# Appendix G

## Keetac Tailings Basin Expansion Groundwater Sensitivity Assessment

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# Technical Memorandum

**To:** Tom Moe and Darren Gietzen
**From:** Barr Engineering Co.
**Subject:** Keetac Tailings Basin Expansion Groundwater Sensitivity Assessment
**Date:** April 8, 2022
**Project:** 23311410
**c:** Bethany Jones

## 1.0 Introduction and Objectives

United States Steel Corporation, Minnesota Ore Operations – Keetac (Keetac) is in the process of Wetland Conservation Act (WCA) permitting through the Minnesota Department of Natural Resources (MnDNR) for Phase 1 of the Keetac Tailings Basin Management Project ("the Phase 1 project") (Figure 1). The project includes limited tailings deposition within the currently inactive Stage 2 Exterior Tailings Basin (Exterior Basin) as the majority of the tailings deposition will be along the toe of the Stage 2 Interior Tailings Basin embankment to provide stability improvement. Tailings were deposited in the Exterior Basin prior to 1998 when the containment berm was completed for the Stage 2 Interior Tailings Basin (Interior Basin). Keetac generally owns the property beyond the Exterior Basin to north of U. S. Highway 169; west to the O'Brien Creek diversion channel; south to the Alborn-Pengilly Trail and County Highway 16; and east to the West Swan River (Figure 2).

The purpose of this technical memorandum is to evaluate the potential for the construction and operation of the Phase 1 project to cause "significant adverse effect on groundwater quality" per Minnesota Rules 8420.0515 Subp. 6. Analyses presented here are supplemental to those included in the Wetland Replacement Plan submitted October 12, 2021, and to updates dated February 24, 2022.

The evaluation approach utilized in this memorandum is consistent with the concepts and framework from "Criteria and Guidelines for Assessing Geologic Sensitivity of Ground Water Resources in Minnesota" (MnDNR, 1991). This evaluation includes a review of geology, hydrogeology, and groundwater quality data.

Because a "significant adverse effect on groundwater quality" is not specified in Minnesota Rules, this evaluation compares constituents of interest (COI) to applicable standards. Chloride, sulfate, and total dissolved solids (TDS) were selected as COIs due to their typical prevalence in Iron Range tailings basins relative to background groundwater and the use of chloride and sulfate as tracers for tailings basin seepage (Kelly et al., 2016). Groundwater quality was compared to the Environmental Protection Agency (EPA) secondary drinking water standards (sMCLs) as the most stringent standards for sulfate and TDS. Groundwater quality was also compared to the class 2B surface water quality standard for chloride as a more stringent standard than the EPA sMCL (230 mg/L vs. 250 mg/L) that is applicable to downgradient

surface water bodies (Hay Creek, Unnamed Creek – Reservoir 2 to Hay Creek, Welcome Creek, and West Swan River).

As described in further detail in subsequent sections, the Phase 1 project is anticipated to have limited potential to cause "significant adverse effect on groundwater quality".

# 2.0 Project Description

Detailed information describing the project is available in the *Keetac Tailings Basin – Permit to Mine Amendment* prepared by GEI Consultants (2022). The following summary of the Phase 1 project includes information from that document as it pertains to the potential for the Phase 1 project to impact groundwater.

The proposed Phase 1 project is a near-term interim solution for Keetac to transition to a longer-term Tailings Basin storage alternative (Phase 2) that utilizes tailings storage within the full area of the Stage 2 Exterior dike. The long-term solution (Phase 2) will address the tailings storage for 40-plus years to align with mine life and will be completed as a separate project. The Phase 1 project consists of the construction of external dike raises (as currently permitted by the existing dam safety permit) to maintain freeboard, and internal diversion dikes to allow for controlled deposition of tailings within the Stage 2 Exterior Tailings Basin to provide stability improvement to the Stage 2 Interior Tailings Basin embankment. The Phase 1 project is intended to allow for safe operation of the existing active Stage 2 Interior Tailings Basin to maintain production of taconite pellets at the Keetac processing facility. This near-term solution (Phase 1) is needed to provide stability improvement for the Stage 2 Interior dike and suitable tailings storage while Tailings Basin engineers complete additional analyses, design, and permitting for the long-term tailings storage solution (Phase 2). Locations of the proposed dike raises and diversion dikes for the Phase 1 project, as well as a near-term tailings discharge schematic, are graphically depicted in Appendix A.

## 2.1 Pumping and Water Management

The tailings will be released using the same pumping system and level of energy as is currently required. The same pipeline could be used to discharge tailings downstream from the Stage 2 Interior Tailings Basin south dike embankment. Tailings deposition would shift into the Stage 2 Exterior footprint instead of the Stage 2 Interior footprint. This change will bypass the decant system within the Stage 2 Interior Basin. The return water circuit will remain the same, with tailings discharge water reporting to the Stage 2 Exterior Pond, flowing through the Stage 2 Exterior decant structure into Reservoir Six, and then being pumped from Reservoir Six to the processing facility. A new tailings pond will not be developed in the Stage 2 Exterior Tailings Basin as part of the Phase 1 project. Appendix A shows a summary of the current discharge pumping and flow regime for the Stage 2 Interior Tailings Basin as well as potential near-term pumping concepts for the Phase 1 project.

### 2.2 Dike Raises

The dike raises will be completed prior to deposition of tailings. The internal diversion dikes (northwest and west) are necessary to prevent tailings from spreading directly into the Stage 2 Exterior Pond. The external dike raises (east and south) will be used to maintain freeboard in the Tailings Basin as tailings and water spread outward.

### 2.3 Tailings Deposition

The Phase 1 project involves discharge of tailings from piping along the south, west, and east Stage 2 Interior Tailings Basin dike embankment (Appendix A). The majority of tailings will be deposited along the outer slope of the dike with fines spreading outward into the Stage 2 Exterior Basin onto existing tailings that were previously deposited in the area. This will result in variable depths of tailings that are generally deepest near the Stage 2 Interior and become gradually thinner outward, with minimal tailings deposition likely near the outer embankment, which is nearly one mile downstream. The Phase 1 project will not increase the size of the Tailings Basin and does not impact any areas that have not previously been used for tailings storage. Appendix A shows the expected discharge schematic for the Exterior Tailings Basin. During the Phase 1 project, U.S. Steel plans to maintain flow rates into and out of the Tailings Basin similar to existing conditions.

U. S. Steel's geologist does not expect the quality of tailings deposited in the Keetac Tailings Basin to change as mining and ore processing continues into the future. Future mining at Keetac will continue in the Upper and Lower Cherty units of the Biwabik Iron Formation, within which, the mineralogy is fairly uniform in Keetac's mining area. U. S. Steel plans to continue exclusive deposition of Keetac tailings in the Tailings Basin.

## 3.0 Geology and Hydrogeology

Keetac's Tailings Basin is located mostly in western St. Louis County, and straddles the border with eastern Itasca County. This area has moderately thick (25 to 200 feet) glacial deposits overlying low-permeability bedrock (Figure 2). Any potential for adverse effects from the project on nearby hydrogeological settings would occur in relatively shallow geologic units.

### 3.1 Surficial Geology

Tailings deposits in the Exterior Basin range from 5 feet to 25 feet thick. Tailings within the active Interior Basin are generally much thicker. A layer of peat generally 3 feet thick or less underlies tailings in parts of the Tailings Basin (e.g., MWI unique ID 191423) and occurs at the surface sporadically beyond the Exterior Basin (Figure 2).

The Tailings Basin is underlain by 25 feet to more than 300 feet of Quaternary-aged unconsolidated deposits of the Aitkin and Independence Formations, and possibly deeper undifferentiated glacial deposits. Near the Tailings Basin, the uppermost Quaternary-aged unit is typically the Aitkin Formation which is composed locally of the Nelson Lake (Map Units an and anh, Figure 3) and Alborn members (Map

Unit aa, Figure 3). The Nelson Lake Member typically consists of brown, fine-grained loam to clay loam till and was deposited by the southwest arm of the St. Louis sublobe (Johnson et al., 2016; Lusardi et al., 2016). The Alborn Member typically consists of reddish loam to clay loam till originating from the St. Louis sublobe (Johnson et al., 2016; Lusardi et al., 2016). The Independence Formation underlies the Aitkin Formation and typically consists of brown, gray, or red rocky, sandy loam till originating from the Rainy lobe in north-central and northeast Minnesota (Johnson et al., 2016). The Quaternary units present in Minnesota Well Index well logs near the Tailings Basin are a mixture of brown, gray, and occasionally red clay, sand, and gravel layers.

The underlying bedrock is Precambrian-age Thomson Formation slate and possibly the Cretaceous-age Coleraine Formation, which consists of conglomerate, lignite, sandstone, and shale (Jirsa et al., 2011). Two deep wells to the north and west of the Interior Tailing Basin suggest bedrock of Biwabik Iron Formation and Pokegama Quartzite underlie the 200- to 500-feet-thick Thomson Formation.

Six monitoring wells are located in or adjacent to the Tailings Basin. Geologic logs are not available, but approximate well bottom elevations were estimated from well depth measurements and 2-ft topographic contours for Itasca and St. Louis Counties. The calculated well depths were compared with the top of native unconsolidated deposits identified in geologic logs from eight Tailings Basin borings. Peat was reported at elevations of 1459 ft to 1489 ft in five borings and other unconsolidated deposits were identified at 1458 ft to 1529 ft in the remaining three borings. The most likely deposits in which each monitoring well is screened are listed in Table 1.

**Table 1 Summary of monitoring well depths**

| Well | Well depth below top of casing (ft) | Approximate ground surface elevation (ft) | Approximate bottom elevation (ft) | Likely deposits in screened interval |
|---|---|---|---|---|
| B401B | 19.1 | 1486.0 | 1466.0 | near boundary between tailings and native unconsolidated deposits |
| C502A | 11.6 | 1491.0 | 1479.0 | near base of tailings |
| MW-1 | 23.6 | 1439.0 | 1418.4 | native unconsolidated deposits |
| MW-11 | 37.6 | 1454.0 | 1418.9 | native unconsolidated deposits |
| MW-12 | 13.6 | 1438.5 | 1426.7 | native unconsolidated deposits |
| SW Well | 32.5 | 1472.5 | 1440.0 | native unconsolidated deposits |

## 3.2 Hydrogeology

Groundwater likely flows generally radially from the Tailings Basin toward surface water features west, south, and east of the basin. The project is not anticipated to affect groundwater north of the Tailings Basin because tailings will be deposited in the Exterior Basin; groundwater in this area may also be upgradient of the Tailings Basin due to the overall topographic slope to the south. Welcome Creek and West Swan River skirt the Tailings Basin on the west and east sides, respectively (Figure 1). Welcome Creek flows south and west through Reservoir Two North and Reservoir Two, and occasionally into Reservoir Six for use as process makeup water. Discharge from Reservoir 2 flows through the O'Brien Creek diversion

channel and into Hay Creek. The headwaters of Hay Creek occur at the south end of the Exterior Tailings Basin. Welcome Creek and Hay Creek are tributaries to the Swan River, which flows into the Mississippi River. West Swan River flows southward just east of the Tailings Basin, then the east to the St. Louis River.

Hydraulic conductivity was estimated for the fine tailings and underlying Quaternary sand layers based on specific capacity data reported on well logs for wells in the Keetac Tailings Basin area, using the approach published by Bradbury and Rothschild (1985). Their approach uses the Cooper-Jacob approximation of the Theis equation and assumes the aquifer is confined, homogeneous, and isotropic. The approach also assumes that the storage coefficient, well loss, and effective aquifer thickness are known. As these assumptions are not satisfied, the resulting hydraulic conductivity values are approximate estimates. The fine tailings hydraulic conductivity, estimated from one well, is approximately 1 ft/day. The hydraulic conductivity of the sand was estimated to range from 7 ft/day to 25 ft/day, with a geometric mean of 12 ft/day. The sand hydraulic conductivity was estimated using data from four wells located less than 6,000 feet (~1 mile) and one well approximately 10,000 feet (~2 miles) away from the Tailings Basin (Figure B-1). These wells may be installed in the Independence Formation, but the well logs do not contain sufficient information to assign the screened intervals to an aquifer. The locations and well logs for wells with specific capacity data used to estimate hydraulic conductivity are included in Appendix B.

# 4.0 Groundwater Quality

Available groundwater quality information for wells on the perimeter of the Interior and Exterior Basin was compared with water quality in and directly downstream from the Tailings Basin, and in background groundwater (Lively and Thorleifson, 2009) to evaluate whether the basin perimeter wells display apparent influence from Tailings Basin seepage. The constituents of interest (COI) for comparison of Tailings Basin seepage to background groundwater quality are chloride, sulfate, and total dissolved solids (TDS). In general, Tailings Basin seepage is expected to have higher concentrations of COIs than background groundwater due to their presence in process water. Chloride is a conservative tracer, and better suited to isolating any Tailings Basin seepage influence than the other COIs. Additional water quality parameters have been monitored at some locations (Appendix C, Table C2), but are not discussed in this document.

## 4.1 Basin Water Quality

Keetac has collected surface water quality samples at the Interior Basin Weir (aka Inner Tailings Basin Decant Tower Weir) five times from 2014 through 2021 (Figure 4). Discharge from the Interior Basin Weir flows through the Stage 2 Pond into Reservoir Six, from which it is pumped to the processing plant as make-up water or can flow north through SD005, then west to Reservoir Two. Discharge from Reservoir Two flows through the O'Brien Creek diversion channel and into Hay Creek. The project will not alter surface discharge routes from the Tailings Basin (Appendix A).

Water quality data were collected at SD005 periodically from 2009 through 2014, then monthly since 2015. Temporal trends in COI concentrations are not apparent in the SD005 data. Samples were also collected in 2014 and 2015 from the tailings slurry, Interior Basin weir, the Stage 2 pond, and the Reservoir

Six Pumphouse (Kelly et al., 2016). Average concentrations of COIs at these locations are shown on Table 2 and supporting data tables are included in Appendix C. Tailings Basin water quality data are not available from other locations.

**Table 2 Summary of basin water quality**

| Location | Chloride (mg/L) | | | Sulfate (mg/L) | | | Total Dissolved Solids (mg/L) | | |
|---|---|---|---|---|---|---|---|---|---|
| **Standard** | **230** | **--** | **--** | **250** | **--** | **--** | **500** | **--** | **--** |
| | Average | Standard Deviation | Samples | Average | Standard Deviation | Samples | Average | Standard Deviation | Samples |
| Tailings Slurry | 30.2 | 2.6 | 2 | 135 | 2.5 | 2 | -- | -- | -- |
| Interior Basin Weir | 30.0 | 6.0 | 5 | 143 | 25.6 | 5 | 489 | 5.0 | 2 |
| Stage 2 Pond | 22.1 | 1.0 | 2 | 109 | 2.9 | 2 | -- | -- | -- |
| Reservoir Six Pumphouse | 24.5 | 4.0 | 3 | 112 | 14.7 | 3 | -- | -- | -- |
| SD005 | 24.8 | 0.0 | 2 | 101 | 19.2 | 90 | 503 | -- | 1 |

-- No data available

Interior Basin discharge meets applicable standards for the COIs; however, TDS is very close to the sMCL at the Interior Basin weir and slightly exceeds the sMCL in the single sample from SD005. Interior Basin water quality provides an analog for Exterior Basin water quality during and following the Phase 1 project because the tailings quality is not expected to change as indicated in Section 2.3.

## 4.2 Background Groundwater Quality

Regional groundwater quality data have been compiled by the Minnesota Pollution Control Agency (MPCA, 1999) and later by the Minnesota Geological Survey (Lively and Thorleifson, 2009). Most domestic wells located near the Tailings Basin are screened in a Quaternary-age buried artesian aquifer (QBAA), likely sandier intervals of the Independence Formation (Figure 3). However, some domestic wells are screened in a Quaternary-age water table aquifer (QWTA) or bedrock, or the screened interval is unknown. Average groundwater quality data from wells screened in Quaternary-age aquifers within 50 miles of the Tailings Basin are presented in Table 3.

**Table 3 Summary of regional groundwater quality[1]**

| Aquifer | Chloride (mg/L) | | | Sulfate (mg/L) | | | Total Dissolved Solids (mg/L) | | |
|---|---|---|---|---|---|---|---|---|---|
| **Standard** | **230** | **--** | **--** | **250** | **--** | **--** | **500** | **--** | **--** |
| | Average | Standard Deviation | Wells | Average | Standard Deviation | Wells | Average | Standard Deviation | Wells |
| Surficial Drift (QWTA) | 6.0 | 6.9 | 9 | 9.8 | 8.2 | 9 | 229 | 83 | 9 |
| Buried Unconfined Drift (QBUU) | 3.4 | 6.0 | 8 | 4.3 | 4.7 | 8 | 235 | 121 | 8 |
| Buried Artesian Drift (QBAA) | 3.1 | 4.5 | 21 | 6.5 | 4.6 | 21 | 244 | 85 | 21 |

1 All values calculated from data at individual wells reported in Lively and Thorleifson (2009).

### 4.3 Water Quality Comparison

Groundwater quality samples were collected at three monitoring wells (MW 1, MW 11, and MW 12, Figure 4) near the southwest corner of the Exterior Basin in 2014 (Kelly et al., 2016). Keetac sampled wells near the perimeter of the Interior Basin in fall 2021 (SW Well, B401B, and C502A). The SW Well was dry; however, two sets of samples were collected from B401B and C502A (Figure 4). The screened intervals of the monitoring wells are unknown. However, as noted in Table 1, B401B and C502A are likely screened near or just below the bottom of tailings, while the remaining wells are very likely screened in native unconsolidated deposits. Average water quality data for the wells are presented in Table 4.

**Table 4 Groundwater quality at site wells**

| Location | Chloride (mg/L) | | | Sulfate (mg/L) | | | Total Dissolved Solids (mg/L) | | |
|---|---|---|---|---|---|---|---|---|---|
| **Standard** | **230** | **--** | **--** | **250** | **--** | **--** | **500** | **--** | **--** |
| | Average | Standard Deviation | Samples | Average | Standard Deviation | Samples | Average | Standard Deviation | Samples |
| B401B | 24.3 | 0.3 | 2 | 167 | 1.5 | 2 | 523 | 23 | 2 |
| C502A | 23.5 | 0.2 | 2 | 75.7 | 1.5 | 2 | 497 | 41 | 2 |
| MW 1 | 23.6 | 0.3 | 2 | 54.9 | 11.1 | 2 | -- | -- | -- |
| MW 11 | 23.3 | -- | 1 | 93.1 | -- | 1 | -- | -- | -- |
| MW 12 | 17.2 | -- | 1 | 57.4 | -- | 1 | -- | -- | -- |

Chloride and sulfate are below applicable standards in the sampled wells. TDS is slightly above the sMCL at B401B and very close to the sMCL at C502A, which are both at the toe of the Interior Basin. Sulfate in groundwater is similar to or slightly lower than sulfate in Tailings Basin surface water, indicating that

sulfate generated from the oxidation of coarse tailings in the perimeter dikes is mostly attenuated by sulfate reduction in or adjacent to the Tailings Basin. This assessment is supported by a MnDNR study, which concluded that sulfate in Keetac's Tailings Basin seepage is likely reduced by microbial activity (Kelly et al., 2016).

Concentrations of COIs in groundwater near the Tailings Basin are elevated relative to regional groundwater. Water quality at the wells is very similar to Interior Basin surface discharge water quality for chloride, sulfate, and TDS, though sulfate is lower in some groundwater samples. With the Phase 1 project, future groundwater quality at the edge of the Exterior Basin is expected to be very similar to the currently-observed water quality at B401B and C502A. Overall, wells near the perimeters of the Interior Basin and Exterior Basin meet applicable standards for chloride and sulfate, and slightly exceed the sMCL for TDS. The sampled locations are expected to represent worst-case water quality conditions due to their proximity to the Tailings Basin; more distant locations would have lower concentrations of the COIs due to dilution and sulfate reduction.

## 5.0 Conclusions

This analysis concludes that hydrogeologic units near the Tailing Basin are capable of supporting drinking water wells as evidenced by the numerous domestic wells located within 2 miles east of the Tailings Basin (Figure 3). However, the West Swan River likely acts as a hydrologic barrier to eastward shallow groundwater flow, preventing potential lateral migration of groundwater to all but two domestic wells downgradient of the Tailings Basin on the east side. Domestic wells downgradient of the Tailings Basin to the south and west are more than 3 miles away and more than 2.4 miles away, respectively. Keetac property ownership extends more than 1 mile and more than 2.3 miles beyond the Exterior Basin to the west and south, respectively, preventing new well installation in those areas. In addition, most of the domestic wells near the Tailings Basin are screened in the Independence Formation, which is generally overlain by clay from the Aitkin Formation and/or peat. The continuity and thickness of the Aitkin Formation under the Tailings Basin are unknown.

Surface water quality from the Interior Basin and groundwater quality from the perimeter of the Interior and Exterior Basins meet applicable standards for chloride and sulfate. TDS is slightly higher in groundwater near the toe of the active Interior Tailings Basin than in the recirculating process water, but remains close to the sMCL. For the following reasons, it is reasonable to anticipate "no significant adverse effect on groundwater quality" at wells located farther from the Tailings Basin as a result of Keetac's proposed Phase 1 project:

- Interior Basin water quality provides a direct analog for Exterior Basin water quality and COI concentrations are either below or slightly above applicable standards
- Groundwater concentrations immediately adjacent to the Tailings Basin are currently either below or just above applicable standards

- Concentrations would be expected to decrease downgradient due to the influence of recharge and other attenuation mechanisms (e.g., dilution, sulfate reduction).

# 6.0 References

Barr Engineering Co. (Barr), 2012. 2011 Water Quality, Hydrology, and Wild Rice Monitoring Year End Report - Swan Lake, Hay Lake, Moose Lake, Hay Creek, and Swan River. Prepared for United States Steel Corporation, Minnesota Ore Operations – Keetac, January 2012.

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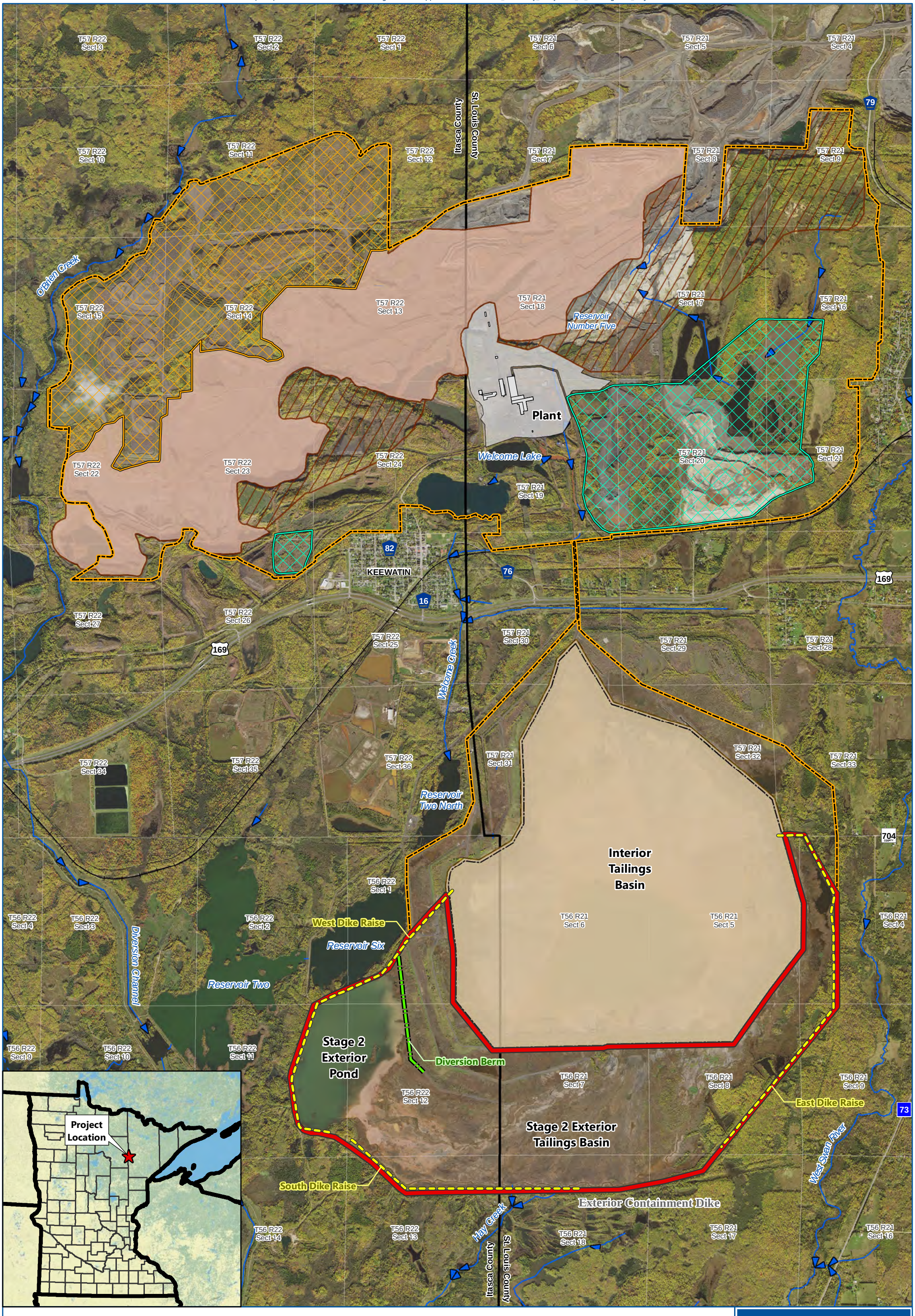
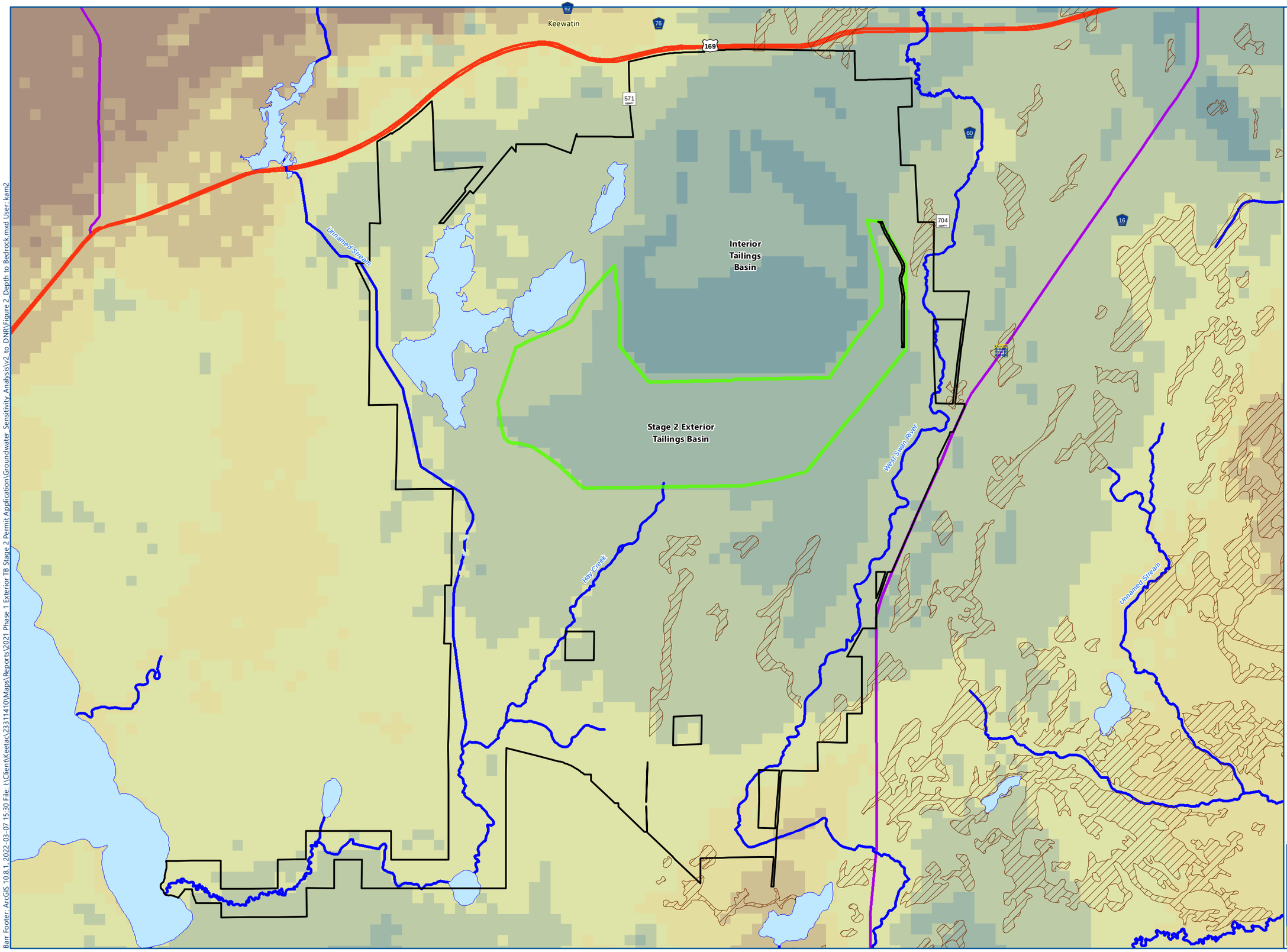
## Attachments

Barr Footer: ArcGIS 10.8.1, 2022-03-23 09:03 File: I:\Client\Keetac\23311410\Maps\Reports\2021 Phase 1 Exterior TB Stage 2 Permit Application\Groundwater_Sensitivity_Analysis\v2_to_DNR\Figure 1_Project Location.mxd User: dmt2




**PROJECT LOCATION**
Keetac Tailings
Basin Management
U. S. Steel - Keetac

FIGURE 1




Public Watercourse

Public Waters Basins

Stage 2 Exterior Tailings Basin

U. S. Steel Property

peat (SSURGO, 2012)

Depth to Bedrock (50 ft. interval)

- 0 - 50
- 51 - 100
- 101 - 150
- 151 - 200
- 201 - 250
- 251 - 300
- 301 - 350
- 351 - 400

0 1,500 3,000 4,500

Feet

*Image Source: FSA (2021)*

**Depth to Bedrock**
Keetac Tailings
Basin Management
U. S. Steel - Keetac

FIGURE 2

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peat (SSURGO, 2012)

**D-1 Surficial Geology (MGS)* Formation/Member**

**Aitkin/Alborn**

- aa:Clay loam over sand and gravel
- aa:Clay loam to loam
- aa:Till; washed
- aah:Mixed deposits, predominantly till
- aah:Till, silt and clay, sand, and gravel
- aii:Sand, gravelly sand, and gravel
- glf:Glacial lake sediment; modified by currents (subaqueous outwash)
- glg:Sand and gravelly sand
- glg:Sand and silty sand
- gls:Sand and silt

**Aitkin/Nelson Lake**

- aii:Ice contact deposits
- an:Till over Rainy lobe deposits
- an:Till; washed; over Rainy lobe deposits
- anh:Complex of till and Rainy-lobe ice contact deposits
- anh:Mixed deposits, predominantly till

**Indepence/Undifferentiated**

- ini:Ice contact deposits

**Boundary Waters/Undifferentiated**

- bw:Till
- bwi:Cobbles and gravel, sandy gravel, and gravelly sand
- bwi:Ice contact deposits
- bwo:Outwash
- bwo:Sand to gravelly sand

**Unspecified**

- al:Alluvium
- al:Sand and gravel, sandy loam to silt loam
- glc:Glacial lake sediment
- glg:Deltaic sediment
- glg:Glacial lake sediment; coarse-grained
- gls:Glacial lake sediment; sandy

**Not Applicable**

- b:Mine-pit-lake
- do:Overburden dump mound
- drc:Coarse-grained rock dump mound
- drc:Dump mound of unknown extent
- drc:Medium-grained rock dump mound
- drc:Overburden dump mound
- drc:Rock dump mound
- drf:Dump mound of unknown extent
- drf:Fine-grained rock tailings basins
- fil:Constructed land
- fil:Disturbed land
- fil:Dump mound of unknown extent

Interior Tailings Basin

Stage 2 Exterior Tailings Basin

Keewatin

Unnamed Stream

Hay Creek

West Swan River

**Active Wells by Aquifer**

- Not Available
- Bedrock
- QBAA
- QBUA
- QUUU
- QWTA
- Public Watercourse
- Interior Tailings Basin
- Stage 2 Exterior Tailings Basin
- U. S. Steel Property

*This surficial geology map is the Minnesota Geological Survey's D-1 Surficial Geology, a database that is continuously updated. The original D-1 Surficial Geology started with the S-23 Geologic Map of Minnesota - Quaternary Geology but the data has now been updated to the D-1 Surficial Geology. The D-1 Surficial geology is a product of compiled and edge matched mapping from 1:100,000 scale MGS Quaternary maps. Downloaded 5/28/2020

0 1,500 3,000 4,500

Feet

*Image Source: FSA (2019)*

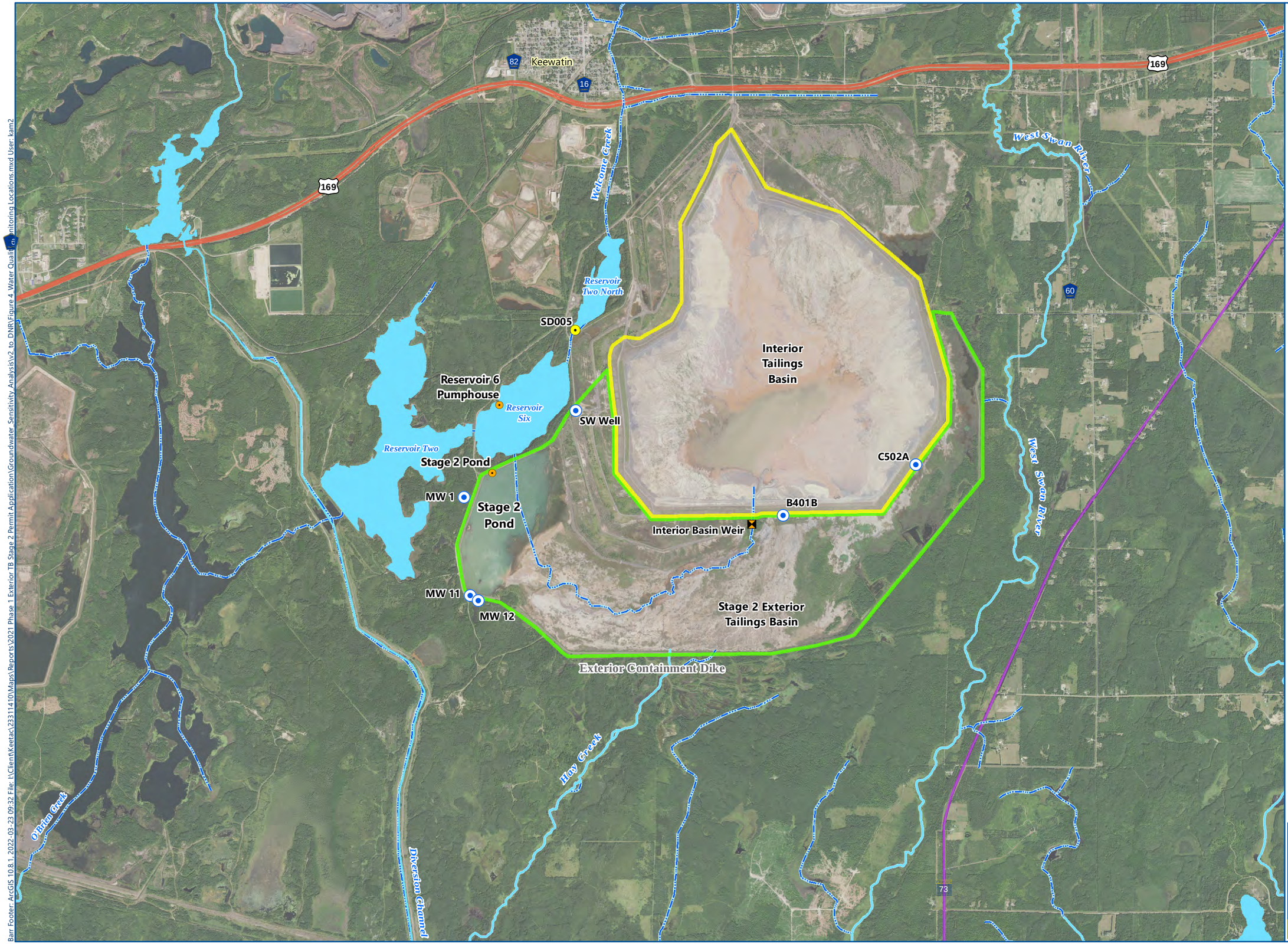
**Minnesota Well Index and Surficial Geology**

Keetac Tailings Basin Management

U. S. Steel - Keetac

FIGURE 3

Barr Footer: ArcGIS 10.8.1, 2022-03-08 17:35 - I:\Client\Keetac\23311410\gis\Reports\2021 Phase 1 Exterior TBasin Stage 2 Permit Application\Groundwater_Sensitivity_Analysis\v2_to_DNR\Figure 3_MN Well Index and Surficial Geology_v3.mxd User: kam2




Barr Footer: ArcGIS 10.8.1, 2022-03-23 09:32 File: I:\Client\Keetac\23311410\Maps\Reports\2021 Phase 1 Exterior TB Stage 2 Permit Application\Groundwater Sensitivity Analysis\v2_to_DNR\Figure 4_Water Quality Monitoring Locations.mxd User: kam2

# Appendix A

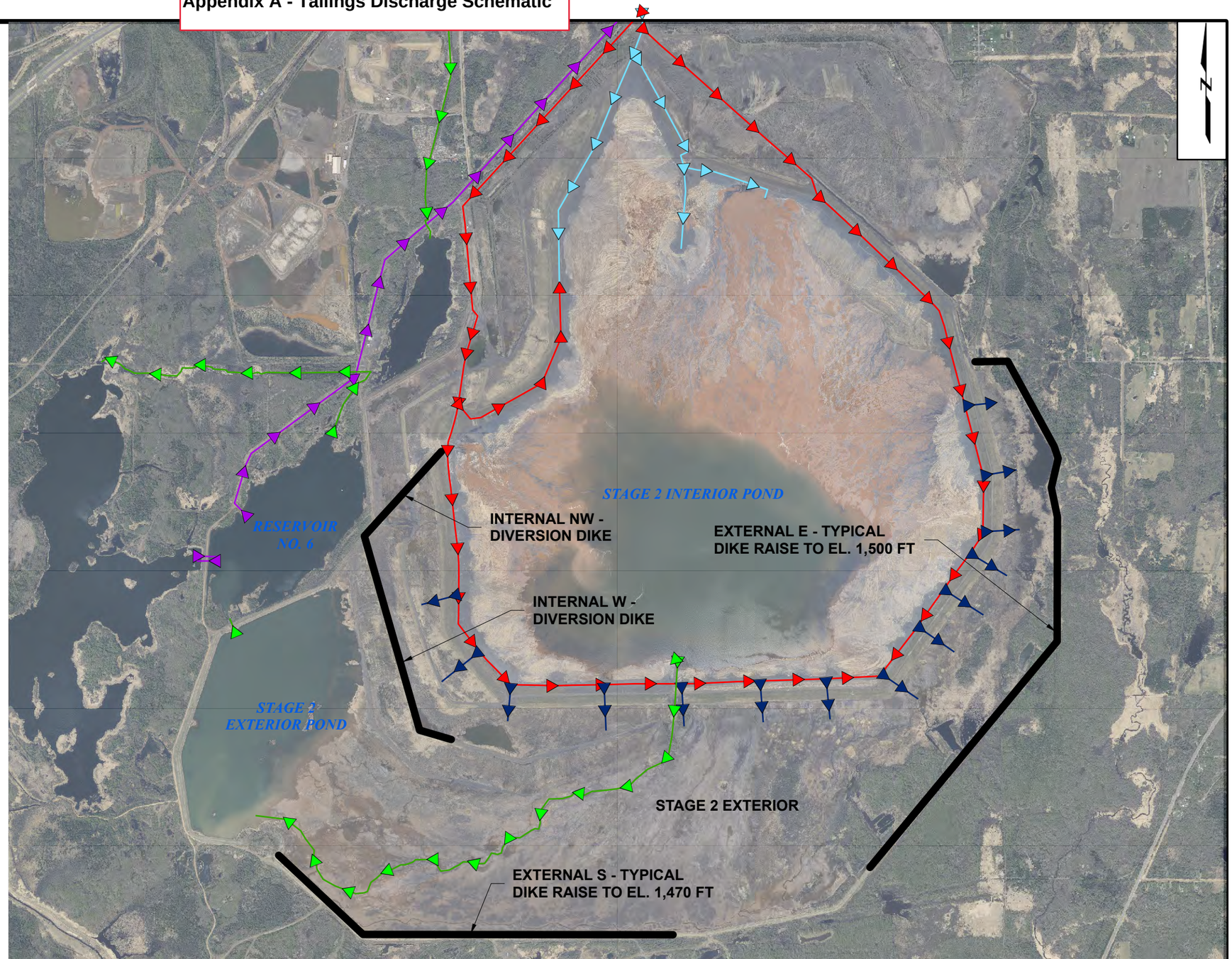
## Tailings Discharge Schematic

# Appendix A - Tailings Discharge Schematic

## ***LEGEND:***

Discharge Schematic

- Gravity / Natural Drainage
- Normal Tailings Line
- Pumping Flow
- Potential Short Term Tailings Discharge Line
- Standby Tailings Line
- 2022 Construction Area




0 1,000 2,000 4,000 6,000 8,000 Feet

Spatial Reference
Name: NAD 1983 2011 StatePlane Minnesota North FIPS 2201 Ft US

Permit to Mine Non-Substantial Amendment
Keetac Tailings Basin
Keewatin, Minnesota

United States Steel Corp.
Keewatin, Minnesota

GEI Consultants

NEAR TERM DISCHARGE SCHEMATIC

Project 2100305

January 2022

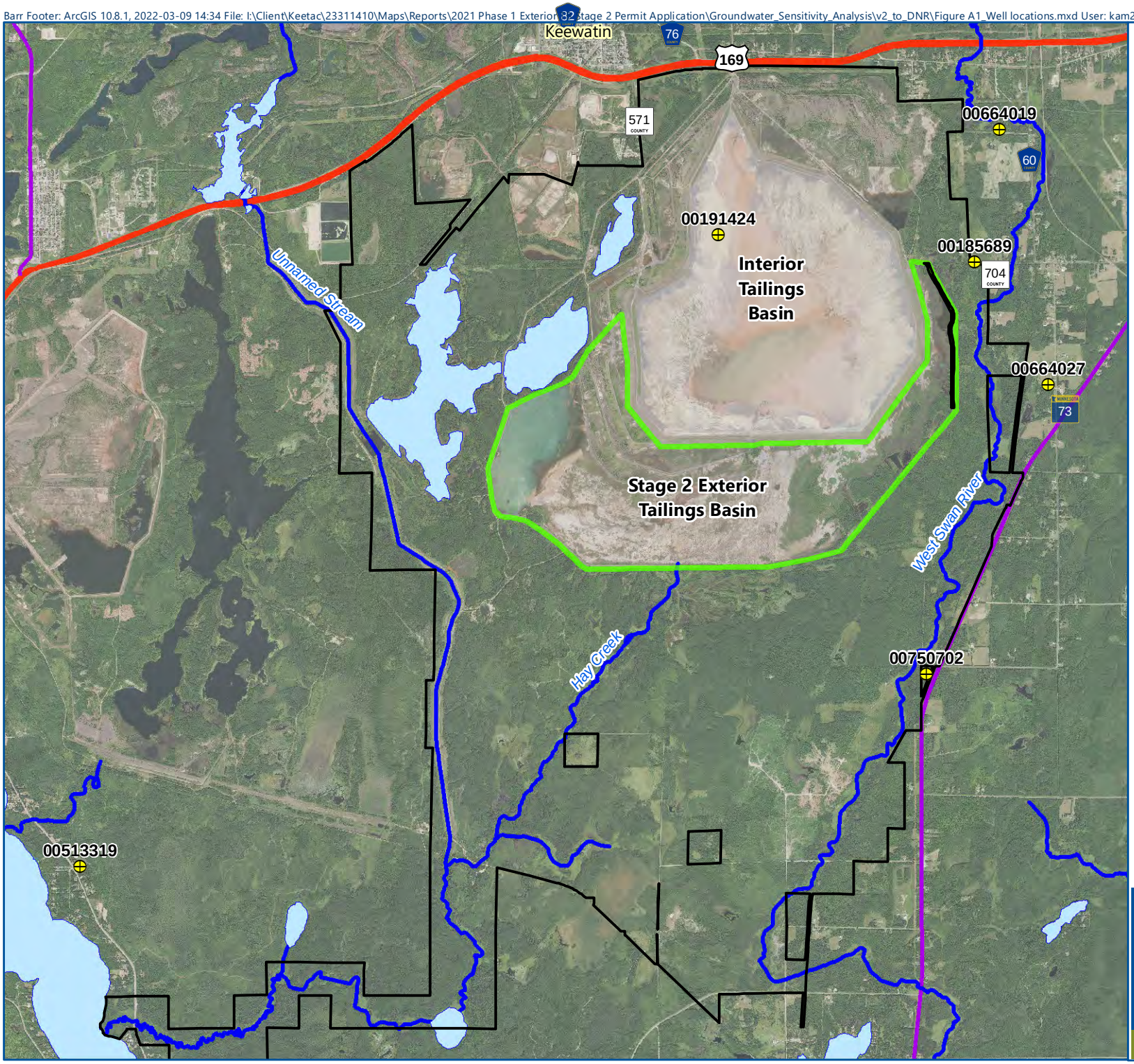
Fig. 3

Path: C:\Users\jhansen\OneDrive - GEI Consultants, Inc\Documents\GIS_Work\KEETAC\2100305_Keetac_2021 Quarterly Tailings Basin PM\2100305_Keetac_2021 Quarterly Tailings Basin PM.aprx

# Appendix B

## Hydraulic Conductivity Estimate Source Information

Barr Footer: ArcGIS 10.8.1, 2022-03-09 14:34 File: I:\Client\Keetac\23311410\Maps\Reports\2021 Phase 1 Exterior Stage 2 Permit Application\Groundwater_Sensitivity_Analysis\v2_to_DNR\Figure A1_Well locations.mxd User: kam2




Well - County Well Index

Public Watercourse

Public Waters Basins

Stage 2 Exterior Tailings Basin

U. S. Steel Property

N

0 2,000 4,000 6,000

Feet

*Image Source: FSA (2021)*

**Wells with Specific Capacity Data**

Keetac Tailings Basin Management

U. S. Steel - Keetac

FIGURE B-1

Minnesota Unique Well Number

**185689**

**County** St. Louis
**Quad** Silica
**Quad ID** 295D

**MINNESOTA DEPARTMENT OF HEALTH**

# WELL AND BORING REPORT

*Minnesota Statutes Chapter 1031*

**Entry Date** 09/10/1990
**Update Date** 07/01/2015
**Received Date**

| Well Name | Township | Range | Dir | Section | Subsection |
|---|---|---|---|---|---|
| WKKQ | 57 | 21 | W | 33 | DCCCCC |

**Elevation** 1466 **Elev. Method** 7.5 minute topographic map (+/- 5 feet)

**Address**

Well HIBBING MN 55746

**Stratigraphy Information**

| Geological Material | From | To (ft.) | Color | Hardness |
|---|---|---|---|---|
| CLAY | 0 | 11 | BROWN | HARD |
| COBBLES | 11 | 59 | BROWN | HARD |
| CLAY | 59 | 91 | BROWN | HARD |
| SAND | 91 | 97 | BROWN | MEDIUM |

**Remarks**

**Well Depth** 97 ft. **Depth Completed** 97 ft. **Date Well Completed** 04/02/1982

**Drill Method** Non-specified Rotary **Drill Fluid**

**Use** domestic **Status** Active

**Well Hydrofractured?** Yes ☐ No ☐ **From** **To**

**Casing Type** Single casing **Joint** Threaded

**Drive Shoe?** Yes ☐ No ☒ **Above/Below** 4 ft.

| Casing Diameter | | Weight | | Hole Diameter | |
|---|---|---|---|---|---|
| 4 in. To 93 ft. | | 14.9 lbs./ft. | | 6.5 in. To 97 ft. | |

**Open Hole** From ft. To ft.

**Screen?** ☒ **Type** stainless **Make** JOHNSON

| Diameter | Slot/Gauze | Length | Set | |
|---|---|---|---|---|
| 3 in. | 15 | 4 ft. | 93 ft. | 97 ft. |

**Static Water Level**

30 ft. land surface Measure 04/02/1982

**Pumping Level (below land surface)**

85 ft. 1 hrs. Pumping at 20 g.p.m.

**Wellhead Completion**

Pitless adapter manufacturer Model

☐ Casing Protection ☒ 12 in. above grade

☐ At-grade (Environmental Wells and Borings ONLY)

**Grouting Information** Well Grouted? ☐ Yes ☒ No ☐ Not Specified

**Nearest Known Source of Contamination**

85 feet South Direction Septic tank/drain field Type

Well disinfected upon completion? ☒ Yes ☐ No

**Pump** ☐ Not Installed Date Installed

Manufacturer's name

Model Number HP Volt

Length of drop pipe ft Capacity g.p. Typ

**Abandoned**

Does property have any not in use and not sealed well(s)? ☐ Yes ☐ No

**Variance**

Was a variance granted from the MDH for this well? ☐ Yes ☐ No

**Miscellaneous**

First Bedrock Aquifer Quat. buried

Last Strat sand-brown Depth to Bedrock ft

Located by Minnesota Geological Survey

Locate Method Digitized - scale 1:24,000 or larger (Digitizing Table)

System UTM - NAD83, Zone 15, Meters X 498925 Y 5246466

Unique Number Verification Information from Input Date 07/26/1993

**Angled Drill Hole**

**Well Contractor**

| Licensee Business | Lic. or Reg. No. | Name of Driller |
|---|---|---|
| Arrowhead Well | 69518 | BEUNING, W. |

Minnesota Unique Well Number

**191424**

**County** St. Louis
**Quad** Silica
**Quad ID** 295D

**MINNESOTA DEPARTMENT OF HEALTH**

# WELL AND BORING REPORT

*Minnesota Statutes Chapter 1031*

**Entry Date** 05/20/1991
**Update Date** 10/16/2018
**Received Date**

| Well Name | Township | Range | Dir | Section | Subsection |
|---|---|---|---|---|---|
| USGS KTB 32 | 57 | 21 | W | 31 | DCBBBD |

**Elevation** 1495.4 **Elev. Method** Surveyed

**Address**

**Stratigraphy Information**

| Geological Material | From | To (ft.) | Color | Hardness |
|---|---|---|---|---|
| TAILINGS V. FINE | 0 | 17 | GRAY | |

**Remarks**

SEALED 12-26-1991 BY M0113.

DRILLED BY BENES WELL DRILLING FOR THE USGS.

| Well Depth | Depth Completed | Date Well Completed |
|---|---|---|
| 17 ft. | 17 ft. | 09/22/1982 |

**Drill Method** **Drill Fluid**

**Use** test well **Status** Sealed

**Well Hydrofractured?** **Yes** ☐ **No** ☐ **From** **To**

**Casing Type** Single casing **Joint**
**Drive Shoe?** **Yes** ☐ **No** ☐ **Above/Below**

| Casing Diameter | Weight | Hole Diameter |
|---|---|---|
| 5 in. To 7 ft. | 2.25 lbs./ft. | 8 in. To 16 ft. |

**Open Hole** From ft. To ft.

**Screen?** ☒ **Type** plastic **Make**

| Diameter | Slot/Gauze | Length | Set | |
|---|---|---|---|---|
| 5 in. | 10 | 10 ft. | 6 ft. | 16 ft. |

**Static Water Level**

4.5 ft. land surface Measure 11/01/1982

**Pumping Level (below land surface)**

15 ft. 1 hrs. Pumping at 0.75 g.p.m.

**Wellhead Completion**

Pitless adapter manufacturer Model

☐ Casing Protection ☒ 12 in. above grade
☐ At-grade (Environmental Wells and Borings ONLY)

**Grouting Information** Well Grouted? ☒ Yes ☐ No ☐ Not Specified

| Material | Amount | From | To |
|---|---|---|---|
| bentonite | | ft. | ft. |

**Nearest Known Source of Contamination**

feet Direction Type

Well disinfected upon completion? ☒ Yes ☐ No

**Pump** ☐ Not Installed Date Installed

Manufacturer's name

Model Number HP Volt

Length of drop pipe ft Capacity g.p. Typ

**Abandoned**

Does property have any not in use and not sealed well(s)? ☐ Yes ☐ No

**Variance**

Was a variance granted from the MDH for this well? ☐ Yes ☐ No

**Miscellaneous**

First Bedrock Aquifer Recent undiff.
Last Strat man-made fill Depth to Bedrock ft
Located by Minnesota Geological Survey
Locate Method Digitization (Screen) - Map (1:24,000) (15 meters or
System UTM - NAD83, Zone 15, Meters X 495763 Y 5246801
Unique Number Verification Other, note in Input Date 10/07/2014

**Angled Drill Hole**

**Well Contractor**

Benes Well Co. 31009
Licensee Business Lic. or Reg. No. Name of Driller

Minnesota Unique Well Number

**513319**

**County** Itasca
**Quad** Pengilly
**Quad ID** 295C

**MINNESOTA DEPARTMENT OF HEALTH**

# WELL AND BORING REPORT

*Minnesota Statutes Chapter 1031*

**Entry Date** 12/31/1992
**Update Date** 05/19/2014
**Received Date**

| Well Name | Township | Range | Dir | Section | Subsection |
|---|---|---|---|---|---|
| FREDENBURG, | 56 | 22 | W | 29 | DACCCD |

**Elevation** 1368 **Elev. Method** 7.5 minute topographic map (+/- 5 feet)

**Address**

Contact HC 1 BOX 966 PENGILLY MN 55775

**Stratigraphy Information**

| Geological Material | From | To (ft.) | Color | Hardness |
|---|---|---|---|---|
| TOP SOIL | 0 | 1 | BLACK | SOFT |
| SAND | 1 | 5 | BROWN | SOFT |
| CLAY SAND | 5 | 17 | BROWN | SOFT |
| CLAY SAND | 17 | 57 | BLUE | SOFT |
| CLAY | 57 | 92 | BLUE | SOFT |
| CLAY SAND | 92 | 106 | BLUE | SOFT |
| AQUIFER | 106 | 111 | WHITE | SOFT |

**Remarks**

ROADSIDE ACRES LOT 1.

**Well Depth** 111 ft. **Depth Completed** 111 ft. **Date Well Completed** 08/05/1992

**Drill Method** Non-specified Rotary **Drill Fluid** Bentonite

**Use** domestic **Status** Active

**Well Hydrofractured?** Yes ☐ No ☐ **From** **To**

**Casing Type** Single casing **Joint**

**Drive Shoe?** Yes ☐ No ☒ **Above/Below**

| Casing Diameter | Weight | Hole Diameter |
|---|---|---|
| 4 in. To 107 ft. | lbs./ft. | 8 in. To 111 ft. |

**Open Hole** From ft. To ft.

**Screen?** ☒ **Type** stainless **Make** WESCO

| Diameter | Slot/Gauze | Length | Set | |
|---|---|---|---|---|
| 4 in. | 7 | 4 ft. | 107 ft. | 111 ft. |

**Static Water Level**

2.5 ft. land surface Measure 08/05/1992

**Pumping Level (below land surface)**

105 ft. 2 hrs. Pumping at 50 g.p.m.

**Wellhead Completion**

Pitless adapter manufacturer MONITOR Model SNAPPY

☐ Casing Protection ☒ 12 in. above grade

☐ At-grade (Environmental Wells and Borings ONLY)

**Grouting Information** Well Grouted? ☒ Yes ☐ No ☐ Not Specified

| Material | Amount | From | To |
|---|---|---|---|
| neat cement | | 10 ft. | 30 ft. |

**Nearest Known Source of Contamination**

75 feet North Direction Septic tank/drain field Type

Well disinfected upon completion? ☒ Yes ☐ No

**Pump** ☐ Not Installed Date Installed 08/20/1992

Manufacturer's name AERMOTOR

Model Number SD12-50 HP 0.5 Volt 115

Length of drop pipe 40 ft Capacity 12 g.p. Typ Submersible

**Abandoned**

Does property have any not in use and not sealed well(s)? ☐ Yes ☒ No

**Variance**

Was a variance granted from the MDH for this well? ☐ Yes ☐ No

**Miscellaneous**

First Bedrock Aquifer Quat. buried

Last Strat sand-white Depth to Bedrock ft

Located by Minnesota Geological Survey

Locate Method Digitized - scale 1:24,000 or larger (Digitizing Table)

System UTM - NAD83, Zone 15, Meters X 487889 Y 5239015

Unique Number Verification Tag on well Input Date 01/13/2000

**Angled Drill Hole**

**Well Contractor**

Benes Well Co. 31009 BENES

Licensee Business Lic. or Reg. No. Name of Driller

Minnesota Unique Well Number

**664019**

**County** St. Louis
**Quad** Keewatin
**Quad ID** 295A

**MINNESOTA DEPARTMENT OF HEALTH**

# WELL AND BORING REPORT

*Minnesota Statutes Chapter 1031*

**Entry Date** 06/19/2002
**Update Date** 02/13/2017
**Received Date** 02/01/2002

| Well Name | Township | Range | Dir | Section | Subsection |
|---|---|---|---|---|---|
| BRAY, | 57 | 21 | W | 28 | DDCCBD |

**Elevation** 1515 **Elev. Method** LiDAR 1m DEM (MNDNR)

**Address**

Contact P.O. BOX 462 DASSEL MN 55325
Well 12545 PELTO RD HIBBING 55746

**Stratigraphy Information**

| Geological Material | From | To (ft.) | Color | Hardness |
|---|---|---|---|---|
| CLAY | 0 | 2 | TAN | SOFT |
| GRAVELY CLAY | 2 | 46 | VARIED | HARD |
| GRAVEL | 46 | 50 | VARIED | HARD |
| CLAY | 50 | 61 | BROWN | SOFT |
| SAND | 62 | 71 | BROWN | SOFT |

**Remarks**

**Well Depth** 71 ft. **Depth Completed** 71 ft. **Date Well Completed** 09/01/2002

**Drill Method** Driven **Drill Fluid** Bentonite

**Use** domestic **Status** Active

**Well Hydrofractured?** Yes ☐ No ☒ **From** **To**

**Casing Type** Single casing **Joint** Solvent Welded
**Drive Shoe?** Yes ☐ No ☒ **Above/Below**

| Casing Diameter | Weight | Hole Diameter |
|---|---|---|
| 4 in. To 63 ft. | lbs./ft. | 8 in. To 20 ft. |
| | | 6.5 in. To 71 ft. |

**Open Hole** From ft. To ft.

**Screen?** ☒ **Type** stainless **Make** COOK

| Diameter | Slot/Gauze | Length | Set | |
|---|---|---|---|---|
| 4 in. | | 8 ft. | 63 ft. | 71 ft. |

**Static Water Level**
20 ft. land surface Measure 09/01/2002

**Pumping Level (below land surface)**
50 ft. 2 hrs. Pumping at 30 g.p.m.

**Wellhead Completion**
Pitless adapter manufacturer SNAPPY Model 4C-1
☐ Casing Protection ☒ 12 in. above grade
☐ At-grade (Environmental Wells and Borings ONLY)

**Grouting Information** Well Grouted? ☒ Yes ☐ No ☐ Not Specified

| Material | Amount | From | To |
|---|---|---|---|
| high solids bentonite | 3 Sacks | 0 ft. | 30 ft. |

**Nearest Known Source of Contamination**
feet Direction Type
Well disinfected upon completion? ☒ Yes ☐ No

**Pump** ☐ Not Installed Date Installed 09/07/2001
Manufacturer's name AERMOTOR
Model Number S12-50 HP 0.5 Volt 230
Length of drop pipe 50 ft Capacity 12 g.p. Typ Submersible

**Abandoned**
Does property have any not in use and not sealed well(s)? ☐ Yes ☒ No

**Variance**
Was a variance granted from the MDH for this well? ☐ Yes ☒ No

**Miscellaneous**
First Bedrock Aquifer Quat. buried
Last Strat sand-brown Depth to Bedrock ft
Located by Minnesota Geological Survey
Locate Method GPS SA Off (averaged) (15 meters)
System UTM - NAD83, Zone 15, Meters X 499228 Y 5248100
Unique Number Verification Tax Records Input Date 02/01/2017

**Angled Drill Hole**

**Well Contractor**
Mark's Well & Pump 69603 SWADER, M.
Licensee Business Lic. or Reg. No. Name of Driller

Minnesota Unique Well Number

**664027**

**County** St. Louis
**Quad** Silica
**Quad ID** 295D

**MINNESOTA DEPARTMENT OF HEALTH**

# WELL AND BORING REPORT

*Minnesota Statutes Chapter 1031*

**Entry Date** 06/27/2002
**Update Date** 10/09/2019
**Received Date**

| Well Name | Township | Range | Dir | Section | Subsection |
|---|---|---|---|---|---|
| OLSON, LONNIE | 56 | 21 | W | 4 | DDADBC |

**Elevation** 1475 **Elev. Method** LiDAR 1m DEM (MNDNR)

**Address**

Well LEIGHTON RD N HIBBING MN 55746

**Stratigraphy Information**

| Geological Material | From | To (ft.) | Color | Hardness |
|---|---|---|---|---|
| CLAY | 0 | 18 | RED | SOFT |
| CLAY/GRAVEL | 18 | 84 | BROWN | MED-HRD |
| CLAY | 84 | 86 | BLUE | SOFT |
| SAND | 86 | 90 | BLACK | SOFT |
| SANDY CLAY | 90 | 95 | VARIED | SOFT |
| SAND | 95 | 107 | BLACK | SOFT |
| HARDPAN | 107 | 112 | VARIED | HARD |

**Remarks**

**Well Depth** 112 ft. **Depth Completed** 106 ft. **Date Well Completed** 10/20/2001

**Drill Method** Non-specified Rotary **Drill Fluid** Bentonite

**Use** domestic **Status** Active

**Well Hydrofractured?** Yes ☐ No ☒ **From** **To**

**Casing Type** Single casing **Joint** Solvent Welded

**Drive Shoe?** Yes ☐ No ☒ **Above/Below**

| Casing Diameter | Weight | Hole Diameter |
|---|---|---|
| 4 in. To 96 ft. | lbs./ft. | 8 in. To 20 ft. |
| | | 6.5 in. To 112 ft. |

**Open Hole** From ft. To ft.

**Screen?** ☒ **Type** plastic **Make** CRESTLINE

| Diameter | Slot/Gauze | Length | Set | |
|---|---|---|---|---|
| 4 in. | 10 | 10 ft. | 96 ft. | 106 ft. |

**Static Water Level**

-0.7 ft. land surface Measure 10/20/2001

**Pumping Level (below land surface)**

70 ft. 2 hrs. Pumping at 30 g.p.m.

**Wellhead Completion**

Pitless adapter manufacturer 4C-1 Model SNAPPY

☐ Casing Protection ☒ 12 in. above grade

☐ At-grade (Environmental Wells and Borings ONLY)

**Grouting Information** Well Grouted? ☒ Yes ☐ No ☐ Not Specified

| Material | Amount | From | To |
|---|---|---|---|
| high solids bentonite | 3 Sacks | 0 ft. | 30 ft. |

**Nearest Known Source of Contamination**

90 feet North Direction Septic tank/drain field Type

Well disinfected upon completion? ☒ Yes ☐ No

**Pump** ☐ Not Installed Date Installed 11/05/2001

Manufacturer's name AERMOTOR

Model Number S12-75 HP 0.75 Volt 230

Length of drop pipe 80 ft Capacity 12 g.p. Typ Submersible

**Abandoned**

Does property have any not in use and not sealed well(s)? ☐ Yes ☒ No

**Variance**

Was a variance granted from the MDH for this well? ☐ Yes ☒ No

**Miscellaneous**

First Bedrock Aquifer Quat. buried

Last Strat pebbly sand/silt/clay Depth to Bedrock ft

Located by Minnesota Geological Survey

Locate Method GPS SA Off (averaged) (15 meters)

System UTM - NAD83, Zone 15, Meters X 499833 Y 5244959

Unique Number Verification Tax Records Input Date 03/09/2017

**Angled Drill Hole**

**Well Contractor**

Mark's Well & Pump 69603 SWADER, M.

Licensee Business Lic. or Reg. No. Name of Driller

**Minnesota Well Index Report** | **664027** | Printed on 09/07/2021

HE-01205-15

Minnesota Unique Well Number

**750702**

**County** St. Louis
**Quad** Silica
**Quad ID** 295D

**MINNESOTA DEPARTMENT OF HEALTH**

# WELL AND BORING REPORT

*Minnesota Statutes Chapter 1031*

**Entry Date**
**Update Date** 03/21/2017
**Received Date** 12/13/2006

| Well Name | Township | Range | Dir | Section | Subsection |
|---|---|---|---|---|---|
| MCLEAN, | 56 | 21 | W | 21 | BBBBDC |

**Elevation** 1420 **Elev. Method** LiDAR 1m DEM (MNDNR)

**Address**

Well 2895 73 HY S HIBBING MN 55746
Contact 1516 N 7TH AV E DULUTH MN 55805

**Stratigraphy Information**

| Geological Material | From | To (ft.) | Color | Hardness |
|---|---|---|---|---|
| TOPSOIL | 0 | 1 | BLACK | SOFT |
| CLAY | 1 | 13 | BLACK | HARD |
| CLAY SAND | 13 | 32 | BROWN | SOFT |
| GRAVEL & ROCK | 32 | 52 | BROWN | SOFT |
| SAND | 52 | 72 | BLACK | SOFT |
| GRAVEL & ROCK | 72 | 78 | BROWN | SOFT |

**Remarks**
DRILLERS: BRUCE BENES, CASEY BENES, & AARON PETZ.

**Well Depth** 78 ft. **Depth Completed** 78 ft. **Date Well Completed** 12/13/2006

**Drill Method** Multiple methods used **Drill Fluid**

**Use** domestic **Status** Active

**Well Hydrofractured?** Yes ☐ No ☒ **From** **To**

**Casing Type** Single casing **Joint** Welded
**Drive Shoe?** Yes ☒ No ☐ **Above/Below**

| Casing Diameter | Weight | Hole Diameter |
|---|---|---|
| 6 in. To 74 ft. | 19 lbs./ft. | 6 in. To 78 ft. |

**Open Hole** From ft. To ft.

**Screen?** ☒ **Type** stainless **Make** JOHNSON

| Diameter | Slot/Gauze | Length | Set |
|---|---|---|---|
| 6 in. | 10 | 4 ft. | 74 ft. 78 ft. |

**Static Water Level**
30 ft. land surface Measure 12/13/2006

**Pumping Level (below land surface)**
65 ft. 3 hrs. Pumping at 10 g.p.m.

**Wellhead Completion**
Pitless adapter manufacturer MONITOR Model SNAPPY
☐ Casing Protection ☐ 12 in. above grade
☐ At-grade (Environmental Wells and Borings ONLY)

**Grouting Information** Well Grouted? ☒ Yes ☐ No ☐ Not Specified

| Material | Amount | From | To |
|---|---|---|---|
| bentonite | 4 Sacks | ft. | 30 ft. |

**Nearest Known Source of Contamination**
60 feet South Direction Body of water Type
Well disinfected upon completion? ☒ Yes ☐ No

**Pump** ☐ Not Installed Date Installed 12/15/2006
Manufacturer's name GOULDS
Model Number 10SB05-422 HP 0.5 Volt 230
Length of drop pipe 60.1 ft Capacity 10 g.p. Typ Submersible

**Abandoned**
Does property have any not in use and not sealed well(s)? ☐ Yes ☒ No

**Variance**
Was a variance granted from the MDH for this well? ☐ Yes ☒ No

**Miscellaneous**
First Bedrock Aquifer Quat. buried
Last Strat gravel (+larger)-brown Depth to Bedrock ft
Located by Minnesota Geological Survey
Locate Method GPS SA Off (averaged) (15 meters)
System UTM - NAD83, Zone 15, Meters X 498334 Y 5241386
Unique Number Verification Tax Records Input Date 03/09/2017

**Angled Drill Hole**

**Well Contractor**
Benes Well Drilling, Inc. 1542 SEE REMARKS
Licensee Business Lic. or Reg. No. Name of Driller

# Appendix C

## Water Quality Data Summarized in Tables 2, 3, and 4

### Electronic Data Submittal