Monitoring Wells North of the Mine Site: Installation and Hydrogeologic Monitoring Plan

NorthMet Project

Prepared for
Poly Met Mining Inc.

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1.0 Introduction

This document describes the Monitoring Plan for assessing hydrogeologic conditions in the area between the Poly Met Mining Inc. (PolyMet) NorthMet Project (Project) Mine Site and the Northshore Peter Mitchell Pit (PMP) operated by an affiliate of Cliffs Natural Resources. The PMP is an active mine located approximately 1 to 2 miles north of the Project Mine Site. To facilitate mining, the PMP is dewatered – groundwater levels are drawn down so ore can be accessed.

Current PMP dewatering does not affect water levels in bedrock at the Project Mine Site. PolyMet has monitored water levels in bedrock wells at the Project Mine Site since 2007, and water levels in these bedrock wells do not show a response to dewatering activities at PMP. The lack of response in the observation wells during a period of dewatering at the Peter Mitchell East Pit provides recent, direct evidence to support the conclusion that water levels in the PMP do not have an effect on bedrock water levels at the Project Mine Site.

Concern has been raised that despite this site-specific data, continued dewatering at PMP has the potential to cause water from the backfilled/flooded NorthMet pits to flow via groundwater to the PMP pits (Reference (1). The Co-lead Agencies determined that the potential for this flow is not reasonably foreseeable, but could not be totally excluded, and as such stated in the FEIS that they would require monitoring of bedrock groundwater levels north of the Mine Site to determine the potential for northward flow between the NorthMet and PMP pits (Section 5.2.2 of Reference (2)). This document presents a proposed monitoring plan consistent with what was described in the FEIS.

The purpose of the monitoring proposed in this plan is to further evaluate potential effects of PMP dewatering in the area north of the Project Mine Site and to collect additional data to refine predictions of future water levels in the area north of the Mine Site as mining at PMP progresses. With early implementation of this Monitoring Plan, PolyMet will be able to collect and analyze additional information concerning "pre-Project" hydrogeologic conditions. Continued monitoring during Project operations and reclamation will provide data for ongoing assessment of potential effects of PMP dewatering activities on groundwater levels and flow directions in the area north of the Project Mine Site.

Implementation of this Monitoring Plan will allow ample opportunity to collect the necessary data, and to complete applicable environmental review and/or permitting, engineering and construction prior to the development of a northward flowpath (if one were to form). As stated in the FEIS, conditions potentially supporting development of a northward flowpath would not exist until water levels in the NorthMet pits are higher than at the Northshore pits (Reference (2)).

PolyMet will analyze monitoring information and use adaptive management practices, as needed, including adaptive engineering controls. These tools are industry standard practice, have been used throughout PolyMet's environmental review process, and will continue to be used in permitting, operations, reclamation, and long-term closure (Reference (3)).

The outline of this document is:

Section 2.0	Description of the basis for monitoring locations
Section 3.0	Methods for monitoring well installation, downhole geophysics, and hydrogeologic testing
Section 4.0	Explanation of how the data collected will be synthesized
Section 5.0	Overview of annual reporting associated with this Plan
Section 6.0	Overview of timing for installation and monitoring activities
Section 7.0	Description of the adaptive management strategy
Section 8.0	Overview of permit requirements for monitoring well installation

2.0 Monitoring Well Installation

2.1 Existing Monitoring Wells

There are five existing NorthMet bedrock wells (OB-1 through OB-5) at the Mine Site. Three of these wells (OB-1, OB-4, and OB-5) will become part of the permanent monitoring network, and two (OB-2 and OB-3) will be abandoned during Mine Site construction, as they are within the footprints of mine features (Large Figure 1). The existing wells will continue to be monitored three times a year until they are abandoned or new monitoring requirements are established for the proposed bedrock monitoring wells.

2.2 Proposed Monitoring Wells

PolyMet proposes installing twelve new bedrock wells in the area between the Project Mine Site and the PMP. At nine of the bedrock well locations, a surficial aquifer well will also be installed, if the unconsolidated materials and aquifer thickness are sufficient. Surficial aquifer wells already exist at three of the locations where new bedrock wells are proposed. The proposed installation will result in a total of twelve new surficial/bedrock well "nests".

The proposed bedrock monitoring network will allow for triangulation of water levels near the NorthMet pits to calculate hydraulic gradients. The network will also result in two transects between the NorthMet pits and the PMP: a western transect, that runs from the NorthMet West Pit to the Northshore Area 003 West pit, and an eastern transect, that runs from the NorthMet East Pit to the Northshore Area 003 East pit. Large Figure 1 depicts the location of the proposed monitoring wells. Table 2-1 presents additional information on the location and depth of the proposed wells. Because bedrock permeability decreases with depth, the currently proposed depths are sufficient to provide the necessary information on subsurface conditions. Once operations commence, PolyMet may drill additional deeper monitoring wells or deepen exiting monitoring wells, if necessary to obtain additional information on bedrock characteristics at depth.

Table 2-1 Summary of Proposed Well Locations North of the Mine Site

Well ID	Location	Winter Only Construction?	Surface Ownership	Estimated Depth (feet below ground surface)[1]	Estimated Bottom Elevation (feet MSL)[2]
Bedrock: GW508[2]	S of Cat 1 WR Stockpile	Yes – Wetland Area	Forest Service (Land Exchange)	235	1380
Surficial: GW468				20-30	1585-1595
Bedrock: GW509[2]	N of East Pit	Yes – Wetland Area	Forest Service (Land Exchange)	223	1380
Surficial: GW499				20-30	1573-1583
Bedrock: GW510[2]	East Transect	Yes – Wetland Area	Forest Service (Land Exchange)	221	1380
Surficial: GW470				20-30	1571-1581
Bedrock: GW512[2,4]	N of Central Pit	Yes – Wetland Area	Forest Service (Land Exchange)	221	1380
Bedrock: GW514[2,4]	NW of Cat 1 WR Stockpile	Yes – Wetland Area	Forest Service (Land Exchange)	233	1380
Bedrock: GW515[2,4]	West Transect	Yes – Wetland Area	Forest Service (Land Exchange)	225	1380
Bedrock: GW517[2]	West Transect	Yes – Wetland Area	Forest Service (Land Exchange)	225	1380
Surficial: GW477				20-30	1575-1585
Bedrock: GW518[2]	West Transect	No – Upland Area	Forest Service (Land Exchange)	230	1380
Surficial: GW478				20-30	1580-1590
Bedrock: GW519[2]	West Transect	No – Upland Area	Forest Service (Land Exchange)	246	1380
Surficial: GW479				20-30	1596-1606
Bedrock: GW521[2]	N of East Pit	Yes – Wetland Area	Forest Service (Land Exchange)	219	1380
Surficial: GW471				20-30	1569-1579
Bedrock: GW522[3]	East Transect	No – Upland Area	State of Minnesota	349	1250
Surficial: GW472				20-30	1569-1579
Bedrock: GW523[3]	East Transect	No – Upland Area	Cliffs Erie	366	1250
Surficial: GW473				20-30	1586-1596

(1) Determined based on estimated ground surface elevations from 2010 LiDAR, 2011 LiDAR, or an average of the two
(2) Bedrock wells will be drilled to estimated maximum extent of mining at the PMP west (1380 ft MSL).
(3) Bedrock wells will be drilled to estimated maximum extent of mining at the PMP east (1250 ft MSL)
(4) Surficial aquifer well already in place

2.3 Drilling Methods and Well Installation

Boreholes for the nested surficial aquifer and bedrock monitoring wells will be advanced using traditional drilling methods, such as Rotasonic, air hammer, or diamond core, depending on the geologic materials encountered. Locations of the boreholes are shown on Large Figure 1 and the estimated depths for the bedrock monitoring wells are included in Table 2-1. The monitoring wells will all be installed in accordance with Minnesota Rules, parts 4725.6450-7000 (administered by the Minnesota Department of Health [MDH]) by a licensed well contractor.

2.3.1 Bedrock Wells

The bedrock monitoring wells are anticipated to be open-hole within the bedrock and will be advanced through the overburden using traditional drilling methods with an approximately eight- to ten-inch diameter bit to the top of bedrock. The top of bedrock is estimated to be approximately 30 feet below ground surface (bgs). A steel casing (large enough to accommodate a four- to six-inch diameter drill bit, respectively) will be installed through the overburden thickness to prevent any caving into the hole and will be seated at least 2 feet into the bedrock; additional measures, such as grouting the casing into place, may be taken to ensure a proper seal between the two units. In the bedrock, drilling with a nominal four- to six-inch diameter bit, depending on the type of drilling, will be used to complete the remainder of the boring to the approximate elevations indicated in Table 2-1.

Drill cuttings or intact core will be removed from the borehole, and samples will be examined by a geologist or geologic technician at least every 5 feet. Samples will be collected and stored in either sample trays, plastic sheeting, or containerized and will be covered overnight and between drilling shifts. Formation water will be collected in an onsite sump (upland areas) or containerized (wetland areas), according to the stormwater pollution prevention plan (SWPPP). If the borehole appears likely to produce more water than can be contained in the sump or containers, either the sump will be enlarged, or additional containers will be used, or drilling advancement will be discontinued. Upon reaching the target depth, the bedrock section of each borehole will be developed to remove solids from the borehole and ensure connectivity across the borehole wall. All containerized formation water and drill core/cuttings will be removed from the wetland areas and properly disposed. Boring logs and well construction logs will be prepared for each bedrock monitoring well.

2.3.2 Surficial Aquifer Wells

If a surficial aquifer well is not currently in place at a bedrock monitoring well location, a new surficial aquifer well will be installed in locations where the total thickness of the unconsolidated materials is greater than 10 feet and the saturated thickness is greater than 5 feet. The surficial aquifer well will be installed approximately 5 feet from the corresponding "nested" bedrock well. The surficial aquifer borehole will be advanced through the unconsolidated materials using Rotasonic, or similar, method. The total depth of the surficial aquifer boreholes will be based on subsurface conditions encountered during the advancement of the bedrock boreholes. Samples of unconsolidated materials will be collected and logged by a geologist or geologic technician in the field; location of transition between unsaturated and saturated material will be recorded. Any drill cuttings or samples not retained will be thin spread in the upland areas or containerized and moved off-site in the wetland areas; during drilling activities, cuttings and samples may be stored on plastic sheeting and will be covered overnight and between drilling shifts. Formation water will be treated similarly as with the bedrock borehole drilling.

In general, the surficial aquifer monitoring well screen will be positioned to intersect the water table; however, at locations where the groundwater is close to the ground surface, the well screen may need to be submerged to permit installation of the required surface seal. Upon reaching the target depth, based on the location of the water table, a monitoring well will be installed in the surficial aquifer borehole. The monitoring wells will be constructed in accordance with Minnesota Rules, constructed with a 2-inch diameter Schedule 40 PVC risers, and will be completed above grade with steel protective casing. It is anticipated that the wells will be constructed with 5- to 15-foot long 10-slot screens; however, the depth and screened interval of the well, the size of the screen mesh, and the type of filter pack will be determined in the field based on unconsolidated material observed during drilling and the water level measured in the borehole. Well development will need to be conducted to remove residual drill cuttings from the well and to ensure connectivity across the filter pack. Boring and well construction logs will be prepared for each surficial monitoring well.

2.4 Well Completion

All the wells will be completed in compliance with Minnesota Rules with a bentonite or cement ground surface seal, which will extend at least five feet from the ground surface. A protective locking steel casing will be placed over the borehole and well riser, and will be completed above grade. In the event that flowing conditions are encountered, the wellhead will be capped and an appropriately rated pressure gauge and sampling tap will be installed. Protective posts will be installed around the monitoring well casings when located near future haul roads or at the request of the property owner (if not PolyMet). The elevation of the top of each monitoring well riser and ground surface will be surveyed to the nearest 0.01 foot, and the easting and northing of each well will be determined using a global positioning system (GPS), and recorded.

Permit requirements for the well installations are discussed in Section 8.0.

3.0 Hydrogeologic Investigation

Following completion and development of the new bedrock wells, downhole geophysical and hydrologic testing will be conducted. The purpose of these wells is to gather data regarding the current water table elevation and bedrock characteristics in specific locations north of the Mine Site pits rather than information about water quality. Nonetheless, to the extent that water quality data is necessary and the collection of such water quality data is permissible under the various access authorizations PolyMet will need to secure, the proposed monitoring wells may be useful in collecting this water quality data.

3.1 Geophysical Testing

Downhole geophysical data will be collected from the open-hole section of each of the bedrock wells. The following geophysical tests are proposed for new bedrock well:

- Caliper: the caliper provides an *in-situ* measure of borehole diameter and can be used to identify the presence of fractures;

- Borehole fluid temperature and resistivity: changes in fluid temperature can be an indication of a location where water is entering or leaving the borehole. The fluid resistivity data can be used to assess the relative salinity of water in different parts of the borehole. Changes in fluid temperature and fluid resistivity can be used along with other borehole logging information to identify hydraulically active fractures;

- Single-point resistance: this test provides information on the variations in lithology encountered within the borehole. The location of fractures can be identified from single-point resistance logs. Single-point resistance logs may provide some qualitative information regarding groundwater salinity and porosity of the formation. Single-point resistance logs can be used for correlation between boreholes;

- Spontaneous potential: this log measures the natural electrical potential between rock and borehole fluids. Spontaneous potential logs can be used to identify contacts between dissimilar rock types along the length of the borehole. As such, information on bed thickness can be determined from the log. Spontaneous potential logs can be used for correlation between boreholes. In cases where the lithology does not change, spontaneous potential logs can provide qualitative information on changes in groundwater salinity. In addition, a spontaneous potential log may provide a qualitative indication of permeability of the rock adjacent to the borehole.

- Short and long normal resistivity: provides information on lithology differences along the length of the borehole. Normal resistivity logs are affected by bed thickness. Normal resistivity logs are also used to evaluate water quality (i.e., variations in salinity) and formation porosity. Normal resistivity logs can be used for correlation between boreholes. In addition, normal resistivity logs can be used to evaluate the distance that drilling fluid has penetrated into the formation;

- Acoustic and/or optical borehole imaging: Borehole imaging logs can be used to measure borehole wall textural variability beyond what is obtained with a caliper log. The logs can also be used to identify fracture locations, fracture aperture, and fracture orientation. Acoustic borehole imaging logs can be run in fluid filled boreholes regardless of whether the fluid is clear or not. Optical borehole imaging (OBI) logs require clear fluid. The imaging tools are equipped to provide oriented logs.

The results of geophysical logging will be compiled into downhole logs and will be reviewed to determine target monitoring intervals for discrete interval hydrogeologic testing described in Section 3.3.

3.2 Flow Logging

Flow logging will be conducted to characterize fractures and estimate transmissivity changes with depth (e.g., Reference (4)). Trolling flow logging can be used to obtain qualitative information on flow in the borehole. Conducting stationary flow logging under both ambient and dynamic (i.e., pumping) conditions provides data for estimating the hydraulic properties of aquifers or fractures identified by geophysical logging methods. Flow logging under ambient conditions provides data for determining the direction of vertical hydraulic gradient between hydraulically active zones, cross-communication between geologic units, and identifying fractures that are hydraulically active. In order to estimate hydraulic properties of fractures or zones in an aquifer, flow logging under both ambient and dynamic conditions is required (Reference (5)).

Flow logging can be used to identify hydraulically active features that may not be apparent from geophysical logs alone. Results may also be used to estimate bulk hydraulic parameters (Reference (4)). Flow logging methods applied will be appropriate for the anticipated borehole flow rates and could include mechanical spinner, electromagnetic (EM), heat-pulse flowmeter, and HydroPhysical™ (HpL™) logging technologies. Due to anticipated low flow rates, the EM, heat-pulse flowmeter, and HpL™ logging technologies may be most appropriate. HpL™ logging has been previously utilized at PolyMet and provides the widest range of identifiable flow rates (0.0005-3,000 gpm). This method replaces the borehole water with deionized water and then profiles changes in electrical conductivity, allowing it to identify both horizontal and vertical flow into/out of the borehole. The HpL™ logging will be conducted under both ambient and dynamic conditions. All formation water and deionized water will be containerized during flow logging and disposed of properly.

3.3 Aquifer Testing

Aquifer testing of discrete intervals will be conducted to further characterize the bedrock. Discrete interval testing involves isolating specific intervals of the open borehole, and then conducting pumping tests in which water is withdrawn or displaced only from the isolated interval. On average, three discrete interval tests will be conducted per borehole, targeting the upper zone which is expected to be more fractured (approximately the upper 40 feet), the middle zone, and the lower zone of each borehole. The specific number and cutoffs for the various zones will be based on the results of the borehole logging, downhole geophysical testing, and flow logging. Details on the aquifer testing will be developed in consultation with the State agencies following completion of the geophysical testing and flow logging.

Each discrete interval test will include isolating the interval with inflatable packers, beginning with the zone closest to the bottom of the hole. The packer assembly will include a pressure transducer beneath the lower pack (assuming it is not placed at the bottom of the borehole), a pressure transducer in the interval between the packers, and a pressure transducer above the upper pack (assuming there is a sufficient volume of water above). These transducers will be used to monitor the hydraulic heads above, within, and below the discrete interval. The packer assembly will also include a submersible pump installed between the packers to lift water from the packed interval to the surface.

Once the packers are inflated, the isolated interval will be allowed to equilibrate and then pumping will begin, assuming sufficient bedrock response. Generally speaking, pumping will be conducted for up to two hours, however this may change depending on conditions encountered. The pumping discharge rate will be measured and recorded periodically. At the completion of pumping, the pump will be turned off and the total pumping time recorded. Water level recovery in the pumped interval and in the interval above and below the packed off discrete interval, if any, will be monitored via the pressure transducers and recorded on the datalogger. Recovery will be allowed to continue until the hydraulic head in the pumped interval has returned to at least 95% of the pre-pumping level. If the hydraulic head in the pumped interval does not recover to at least 95% of the pre-pumping level within four hours, then testing of the zone will be terminated. Water level data from the pumping and recovery periods will be analyzed by a Barr hydrogeologist to estimate the hydraulic conductivity of the formation in the tested interval. Additional testing, such as step drawdown pumping tests and slug tests may also be conducted to supplement the results of the single-well pumping tests.

3.4 Long-Term Hydrogeologic Monitoring

PolyMet will begin monitoring water levels in the surficial and bedrock wells within one month following the completion of well/borehole testing, and will continue until the end of mine closure or an alternative period authorized by the Minnesota Department of Natural Resources (MDNR) and the Minnesota Pollution Control Agency (MPCA). Monitoring will be conducted using a combination of continuous data-logging pressure transducers and periodic manual measurements.

Continuous loggers (pressure transducers) will be installed at locations where more frequent water level data are desired for monitoring the water level effects of PMP operations and where access constraints preclude obtaining periodic manual measurements. Pressure transducers will be installed at each of the monitoring network locations, including the twelve monitoring well “nests” and the three OB-series wells, for a total of 27 pressure transducers. The pressure transducers will record water levels at least hourly to provide a continuous log of water levels throughout the period of monitoring. Vented pressure transducers may be utilized as they autocorrect for barometric pressure changes, removing the need for installing barotrolls and manually correcting transducer data for barometric pressure fluctuations. Manual measurements of water levels will be conducted in these wells quarterly using an electronic water level indicator to set level references for the continuous monitoring equipment. Annual maintenance will be conducted on the transducers. Monitoring frequencies may decrease in the future following consultation with the MDNR and MPCA.

Periodic manual measurements will be used at locations where less frequent water level data is required. All pressure transducer data will be verified with manual measurements. Where pressure transducers are not installed, water levels will be recorded manually on a monthly basis using an electronic water level indicator.

4.0 Data Synthesis and Predictive Simulations

Data collected during the installation and testing of the proposed bedrock and surficial aquifer wells will be analyzed in conjunction with other available information on the hydrogeologic conditions in the area between the PMP and NorthMet Mine Site. Results from the geophysical testing, flow logging and aquifer testing will provide useful information on key aspects that will help confirm the lack of hydrologic connection between the two mining areas, and to rule out the potential for northerly flow. Specifically, information on conditions within the Virginia Formation distal from the contact with the Duluth Complex and the Biwabik Iron Formation, including fracture density, presence or absence of flow zones with depth, and changes in horizontal hydraulic conductivity with depth.

This data will be used to help predict how water levels are likely to change under future conditions at NorthMet, and to the extent they are known, at the PMP. Predictions could be made using analytical or numerical techniques, and will address uncertainty in the predictions. Predictive simulations will be conducted for key time periods during PMP and NorthMet operations and closure. The key times that will be simulated will be determined in consultation with the State agencies and will likely include conditions with the PMP and NorthMet pits at maximum depths. Updated predictions of whether adaptive management measures will be necessary will be made; this assessment will be updated annually, as discussed below, as additional data is collected throughout the life of mine. The predictive simulations done for this purpose will be done under the review and approval of the State agencies.

PolyMet anticipates that the State agencies will evaluate potential permit conditions that may be incorporated into the appropriate permit (e.g., NPDES/SDS, permit to mine). These permit conditions could include post-permitting requirements relating to monitoring activities or predictive simulations, as well as thresholds for collecting additional data, and when adaptive management (including contingency mitigation measures) might be needed and initiated.

5.0 Annual Reporting

Annual reports will provide the results of the water level monitoring presented in Section 3.4, which will include the raw data in an electronic form. Information on the water levels and/or mining depths in the NorthMet pits, as well as publicly available data, if there is any, for the water levels and pit depths at PMP, will also be included. The annual report will include an updated assessment of exiting groundwater flow conditions for the area between Project Mine Site and the PMP. The annual assessment will include the following:

- verify that mine plans for NorthMet and if publicly available, PMP have not changed for the current year and following year (information provided in the annual reports of the respective Permits to Mine)
- analyze water levels relative to expected conditions (from previous year's predictive simulations)
- update predictive simulation based on new data if necessary (could include recalibration of existing tools, modification of existing tools, or development of new tools)
- update predictive simulations for the next year of operations, and assess the need for (and effectiveness of) potential engineering controls

6.0 Timing for Installation and Monitoring Activities

The proposed timing of activities included in this plan is summarized in Table 6-1. The specific timing for installation of monitoring wells is dependent on (1) PolyMet obtaining necessary permitting authorizations; (2) PolyMet securing the necessary access authorizations from land owners; and (3) the suitability of field conditions for installation activities.

Table 6-1 Summary of timing of plan activities

Timeframe related to NPDES/SDS permit	Month/year	Tasks to be Completed
Pre-application submittal	May and June 2016	• Submittal/approval of Well Installation, Testing and Monitoring Plan • Develop access agreements for properties not owned by PolyMet to conduct work

Pre-permit issuance	June 2016 - 2017	• Obtain all permit approvals and access authorizations needed for the well installations
		• Install monitoring wells
		  ○ Upland locations –fall, winter (once access authorizations obtained)
		  ○ Wetland locations – winter
		• Hydrogeological investigation and reporting
		• Monitoring of water levels
		• Monitoring for water quality (to extent necessary and authorized under access authorizations)

Post permit issuance	2017 – Life of Mine	• Monitoring of water levels • Monitoring for water quality (to extent necessary and authorized under access authorizations) • Adjust monitoring plan, if needed • Annual reporting

7.0 Adaptive Management

Adaptive management is an important tool that PolyMet will use during construction, operations, reclamation, and long-term closure. There are two key adaptive management components considered here: 1) refinement of plan and/or monitoring network, and 2) implementation of adaptive engineering controls. The need for adaptive management will be assessed annually using the process developed for this purpose, as discussed in Section 5.0.

7.1 Refinement of Monitoring Plan

As additional information is gathered through the implementation of this Monitoring Plan, more will be known about the hydrogeologic conditions in the area between the Project Mine Site and the PMP. PolyMet will use this information to assess whether any changes to the Monitoring Plan are warranted. Changes to the Monitoring Plan could include changing the monitoring network (adding or retiring monitoring wells), the frequency of monitoring or reporting, the process for conducting predictive simulations, or the requirements for the annual report.

7.2 Adaptive Engineering Controls

There are adaptive management actions that could be implemented if monitoring data and predictive simulations suggest that there will be northward flow in the future. In general the steps will be:

1. initiate field studies to gather additional data, if needed, to understand the issue
2. develop the conceptual design for mitigation options
3. collect additional data for the assessment of mitigation options, if needed
4. select of mitigation measures to be implemented
5. develop final design for the selected mitigations measures
6. obtain permits and/or conduct environmental review, if needed
7. implement mitigation

The FEIS presented feasible adaptive engineering controls that could prevent a northward flow of water from the proposed NorthMet pits to the PMP if data and analysis suggests they are necessary. These include:

- NorthMet pit water level suppression
- bedrock water level maintenance via extraction wells or artificial recharge
- pit wall grouting

Additional adaptive management options may also be identified and considered during the adaptive management process.

8.0 Permit Requirements for Well Installations

The temporary workspace areas and temporary access routes required for the installation of the groundwater monitoring wells will, in aggregate, result in greater than one acre of land disturbance and therefore will require coverage under the Minnesota General Permit Authorization to Discharge Stormwater associated with Construction Activity under the National Pollutant Discharge Elimination System / State Disposal System (NPDES/SDS) Program (Permit No. MN R100001). Per the requirements of this permit, an associated Construction SWPPP has been developed and will be implemented.

Additionally, temporary and permanent impacts for certain well pads and access routes will occur within wetlands requiring authorization from the U.S. Army Corps of Engineers (USACE) to complete the work under Regional General Permit 3 (RGP-003-MN) and notification to the MDNR and Northern St. Louis County Soil and Water Conservation District for a Minnesota Wetland Conservation Act (WCA) no loss/exemption. A Pre-Construction Notification (PCN) will be submitted to the USACE, St. Paul District and a letter providing the information to confirm the no-loss and exemption determinations will be submitted to the MDNR. Monitoring well permits will be obtained from the MDH as required by Minnesota Well Code. Monitoring well permit applications will be submitted by a licensed well contractor or registered monitoring well contractor.

Finally, any access arrangements that may be needed for the well installation will be obtained prior to the start of work. To the extent that the access arrangements require any authorizations or other actions from any governmental bodies, PolyMet will complete the applicable regulatory processes in advance of undertaking well installations.

9.0 References

1. **U.S. Army Corps of Engineers; U.S. Forest Service; Minnesota Department of Natural Resources.** NorthMet Environmental Impact Statement Co-lead Agencies' Consideration of Possible Mine Site Bedrock Northward Flowpath. October 12, 2015.

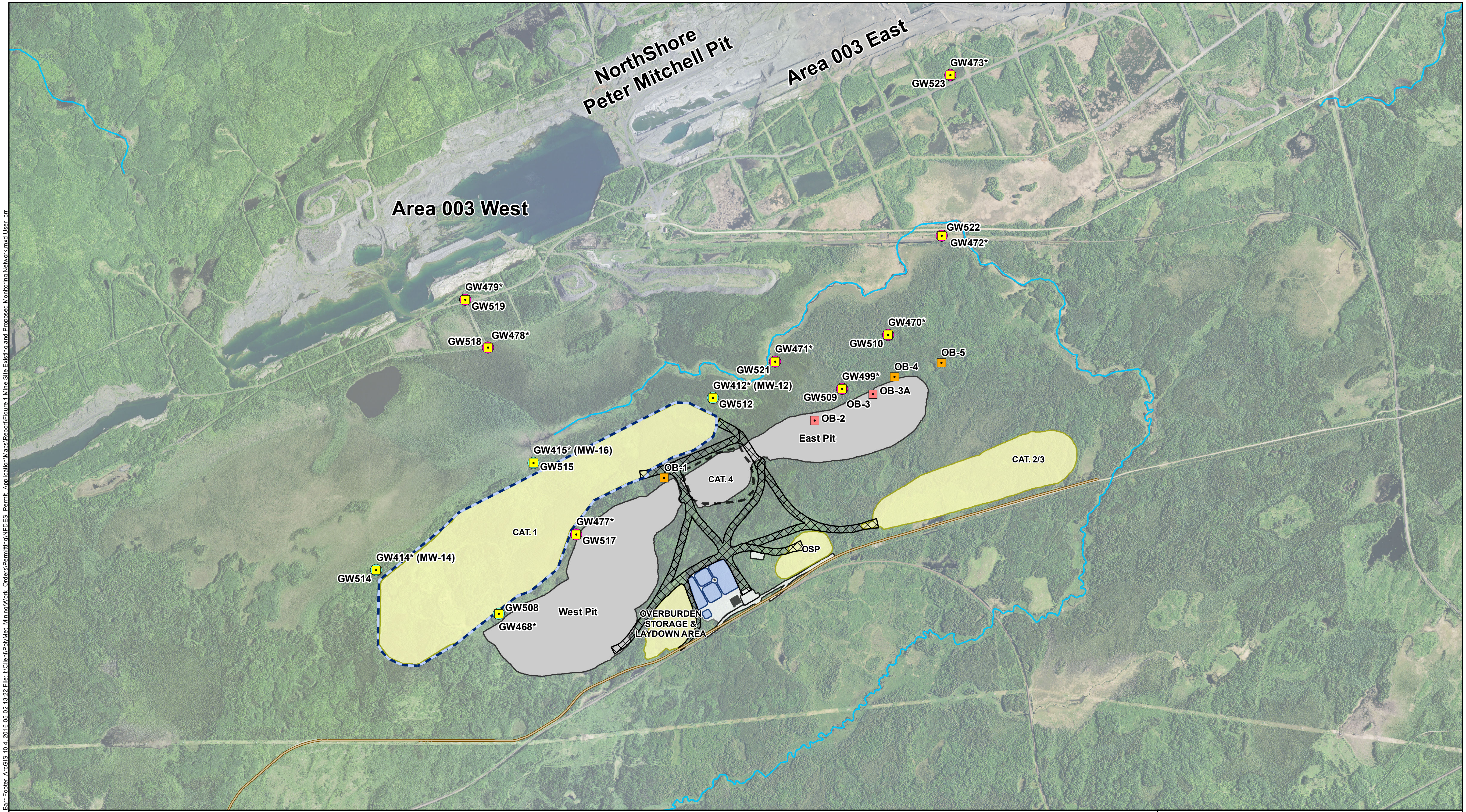
2. **Minnesota Department of Natural Resources, U.S. Army Corps of Engineers and U.S. Forest Service.** Final Environmental Impact Statement: NorthMet Mining Project and Land Exchange. November 2015.

3. **Barr Engineering Co.** Response to Cooperating Agency Comments Related to Peter Mitchell Pit – Version 4 Technical Memo to Bill Johnson, Minnesota Department of Natural Resources. September 14, 2015.

4. **Day-Lewis, F. D., et al.** A computer program for flow-log analysis of single holes (FLASH): Ground Water. [Online] 2011.

5. **Young, Steven C. and Pearson, Hubert S.** The Electromagnetic Borehole Flowmeter: Description and Application. *Ground Water.* 1995, Vol. 33, pp. 311-318.

Large Figures



Existing Surficial Aquifer Monitoring Wells
Proposed Surficial Monitoring Wells
Proposed Bedrock Monitoring Wells
Existing Bedrock Monitoring Wells
Wells to be Abandoned

GW405* (MW-5) Proposed NPDES/SDS Monitoring Station ID (Current Monitoring Station ID)

* Indicated Surficial Monitoring Well

Year 11 Features
Haul Roads
Active Stockpile
Removed Stockpile
Mine Pit

Public Waters Inventory (PWI) Watercourses
Groundwater Containment System

0 1,250 2,500 5,000
Feet

Large Figure 1
MINE SITE: EXISTING AND PROPOSED MONITORING NETWORK
Monitoring Wells North of the Mine Site: Installation and Monitoring Plan
NorthMet Project
Poly Met Mining Inc.