland land use{14} + Stormwater runoff pretreatment & detention{20} + Sediment delivery {18} + (Upland buffer width{$23_{WQ}$} + Upland buffer vegetative cover{24} + Upland buffer slope {26})/3 + (Flow-through %emergent vegetative cover{16} + Flow-through emergent vegetative roughness{17})/2 + Downstream sensitivity{27}+ Outlet for flood{12})/7

Downstream Water Quality Variables

| MnRAM # | Excel # | Variable Description | Type of Interaction |
|---|---|---|---|
| 14 | E18 | Dominant upland land use | Controlling |
| 20 | E24 | Stormwater runoff pretreatment & detention | Controlling |
| 18 | E22 | Sediment delivery | Controlling |
| 23 | G27 | Upland buffer width—water quality valuation | Comp. |
| 24 | G28 | Upland area management | Comp. |
| 26 | G34 | Upland area slope | Comp. |
| 16 | F20 | Emergent vegetation (% cover) | Comp.—optional |
| 17 | E21 | Emergent vegetation (roughness coefficient) | Comp.—optional |
| 27 | E39 | Downstream sensitivity | Comp. |
| 12 | E16 | Outlet for flood | Controlling--optional |

### *6.5 MAINTENANCE OF WETLAND WATER QUALITY*

The sustainability of a wetland is partially driven by the quality and quantity of stormwater runoff entering the wetland. The ability of the wetland to sustain its characteristics is evaluated based on characteristics of the contributing subwatershed and indicators within the wetland. Subwatershed conditions which affect the wetland's sustainability in relation to water quality impacts include: upland land use; sediment delivery characteristics to the wetland; stormwater runoff volumes and rates; and the extent, condition, and width of upland buffer. Indicators of nutrient loading to the wetland indicate that a diverse wetland may not be sustainable. Indicators that a wetland has been affected by nutrient loading include the presence of monotypic vegetation and/or algal blooms.

This functional index was derived from a combination of sources including MNRAM, HGM, WEM, WET, and experiences of the project team. The sustainability of a wetland is partially driven by the quality and quantity of stormwater runoff entering the wetland. The ability of the wetland to sustain its characteristics is evaluated based on characteristics of the contributing subwatershed and indicators within the wetland. Subwatershed conditions which affect the wetland's sustainability in relation to water quality impacts include: upland land use; sediment delivery characteristics to the wetland; stormwater runoff volumes and rates; and the extent,

condition, and width of upland buffer. Indicators of nutrient loading to the wetland indicate that a diverse wetland may not be sustainable. Indicators that a wetland has been affected by nutrient loading include the presence of monotypic vegetation and/or algal blooms.

### Wetland Water Quality Functional Index Computation:

(3e*2+14+$20_{reversed}$ +(**23**+**24**+**26)**/3+18+28)/7

**Entire Formula:**
(Vegetative Diversity/Integrity{3e*2} + Dominant upland land use{14} + Stormwater runoff pretreatment & detention{$20_{reversed}$} + (Upland buffer width{$23_{WQ}$} + Upland buffer vegetative cover {24} + Upland buffer slope {26})/3 + Sediment delivery {18})/2 + Nutrient loading {28})/7

**Wetland Water Quality Variables**

| MnRAM # | Excel # | Variable Description | Type of Interaction |
|---|---|---|---|
| 3e | D6*2 | Vegetative Diversity/Integrity | Contributing |
| 14 | E18 | Dominant upland land use | Contributing |
| 20 R | F24 | Stormwater runoff pretreatment and detention—RR | Contributing |
| 23 | G27 | Upland buffer width—water quality valuation | Contributing |
| 24 | G28 | Upland area management | Contributing |
| 26 | G34 | Upland area slope | Contributing |
| 18 | E22 | Sediment delivery | Contributing |
| 28 | E40 | Nutrient loading | Contributing |

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This functional index was derived from a combination of sources including MNRAM, HGM, WEM, WET, and experiences of the project team. The sustainability of a wetland is partially driven by the quality and quantity of stormwater runoff entering the wetland. The ability of the wetland to sustain its characteristics is evaluated based on characteristics of the contributing subwatershed and indicators within the wetland. Subwatershed conditions which affect the wetland's sustainability in relation to water quality impacts include: upland land use; sediment delivery characteristics to the wetland; stormwater runoff volumes and rates; and the extent, condition, and width of upland buffer. Indicators of nutrient loading to the wetland indicate that a diverse wetland may not be sustainable. Indicators that a wetland has been affected by nutrient loading include the presence of monotypic vegetation and/or algal blooms.

## *6.6 SHORELINE PROTECTION*

Shoreline protection is evaluated only for those wetlands adjacent to lakes, streams, or deepwater habitats. The function is rated based on the wetlands opportunity to protect the shoreline; i.e. wetlands located in areas frequently experiencing large waves and high currents have the best opportunity to protect the shore. In addition, shore areas composed of sands and loams with little vegetation or shallow-rooted vegetation will benefit the most from shoreline wetlands. The wetland width, vegetative cover, and resistance of the vegetation to erosive forces determine the wetland's ability to protect the shoreline.

Each of the five parameters contributes equally[27]: based primarily on the characteristics presented in WEM with a simple, straightforward computation of the index assuming all characteristics contribute equally.

| MnRAM # | Excel # | Variable Description | Type of Interaction |
|---|---|---|---|
| 29 | E41 | Shoreline? | Controlling |
| 30 | E42 | Rooted shoreline vegetation (% cover) | Contributing |
| 31 | E43 | Wetland width (average) | Contributing |
| 32 | E44 | Emergent vegetation erosion resistance | Contributing |
| 33 | E45 | Shoreline erosion potential | Contributing |
| 34 | E46 | Bank protection ability | Contributing |

**Shoreline Protection Functional Index Computation:**

If 29=1, then:
Shoreline Protection Index = (30+31+32+33+34)/5

**Entire Formula:**
(Rooted shoreline vegetation {30} + Average shoreline wetland width {31} + Emergent vegetation erosion resistance {32} + (Shoreline erosion potential {33} + Bank protection ability {34})/5

### *6.7 MAINTENANCE OF CHARACTERISTIC WILDLIFE HABITAT STRUCTURE*

The ability of a wetland to support various wildlife species is difficult to determine due to the specific requirements of the many wildlife species that utilize wetlands. This function determines the value of a wetland for wildlife in a more general sense, and not based on any specific species. The characteristics evaluated to determine the wildlife habitat function include: vegetative quality, outlet characteristics (which control hydrologic regime), upland land use, wetland soil type and conditions, water quality of storm water runoff entering the wetland, upland buffer extent, condition, and diversity; the interspersion of wetlands in the area; barriers to wildlife movement; wetland size; vegetative and community interspersion within the wetland; and amphibian breeding potential and overwintering habitat.

Thirteen parameters are weighed equally as described below; vegetative quality is weighted double the other factors. The questions are borrowed or modified from MNRAM, WET, WEM, and HGM methodologies, combined to provide a measure of wildlife habitat in general, not focusing on any particular species.

If Rare Wildlife (35) or Rare Natural Community (36) are true, then this Index is Exceptional.

If Special Features d, g, or j are checked, then this Index is Exceptional, otherwise, follow conditions below:

If 37=0 and 38=0 and 39=0 [Vegetation (37) and Community interspersion (38) and Wetland Detritus (39) are all n/a], then:
(3e*2+40+41+(**23**+**24**+**25)**/3+13+ 20)/7

If 38=0 and 39=0 [Community interspersion (38) and Wetland Detritus (39) are n/a], then:
(3e*2+37+40+41+(**23**+**24**+**25)**/3+ 13+20)/8

[27] Based primarily on the characteristics presented in WEM.

If 37=0 and 39=0 [Vegetation (37) and Wetland Detritus (39) are n/a], then:
(3e*2+38+40+41+(**23**+**24**+**25)**/3+ 13+20)/8

If 37=0 and 38=0 [Vegetation (37) and Community interspersion (38) are n/a], then:
(3e*2+39+40+41+(**23**+**24**+**25)**/3+ 13+20)/8

If 39=0 [Wetland Detritus (39) is n/a], then:
(3e*2+37+38+40+41+(**23**+**24**+**25)**/3+13+20)/9

If 38=0 [Community interspersion (38) is n/a], then:
(3e*2+39+37+40+41+(**23**+**24**+**25)**/3+13+20)/9

If 37=0 [Vegetation interspersion (37) is n/a], then:
(3e*2+39+38+40+41+(**23**+**24**+**25)**/3+13+20)/9

If 37>0 and 38>0 and 39>0, then:
(3e*2+39+37+38+40+41+(**23+24+25**)/3+13+20)/10

**Entire Equation:**
(Vegetative Diversity/Integrity{3e*2} + Wetland Detritus {39} + Vegetation Interspersion {37} + Community Interspersion {38} + Wetland Interspersion {40} + Wildlife Barriers {41} + (Upland buffer width {$23_{\text{wildlife value}}$} + Upland Area Management{24} + Upland area diversity {25})/3 + Outlet natural hydrologic regime {13}+ Stormwater runoff pretreatment and detention $20_{\text{reversed}}$)/10

| MnRAM # | Excel # | Variable Description | Type of Interaction |
|---|---|---|---|
| 41 | E53 | Wildlife barriers | Controlling |
| 3e | D6 | Vegetative Ranking (communities' weighted average) | Compensatory |
| 39 | E51 | Wetland detritus (n/a) | Contributing |
| 23 | I27 | Upland buffer average width—wildlife valuation | Contributing |
| 24 | G28 | Upland area management | Contributing |
| 25 | G31 | Upland area diversity | Contributing |
| 13 | E17 | Outlet natural hydrologic regime | Contributing |
| 20 R | F24 | Stormwater runoff pretreatment & detention—reversed | Contributing |
| 37 | F49 | Vegetation interspersion (n/a) | Contributing |
| 38 | F50 | Community interspersion (n/a) | Contributing |
| 40 | E52 | Wetland interspersion | Contributing |

### *6.8 MAINTENANCE OF CHARACTERISTIC FISH HABITAT*

The ability of the wetland to support native fish populations is determined by structural factors within the wetland as well as water quality contributions from upland factors. Wetlands rated High are lacustrine or riverine and provide spawning/nursery habitat, or refuge for native species (included but not limited to game fish). Wetlands rated Low for fish habitat do not have a direct hydrologic connection to a waterbody with a native fishery or have poor water quality.

| MnRAM # | Excel # | Variable Description | Type of Interaction |
|---|---|---|---|
| 46 | E58*2 | Fish habitat quality | Controlling |
| 29 | D41 | Fringe wetland? | Contributing |
| 24 | G28 | Adjacent area management | Compensatory |

| | | | |
|---|---|---|---|
| 18 | E22 | Sediment delivery | Compensatory |
| 20 R | F24 | Storm water runoff—reversed | Compensatory |
| 28 | E40 | Nutrient load | Compensatory |
| 30 | E42 | Percent cover | Compensatory |
| 31 | E43 | Wetland shoreline width | Compensatory |
| 33 (R) | F45 | Shoreline erosion potential | Compensatory |

**Fish Habitat Functional Index Computation:**

If Special Features a or g are checked, then Fishery Habitat Index = Exceptional.

If 46=0, then Fishery Habitat = N/A

If 29=0, Fishery Habitat Index = $[(46*2)+24+18+20_{reversed}+28]/6$

If 29>0, Fishery Habitat Index = $[(46*2)+24+18+20_{reversed}+28+\mathbf{30}+\mathbf{31}+\mathbf{33(R)}]/9$

### *6.9 MAINTENANCE OF CHARACT. AMPHIBIAN HABITAT FOR BREEDING/OVERWINTERING*

The characteristic ability of a wetland to support various amphibian species is difficult to determine due to the specific requirements of the many amphibian species that depend on wetlands. This function determines the value of a wetland for amphibians in general, not based on specific species. An adequate wetland hydroperiod and the presence or absence of predatory fish are considered to be limiting variables for this function. In general, wetlands must remain inundated until early to mid-June to allow the larval stages to metamorphose into adults. Because many amphibians are partly terrestrial, the characteristics evaluated to determine the amphibian habitat function include numerous hydrology and terrestrial measures. The characteristics evaluated include: upland land use, upland buffer width, water quality of storm water runoff entering the wetland, barriers to wildlife movement, and amphibian breeding potential and overwintering habitat.

An adequate wetland hydroperiod (Question 42) is considered to be the primary limiting variable for this functional index. If the hydroperiod is insufficient for breeding, the wetland rating for amphibian use will be Not Sufficient. The status of predatory fish in the wetland (Q.43) is a secondary limiting factor to the final rating; the lowest rating for this variable, however, is 0.1 (Low), rather than zero (Not Sufficient).

Amphibians' ability to use a particular wetland for over wintering is a contributing factor in rating the wetland's functional index (Q.44). Because most amphibians are partly terrestrial, the extent of upland buffer habitat surrounding the wetland (Q.23) is an important habitat component[28] and is weighted by a factor of two. Question 14 (Upland Land Use) is also included as an indicator of the quality of the surrounding upland habitat[56]. Unnatural fluctuations in water depth in wetlands from conducted storm water runoff can impair reproductive success in amphibians, which often attach their eggs to stems of wetland vegetation, e.g., salamanders, tree frogs, green frogs, and wood frogs[29]. Extreme water level fluctuations during winter may also cause mortality in overwintering reptiles and amphibians[30]. Thus,

[28] Knutson et al., 2000
[29] Richter and Azous, 1995
[30] Hall and Cuthbert, 2000

Question 20 is included in the formula, with a reverse rating. Question 41 (Barriers) is included because access to and from the wetland by amphibians is an important factor in habitat quality[31].

**Amphibian Habitat Functional Index Computation:**

If 42=0, then N/A

Otherwise: Amphibian Habitat Index = (43) * [( 44 + 2*$23_{wildlife}$ + 14 + 41 + $20_{reversed}$)/6]

**Entire Formula:**

If Amphibian Breeding Potential-Hydroperiod {42} is applicable, then: (Amphibian Breeding Potential-Predator Fish {43}) * {[(Amphibian Overwintering Habitat {44}+ 2*Upland Buffer Width $(23)_{Wildlife}$ + Dominant Upland Land Use {14} + Barriers {41} + Stormwater Input $\{20_{reverse}\}$]/6}

Amphibian Habitat Variables

| MnRAM # | **Excel #** | Variable Description | Type of Interaction |
|---|---|---|---|
| 42 | D54 | Amphibian breeding potential—hydroperiod | Controlling |
| 43 | D55 | Amphibian breeding potential—fish presence | Controlling |
| 44 | E56 | Amphibian overwintering habitat | Compensatory |
| 23 | I27 | Upland buffer width | Compensatory |
| 41 | E53 | Wildlife barriers | Compensatory |
| 14 | E18 | Dominant upland land use | Compensatory |
| 20 | F24 | Stormwater runoff pretreatment & detention—RR | Compensatory |

### *6.10 AESTHETICS/RECREATION/EDUCATION/CULTURAL/SCIENCE*

The aesthetics/recreation/education/cultural and science function and value of each wetland is evaluated based on the wetland's visibility, accessibility, evidence of recreational uses, evidence of human influences (e.g. noise and air pollution) and any known educational or cultural purposes. Accessibility of the wetland is key to its aesthetic or educational appreciation. While dependent on accessibility, a wetland's functional level could be evaluated by the view it provides observers. Distinct contrast between the wetland and surrounding upland may increase its perceived importance. Also, diversity of wetland types or vegetation communities may increase its functional level as compared to monotypic open water or vegetation. Excess negative human influence on the wetland is counted double in the formula.

All questions contribute equally to the overall index.

| MnRAM # | Excel # | Variable Description | Type of Interaction |
|---|---|---|---|
| 48 | E60 | Rare educational opportunity | Controlling |
| 49 | E61 | Wetland visibility | Compensatory |
| 50 | E62 | Proximity to population | Compensatory |
| 51 | E63 | Public ownership | Compensatory |
| 52 | E64 | Public access | Compensatory |
| 53 | E65 | Human influence—wetland | Compensatory |

[31] Knutson, et al., 1999; Findlay and Bourdages, 2000; Semlitsch, 2000.

| | | | |
|---|---|---|---|
| 54 | E66 | Human influence—viewshed | Compensatory |
| 55 | E67 | Spatial buffer | Compensatory |
| 56 | E68 | Recreational activities in wetland | Compensatory |

---

**Aesthetics/Recreation/Education/Cultural/Science Functional Index Computations:**

If Special Features c, h, or u is checked[32], or

If 48=1, then Index = Exceptional;

If 53=0.1 (Low), then = (50+51+52+2*53+54+55+56)/8

If 53>0.1, then = (49+50+51+52+53+54+55+56)/8

**Entire Formula**

(Wetland Visibility {49} + Proximity to Population {50} + Public Ownership {51} + Public Access {52} + Human Influence - Wetland {53} + Human Influence - Viewshed {54} + Spatial Buffer {55} + Recreational Activities in Wetland {56})/8

---

### *6.11 COMMERCIAL USES*

This question considers the nature of any commercially-valuable use of the wetland and requires the assessor to consider how such use may be a detriment to the sustainability of the wetland. Some row crops can be planted in Type 1 wetlands after spring flooding has ceased and still have adequate time to grow to maturity. This non-wetland-dependent agricultural use of wetlands may include hay, pasture/grazing, or row crops such as soybeans or corn. Wetland-dependent crops include wild rice and cranberries, which rely on the wetland hydrology for part of their life cycle.

Sustainable uses of the wetland would not require modifying a natural wetland. Products in this category would include collection of botanical products, wet native grass seed, floral decorations, wild rice, black spruce, white cedar, and tamarack. Sustainable uses may require modification of the natural hydrology, such as for wetland-dependent crops (rice, cranberries). Haying and grazing can be less intrusive agricultural activities utilized more or less casually when hydrologic conditions permit; light pasture and occasional haying would be considered more or less sustainable. Like peat-mining, cropping is an unsustainable use of the wetland as it is results in severe alterations of wetland characteristics (soil, vegetation, hydrology).

| MnRAM # | **Excel #** | Variable Description | Type of Interaction |
|---|---|---|---|
| 57 | **E69** | Commercial crop—hydrologic impact | Controlling |

[32] c = Designated scientific and natural area; h = Archeologic or historic site designated by the State Historic Preservation Office; u = State or Federal designated wilderness area.

**Commercial Uses Functional Index =** 57

### *6.12 GROUND-WATER INTERACTION*

The ground water interaction function is the most difficult to assess. Here the most likely type of ground water interaction is determined, i.e. recharge or discharge, or a combination. In many cases, a wetland will exhibit both recharge and discharge characteristics, however one is usually more dominant. Several wetland and watershed characteristics are evaluated to determine the likely interaction including: wetland soil type, upland land use, upland soil types and wetland size, wetland hydroperiod, wetland outlet characteristics, and topographic relief.

The purpose of this function is strictly to determine the likelihood of the appropriate ground-water interaction based on observable characteristics of the wetland and watershed. The significance of ground water as a component of the wetland water budget is the most difficult functional characteristic to determine without large quantities of detailed hydrologic and geologic information. The following methodology takes the most easily observable and distinct measures of recharge/discharge relationships from the *Wetland Evaluation Technique*[33] and the *Hydrogeomorphic Assessment Methodology*[34]. In many wetlands, surface water and ground water both make significant contributions to the water budget, but occasionally recharge or discharge is dominant. The goal here is to identify the dominant ground-water interaction (if there is one) to help guide future management and provide an indication when additional information may be warranted.

- If 5 or 6 of questions 58-63 are answered the same, this indicates a strong likelihood that the most frequently stated interaction exerts the primary influence on the wetland.
- If 3-4 questions are answered the same, then the wetland is likely influenced by a combination of both recharge and discharge interactions (i.e. both types of ground water interaction are likely to be present at some point during most years).

58. Wetland Soils – from HGM system functional assessments and Novitzki
59. Subwatershed Land Use/Imperviousness – taken from WET Volume I
60. Wetland Size and Upland Soils – taken from WET Volume I and HGM
61. Wetland Hydrologic Regime– taken from WET Volume I and HGM
62. Inlet/Outlet Configuration – taken from WET Volume I and HGM
63. Upland Topographic Relief – taken from WET Volume I

Special Concerns for Recharge Wetlands

Wherever ground water recharge is indicated as the **primary** interaction and the wetland lies within a sensitive ground water area (**Special Feature Question q**), a contribution area to a public water supply, or a wellhead protection area (**Special Feature Question r**), it should be recorded as Exceptional for the ground water/wetland function.

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[33] Adamus, et al., 1987
[34] Magee and Hollands, 1998

### 6.13 WETLAND RESTORATION POTENTIAL

The potential for wetland restoration is determined based on the ease with which the wetland could be restored, the number of landowners within the historic wetland basin, the size of the potential restoration area, the potential for establishing buffer areas or water quality ponding, and the extent and type of hydrologic alteration. Each variable uses the High, Medium, Low rating rather than raw numbers—see MnRAM for individual ranges.

| MnRAM # | Excel # | Variable Description | Type of Interaction |
|---|---|---|---|
| 64 | **D79** | Wetland Restoration Potential | Controlling |
| 65 | F80 | Number of Landowners Affected | Contributing |
| 21 | E25 | Subwatershed Wetland Density | Contributing |
| 66b | F82 | Total Wetland Restored Size (Potential) | Contributing |
| 66c | F83 | Calculated potential new wetland area | Contributing |
| 67 | F84 | Potential Buffer Width | Contributing |
| 68 | F85 | Likelihood of Restoration Success | Contributing |

If 64="Yes", then Wetland Restoration Potential = (65+21+66b+66c+67+68)/6,

Otherwise, if 64="No" then "N/A"

**Entire Formula**
(Landowners Affected by Restoration (65)+Subwatershed Wetland Density (21)+ Wetland Restoration Size (66b)+Proportion of Wetland Drained (66c)+Potential Buffer Width (67)+Likelihood of Restoration Success (68))/6

### 6.14 WETLAND SENSITIVITY TO STORMWATER INPUT AND URBAN DEVELOPMENT

The sensitivity of the wetland to stormwater and urban development is determined based on guidance within the *Storm-Water and Wetlands: Planning and Evaluation Guidelines for Addressing Potential Impacts of Urban Storm-Water and Snow-Melt Runoff on Wetlands*, State of Minnesota Storm-Water Advisory Group, June 1997. The database pulls this rating directly from the Plant Community entry. If any of the following plant communities are present, this value will always be Exceptional: 3B, 4A, 4B, 7A,7B, 10A,13A,14A, 16B.

**Use habitat proportions from Vegetative Integrity section and enter into a formula to compute answer according to the following criteria[35].**

Exceptional = Sedge meadows, open and coniferous bogs, calcareous fens, low prairies, wet to wet-mesic prairies, coniferous swamps, lowland hardwood swamps, or seasonally flooded basins.

A = Shrub-carrs, alder thickets, diverse fresh wet meadows dominated by native species, diverse shallow and deep marshes, and diverse shallow, open water communities.

B = Floodplain forests, fresh wet meadows dominated by reed canary grass, shallow and deep marshes dominated by cattail, reed canary grass, giant reed or purple loosestrife, and shallow, open water communities with low to moderate vegetative diversity.

C = Gravel pits, cultivated hydric soils, or dredge/fill disposal sites.

[35] Taken directly from State of Minnesota Storm-Water Advisory Group, 1997.

### *6.15 ADDITIONAL STORMWATER TREATMENT NEEDS*

This rates the sustainability of the wetland with regard to stormwater discharges to the wetland. The need for additional stormwater treatment prior to discharge to the wetland is rated based on the overall rating for Maintenance of Wetland Water Quality. If a wetland is severely degraded by stormwater inputs, the rating will be low, since a diverse, high quality wetland will not be sustainable.

Use functional rating for Maintenance of Wetland Water Quality (MWWQ) as follows (this index is rated strictly from the measure of the water quality in the wetland and the sustainability, i.e. if the water quality in the wetland is low, additional stormwater treatment is needed to protect the wetland and the rating is low):

Use Value for Maintenance of Wetland Water Quality Index (D76, Excel spreadsheet) and apply to criteria below.

A = Maintenance of Wetland Water Quality Index >0.66 (no additional treatment needed)
B = 0.33 < Maintenance of Wetland Water Quality Index # < 0.66 (sediment removal needed)
C = Maintenance of Wetland Water Quality Index < 0.33 (sediment and nutrient removal needed)

# Appendix I

## Big and Little 39 Creeks MNSQT Assessment Data

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BARR

# Technical Memorandum

**To:** Nathaniel Schroeder
**From:** Rebecca Eiden, Jessica Olson
**Subject:** Big 39 and Little 39 Stream Quantification Tool Rationale
**Date:** 12/5/2019
**Project:** 23381049.00

On December 4th, 2019 Barr Engineering and Keith Anderson met to discuss the stream assessment of Big 39 and Little 39 and the rationale for the field values used in the Stream Quantification Tool (SQT). The following information provides a description of how the field values were determined, as well as data gaps.

## 1.0 Big 39 SQT

Big 39 has been split into two different reaches: the first is the portion of the stream that includes beaver dams, and the second is the portion of the stream that does not include beaver dams. The existing stream length of the two reaches used in the SQT debit tool were extracted from the Technical Memorandum (Barr 2019) submitted to the St. Paul District Army Corps of Engineers (USACE) on November 8, 2019 (Attachment 1). The rationale for dissecting Big 39 into these two reaches is because the method for quantifying the beaver dam impoundments using the SQT has not yet been determined. Once that decision is made, the impounded reach can be incorporated into the functional feet calculation if it is determined that it should be assessed as a stream, or it can be removed if it is determined that it should be assessed as a wetland complex.

The following table provides the existing stream length, the existing condition score and the existing functional feet for Big 39, data provided in the debit calculator of the SQT.

**Table 1: Debit Calculator Summary of Big 39**

| Stream ID by Reach | Existing Stream Length | Existing Conditions Score | Functional Feet |
|---|---|---|---|
| Big 39, Beaver Dam Areas | 3925 | 0.61 | 2394.3 |
| Big 39, Channel Areas | 1225 | 0.52 | 637 |

### 1.1 Big 39, Beaver Dam Areas

The following Function-Based Parameters were utilized in the SQT for the Big 39, Beaver Dam Areas reach: Reach Runoff, Floodplain Connectivity, Large Woody Debris, Lateral Migration, Bed Form Diversity,

Temperature, Dissolved Oxygen, Total Suspended Solids, Macroinvertebrates, and Fish. The following information is the rationale behind each of the field values that were used to determine the functionality of each of the function-based parameters.

**Land Use Coefficient:** The land use coefficient was determined by delineating the lateral drainage area of Big 39 using StreamStats (https://streamstats.usgs.gov/ss/) and using the land use types derived from the StreamStats report (Attachment B). The land use types were then correlated with the land use descriptions provided in Table 9 of the Minnesota Stream Quantification Tool and Debit Calculator User Manual (https://bwsr.state.mn.us/sites/default/files/2019-09/MNSQT%20User%20Manual%20v1.0%2008292019_combined.pdf).

**Concentrated Flow Points:** This field value was determined by reviewing aerial photographs and documenting any man-made flow points observed in the field.

**Bank Height Ratio:** Bank height ratio is the height of the low bank divided by the bankfull height. In the areas of beaver dam causing inundation of the reach, it is assumed that the bankfull height is the same as the top of bank; therefore, the Bank Height Ratio in the Big 39 Beaver Dam Areas is 1.

**Entrenchment Ratio:** The entrenchment ratio is not applicable to stream/wetland complexes; therefore it is not a metric utilized for the Big 39, Beaver Dam Area.

**Large Woody Debris (# of Pieces):** Number of pieces of large woody debris was counted in the field for this value.

**Dominant BEHI/NBS**: The dominant bank erosion hazard index (BEHI) and near bank stress (NBS) methods were measured in the field.

**Percent Streambank Erosion:** Length of streambank erosion was documented in the field.

**Percent Armoring:** Armoring along the reach was not observed in the field.

**Pool Spacing Ratio:** The pool spacing ratio measures how many geomorphic pools are present within a given reach. Since this reach is inundated by beaver dams, we are defining this entire reach as a pool with no riffle present. Based on the curves developed by Harman et al. the field value that represents this condition is 12; thus the rationale for the field value of 12.

**Pool Depth Ratio:** The pool depth ratio is a ratio of the maximum pool depths divided by the mean riffle depth. Since this reach is inundated by beaver dams, we are determining that there are no planform features like riffles present; therefore, this ratio has a field value of 0.

**Percent Riffle:** The percent riffle is the portion of the representative sub-reach containing riffle bed form features. Since this reach is inundated by beaver dams, we are determining that there are no planform features like riffles present; therefore, the percent riffle field value is 0.

**Aggradation Ratio:** The aggradation ratio is the bankfull width at the widest riffle within the representative sub-reach divided by the mean bankfull riffle depth. This ratio is then divided by the reference width depth ratio. Again, since this reach is inundated by beaver dams, we are determining that there are no planform features like riffles present; therefore, the percent riffle field value is 2 (arbitrary value); which results in an index value of 0.

**Riparian Vegetation Function-Based Parameters:** The measurement methods of riparian vegetation outlined in the Minnesota SQT and Debit Calculator User Manual was not carried out, thus the default index value of 0.8 was used for all four measurements methods used to determine the riparian vegetation. For reference as to conditions, the MPCA Stream Habitat Assessment was carried out and included in the field notes.

**Physicochemical and Biology Functional Category:** These values were measured in the field.

### 1.2 Big 39, Channel Areas

The following information is the rationale behind the field values used in the Channel Areas reach that are different than the values used in the Beaver Dam Area reach due to the difference of systems. These field values include Bank Height Ratio, Entrenchment Ratio, and Bedform Diversity function-based parameters.

**Bank Height Ratio:** Bank height ratio is the height of the low bank divided by the bankfull height. Barr staff used bankfull indicators to identify bankfull height in the field, and surveyed the representative riffle cross-section with a laser level. Because the drainage area has significantly decreased in size since the construction of the diversion bypass channel, the current bankfull elevation is significantly lower than the historic bankfull elevation, which was visible in the field. The current bankfull bench is roughly 2 times wider than the estimated bankfull channel width. Per guidance from Will Harman during the November 5, 2019 USACE-sponsored SQT training, the bankfull bench must be at least 2.2 times larger than the bankfull width to be considered the "low bank" for purposes of Bank Height Ratio calculation. For Big 39, then, the low bank is the historic bankfull bench, so the Bank Height Ratio is 2, resulting in an incised channel. Figure 1 is a typical cross section of Big 39 with call-outs as to where the bankfull indicators were identified and where the historic bankfull height was located.

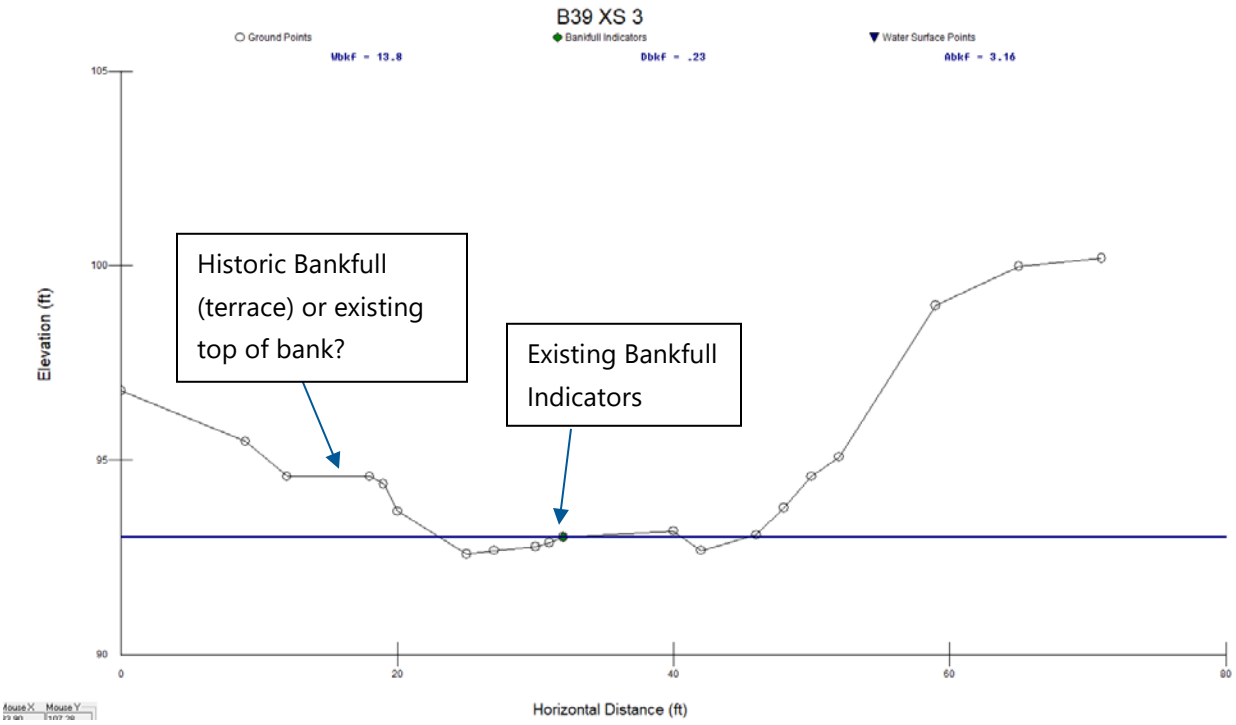


**Figure 1: Representative Cross Section of Big 39**

**Entrenchment Ratio:** The entrenchment ratio is the ratio of the floodprone width and the bankfull width. The entrenchment ratio used the existing bankfull height, determined by bankfull indicators measured in the field.

**Pool Spacing Ratio:** This reach does contain geomorphic features; thus we are able to measure the pool spacing ratio; however, we believe that there is a data gap with our longitudinal profile, therefore we have opted to use the default index value of 0.8 (functioning)

**Pool Depth Ratio:** There is a data gap for this information from the longitudinal profile and the pool depth ratio cannot be determined with existing data; therefore, we have opted to use the default index value of 0.8 (functioning).

**Percent Riffle:** There is a data gap for this information from the longitudinal profile and the percent riffle cannot be determined with existing data; therefore, we have opted to the default index value of 0.8 (functioning).

**Aggradation Ratio:** The aggradation ratio is the bankfull width at the widest riffle within the representative sub-reach divided by the mean bankfull riffle depth at that riffle. This ratio is then divided by the reference width depth ratio (WDR). The bankfull width values at the riffles were collected from our cross sectional surveys and the selected reference WDR is 12, which is the minimum WDR of a B-channel.

# 2.0 Little 39 SQT

Little 39 has also been split into two different reaches: the first is the portion of the stream that includes beaver dams, and the second is the portion of the stream that does not include beaver dams. The existing stream length of the two reaches used in the SQT debit tool were extracted from the Technical Memorandum (Barr, 2019) submitted to the St. Paul District Army Corps of Engineers (USACE) on November 8, 2019 (Attachment 1). The rationale for dissecting Little 39 into these two reaches is because the method for quantifying the beaver dam impoundments using the SQT has not yet been determined. Once that decision is made, the impounded reach can be incorporated into the functional feet calculation if it is determined that it should be assessed as a stream, or it can be removed if it is determined that it should be assessed as a wetland complex.

The following table provides the existing stream length, the existing condition score and the existing functional feet for Little 39, data provided in the debit calculator of the SQT.

| Stream ID by Reach | Existing Stream Length | Existing Conditions Score | Functional Feet |
|---|---|---|---|
| Little 39, Beaver Dam Areas | 1340 | 0.62 | 884 |
| Little 39, Channel Areas | 2080 | 0.56 | 1165 |

## 2.1 Little 39, Beaver Dam Areas

The following Function-Based Parameters were utilized in the SQT for the Little 39, Beaver Dam Areas reach: Reach Runoff, Floodplain Connectivity, Large Woody Debris, Lateral Migration, Bed Form Diversity, Temperature, Dissolved Oxygen, Total Suspended Solids, Macroinvertebrates, and Fish. The following information is the rationale behind each of the field values that were used to determine the functionality of each of the function-based parameters.

**Land Use Coefficient:** The land use coefficient was determined by delineating the lateral drainage area of Little 39 using StreamStats (https://streamstats.usgs.gov/ss/) and using the land use types derived from the StreamStats report (Attachment B). The land use types were then correlated with the land use descriptions provided in Table 9 of the Minnesota Stream Quantification Tool and Debit Calculator User Manual (https://bwsr.state.mn.us/sites/default/files/2019-09/MNSQT%20User%20Manual%20v1.0%2008292019_combined.pdf).

**Concentrated Flow Points:** This field value was determined by reviewing aerial photographs and documenting any man-made flow points observed in the field.

**Bank Height Ratio:** Bank height ratio is the height of the low bank divided by the bankfull height. In the areas of beaver dam causing inundation of the reach, it is assumed that the bankfull height is the same as the top of bank; therefore, the Bank Height Ratio in the Big 39 Beaver Dam Areas is 1.

**Entrenchment Ratio:** The entrenchment ratio is not applicable to stream/wetland complexes; therefore it is not a metric utilized for the Big 39, Beaver Dam Area.

**Large Woody Debris (# of Pieces):** Number of pieces of large woody debris was counted in the field for this value.

**Dominant BEHI/NBS**: The dominant bank erosion hazard index (BEHI) and near bank stress (NBS) methods were measured in the field.

**Percent Streambank Erosion:** Length of streambank erosion was documented in the field.

**Percent Armoring:** Armoring along the reach was not observed in the field. The field value is 0.

**Pool Spacing Ratio:** The pool spacing ratio measures how many geomorphic pools are present within a given reach. Since this reach is inundated by beaver dams, we are defining this entire reach as a pool with no riffle present. Based on the curves developed by Harman et al. the field value that represents this condition is 12; thus the rationale for the field value of 12.

**Pool Depth Ratio:** The pool depth ratio is a ratio of the maximum pool depths divided by the mean riffle depth. Since this reach is inundated by beaver dams, we are determining that there are no planform features like riffles present; therefore, this ratio has a field value of 0.

**Percent Riffle:** The percent riffle is the portion of the representative sub-reach containing riffle bed form features. Since this reach is inundated by beaver dams, we are determining that there are no planform features like riffles present; therefore, the percent riffle field value is 0.

**Aggradation Ratio:** The aggradation ratio is the bankfull width at the widest riffle within the representative sub-reach divided by the mean bankfull riffle depth. This ratio is then divided by the reference width depth ratio. Again, since this reach is inundated by beaver dams, we are determining that there are no planform features like riffles present; therefore, the percent riffle field value is 2 (arbitrary value); which results in an index value of 0.

**Riparian Vegetation Function-Based Parameters:** The measurement methods of riparian vegetation outlined in the Minnesota SQT and Debit Calculator User Manual was not carried out, thus the default index value of 0.8 was used for all four measurements methods used to determine the riparian vegetation. For reference as to conditions, the MPCA Stream Habitat Assessment was carried out and included in the field notes.

**Physicochemical and Biology Functional Category:** These values were measured in the field.

## 2.2 Little 39, Channel Areas

The following information is the rationale behind the field values that are different that the values used in the Beaver Dam Area reach due to the difference of systems. These field values include Entrenchment ratio and bedform diversity function-based parameters.

**Bank Height Ratio:** Bank height ratio is the height of the low bank divided by the bankfull height. Barr staff used bankfull indicators to identify bankfull height in the field, and surveyed the representative riffle cross-section with a laser level. Because the drainage area has significantly decreased in size since the construction of the diversion bypass channel, the current bankfull elevation is significantly lower than the historic bankfull elevation, which was visible in the field. The current bankfull bench is roughly the same width as the estimated bankfull channel width. Per guidance from Will Harman during the November 5, 2019 USACE-sponsored SQT training, the bankfull bench must be at least 2.2 times larger than the bankfull width to be considered the "low bank" for purposes of Bank Height Ratio calculation. For Little 39, then, the low bank is the historic bankfull bench, so the Bank Height Ratio is 2, resulting in an incised channel. Figure 1 is a typical cross section of Little 39 with call-outs as to where the bankfull indicators were identified and where the historic bankfull height was located.

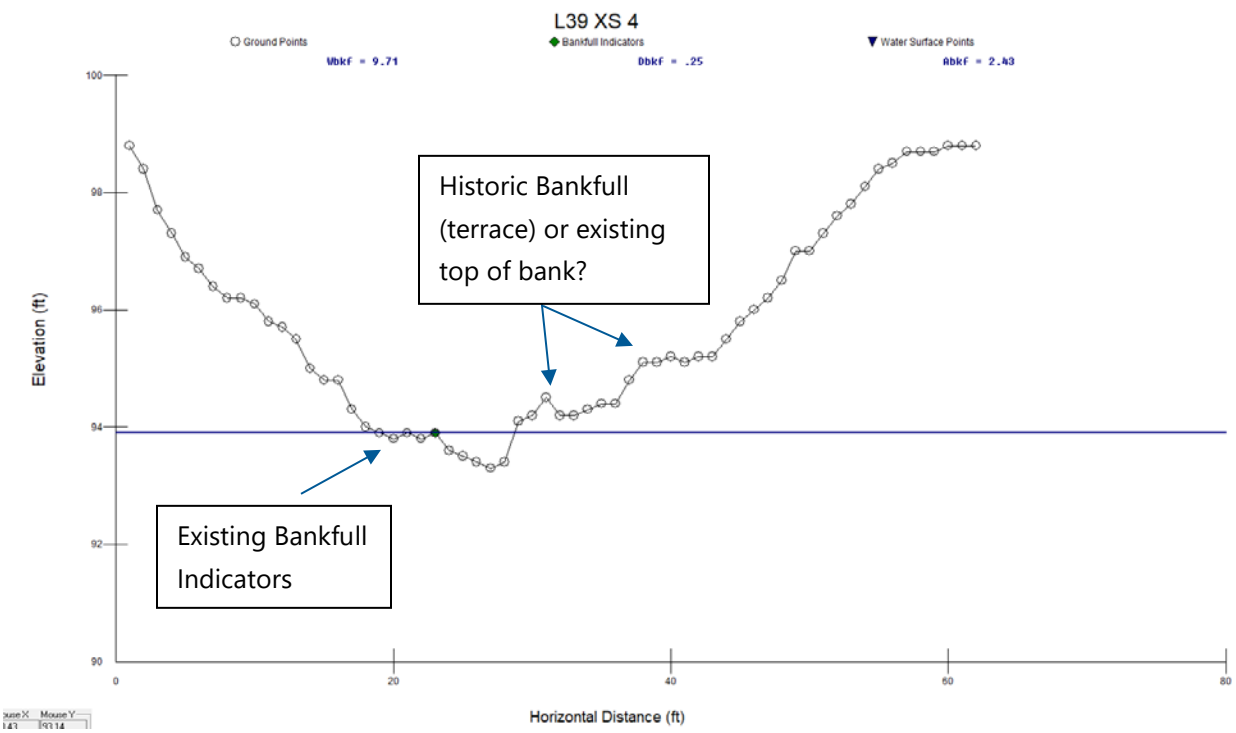


**Figure 2: Representative Cross Section of Little 39**

**Entrenchment Ratio:** The entrenchment ratio is the ratio of the floodprone width and the bankfull width. The entrenchment ratio used the existing bankfull height, determined by bankfull indicators measured in the field.

**Pool Spacing Ratio:** This reach does contain geomorphic features; thus we are able to measure the pool spacing ratio; however, we believe that there is a data gap with our longitudinal profile, therefore we have opted to use the default index value of 0.8 (functioning)

**Pool Depth Ratio:** There is a data gap for this information from the longitudinal profile and the pool depth ratio cannot be determined with existing data; therefore, we have opted to the default index value of 0.8 (functioning).

**Percent Riffle:** There is a data gap for this information from the longitudinal profile and the percent riffle cannot be determined with existing data; therefore, we have opted to the default index value of 0.8 (functioning).

**Aggradation Ratio:** The aggradation ratio is the bankfull width at the widest riffle within the representative sub-reach divided by the mean bankfull riffle depth at that riffle. This ratio is then divided by the reference width depth ratio (WDR). The bankfull width values at the riffles were collected from our cross sectional surveys and the selected reference WDR is 12, which is the minimum WDR of a B-channel.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Reach ID: | Big 39, Beaver Dam Areas | Use Class: | 2A | Fish IBI Class: | Northern Coldwater | Upstream Latitude: | |
| Existing Stream Type: | DA | River Nutrient Regions: | North | Valley Type: | Unconfined Alluvial | Upstream Longitude: | |
| Reference Stream Type: | Bc | Proposed Bed Material: | Cobble | Outstanding Resource Waters: | No | Downstream Latitude: | |
| Woody Veg Natural Component: | Yes | Macroinvertebrate IBI Class: | Northern Coldwater | Proposed BMPs: | No | Downstream Longitude: | |
| Stream/Wetland Complex? | Yes | Is Armoring present? | No | | | | |

| EXISTING CONDITION ASSESSMENT | | | | | Roll Up Scoring | | | |
|---|---|---|---|---|---|---|---|---|
| **Functional Category** | **Function-Based Parameters** | **Measurement Method** | **Field Value** | **Index Value** | **Parameter** | **Category** | **Category** | **ECS** |
| Hydrology | Reach Runoff | Land Use Coefficient | 53 | 0.86 | 0.93 | 0.93 | Functioning | 0.65 |
| | | BMP MIDS Rv Coefficient | | | | | | |
| | | Concentrated Flow Points / 1,000 feet | 0 | 1.00 | | | | |
| Hydraulics | Floodplain Connectivity | Bank Height Ratio | 1 | 1.00 | 1.00 | 1.00 | Functioning | |
| | | Entrenchment Ratio | | | | | | |
| Geomorphology | Large Woody Debris | Large Woody Debris Index | | | 0.80 | 0.65 | Functioning At Risk | |
| | | # Pieces | | 0.80 | | | | |
| | Lateral Migration | Dominant BEHI/NBS | L/L | | 1.00 | | | |
| | | Percent Streambank Erosion (%) | 0 | 1.00 | | | | |
| | | Percent Armoring (%) | 0 | 1.00 | | | | |
| | Bed Material Characterization | Size Class Pebble Count Analyzer (p-value) | | | | | | |
| | Bed Form Diversity | Pool Spacing Ratio | 12 | | 0.00 | | | |
| | | Pool Depth Ratio | 0 | | | | | |
| | | Percent Riffle (%) | 0 | | | | | |
| | | Aggradation Ratio | 2 | 0.00 | | | | |
| | Riparian Vegetation | Riparian Buffer Width (%) | | 0.80 | 0.80 | | | |
| | | Canopy Cover (%) | | 0.80 | | | | |
| | | Herbaceous Vegetation Cover (%) | | 0.80 | | | | |
| | | Woody Stem Basal Area (sqm/hectare) | | 0.80 | | | | |
| Physicochemical | Temperature | Summer Average ($^{o}$C) | 18.1 | 0.29 | 0.29 | 0.55 | Functioning At Risk | |
| | Dissolved Oxygen | DO (mg/L) | 6.5 | 0.36 | 0.36 | | | |
| | Total Suspended Solids | TSS (mg/L) | 1.7 | 1.00 | 1.00 | | | |
| Biology | Macroinvertebrates | Macroinvertebrate IBI | 30.6 | 0.27 | 0.27 | 0.14 | Not Functioning | |
| | Fish | Fish IBI | 19 | 0.00 | 0.00 | | | |

## Reach Information and Reference Selection

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Reach ID: | Little 39 Beaver Dam Areas | Use Class: | 2A | Fish IBI Class: | Northern Coldwater | Upstream Latitude: | |
| Existing Stream Type: | DA | River Nutrient Regions: | North | Valley Type: | Unconfined Alluvial | Upstream Longitude: | |
| Reference Stream Type: | Bc | Proposed Bed Material: | Cobble | Outstanding Resource Waters: | No | Downstream Latitude: | |
| Woody Veg Natural Component: | Yes | Macroinvertebrate IBI Class: | Northern Coldwater | Proposed BMPs: | No | Downstream Longitude: | |
| Stream/Wetland Complex? | Yes | Is Armoring present? | No | | | | |

| EXISTING CONDITION ASSESSMENT | | | | | Roll Up Scoring | | | |
|---|---|---|---|---|---|---|---|---|
| **Functional Category** | **Function-Based Parameters** | **Measurement Method** | **Field Value** | **Index Value** | **Parameter** | **Category** | **Category** | **ECS** |
| Hydrology | Reach Runoff | Land Use Coefficient | 52 | 0.87 | 0.94 | 0.94 | Functioning | 0.63 |
| | | BMP MIDS Rv Coefficient | | | | | | |
| | | Concentrated Flow Points / 1,000 feet | 0 | 1.00 | | | | |
| Hydraulics | Floodplain Connectivity | Bank Height Ratio | 1 | 1.00 | 1.00 | 1.00 | Functioning | |
| | | Entrenchment Ratio | | | | | | |
| Geomorphology | Large Woody Debris | Large Woody Debris Index | | | 0.80 | 0.65 | Functioning At Risk | |
| | | # Pieces | | 0.80 | | | | |
| | Lateral Migration | Dominant BEHI/NBS | L/L | | 1.00 | | | |
| | | Percent Streambank Erosion (%) | 0 | 1.00 | | | | |
| | | Percent Armoring (%) | 0 | 1.00 | | | | |
| | Bed Material Characterization | Size Class Pebble Count Analyzer (p-value) | | | | | | |
| | Bed Form Diversity | Pool Spacing Ratio | 12 | | 0.00 | | | |
| | | Pool Depth Ratio | 0 | | | | | |
| | | Percent Riffle (%) | 0 | | | | | |
| | | Aggradation Ratio | 2 | 0.00 | | | | |
| | Riparian Vegetation | Riparian Buffer Width (%) | | 0.80 | 0.80 | | | |
| | | Canopy Cover (%) | | 0.80 | | | | |
| | | Herbaceous Vegetation Cover (%) | | 0.80 | | | | |
| | | Woody Stem Basal Area (sqm/hectare) | | 0.80 | | | | |
| Physicochemical | Temperature | Summer Average (°C) | 14.49 | 0.53 | 0.53 | 0.51 | Functioning At Risk | |
| | Dissolved Oxygen | DO (mg/L) | 4.32 | 0.00 | 0.00 | | | |
| | Total Suspended Solids | TSS (mg/L) | 1.1 | 1.00 | 1.00 | | | |
| Biology | Macroinvertebrates | Macroinvertebrate IBI | 25 | 0.13 | 0.13 | 0.07 | Not Functioning | |
| | Fish | Fish IBI | 16 | 0.00 | 0.00 | | | |

## Reach Information and Reference Selection

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Reach ID: | Big 39, channel areas | Use Class: | 2A | Fish IBI Class: | Northern Coldwater | Upstream Latitude: | |
| Existing Stream Type: | B | River Nutrient Regions: | North | Valley Type: | Unconfined Alluvial | Upstream Longitude: | |
| Reference Stream Type: | B | Proposed Bed Material: | Cobble | Outstanding Resource Waters: | No | Downstream Latitude: | |
| Woody Veg Natural Component: | Yes | Macroinvertebrate IBI Class: | Northern Coldwater | Proposed BMPs: | No | Downstream Longitude: | |
| Stream/Wetland Complex? | No | Is Armoring present? | No | | | | |

| EXISTING CONDITION ASSESSMENT | | | | | Roll Up Scoring | | | |
|---|---|---|---|---|---|---|---|---|
| **Functional Category** | **Function-Based Parameters** | **Measurement Method** | **Field Value** | **Index Value** | **Parameter** | **Category** | **Category** | **ECS** |
| Hydrology | Reach Runoff | Land Use Coefficient | 53 | 0.86 | 0.93 | 0.93 | Functioning | 0.56 |
| | | BMP MIDS Rv Coefficient | | | | | | |
| | | Concentrated Flow Points / 1,000 feet | 0 | 1.00 | | | | |
| Hydraulics | Floodplain Connectivity | Bank Height Ratio | 2 | 0.00 | 0.36 | 0.36 | Functioning At Risk | |
| | | Entrenchment Ratio | 1.44 | 0.72 | | | | |
| Geomorphology | Large Woody Debris | Large Woody Debris Index | | | 0.80 | 0.80 | Functioning | |
| | | # Pieces | | 0.80 | | | | |
| | Lateral Migration | Dominant BEHI/NBS | L/M | 1.00 | 1.00 | | | |
| | | Percent Streambank Erosion (%) | 0 | 1.00 | | | | |
| | | Percent Armoring (%) | | | | | | |
| | Bed Material Characterization | Size Class Pebble Count Analyzer (p-value) | | | | | | |
| | Bed Form Diversity | Pool Spacing Ratio | | 0.80 | 0.60 | | | |
| | | Pool Depth Ratio | | 0.80 | | | | |
| | | Percent Riffle (%) | | 0.80 | | | | |
| | | Aggradation Ratio | 3.2 | 0.00 | | | | |
| | Riparian Vegetation | Riparian Buffer Width (%) | | 0.80 | 0.80 | | | |
| | | Canopy Cover (%) | | 0.80 | | | | |
| | | Herbaceous Vegetation Cover (%) | | 0.80 | | | | |
| | | Woody Stem Basal Area (sqm/hectare) | | 0.80 | | | | |
| Physicochemical | Temperature | Summer Average (°C) | 18.1 | 0.29 | 0.29 | 0.55 | Functioning At Risk | |
| | Dissolved Oxygen | DO (mg/L) | 6.5 | 0.36 | 0.36 | | | |
| | Total Suspended Solids | TSS (mg/L) | 1.7 | 1.00 | 1.00 | | | |
| Biology | Macroinvertebrates | Macroinvertebrate IBI | 30.6 | 0.27 | 0.27 | 0.14 | Not Functioning | |
| | Fish | Fish IBI | 19 | 0.00 | 0.00 | | | |

## Reach Information and Reference Selection

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Reach ID: | Little 39 Channel Areas | Use Class: | 2A | Fish IBI Class: | Northern Coldwater | Upstream Latitude: | |
| Existing Stream Type: | B | River Nutrient Regions: | North | Valley Type: | Unconfined Alluvial | Upstream Longitude: | |
| Reference Stream Type: | B | Proposed Bed Material: | Cobble | Outstanding Resource Waters: | No | Downstream Latitude: | |
| Woody Veg Natural Component: | Yes | Macroinvertebrate IBI Class: | Northern Coldwater | Proposed BMPs: | No | Downstream Longitude: | |
| Stream/Wetland Complex? | No | Is Armoring present? | No | | | | |

| EXISTING CONDITION ASSESSMENT | | | | | Roll Up Scoring | | | |
|---|---|---|---|---|---|---|---|---|
| **Functional Category** | **Function-Based Parameters** | **Measurement Method** | **Field Value** | **Index Value** | **Parameter** | **Category** | **Category** | **ECS** |
| Hydrology | Reach Runoff | Land Use Coefficient | 52 | 0.87 | 0.94 | 0.94 | Functioning | 0.55 |
| | | BMP MIDS Rv Coefficient | | | | | | |
| | | Concentrated Flow Points / 1,000 feet | 0 | 1.00 | | | | |
| Hydraulics | Floodplain Connectivity | Bank Height Ratio | 2 | 0.00 | 0.46 | 0.46 | Functioning At Risk | |
| | | Entrenchment Ratio | 1.98 | 0.92 | | | | |
| Geomorphology | Large Woody Debris | Large Woody Debris Index | | | 0.80 | 0.78 | Functioning | |
| | | # Pieces | | 0.80 | | | | |
| | Lateral Migration | Dominant BEHI/NBS | L/M | 1.00 | 1.00 | | | |
| | | Percent Streambank Erosion (%) | 0 | 1.00 | | | | |
| | | Percent Armoring (%) | | | | | | |
| | Bed Material Characterization | Size Class Pebble Count Analyzer (p-value) | | | | | | |
| | Bed Form Diversity | Pool Spacing Ratio | 4.32 | 0.92 | 0.54 | | | |
| | | Pool Depth Ratio | 1.5 | 0.30 | | | | |
| | | Percent Riffle (%) | 48 | 0.93 | | | | |
| | | Aggradation Ratio | 8.6 | 0.00 | | | | |
| | Riparian Vegetation | Riparian Buffer Width (%) | | 0.80 | 0.80 | | | |
| | | Canopy Cover (%) | | 0.80 | | | | |
| | | Herbaceous Vegetation Cover (%) | | 0.80 | | | | |
| | | Woody Stem Basal Area (sqm/hectare) | | 0.80 | | | | |
| Physicochemical | Temperature | Summer Average (°C) | 14.49 | 0.53 | 0.53 | 0.51 | Functioning At Risk | |
| | Dissolved Oxygen | DO (mg/L) | 4.32 | 0.00 | 0.00 | | | |
| | Total Suspended Solids | TSS (mg/L) | 1.1 | 1.00 | 1.00 | | | |
| Biology | Macroinvertebrates | Macroinvertebrate IBI | 25 | 0.13 | 0.13 | 0.07 | Not Functioning | |
| | Fish | Fish IBI | 16 | 0.00 | 0.00 | | | |

# *Appendix F*

# *Lake Superior South WRAPS Report*

# Lake Superior South Watershed Restoration and Protection Strategy Report

MINNESOTA POLLUTION CONTROL AGENCY

wq-ws4-41a

**December 2018**

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In addition, this WRAPS builds on the collaboration and stakeholder input processes that supported the One Watershed, One Plan that was completed in 2016. This effort was led by Dan Shutte from the Lake County Soil and Water Conservation District and Ilena Berg from the Cook County Soil and Water Conservation District.

# Table of Contents

Table of Contents ..... i

Tables ..... ii

Figures ..... iii

Key Terms ..... v

Executive Summary ..... vii

What is the WRAPS Report? ..... viii

1. Watershed Background and Description ..... 1

2. Watershed Conditions ..... 4

2.1 Condition Status ..... 4

Streams ..... 6

Lakes ..... 16

Beaches ..... 16

2.2 Water Quality Trends ..... 19

Streams ..... 19

Lakes ..... 21

Beaches ..... 22

2.3 Stressors and Sources ..... 23

Stressors of Biologically-Impaired Stream Reaches ..... 24

Pollutant Sources ..... 30

2.4 Protection Considerations ..... 37

3. Prioritizing and Implementing Restoration and Protection ..... 40

3.1 Targeted Geographic Areas ..... 40

3.2 Civic Engagement ..... 43

WRAPS Development ..... 43

One Watershed, One Plan for the Lake Superior North Watershed ..... 43

Public Notice for Comments ..... 44

3.3 Restoration & Protection Strategies ..... 44

4. Monitoring Plan ..... 69

Existing Monitoring ..... 69

Monitoring Needs ..... 69

5. References and Further Information ..... 71

Appendix A – TMDL Summaries ..... 72

## Tables

Table 1. Impairments in the LSS Watershed ..... 7

Table 2. Lake condition in the LSS Watershed ..... 16

Table 3. E. coli impaired beaches ..... 17

Table 4. Water quality trend analysis for the Beaver River (S000-252) and Knife River (S003-64) ..... 19

Table 5. Lake water quality trends ..... 22

Table 6. Completed TMDLs in the LSS Watershed ..... 24

Table 7. Summary of probable stressors to the biota impaired streams (MPCA 2017) ..... 25

Table 8. Permitted point sources in the LSS Watershed ..... 32

Table 9. 10-Year targeted geographic areas for restoration and protection ..... 41

Table 10. Watershed wide strategies and actions proposed for the LSS Watershed ..... 47

Table 11. Nearshore Lake Superior protection strategies ..... 53

Table 12. HUC10 specific strategies and actions proposed for the LSS Watershed ..... 55

Table 13. TSS TMDL Summary, Beaver River (04010102-501) ..... 73

Table 14. TSS TMDL Summary, Big Sucker Creek (Sucker River; 04010102-555) ..... 74

Table 15. TSS TMDL Summary, French River (04010102-698) ..... 76

Table 16. TSS TMDL Summary, Talmadge River (Talmadge Creek; 04010102-508) ..... 78

Table 17. Knife River TMDL summary table (excerpted from SSLSCWD 2010) ..... 79

Table 18 . TSS TMDL Summary, Little Knife River (East Branch Little Knife River; 04010102-840) ..... 81

Table 19. TSS TMDL Summary, Skunk Creek (04010102-528) ..... 82

Table 20. E. coli TMDL summary, Skunk Creek (04010102-528) ..... 83

## Figures

Figure 1. WRAPS 10-year cycle. ..... viii

Figure 2. Land use in the LSS Watershed. ..... 2

Figure 3. Land ownership in the LSS Watershed (GAP 2008). ..... 3

Figure 4. Impaired waters in the LSS Watershed. ..... 5

Figure 5. Stream E. coli exceedances in the LSS Watershed. ..... 12

Figure 6. Average stream TP concentrations in the LSS Watershed. Average TP concentrations greater than 0.05 mg/L may be considered high. ..... 13

Figure 7. Average stream TSS concentrations in the LSS Watershed. Average TSS concentrations greater than 15 mg/L may be considered high. ..... 14

Figure 8. Average stream TN concentrations in the LSS Watershed. ..... 15

Figure 9. Beach E. coli exceedances in the LSS Watershed. ..... 18

Figure 10. Total suspended solids concentrations (Apr–Sep) by year on the Beaver River south of CSAH-3, 1.5 NW of Beaver Bay (S000-252). ..... 20

Figure 11. Chloride concentration (Jan–Dec) by year on the Beaver River south of CSAH-3, 1.5 NW of Beaver Bay (S000-252). ..... 20

Figure 12. Total suspended solids concentrations (Apr–Sep) by year on the Knife River upstream of Old US-61 (S000-257) and downstream of US-61 (S003-642). ..... 21

Figure 13. E. coli concentrations at impaired beaches. ..... 23

Figure 14. Continuous pH monitoring results for several Beaver River stations. ..... 26

Figure 15. Percent of temperature readings in brook trout growth range for Beaver River watershed monitoring locations; June 1–August 31, 2013. ..... 27

Figure 16. Dissolved oxygen concentrations, West Branch Beaver River 8/19/15–9/17/15. ..... 28

Figure 17. Percent of temperature readings in brook trout growth range for West Branch Beaver River watershed monitoring locations; June 1–August 31, 2013. ..... 28

Figure 18. Dissolved oxygen concentrations, Talmadge River, 8/5/2015–8/23/2015. ..... 29

Figure 19. Dissolved oxygen data, Little Knife River (East Branch Little Knife River; AUID 04010102-840). ..... 30

Figure 20. Sources of sediment from HSPF modeling (Tetra Tech 2016). ..... 31

Figure 21. TN yield by HUC12 from HSPF model in LSS. ..... 33

Figure 22. TP yield by HUC12 from HSPF model in LSS. ..... 34

Figure 23. TSS yield by HUC12 from HSPF modeling in LSS. ..... 35

Figure 24. Stream crossings in the LSS Watershed. ..... 36

Figure 25. F-IBI categories in the LSS Watershed. ..... 38

Figure 26. M-IBI categories in the LSS Watershed. ..... 39

Figure 27. Targeted geographic areas. ..... 42

Figure 28. ResourceFULL process. ..... 43

Figure 29. TSS load duration curve, Beaver River (04010102-501). ..... 72

Figure 30. TSS load duration curve, Big Sucker Creek (Sucker River; 04010102-555). ..... 74

Figure 31. TSS load duration curve, French River (04010102-698). ..... 75

Figure 32. TSS load duration curve, Talmadge River (Talmadge Creek; 04010102-508). ..... 78

Figure 33. TSS load duration curve, Little Knife River (East Branch Little Knife River; 04010102-840). ..... 80

Figure 34. TSS load duration curve, Skunk Creek (04010102-528). ..... 82

Figure 35. E. coli load duration curve, Skunk Creek (04010102-528). ..... 83

## Key Terms

**Assessment Unit Identifier (AUID):** The unique water body identifier for each river reach comprised of the USGS eight-digit Hydrologic Unit Code (HUC) plus a three-character code unique within each HUC.

**Aquatic life impairment:** The presence and vitality of aquatic life is indicative of the overall water quality of a stream. A stream is considered impaired for impacts to aquatic life if the fish Index of Biotic Integrity (IBI), macroinvertebrate IBI, dissolved oxygen, turbidity, or certain chemical standards are not met.

**Aquatic recreation impairment:** Streams are considered impaired for impacts to aquatic recreation if fecal bacteria standards are not met. Lakes are considered impaired for impacts to aquatic recreation if total phosphorus, chlorophyll-a, or Secchi disc depth standards are not met.

**BANCS (Bank Assessment for Non-point source Consequences of Sediment):** A model developed by Dave Rosgen in 1996 and adopted by the EPA in 2006 as part of the Watershed Assessment of River Stability and Sediment Supply, or WARSSS framework. The BANCS model combines Bank Erosion Hazard Index (BEHI) and Near Bank Stress (NBS) measurements to estimate an erosion rate. Measurements are completed at an individual bank scale and extrapolated to a reach scale. At each assessment bank, characteristics such as plant root depth and density, bank height and bank angle were used to calculate a BEHI score and the location of dominant channel flow relative to the bank or depositional properties and other channel characteristics were used to calculate a NBS score. BEHI and NBS relationship curves developed for the BANCS model were then used to calculate a bank erosion rate.

**Hydrologic Unit Code (HUC):** A HUC is assigned by the USGS for each watershed. HUCs are organized in a nested hierarchy by size. For example, the Lake Superior Basin is assigned a HUC4 of 0702 and the Lake Superior South Watershed is assigned a HUC8 of 07020002.

**Impairment:** Water bodies are listed as impaired if water quality standards are not met for designated uses including: aquatic life, aquatic recreation, and aquatic consumption.

**Index of Biotic integrity (IBI):** A method for describing water quality using characteristics of aquatic communities, such as the types of fish and invertebrates found in the waterbody. It is expressed as a numerical value between 0 (lowest quality) to 100 (highest quality).

**Protection:** This term is used to characterize actions taken in watersheds of waters not known to be impaired to maintain conditions and beneficial uses of the waterbodies.

**Restoration:** This term is used to characterize actions taken in watersheds of impaired waters to improve conditions, eventually to meet water quality standards and achieve beneficial uses of the waterbodies.

**Source (or Pollutant Source):** This term is distinguished from 'stressor' to mean only those actions, places or entities that deliver/discharge pollutants (e.g., sediment, phosphorus, nitrogen, pathogens).

**Stressor (or Biological Stressor):** This is a broad term that includes both pollutant sources and non-pollutant sources or factors (e.g., altered hydrology, dams preventing fish passage) that adversely impact aquatic life.

**Total Maximum Daily Load (TMDL):** A calculation of the maximum amount of a pollutant that may be introduced into a surface water and still ensure that applicable water quality standards for that water are met. A TMDL is the sum of the wasteload allocation for point sources, a load allocation for nonpoint sources and natural background, an allocation for future growth (i.e., reserve capacity), and a margin of safety as defined in the Code of Federal Regulations.

## Executive Summary

The State of Minnesota has adopted a watershed approach to address the state's 80 major watersheds (denoted by 8-digit hydrologic unit code or HUC). This watershed approach incorporates water quality assessment, watershed analysis, public participation, planning, implementation, and measurement of results into a 10-year cycle that addresses both restoration and protection as part of a Watershed Restoration and Protection Strategy (WRAPS) report. This WRAPS report addresses a portion of the waterbodies within the Lake Superior South (LSS) Watershed (HUC 04010102) that is located north and east of the Duluth Urban Area. The watershed constitutes 551 square miles and lies within the Northern Lakes and Forest ecoregion. Lake Superior shoreline comprises the entirety of the eastern border of the LSS Watershed. The dominant land cover is forest and wetland, and the majority of the watershed is undeveloped.

Thirty-six assessment units in the LSS Watershed were assessed by the Minnesota Pollution Control Agency (MPCA) to identify impaired waters and waters in need of protection. Seven stream reaches were identified as impaired for aquatic life and one stream reach was identified as impaired for both aquatic life and aquatic recreation. Two Lake Superior beaches are also impaired for aquatic recreation. All impaired streams and beaches require restoration activities. In addition, all lakes and streams in the watershed require protection, including those listed as impaired. Stream vulnerability based on biological integrity and lake water quality risk were considered in protection efforts. For the purposes of this WRAPS report, stream reaches and lakes vulnerable to degradation were prioritized, in addition to those with high value and high quality.

Restoration and protection strategies for implementation in the LSS Watershed aim to improve water quality in impaired streams and preserve and enhance water quality in non-impaired waters. Activities include: addressing sources of untreated wastewater (e.g., failing septic systems, leaky infrastructure), protecting and stabilizing lakeshores, improving fisheries management, stream connectivity improvements, improvements to biological integrity, invasive species control, land use planning and ordinance development, managing stormwater runoff, forest management, addressing aggregate mining issues, groundwater management, wetland management, and education and outreach activities. Targeted geographic areas for implementation were identified based on a detailed prioritization and ranking process conducted as part of the One Watershed, One Plan (1W1P) process in Lake and Cook counties and include: Beaver River, Knife River, the City of Two Harbors, Gooseberry River Watershed, Stewart River, and nearshore Lake Superior. These geographic areas are prioritized for the first 10 years of implementation.

A core team of local, state, and federal resource management agency staff supported the WRAPS process and provided valuable input. The WRAPS study summarizes and is supported by previous work including the *Lake Superior North 1W1P* (Cook and Lake counties' Soil and Water Conservation Districts 2016), *Lake Superior - South Monitoring and Assessment Report* (MPCA 2014), the *Lake Superior - South Stressor Identification Report* (MPCA 2017), *Lake Superior North and Lake Superior South Basins–Watershed Model Development Report* (Tetra Tech 2016), *Lake Superior South Total Maximum Daily Load Study* (Tetra Tech 2018), and the *Knife River Total Maximum Daily Load Study and Implementation Plan* (SSLSWCD 2010, 2011).

## What is the WRAPS Report?

Minnesota has adopted a watershed approach to address the state's 80 major watersheds. The Minnesota Watershed Approach incorporates **water quality assessment, watershed analysis, civic engagement, planning, implementation**, and **measurement of results** into a 10-year cycle that addresses both restoration and protection (Figure 1).

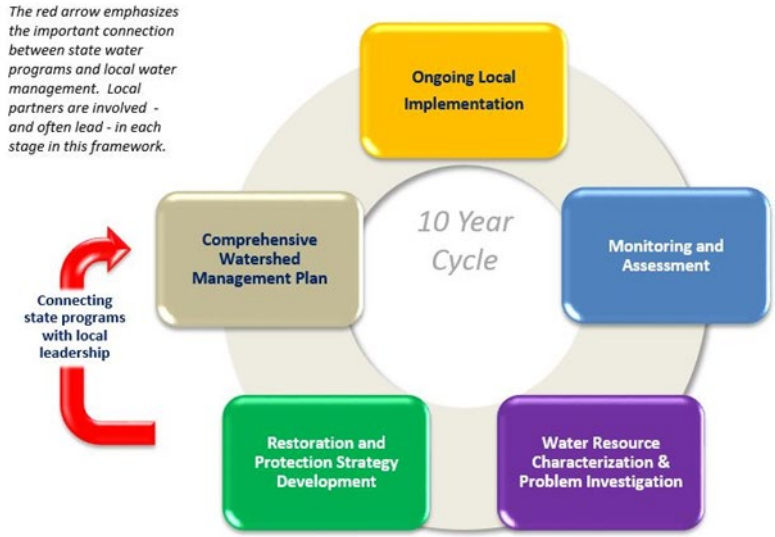


Figure 1. WRAPS 10-year cycle.

As part of the watershed approach, the MPCA developed a process to identify and address threats to water quality in each of these major watersheds. This process is called WRAPS development. WRAPS reports have two parts: impaired waters have strategies for restoration, and waters that are not impaired have strategies for protection.

Waters not meeting state standards are listed as impaired and Total Maximum Daily Load (TMDL) studies are developed, as they have been in the past. TMDLS are incorporated into WRAPS. In addition, the watershed approach process facilitates a more cost-effective and comprehensive characterization of multiple water bodies and overall watershed health, including both protection and restoration efforts. A key aspect of this effort is to develop and utilize watershed-scale data and other tools to identify strategies and actions for point and nonpoint source pollution that will cumulatively achieve water quality goals. For nonpoint source pollution, this report informs local planning efforts, but ultimately the local partners decide what work will be included in their local plans. This report also serves as a watershed plan to at least partially address the Environmental Protection Agency's (EPA's) Nine Minimum Elements of watershed planning, helping to qualify applicants for possible Clean Water Act Section 319 implementation funds.

The watershed approach for the LSS Watershed is unique, as Lake and Cook counties and soil and water conservation districts (SWCDs) have recently completed a watershed-based local water plan through the 1W1P process. As part of the 1W1P planning process, partner and public engagement and input was conducted. This WRAPS document summarizes and incorporates the valuable information from the 1W1P and maintains the same targeted areas for implementation over the next 10 years. This WRAPS document additionally:

- Provides updated pollutant source modeling results
- Identifies at-risk waters and unique and high value water resources for protection
- Identifies best management practices for sediment control along impaired stream reaches

- Provides a smaller scale analysis of priorities, trends, and pollution sources as it covers the smaller MPCA-defined LSS Watershed
- Summarizes and compiles relevant watershed plans within the LSS Watershed in one document
- Makes any necessary adaptations to implementation activities identified in the 1W1P due to the above additions

| | |
|---|---|
| Purpose | • Support local working groups and jointly develop scientifically-supported restoration and protection strategies to be used for future implementation planning<br>• Summarize Watershed Approach work done to date including the following:<br>  • *Lake Superior North One Watershed, One Plan*<br>  • *Lake Superior – South Watershed Monitoring and Assessment Report*<br>  • *Lake Superior South Watershed Biotic Stressor Identification*<br>  • *Lake Superior North and Lake Superior South Basins—Watershed Model Development Report*<br>  • *Lake Superior South Watershed Total Maximum Daily Load Study*<br>  • *Knife River TMDL and Implementation Plan* |
| Scope | • Impacts to aquatic recreation and aquatic life in streams<br>• Impacts to aquatic recreation in lakes and at beaches<br>• Protection of uses in high quality water resources |
| Audience | • Non-profits (watershed groups, Trout Unlimited, etc.)<br>• Local governments and soil and water conservation districts<br>• State agencies (MPCA, DNR, BWSR, etc.)<br>• Federal agencies (USDA, USGS, EPA, etc.)<br>•Citizens and land-owners in the watershed |

# 1. Watershed Background and Description

The LSS Watershed is located in northeastern Minnesota in the Lake Superior Basin, and is in the Northern Lakes and Forests ecoregion. The watershed is 624 square miles and covers portions of St. Louis and Lake Counties. In this report, "LSS Watershed" refers to the portion of the watershed north of the urbanized Duluth area (i.e., northeast of the Lester River) and constitutes 551 square miles. The urban streams within the Duluth area are being addressed as part of a separate effort (Duluth Urban Area WRAPS, concurrently under development). All of the watershed's streams and rivers drain to Lake Superior, but there is no single "pour point" for the entire watershed (Figure 2).

The LSS Watershed contains many exceptional water resources; however, there are streams and beaches that do not met water quality standards for aquatic life and recreational uses. The watershed is 45% privately owned, leaving the majority of the land undeveloped and publicly owned (Figure 3). The dominant land cover in the LSS Watershed is forest and wetland, followed by shrub/scrub. Pasture, open water, and developed and barren land each make up less than 5% of the watershed as a whole. Urban land uses are a mix of commercial, industrial, resort and rural residential, with an active mining operation in Silver Bay. The majority of the watershed is undeveloped, with the exception of Two Harbors (population 3,745) and the town of Beaver Bay (population 181) as concentrated population centers.

Lake Superior shoreline comprises the entirety of the eastern boarder of the LSS Watershed. As such, the Great Lake has cultural, social, and economic value for its communities. For example, Lake Superior is an integral aspect of the many Native American traditions that revolve around sustenance, stories and legends. Additionally, Lake Superior's ocean-like qualities support a strong regional tourism industry and provide shipping access to international markets, contributing to local economic prosperity.

### *Additional Lake Superior South Watershed Resources*

USDA Natural Resources Conservation Service (NRCS) Rapid Watershed Assessment for the Lake Superior South Watershed:
https://www.nrcs.usda.gov/wps/portal/nrcs/detail/mn/technical/dma/rwa/?cid=nrcs142p2_023578

Minnesota Department of Natural Resources (DNR) Watershed Assessment Mapbook for the Lake Superior South Watershed:
http://files.dnr.state.mn.us/natural_resources/water/watersheds/tool/watersheds/wsmb2.pdf

One Watershed, One Plan for the Lake Superior North Watershed:
http://www.co.lake.mn.us/document_center/SWCD_Doc_Center/Final%20Lake%20Superior%20North%20Watershed%20Comp%20Plan.pdf

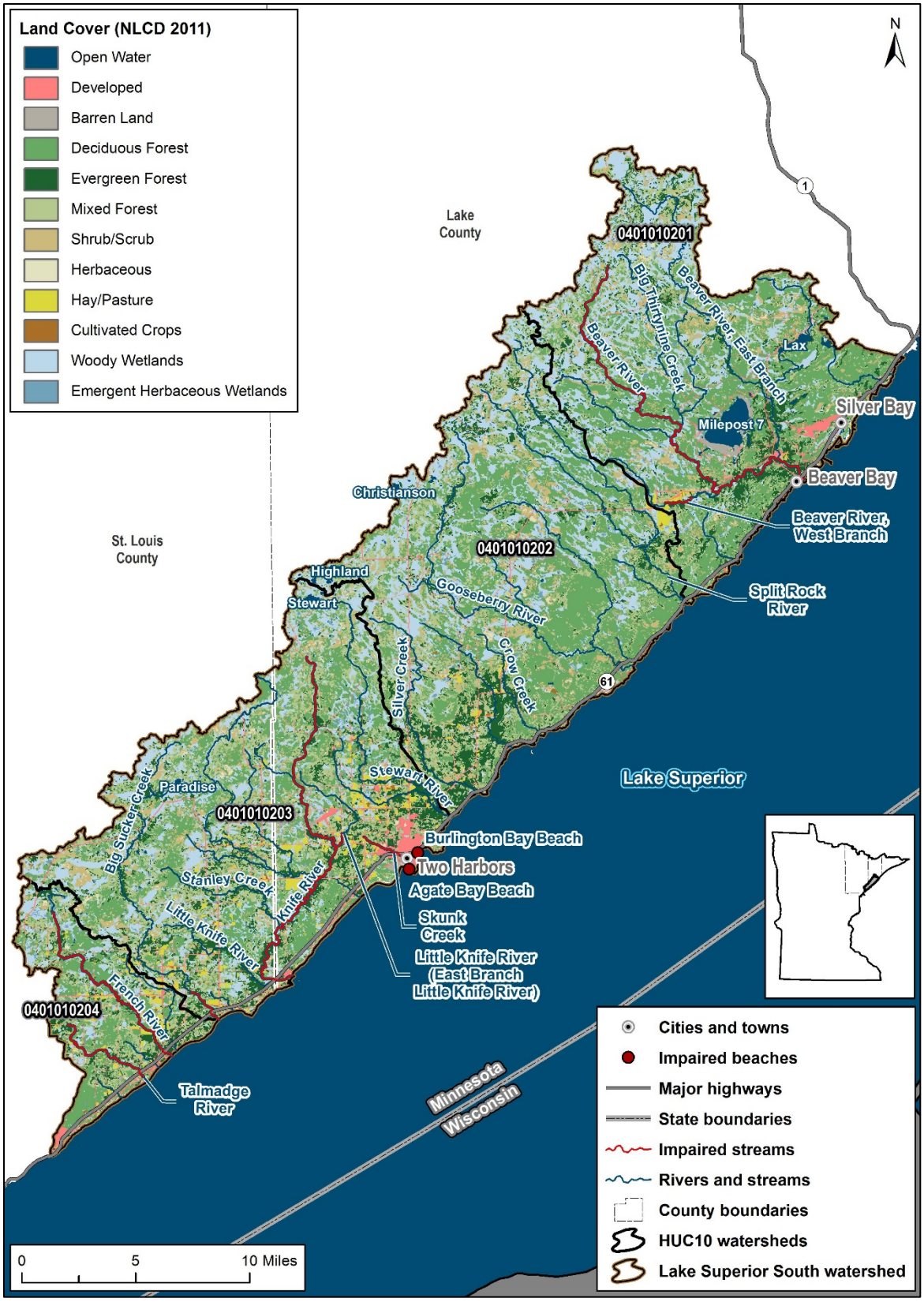


Figure 2. Land use in the LSS Watershed.

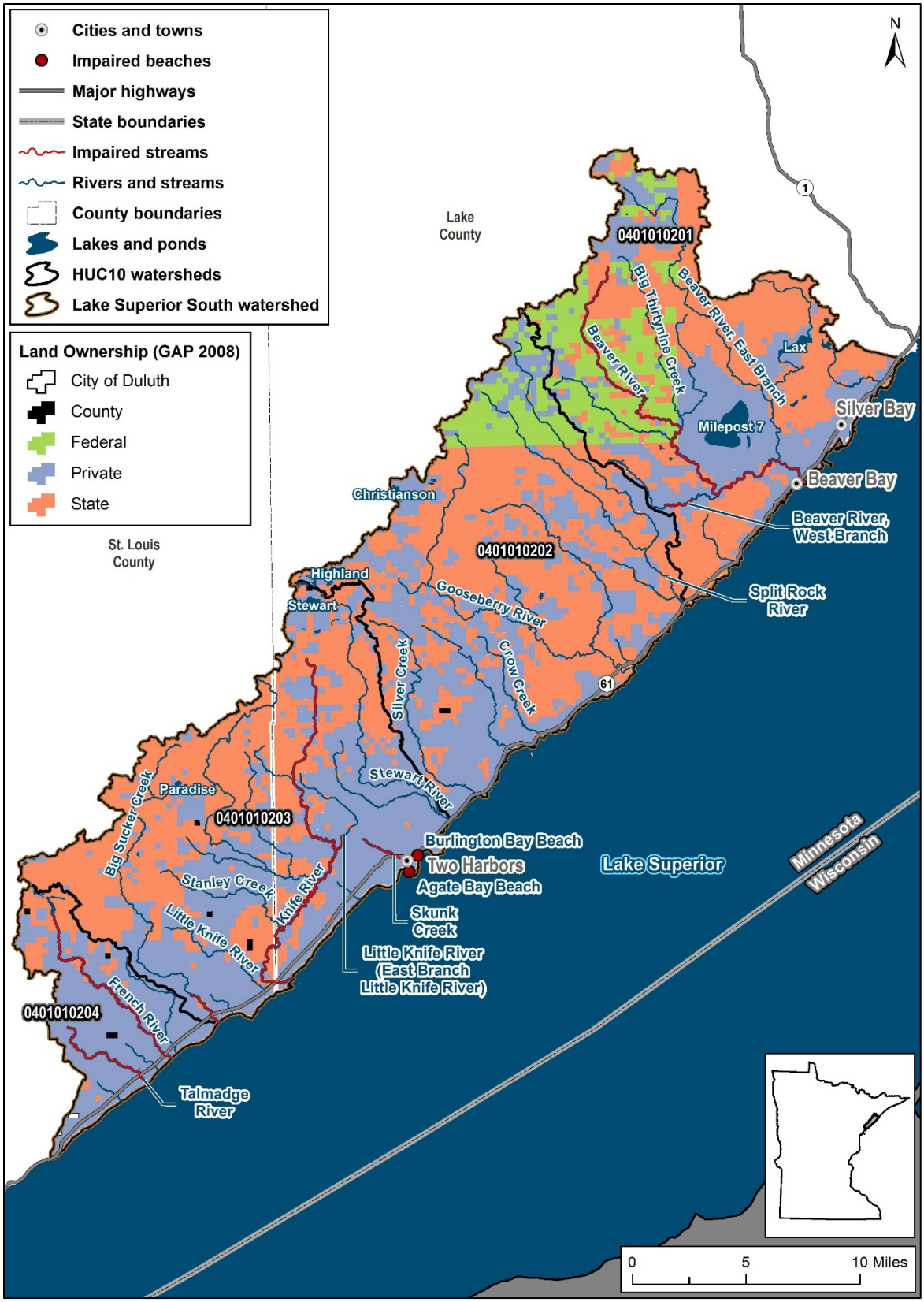


Figure 3. Land ownership in the LSS Watershed (GAP 2008).

# 2. Watershed Conditions

The LSS Watershed is defined by a series of small streams that transition from slower moving, meandering gravel-bed streams through wetland complexes upstream of the bluff line, to high gradient, fast moving bedrock-controlled streams near their outlets to Lake Superior. The watershed consists of several small- to medium-sized catchments, each of which drains to the western shore of Lake Superior. Fine-grained clay soils dominate the watershed. Many small wetlands are present in the watershed, with 16 lakes identified as greater than 10 acres in surface area. However, the watershed is stream-dominated with limited natural water storage and recharge. The watershed is mostly undeveloped above the escarpment and has historically been used for extractive industries such as logging, mining, and the fur trade business. Developed areas are found primarily in Two Harbors (population 3,745) and Beaver Bay (population 181), as well as along the Highway 61 lakefront.

## 2.1 Condition Status

The MPCA assesses water quality based on each water body's ability to support aquatic life (e.g., fish and macroinvertebrates) and aquatic recreation (e.g., fishing and swimming). Data from the water bodies are compared to state water quality standards. Water bodies that meet the standards are considered to be unimpaired and are the focus of protection efforts; water bodies that do not meet at least one target are considered to be impaired and are the focus of restoration efforts. Waters that are not yet assessed continue through a process of data collection and evaluation and can be candidates for protection work. In the LSS, there are eight impaired streams and two impaired beaches (Figure 4).

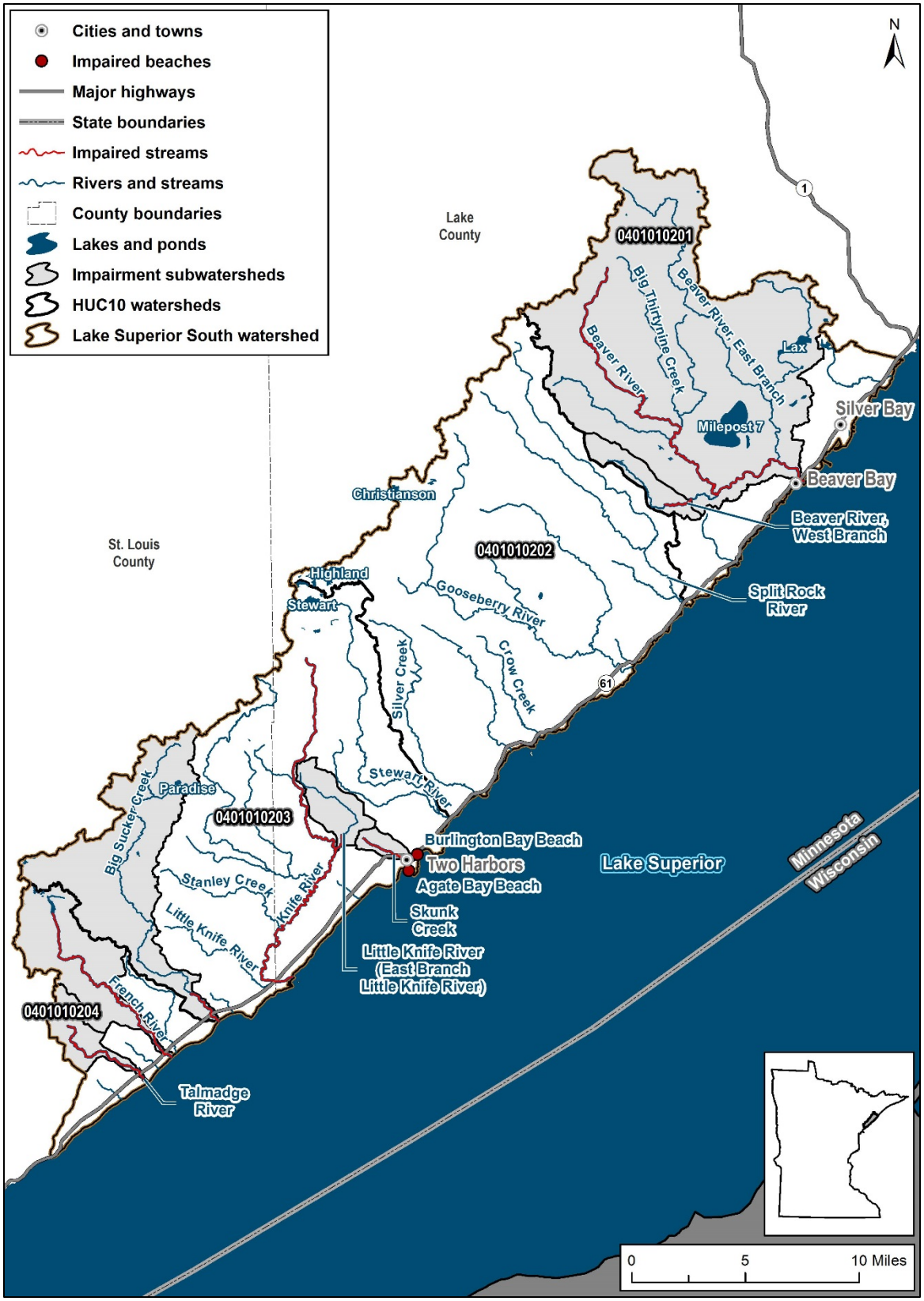


Figure 4. Impaired waters in the LSS Watershed.

## Streams

Thirty-six assessment units in the LSS Watershed were assessed by the MPCA to identify impaired waters and waters in need of protection. Waters that do not meet targets for fish assemblage, macroinvertebrate assemblage, dissolved oxygen (DO), turbidity, chloride, pH, or ammonia are considered to not meet the aquatic life beneficial use. Waters that do not meet the targets for fecal indicator bacteria do not meet the aquatic recreation beneficial use; levels of the bacteria *Escherichia coli* (*E. coli*) are used to approximate the amount of fecal contamination in surface waters.

Overall, the LSS Watershed contains a number of high quality streams. Of the 36 stream reaches assessed, seven are impaired for aquatic life and one for both aquatic life and aquatic recreation (Table 1 and Figure 4). The remaining reaches meet water quality standards or were not assessed for aquatic life and aquatic recreation. *E. coil* exceedances, and average total phosphorus (TP), total suspended solids (TSS) and total nitrogen (TN) concentrations are provided in Figure 5 through Figure 8.

The number of *E. coli* exceedances at each sample site is provided in Figure 5; exceedances are presented for the individual sample water quality standard (1,260 org/100 mL). Figure 6, Figure 7 and Figure 8 summarize the average water quality data for TP, TSS, and TN. Applicable TSS water quality standards are 10 mg/L for all assessed streams, except for Skunk Creek and West Branch Knifer River; the TSS standard is 15 mg/L for these two streams. The in-stream TP standard is 0.05 mg/L. There is currently no water quality standard for nitrogen as pertains to aquatic life; however, 10 mg/L nitrate-nitrogen is used to assess for drinking water uses.

**Table 1. Impairments in the LSS Watershed.**

| HUC10 Subwatershed | Assessment Unit (Last 3 digits) | Stream | Reach Description | Aquatic Life | | | | | | | | Aquatic Recreation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Fish Index of Biotic Integrity | Macroinvertebrate Index of Biotic Integrity | Dissolved Oxygen | Turbidity/TSS | Chloride | pH | $NH_3$ | Pesticides | Bacteria |
| Beaver River – Frontal Lake Superior (0401010201) | 501 | Beaver River | Headwaters to Lake Superior | Imp | Sup | Sup | Imp | Sup | Imp | Sup | NA | Sup |
| | 529 | Palisade Creek | Unnamed Creek to Lake Superior | Sup | Sup | NA | NA | NA | NA | NA | NA | NA |
| | 530 | Beaver River, East Branch | Unnamed Creek to Unnamed Creek | Sup | Sup | NA | NA | NA | NA | NA | NA | NA |
| | 535 | Beaver River, East Branch | Cedar Creek to Unnamed Creek | Sup | Sup | NA | NA | NA | NA | NA | NA | NA |
| | 572 | Cedar Creek | Unnamed Lake (38-0407-00) outlet to Unnamed Creek | Sup | Sup | NA | NA | NA | NA | NA | NA | NA |
| | 577 | Beaver River, West Branch | Unnamed Creek to Unnamed Creek | Imp | Imp | NA | NA | NA | NA | NA | NA | NA |
| | B28 | Big Thirtynine Creek | Unnamed Creek to Unnamed Creek | Sup | Sup | NA | NA | NA | NA | NA | NA | NA |
| | B44 | Little Thirtynine Creek | Unnamed Creek to Unnamed Creek | Sup | Sup | NA | NA | NA | NA | NA | NA | NA |

| HUC10 Subwatershed | Assessment Unit (Last 3 digits) | Stream | Reach Description | Aquatic Life | | | | | | | | Aquatic Recreation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Fish Index of Biotic Integrity | Macroinvertebrate Index of Biotic Integrity | Dissolved Oxygen | Turbidity/TSS | Chloride | pH | $NH_3$ | Pesticides | Bacteria |
| Gooseberry River – Frontal Lake Superior (0401010202) | 502 | Gooseberry River | Headwaters to Lake Superior | Sup | Sup | Sup | Sup | Sup | Sup | Sup | NA | Sup |
| | 513 | Silver Creek | Headwaters to Lake Superior | Sup | Sup | NA | Sup | NA | NA | NA | NA | NA |
| | 515 | Crow Creek | Headwaters to Lake Superior | Sup | Sup | NA | NA | NA | NA | NA | NA | NA |
| | 519 | Split Rock River | West Branch Split Rock River to Lake Superior | NA | NA | Sup | IF | Sup | Sup | Sup | NA | Sup |
| | 520 | West Split Rock River | Headwaters to Split Rock River | Sup | Sup | NA | NA | NA | NA | NA | NA | NA |
| | 551 | Skunk Creek | T55 R10W S14, West Line to T54 R9W S16, South Line | Sup | Sup | NA | NA | NA | NA | NA | NA | NA |
| | 554 | Encampment River | T54 R10W S17, West Line to Lake Superior | IF | Sup | Sup | Sup | Sup | Sup | Sup | NA | Sup |
| | 668 | Dago Creek | Headwaters to Unnamed Creek | Sup | Sup | NA | NA | NA | NA | NA | NA | NA |
| | 740 | Little Gooseberry River | Unnamed Creek to Gooseberry River | Sup | Sup | NA | NA | NA | NA | NA | NA | NA |
| | A41 | Unnamed Creek (Split Rock River Tributary) | T55 R9W S34, West Line to Split Rock River | NA | Sup | NA | NA | NA | NA | NA | NA | NA |

| HUC10 Subwatershed | Assessment Unit (Last 3 digits) | Stream | Reach Description | Aquatic Life | | | | | | | | Aquatic Recreation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Fish Index of Biotic Integrity | Macroinvertebrate Index of Biotic Integrity | Dissolved Oxygen | Turbidity/TSS | Chloride | pH | $NH_3$ | Pesticides | Bacteria |
| Gooseberry River – Frontal Lake Superior (0401010202) (continued) | A44 | East Split Rock River | Unnamed Creek to Unnamed Creek | Sup | Sup | Sup | Sup | Sup | Sup | Sup | NA | Sup |
| Knife River – Frontal Lake Superior (0401010203) | 503 | Stewart River | Headwaters (Stewart Lake 38-0744-00) to Lake Superior | Sup | Sup | NA | Sup | NA | NA | NA | NA | NA |
| | 504 | Knife River | Headwaters to Lake Superior | Sup | Sup | Sup | Imp | Sup | Sup | Sup | NA | Sup |
| | 528 | Skunk Creek | Headwaters to Lake Superior | NA | NA | NA | Imp | Sup | Sup | Sup | NA | Imp |
| | 538 | Knife River, West Branch | Unnamed Creek to Knife River | Sup | Sup | NA | NA | NA | NA | NA | NA | NA |
| | 555 | Big Sucker Creek (Sucker River) | Unnamed Creek to Lake Superior | Sup | Sup | Sup | Imp | Sup | Sup | Sup | NA | Sup |
| | 556 | Big Sucker Creek (Sucker River) | T53 R12W S20, North Line to Unnamed Creek | Sup | Sup | NA | IF | NA | NA | NA | NA | NA |
| | 584 | Captain Jacobson Creek | T53 R12W S33, North Line to West Branch Knife River | Sup | Sup | NA | NA | NA | NA | NA | NA | NA |

| HUC10 Subwatershed | Assessment Unit (Last 3 digits) | Stream | Reach Description | Aquatic Life | | | | | | | | Aquatic Recreation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Fish Index of Biotic Integrity | Macroinvertebrate Index of Biotic Integrity | Dissolved Oxygen | Turbidity/TSS | Chloride | pH | $NH_3$ | Pesticides | Bacteria |
| Knife River – Frontal Lake Superior (0401010203) (continued) | 586 | Knife River, West Branch | Unnamed Creek to Captain Jacobson Creek | Sup | Sup | NA | NA | NA | NA | NA | NA | NA |
| | 824 | Little Knife River | Unnamed Creek to Unnamed Creek | Sup | Sup | NA | Sup | NA | NA | NA | NA | NA |
| | 840 | Little Knife River (East Branch Little Knife River) | Unnamed Creek to Knife River | NA | NA | Imp | Imp | NA | Sup | NA | NA | NA |
| | 846 | Unnamed Creek (West Branch Little Knife River) | Unnamed Creek to West Branch Knife River | Sup | Sup | NA | NA | NA | NA | NA | NA | NA |
| | 887 | McCarthy Creek | Unnamed Creek to Unnamed Creek | Sup | Sup | NA | NA | NA | NA | NA | NA | NA |
| | A94 | Little Stewart River | T53 R11W S3, West Line to Stewart River | Sup | Sup | NA | NA | NA | NA | NA | NA | NA |
| | B01 | Brophy Creek | T53 R12W S19, North Line to Big Sucker Creek | Sup | Sup | NA | NA | NA | NA | NA | NA | NA |
| | C16 | Knife River, West Branch | T54 R12W S36, East Line to Unnamed Creek | Sup | NA | NA | NA | NA | NA | NA | NA | NA |

| HUC10 Subwatershed | Assessment Unit (Last 3 digits) | Stream | Reach Description | Aquatic Life | | | | | | | | Aquatic Recreation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Fish Index of Biotic Integrity | Macroinvertebrate Index of Biotic Integrity | Dissolved Oxygen | Turbidity/TSS | Chloride | pH | $NH_3$ | Pesticides | Bacteria |
| City of Duluth – Frontal Lake Superior (0401010204) | 508 | Talmadge River (Talmadge Creek) | Headwaters to Lake Superior | Imp | Sup | Imp | Imp | Sup | Sup | NA | NA | IF |
| | 698 | French River | Unnamed Lake (69-182-00) to Lake Superior | Sup | Sup | Sup | Imp | Sup | Sup | NA | NA | Sup |

Sup = found to meet the water quality standard, Imp = does not meet the water quality standard and therefore, is impaired, IF = the data collected was insufficient to make a finding, NA = not assessed

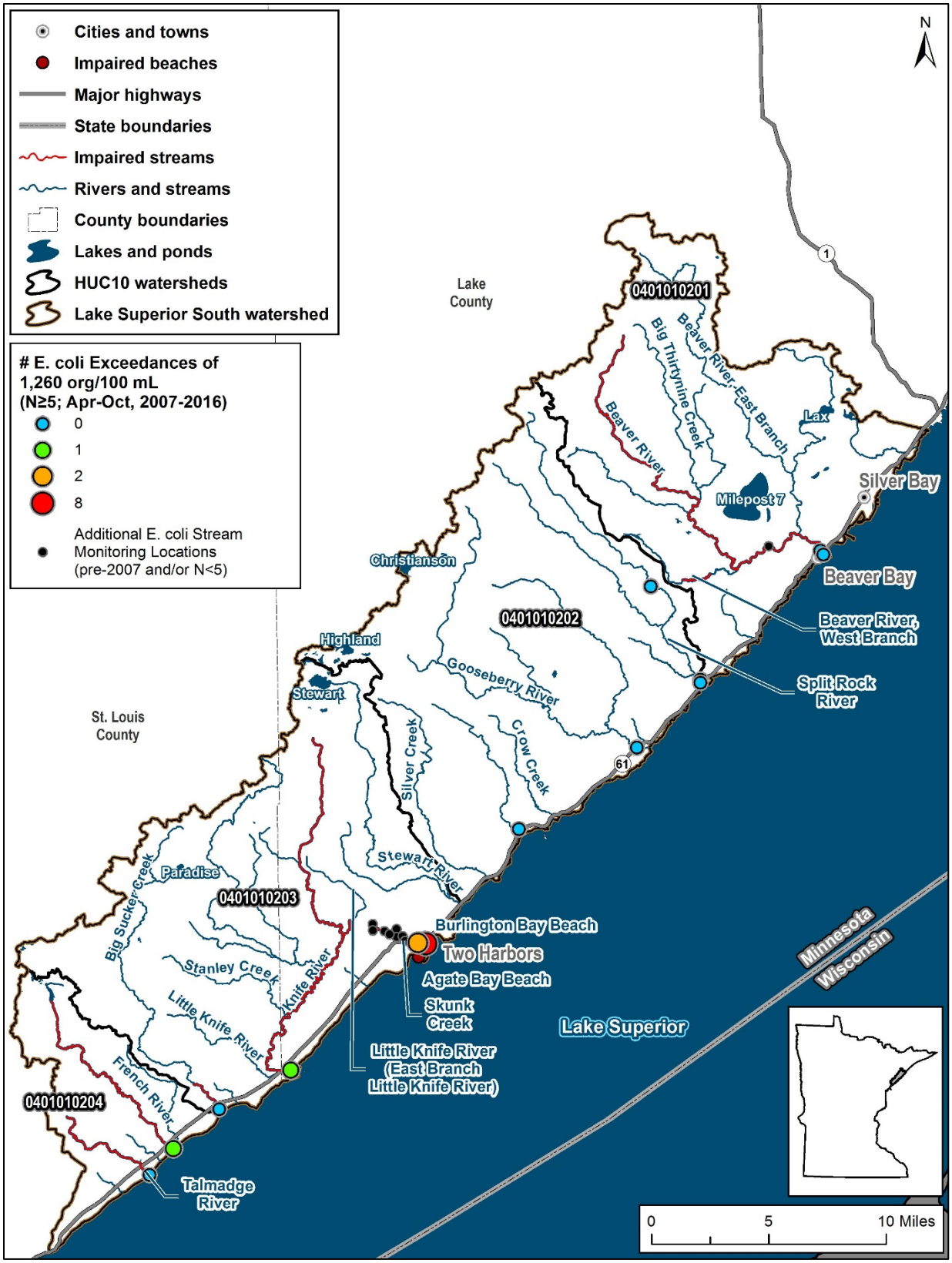


Figure 5. Stream *E. coli* exceedances in the LSS Watershed.

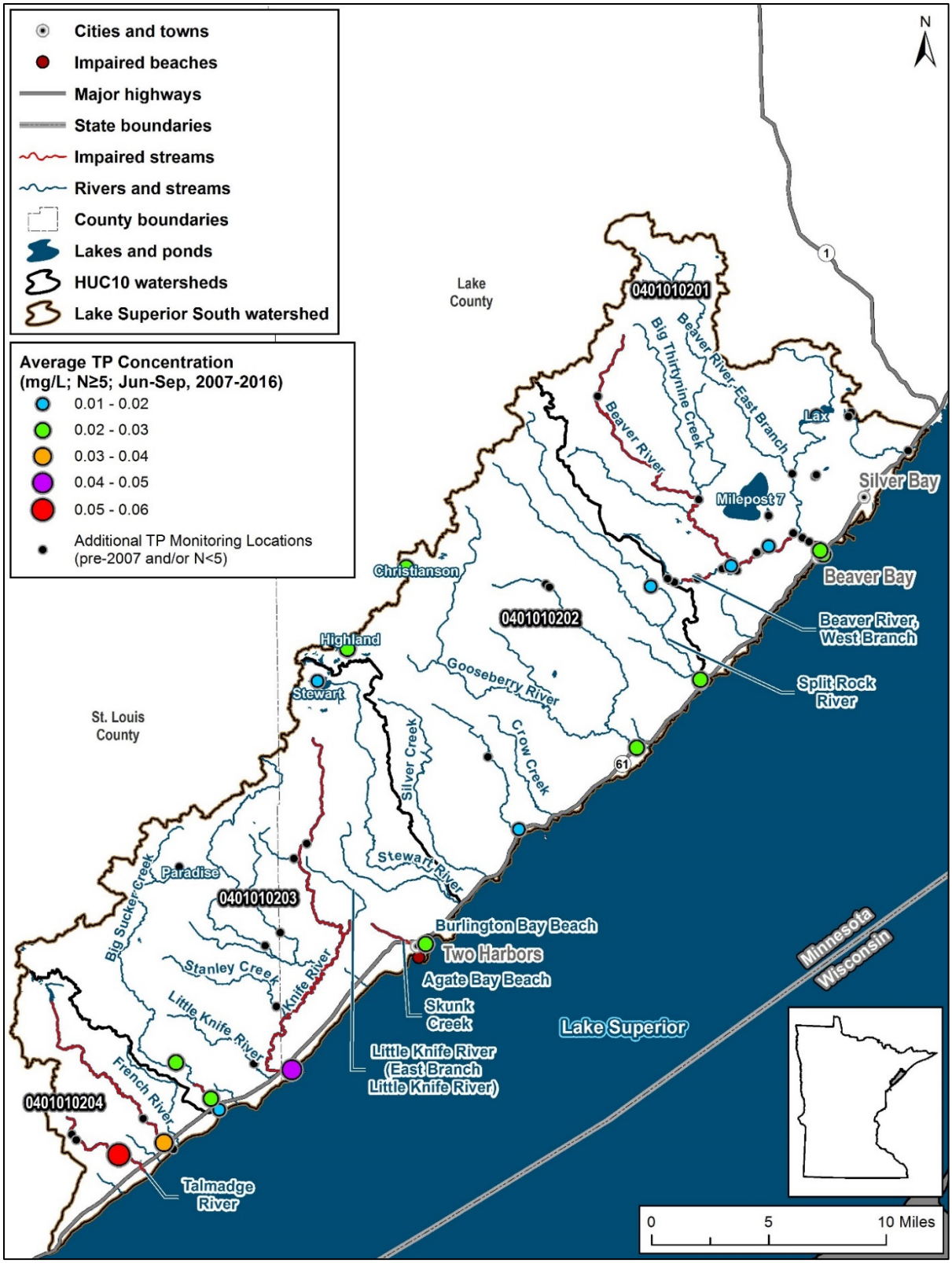


Figure 6. Average stream TP concentrations in the LSS Watershed. Average TP concentrations greater than 0.05 mg/L may be considered high.

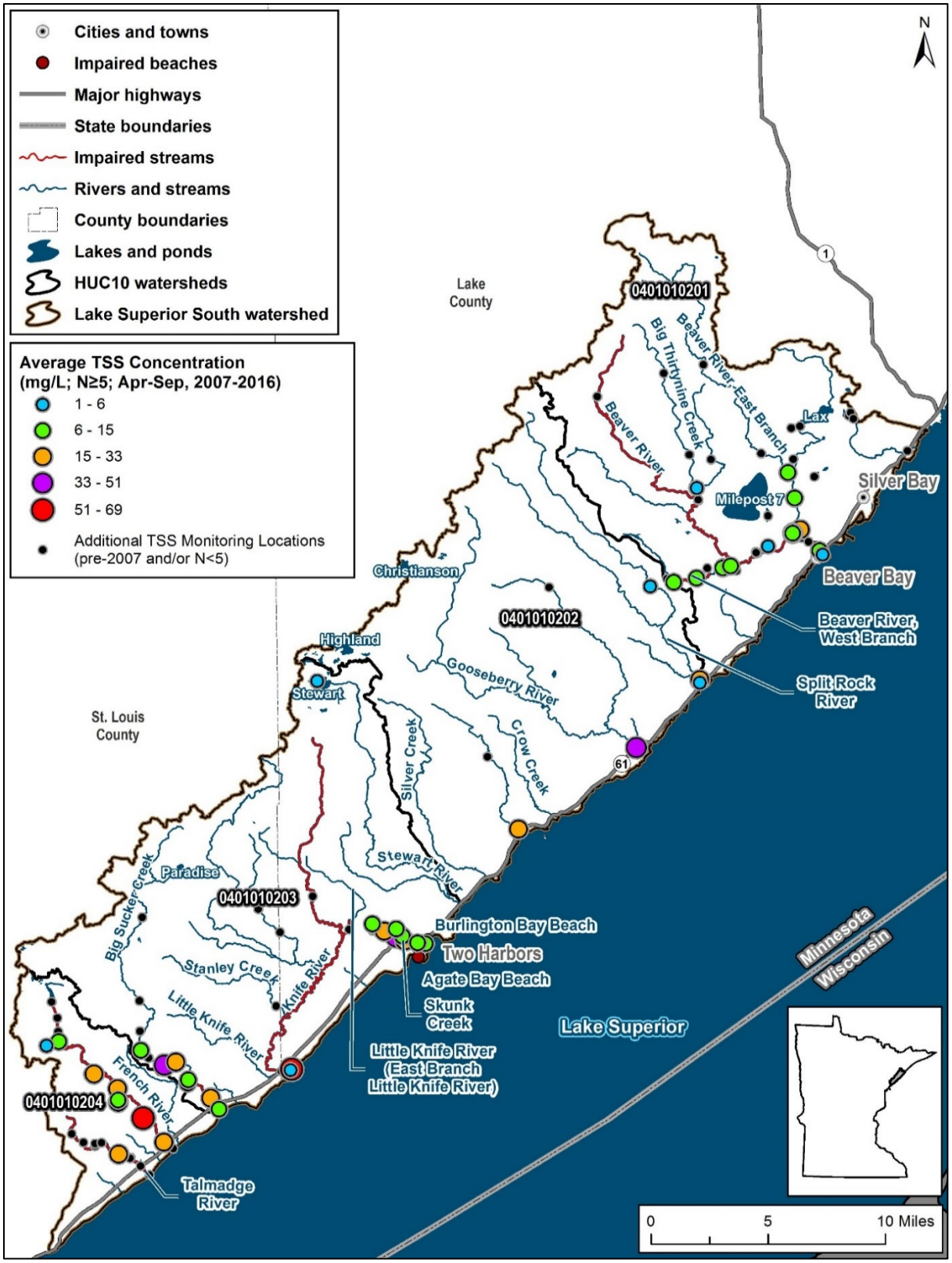


Figure 7. Average stream TSS concentrations in the LSS Watershed. Average TSS concentrations greater than 15 mg/L may be considered high.

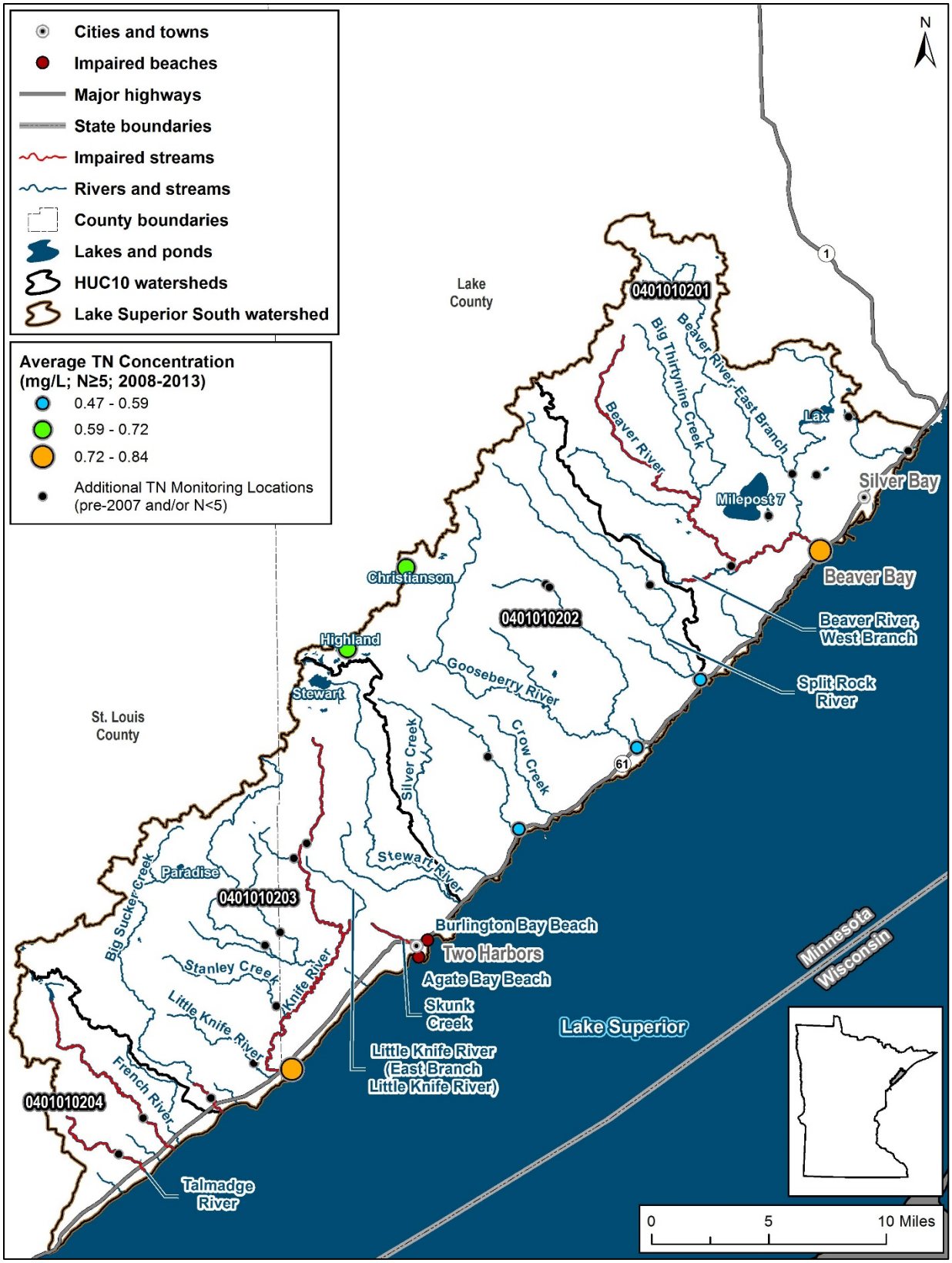


Figure 8. Average stream TN concentrations in the LSS Watershed.

## Lakes

Lakes are assessed for their ability to support aquatic recreation based on the level of eutrophication. Water transparency and levels of phosphorus and chlorophyll are used to evaluate eutrophication. Phosphorus is a nutrient that plants and algae need to grow, and chlorophyll is a measure of the amount of algae in the water. Five lakes in the LSS Watershed were assessed for their ability to support aquatic recreation (Table 2). All five lakes were found to meet water quality standards and will be the focus of protection efforts. Lax, Stewart and Paradise Lake were considered to be of the highest quality (MPCA 2014).

**Table 2. Lake condition in the LSS Watershed**

| HUC10 Subwatershed | Lake ID | Lake | Aquatic Recreation |
|---|---|---|---|
| Beaver River – Frontal Lake Superior (401010201) | 38-0406-00 | Lax | Sup |
| Gooseberry River – Frontal Lake Superior (401010202) | 38-0750-00 | Christianson | Sup |
| | 38-0753-00 | Highland | Sup |
| Knife River – Frontal Lake Superior (401010203) | 69-0007-00 | Paradise | Sup |
| | 38-0744-00 | Stewart | Sup |

Imp = impaired for impacts to aquatic recreation, Sup = fully supporting aquatic recreation, IF = insufficient data to make an assessment

## Beaches

Elevated bacteria levels pose a human health threat, and beaches closed due to contamination can negatively impact tourism and the local economy. Routine beach monitoring to quantify bacteria levels is conducted by the Minnesota Department of Health (MDH) (and partners) at various locations as part of the Beaches Environmental Assessment and Coastal Health (BEACH) Act. This includes monitoring sites along the Lake Superior shoreline. The *E. coli* water quality standards are applicable to recreational uses of beaches between April 1 and October 31; they are documented in BEACH Act Rule and include:

- 126 organisms per 100 mL of water not to be exceeded as the geometric mean of not less than 5 samples in a calendar month and
- 235 organisms per 100 mL of water not to be exceeded by 10% of all samples taken in a calendar month, individually

Beaches are assessed according to the following procedure documented by the MPCA (2016):

> *There is a considerable amount of E. coli data collected as part of the beach monitoring program in Minnesota. Most beaches are monitored weekly from Memorial Day to Labor Day, while some are monitored twice weekly. To ensure use of the most recent data, data for the most recent 5-year period are used and assessments are made every other (odd numbered) year.*

*When there are five or more samples per individual month or 30 day time period, individual monthly geometric means are calculated and compared to the 126 orgs/100mL standard for the period April 1 through October 31. If more than 10% of the geometric means calculated exceed the 126 orgs/100mL standard, or if more than 10% of the individual sample results in the entire dataset exceed the maximum criterion of 235 orgs/100mL, the AUID is assessed as not supporting.*

*When sampling frequency results in smaller data sets, data is aggregated by month across years. If one or more of the monthly aggregated geometric means exceeds 126 orgs/100mL, or more than 10% of the individual sample results in the entire dataset exceed the maximum criterion of 235 orgs/100mL, the AUID is assessed as not supporting.*

*Data from adjacent sampling sites on the same beach are combined. For sites with both tributary mouth stations and BEACH stations, data from each station are assessed separately and the results considered using best professional judgment to make an assessment decision. For sites with only tributary mouth samples, the data are assessed against the coastal recreation water standards. Streams tributary to Lake Superior with bacteria data at stations upstream of the mouth are assessed as stream AUIDs using the statewide water quality standards and methodology in part A.*

A summary of *E. coli* exceedances are provided in Figure 9. *E. coli* results were observed above water quality standards at two locations in the LSS Watershed and they were ultimately placed on the 303(d) list of impaired waterbodies (Table 3).

**Table 3. *E. coli* impaired beaches**

| Beach Name | Beach ID | Location Description |
|---|---|---|
| Burlington Bay Beach | 04010102-C30 | Near Two Harbors; Burlington Bay Beach near the outlet of Skunk Creek (impaired for *E. coli*) |
| Agate Bay Beach | 04010102-C31 | |

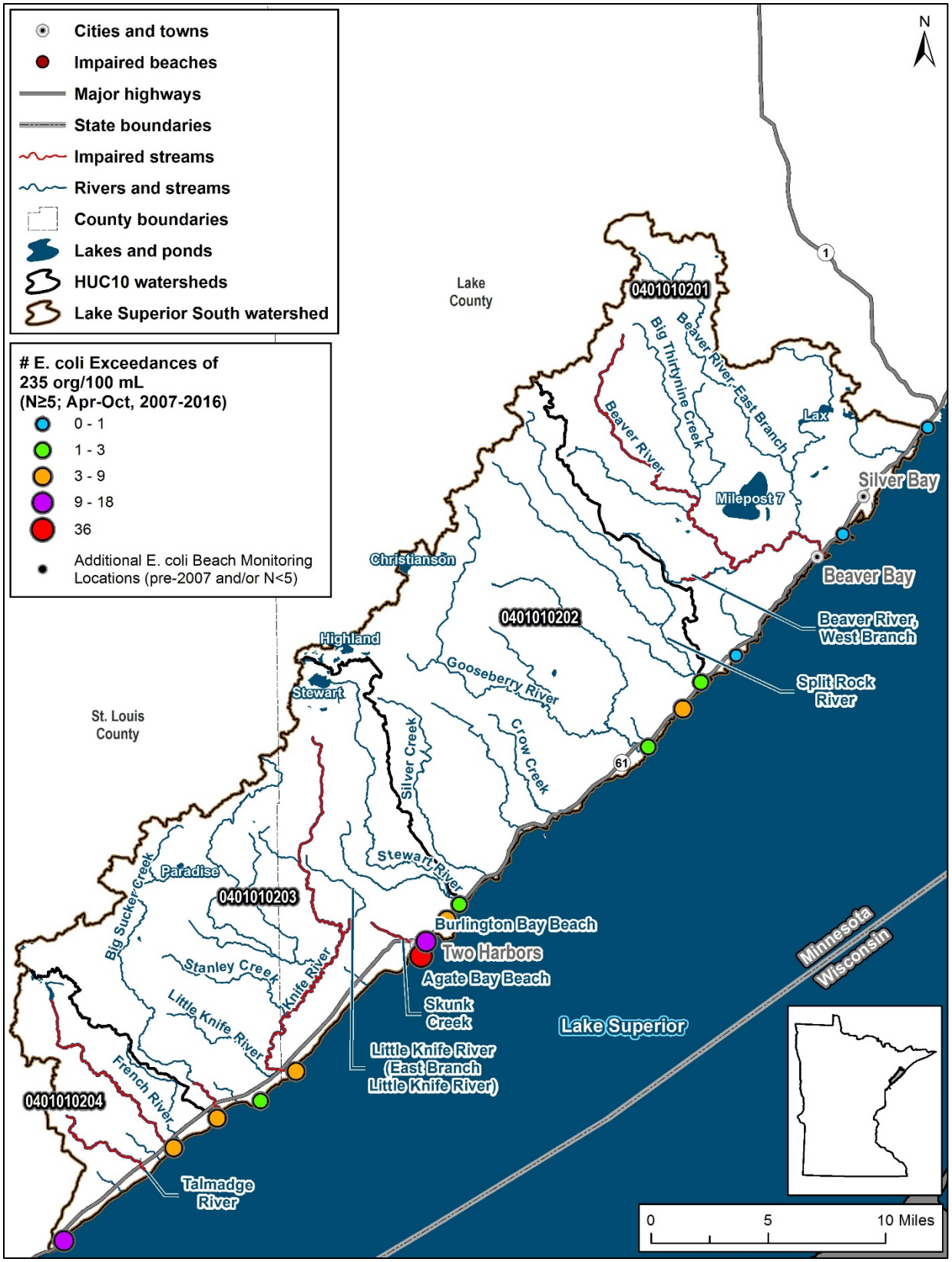


Figure 9. Beach *E. coli* exceedances in the LSS Watershed.

## 2.2 Water Quality Trends

### Streams

Long-term water quality data (1973 through 2016) were evaluated using a combined dataset of samples collected at the sites with the longest period of record and greatest numbers of samples—the Beaver River and the Knife River. Kendall Tau correlation analyses were used to evaluate long term trends in water quality at these sites (Table 5). In the Beaver River, TSS concentrations have decreased over the long term, with concentrations relatively steady over the last 20 years (Figure 10 and Table 4). Phosphorus and ammonia concentrations have also decreased over the long term, and chloride concentrations have increased (Figure 11 and Table 4). In the Knife River, TSS concentrations have increased in the last 20 years (Figure 12), and ammonia and BOD have decreased over the long term (Table 4).

**Table 4. Water quality trend analysis for the Beaver River (S000-252) and Knife River (S003-64)**

Kendall-Tau correlation analysis on annual medians ($p < 0.05$). Months over which data were averaged—TSS, nitrate+ nitrite, ammonia, biochemical oxygen demand: Apr–Sep; Phosphorus: Jun–Sep; and chloride: Jan–Dec. A year of data was used only if N≥4.

| Parameter | Beaver River south of CSAH-3 1.5 miles NW of Beaver Bay (S000-252) | | Knife River upstream of Old US-61 at Knife River (S000-257) and Knife River downstream of US-61 (S003-642) | |
|---|---|---|---|---|
| | 1973–2016 | 1995–2016 | 1973–2010 | 1998–2015 |
| TSS | Decreasing | No trend | No trend | Increasing |
| Phosphorus | Decreasing | – [a] | No trend | No trend |
| Nitrate + nitrite | Increasing | Increasing | No trend | No trend |
| Ammonia (total) | Decreasing | – [a] | Decreasing | – [a] |
| Biochemical oxygen demand | No trend | No trend | Decreasing | No trend |
| Chloride | Increasing | – [a] | No trend | – [a] |

a. Not enough data (less than 5 years) to evaluate trends over time.

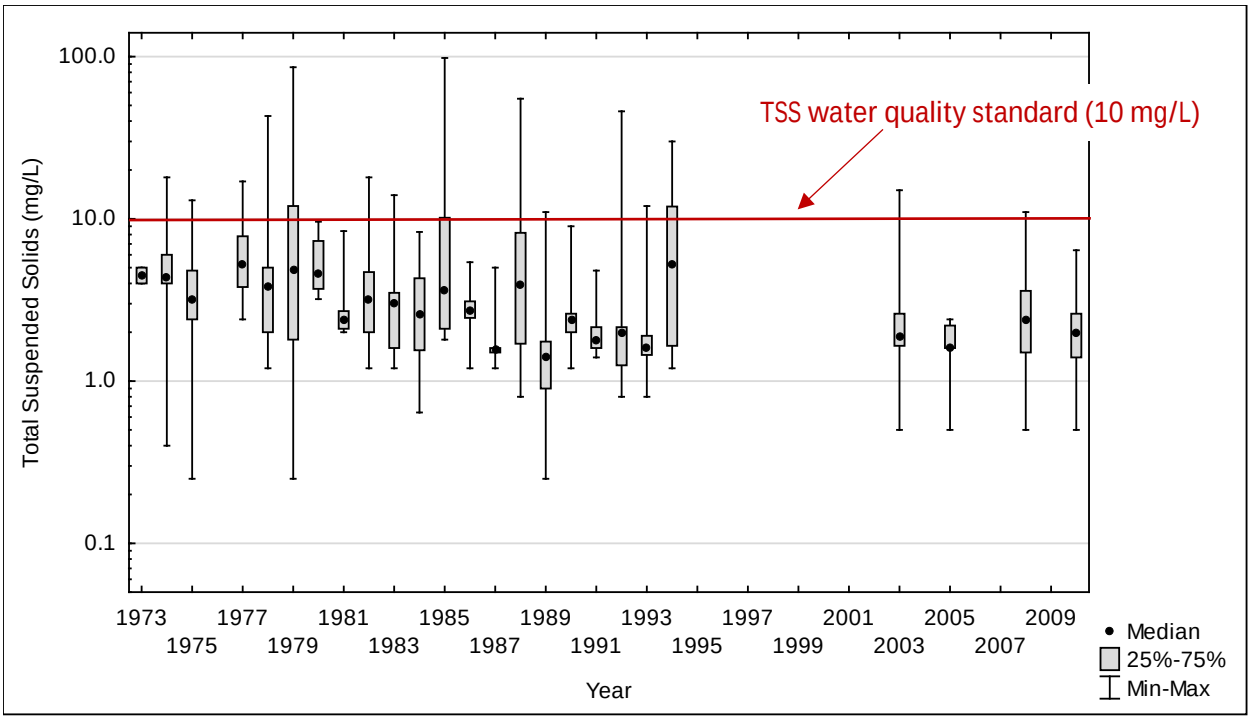


Figure 10. Total suspended solids concentrations (Apr–Sep) by year on the Beaver River south of CSAH-3, 1.5 NW of Beaver Bay (S000-252).

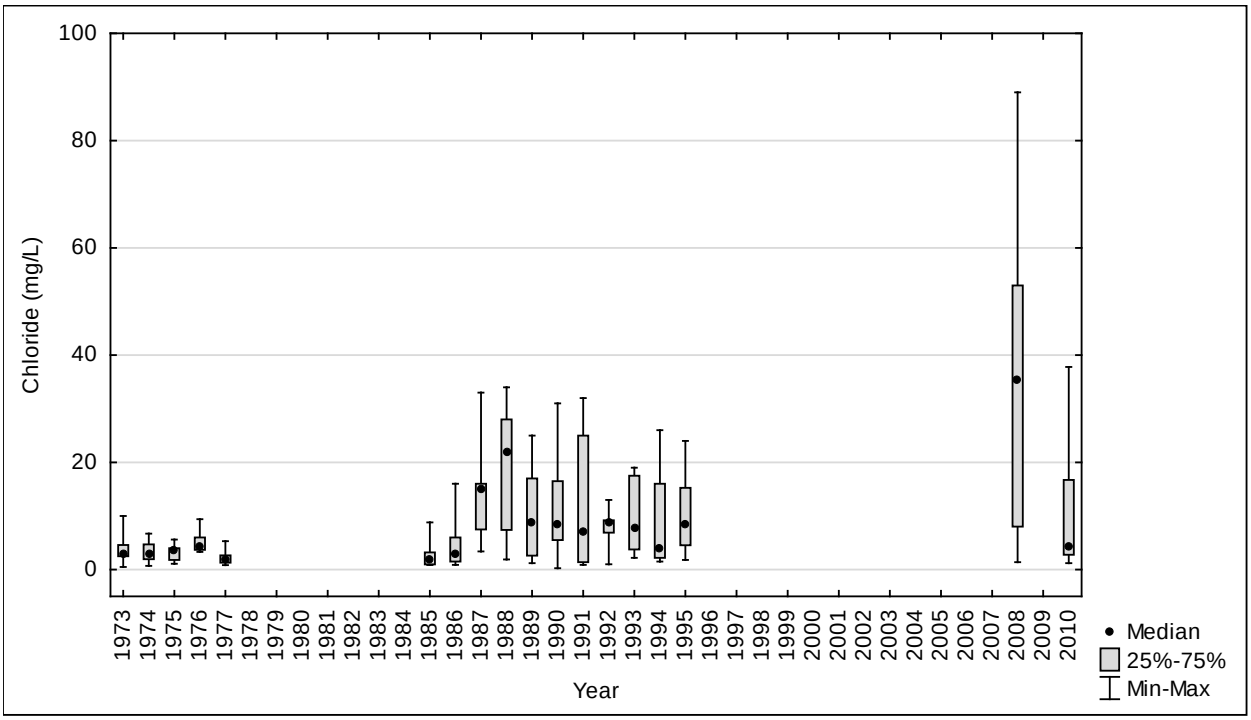


Figure 11. Chloride concentration (Jan–Dec) by year on the Beaver River south of CSAH-3, 1.5 NW of Beaver Bay (S000-252).

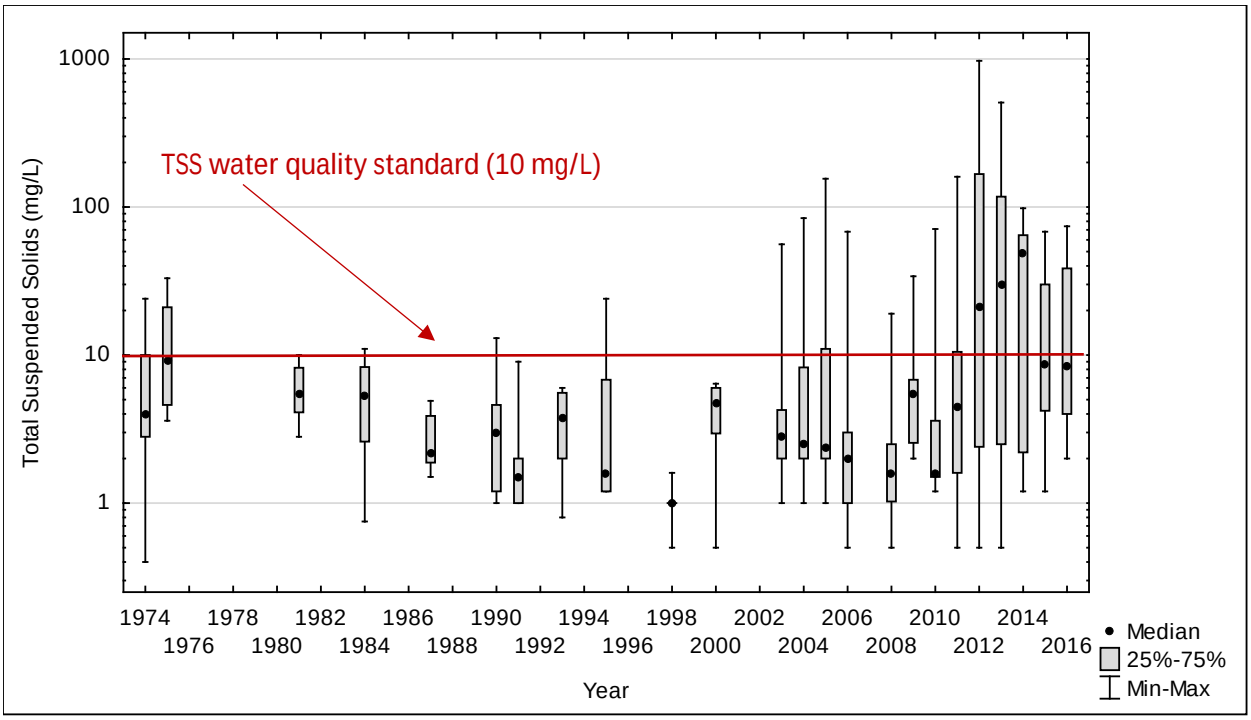


**Figure 12. Total suspended solids concentrations (Apr–Sep) by year on the Knife River upstream of Old US-61 (S000-257) and downstream of US-61 (S003-642).**

## Lakes

Lake water quality is generally very good across the watershed. A water clarity trend analysis was conducted as part of an interagency lake prioritization effort conducted by staff from the MPCA, Minnesota Department of Natural Resources (DNR), Board of Water and Soil Resources (BWSR), Minnesota Department of Agriculture (MDA), and MDH. Only lakes with eight or more years of data were analyzed for the presence of a trend. Section 2.4 contains further information on the lake prioritization effort. Of the 10 LSS lakes included in the effort, two had sufficient data for conducting a trend analysis (Lax and Stewart). Only Stewart Lake shows evidence of a decreasing trend in clarity. The remaining lakes did not have sufficient data for a trend analysis (Table 5).

Table 5. Lake water quality trends

| Lake Name | Lake ID | Impaired | Average Total Phosphorus (µg/L) | Average Transparency (m) | Trend in Clarity [a] |
|---|---|---|---|---|---|
| Bear | 38040800 | **N** | 10.5 | -- | -- |
| Nicado | 38023000 | **N** | 11.0 | -- | -- |
| Bear | 38040500 | **N** | 12.9 | 7.25 | -- |
| Tetagouche | 38023100 | **N** | 14.0 | 2.25 | -- |
| Bean | 38040900 | **N** | 16.0 | 3.70 | -- |
| Paradise | 69000700 | **N** | 18.0 | 2.42 | -- |
| Lax | 38040600 | **N** | 18.2 | 3.21 | N |
| Highland | 38075300 | **N** | 21.7 | 1.50 | -- |
| Stewart | 38074400 | **N** | 22.9 | 3.22 | ↓ |
| Christianson | 38075000 | **N** | 38.7 | 1.07 | -- |

a. ↓: decreasing trend
N: no evidence for a trend
--: insufficient data

## Beaches

*E. coli* concentrations along the shoreline and beach closures are a concern throughout the North Shore. Beach *E. coli* data (2003 through 2016) were evaluated to describe trends in *E. coli* concentrations. A trend of increasing *E. coli* concentration (Kendall Tau correlation analyses on geometric means, $p<0.05$) was observed at the following beach monitoring sites:

- Bluebird Landing NE of Duluth (B014)
- Stony Point NE of Duluth (B015)
- Twin Points Pub Access 15 miles NE of Two Harbors (B020)
- Split Rock River Mouth 16.5 miles NE of Two Harbors (B021)
- Silver Bay Marina in Silver Bay (B023)
- Knife River Marina SW of Two Harbors (B035)

Exceedances of the maximum *E. coli* standard were observed at all of the monitored beaches, but only two beaches in the watershed—Burlington Bay and Agate Bay—have aquatic recreation impairments due to high *E. coli*. At the two impaired beaches, the annual maximum observed *E. coli* concentration has increased in recent years (Figure 13).

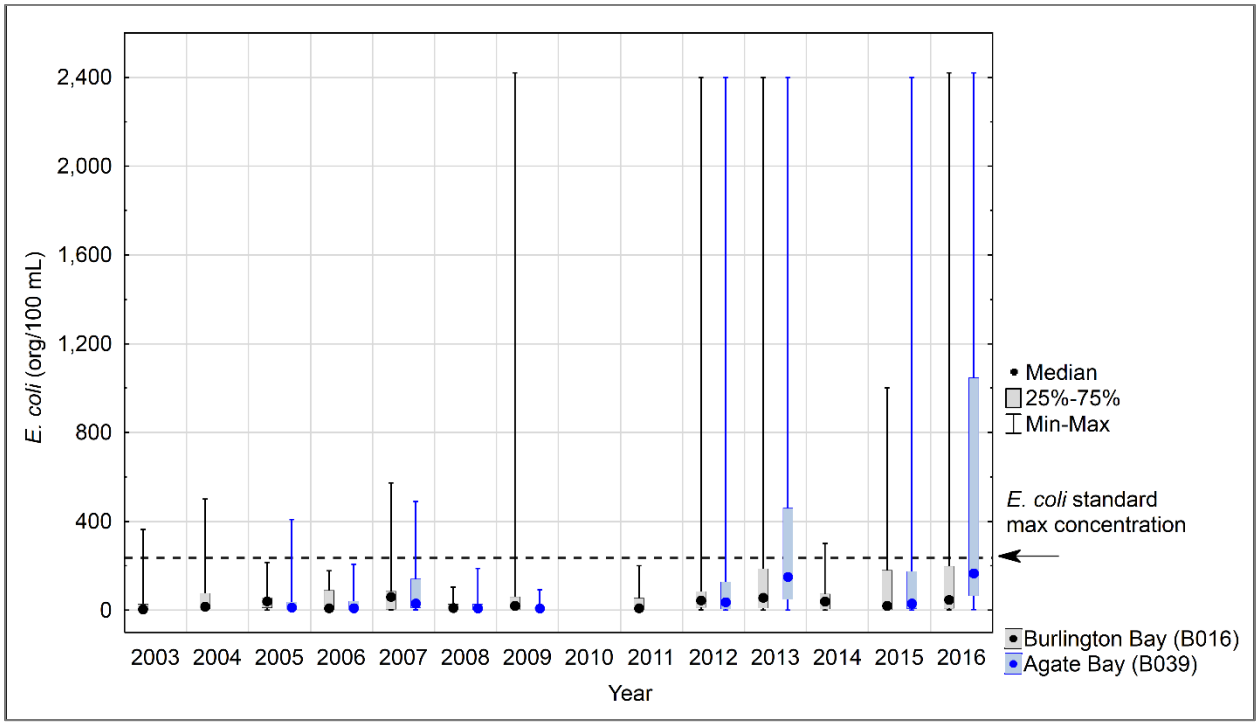


**Figure 13. *E. coli* concentrations at impaired beaches.**

## 2.3 Stressors and Sources

In order to develop appropriate strategies for restoring or protecting waterbodies, the stressors and/or sources impacting or threatening them must be identified and evaluated. The Clean Water Act and U.S. EPA regulations require that TMDLs be developed for waters that do not support their designated uses. A TMDL is a plan to attain and maintain water quality standards in waters that are not currently meeting them. There are eight impaired stream reaches (Table 6) and two impaired beaches in the LSS Watershed. Biological stressor identification is done for streams with either fish or macroinvertebrate impairments, and encompasses both evaluation of pollutants and non-pollutant-related factors as potential stressors (e.g., altered hydrology, fish passage, habitat).

*E. coli* TMDLs were developed for the aquatic recreation impairments that are indicated by high *E. coli* concentrations. TSS TMDLs were developed for aquatic life use impairments due to turbidity or for which suspended solids were identified as a primary stressor. TMDLs were deferred due to a lack of data for impairments resulting from low DO, pH, or temperature. Non-pollutants such as altered hydrology are also not addressed by TMDLs. In addition, beach TMDLs have not yet been completed. Table 6 includes the water bodies with completed TMDLs and Appendix A provides the current pollutant loading, load reductions needed, and load and wasteload allocations from the TMDLs.

Table 6. Completed TMDLs in the LSS Watershed

| HUC10 Subwatershed | Stream/Reach (AUID) or Lake (ID) | Affected Designated Use | Cause/Indicator of Impairment [a] | TMDL Pollutant(s) |
|---|---|---|---|---|
| Beaver River – Frontal Lake Superior (0401010201) | Beaver River (501) | Aquatic Life | Fish Index of Biotic Integrity<br>**Turbidity/TSS**<br>pH | TSS |
| | Beaver River, West Branch (577) | Aquatic Life | Fish Index of Biotic Integrity<br>Macroinvertebrate Index of Biotic Integrity | None |
| Knife River – Frontal Lake Superior (0401010203) | Knife River (504) | Aquatic Life | **Turbidity** | TSS |
| | Little Knife River (East Branch Little Knife River; 840) | Aquatic Life | Dissolved Oxygen<br>**Turbidity/TSS** | TSS |
| | Skunk Creek (528) | Aquatic Life<br>Aquatic Recreation | **Turbidity/TSS**<br>***Escherichia coli*** | TSS<br>*E. coli* |
| City of Duluth – Frontal Lake Superior (0401010204) | Talmadge River (Talmadge Creek; 508) | Aquatic Life | Fish Index of Biotic Integrity<br>Dissolved Oxygen<br>**Turbidity/TSS** | TSS |
| | Big Sucker Creek (Sucker River; 555) | Aquatic Life | **Turbidity/TSS** | TSS |
| | French River (698) | Aquatic Life | **Turbidity/TSS** | TSS |

a. **BOLD** – Cause or indicator of impairment that is addressed by a TMDL. The remaining cause/indicators of impairment have not yet been addressed.

TMDL studies completed in the watershed provide for detailed analysis of water quality data. For those impairments not addressed by TMDLs, additional information on stressors and water quality are provided below. In addition, pollutant source assessments are provided for pollutants of concern in the watershed including *E. coli*, phosphorus, nitrogen, and TSS.

## Stressors of Biologically-Impaired Stream Reaches

Biotic impairments (i.e., aquatic macroinvertebrate or fishes bioassessments) in the Beaver River, West Branch Beaver River and Talmadge River were further evaluated for the cause of impairment as part of the stressor identification process (MPCA 2017). Table 7 summarizes the candidate causes evaluated for each biotic impaired stream. TMDLs are developed to address the primary stressors that are pollutant-based. Specifically, high levels of turbidity and TSS in Beaver River and Talmadge River are addressed by TSS TMDLs.

Table 7. Summary of probable stressors to the biota impaired streams (MPCA 2017)

| Candidate Stressor | Beaver River | West Branch Beaver River | Talmadge River |
|---|---|---|---|
| Elevated water temperature | • | X | X |
| Low dissolved oxygen | X | • | • |
| Elevated ionic strength | o | -- | -- |
| pH | o | -- | -- |
| Poor habitat | • | • | • |
| Loss of connectivity | o | o | o |
| Elevated turbidity/TSS | • | o | • |
| Altered hydrology | o | o | • |

Key: • = confirmed stressor, o = potential stressor, **X** = eliminated candidate cause, -- = not evaluated

### Beaver River (04010102-501)

The Beaver River is listed as impaired due to turbidity/TSS as well as pH and fishes bioassessments. Stressor identification work (MPCA 2017) also identified elevated water temperatures and poor habitat as confirmed stressors to the biota. A TSS TMDL was completed (Tetra Tech 2018) and, as part of the stressor identification process, additional information were collected on the biota impairment (i.e., fishes bioassessment). Figure 14 identifies the continuous pH monitoring data that were collected as part of the stressor identification process (MPCA 2017). Daily fluctuations in pH upstream of Milepost 7 are mitigated by Milepost 7 surface water discharge (Figure 14), although violations of the pH standard occurred both upstream and downstream of Milepost. Continuous in-stream temperature data (MPCA 2017) were favorable to brook trout in the headwaters, and temperatures in the lower third of the watershed were marginal to poor for supporting coldwater fisheries (Figure 15).

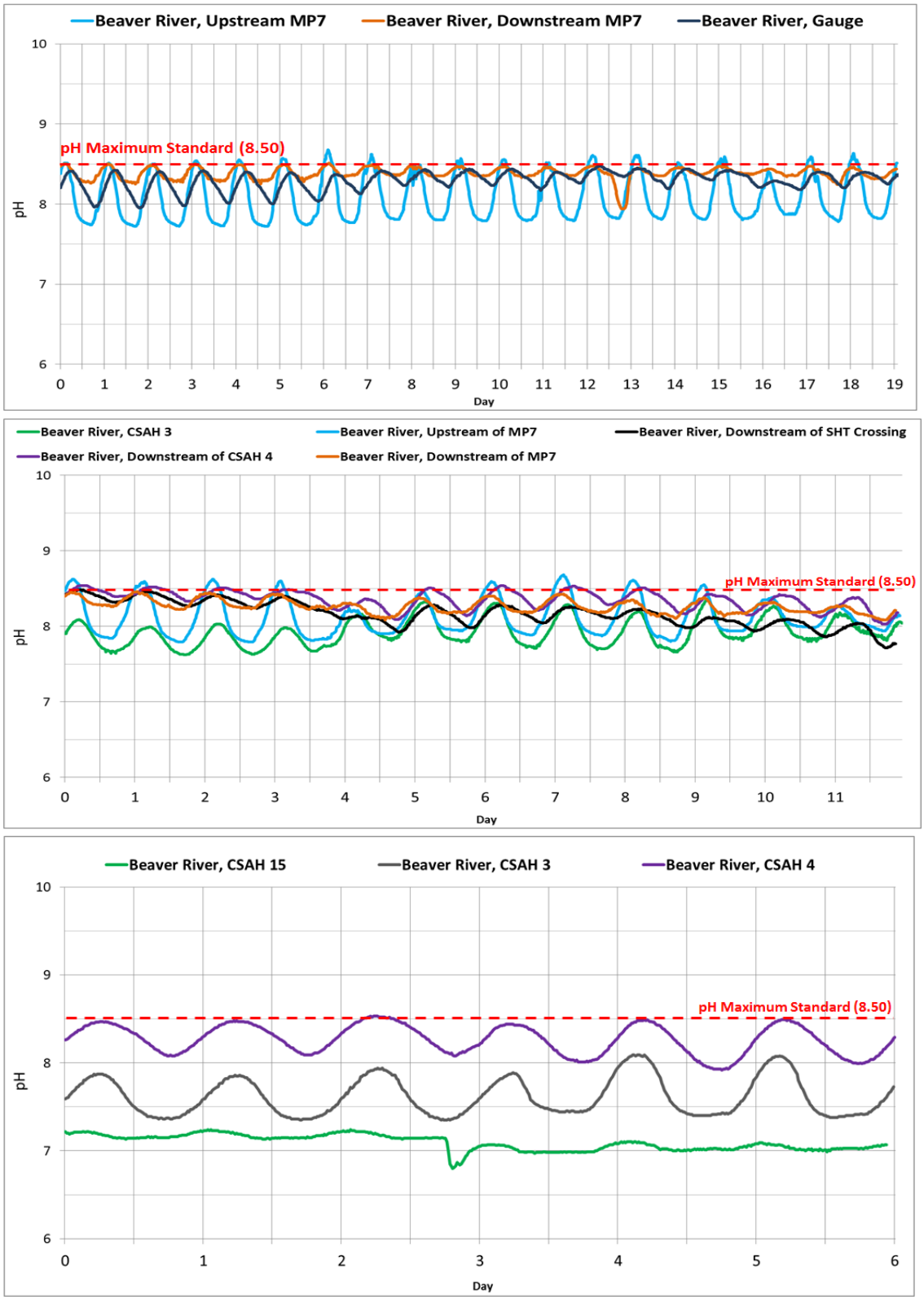


**Figure 14. Continuous pH monitoring results for several Beaver River stations.**

Figure from Lake Superior South Watershed Stressor Identification Report (MPCA 2017). Top: 7/22/2015–8/10/2015, middle: 8/7/2014–8/19/2014, bottom: 8/16/2013–8/22/2013.

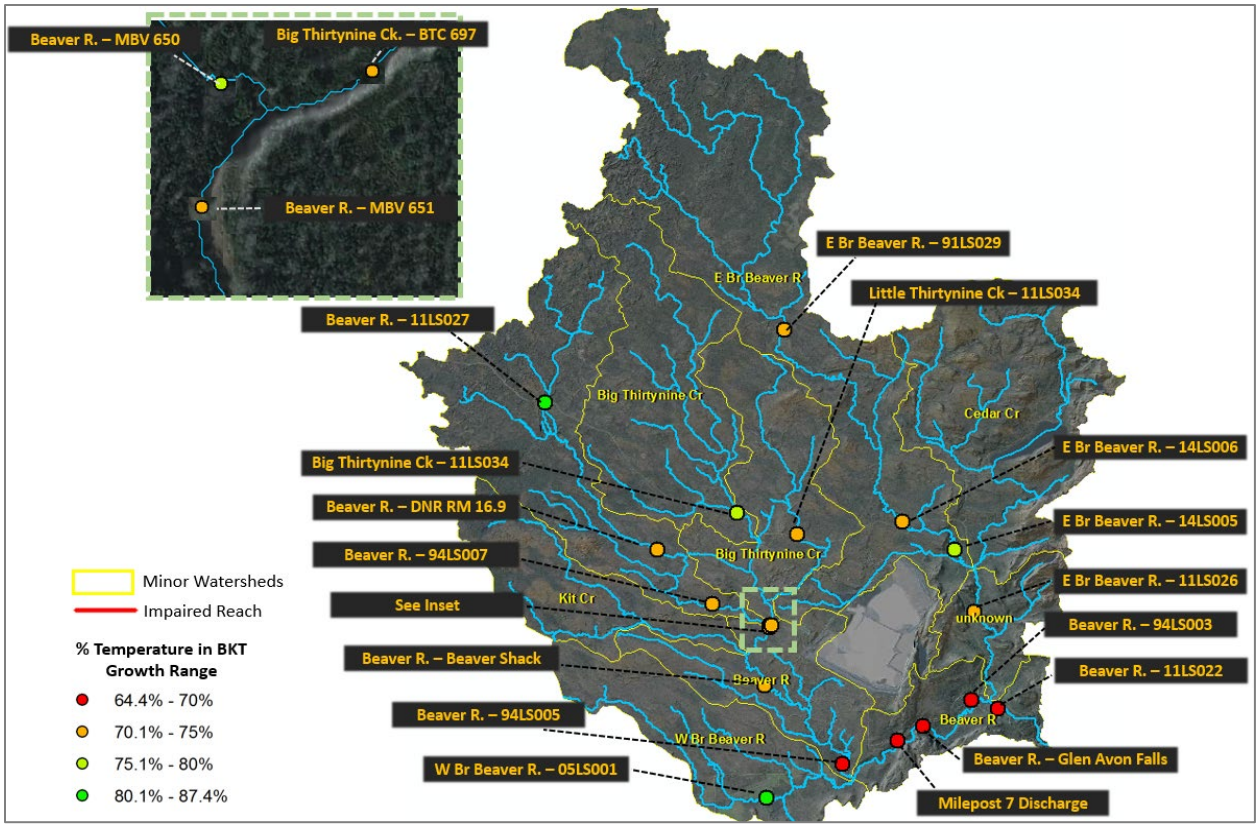


**Figure 15. Percent of temperature readings in brook trout growth range for Beaver River watershed monitoring locations; June 1–August 31, 2013.**
BKT = brook trout; Figure from the Lake Superior South Watershed Stressor Identification Report (MPCA 2017).

### Beaver River, West Branch (04010102-577)

The West Branch Beaver River is impaired for use by aquatic macroinvertebrate and fishes bioassessments. As part of the stressor identification process, DO and elevated water temperatures were identified as stressors contributing to impairment. DO concentrations were low immediately downstream of the beaver dam located upstream of the impaired reach (site S007-364 in Figure 16). DO also fell below the standard along non-impounded reaches of the river (e.g., site S007-363 in Figure 16). The stressor identification report concludes that, "DO conditions in the West Branch Beaver River are poor for supporting brook trout and other sensitive fish species as well as DO -sensitive aquatic macroinvertebrates."

During the monitoring period, water temperatures were favorable to brook trout at two stations, and warmer water temperatures were observed in the lower reach (Figure 17). The stressor identification report states, "Suitable temperatures for coldwater taxa are present in the West Branch Beaver River, but appear to be limited to be highly localized. Areas with lower width to depth ratios, moderate stream slope, overhanging vegetation, and unimpeded flow are correlated with suitable coldwater thermal

regimes in this watershed. Our data suggests that stream temperatures in the lower two miles of the West Branch Beaver River are marginal to poor for supporting coldwater taxa."

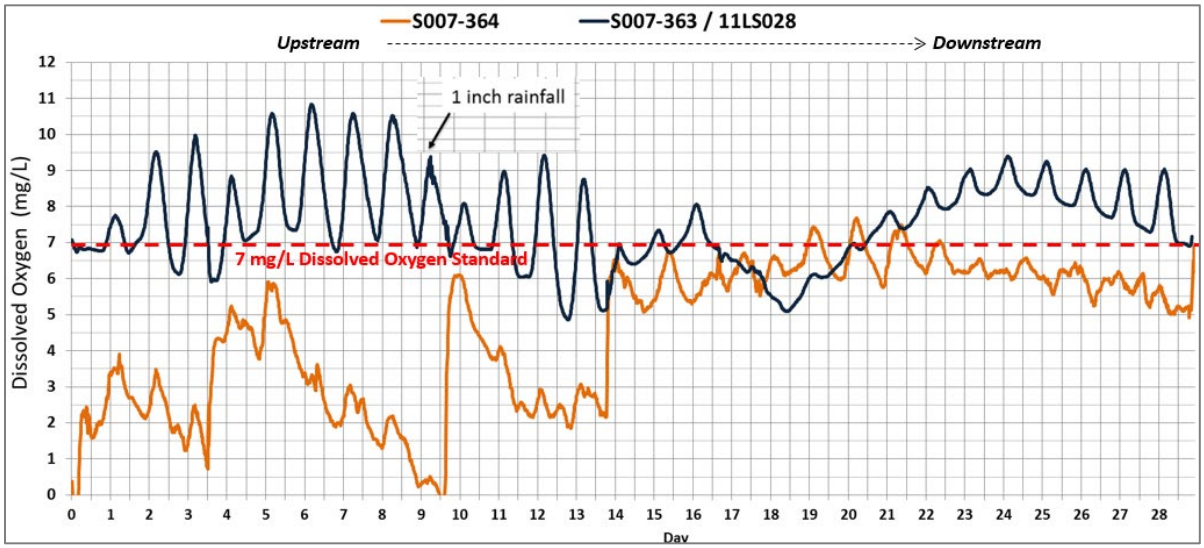


**Figure 16. Dissolved oxygen concentrations, West Branch Beaver River 8/19/15–9/17/15.**
Figure from Lake Superior South Watershed Stressor Identification Report (MPCA 2017).

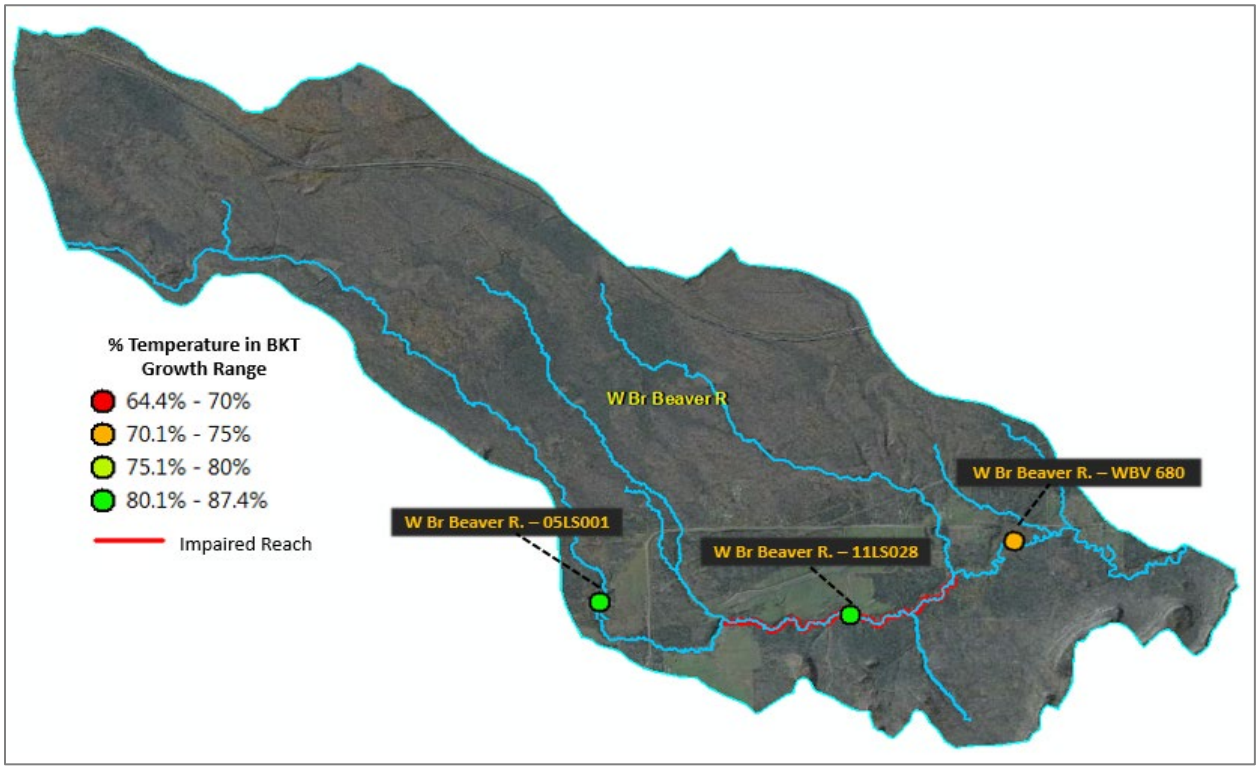


**Figure 17. Percent of temperature readings in brook trout growth range for West Branch Beaver River watershed monitoring locations; June 1–August 31, 2013.**
Figure from the Lake Superior South Watershed Stressor Identification Report (MPCA 2017).

### Talmadge River (Talmadge Creek; 04010102-508)

The Talmadge River is listed as impaired by turbidity/TSS and low DO. A TSS TMDL was developed (Tetra Tech 2018), and DO was further evaluated as part of stressor identification work (MPCA 2017). DO concentrations were marginal to poor for sensitive aquatic life in the headwaters of the Talmadge River (S007-449, Figure 18). Downstream of a 3.5-acre reservoir created by an earthen dam, long durations of DO concentrations less than 7 mg/L were observed (S008-810, Figure 18). DO concentrations recovered somewhat at site S007-614, approximately 1.5 miles downstream, but were still rated as marginal for trout and other sensitive aquatic life at times.

**Figure 18. Dissolved oxygen concentrations, Talmadge River, 8/5/2015–8/23/2015.**

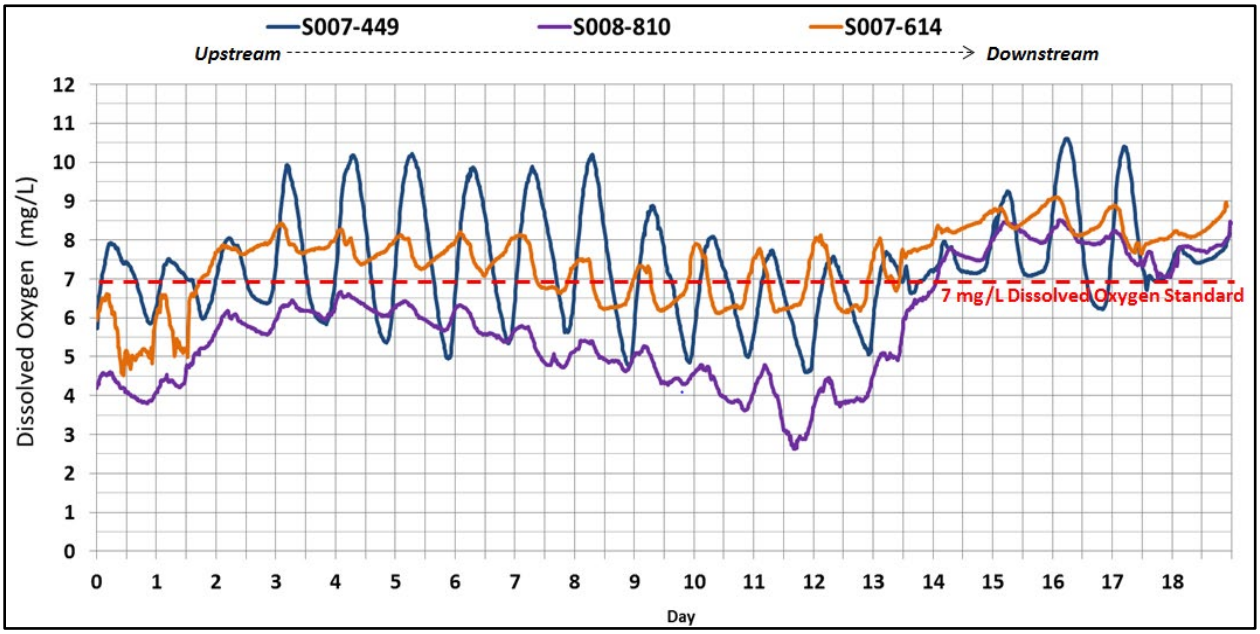


Figure from the Lake Superior South Watershed Stressor Identification Report (MPCA 2017).

### Little Knife River (East Branch Little Knife River; 04010102-840)

The Little Knife River is listed as impaired by turbidity/TSS and low DO. A TSS TMDL was developed (Tetra Tech 2018). No DO data have been collected in the last 10 years. There is one historic DO monitoring station located along the impaired reach of Little Knife River. Several samples collected in 2004 and 2005 were below the standard of 7 mg/L (Figure 19). Four of the five samples below the standard were collected in August, with three in August of 2005. There is no further information available on the current status of this impairment or the cause of low DO.

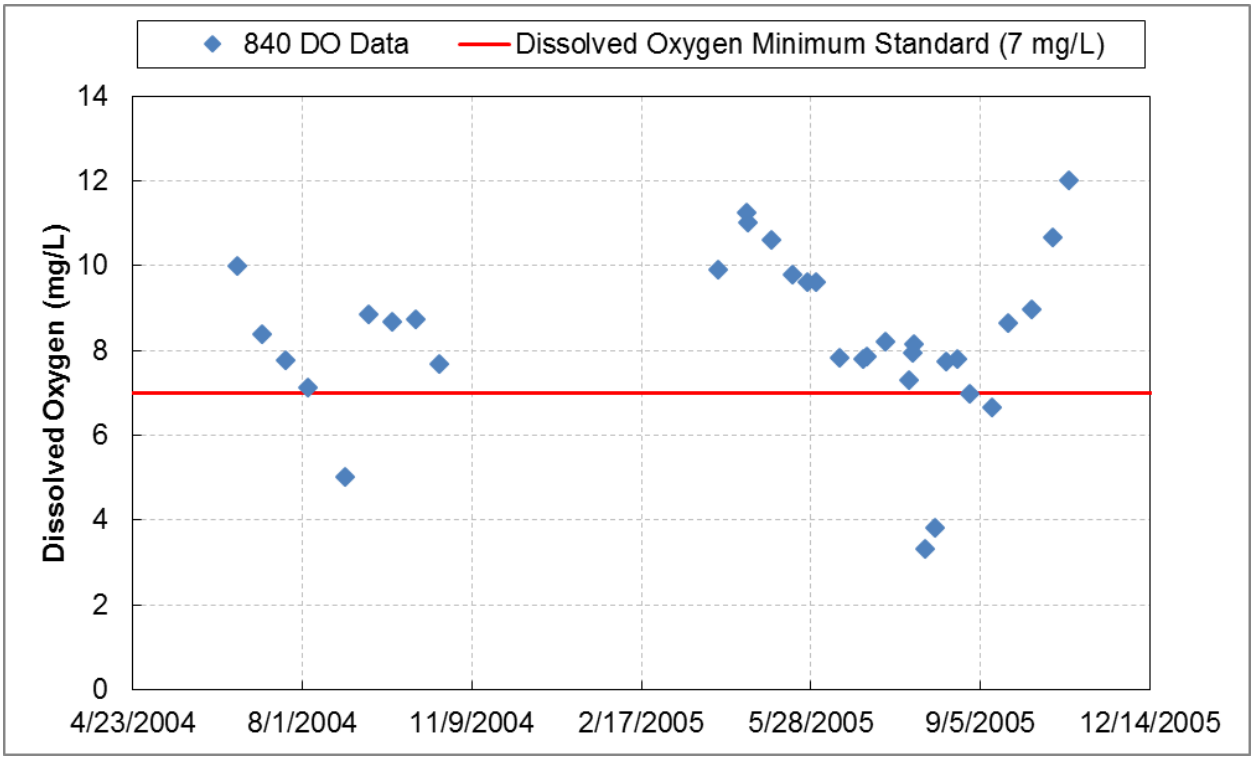


Figure 19. Dissolved oxygen data, Little Knife River (East Branch Little Knife River; AUID 04010102-840).

## Pollutant Sources

A Hydrologic Simulation Platform-Fortran (HSPF) watershed model was developed to simulate watershed scale hydrology and water quality (Tetra Tech 2016). The HSPF model simulates watershed hydrology and water quality for both conventional and toxic organic pollutants from pervious and impervious land in a basin scale analysis framework.

Sediment is the main pollutant for impairment in the watershed and sources include watershed loading, near-channel erosion and to a small degree wastewater, regulated municipal separate storm sewer systems (MS4s), and industrial and construction stormwater. Figure 20 summarizes the watershed-wide upland and near-channel sources of sediment.

Eroding bluffs have been identified as a major source of sediment in many of the North Shore tributaries (Nieber et al. 2008). Loadings from bluffs in the watershed models were specified using a constant rate of replenishment to the bed sediment storage in affected reaches and are based on high risk erosion areas identified as part of a Light Detection and Ranging (LiDAR)-based bluff assessment conducted by the Natural Resources Research Institute (2015). A large number of identified bluffs along the Big Sucker Creek, French River, and Talmadge River account for the dominance of near channel sources. Skunk Creek, located in Two Harbors, has the highest proportion of sediment loads from development and roads. For most streams, the highest amount of erosion is found in the transitional area between upstream/ headwater areas that have low slopes and the high slope, bedrock-controlled areas near Lake Superior. This area tends to correspond to soils with high clay content and higher stream power.

Upland forest contributes the second highest percentage of total sediment to the watershed; it also comprises 87% of the land cover. It should be noted that on a per acre level, forest contributes a very small TSS load. Pollutant loading from subwatersheds derived from the HSPF model are presented as yields in Figure 21, Figure 22, and Figure 23 for nitrogen, phosphorus, and TSS, respectively.

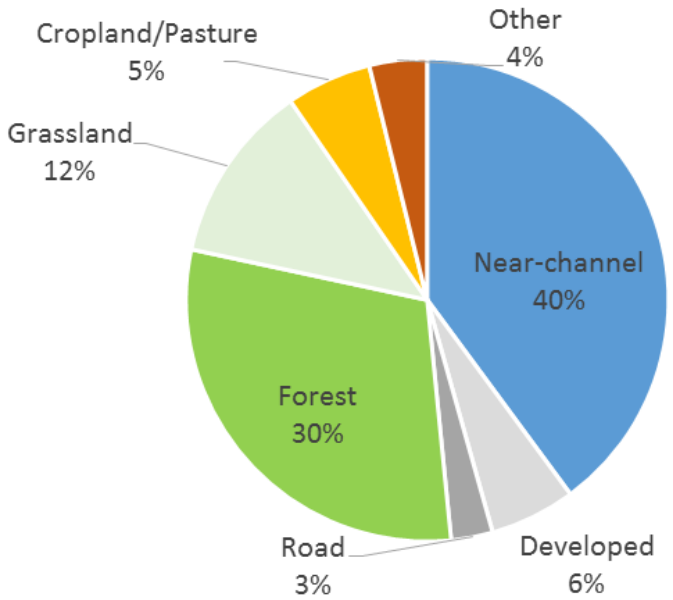


**Figure 20. Sources of sediment from HSPF modeling (Tetra Tech 2016).**

Sources of *E. coli* in streams and beaches are widespread and often intermittent. Threats to the watershed include stormwater runoff, wastewater effluent (point sources and individual septic systems), other wastewater collection systems (e.g., portable toilets), commercial and recreational boating, pets, birds and wildlife. Some sources pose a greater risk to human health than others. Skunk Creek, an *E. coli*-impaired stream, discharges to Lake Superior at Burlington Bay and is a likely contributor to that beach impairment.

Table 8 includes permitted point sources in the LSS Watershed. Point sources are potentially contributing to sediment impairments in the Beaver River and French River and require additional monitoring or reductions in loading. Based on HSPF modeling, point sources contribute approximately 2% of the phosphorus load and 6% of the nitrogen load in the watershed, with the remaining load from nonpoint sources. Regulated stormwater sources may also contribute to sediment loading; the Big Sucker Creek (Sucker River) watershed includes a portion of the Duluth Township's regulated MS4.

Stream crossings and culverts are likely to be affecting fish populations (i.e., physical barrier) and contributing to sediment loading through erosion in the LSS Watershed. An inventory and analysis of stream crossings and culverts was conducted by Lake County SWCD and is provided in Figure 24.

**Table 8. Permitted point sources in the LSS Watershed**

| HUC10 Subwatershed | Point Source | | | Pollutant reduction needed beyond current permit? |
|---|---|---|---|---|
| | Name | Permit # | Type | |
| Beaver River – Frontal Lake Superior (0401010201) | Beaver Bay WWTP | MN0040754 | Municipal wastewater | Yes |
| | Best Ready Mix - Silver Bay | MNG490286 | Industrial stormwater | No |
| | Lake County Highway Department Gravel Pits | MNG490296 | Industrial stormwater | No |
| | Northshore Mining Co - Silver Bay | MN0055301 | Industrial discharge | Yes |
| | Silver Bay WWTP | MN0024899 | Municipal wastewater | No |
| Gooseberry River – Frontal Lake Superior (0401010202) | Castle Danger Demo Landfill | MNR0539TF | Industrial stormwater | No |
| | Hudson Aggregates LLC | MNG490220 | Industrial stormwater | No |
| | Lake County Highway Department Gravel Pits | MNG490296 | Industrial stormwater | No |
| | Lake County Sanitary Landfill | MNRNE3BXL | Industrial stormwater | No |
| | Silver Creek Township WWTP | MN0063908 | Municipal wastewater | No |
| | Two Harbors WWTP - ISW | MNRNE3CWM | Industrial stormwater | No |
| Knife River – Frontal Lake Superior (0401010203) | Arrowhead Recycle Center | MNR0539TD | Industrial stormwater | No |
| | B&B Aggregates | MNRNE38YB | Industrial stormwater | No |
| | Best Ready Mix – Silver Bay | MNG490286 | Industrial stormwater | No |
| | Builtrite Manufacturing Inc | MNR053CHH | Industrial stormwater | No |
| | Daniel Zeimet's Property | MNR0538RV | Industrial stormwater | No |
| | Lake County Highway Department Gravel Pits | MNG490296 | Industrial stormwater | No |
| | Larsmont Cottages on Lake Superior | MN0068853 | Private wastewater | No |
| | Louisiana-Pacific Corp – Two Harbors | MNR0539XC | Industrial stormwater | No |
| | Northshore Steel Inc | MNR053B9H | Industrial stormwater | No |
| | Richard B Helgeson Airport | MNR0539FF | Industrial stormwater | No |
| | Stanley LaBounty | MNR053BJJ | Industrial stormwater | No |
| | Two Harbors WWTP | MN0022250 | Municipal wastewater | No |
| | Willamette Valley Co | MNRNE38FN | Industrial stormwater | No |
| | Wisconsin Central Ltd - Two Harbors Transshipment | MN0049018 | Industrial discharge | No |
| City of Duluth – Frontal Lake Superior (0401010204) | MDNR French River Hatchery | MN0004413 | Industrial discharge | Yes |
| | US EPA - MED-Duluth | MN0110914 | Industrial discharge | No |

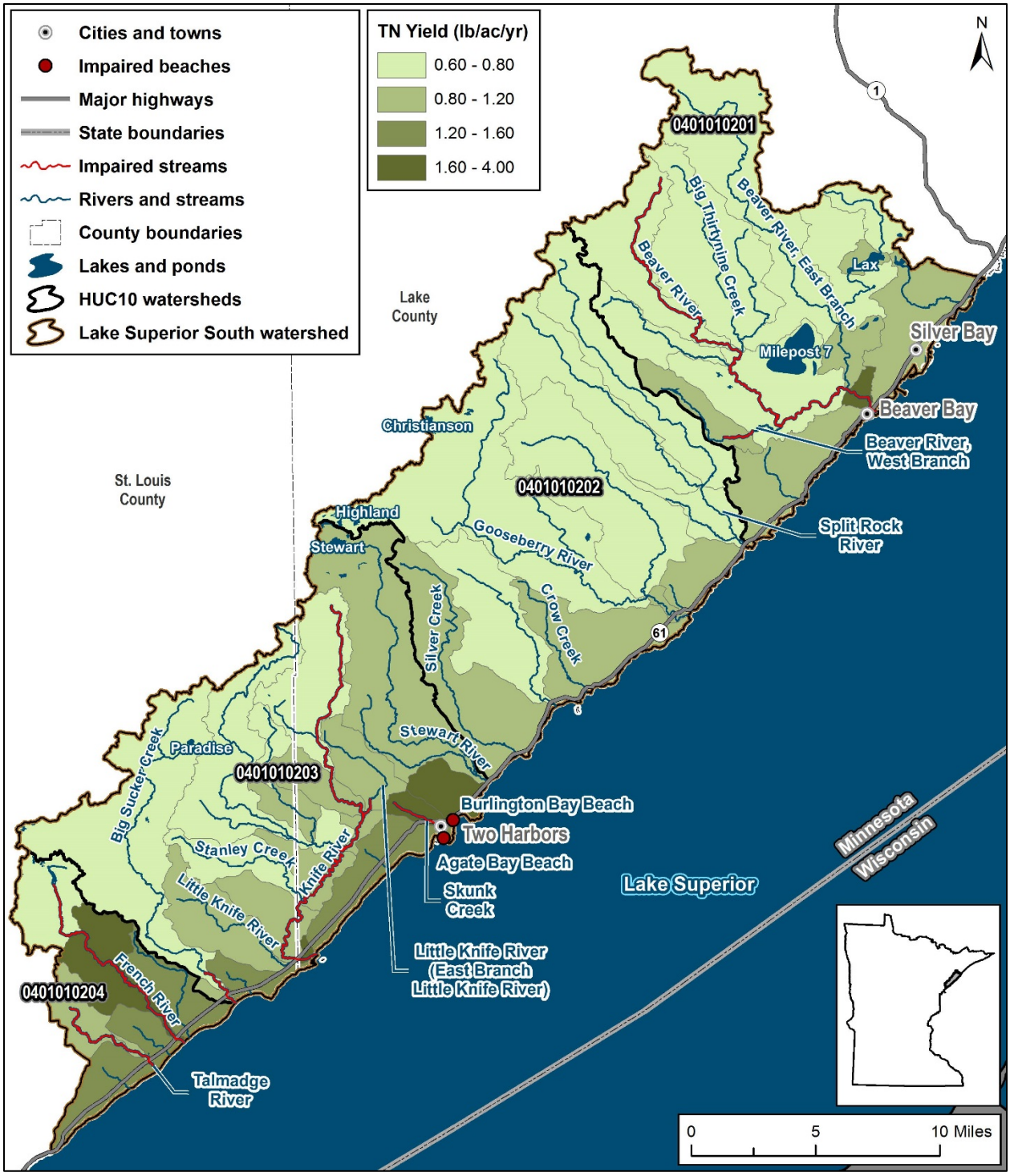


Figure 21. TN yield by HUC12 from HSPF model in LSS.

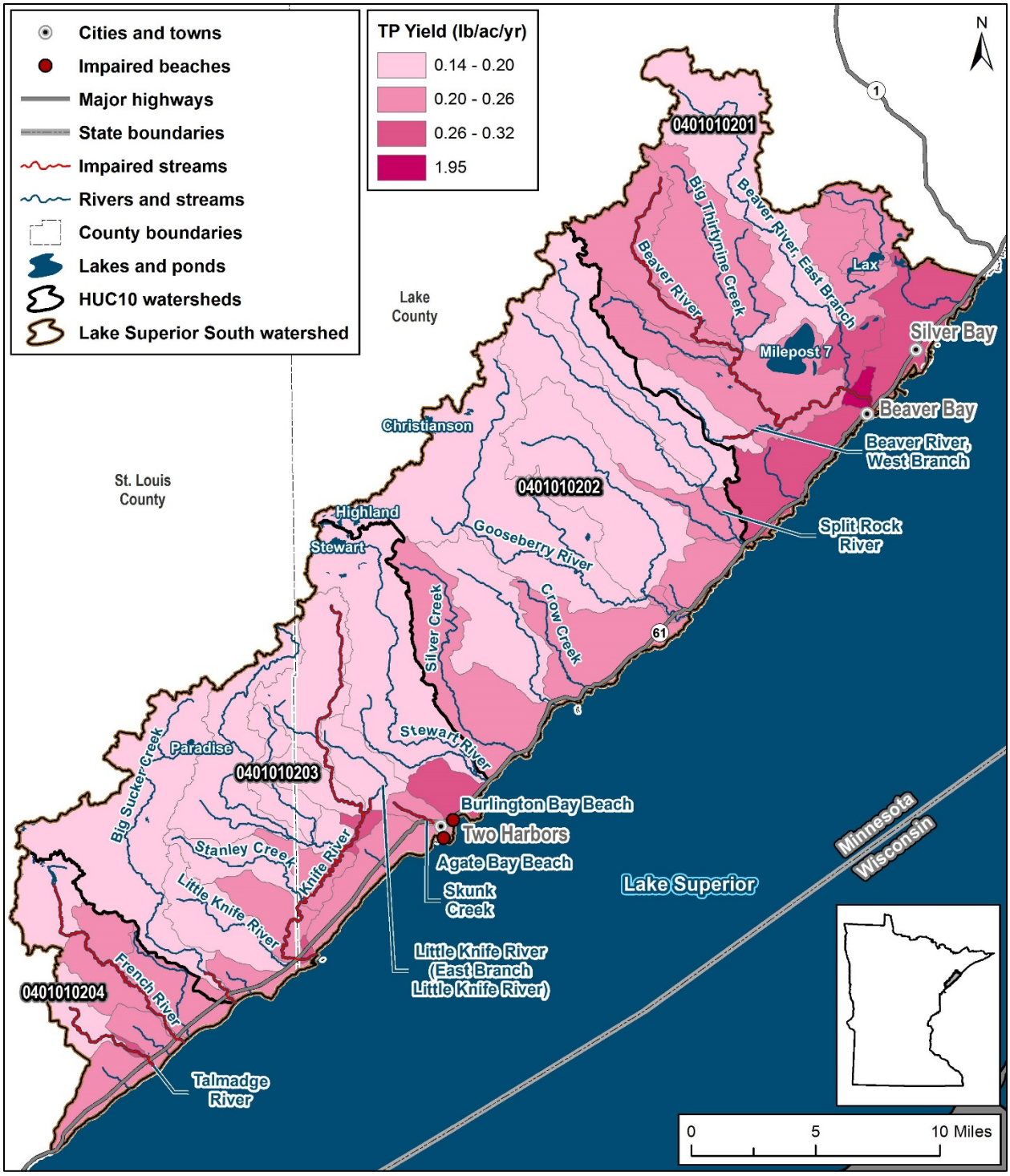


Figure 22. TP yield by HUC12 from HSPF model in LSS.

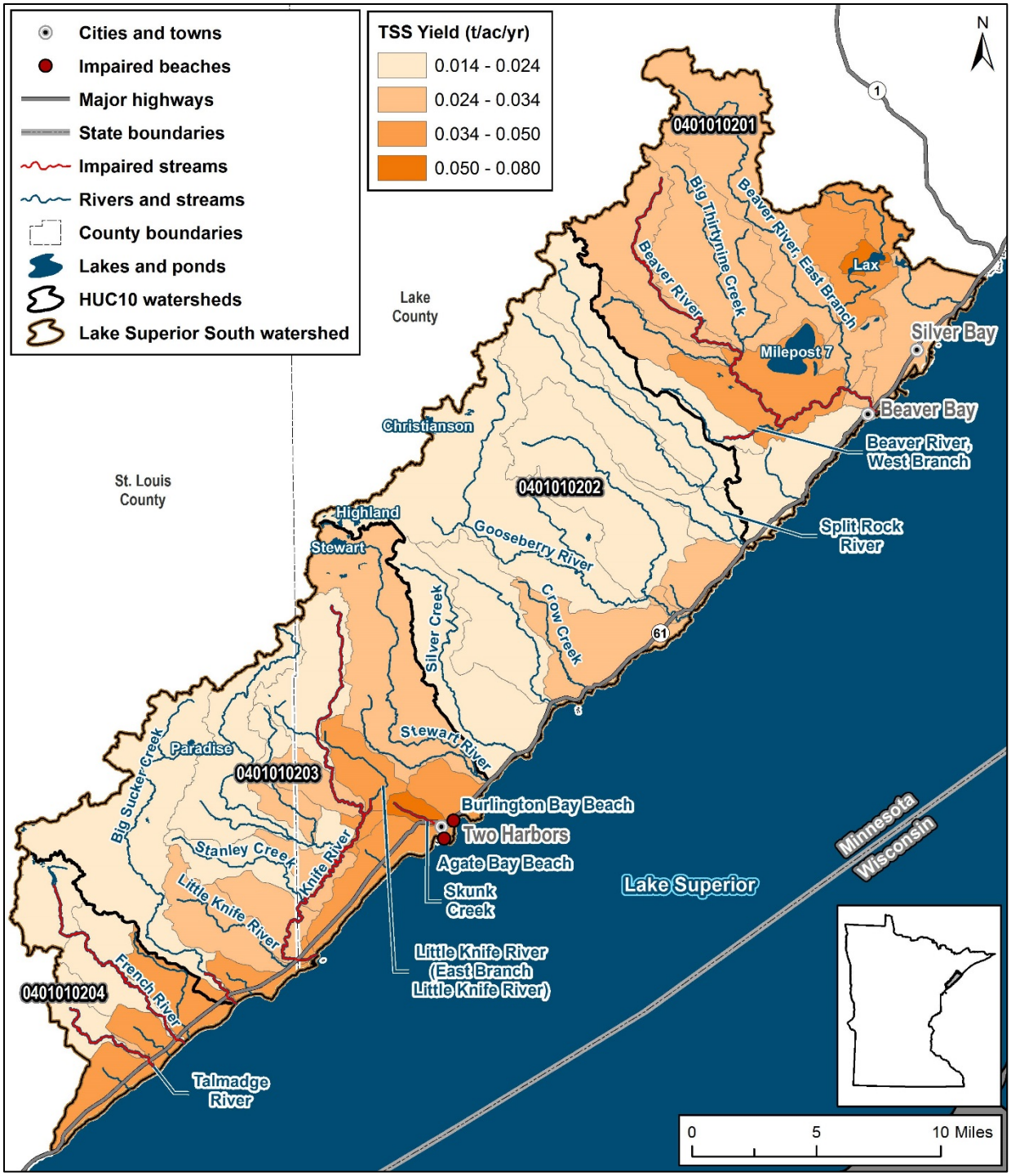


Figure 23. TSS yield by HUC12 from HSPF modeling in LSS.

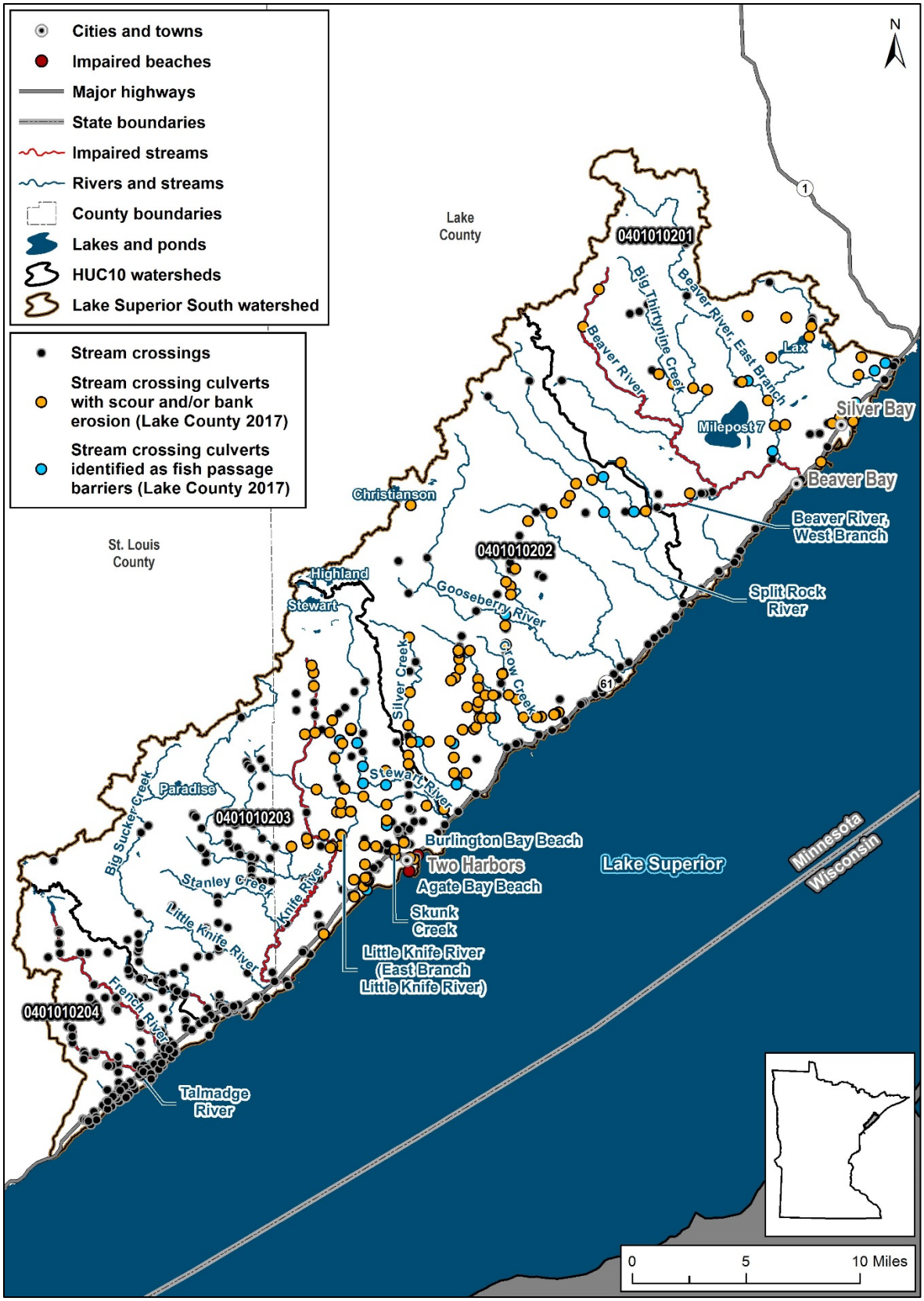


Figure 24. Stream crossings in the LSS Watershed.

## 2.4 Protection Considerations

All waters in the LSS Watershed require protection in some capacity, including those listed as impaired. For non-impaired waters, protection considerations are based on identifying those waters that are particularly threatened or vulnerable, as well as those that are of the highest value and quality. Protection is often implemented through land use planning and ordinances, as well as conservation practices.

Stream vulnerability was determined based on their index of biotic integrity (IBI) scores (Figure 25 and Figure 26). In the figures below, the blue markers ("> upper confidence limit") indicate streams that are comfortably meeting IBI targets. The green and purple markers ("> or < threshold") indicate streams with IBI scores that are close enough to the targets that the streams are considered threatened of becoming impaired, and the red markers ("< lower confidence limit") indicate streams that do not meet the IBI targets. The streams that are near the expected target score for either fish or macroinvertebrate IBI (green and purple markers) are unimpaired but at risk of becoming so. These streams are considered for protection because (1) they have a high potential for restoration and (2) they are potentially vulnerable to impairment in the future. It is possible that some of the lower scoring monitoring sites are due to poor monitoring site selection, physical barriers downstream, or application of a target that is not reflective of the stream condition. In the future, a Tiered Aquatic Land Uses framework may provide stream-specific IBI targets that could result in changes to this protection assessment. Those streams that are unimpaired and/or threatened based on the IBI data include:

- Palisade Creek
- Cedar Creek
- Beaver River, West Branch and East Branch
- Crow Creek
- Silver Creek
- Stewart River
- Little Stewart River
- Encampment Creek
- Unnamed Creek (tributary to Split Rock River)
- Skunk Creek
- Little Gooseberry River
- Dago Creek
- Gooseberry River
- Knife River, West Branch
- Little Knife River
- Big Sucker Creek (Sucker River)

Lakes were also analyzed for protection as part of a statewide effort. The effort developed goals for lakes that meet water quality standards, identified unimpaired lakes that are at greatest risk, and developed a preliminary priority ranking for protection efforts. Water quality risk is determined by each lake's sensitivity to increased phosphorus loading, proximity to the water quality standard, the percent of disturbed land use in the watershed, lake size, existing phosphorus levels, and whether the lake shows a declining trend in water clarity (MPCA et al. 2017). As a result of this effort, Stewart Lake (38074400) was identified for water quality protection. The statewide effort did not evaluate Lake Superior. However, Lake Superior is recognized nationally and internationally as one of world's most important freshwater lakes. In addition, Lake Superior is identified as one of the most important resources locally. Lakes identified for protection in this WRAPS include Stewart Lake and Lake Superior.

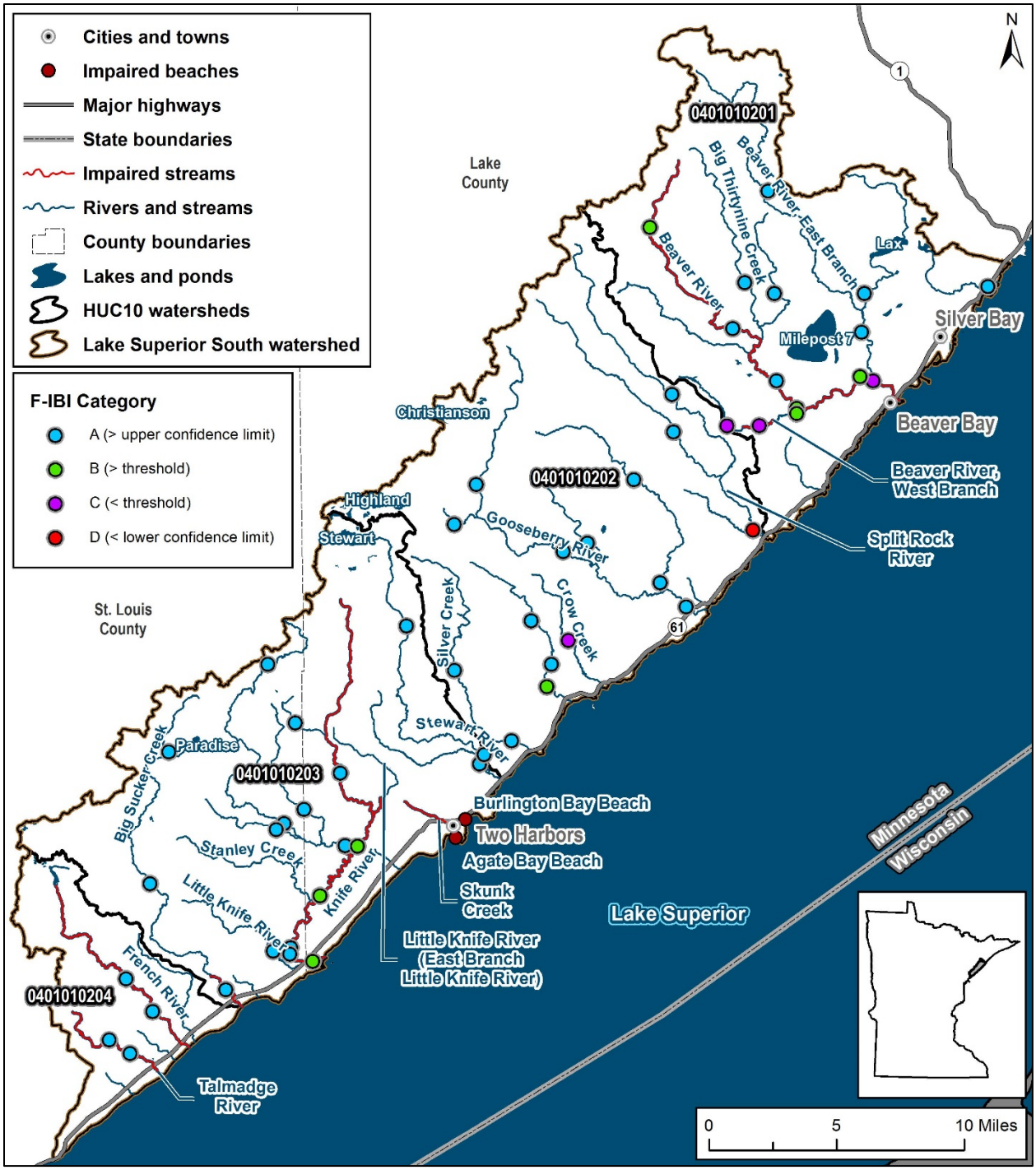


Figure 25. F-IBI categories in the LSS Watershed.

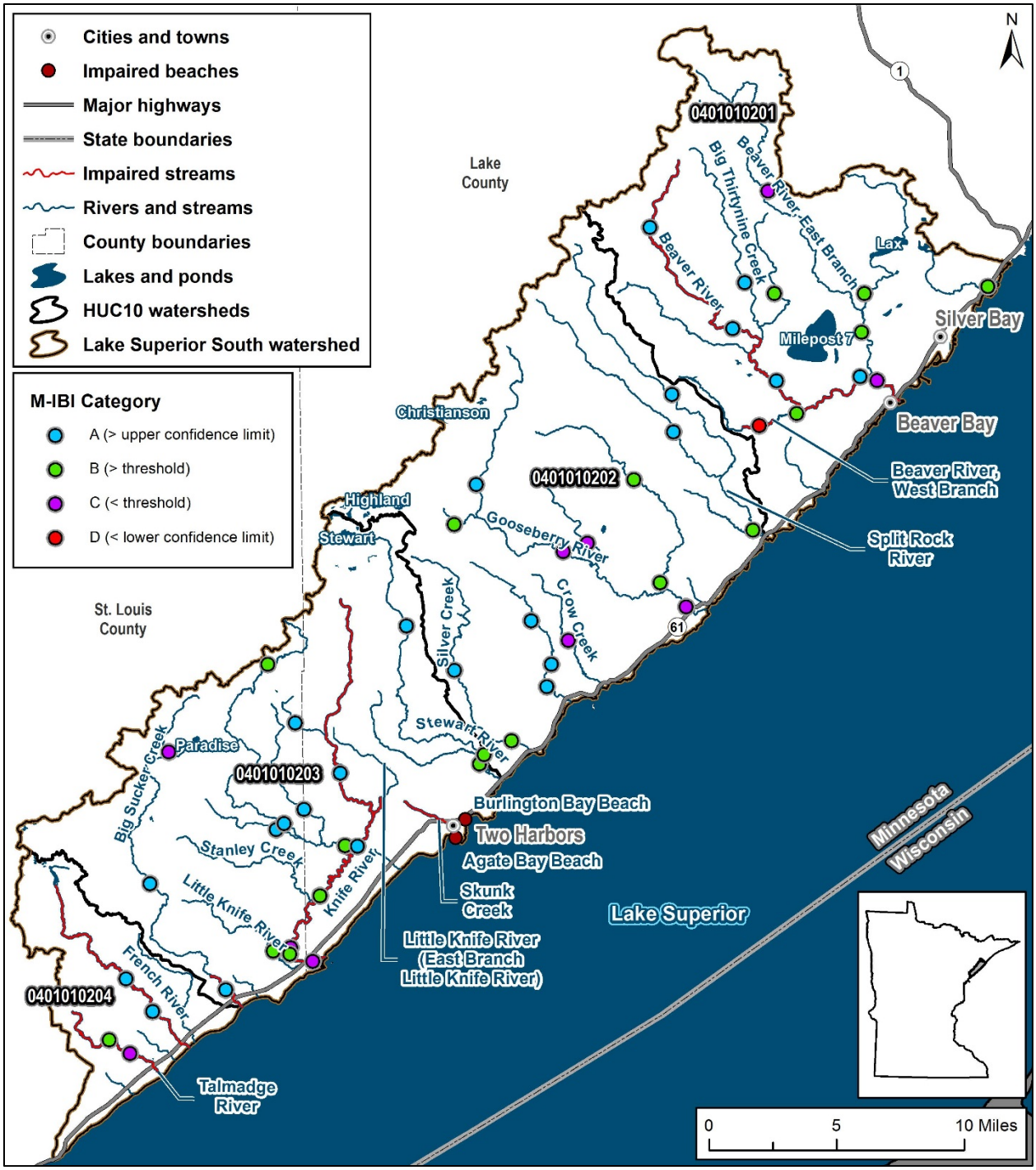


Figure 26. M-IBI categories in the LSS Watershed.

# 3. Prioritizing and Implementing Restoration and Protection

The LSS Watershed contains several waters in need of restoration, and numerous streams, lakes, and natural areas that are very high quality and require protection. There are also several water resources that are threatened and vulnerable to land use changes and management activities. Sediment, fecal bacteria (*E. coli*), high temperatures, low DO, pH, poor habitat, altered flow, and loss of connectivity contribute to these challenges. Restoration strategies to address these concerns are provided by stream in Section 3.3. All waters are also in need of protection; activities that promote protection typically rely on land use planning and conservation.

The Clean Water Legacy Act (CWLA) requires that WRAPS reports summarize priority areas for targeting actions to improve water quality, identify point sources, and identify nonpoint sources of pollution with sufficient specificity to prioritize and geographically locate watershed restoration and protection actions. In addition, the CWLA requires including an implementation table of strategies and actions that are capable of cumulatively achieving needed pollution load reductions for point and nonpoint sources.

This section of the report provides the results of prioritization and strategy development. Because many of the nonpoint source strategies outlined in this section rely on voluntary implementation by landowners, land users and residents of the watershed, it is imperative to create social capital (trust, networks and positive relationships) with those who will be needed to voluntarily implement best management practices. Thus, effective ongoing civic engagement is part of the overall plan moving forward.

The implementation strategies, including associated scales of adoption and timelines provided in this section, are the result of existing local watershed plans and professional judgment based on what is known at this time and, thus, should be considered approximate. Furthermore, many strategies are predicated on needed funding being secured. As such, the proposed actions outlined are subject to adaptive management—an iterative approach of implementation, evaluation and course correction.

## 3.1 Targeted Geographic Areas

The primary purpose of this section is to identify targeted or critical areas in which to focus implementation activities during the first 10 years of implementation. Targeted geographic areas are identified based on a detailed prioritization and ranking process conducted as part of the 1W1P process. This process involved numerous meetings with stakeholders and reflects the local priorities in the watershed. The process also included integration of local and regional management plans, expertise from regional partnering agencies and organizations, and the use of Zonation. Zonation is a value-based model that uses a combination of individual landscape features and analyzed spatial information about these criteria to prioritize areas for conservation and restoration. From this in-depth process, priority areas for the first 10 years of implementation were identified (Table 9 and Figure 27). Three impaired streams including the Talmadge River, French River, and Big Sucker Creek were not included in the Zonation process and were not ranked for prioritization in the 1W1P. In the future, additional prioritization work should focus on evaluating all of the waters within the LSS Watershed.

In addition, a summary of point and nonpoint pollutant loading by model catchment (approximately HUC12 scale) derived from watershed modeling results is provided in Section 2.3. The results identify areas with disproportionately high loading rates of various pollutants and can be used to focus implementation activities.

**Table 9. 10-Year targeted geographic areas for restoration and protection**

| Type | HUC10 | Priority Area | Description (from One Watershed, One Plan) |
|---|---|---|---|
| Restoration [a] | Beaver River – Frontal Lake Superior (0401010201) | Beaver River | · Includes impaired waters on the EPA 303(d) list<br>· Includes areas of biological significance<br>· Susceptible to ground water contamination |
| | Knife River – Frontal Lake Superior (0401010203) | Knife River | · Included on the EPA 303(d) list of impaired waters |
| | | Two Harbors | · One of the largest municipalities in watershed<br>· Experiencing increased land development pressures<br>· Contains Skunk Creek impaired for recreation and aquatic life |
| Protection [b] | Gooseberry River – Frontal Lake Superior (0401010202) | Gooseberry River HUC10 | · Only HUC10 in Lake County with no impairments<br>· Includes a large area of intact forests and undisturbed wetlands<br>· Considered a vulnerable watershed |
| | Knife River – Frontal Lake Superior (0401010203) | Stewart River | · Concern for the impact of this watershed's discharge on the source water quality for the Two Harbors municipality<br>· Identified as a priority watershed in the Lake County 2005-2015 Local Water Management Plan |
| | All | Nearshore Lake Superior | · Area with strong potential for future land development, known septic issues, and significant shoreline management issues, including the presence of a number of erosion hazard zones<br>· Several trout streams s flow through this area<br>· Includes a significant number of rare features and sites of biological significance |

a. The French River, Talmadge River, and Big Sucker Creek are all impaired waters, however these watersheds were not evaluated as part of the 1W1P Zonation process and therefore were not included in the 1W1P prioritization. Future prioritization work should include evaluation of all waters in the LSS Watershed.
b. Note that the entire watershed requires protection.

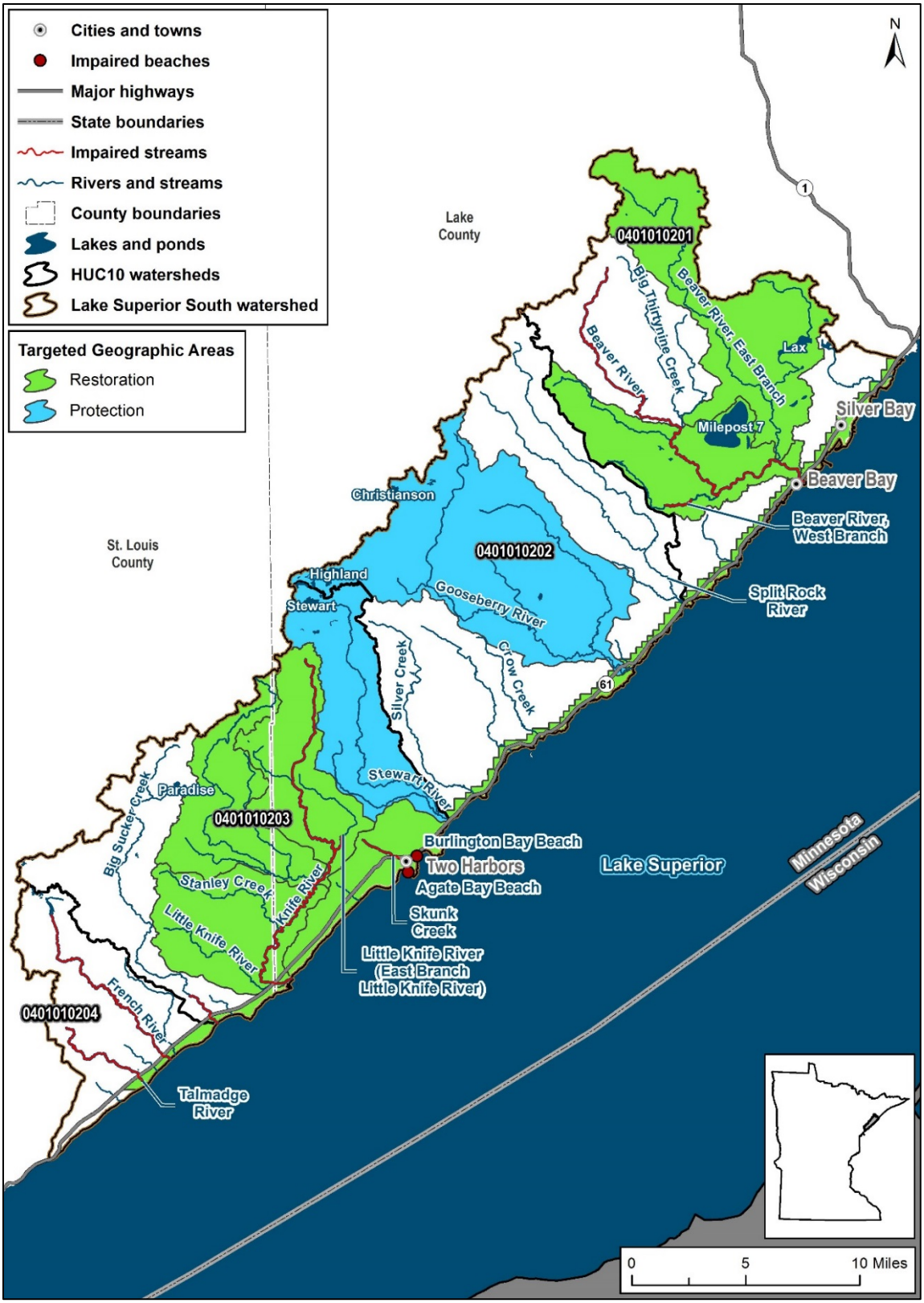


**Figure 27. Targeted geographic areas.**
Note that the entire watershed requires protection; targeted geographic areas focuses implementation activities over the next 10 years in select areas.

## 3.2 Civic Engagement

A key prerequisite for successful strategy development and on-the-ground implementation is meaningful civic engagement. This is distinguished from the broader term 'public participation' in that civic engagement encompasses a higher, more interactive level of involvement. The MPCA has coordinated with the University of Minnesota Extension Service for years on developing and implementing civic engagement approaches and efforts for the Watershed Approach. Specifically, the University of Minnesota Extension's definition of civic engagement is "Making 'resourceFULL' decisions and taking collective action on public issues through processes that involve public discussion, reflection, and collaboration." Extension defines a resourceFULL decision as one based on diverse sources of information and supported with buy-in, resources (including human), and competence. Further information on civic engagement is available at: https://extension.umn.edu/customized-education#leadership.

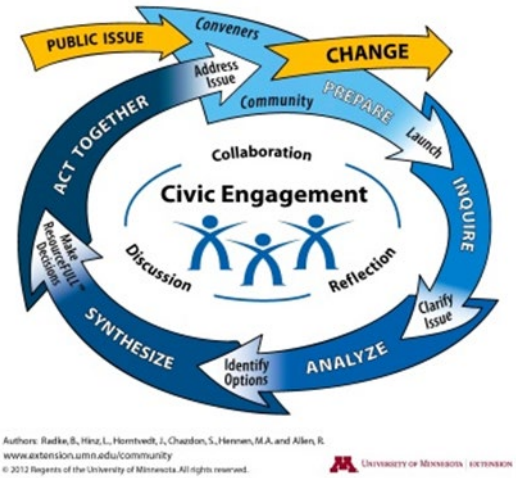


Figure 28. ResourceFULL process.

### WRAPS Development

During the development of the LSS WRAPS, four meetings were held with the Lake Superior South Watershed Core Team for technical advice, updates, and strategy prioritization: January 24th, April 3rd, June 13th, and October 26th of 2017. Lake County and South St. Louis SWCD staff conducted a series of complimentary public engagement events ranging from homeowner workshops to hosting and interviewing guests on a local radio program. Examples of events held in the LSS include:

- Water resource management site tour (9 attendees)
- Rain garden planting workshop, Knife River (15 participants)
- Six community conversations, various locations (70+ participants)
- Culvert workshop field day (45 participants)
- Participation in St. Urho's Day in Finland (north of the watershed) and Two Harbor Heritage Day parades (7,000+ impressions)

### One Watershed, One Plan for the Lake Superior North Watershed

During the development of 1W1P for the Lake Superior North, public meetings were held to create opportunities for local constituents to participate in identifying water quality concerns in the watershed, and to provide the public with background information and an overview of the 1W1P process. Broad natural resource issues were discussed to gain local insight to water quality problems. The following four issue categories were discussed:

- Reducing erosion and runoff
- Protecting/improving waters of concern

- Protecting/improving fish and wildlife habitat
- Protecting/focusing on lands of concern

Citizen input was gathered and incorporated into the planning process. For more information, see the 1W1P Section 2.2.3 and Appendix A.

### Public Notice for Comments

An opportunity for public comment on the draft WRAPS report was provided via a public notice in the *State Register* from February 26, 2018 to March 28, 2018.

## 3.3 Restoration & Protection Strategies

The LSS Watershed transitions from the developed areas surrounding Duluth and Two Harbors northeast to the forested North Shore of Lake Superior. Because of its proximity to urban areas, this watershed is subject to development pressures, along with the effects of existing development, forestry activities, recreation, and industry. Development in the watershed results in new impervious surfaces, increases in runoff and associated pollutant loads, new roads and culvert crossings, and conveyance systems (e.g., ditches, storm sewers). The watershed is also stream-dominated, with little available runoff storage in the form of lakes and wetlands. These characteristics, combined with highly erodible soils, result in high peak flows and associated sediment concentrations. Creating opportunities for additional storage and stabilizing erodible soils are important strategies for restoration and protection. During the development of the WRAPS, existing watershed plans and assessments provided meaningful local knowledge to the selection of strategies. This section provides a summary of implementation strategies and actions for both restoration and protection. There are several strategies that apply across the entire watershed; these are provided in a watershed-wide summary table (Table 10). In an effort to coordinate and align the WRAPS document with the pre-existing local water management plan for the area, specific goals from the 1W1P that are applicable to the WRAPS document were included as restoration and protection strategies and are delineated by *italics* when applicable. Table 11 includes protection strategies specific to the nearshore area of Lake Superior. This priority area is present across the entire watershed. Strategies are then summarized at a HUC10 watershed scale, and by assessment unit for impaired waters or waters that are targeted for protection efforts in Table 12. The summary tables include the following information:

- ***Water Quality – Current Conditions:*** "Current" condition is interpreted as the baseline condition over the evaluation period for the pollutant or non-pollutant stressor identified in the previous column. Current loads represent available data sources and reference information included in Section 2.1.
- ***Water Quality – Goals / Targets and Estimated % and Load Reduction by Flow Regime:*** Includes the reductions needed to meet water quality standards, and are referenced to Appendix A that includes the TMDL summaries. Percent reductions are typically included as a range that covers the different flow regimes (e.g., reductions under high flow and dry

conditions) when a TMDL is provided for multiple flow regimes (see Appendix A). The range represents the highest and lowest reduction needed across all flow regimes.

- ***Strategy and Strategy Type:*** These columns provide the strategies to be used for both protection and restoration. Strategies outline the method, approach, or combination of approaches that could be taken to achieve or maintain water quality goals.
- ***Estimated Adoption Rates:*** These columns tie to the strategies column and generally describe the magnitude of effort that it will take to achieve the 10-year milestones and ultimate implementation goal. These estimates are meant to describe approximately "what needs to happen" but does not detail precisely "how" goal attainment will be achieved (the latter is left to subsequent planning steps). These estimates are an approximation only and subject to adaptive management. Note that some water bodies do not have any planned activity during the first 10 years. These water bodies are lower priority and activities are expected to take place in the future. The method used to derive numeric milestones for the *Streambank Stabilization* strategy was based on the following when applicable:
    - Available stream-specific geomorphic data were used to determine the linear feet of restoration needed to achieve the water quality goal associated with this strategy. Those stream segments with the highest loading rate per linear foot were prioritized for restoration.
- ***Governmental Units with Primary Responsibility:*** Identifies the governmental unit with primary responsibility. Other government entities as well as stakeholders, non-profits, and non-governmental organizations will likely support these strategies.
- ***Estimated Year to Achieve Water Quality Targets:*** This applies to the water body, specifically the year it is reasonably estimated that applicable water quality targets will be achieved. These dates are based on the level of implementation needed to achieve standards, watershed priorities, and best professional judgement. Activities related to protection efforts are ongoing.

Achieving the goals of this WRAPS will require partnerships and collaboration, in addition to financial resources. Governmental units with primary implementation responsibility include the following entities:

- MPCA
- DNR
- MDH
- BWSR
- USDA Forest Service
- Counties (Lake and St. Louis)
- SWCDs (Lake and St. Louis counties)
- Municipalities

In addition, many other partners are anticipated to participate with implementation:

- Forestry and mining interests
- Non-profits (e.g., Trout Unlimited, Sugarloaf Stewardship Association)
- Universities
- Land and business owners

Government agencies with secondary responsibilities include the MDA, USGS, EPA, USDA NRCS, and Fish and Wildlife Service. These agencies will work with private landowners and other agencies and project partners to support implementation of this WRAPS.

The proposed WRAPS will rely on available funding sources to fund projects and programs. The level of implementation proposed for the first 10 years is significantly higher than existing efforts and will require new sources of funding for local capacity and capital improvement projects. Potential funding sources for implementation activities include:

- Clean Water Fund, part of the Clean Water, Land, and Legacy Amendment
- Outdoor Heritage Fund, part of the Clean Water, Land, and Legacy Amendment
- Legislative-Citizen Commission on Minnesota Resources
- Local government cost-share and loan programs
- Minnesota Lake Superior Coastal Program
- Federal grants and technical assistance programs
- Conservation Reserve Program and NRCS cost-share programs
- Federal Clean Water Act Section 319 program for watershed improvements
- Great Lakes Restoration Initiative
- National Fish and Wildlife Foundation
- Great Lakes Protection Fund
- Minnesota Clean Water Partnership Loan Program

Table 10. Watershed wide strategies and actions proposed for the LSS Watershed

| Waterbody and Location | | | Water Quality | | | Strategies | Strategy scenario showing estimated scale of adoption to meet 10-year milestone and final water quality targets. Scenarios and adoption levels may change with additional local planning, research showing new BMPs, changing financial support and policies, and experience implementing the plan. | | | | | Governmental Units with Primary Responsibility | | | | | | | | Estimated Year to Achieve Water Quality Target |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| HUC10 Subwatershed | Waterbody (ID) | Location and Upstream Influence Counties | Parameter (incl. non-pollutant stressors) | Current Conditions (load or conc.) | Goals / Targets and Estimated % Reduction | | Strategy Type | Estimated Adoption Rate: Current strategy adoption level, if known | Interim 10-year Milestone | Suggested Goal | Units | Counties | SWCDs | Cities/Townships | MPCA | DNR | MDH | BWSR | Forest Service | |
| All | All | St. Louis and Lake Counties | Parameters cited in permit | - | - | | Construction and Industrial Stormwater permittees—compliance with general permits | | | | | | | | X | | | | | Ongoing |
| | | | Varies | Varies (see Figure 5, Figure 6, Figure 7 and Figure 8 for current water quality conditions) | Varies (see Appendix A for % reductions)<br><br>Meet or exceed IBI standards in all streams | Address subsurface sewage treatment systems (SSTS) | Inventory and assess the potential for septic systems/private wastewater systems to be sources of *E. coli* and nutrients.<br><br>Create and maintain a database of SSTS (i.e., owner, age, installer, size, location, construction technique, maintenance records, etc.).<br><br>Replace all systems deemed imminent threat to public health (e.g., straight pipes, surface seepage).<br><br>Support increased compliance inspections (in addition to current point of sale inspections).<br><br>Landowner focused education and outreach on septic system maintenance and compliance.<br><br>Additional setbacks in sensitive areas.<br><br>*Applicable 1W1P Goals:*<br><br>*Provide financial assistance for SSTS upgrades.*<br><br>*Implement and enforce county SSTS ordinances.* | -- | Complete all SSTS work in Skunk Creek Watershed including upgrade of all systems deemed imminent threat to public health | 100% compliance of SSTS in the watershed | # of septic systems | X | | | X | | | | | 2030 |
| | | | | | | Protect and stabilize lakeshores | Shoreland survey—evaluate the shoreland and identify areas of disturbance, such as altered vegetation (e.g., lawns), bare soil, and shoreland erosion.<br><br>Lakeshore revegetation and buffers. | -- | Complete shoreland survey | Natural buffers around majority of lakeshore | % of buffers | X | X | | | X | | X | X | 2040 |
| | | | | | | Fisheries management | Improve riparian buffers to provide shade and remain consistent with current buffer requirements (Shoreland Management Act, MN Buffer Law).<br><br>Advocate for a healthy fishery with emphasis on key species in specific locations.<br><br>Provide steelhead nursery habitat.<br><br>*Applicable 1W1P Goals:*<br><br>*Maintain high quality and diverse fishery.* | -- | Buffers for all stream reaches consistent with Buffer Law and Shoreland Management Act | Maintain flows and water levels that emulate natural conditions in all streams | % of flows and water levels | | | | | X | | | | Ongoing |

| Waterbody and Location | | | Water Quality | | | Strategies | Strategy scenario showing estimated scale of adoption to meet 10-year milestone and final water quality targets. Scenarios and adoption levels may change with additional local planning, research showing new BMPs, changing financial support and policies, and experience implementing the plan. | | | | | Governmental Units with Primary Responsibility | | | | | | | | Estimated Year to Achieve Water Quality Target |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| HUC10 Subwatershed | Waterbody (ID) | Location and Upstream Influence Counties | Parameter (incl. non-pollutant stressors) | Current Conditions (load or conc.) | Goals / Targets and Estimated % Reduction | | Strategy Type | Estimated Adoption Rate: Current strategy adoption level, if known | Interim 10-year Milestone | Suggested Goal | Units | Counties | SWCDs | Cities/Townships | MPCA | DNR | MDH | BWSR | Forest Service | |
| All (cont.) | All | St. Louis and Lake Counties | Varies | Varies (see Figure 5, Figure 6, Figure 7 and Figure 8 for current water quality conditions) | Varies (see Appendix A for % reductions)<br><br>Meet or exceed IBI standards in all streams | Fisheries management (cont.) | *Evaluate impacts of beaver and beaver dams on cold water fisheries (water storage, flashiness, bank susceptibility, temperature).*<br><br>*Maintain or enhance current brook trout populations. Identify and preserve sites that have high species diversity and/or critical habitat for fish or wildlife.*<br><br>*Evaluate implications of single species management. Identify minimum standards of water levels required for in–stream biological uses.* | -- | See above | See above | See above | | | | | X | | | | Ongoing |
| | | | | | | Increase stream connectivity | Identify/prioritize the rehabilitation of problematic road or trail and stream intersections.<br><br>Upgrade and replace culverts identified as barriers to fish passage (see Figure 24)<br><br>Properly size and place bridges and culverts for flow, stream stability, and fish passage.<br><br>Coordinate with transportation departments to ensure bridge or culvert replacements are designed and constructed to eliminate fish passage and erosion problems.<br><br>*Applicable 1W1P Goals:*<br><br>*Develop and maintain road construction and maintenance policies that assure free-flowing riparian systems and stream–accessible floodplains that connect Lake Superior with the headwater lakes, streams and wetlands. All stream and wetland crossings will follow the principles of MESBOAC.*<br><br>*Update county and SWCD culvert standard to accommodate fish passage and larger storm events.* | -- | Complete inventory of culverts in St. Louis County<br><br>Updated county culvert standards | Replace all of culverts identified as barriers to fish passage on trout streams | # of culverts | X | | X | | X | | | | 2040 |
| | | | | | | Improve fish and macroinvertebrate IBI scores | Further evaluate cause of low IBI scores (see Figure 25 and Figure 26).<br><br>Implementation activities to improve biological diversity and abundance (e.g., habitat restoration, barrier removal, etc.). | 44% of macroinvertebrate IBI score > threshold<br><br>72% of fish IBI score > threshold | 10-15% increase in % of sites meeting IBI use thresholds | 100% of sites meeting IBI use thresholds | % of sites | | X | | X | | | | | 2040 |

| Waterbody and Location | | | Water Quality | | | Strategies | Strategy scenario showing estimated scale of adoption to meet 10-year milestone and final water quality targets. Scenarios and adoption levels may change with additional local planning, research showing new BMPs, changing financial support and policies, and experience implementing the plan. | | | | | Governmental Units with Primary Responsibility | | | | | | | | Estimated Year to Achieve Water Quality Target |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| HUC10 Subwatershed | Waterbody (ID) | Location and Upstream Influence Counties | Parameter (incl. non-pollutant stressors) | Current Conditions (load or conc.) | Goals / Targets and Estimated % Reduction | | Strategy Type | Estimated Adoption Rate: Current strategy adoption level, if known | Estimated Adoption Rate: Interim 10-year Milestone | Estimated Adoption Rate: Suggested Goal | Estimated Adoption Rate: Units | Counties | SWCDs | Cities/Townships | MPCA | DNR | MDH | BWSR | Forest Service | |
| All (cont.) | All | St. Louis and Lake Counties | Varies | Varies (see Figure 5, Figure 6, Figure 7 and Figure 8 for current water quality conditions) | Varies (see Appendix A for % reductions)<br><br>Meet or exceed IBI standards in all streams | Invasive species control | Implement County aquatic invasive species plans; Lake County and St. Louis County plans completed in 2015.<br><br>Continue coordination and implementation of activities as part of Arrowhead Invasive Species collaboration.<br><br>Research and develop guidance on activities to control invasive species (e.g., dwarf mistletoe) that balance watershed health. | Boat access sites have signage and information on aquatic invasive species | Implement County AIS plans | Implement County AIS plans | # of activities | X | X | | | X | | | | Ongoing |
| | | | | | | Land use planning and ordinance | Align and coordinate riparian buffer regulations at the federal/state/ and local levels.<br><br>Inventory potential for tax forfeited lands, School Trust Lands, and Con Con (consolidated conservation lands) Lands to provide water quality protection or improvements; retain the ecosystem benefits provided by these lands where appropriate.<br><br>Conservation easements to protect riparian, lakeshore, wetland, and high quality upland areas.<br><br>Additional setbacks for lakeshore development.<br><br>Utilize audit tools such as EPA's Water Quality Scorecard to systematically address ordinance deficiencies and gaps.<br><br>Evaluate impacts of and increase resiliency to climate change on water resources. Develop and adopt in-stream flow targets, particularly in periods of extreme drought or low flows.<br><br>Monitor and enforce no dumping regulations at popular sites for illegal dumping.<br><br>Increased trash receptacles and dog waste stations on or near beaches. | -- | Complete plan to address tax forfeited lands and School Trust lands into the future<br><br>Complete analysis to align buffer regulations<br><br>Identify gaps in current ordinances | Update all ordinances in consideration of water quality protection | # of updates | X | | X | | | | | | 2030 |
| | | | | | | Stormwater runoff management | Implement green infrastructure practices and BMPs to increase infiltration and reduce flooding and runoff in upstream reaches. See MPCA Stormwater Manual http://stormwater.pca.state.mn.us/index.php/Information_on_pollutant_removal_by_BMPs.<br><br>Evaluate altered hydrology as the underlying cause of channel scour, bank instability and water quality impairments.<br><br>Implement a program to disconnect impervious surfaces from conveyances or direct drainage. | Two Harbors has an existing stormwater plan, dated 2001 | Update stormwater management plan in Two Harbors | Update stormwater management plans every 10 years<br><br>Conduct stormwater maintenance on a regular schedule | # plan updates completed<br><br># hours conducting maintenance | X | X | X | | | | | | Ongoing |

| Waterbody and Location | | | Water Quality | | | Strategies | Strategy scenario showing estimated scale of adoption to meet 10-year milestone and final water quality targets. Scenarios and adoption levels may change with additional local planning, research showing new BMPs, changing financial support and policies, and experience implementing the plan. | | | | | Governmental Units with Primary Responsibility | | | | | | | | Estimated Year to Achieve Water Quality Target |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Estimated Adoption Rate | | | | | | | | | | | | |
| HUC10 Subwatershed | Waterbody (ID) | Location and Upstream Influence Counties | Parameter (incl. non-pollutant stressors) | Current Conditions (load or conc.) | Goals / Targets and Estimated % Reduction | | Strategy Type | Current strategy adoption level, if known | Interim 10-year Milestone | Suggested Goal | Units | Counties | SWCDs | Cities/Townships | MPCA | DNR | MDH | BWSR | Forest Service | |
| All (cont.) | All | St. Louis and Lake Counties | Varies | Varies (see Figure 5, Figure 6, Figure 7 and Figure 8 for current water quality conditions) | Varies (see Appendix A for % reductions)<br><br>Meet or exceed IBI standards in all streams | Stormwater runoff management (cont.) | Develop or update existing stormwater management plans.<br><br>Develop and implement new guidance on ditch (public and private) maintenance activities that will minimize un-vegetated channels and associated erosion.<br><br>Assess the state of existing roadside ditches and identify priority locations for ditch management (e.g., re-vegetation, armoring).<br><br>Institutionalize operation and maintenance procedures for road ditches.<br><br>*Applicable 1W1P Goals:*<br><br>*Develop stormwater management plans on priority riparian land, including golf courses.*<br><br>*Inventory, maintain and re-vegetate current ditches with native species.*<br><br>*Consider and implement climate change adaptation strategies on all stormwater management projects.*<br><br>*Inspect, maintain, update or replace stormwater management systems to increase lifespan.* | | Update guidance on ditch management and conduct training<br><br>*Develop two stormwater management plans in urban nodes of each county* | Conduct training on ditch management every 5 years<br><br>Ensure all roads have adequate stormwater management that reduces sediment loading<br><br>*Transition 10% of inventoried ditches in each county to native vegetation* | # of trainings<br><br>% roads<br><br>% of ditches | X | X | X | | | | | | Ongoing |
| | | | | | | Forestry management | Expand forestry programs to include management at small scales (e.g., properties under 20 acres). Promote and periodically revise forest stewardship plans.<br><br>Develop public/private partnerships to promote forest stewardship.<br><br>Develop and implement forest stewardship plans for private lands (Sustainable Forestry Incentive Act).<br><br>Conduct research to find a suitable tree species to fill the ecological niche of ash trees.<br><br>Inventory black ash in buffer and woody wetland areas and determine potential impact to water resources if extensive tree loss and/or removal occurs. Recognize that 100% loss is unlikely, and that survivors are valuable as carriers of genetic traits necessary for survival and reforestation<br><br>Continue forestry education, outreach and training efforts. | -- | Increase local forestry management technical assistance/ capacity<br><br>Open lands assessment completed<br><br>Ash tree inventory | Forest stewardship plans implemented on 50% of private land<br><br>Open lands assessment completed every 10 years<br><br>Open lands or 0-15 age class <60% at subwatershed scale<br><br>Ash tree inventory | # of plans<br><br># of assessments completed<br><br>% open lands<br><br># of tree inventories | X | X | | | X | | | X | Ongoing |

| Waterbody and Location | | | Water Quality | | | Strategies | Strategy scenario showing estimated scale of adoption to meet 10-year milestone and final water quality targets. Scenarios and adoption levels may change with additional local planning, research showing new BMPs, changing financial support and policies, and experience implementing the plan. | | | | | Governmental Units with Primary Responsibility | | | | | | | | Estimated Year to Achieve Water Quality Target |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Estimated Adoption Rate | | | | | | | | | | | | |
| HUC10 Subwatershed | Waterbody (ID) | Location and Upstream Influence Counties | Parameter (incl. non-pollutant stressors) | Current Conditions (load or conc.) | Goals / Targets and Estimated % Reduction | | Strategy Type | Current strategy adoption level, if known | Interim 10-year Milestone | Suggested Goal | Units | Counties | SWCDs | Cities/Townships | MPCA | DNR | MDH | BWSR | Forest Service | |
| All (cont.) | All | St. Louis and Lake Counties | Varies | Varies (see Figure 5, Figure 6, Figure 7 and Figure 8 for current water quality conditions) | Varies (see Appendix A for % reductions)<br><br>Meet or exceed IBI standards in all streams | Forestry Management (cont.) | Evaluate management of forests on School Trust, Con, Con (consolidated conservation lands), tax forfeit and large tracts of privately held land. Quantify and develop protection strategies to preserve water quality and quantity benefits provided by forests (ecosystem benefits).<br><br>Protect riparian, wetland and high quality upland areas using easements, restrictive covenants, low impact development, tax incentives, purchasing of development rights, and other conservation tools.<br><br>Update forestry ordinances/guidelines and encourage compliance with MN Forest Resources Council Forest Management Guidelines.<br><br>Conduct open lands assessment every 10 years. Take action to ensure subwatersheds have <60% of the land in the 0-15 year age class.<br><br>Define riparian management zones and enforce regulations on soil disturbance and tree harvesting.<br><br>Enforce the Shipstead-Nolan Act as it relates to timber harvests near streams (U.S. Code Title 16, Section 577).<br><br>*Applicable 1W1P Goals:*<br><br>*Manage the density and composition of the forest canopy to control runoff and extend snowmelt to reduce erosive stream flow volume and rate.*<br><br>*Increase the local technical capacity to help landowners implement existing forestry management plans.* | -- | See above | Develop and implement updated forest plan<br><br>Protect prioritized areas<br><br>Updated ordinances | # of implementa-tion activities<br><br>% of acres protected<br><br># of ordinances | X | X | | | X | | | X | Ongoing |
| | | | | | | Aggregate mining management | Consider factors such as location, water quality, temperature, and changes in drainage networks, lake inflow or outflow, and baseflow associated with operational and expansion plans of aggregate mining companies.<br><br>*Applicable 1W1P Goals:*<br><br>*Minimize environmental risks to surface waters, groundwater, groundwater dependent natural resources and rare/high quality plant communities where aggregate resources and high value biological and water resources overlap.* | -- | -- | Expand ordinances to address surface and groundwater interactions | # updated ordinances | X | | | | X | | | | 2030 |

| Waterbody and Location | | | Water Quality | | | Strategies | Strategy scenario showing estimated scale of adoption to meet 10-year milestone and final water quality targets. Scenarios and adoption levels may change with additional local planning, research showing new BMPs, changing financial support and policies, and experience implementing the plan. | | | | | Governmental Units with Primary Responsibility | | | | | | | | Estimated Year to Achieve Water Quality Target |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Estimated Adoption Rate | | | | | | | | | | | | |
| HUC10 Subwatershed | Waterbody (ID) | Location and Upstream Influence Counties | Parameter (incl. non-pollutant stressors) | Current Conditions (load or conc.) | Goals / Targets and Estimated % Reduction | | Strategy Type | Current strategy adoption level, if known | Interim 10-year Milestone | Suggested Goal | Units | Counties | SWCDs | Cities/Townships | MPCA | DNR | MDH | BWSR | Forest Service | |
| All (cont.) | All | St. Louis and Lake Counties | Varies | Varies (see Figure 5, Figure 6, Figure 7 and Figure 8 for current water quality conditions) | Varies (see Appendix A for % reductions)<br><br>Meet or exceed IBI standards in all streams | Education and outreach activities | Support watershed stewardship groups for residents and landowners.<br><br>Continue education and outreach activities on conservation BMPs and implementation for landowners and county/municipal staff.<br><br>Continue implementation of a watershed and water quality education and outreach program focused on riparian users/owners (lakes and streams), municipal operations, forestry activities, septic system maintenance and compliance, stakeholders and residents.<br><br>Continue to educate public on deterring geese and bird feeding.<br>*Applicable 1W1P Goals:*<br><br>*Strengthen understanding of the connections of land management and the impacts both positive and negative to the water quality and aquatic ecosystems.*<br><br>*Increase public education on spread and control of aquatic invasive species.* | SWCDs currently have contract for education and outreach work in the watershed | 1-2 watershed stewardship groups formed<br><br>Continue implementation of a watershed and water quality education and outreach program | 4-5 watershed stewardship groups or partnerships formed<br><br>Continue to implement watershed and water quality education and outreach programs | # of groups<br><br># of outreach efforts | | X | | X | X | | X | | Ongoing |
| | | | | | | Wetland management | Complete assessment of wetland functions, including threshold limits for loss and impairment.<br><br>Develop area-specific wetland regulations to address the unique wetland resources and functional replacement challenges.<br><br>Determine priority locations for functional uplift.<br><br>*Applicable 1W1P Goals:*<br><br>*Identify priority areas for wetland protection activities.*<br><br>*Wetland banking and mitigation activities.*<br><br>*Preserve and restore/rehabilitate high quality wetland resources through the implementation of the Wetlands Conservation Act and coordination with the MN DNR Protected Waters Program and the USACE Section 404 Permitting Program.* | -- | -- | Complete assessment of wetland functions<br><br>Priority wetlands for protection identified | % completed<br><br># identified | X | X | | | X | | X | | 2030 |
| | | | | | | Groundwater / Drinking water management | Adoption of BMPs to sustainably manage surface/groundwater quantity. | -- | -- | Expand ordinances to address surface and groundwater interactions | # of updated ordinances | X | | X | | X | X | | | 2030 |

Table 11. Nearshore Lake Superior protection strategies

| Waterbody and Location | | | Water Quality | | | Strategies (see key below) | Strategy scenario showing estimated scale of adoption to meet 10-year milestone and final water quality targets. Scenarios and adoption levels may change with additional local planning, research showing new BMPs, changing financial support and policies, and experience implementing the plan. | | | | | Governmental Units with Primary Responsibility | | | | | | | | Estimated Year to Achieve Water Quality Target |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| HUC10 Subwatershed | Water-body (ID) | Location and Upstream Influence Counties | Parameter (incl. non-pollutant stressors) | Current Conditions (load or conc.) | Goals / Targets and Estimated % Reduction | | Strategy Type | Estimated Adoption Rate: Current strategy adoption level, if known | Interim 10-year Milestone | Suggested Goal | Units | Counties | SWCDs | Cities/Townships | MPCA | DNR | MDH | BWSR | Forest Service | |
| All | Nearshore Lake Superior | Lake and St. Louis | -- | -- | -- | Reduce industrial/ municipal wastewater discharges | Ensure compliance with discharge permits. | -- | Compliance with discharge permits | Compliance with discharge permits | Compliance rate | | | | X | | | | | Ongoing |
| | | | | | | Stormwater runoff management | See watershed-wide strategies<br>Enhance stormwater requirements to reduce peak flows and volume from impervious surfaces.<br>Identify opportunities for stormwater practice retrofits. | -- | Survey ditches and identify priority areas for upgrades/ maintenance<br>Identify opportunities for stormwater retrofits<br>Implement 2 stormwater BMP projects | Ensure all roads and developed areas apply stormwater BMPs to control sediment loading | % of roads and areas | X | X | X | | | | | | 2040 |
| | | | | | | Forestry management | See watershed-wide strategies. | -- | Complete open lands assessment<br>Develop 2 forest stewardship plans | Conduct 0-15 year age class (open lands) assessments every 10 years<br>Forest stewardship plans on 50% of private lands (parcels over 20 acres in size)<br>Open lands or 0-15 age class <60% at sub-watershed scale | # of assessments completed<br># of plans<br>% open lands | X | X | | | X | | | X | Ongoing |
| | | | | | | Address subsurface sewage treatment systems (SSTS) | See watershed-wide strategies. | -- | Complete inventory and inspection of SSTS in watershed<br>Upgrade 25% of failing septic systems | Complete inventory and inspection of SSTS every 10 years<br>100% of SSTS in compliance | # of systems | X | | | X | | | | | 2030 |

| Waterbody and Location | | | Water Quality | | | Strategies (see key below) | Strategy scenario showing estimated scale of adoption to meet 10-year milestone and final water quality targets. Scenarios and adoption levels may change with additional local planning, research showing new BMPs, changing financial support and policies, and experience implementing the plan. | | | | | Governmental Units with Primary Responsibility | | | | | | | | Estimated Year to Achieve Water Quality Target |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Estimated Adoption Rate | | | | | | | | | | | | |
| HUC10 Subwatershed | Water-body (ID) | Location and Upstream Influence Counties | Parameter (incl. non-pollutant stressors) | Current Conditions (load or conc.) | Goals / Targets and Estimated % Reduction | | Strategy Type | Current strategy adoption level, if known | Interim 10-year Milestone | Suggested Goal | Units | Counties | SWCDs | Cities/Townships | MPCA | DNR | MDH | BWSR | Forest Service | |
| All (cont.) | Nearshore Lake Superior (cont.) | Lake and St. Louis (cont.) | -- | -- | -- | Invasive species control | Implement County aquatic invasive species (AIS) plans; Lake County and St. Louis County plans completed in 2015. | Boat access sites have information on AIS | Implement County AIS plans | Implement County AIS plans | # of activities | X | X | | | X | | | | Ongoing |
| | | | | | | Land use planning and ordinance | See watershed-wide strategies.<br>Incorporate stormwater management and the impact of imperviousness on water quality and runoff into land use planning efforts (see stormwater runoff management above).<br>Consider increased trash receptacles and dog waste stations on beaches. | -- | Identify gaps in current ordinances | Pet waste and trash receptacles at all public beaches | # of receptacles | X | | X | | X | | | | 2025 |

Protection waters  Restoration waters

Table 12. HUC10 specific strategies and actions proposed for the LSS Watershed

| Waterbody and Location | | | Water Quality | | | Strategies (see key below) | Strategy scenario showing estimated scale of adoption to meet 10-year milestone and final water quality targets. Scenarios and adoption levels may change with additional local planning, research showing new BMPs, changing financial support and policies, and experience implementing the plan. | | | | | Governmental Units with Primary Responsibility | | | | | | | | Estimated Year to Achieve Water Quality Target |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| HUC10 Subwatershed | Water-body (ID) | Location and Upstream Influence Counties | Parameter (incl. non-pollutant stressors) | Current Conditions (load or conc.) | Goals / Targets and Estimated % Reduction | | Strategy Type | Estimated Adoption Rate: Current strategy adoption level, if known | Interim 10-year Milestone | Suggested Goal | Units | Counties | SWCDs | Cities/Townships | MPCA | DNR | MDH | BWSR | Forest Service | |
| Beaver River – Frontal Lake Superior (0401010201) | Beaver River (501) | Lake | Fishes bioassess-ments (elevated water temperature, poor habitat, turbidity/ TSS), turbidity/ TSS, pH<br><br>**TSS TMDL** | See Table 13 and Figure 25 | 0-81% TSS reduction (See Table 13)<br><br>FIBI and MIBI general use standards | Reduce industrial/ municipal wastewater discharges | Reduce point source loading per the Beaver River TMDL (Tetra Tech 2018).<br><br>Continue to evaluate the potential for Mile Post 7 to contribute to existing impairments in the Beaver River system. | Currently meeting permit requirements | Update permits as needed | Compliance with wasteload allocations | Compliance rate | | | | X | | | | | 2043 |
| | | | | | | Streambank stabilization and riparian management | Address highest TSS loading areas identified in the Beaver River TMDL (Tetra Tech 2018) – see the BANCS modeling results). Activities could include bank armoring, bioengineering, stream meanders, etc.<br><br>Implement recommendations in the Stressor ID (MPCA 2017):<br>· Improve trails and trail crossings at Glen Avon Falls trail to reduce sediment loading.<br><br>Address stream crossings:<br>· Roads and trails causing direct erosion (see Figure 24).<br>· Add controlled stream crossings for ATVs, forest activities, etc.<br>· Install exclusion fencing or stream crossings to limit access to streams.<br><br>Preserve the natural vegetation along stream corridors. Minnesota's buffer initiative requires establishment of up to 50 feet of perennial vegetation along many rivers, streams, and ditches. The Shoreland Management Act contains provisions to protect native vegetation.<br><br>Coordinate with transportation departments to ensure bridge or culvert replacements are designed and constructed to eliminate fish passage and erosion problems. | -- | Stabilize 4,200 feet<br><br>Conduct annual coordination with road authorities to review stream crossing projects<br><br>Buffers as required by Buffer Law | Adaptive management; additional stream stabilization as needed<br><br>Riparian buffers on all mainstream and tributary streams<br><br>Upgrade all road and trail crossings causing erosion | Linear feet<br><br>% with buffers<br><br>% upgraded | X | X | | | X | | X | X | 2043 |
| | | | | | | Forestry management | See watershed-wide strategies. | -- | Complete open lands assessment<br><br>Develop 3 forest stewardship plans | Open lands assessment every 10 years | # of assessments completed | X | X | | | X | | | X | Ongoing |

| Waterbody and Location | | | Water Quality | | | Strategies (see key below) | Strategy scenario showing estimated scale of adoption to meet 10-year milestone and final water quality targets. Scenarios and adoption levels may change with additional local planning, research showing new BMPs, changing financial support and policies, and experience implementing the plan. | | | | | Governmental Units with Primary Responsibility | | | | | | | | Estimated Year to Achieve Water Quality Target |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| HUC10 Subwatershed | Water-body (ID) | Location and Upstream Influence Counties | Parameter (incl. non-pollutant stressors) | Current Conditions (load or conc.) | Goals / Targets and Estimated % Reduction | | Strategy Type | Estimated Adoption Rate: Current strategy adoption level, if known | Estimated Adoption Rate: Interim 10-year Milestone | Estimated Adoption Rate: Suggested Goal | Estimated Adoption Rate: Units | Counties | SWCDs | Cities/Townships | MPCA | DNR | MDH | BWSR | Forest Service | |
| Beaver River – Frontal Lake Superior (0401010201) (cont.) | Beaver River (501) (cont.) | Lake | Fishes bioassess-ments (elevated water temperature, poor habitat, turbidity/ TSS), turbidity/ TSS, pH<br><br>**TSS TMDL** | See Table 13 and Figure 25 | 0-81% TSS reduction (See Table 13)<br><br>FIBI and MIBI general use standards | Forestry management (cont.) | See above | -- | See above | Forest stewardship plans on 50% of private lands<br><br>Open lands or 0-15 age class <60% at sub-watershed scale | # of plans<br><br>% open lands | X | X | | | X | | | X | Ongoing |
| | | | | | | Stormwater runoff management | See watershed-wide strategies.<br><br>Enhance stormwater requirements to reduce peak flows and volume from impervious surfaces.<br><br>Identify opportunities for stormwater practice retrofits. | -- | Survey ditches and identify priority areas for upgrades/ maintenance<br><br>Identify opportunities for stormwater retrofits<br><br>Implement 3 stormwater BMP projects | Ensure all roads and developed areas have adequate stormwater management that reduces sediment loading | % of roads and areas | X | X | X | | | | | | Ongoing |
| | | | | | | Land use planning and ordinance | See watershed-wide strategies.<br><br>Consider additional setbacks or overlay districts in red clay areas or hazard areas to minimize property loss and water quality impacts.<br><br>Protect riparian, wetland and high quality upland areas using easements, restrictive covenants, low impact development, tax incentives, and purchasing of development rights, and other conservation tools. | -- | Identify gaps in current ordinances | Updated ordinances that protect sensitive areas | # updated | X | | X | | | | | | 2030 |

| Waterbody and Location | | | Water Quality | | | Strategies (see key below) | Strategy scenario showing estimated scale of adoption to meet 10-year milestone and final water quality targets. Scenarios and adoption levels may change with additional local planning, research showing new BMPs, changing financial support and policies, and experience implementing the plan. | | | | | Governmental Units with Primary Responsibility | | | | | | | | Estimated Year to Achieve Water Quality Target |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| HUC10 Subwatershed | Water-body (ID) | Location and Upstream Influence Counties | Parameter (incl. non-pollutant stressors) | Current Conditions (load or conc.) | Goals / Targets and Estimated % Reduction | | Strategy Type | Estimated Adoption Rate: Current strategy adoption level, if known | Interim 10-year Milestone | Suggested Goal | Units | Counties | SWCDs | Cities/Townships | MPCA | DNR | MDH | BWSR | Forest Service | |
| Beaver River – Frontal Lake Superior (0401010201) (cont.) | West Beaver River (577) | Lake | Aquatic macroinverte-brate bioassess-ments, fisheries bioassess-ments (low (DO), poor habitat) | See Figure 25 and Figure 26 | FIBI and MIBI use standards | Implement recommendations in the Stressor ID (MPCA 2017) | Improve width/depth ratio to increase flows to support fish species habitat.<br><br>Increase cover (e.g., woody debris, trees, and boulders) in riparian zones to improve fish habitat.<br><br>Re-meander channelized tributaries.<br><br>Address positive and negative impacts of beaver dams on fish passage, temperature, sediment transport and the potential for catastrophic release or failure. | -- | Conduct geomorphic analysis to determine high priority restoration sites | Adaptive management; additional stream stabilization as needed | Linear feet | | X | | X | | | | | 2043 |
| | Lax Lake (38-0406-00) | Lake | -- | TP = 18.2 µg/L | -- | See watershed wide strategies (Table 10). | | | | | | | | | | | | | | Ongoing |
| | All | Lake | -- | -- | FIBI and MIBI use standards | See watershed wide strategies (Table 10). | | | | | | | | | | | | | | Ongoing |
| City of Duluth – Frontal Lake Superior (0401010204) | Talmadge River (Talmadge Cr) (508) | St. Louis | Dissolved oxygen (DO), fisheries bioassess-ments (low dissolved oxygen, poor habitat, elevated turbidity/ TSS, altered hydrology), turbidity/ TSS<br><br>**TSS TMDL** | See Table 16, and Figure 25 and Figure 26 | 0-97% TSS reduction See Table 16<br><br>FIBI and MIBI use standards | Streambank stabilization and riparian management | Address highest TSS loading areas identified in the Talmadge River TMDL (Tetra Tech 2018) – see the BANCS modeling results). Activities could include bank armoring, bioengineering, stream meanders, etc.<br><br>Implement recommendations in the Stressor ID (MPCA 2017):<br>· Address erosion from steep slopes in downstream waters.<br>· Re-meander channelized headwaters.<br>· Address impoundment at the Duluth Retriever Club.<br>· Fix priority undersized/perched culverts to adhere to MESBOAC design procedure (MN DNR 2011).<br>· Improve width/depth ratio to increase flows and support brook trout and other fish species habitat.<br>· Increase cover (e.g., woody debris, trees, and boulders) in riparian zones.<br>· Restore riffle substrate where appropriate to improve DO levels.<br>· Address impacts of beaver dams and activity on pooling and temperature. | -- | Conduct annual coordination with road authorities to review stream crossing projects<br><br>Buffers as required by Buffer Law | 1,500 feet restored<br><br>Riparian buffers on all mainstream and tributary streams<br><br>Upgrade all road and trail crossings causing erosion | Linear feet<br><br>% with buffers<br><br>% upgraded | X | X | | | X | | X | X | 2043 |

| Waterbody and Location | | | Water Quality | | | Strategies (see key below) | Strategy scenario showing estimated scale of adoption to meet 10-year milestone and final water quality targets. Scenarios and adoption levels may change with additional local planning, research showing new BMPs, changing financial support and policies, and experience implementing the plan. | | | | | Governmental Units with Primary Responsibility | | | | | | | | Estimated Year to Achieve Water Quality Target |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Estimated Adoption Rate | | | | | | | | | | | | |
| HUC10 Subwatershed | Water-body (ID) | Location and Upstream Influence Counties | Parameter (incl. non-pollutant stressors) | Current Conditions (load or conc.) | Goals / Targets and Estimated % Reduction | | Strategy Type | Current strategy adoption level, if known | Interim 10-year Milestone | Suggested Goal | Units | Counties | SWCDs | Cities/Townships | MPCA | DNR | MDH | BWSR | Forest Service | |
| City of Duluth – Frontal Lake Superior (0401010204) (cont.) | Talmadge River (Talmadge Cr) (508) (cont.) | St. Louis | Dissolved oxygen, fisheries bioassess-ments (low dissolved oxygen, poor habitat, elevated turbidity/ TSS, altered hydrology), turbidity/ TSS<br><br>**TSS TMDL** | See Table 16, and Figure 25 and Figure 26 | 0-97% TSS reduction See Table 16<br><br>FIBI and MIBI use standards | Streambank stabilization and riparian management (cont.) | Address stream crossings:<br>· Roads and trails causing direct erosion (see Figure 24).<br>· Add controlled stream crossings for ATVs, forest activities, etc.<br>· Install exclusion fencing or stream crossings to limit access to streams.<br><br>Preserve the natural vegetation along stream corridors. Minnesota's buffer initiative requires establishment of up to 50 feet of perennial vegetation along many rivers, streams, and ditches. The Shoreland Management Act requires protection of shoreline vegetation.<br><br>Coordinate with transportation departments to ensure bridge or culvert replacements are designed and constructed to eliminate fish passage and erosion problems. | -- | See above | See above | See above | X | X | | | X | | X | X | 2043 |
| | | | | | | Forestry management | See watershed-wide strategies. | -- | -- | Open lands assessment every 10 years<br><br>Forest stewardship plans on 50% of private lands<br><br>Open lands or 0-15 age class <60% at sub-watershed scale | # of plans<br><br># of assessments completed<br><br>% open lands | X | X | | | X | | | X | Ongoing |
| | | | | | | Stormwater runoff management | See watershed-wide strategies.<br><br>Enhance stormwater requirements to reduce peak flows and volume from impervious surfaces.<br><br>Identify opportunities for stormwater practice retrofits. | -- | -- | Ensure all roads and developed areas have adequate stormwater management that reduces sediment loading | % of roads and areas | X | X | X | | | | | | Ongoing |

| Waterbody and Location | | | Water Quality | | | Strategies (see key below) | Strategy scenario showing estimated scale of adoption to meet 10-year milestone and final water quality targets. Scenarios and adoption levels may change with additional local planning, research showing new BMPs, changing financial support and policies, and experience implementing the plan. | | | | | Governmental Units with Primary Responsibility | | | | | | | | Estimated Year to Achieve Water Quality Target |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| HUC10 Subwatershed | Water-body (ID) | Location and Upstream Influence Counties | Parameter (incl. non-pollutant stressors) | Current Conditions (load or conc.) | Goals / Targets and Estimated % Reduction | | Strategy Type | Estimated Adoption Rate: Current strategy adoption level, if known | Estimated Adoption Rate: Interim 10-year Milestone | Estimated Adoption Rate: Suggested Goal | Estimated Adoption Rate: Units | Counties | SWCDs | Cities/Townships | MPCA | DNR | MDH | BWSR | Forest Service | |
| City of Duluth – Frontal Lake Superior (0401010204) (cont.) | Talmadge River (Talmadge Cr) (508) (cont.) | St. Louis | Dissolved oxygen, fisheries bioassess-ments (low dissolved oxygen, poor habitat, elevated turbidity/ TSS, altered hydrology), turbidity/ TSS<br><br>**TSS TMDL** | See Table 16, and Figure 25 and Figure 26 | 0-97% TSS reduction See Table 16<br><br>FIBI and MIBI use standards | Land use planning and ordinance | See watershed-wide strategies.<br><br>Consider additional setbacks or overlay districts in red clay areas or hazard areas to minimize property loss and water quality impacts.<br><br>Protect riparian, wetland and high quality upland areas using easements, restrictive covenants, low impact development, tax incentives, and purchasing of development rights, and other conservation tools. | -- | Identify gaps in current ordinances | Updated ordinances that protect sensitive areas | # of ordinances | X | | X | | | | | | 2030 |
| | French River (698) | St. Louis | Turbidity/ TSS<br><br>**TSS TMDL** | See Table 15 | 0-95% TSS reduction (see Table 15)<br>FIBI and MIBI use standards | Reduce industrial/ municipal wastewater discharges | Reduce point source loading per French River TMDL (Tetra Tech 2018). | -- | Compliance with permits and wasteload allocations | Compliance with permits and wasteload allocations | Compliance rate | | | X | | | | | | Ongoing |
| | | | | | | Streambank stabilization and riparian management | Address highest TSS loading areas identified in the French River TMDL (Tetra Tech 2018) – see the BANCS modeling results). Activities could include bank armoring, bioengineering, stream meanders, etc.<br><br>Address stream crossings:<br>· Roads and trails causing direct erosion (see Figure 24).<br>· Add controlled stream crossings for ATVs, forest activities, etc.<br>· Install exclusion fencing or stream crossings to limit access to streams.<br><br>Preserve the natural vegetation along stream corridors. Minnesota's buffer initiative requires establishment of up to 50 feet of perennial vegetation along many rivers, streams, and ditches. The Shoreland Management Act requires protection of shoreline vegetation.<br><br>Coordinate with transportation departments to ensure bridge or culvert replacements are designed and constructed to eliminate fish passage and erosion problems. | -- | Conduct annual coordination with road authorities to review stream crossing projects<br><br>Buffers as required by Buffer Law | 3,600 feet restored<br><br>Riparian buffers on all mainstream and tributary streams<br><br>Upgrade all road and trail crossings causing erosion | Linear feet<br><br>% with buffers<br><br>% upgraded | X | X | | | X | | X | X | 2043 |

| Waterbody and Location | | | Water Quality | | | Strategies (see key below) | Strategy scenario showing estimated scale of adoption to meet 10-year milestone and final water quality targets. Scenarios and adoption levels may change with additional local planning, research showing new BMPs, changing financial support and policies, and experience implementing the plan. | | | | | Governmental Units with Primary Responsibility | | | | | | | | Estimated Year to Achieve Water Quality Target |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| HUC10 Subwatershed | Water-body (ID) | Location and Upstream Influence Counties | Parameter (incl. non-pollutant stressors) | Current Conditions (load or conc.) | Goals / Targets and Estimated % Reduction | | Strategy Type | Estimated Adoption Rate: Current strategy adoption level, if known | Estimated Adoption Rate: Interim 10-year Milestone | Estimated Adoption Rate: Suggested Goal | Estimated Adoption Rate: Units | Counties | SWCDs | Cities/Townships | MPCA | DNR | MDH | BWSR | Forest Service | |
| City of Duluth – Frontal Lake Superior (0401010204) (cont.) | French River (698) (cont.) | St. Louis | Turbidity/ TSS<br><br>**TSS TMDL** | See Table 15 | 0-95% TSS reduction (see Table 15)<br>FIBI and MIBI use standards | Forestry management | See watershed-wide strategies. | -- | -- | Open lands assessment every 10 years<br><br>Forest stewardship plans on 50% of private lands<br><br>Open lands or 0-15 age class <60% at sub-watershed scale | # of assessments completed<br><br># of plans<br><br>% open lands | X | X | | | X | | | X | Ongoing |
| | | | | | | Stormwater runoff management | See watershed-wide strategies.<br><br>Enhance stormwater requirements to reduce peak flows and volume from impervious surfaces.<br><br>Identify opportunities for stormwater practice retrofits. | -- | -- | Ensure all roads and developed areas have adequate stormwater management that reduces sediment loading | % of roads and areas | X | X | X | | | | | | Ongoing |
| | | | | | | Land use planning and ordinance | See watershed-wide strategies.<br><br>Consider additional setbacks or overlay districts in red clay areas or hazard areas to minimize property loss and water quality impacts.<br><br>Protect riparian, wetland and high quality upland areas using easements, restrictive covenants, low impact development, tax incentives, and purchasing of development rights, and other conservation tools. | -- | Identify gaps in current ordinances | Updated ordinances that protect sensitive areas | # updated | X | | X | | | | | | 2030 |
| | All | St. Louis | -- | -- | FIBI and MIBI use standards | See watershed wide strategies (Table 10). | | | | | | | | | | | | | | Ongoing |

| Waterbody and Location | | | Water Quality | | | Strategies (see key below) | Strategy scenario showing estimated scale of adoption to meet 10-year milestone and final water quality targets. Scenarios and adoption levels may change with additional local planning, research showing new BMPs, changing financial support and policies, and experience implementing the plan. | | | | | Governmental Units with Primary Responsibility | | | | | | | | Estimated Year to Achieve Water Quality Target |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| HUC10 Subwatershed | Water-body (ID) | Location and Upstream Influence Counties | Parameter (incl. non-pollutant stressors) | Current Conditions (load or conc.) | Goals / Targets and Estimated % Reduction | | Strategy Type | Estimated Adoption Rate: Current strategy adoption level, if known | Interim 10-year Milestone | Suggested Goal | Units | Counties | SWCDs | Cities/Townships | MPCA | DNR | MDH | BWSR | Forest Service | |
| Knife River – Frontal Lake Superior (0401010203) | Big Sucker Creek (Sucker River) (555) | St. louis | Turbidity/ TSS<br><br>**TSS TMDL** | See Table 14 | 0-96% TSS reduction (see Table 14)<br><br>FIBI and MIBI use standards | Streambank stabilization and riparian management | Address highest TSS loading areas identified in the Big Sucker Creek TMDL (Tetra Tech 2018 – see the BANCS modeling results). Activities could include bank armoring, bioengineering, stream meanders, etc.<br><br>Address stream crossings:<br>· Roads and trails causing direct erosion (see Figure 24).<br>· Add controlled stream crossings for ATVs, forest activities, etc.<br>· Install exclusion fencing or stream crossings to limit livestock access to streams.<br><br>Preserve the natural vegetation along stream corridors. Minnesota's buffer initiative requires establishment of up to 50 feet of perennial vegetation along many rivers, streams, and ditches. The Shoreland Management Act requires protection of shoreline vegetation.<br><br>Coordinate with transportation departments to ensure bridge or culvert replacements are designed and constructed to eliminate fish passage and erosion problems. | -- | Conduct annual coordination with road authorities to review stream crossing projects<br><br>Buffers as required by Buffer Law | 4,200 feet restored<br><br>Riparian buffers on all mainstream and tributary streams<br><br>Upgrade all road and trail crossings causing erosion | Linear feet<br><br>% with buffers<br><br># upgraded | X | X | | | X | | X | X | 2043 |
| | | | | | | Forestry management | See watershed-wide strategies. | -- | -- | Open lands assessment every 10 years<br><br>Forest stewardship plans on 50% of private lands<br><br>Open lands or 0-15 age class <60% at sub-watershed scale | # of assessments completed<br><br># of plans<br><br>% open lands | X | X | | | X | | | X | Ongoing |

| Waterbody and Location | | | Water Quality | | | Strategies (see key below) | Strategy scenario showing estimated scale of adoption to meet 10-year milestone and final water quality targets. Scenarios and adoption levels may change with additional local planning, research showing new BMPs, changing financial support and policies, and experience implementing the plan. | | | | | Governmental Units with Primary Responsibility | | | | | | | | Estimated Year to Achieve Water Quality Target |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| HUC10 Subwatershed | Water-body (ID) | Location and Upstream Influence Counties | Parameter (incl. non-pollutant stressors) | Current Conditions (load or conc.) | Goals / Targets and Estimated % Reduction | | Strategy Type | Estimated Adoption Rate: Current strategy adoption level, if known | Interim 10-year Milestone | Suggested Goal | Units | Counties | SWCDs | Cities/Townships | MPCA | DNR | MDH | BWSR | Forest Service | |
| Knife River – Frontal Lake Superior (0401010203) (cont.) | Big Sucker Creek (Sucker River) (555) (cont.) | St. louis | Turbidity/ TSS<br><br>**TSS TMDL** | See Table 14 | 0-96% TSS reduction (see Table 14)<br><br>FIBI and MIBI use standards | Land use planning and ordinance | See watershed-wide strategies.<br><br>Consider additional setbacks or overlay districts in red clay areas or hazard areas to minimize property loss and water quality impacts.<br><br>Protect riparian, wetland and high quality upland areas using easements, restrictive covenants, low impact development, tax incentives, and purchasing of development rights, and other conservation tools. | -- | Identify gaps in current ordinances | Updated ordinances that protect sensitive areas | # updated | X | | X | | | | | | 2030 |
| | Skunk Creek (528) | Lake | *Escherichia coli*<br><br>***E. coli* TMDL** | See Table 20 | 24-66% reduction in *E. coli* (see Table 20) | Reduce industrial/ municipal wastewater discharges | Address overflows from Two Harbors WWTP to Skunk Creek.<br><br>Upgrade leaky wastewater infrastructure in urban areas. | -- | Eliminate overflows to Skunk Creek<br><br>Assess wastewater infrastructure crossing Skunk Creek and tributaries | Upgrade leaky infrastructure as needed | # of upgrades | | | X | X | | | | | 2043 |
| | | | | | | Address subsurface sewage treatment systems | See watershed-wide strategies. | -- | Complete inventory and inspection of SSTS in watershed<br><br>Upgrade 50% of failing septic systems | Complete inventory and inspection of septic systems every 10 years<br><br>100% of septic systems in compliance | # of septic systems | X | | | X | | | | | 2030 |
| | | | | | | Education and outreach activities | See watershed-wide activities.<br><br>Enhance pet waste management programs.<br><br>Update ordinances to include enforcement of pet waste ordinances.<br><br>Continue to educate public on deterring geese and bird feeding. | -- | Outreach campaign that addresses *E. coli* sources<br><br>Consider updating ordinances to include pet waste clean-up enforcement | Conduct focused outreach every 5-years | # of outreach efforts | | X | X | | | | | | Ongoing |

| Waterbody and Location | | | Water Quality | | | Strategies (see key below) | Strategy scenario showing estimated scale of adoption to meet 10-year milestone and final water quality targets. Scenarios and adoption levels may change with additional local planning, research showing new BMPs, changing financial support and policies, and experience implementing the plan. | | | | | Governmental Units with Primary Responsibility | | | | | | | | Estimated Year to Achieve Water Quality Target |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| HUC10 Subwatershed | Water-body (ID) | Location and Upstream Influence Counties | Parameter (incl. non-pollutant stressors) | Current Conditions (load or conc.) | Goals / Targets and Estimated % Reduction | | Strategy Type | Estimated Adoption Rate: Current strategy adoption level, if known | Interim 10-year Milestone | Suggested Goal | Units | Counties | SWCDs | Cities/Townships | MPCA | DNR | MDH | BWSR | Forest Service | |
| Knife River – Frontal Lake Superior (0401010203) (cont.) | Skunk Creek (528) (cont.) | Lake | *Escherichia coli*<br><br>***E. coli* TMDL** | See Table 20 | 24-66% reduction in *E. coli* (see Table 20) | Stormwater runoff management | Update existing stormwater management plans (e.g., Two Harbors). | -- | See Skunk Creek Turbidity/TSS below | See Skunk Creek Turbidity/TSS below | -- | X | X | X | | | | | | 2043 |
| | | | | | | Monitoring | Conduct additional monitoring and microbial source tracking to identify hotspots and determine sources of *E. coli* for targeted implementation. | -- | Microbial source tracking project<br><br>Identify priority areas | Conduct activities as needed to address priority areas | # of activities | | X | X | X | | X | | | 2043 |
| | | | Turbidity/ TSS<br><br>**TSS TMDL** | See Table 19 | 0-91% TSS reduction (see Table 19)<br><br>FIBI and MIBI use standards | Streambank stabilization and riparian management | Conduct geomorphic analysis to determine high priority restoration sites.<br><br>Address stream crossings:<br>· Roads and trails causing direct erosion (see Figure 24).<br>· Add controlled stream crossings for ATVs, forest activities, etc.<br>· Install exclusion fencing or stream crossings to limit access to streams.<br><br>Preserve the natural vegetation along stream corridors. Minnesota's buffer initiative requires establishment of up to 50 feet of perennial vegetation along many rivers, streams, and ditches. The Shoreland Management Act requires protection of shoreline vegetation.<br><br>Coordinate with transportation departments to ensure bridge or culvert replacements are designed and constructed to eliminate fish passage and erosion problems. | -- | Conduct geomorphic analysis and identify highest loading segments<br><br>Stream stabilization for highest loading segments<br><br>Conduct annual coordination with road authorities to review stream crossing projects<br><br>Buffers as required by Buffer Law | Adaptive management; additional stream stabilization as needed<br><br>Riparian buffers on all mainstream and tributary streams<br><br>Upgrade all road and trail crossings causing erosion | Linear feet<br><br>% with buffers<br><br>% upgraded | X | X | | | X | | X | X | 2043 |
| | | | | | | Land use planning and ordinance | See watershed-wide strategies.<br><br>Consider additional setbacks or overlay districts in red clay areas or hazard areas to minimize property loss and water quality impacts.<br><br>Protect riparian, wetland and high quality upland areas using easements, restrictive covenants, low impact development, tax incentives, and purchasing of development rights, and other conservation tools. | -- | Identify gaps in current ordinances | Updated ordinances that protect sensitive areas | # updated | X | | X | | | | | X | 2030 |

| Waterbody and Location | | | Water Quality | | | Strategies (see key below) | Strategy scenario showing estimated scale of adoption to meet 10-year milestone and final water quality targets. Scenarios and adoption levels may change with additional local planning, research showing new BMPs, changing financial support and policies, and experience implementing the plan. | | | | | Governmental Units with Primary Responsibility | | | | | | | | Estimated Year to Achieve Water Quality Target |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| HUC10 Subwatershed | Water-body (ID) | Location and Upstream Influence Counties | Parameter (incl. non-pollutant stressors) | Current Conditions (load or conc.) | Goals / Targets and Estimated % Reduction | | Strategy Type | Estimated Adoption Rate: Current strategy adoption level, if known | Interim 10-year Milestone | Suggested Goal | Units | Counties | SWCDs | Cities/Townships | MPCA | DNR | MDH | BWSR | Forest Service | |
| Knife River – Frontal Lake Superior (0401010203) (cont.) | Skunk Creek (528) (cont.) | Lake | Turbidity/ TSS<br><br>**TSS TMDL** | See Table 19 | 0-91% TSS reduction (see Table 19)<br><br>FIBI and MIBI use standards | Stormwater runoff management | See watershed-wide strategies.<br><br>Update the stormwater management plan for Two Harbors.<br><br>Enhance stormwater requirements to reduce peak flows and volume from impervious surfaces.<br><br>Identify opportunities for stormwater practice retrofits.<br><br>Identify and protect areas of high infiltration or storage. | -- | Update Two Harbors stormwater plan<br><br>Survey ditches and identify priority areas for upgrades/ maintenance<br><br>Identify opportunities for stormwater retrofits<br><br>Implement 4 stormwater BMP projects | Ensure all roads and developed areas have adequate stormwater management that reduces sediment loading<br><br>Update stormwater plan every 10 years | % of roads and areas<br><br># of plan updates | X | X | X | | | | | | Ongoing |
| | | | | | | Forestry management | See watershed-wide strategies. | -- | Complete open lands assessment<br><br>Develop 2 forest stewardship plans | Open lands assessment every 10 years<br><br>Forest stewardship plans on 50% of private lands<br><br>Open lands or 0-15 age class <60% at sub-watershed scale | # of assessments completed<br><br># of plans<br><br>% open lands | X | X | | | X | | | X | Ongoing |
| | Little Knife River (East Branch Little Knife River; 840) | Lake | Dissolved oxygen, turbidity/ TSS<br><br>**TSS TMDL** | See Table 18 | Unknown reductions needed (see Table 18)<br><br>FIBI and MIBI use standards | Streambank stabilization and riparian management | Conduct geomorphic analysis to determine high priority restoration sites.<br><br>Conduct monitoring to determine sources of sediment and presence of low dissolved oxygen.<br><br>Preserve the natural vegetation along stream corridors. Minnesota's buffer initiative requires establishment of up to 50 feet of perennial vegetation along many rivers, streams, and ditches. The Shoreland Management Act requires protection of shoreline vegetation. | -- | Conduct geomorphic analysis and monitoring<br><br>Stream stabilization for highest loading segments | Adaptive management; additional stream stabilization as needed<br><br>Riparian buffers on all mainstream and tributary streams | Linear feet<br><br>% with buffers | X | X | | | X | | X | X | 2043 |

| Waterbody and Location | | | Water Quality | | | Strategies (see key below) | Strategy scenario showing estimated scale of adoption to meet 10-year milestone and final water quality targets. Scenarios and adoption levels may change with additional local planning, research showing new BMPs, changing financial support and policies, and experience implementing the plan. | | | | | Governmental Units with Primary Responsibility | | | | | | | | Estimated Year to Achieve Water Quality Target |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| HUC10 Subwatershed | Water-body (ID) | Location and Upstream Influence Counties | Parameter (incl. non-pollutant stressors) | Current Conditions (load or conc.) | Goals / Targets and Estimated % Reduction | | Strategy Type | Estimated Adoption Rate: Current strategy adoption level, if known | Interim 10-year Milestone | Suggested Goal | Units | Counties | SWCDs | Cities/Townships | MPCA | DNR | MDH | BWSR | Forest Service | |
| Knife River – Frontal Lake Superior (0401010203) (cont.) | Little Knife River (East Branch Little Knife River; 840) | Lake | Dissolved oxygen, turbidity/ TSS<br><br>**TSS TMDL** | See Table 18 | Unknown reductions needed (see Table 18)<br><br>FIBI and MIBI use standards | Streambank stabilization and riparian management (cont.) | Address stream crossings:<br>· Roads and trails causing direct erosion (see Figure 24).<br>· Add controlled stream crossings for ATVs, forest activities, etc.<br>· Install exclusion fencing or stream crossings to limit access to streams.<br><br>Coordinate with transportation departments to ensure bridge or culvert replacements are designed and constructed to eliminate fish passage and erosion problems. | | Conduct annual coordination with road authorities to review stream crossing projects<br><br>Buffers as required by Buffer Law | Upgrade all road and trail crossings causing erosion | % upgraded | X | X | | | X | | X | X | 2043 |
| | | | | | | Forestry management | See watershed-wide strategies. | -- | Complete open lands assessment<br><br>Develop 2 forest stewardship plans | Open lands assessment every 10 years<br><br>Forest stewardship plans on 50% of private lands<br><br>Open lands or 0-15 age class <60% at subwatershed scale | # of assessments completed<br><br># of plans<br><br>% open lands | X | X | | | X | | | X | Ongoing |
| | | | | | | Stormwater runoff management | See watershed-wide strategies.<br><br>Enhance stormwater requirements to reduce peak flows and volume from impervious surfaces.<br><br>Identify opportunities for stormwater practice retrofits. | -- | Survey ditches and identify priority areas for upgrades or maintenance<br><br>Identify opportunities for stormwater retrofits (e.g., airport, high impervious areas)<br><br>Implement 2 stormwater BMP projects | Ensure all roads and developed areas have adequate stormwater management that reduces sediment loading | % of roads and areas | X | X | X | | | | | | Ongoing |

| Waterbody and Location | | | Water Quality | | | Strategies (see key below) | Strategy scenario showing estimated scale of adoption to meet 10-year milestone and final water quality targets. Scenarios and adoption levels may change with additional local planning, research showing new BMPs, changing financial support and policies, and experience implementing the plan. | | | | | Governmental Units with Primary Responsibility | | | | | | | | Estimated Year to Achieve Water Quality Target |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| HUC10 Subwatershed | Water-body (ID) | Location and Upstream Influence Counties | Parameter (incl. non-pollutant stressors) | Current Conditions (load or conc.) | Goals / Targets and Estimated % Reduction | | Strategy Type | Estimated Adoption Rate: Current strategy adoption level, if known | Interim 10-year Milestone | Suggested Goal | Units | Counties | SWCDs | Cities/Townships | MPCA | DNR | MDH | BWSR | Forest Service | |
| Knife River – Frontal Lake Superior (0401010203) (cont.) | Little Knife River (East Branch Little Knife River; 840) (cont.) | Lake | Dissolved oxygen, turbidity/ TSS<br><br>**TSS TMDL** | See Table 18 | Unknown reductions needed (see Table 18)<br><br>FIBI and MIBI use standards | Land use planning and ordinance | See watershed-wide strategies.<br><br>Consider additional setbacks or overlay districts in red clay areas or hazard areas to minimize property loss and water quality impacts.<br><br>Protect riparian, wetland and high quality upland areas using easements, restrictive covenants, low impact development, tax incentives, and purchasing of development rights, and other conservation tools. | -- | Identify gaps in current ordinances | Updated ordinances that protect sensitive areas | # updated | X | | X | | | | | | 2030 |
| | Impaired Beaches: Burlington Bay (04010102-C30) and Agate Bay (04010102-C31) | Lake | *Escherichia coli* | | Reduce # of beach closings by 100% | Address *E. coli* loading from Skunk Creek to Burlington Bay | See Skunk Creek (528). | | | | | X | X | X | X | | X | | | 2043 |
| | | | | | | Reduce industrial/ municipal wastewater discharges | Ensure compliance with discharge permits. | -- | Compliance with discharge permits | Compliance with discharge permits | Compliance rate | | | | X | | | | | Ongoing |
| | | | | | | TMDL development | Complete TMDL development for impaired beaches.<br><br>Conduct microbial source tracking to determine sources of *E. coli.* | -- | Complete TMDLs and implementation plan | Complete TMDLs and plan implementation | % completed | | | | X | | X | | | 2020 |
| | | | | | | Address subsurface sewage treatment systems (SSTS) | See watershed-wide strategies. | -- | Complete inventory and inspection of SSTS in watershed<br><br>Upgrade 50% of failing septic systems in direct contributing area<br><br>Also see Skunk Creek (528) | Complete inventory and inspection of septic systems every 10 years<br><br>100% of septic systems in compliance | # of septic systems | X | | | X | | | | | 2030 |
| | | | | | | Monitoring | Monitor and determine potential for ballast water to be a source of *E. coli* in near shore areas and at beaches; address source as needed.<br><br>Conduct microbial source tracking to determine sources of *E. coli.* | -- | Microbial source tracking project<br><br>Complete study on ballast water | Target source reductions as needed | # of reduction projects | | | | X | | X | | | Ongoing |

| Waterbody and Location | | | Water Quality | | | Strategies (see key below) | Strategy scenario showing estimated scale of adoption to meet 10-year milestone and final water quality targets. Scenarios and adoption levels may change with additional local planning, research showing new BMPs, changing financial support and policies, and experience implementing the plan. | | | | | Governmental Units with Primary Responsibility | | | | | | | | Estimated Year to Achieve Water Quality Target |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| HUC10 Subwatershed | Water-body (ID) | Location and Upstream Influence Counties | Parameter (incl. non-pollutant stressors) | Current Conditions (load or conc.) | Goals / Targets and Estimated % Reduction | | Strategy Type | Estimated Adoption Rate: Current strategy adoption level, if known | Interim 10-year Milestone | Suggested Goal | Units | Counties | SWCDs | Cities/Townships | MPCA | DNR | MDH | BWSR | Forest Service | |
| Knife River – Frontal Lake Superior (0401010203) (cont.) | Impaired Beaches: Burlington Bay (-C30) and Agate Bay (-C31) (cont.) | Lake | *Escherichia coli* | | Reduce # of beach closings by 100% | Land use planning and ordinance | See watershed-wide strategies.<br><br>Monitor and enforce no dumping regulations.<br><br>Enhance current pet waste ordinances to include enforcement.<br><br>Consider increased placement of trash receptacles on beaches.<br><br>Ensure availability of adequate bathroom facilities near beaches. | -- | Develop plan for bathroom facilities, as needed | Updated facilities as needed to address *E. coli* sources (bathrooms, pet waste, trash) | # of new or updated facilities | X | | X | | X | | | | 2030 |
| | | | | | | Education and outreach activities | See watershed-wide strategies.<br><br>Educate boat owners on proper disposal of waste to reduce *E. coil* loading in Lake Superior.<br><br>Encourage boat owners and operators to participate in Green Marina programs.<br><br>Education and outreach on reducing *E. coli* at beaches (i.e., proper waste disposal, pet waste disposal and signage to prevent feeding of wildlife). Ensure information is available at nearby campgrounds. | -- | Outreach campaign that addresses sources of *E. coli* | Conduct focused outreach every 5-years | # of outreach efforts | X | X | X | | | X | | | Ongoing |
| | Knife River (504) | St. Louis and Lake | Turbidity<br><br>**TSS TMDL** | 0.01-31 tons/day TSS (SSLSCWD 2010) | 0-90% TSS reduction (see Table 17)<br><br>FIBI and MIBI use standards | Implement approved Knife River TMDL Implementation Plan (SSLSWCD 2011) | Land use/cover management activities:<br>· Tree planting in open land areas<br>· Miscellaneous runoff reduction activities in open land areas<br>· Riparian area forest management<br>· Upland forest management<br>· Beaver dam inventory, monitoring and evaluation<br><br>Stream bank and bluff restoration activities:<br>· Grand control measures<br>· Bankfull benches<br>· Tree planting on bluffs<br><br>Upland erosion control activities:<br>· Gully stabilizations<br>· Road ditch maintenance and re-vegetation (stormwater management)<br>· Stormwater BMPs inventory, training and implementation<br>· Wetland enhancement, creation and preservation | | Implement according to approved Implementation Plan (SSLSWCD 2011) | | | X | X | X | | X | | | X | 2035 |

| Waterbody and Location | | | Water Quality | | | Strategies (see key below) | Strategy scenario showing estimated scale of adoption to meet 10-year milestone and final water quality targets. Scenarios and adoption levels may change with additional local planning, research showing new BMPs, changing financial support and policies, and experience implementing the plan. | | | | | Governmental Units with Primary Responsibility | | | | | | | | Estimated Year to Achieve Water Quality Target |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| HUC10 Subwatershed | Water-body (ID) | Location and Upstream Influence Counties | Parameter (incl. non-pollutant stressors) | Current Conditions (load or conc.) | Goals / Targets and Estimated % Reduction | | Strategy Type | Estimated Adoption Rate: Current strategy adoption level, if known | Interim 10-year Milestone | Suggested Goal | Units | Counties | SWCDs | Cities/Townships | MPCA | DNR | MDH | BWSR | Forest Service | |
| Knife River – Frontal Lake Superior (0401010203) (cont.) | Knife River (504) (cont.) | St. Louis and Lake | Turbidity<br><br>**TSS TMDL** | 0.01-31 tons/day TSS (SSLSCWD 2010) | 0-90% TSS reduction (see Table 17)<br><br>FIBI and MIBI use standards | Implement approved Knife River TMDL Implementation Plan (SSLSWCD 2011) | Outreach and education:<br>· Education activities<br>· Outreach through information dissemination<br>· Training for contractors, local government unit staff and planning boards<br>· Civic engagement / organizing<br>· Regional agency collaboration<br>· Incorporate the LSS TMDL and WRAPS into the North Shore Management Plan<br><br>Survey, inventory and analysis activities. | | See above | | | X | X | X | | X | | | X | 2035 |
| | Captain Jacobson Creek (584) | St. Louis | -- | -- | -- | Implement recommendations in the Stressor ID (MPCA 2017) | Restore connectivity and geomorphology to support resilient trout populations.<br><br>Replace the CSAH 41 crossing for fish passage. | -- | Upgrade crossing at CSAH 41 | Upgrade crossing at CSAH 41 | # of upgrades | X | X | | | X | | | | 2035 |
| | McCarthy Creek (887) | Lake | -- | -- | -- | Implement recommendations in the Stressor ID (MPCA 2017 | Protect critical habitat for steelhead and Brook Trout populations. | -- | -- | -- | -- | | | | | X | | | | Ongoing |
| | Stewart Lake (38-0744-00) | Lake | -- | TP = 22.9 µg/L | -- | See watershed wide strategies (Table 10). | | | | | | | | | | | | | | Ongoing |
| | Paradise Lake (69-0007-00) | St. Louis | -- | TP = 18.0 µg/L | -- | See watershed wide strategies (Table 10). | | | | | | | | | | | | | | Ongoing |
| | All | St. Louis and Lake | -- | -- | -- | See watershed wide strategies (Table 10). | | | | | | | | | | | | | | Ongoing |
| Gooseberry River – Frontal Lake Superior (0401010202) | Christianson (38-0750-00) | Lake | -- | TP = 38.7 µg/L | -- | See watershed wide strategies (Table 10). | | | | | | | | | | | | | | Ongoing |
| | Highland (38-0753-00) | Lake | -- | TP = 21.7 µg/L | -- | See watershed wide strategies (Table 10). | | | | | | | | | | | | | | |
| | All | Lake | -- | -- | -- | See watershed wide strategies (Table 10). | | | | | | | | | | | | | | |

Protection waters  Restoration waters

# 4. Monitoring Plan

Monitoring of flow and water quality are needed to refine source assessments, further focus implementation activities identified as part of the watershed approach process, inform protection efforts for all unimpaired uses, and evaluate the effect of improvements for those resources that show declining trends in water quality. New data can also be used to further improve watershed modeling efforts. Monitoring is also a critical component of an adaptive management approach and can be used to help determine when a change in management is needed. This section describes recommended monitoring activities in the watershed, subject to availability of resources and priorities.

It is the intent of the implementing organizations in this watershed to make steady progress in terms of pollutant reduction. Accordingly, as a very general guideline, progress benchmarks are established for this watershed that assume improvements will occur resulting in a water quality pollutant concentration decline each year equivalent to approximately 3% to 4% of the starting (i.e., long-term) pollutant concentration. Factors that may mean slower progress include: limits in funding or landowner acceptance, challenging fixes (e.g., unstable bluffs and ravines, invasive species) and unfavorable climatic factors. Conversely, there may be faster progress for some impaired waters, especially where high-impact fixes are slated to occur. Monitoring efforts will also be used to evaluate water quality trends and ensure protection efforts are being effectively implemented.

## Existing Monitoring

The MPCA conducted intensive monitoring throughout the watershed during 2010 and 2011 as part of the Watershed Approach. These efforts are summarized in the monitoring and assessment report (MPCA 2014). It is anticipated that the next round of intensive monitoring will begin in 2021. Several other monitoring entities exist within the watershed including:

- SWCDs
- State agencies (e.g., DNR, MDH Beach Program)
- Federal agencies (e.g., EPA, U.S. Department of Agriculture Forest Service, U.S. Fish and Wildlife Service, and U.S. Geological Survey)
- Citizen monitors
- Site-specific monitoring led by the University of Minnesota and special interest groups

## Monitoring Needs

- Monitoring of lake clarity and food web dynamics related to invasive species (i.e., zebra mussels)
- Biological surveys and assessments of headwaters of Talmadge River upstream of Lester River Road as recommended in the *LSS Stressor Identification Report* (MPCA 2017).
- Bacterial source tracking for impaired streams and beaches with *E. coli* concerns.
- Additional flow monitoring at all water quality sampling sites.

- Expanded continuous flow monitoring to more tributaries and during winter time periods to improve hydrologic modeling in the watershed, which will in turn improve pollutant loading estimates.
- Assessment of *E. coli* sources in the Skunk Creek Subwatershed, including longitudinal assessment of sources, assessment of wastewater infrastructure and potential for cross connections between sanitary and storm sewers, field evaluation, and compliance inspections for all septic systems in the watershed.
- TSS samples are needed throughout the impaired watersheds to further assess potential sources and focus implementation activities, see the LSS TMDL (Tetra Tech 2018) for more details.
- Complete geomorphic assessments on Little Knife and Skunk Creek to identify sources of sediment.

As implementation activities are conducted in the watershed, an evaluation of the before and after conditions can be useful to aid in future project planning. In addition to flow and water quality monitoring, a broader assessment of ecological function and restoration could be used to assess various components of the stream system and overall effectiveness of the implementation activity.

# 5. References and Further Information


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Tetra Tech. 2016. Lake Superior North and Lake Superior South Basins Watershed Model Development Report. Prepared for the Minnesota Pollution Control Agency, St. Paul, MN.

Tetra Tech. 2018. Lake Superior South Total Maximum Daily Load Study. Prepared for the Minnesota Pollution Control Agency, Duluth, MN. May 2018.


## *Lake Superior South Watershed Reports*

*Many of the Lake Superior South Watershed reports referenced in this watershed report are available at: https://www.pca.state.mn.us/water/watersheds/lake-superior-south*

# Appendix A – TMDL Summaries

## TSS TMDLs

### Beaver River (04010102-501)

The load duration curve and TMDL allocations for the Beaver River are presented below. Load reductions are needed under all flow regimes, with the exception of low flows. The largest reductions are needed under very high and high flow conditions.

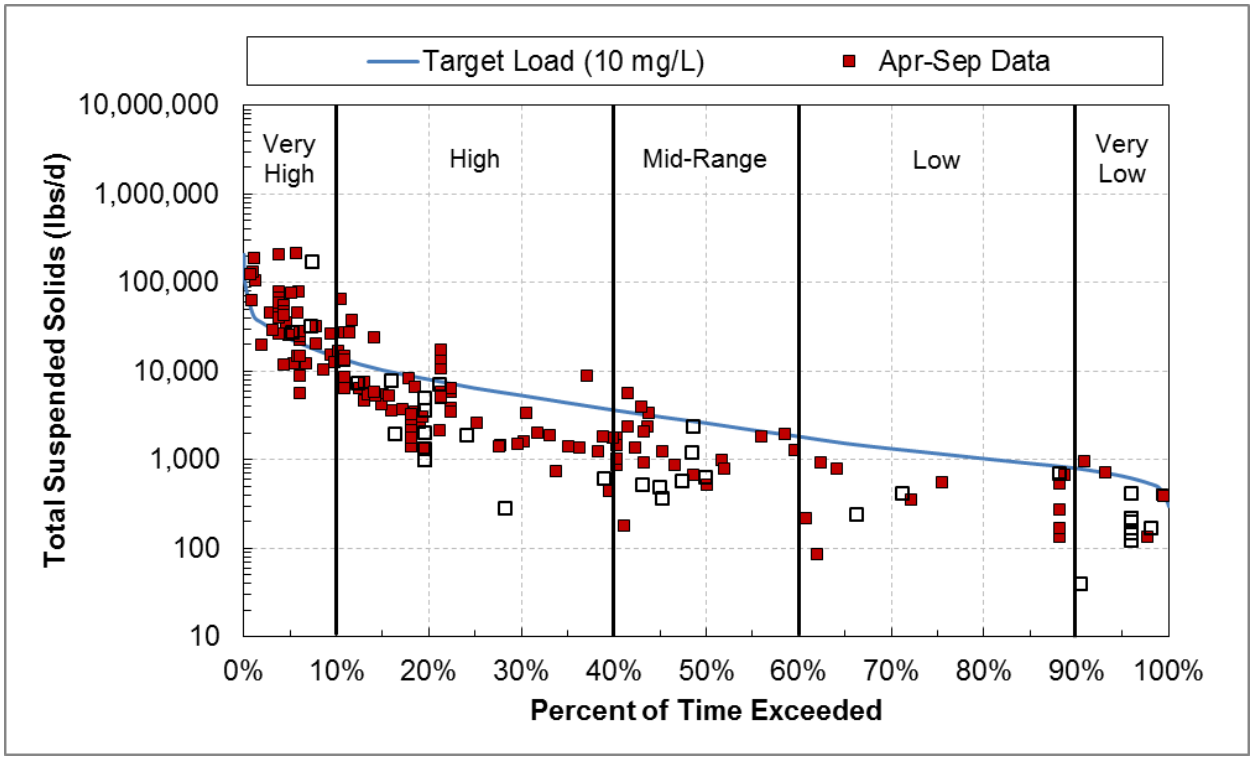


**Figure 29. TSS load duration curve, Beaver River (04010102-501).**
Hollow points indicate samples during months when the standard does not apply

Table 13. TSS TMDL Summary, Beaver River (04010102-501)

| TMDL Parameter | | Flow Regime | | | | |
|---|---|---|---|---|---|---|
| | | Very High | High | Mid-Range | Low | Very Low |
| | | TSS Load (lbs/day) | | | | |
| Wasteload Allocation | Beaver Bay WWTP (MN0040754) [a] | 22 | 22 | 22 | 22 | 22 |
| | Northshore Mining – Silver Bay (MN0055301) [b] | 417 | 417 | 417 | 417 | 417 |
| | Industrial Stormwater (MNR050000 and MNG490296) [c] | 406 | 107 | 38 | 12 | 3 |
| | Construction Stormwater (MNR100001) [c] | 203 | 53 | 19 | 6 | 1 |
| Load Allocation | | 19,678 | 5,184 | 1,839 | 600 | 144 |
| MOS | | 2,303 | 643 | 259 | 117 | 65 |
| **Loading Capacity** | | **23,029** | **6,426** | **2,594** | **1,174** | **652** |
| Existing Load | | 120,284 | 16,926 | 3,039 | 785 | 849 |
| Percent Load Reduction | | 81% | 62% | 15% | 0% | 23% |

a. The WLA for Beaver Bay WWTP applies from April 1 through September 30. It is assumed that the facility's 30 mg/L TSS effluent limit is sufficient to ensure that effluent NVSS concentrations will not exceed the 10 mg/L inorganic TSS concentration which is the basis for the water quality standard. Effluent monitoring may be required to confirm this assumption.
b. The current permit limit of Northshore Mining–Silver Bay (MN0055301) is based on 20 mg/L TSS, and the WLA is based on 10 mg/L TSS. A WQBEL will need to be considered upon permit reissuance.
c. It is assumed that loads from permitted construction and industrial stormwater sites that operate in compliance with the permits are meeting the WLA.

### Big Sucker Creek (Sucker River; 04010102-555)

The load duration curve and TMDL allocation for Big Sucker Creek (Sucker River) are presented below. Load reductions are needed under very high and high flow conditions. A large load reduction of 96% is needed under very high flow conditions.

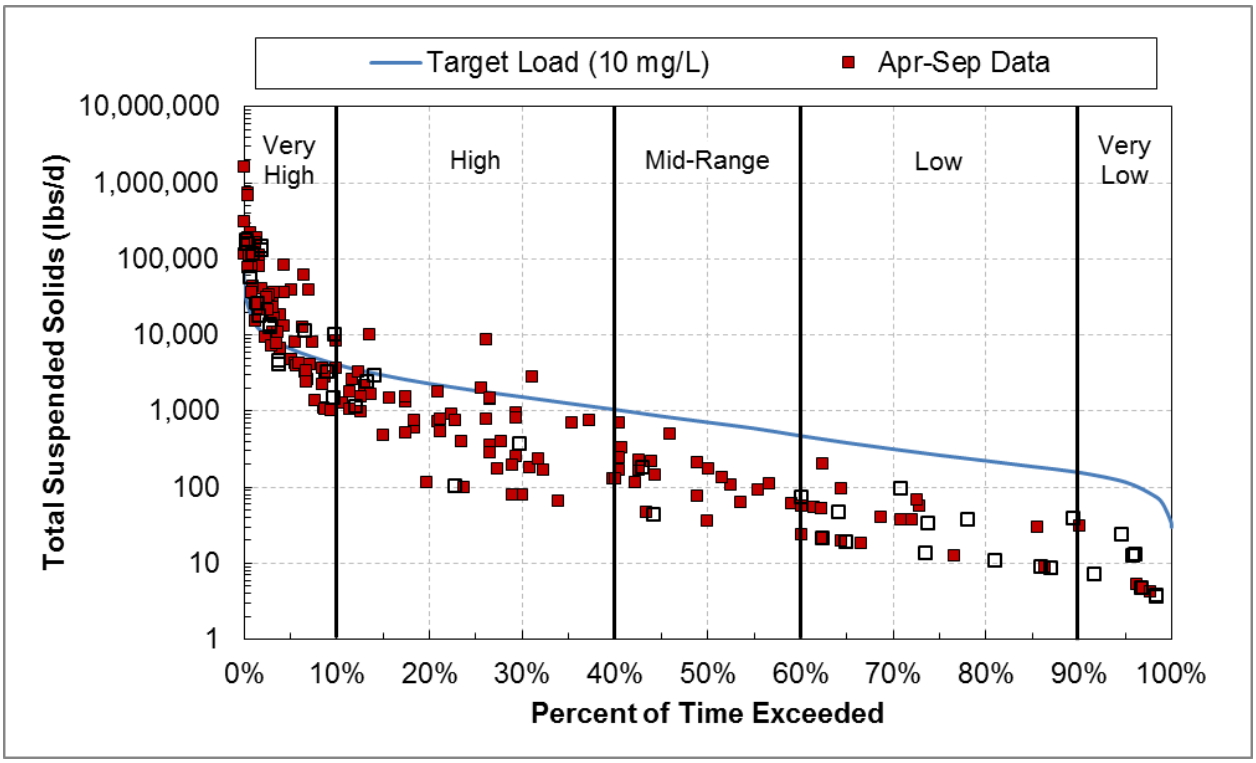


**Figure 30. TSS load duration curve, Big Sucker Creek (Sucker River; 04010102-555).**
Hollow points indicate samples during months when the standard does not apply

**Table 14. TSS TMDL Summary, Big Sucker Creek (Sucker River; 04010102-555)**

| TMDL Parameter | | Flow Regime | | | | |
|---|---|---|---|---|---|---|
| | | Very High | High | Mid-Range | Low | Very Low |
| | | TSS Load (lbs/day) | | | | |
| Wasteload Allocation | Duluth Township MS4 (MS400134) | 4 | 1 | 0.5 | 0.2 | 0.1 |
| | Industrial Stormwater (MNR050000) [a] | 119 | 33 | 13 | 5 | 2 |
| | Construction Stormwater (MNR100001) [a] | 60 | 17 | 6 | 2 | 1 |
| Load Allocation | | 5,781 | 1,622 | 623 | 231 | 102 |
| MOS | | 663 | 186 | 71 | 26 | 12 |
| **Loading Capacity [b]** | | **6,627** | **1,859** | **714** | **264** | **117** |
| Existing Load | | 170,024 | 2,195 | 328 | 77 | 23 |
| Percent Load Reduction | | 96% | 15% | 0% | 0% | 0% |

a. It is assumed that loads from permitted construction and industrial stormwater sites that operate in compliance with the permits are meeting the WLA.
b. Loading capacity rounded to nearest whole number.

### French River (04010102-698)

The load duration curve and TMDL allocation for the French River are presented below. Load reductions are needed under very high and high flow conditions. TSS loads decrease significantly under mid-range and low flow conditions. Samples were not collected under very low flow conditions.

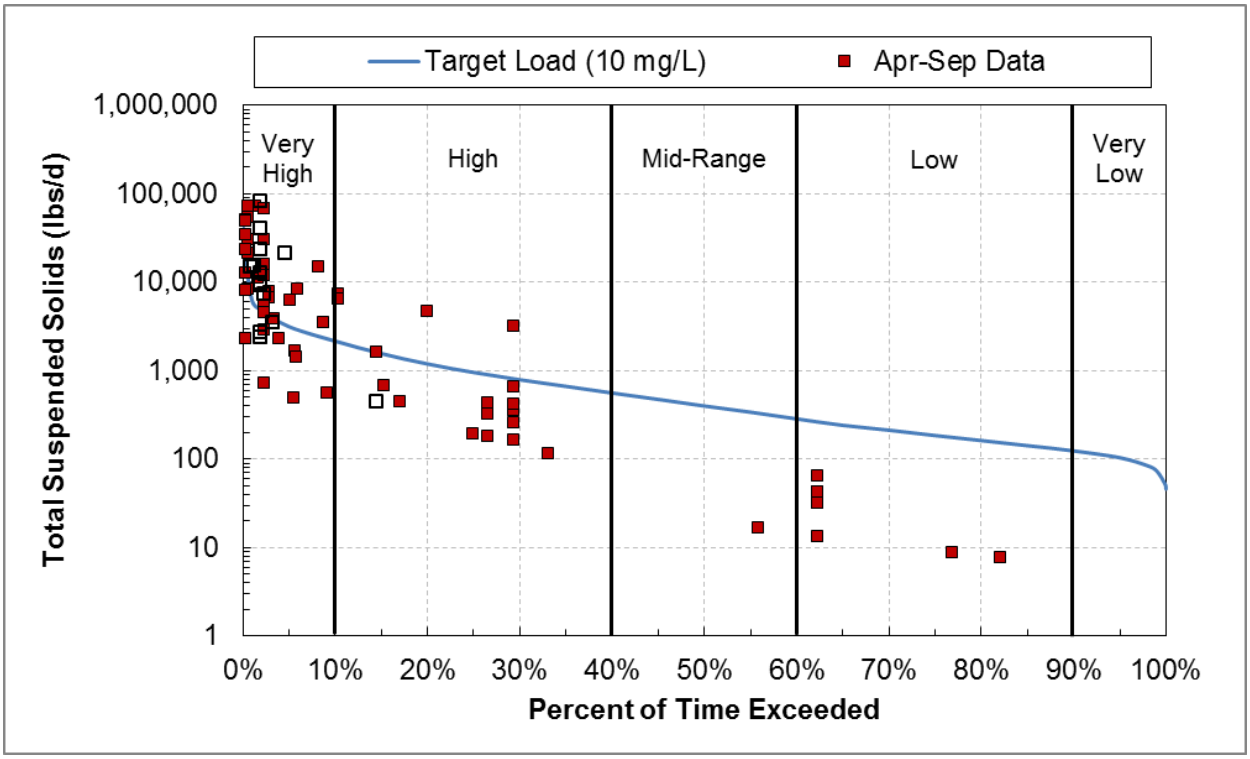


**Figure 31. TSS load duration curve, French River (04010102-698).**
Hollow points indicate samples during months when the standard does not apply

Table 15. TSS TMDL Summary, French River (04010102-698)

| TMDL Parameter | | Flow Regime | | | | |
|---|---|---|---|---|---|---|
| | | Very High (40–882 cfs) | High (10–40 cfs) | Mid-Range (5–10 cfs) | Low (2–5 cfs) | Very Low (0.9–2 cfs) |
| | | TSS Load (lbs/day) | | | | |
| Wasteload Allocation | DNR French River Hatchery (MN0004413) [a] | 127 | 127 | 127 | 127 | – [b] |
| | Duluth Township MS4 | 0.3 | 0.08 | 0.03 | 0.004 | – [b] |
| | Industrial Stormwater (MNR050000) [c] | 54 | 15 | 5 | 1 | – [b] |
| | Construction Stormwater (MNR100001) [c] | 27 | 7 | 2 | 0.4 | – [b] |
| Load Allocation | | 2,626 | 712 | 226 | 39 | – [b] |
| MOS | | 315 | 96 | 40 | 18 | 10 |
| **Loading Capacity [d]** | | **3,149** | **957** | **400** | **185** | **104** |
| 90th Percentile Existing Concentration (mg/L) [e] | | 61 mg/L | | | | |
| Overall Estimated Concentration-Based Percent Reduction (%) [f] | | 84% | | | | |

a. The current permit limit of DNR French River Hatchery (MN0004413) is based on 30 mg/L TSS, and the WLA is based on 10 mg/L TSS. A WQBEL will need to be considered upon permit reissuance.
b. Permitted wastewater design flows exceed stream flow in the indicated flow zone. The allocations are expressed as an equation rather than an absolute number: allocation = flow contribution from a given source x 10 mg/L. See *Municipal and Industrial Wastewater* (Section 4.1.1) for more detail.
c. It is assumed that loads from permitted construction and industrial stormwater sites that operate in compliance with the permits are meeting the WLA.
d. Loading capacity rounded to nearest whole number.

e. The existing concentration was calculated as the 90th percentile of observed TSS concentrations from the months that the standard applies (April through September). The 90th percentile was used because the TSS standard states that the numeric criterion (10 mg/L) may be exceeded for no more than 10 percent of the time.
f. The overall estimated concentration-based percent reduction needed to meet the TMDL was calculated as the existing concentration minus the TSS standard (10 mg/L) divided by the existing concentration. This overall reduction provides a rough approximation of the overall reduction needed for the French River to meet the TMDL. It should not be construed to mean that each of the separate sources listed in the TMDL table need to be reduced by that amount.
-: No data

### Talmadge River (Talmadge Creek; 04010102-508)

The load duration curve and TMDL allocation for Talmadge River (Talmadge Creek) are presented below. Load reductions are needed under very high and high flow conditions. TSS loads decrease significantly under mid-range and low flow conditions. Samples were not collected under very low flow conditions.

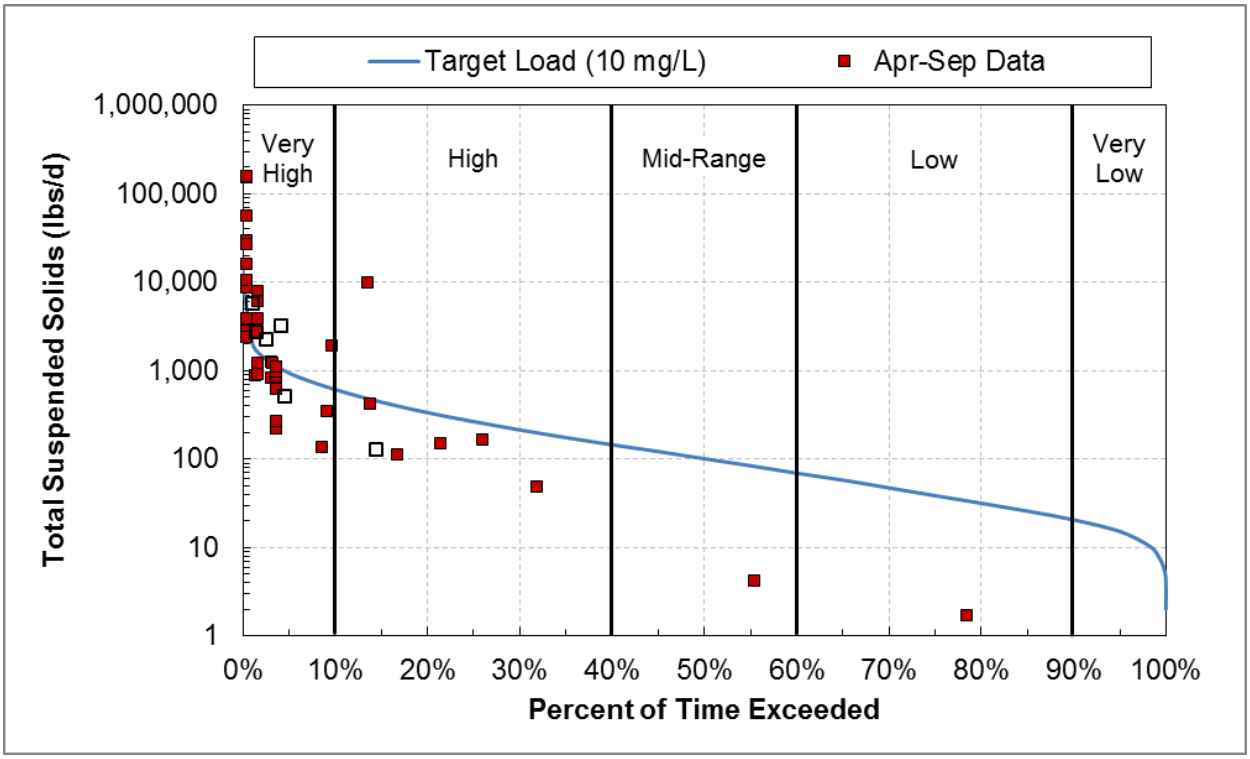


**Figure 32. TSS load duration curve, Talmadge River (Talmadge Creek; 04010102-508).**
Hollow points indicate samples during months when the standard does not apply

**Table 16. TSS TMDL Summary, Talmadge River (Talmadge Creek; 04010102-508)**

| TMDL Parameter | | Flow Regime | | | | |
|---|---|---|---|---|---|---|
| | | Very High | High | Mid-Range | Low | Very Low |
| | | TSS Load (lbs/day) | | | | |
| Wasteload Allocation | Industrial Stormwater (MNR050000) [a] | 16.9 | 4.8 | 1.8 | 0.7 | 0.3 |
| | Construction Stormwater (MNR100001) [a] | 8.5 | 2.4 | 0.9 | 0.3 | 0.1 |
| Load Allocation | | 821.9 | 231.9 | 88.4 | 33.7 | 13.3 |
| MOS | | 94.1 | 26.6 | 10.1 | 3.9 | 1.5 |
| **Loading Capacity** | | **941.4** | **265.7** | **101.2** | **38.6** | **15.2** |
| Existing Load | | 28,149.7 | 5,024.5 | 4.2 | 1.7 | - |
| Percent Load Reduction | | 97% | 95% | 0% [b] | 0% [b] | - |

-: No data

a. It is assumed that loads from permitted construction and industrial stormwater sites that operate in compliance with the permits are meeting the WLA.

b. Reductions based on one sample point. Additional sampling is needed to verify existing loads.

**Knife River (04010102-504)**

The Knife River TMDL was developed in 2010. As described in SSLSWCD (2010):

> *…the loading capacity for the river was only exceeded in the Moist Conditions and High Flow zones of the load duration curve based on the 2004 – 2006 sampling data. A duration curve based on a regression of observed data and corresponding flow values provides an estimated curve of "observed" loads in the river. A comparison of these values against the load duration curve for the TMDL indicates that a load reduction of about 70 to 90 percent for the Moist Conditions and High Flow zones, respectively.*

**Table 17. Knife River TMDL summary table (excerpted from SSLSCWD 2010)**

| Knife River Assimilative Capacity by Flow Zone | | | | | |
|---|---|---|---|---|---|
| All values in tons/day | | | | | |
| | High Flows | Moist Conditions | Mid-Range Flows | Dry Conditions | Low Flows |
| TMDL | 5.300 | 0.860 | 0.270 | 0.120 | 0.043 |
| WLA - Construction | 0.030 | 0.0004 | 0.002 | 0.001 | 0.001 |
| WLA – Duluth Township MS4 (Permit # MS400134) | 0.427 | 0.066 | 0.031 | 0.011 | 0.004 |
| LA | 2.243 | 0.344 | 0.165 | 0.058 | 0.021 |
| MOS | 2.600 | 0.450 | 0.072 | 0.050 | 0.017 |

### Little Knife River (East Branch Little Knife River; 04010102-840)

The load duration curve and TMDL allocation for the Little Knife River (East Branch Little Knife River) are presented below. No data collection was completed during the TMDL time period of 2007 through 2016; therefore existing loads and load reductions cannot be calculated. Data collection from 2004 through 2006 was investigated to determine potential reductions needed. Based on the older data, reductions are needed under all flow conditions except the mid-range, with the highest reductions needed under high flow conditions. New monitoring efforts should be completed within the watershed to determine existing loads and needed reductions.

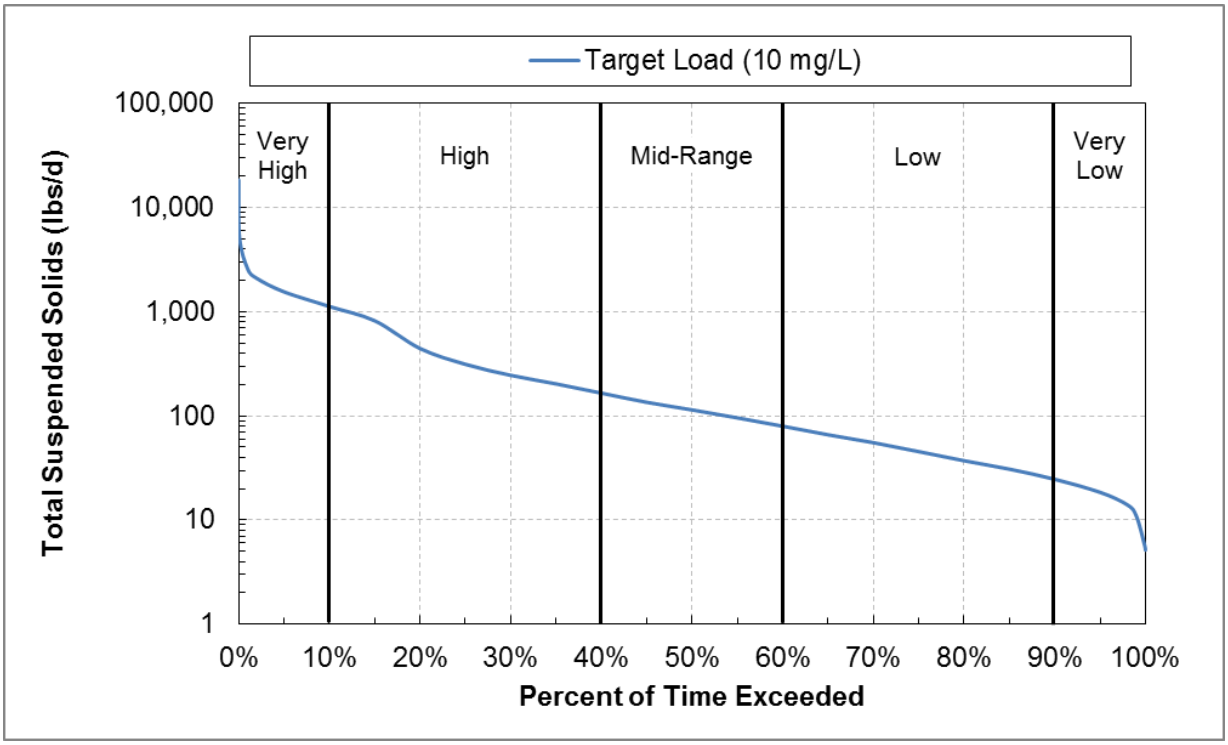


**Figure 33. TSS load duration curve, Little Knife River (East Branch Little Knife River; 04010102-840).**
Hollow points indicate samples during months when the standard does not apply

Table 18 . TSS TMDL Summary, Little Knife River (East Branch Little Knife River; 04010102-840)

| TMDL Parameter | | Flow Regime | | | | |
|---|---|---|---|---|---|---|
| | | Very High | High | Mid-Range | Low | Very Low |
| | | TSS Load (lbs/day) | | | | |
| Wasteload Allocation | Industrial Stormwater (MNR050000, MNR0539FF, MNG490296, and MNRNE38YB) [a] | 28.0 | 5.6 | 2.1 | 0.8 | 0.3 |
| | Construction Stormwater (MNR100001) [a] | 14.0 | 2.8 | 1.0 | 0.4 | 0.2 |
| Load Allocation | | 1,360.0 | 273.7 | 99.9 | 39.7 | 16.1 |
| MOS | | 155.8 | 31.3 | 11.4 | 4.6 | 1.9 |
| **Loading Capacity** | | **1,557.8** | **313.4** | **114.4** | **45.5** | **18.5** |
| Existing Load | | - | - | - | - | - |
| Percent Load Reduction | | - | - | - | - | - |

a. It is assumed that loads from permitted construction and industrial stormwater sites that operate in compliance with the permits are meeting the WLA.

-: Data not available during the 2007-2016 TMDL time period

### Skunk Creek TSS TMDL (04010102-528)

The load duration curve and TMDL allocation for Skunk Creek are presented below. Load reductions are needed under all flow regimes, with the exception of high and mid-range flows. The largest reduction is needed under very high flow conditions.

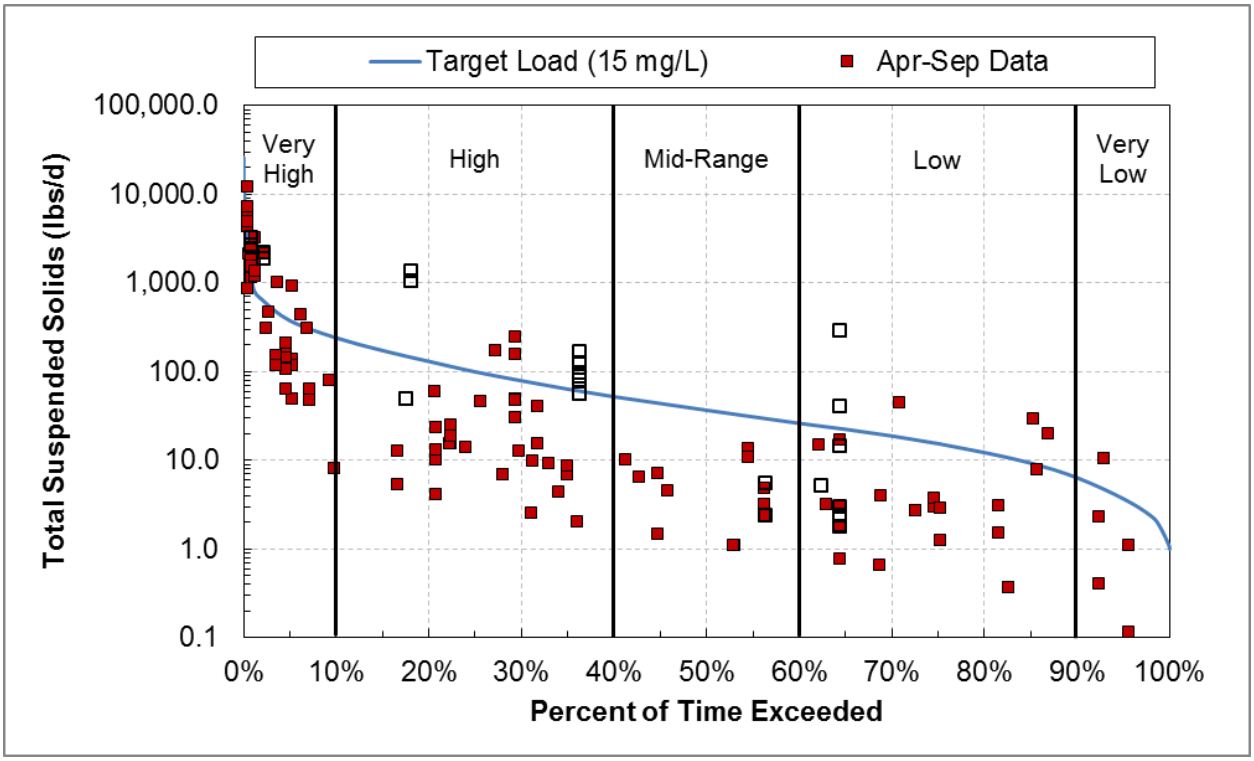


**Figure 34. TSS load duration curve, Skunk Creek (04010102-528).**
Hollow points indicate samples during months when the standard does not apply

**Table 19. TSS TMDL Summary, Skunk Creek (04010102-528)**

| TMDL Parameter | | Flow Regime | | | | |
|---|---|---|---|---|---|---|
| | | Very High | High | Mid-Range | Low | Very Low |
| | | TSS Load (lbs/day) | | | | |
| Wasteload Allocation | Industrial Stormwater (MNR050000, MNR053CHH and MNR0539TD) [a] | 6.77 | 1.79 | 0.66 | 0.28 | 0.07 |
| | Construction Stormwater (MNR100001) [a] | 3.39 | 0.90 | 0.33 | 0.14 | 0.03 |
| Load Allocation | | 328.44 | 86.87 | 32.10 | 13.48 | 3.21 |
| MOS | | 37.62 | 9.95 | 3.68 | 1.54 | 0.37 |
| **Loading Capacity** | | **376.22** | **99.51** | **36.77** | **15.44** | **3.68** |
| Existing Load | | 4,179.49 | 54.42 | 10.79 | 20.14 | 7.23 |
| Percent Load Reduction | | 91% | 0% | 0% | 23% | 49% |

a. It is assumed that loads from permitted construction and industrial stormwater sites that operate in compliance with the permits are meeting the WLA.

## *E. coli* TMDL

### Skunk Creek *E. coli* TMDL (04010102-528)

The load duration curve and TMDL allocations for Skunk Creek are presented below. Based on the observed geometric mean load, reductions are needed under all flow conditions. The largest load reductions are needed under very high to mid-range flow conditions.

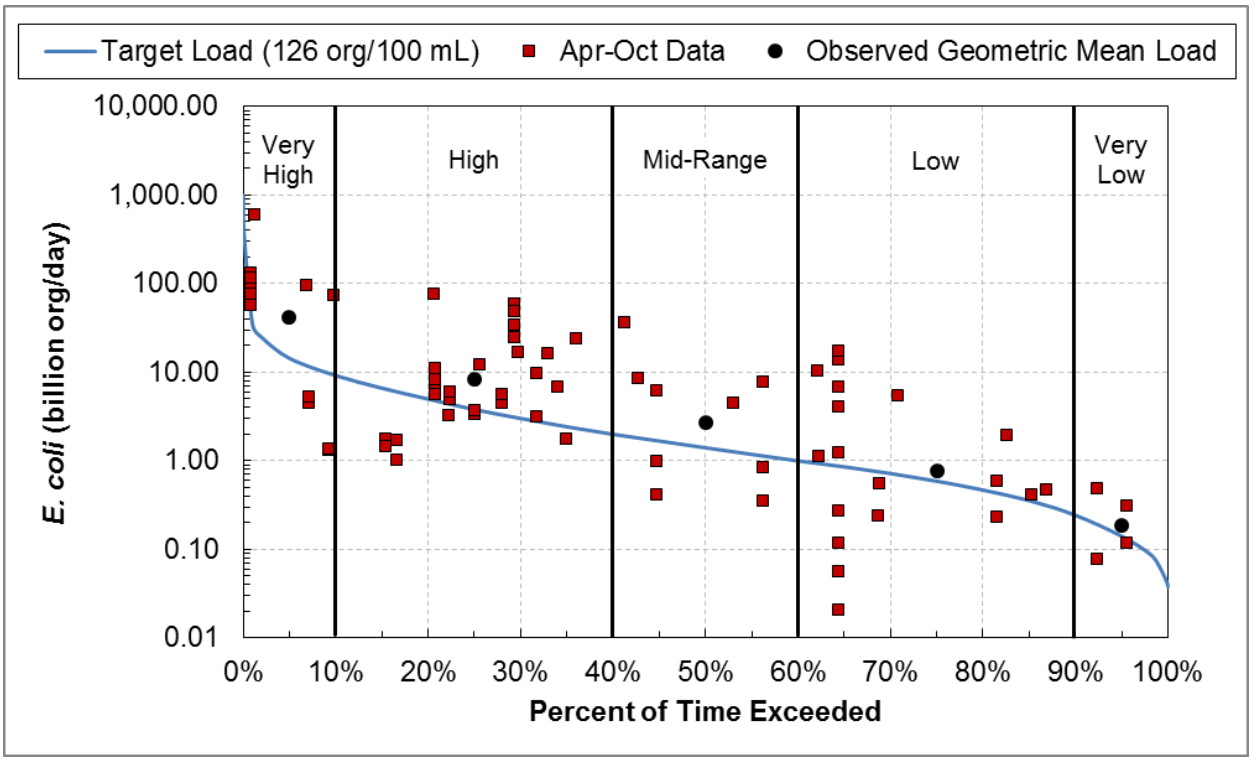


Figure 35. *E. coli* load duration curve, Skunk Creek (04010102-528).

Table 20. *E. coli* TMDL summary, Skunk Creek (04010102-528)

| TMDL Parameter | Flow Regime | | | | |
|---|---|---|---|---|---|
| | Very High | High | Mid-Range | Low | Very Low |
| | *E. coli* Load (billion org/day) | | | | |
| Load Allocation | 12.90 | 3.41 | 1.26 | 0.53 | 0.13 |
| MOS | 1.43 | 0.38 | 0.14 | 0.06 | 0.01 |
| **Loading Capacity** | **14.33** | **3.79** | **1.40** | **0.59** | **0.14** |
| Existing Load | 42.05 | 8.31 | 2.69 | 0.78 | 0.19 |
| Percent Load Reduction | 66% | 54% | 48% | 24% | 26% |