Memorandum

To: Steve Eggers (USACE), Colleen Allen (MNDNR)
From: Barr Engineering Company
Subject: Potential Indirect Wetland Impact Vegetation Monitoring Plan
Date: June 8, 2015
Project: NorthMet Project
c: Jennifer Saran, Kevin Pylka (PolyMet)

This memorandum presents the plan for vegetation monitoring in wetlands that may be potentially indirectly impacted by the NorthMet Project (Project). The objectives of this plan include: 1) establishing baseline vegetation community data at all wetland hydrology monitoring well locations and 2) using the wetland hydrology and vegetation data to monitor whether changes occur over time in order to determine if indirect wetland impacts result from the Project.

Existing wetland hydrology monitoring locations and the wetland community types (using Eggers and Reed 1997)[1] are shown on Figure 1. The wetland monitoring system includes 61 shallow groundwater monitoring wells that are located within wetlands representative of the Project. Five of these wells are in reference wetlands. Electronic monitoring wells have been installed at all 61 locations, with the date of installation identified on Table 1. Based on the installation dates, these wells have been electronically monitored for 4 to 9 years and represent baseline hydrology data for the Project.

Vegetation monitoring will be conducted within plots near these well locations within the wetland community type where the well is installed as identified on Table 1. For the purposes of this plan, a "plot" includes a vegetation relevé monitoring, a vegetation meander survey, and vegetation community survey.

1.0 Monitoring Protocol

The protocol described in the following sections describes methodology for locating the plots and monitoring potential indirect wetland impact for the Project. The time periods for monitoring include pre-Project (baseline conditions), during the Project, and post-Project.

[1] Eggers, S.D. and D.M. Reed. 1997. Wetland Plants and Plant Communities of Minnesota and Wisconsin. Second s.l.: U.S. Army Corps of Engineers, St. Paul District.,

1.1 Establishing and Monumenting Relevés

The relevé center will be established near the associated shallow groundwater well; however, the shallow groundwater well will not be in the relevé. This is because repeated visits to the wells could result in changes in vegetation that are not related to changes in hydrology. The center of the relevé should be recorded with a GPS unit. Where feasible, a distance and bearing from the relevé center to the associated well will be recorded as a secondary means of re-establishing the relevé center on subsequent monitoring visits. Relevés will be laid out, wherever feasible, with the centerline of the relevé on a north-south axis. If laying out the relevé on a north-south axis results in portions of the relevé lying outside of the vegetation community type associated with the well, then the centerline should be rotated to get all or as much of the relevé within the same vegetation community type. Where relevés cannot be laid out on a north-south axis, the orientation of the centerline through the relevé will be recorded (e.g., 285º).

Photographs will be taken, at a minimum, from the relevé center in all four cardinal directions, and from the relevé corners, facing inward to the center. Photographs will be intermediate to wide-angle to maximize the view of all strata.

1.2 Wetland Hydrology Monitoring

Wetland hydrology monitoring will continue within the existing 61 shallow groundwater wells. Pre-Project hydrology monitoring will be used as baseline data. Hydrology monitoring will continue throughout the life of the Project and post-Project. During the Project, baseline hydrology data from the five reference wells will be compared with the rest of the hydrology monitoring data to evaluate whether potential indirect impacts have occurred in the wetlands.

1.3 Vegetation Relevé Monitoring

Vegetation relevé monitoring will be conducted to characterize baseline conditions in the wetlands and evaluate in the future whether potential indirect impacts result from the Project. The relevé monitoring will be replicated every two years for the first six years, and every five years after that to determine if the wetlands are potentially indirectly impacted by the Project. Vegetation will be monitored in 61 permanent relevés, which include five reference relevés. Each relevé will be located near one of the existing 61 shallow groundwater monitoring wells (Figure 1).

Each relevé will measure 10-meters by 10-meters in non-forested communities. Relevés in forested communities will be 20-meters by 20-meters for shrub and tree strata, with a 10-meter by 10-meter herbaceous and vine plot nested within the larger relevé. The size for these relevés were selected based

on the MNDNR relevé method, which uses the same size for relevés.[2] The four corners of each relevé will be flagged and the points will be located using GPS (with sub-meter accuracy) so that the relevé is easily located in subsequent years of monitoring.

Vegetation in the monitoring relevés will be inventoried during June or July when most plant species will be readily identified by botanists/ecologists. Surveyors will record the species name and cover class for all plant species present within the plot. All vascular plants observed within the plots will be identified to the genus level and preferably to species. All plant species that cannot be identified in the field will also be recorded so their cover can be estimated; voucher specimens will be collected for later identification. The botanical team will estimate the absolute cover of each plant species identified within the relevé.

The vegetation monitoring will also include characterization of the vegetation community structure, including the relevé and wetland community in which each well is located. The documentation will include vegetation community type (see Section 1.4 below), type(s) of observed disturbance(s), disturbance level and extent, percent cover of forested canopy, percent sphagnum cover, percent non-sphagnum bryophyte cover, and percent cover by four stratum classes. The four stratum classes are defined as trees (woody plants 3 inches or more in diameter at breast height), sapling/shrub stratum (woody plants less than 3 inches in diameter at breast height and greater than one meter tall), herbaceous layer (consists of all herbaceous plants including herbaceous vines, regardless of size, and woody plants less than 1 meter tall), and woody vines (consists of all woody vines greater than 1 meter in height).

1.4 Vegetation Meander Survey

In addition to the relevé survey, a timed vegetation meander survey (meander survey) will be conducted in the vicinity of the relevé, within the wetland community where each monitoring well is located. The meander survey will only be conducted within the wetland community type specified for the monitoring well (Attachment A). The purpose of this meander survey is to document additional species within the wetland community that were not observed and identified during the relevé survey. The additional documentation of plant species along the meander survey augments the relevé inventory, and yields a more comprehensive measure of species richness at each plot.

At the beginning of the meander survey, the biologist will meander for at least 20 minutes, documenting every plant species observed while walking through the wetland community. During this 20 minutes, the

[2] Minnesota Department of Natural Resources. 2013. A handbook for collecting vegetation plot data in Minnesota: The relevé method. 2nd ed. Minnesota Biological Survey, Minnesota Natural Heritage and Nongame Research Program, and Ecological Land Classification Program. Biological Report 92. St. Paul: Minnesota Department of Natural Resources. ©2013. State of Minnesota, Department of Natural Resources.

biologist will meander for 15 minutes while recording every observed species; during the final 5 minutes, if more than 2 new species are observed and recorded, the biologist will continue to meander for an additional 5 minutes (for a total time of 25 minutes). At the end of the meander survey, the estimated cover for each observed species will be estimated by the biologist.

1.5 Vegetation Community Monitoring

Vegetation community characterization and mapping will also be conducted for the relevé, and for community types immediately adjacent to the vegetation community in which the relevé is located. Adjacent community types will be determined according to the Eggers and Reed community types[3] and the Native Plant Community (NPC) classification system based on Minnesota Department of Natural Resources ecological land classifications (NPC), documented to the NPC Class Code level (e.g., APn80)[4]. Baseline data will include documentation of the adjacent community types in close proximity to the wells and their dominant vegetation. Photographs will be taken within the adjacent vegetation community.

1.5.1 Wetland Boundary Evaluation

Wetland boundaries will be evaluated if and when changes are detected in the hydrology and/or vegetation of the wetland. Wetland boundaries have already been delineated and approved, as described in the Wetland Data Package v11, and in the Wetland Permit Application v1. Subsequent monitoring visits will evaluate a subset (~10%) of the initial boundary to determine whether there have been changes.

2.0 Frequency of Monitoring

Baseline conditions will be established in 2015. Subsequent monitoring will continue at five year intervals throughout the life of the Project, unless triggers for hydrology or vegetation indicate the need for more frequent vegetation monitoring.

3.0 Potential Indirect Wetland Impact Analysis

The hydrology, vegetation, and vegetation community monitoring data collected as part of this monitoring program will be evaluated to determine if adverse, indirect wetland impacts occur as a result of the Project. The evaluation of the cause of impacts should consider other sources of disturbance, including beaver activity, or introduction of invasive species and other factors, such as logging, that may

[3] Eggers, S.D. and D.M. Reed. 2011. Wetland Plants and Plant Communities of Minnesota and Wisconsin (3rd Ed). U. S. Army Corps of Engineers, St. Paul District, St. Paul, Minnesota

[4] Minnesota Department of Natural Resources (MNDNR). 2003. Field Guide to the Native Plant Communities of Minnesota: The Laurentian Mixed Forest Province. Ecological Land Classification Program, Minnesota County Biological Survey, and Natural Heritage and Nongame Research Program. MNDNR St. Paul, MN.

be unrelated to Project activity. In addition, the evaluation will consider extreme climate events, such as prolonged drought, and other natural variability by comparison of the results to the reference wetland results.

3.1 Triggers for More Frequent Vegetation Monitoring

If any of the following hydrology triggers is met, the vegetation monitoring interval may be decreased from 5 years to 2 years.

3.1.1 Hydrology Triggers

There are two hydrology triggers[5] to consider:

1. Since a 50 percent reduction of the baseline wetland hydrology is considered to indicate an adverse wetland impact, a 25 percent reduction of the baseline wetland hydroperiod will be considered the hydrology trigger for evaluating whether the vegetation monitoring interval should be reduced.

2. Alternatively- Use the attached Table 2: Summary of Potential Wetland Community Changes Due to Drawdown as a guideline to indicate the potential of water level drawdown for each wetland community type. If water level drawdown, as documented in hydrology monitoring, continues to be within the "None" Impact Sensitivity Category, no hydrology impact triggers will be met. If water level drawdown reaches the lower range of the "Moderate" Impact Sensitivity Category, the hydrology trigger will be met.

3.1.2 Vegetation Triggers

The meander vegetation survey can indicate broad changes in vegetation. The vegetation plot surveys can provide more detailed documentation of the changes.

There are triggers that may indicate the potential development of adverse indirect impacts. The vegetation triggers that are indicative of potential indirect impacts:

- 12% change in species richness;

- 12% change in living tree cover;

[5] PolyMet Mining Company. 2015. NorthMet Project Wetland Data Package, v11, April 2015

- Appearance of non-native invasive species in a relevé where none were previously recorded, or a 12% increase in non-native invasive cover or number of species in relevés where non-native invasive species were previously recorded; or

- A 12% reduction of native hydrophytes in the relevé.

3.2 Regulatory Impact Criteria

Criteria for determination of potential indirect wetland impacts will be based on guidance previously provided to Barr.[6] The triggers identified in Section 3.1 will be used to evaluate changes in hydrology and vegetation for initial signs of developing adverse potential indirect impacts for one or more regulatory impact criteria. These triggers would be used to determine whether the monitoring interval needs to be reduced as a response to avoiding the potential development of adverse indirect impacts. Regulatory criteria that may indicate an adverse, indirect wetland impact are as follows:

1. **A 50 percent 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 conducted from 2005 through 2015.

2. **Change in vegetation species composition and/or cover as described below, inconsistent with vegetation changes in the reference wetlands.**
   - 25% change in species richness;
   - 25% change in living tree cover;
   - Appearance of non-native invasive species in a relevé where none were previously recorded, or a 25% increase in non-native invasive cover or number of species in relevés where non-native invasive species were previously recorded; or

   - A 25% reduction of native hydrophytes in the relevé.

3. **Changes in monitored wetland boundaries inconsistent with changes in boundaries of reference wetlands.**

[6] PolyMet Mining Company. 2015. NorthMet Project Wetland Data Package, v11, April 2015

4.0 Reporting

Should adverse, indirect wetland impacts be identified during the monitoring program, an estimation of such impacts will would be included in the monitoring report in the year that they are first detected. The data for hydrology, vegetation, and vegetation community boundary monitoring will be compiled in a report, including methods, results, and evaluation of potential adverse indirect wetland impacts, which will be submitted to the USACE, MNDNR, and MPCA by March 1st following the end of each monitoring year.

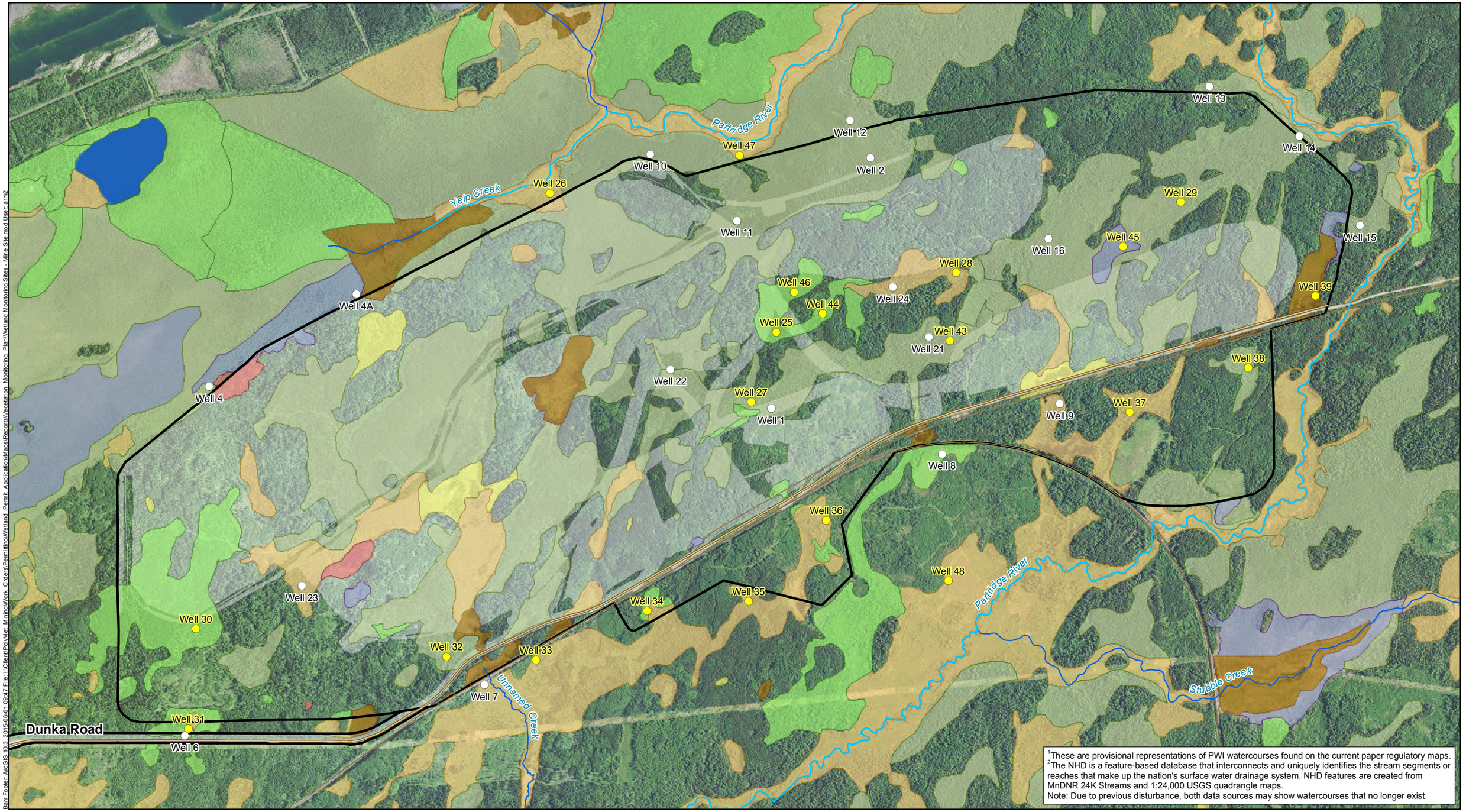
Table 1. Wetland Monitoring Locations for the NorthMet Project (June 8, 2015)

Well Name	Wetland ID	Location	Install Date	Dominant Community (Eggers & Reed)
Ref1	900	Mine Site Area	5/21/2008	Coniferous bog
Ref2	897	Mine Site Area	5/21/2008	Alder thicket
Ref3	394A	Mine Site Area	7/01/2014	Coniferous swamp
Well 1	48	Mine Site	5/22/2008	Coniferous bog
Well 2	100	Mine Site	5/22/2008	Coniferous bog
Well 4	887	Mine Site Area	11/9/2005	Coniferous bog
Well 4A	899	Mine Site Area	5/21/2008	Open bog
Well 6	54B	Mine Site	5/23/2008	Alder thicket
Well 7	53D	Mine Site Area	11/9/2005	Alder thicket
Well 8	106	Mine Site Area	5/23/2008	Coniferous swamp
Well 9	58	Mine Site	6/27/2008	Alder thicket
Well 10	888	Mine Site Area	5/22/2008	Coniferous bog
Well 11	100	Mine Site	5/22/2008	Coniferous bog
Well 12	888	Mine Site Area	11/9/2005	Coniferous bog
Well 13	84A	Mine Site Area	5/23/2008	Coniferous bog
Well 14	699	Mine Site Area	5/23/2008	Coniferous bog
Well 15	693	Mine Site Area	5/23/2008	Coniferous bog
Well 16	90	Mine Site	5/22/2008	Coniferous bog
Well 21	48	Mine Site	5/22/2008	Coniferous bog
Well 22	48	Mine Site	5/22/2008	Coniferous bog
Well 23	45	Mine Site	5/15/2010	Alder thicket
Well 24	33A	Mine Site	5/15/2010	Alder thicket
Well 25	68	Mine Site	6/30/2014	Coniferous swamp
Well 26	315	Mine Site Area	7/01/2014	Alder thicket or Shrub-carr
Well 27	48A	Mine Site	6/30/2014	Coniferous swamp
Well 28	33A	Mine Site	7/02/2014	Alder thicket
Well 29	90	Mine Site	7/02/2014	Coniferous bog
Well 30	57	Mine Site	6/30/2014	Coniferous swamp
Well 31	54G	Mine Site Area	6/30/2014	Coniferous swamp
Well 32	107	Mine Site	7/02/2014	Coniferous bog
Well 33	53D	Mine Site Area	7/01/2014	Alder thicket
Well 34	53C	Mine Site	7/01/2014	Coniferous swamp
Well 35	53D	Mine Site Area	7/02/2014	Alder thicket
Well 36	53	Mine Site	7/02/2014	Alder thicket
Well 37	58	Mine Site	7/02/2014	Alder thicket
Well 38	11	Mine Site	7/01/2014	Coniferous bog
Well 39	29	Mine Site	7/01/2014	Shallow marsh
Well 43	48	Mine Site	7/02/2014	Coniferous bog
Well 44	68	Mine Site	7/01/2014	Coniferous swamp
Well 45	90A	Mine Site	7/02/2014	Open bog
Well 46	68	Mine Site	7/01/2014	Coniferous swamp
Well 47	315	Mine Site Area	7/01/2014	Alder thicket or Shrub-carr
Well 48	53D	Mine Site	7/02/2014	Alder thicket
Well 40	571	Transportation Corridor	7/02/2014	Coniferous swamp
Well 41	R-7A	Transportation Corridor	7/01/2014	Shallow marsh
Well 42	1041	Transportation Corridor	7/01/2014	Alder thicket or Shrub-carr
Well TB1	923	Tailings Basin Area	4/26/2010	Wet meadow
Well TB2	917	Tailings Basin Area	4/26/2010	Coniferous bog
Well TB3	260	Tailings Basin Area	4/26/2010	Shallow marsh
Well TB4	260	Tailings Basin Area	4/27/2010	Shallow marsh
Well TB5	868	Tailings Basin Area	4/26/2010	Hardwood swamp
Well TB6	1151	Tailings Basin Area	4/27/2010	Coniferous swamp
Well TB7	915	Tailings Basin Area	4/27/2010	Alder thicket
RefTB8	974	Tailings Basin Area	4/26/2010	Coniferous bog
Well TB9	1162	Second Creek	6/30/2014	Shallow marsh
Well TB10	1176	Tailings Basin Area	6/30/2014	Hardwood swamp
Well TB11	282A	Tailings Basin Area	7/03/2014	Shallow marsh
Well TB12	968	Tailings Basin Area	6/30/2014	Coniferous swamp
Well TB13	584	Tailings Basin Area	7/03/2014	Alder thicket/Shrub-carr
Well TB14	T13A	Spring Mine Creek	6/30/2014	Deep marsh
RefTB1	989	Tailings Basin Area	7/03/2014	Coniferous swamp

Table 2. Summary of Potential Wetland Community Changes Due to Drawdown[(1)]

Impact Sensitivity Category	None		Moderate		Severe	
Community Type	Water Level Drawdown (feet)	Potential Impact	Water Level Drawdown (feet)	Potential Impact	Water Level Drawdown (feet)	Potential Impact
Ombrotrophic Coniferous and Open bog	<0.75	None	0.75 - 2	Minor vegetation changes; Increased tree growth	>2	Possible conversion of wetland type
Minerotrophic Coniferous and Open bog	<0.5	None	0.5 - 2	Change in vegetation; Increased tree growth	>2	Possible conversion of wetland type
Shallow marsh	<1	None	1 -3	Conversion of type	>3	Conversion of wetland type
Deep marsh	<2	None	2 - 4	Conversion of type	>4	Conversion of wetland type
Shallow, open water	<2	None	2 - 4	Conversion of type	>4	Conversion of wetland type
Conifer swamp	<1	None	1 -2	Minor vegetation changes; Increased tree growth	>2	Change in vegetation
Hardwood swamp	<2	None	2 - 4	Change in vegetation; Increased tree growth	>4	Conversion of wetland type; possible conversion to upland
Alder thicket	<1	None	1 - 4	Change in vegetation; Increased shrub growth	>4	Conversion of wetland type; increased shrub growth
Shrub-carr	<0.5	None	0.5 - 3	Change in vegetation; Increased shrub growth	>3	Conversion of wetland type
Wet/Sedge meadow	<0.5	None	0.5 - 3	Change in vegetation; Conversion of type	>3	Conversion to upland

(1) PolyMet Mining Company. 2015. NorthMet Project Wetland Data Package, v11, April 2015



[1]These are provisional representations of PWI watercourses found on the current paper regulatory maps.
[2]The NHD is a feature-based database that interconnects and uniquely identifies the stream segments or reaches that make up the nation's surface water drainage system. NHD features are created from MnDNR 24K Streams and 1:24,000 USGS quadrangle maps.
Note: Due to previous disturbance, both data sources may show watercourses that no longer exist.

Wetland Hydrology Monitoring Locations
- Installed Prior to 2014
- Installed in 2014
- Dunka Road
- Railroads

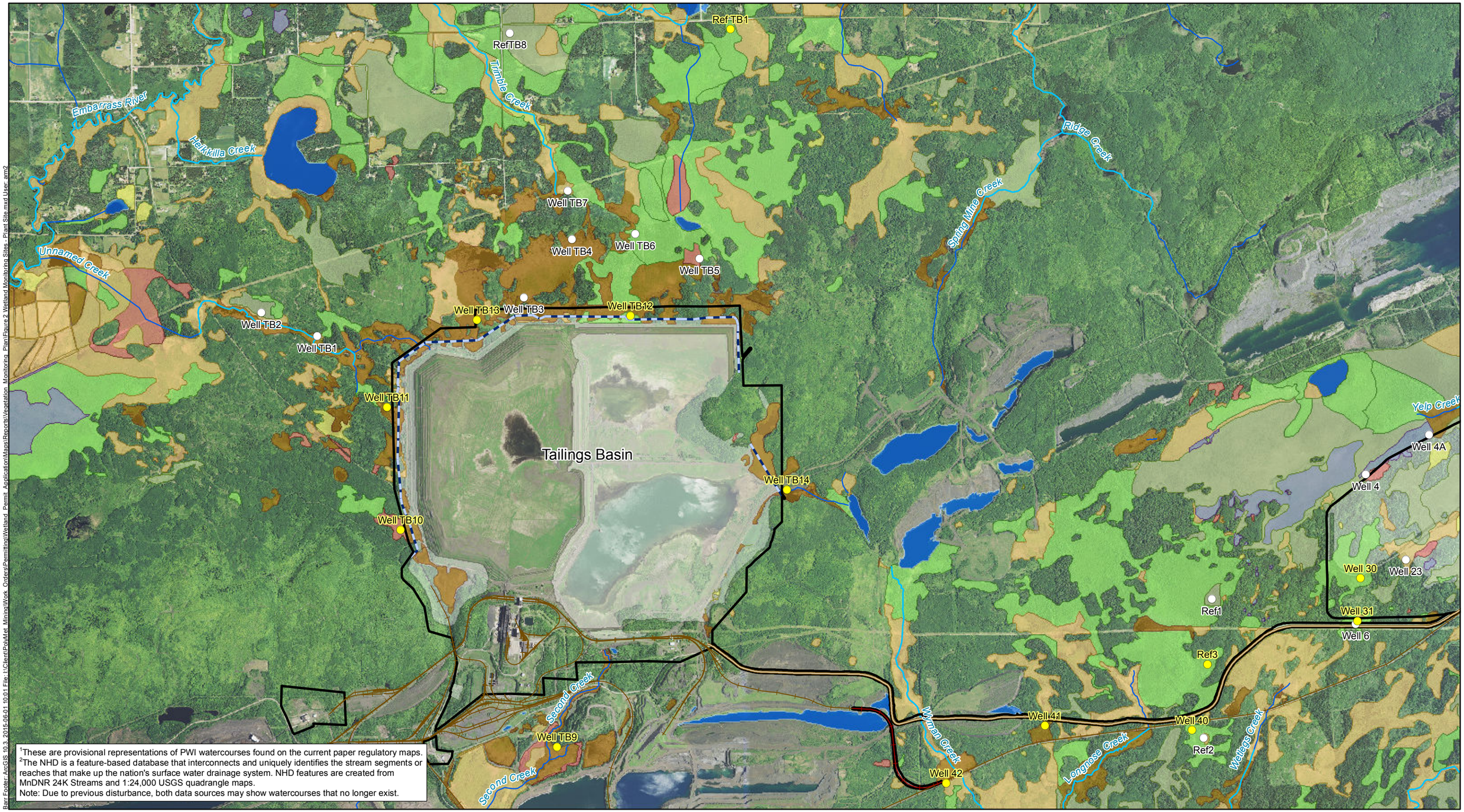
- Public Waters Inventory (PWI) Watercourses[1]
- National Hydrography Dataset (NHD) Rivers & Streams[2]
- Project Areas
- Areas Disturbed by Proposed Project Features

Eggers & Reed Wetland Types
- Shrub Swamps (Alder thickets & Shrub-carrs)
- Coniferous bog
- Coniferous swamp
- Deep marsh; Shallow marsh
- Hardwood swamp
- Open water (Shallow, open water & lakes)
- Open bog
- Sedge meadow; Wet meadow

N

0 750 1,500 3,000
Feet

Figure 1
WETLAND MONITORING SITES - MINE SITE
NorthMet Project
Poly Met Mining Inc.
Hoyt Lakes, MN



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Note: Due to previous disturbance, both data sources may show watercourses that no longer exist.

Wetland Hydrology Monitoring Locations
- Installed Prior to 2014
- Installed in 2014
- Dunka Road
- Existing Private Railroad
- Proposed Railroad Track
- FTB Containment System

- Public Waters Inventory (PWI) Watercourses[1]
- National Hydrography Dataset (NHD) Rivers & Streams[2]
- Project Areas
- Areas Disturbed by Proposed Project Features

Eggers & Reed Wetland Types
- Shrub Swamps (Alder thickets & Shrub-carrs)
- Coniferous bog
- Coniferous swamp
- Deep marsh; Shallow marsh
- Hardwood swamp
- Open water (Shallow, open water & lakes)
- Open bog
- Sedge meadow; Wet meadow

0 1,750 3,500 7,000
Feet

Figure 2
WETLAND MONITORING SITES - PLANT SITE AND TRANSPORTATION AND UTILITY CORRIDOR
NorthMet Project
Poly Met Mining Inc.
Hoyt Lakes, MN