Application

Permit to Mine Application

Project I.D.: 12P778

Poly Met Mining, Inc.
St. Paul, Minnesota

November 2016

Permit to Mine Application

Project ID: 12P778

Prepared for

Poly Met Mining, Inc.

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Prepared by

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Barr Engineering Co.

November 2016

Permit to Mine Application

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List of Abbreviations, Acronyms, and Symbols

<	less than
>	greater than
°	degrees
c'	drained cohesion
C	Cohesion
c_u	undrained cohesion
%	percent
404 Permit	Clean Water Act Section 404 Permit
amsl	above mean sea level
AERA	Air Emission Risk Analyses
APE	Area of Potential Effect
ANFO	ammonium nitrate and fuel oil
Application	Permit to Mine Application
ASTM	American Society for Testing and Materials
Au/PGM	gold and platinum group metal
BACT	Best Available Control Technology
Barr	Barr Engineering Co.
BMP	best management practices
BSA	Bank Service Area
BWCAW	Boundary Waters Canoe Area Wilderness
BWSR	Board of Water and Soil Resources
CAA	Clean Air Act
CDSM	Cement Deep Soil Mixing
CAP	Contingency Action Plan
cfs	cubic feet per second
cm/sec	centimeters per second
CO	carbon monoxide
CPS	Central Pumping Station
CPTE	Controlled Potential to Emit
CRE	Contingency Reclamation Estimate
CSP	Consumer Price Index
CWA	Clean Water Act
EIS	Environmental Impact Statement
ELT	Ecological Land Types
ESA	Endangered Species Act
ESSA	effective strength stability analysis
FEC	Fugitive Emission Control
FEIS	Final Environmental Impact Statement
FOS	Factor of Safety

FTB	Flotation Tailings Basin
GIS	Geographic Information System
gr/dscf	grains per day standard cubic foot
GCL	geosynthetic clay liner
GCS	Groundwater Containment System
gpm	gallons per minute
Golder	Golder Associates
H_2S	hydrogen sulfide
HAP	Hazardous Air Pollutants
HDPE	high density polyethylene
HEPA	High Efficiency Particulate Arrestor
HRF	Hydrometallurgical Residue Facility
Residue	hydrometallurgical process
HUC	Hydrologic Unit Code
I/I	infiltration and inflow
LOM	Life of Mine
LLDPE	linear low density polyethylene
Longyear	Longyear Mesaba Company
LTVSMC	LTV Steel Mining Company
m	meters
MAAQS	Minnesota Ambient Air Quality Standards
MACT	Maximum Achievable Control Technology
MDH	Minnesota Department of Health
MDNR	Minnesota Department of Natural Resources
MEPA	Minnesota Environmental Policy Act
mg/L	milligrams per liter
MHP	mixed hydroxide product
MIBC	methyl isobutyl carbinol
MnRAM	Minnesota Rapid Assessment Method
MPCA	Minnesota Pollution Control Agency
MSFMF	Mine Site Fueling and Maintenance Facility
MSHA	Mine Safety and Health Administration
N/A	not applicable
NAAQS	National Ambient Air Quality Standards
NEPA	National Environmental Policy Act
NFS	National Forest System
NO_X	oxides of nitrogen
NPDES	National Pollutant Discharge Elimination System
NRCS	National Resources Conservation Service
NRHP	National Register of Historic Places

NSPS	New Source Performance Standard
NSR	New Source Review
OSLA	Overburden Storage and Laydown Area
OSP	Ore Surge Pile
PAX	potassium amyl xanthate
Pb	lead
PGE	platinum group elements
PM	particulate matter
PM_{10}	particulate matter in the 10 micron or less size range
$PM_{2.5}$	particulate matter in the size range 2.5 microns or less
PMP	probable maximum precipitation
PolyMet	Poly Met Mining, Inc.
PRI	Partridge River Intrusion
Project	NorthMet Project
PSD	Prevention of Significant Deterioration
PTM	Permit to Mine
QA	quality assurance
QC	quality control
RCRA	Resource Conservation and Recovery Act
RGGS	RGGS Land & Minerals, Ltd. L.P.
RGU	Responsible Government Unit
RO	reverse osmosis
ROD	Record of Decision
RQD	rock quality designation
RTH	Rail Transfer Hopper
SAG	semi-autogenous grinding
SDEIS	Supplemental Draft Environmental Impact Statement
SDS	State Disposal System
SEDAR	System for Electronic Document Analysis and Retrieval
SO_2	sulfur dioxide
SPCC	Spill Prevention, Control, and Countermeasure
SRCE	Standardized Reclamation Cost Estimator
SRK	SRK Consulting
SWPPP	Stormwater Pollution Prevention Plan
TCLP	Toxicity Characteristic Leaching Procedure
tpy	tons per year
TSS	total suspended solids
TWP	treated water pipeline
USACE	U.S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency

USFS	U.S. Forest Service
USFWS	U.S. Fish & Wildlife Service
USGS	U.S. Geological Survey
USSA	undrained shear strength analysis
$USSA_{liq}$	liquefied shear strength analysis of liquefaction
$USSA_{yield}$	undrained shear strength analysis of yield
VOC	volatile organic compound
VSEP	Vibratory Shear Enhanced Processing
WCA	Wetland Conservation Act of 1991; Minnesota Rules, chapter 8420
WWTF	Waste Water Treatment Facility
WWTP	Waste Water Treatment Plant

1 Introduction

Poly Met Mining, Inc. (PolyMet) proposes to develop a copper-nickel and platinum-group elements (PGE) ore deposit known as the NorthMet Deposit. Figure 1-1 shows the location of the NorthMet Deposit near Hoyt Lakes, Minnesota, which is on the eastern side of the mining district known as the Mesabi Iron Range. The Mesabi Iron Range hosts extensive mining operations devoted to the extraction and processing of iron ore and taconite.

Ore will be extracted using open pit mining methods. PolyMet will process the ore at the former LTV Steel Mining Company (LTVSMC) plant site, which will be refurbished for the NorthMet Project (Project). Tailings will be disposed of in the existing LTVSMC tailings basin, which will be upgraded to receive nonferrous Flotation Tailings. This Permit to Mine (PTM) Application (Application) refers to the NorthMet Deposit and immediately adjacent land as the “Mine Site”, and to the plant processing facilities and nearby tailings basin and rail facilities as the “Plant Site.” The Plant Site and the Mine Site will be connected by the Transportation and Utility Corridors, and an additional pipeline corridor (Colby Lake Pipeline Corridor) will supply water to the Plant Site when needed. Collectively, these facilities and infrastructure comprise the Project. The geographic area of land that encompasses all of these Project components is the Mining Area, as defined under Minnesota Rules, chapter 6132. Because the final boundary of the Mining Area may be further refined during the permitting process, PolyMet describes the Mining Area as the "Facility Boundary" on figures contained in this Application. Figure 1-2 depicts the location and extent of the Mining Area (identified on the figure as the Facility Boundary), including facilities and infrastructure elements included in the Project.

The Mine Site is located on federal land within the Superior National Forest that is administered by the U.S. Forest Service (USFS). The underlying minerals are owned by RGGS Land & Minerals, Ltd. L.P. (RGGS) and the Longyear Mesaba Company (Longyear), and are leased to PolyMet. As described in its Draft Record of Decision, the USFS is proposing to convey approximately 6,495 acres Geographic Information System (GIS) of Superior National Forest lands encompassing the ore deposit and the adjacent land to PolyMet. In exchange, PolyMet will convey approximately 7,075 acres (GIS) of private land within the Superior National Forest to the USFS. Figure 1-3 and Figure 1-4 show the location of the USFS and PolyMet land holdings that constitute the land exchange. These figures show that the private lands to be conveyed will facilitate the USFS’s stated goal of consolidating its land holdings in the region. Figure 1-5 depicts the surface interests in the vicinity of the Project after the proposed USFS land exchange. Figure 1-6 depicts the mineral interests encompassed in the Mining Area. Additional information regarding PolyMet's surface and mineral interests associated with the Project is provided in Section 4.

The USFS, together with the U.S. Army Corps of Engineers (USACE) and the Minnesota Department of Natural Resources (MDNR) (collectively, the “Co-Lead Agencies”) led a joint federal and state environmental review of the Project under the National Environmental Policy

Act (NEPA) and the Minnesota Environmental Policy Act (MEPA). This comprehensive process included multiple rounds of agency, tribal, and public review and comment. The Co-Lead Agencies published the Final Environmental Impact Statement (FEIS) in November 2015 (Appendix 16.1). Appendix 16 contains the FEIS and the related environmental studies and analyses.

The FEIS provides governmental decision makers and the public with information about the potential effects of the Project, as well as the mitigation measures that will be taken to eliminate or reduce the effects of the Project on the surrounding environment. As required by NEPA and MEPA, agency decision makers must consider the information in the FEIS before issuing the various permits and approvals needed to build and operate the Project.

The information included in the FEIS and this Application builds on work by Minnesota's state agencies, the copper-nickel mining industry, and members of Minnesota's community (i.e., stakeholders), which have collectively spent decades studying environmental issues relating to the development and production of Minnesota's nonferrous mineral resources. These studies include:

- the Regional Copper-Nickel Study completed in 1979, which concluded that copper-nickel mining can be conducted in an environmentally sound manner (Reference (1))
- the Mining Simulation Study completed in 1990, which focused on the environmental review and permitting processes for metallic minerals mining (Reference (2))
- environmental studies conducted by the MDNR and the Minnesota Pollution Control Agency (MPCA) on water, rock characterization, and reclamation as they relate to copper-nickel mining (Reference (3))

Given the results of this comprehensive analysis of the potential environmental issues associated with copper-nickel mining, and recognizing the beneficial aspects of nonferrous metallic mineral mining, the issuance of a Permit to Mine for the Project will bolster Minnesota's efforts to diversify its mineral economy through long-term support of mineral development, production, and commercialization as set forth in Minnesota Statutes, section 93.001. Additionally, consistent with the policies set forth in Minnesota Rules, part 6132.0200, the Project will promote the orderly development of nonferrous metallic mineral mining by using mining and reclamation best practices to minimize and mitigate adverse environmental effects and to preserve and protect natural resources through each phase of the Project. As further detailed in this Application, PolyMet will, to the extent practicable, implement practices and controls that satisfy each of the provisions in Minnesota Rules, parts 6132.0100 to 6132.5300.

1.1 Overview of Application

This Application consists of five volumes. Volume I contains a comprehensive summary of the Project, including an overview of the Project (Section 3), the environmental setting for the Project (Section 5), the Project mining and reclamation plan (Sections 7-10, and 15), environmental and natural resource management and protection (Sections 11-14), and PolyMet's proposed approach to financial assurance (Section 16). As appropriate, Volume I also describes specific regulatory standards governing various aspects of the Project and the basis of design and/or operational protocols that PolyMet will use to meet these requirements. This information is organized into the following sections:

- Section 1 – Introduction
- Section 2 – PolyMet Organizational Information and Documents
- Section 3 – Overview of the Project's Mining and Reclamation Plan
- Section 4 – Land Management
- Section 5 – Environmental Setting Information
- Section 6 – Related Environmental Review and Permitting
- Section 7 – Mine Site and Mining Facilities
- Section 8 – Plant Site and Ore Processing Facilities
- Section 9 – Transportation and Utility Corridors and Colby Lake Pipeline Corridor
- Section 10 – Characterization and Management of Mine Waste
- Section 11 – Water Management
- Section 12 – Wetland Avoidance and Mitigation
- Section 13 – Air Quality Management
- Section 14 – Project Monitoring Plans
- Section 15 – Reclamation, Closure, and Postclosure Maintenance
- Section 16 – Financial Assurance
- Section 17 – References

Volumes II through IV contain the first set of appendices, which contain more detailed technical information pertinent to the nonferrous mining regulatory requirements. Volume II includes:

- Appendix 1 Regulatory Filings and Compliance Documents
- Appendix 2 Mine Waste Characterization Documentation and Results

Volumes III and IV contain appendices relating to engineering plans, operational plans, and reclamation plans. The engineering plans contain permit application support drawings that detail permit level designs. Descriptions of the designs, and the basis of the designs, can be found in the Management Plans and Data Packages (Appendix 16). The engineering plans include:

- Appendix 3 Mine Site and Dunka Road Earthwork Permit Application Support Drawings
- Appendix 4 Categories 1, 2/3, and 4 Stockpiles and Ore Surge Pile Design and Category 1 Stockpile Groundwater Containment System Permit Application Support Drawings
- Appendix 5 Mine Site Stormwater Permit Application Support Drawings
- Appendix 6 Flotation Tailings Basin and FTB Seepage Containment and Stream Augmentation Systems Permit Application Support Drawings
- Appendix 7 Hydrometallurgical Residue Facility Permit Application Support Drawings
- Appendix 9 Sewage Treatment System Permit Application Support Drawings
- Appendix 8 Mechanical Infrastructure Permit Application Support Drawings
- Appendix 10 Plant Site Stormwater Permit Application Support Drawings

Operational plans, which provide supplemental information on how the facility will be operated and managed over the life of the mine include:

- Appendix 11 Mine Site: Management and Monitoring Plans Outlines
- Appendix 12 Plant Site: Management and Monitoring Plans Outlines
- Appendix 13 Annual Report

Reclamation plans and closure cost estimates are detailed in:

- Appendix 14
- Appendix 15 Financial Assurance

Note that Appendices 11, 12 and 13 are currently in outline form. The intent of these outlines is for them to become management and monitoring plans that will be used during operations to ensure compliance with permit conditions. Once permit conditions are drafted, the outlines for these plans will be updated and plans will be written.

Volume V contains Appendix 16 through Appendix 18. Appendix 16 contains the FEIS, along with related environmental reports. The related environmental reports include the management plans and data packages, which have been iteratively developed and updated throughout the environmental review process. These reports, or portions of them, may be further refined to address specific matters in permitting. Appendix 17 contains work plans and monitoring plans, and Appendix 18 contains wetland related reports:

- Appendix 16 Final Environmental Impact Statement and Related Environmental Reports
- Appendix 17 Work Plans

- Appendix 18 Wetland Related Reports

1.2 Regulatory Compliance

The five volumes of this Application were prepared to meet the regulatory requirements set forth in Minnesota Statutes, chapter 93 and Minnesota Rules, chapter 6132. For ease of reference, Table 1-1 sets forth the regulatory requirements for a complete application and indicates the specific section of this Application which contains the required information.

Minnesota Rules, chapter 6132 also contains substantive requirements that govern the operation and reclamation of nonferrous mines. This Application describes how the Project will comply with these requirements.

In addition to the Application, the Project triggers various other federal, state, and county regulatory requirements. A list of the other permits and approvals potentially required for the Project is provided in Table 1-2.

1.3 Permit to Mine Application Process

Minnesota has developed detailed procedures for obtaining a Permit to Mine, which are set forth in Minnesota Statutes, chapter 93 and Minnesota Rules, chapter 6132. PolyMet has complied with the regulatory procedures required to be completed in advance of filing this Application, and will continue to comply with subsequent procedural requirements. Table 1-3 sets forth the primary procedural requirements for the Application through the MDNR determination that the Application is deemed filed. Appendix 1 contains a compilation of materials documenting PolyMet's compliance with applicable procedural requirements.

Table 1-1 Documentation Required in the Application

Required Content	Applicable Regulatory Citation	Location in Application
Documents and Fees		
PTM Application (in duplicate)	Minnesota Rules, part 6132.1100, subpart 2	
Advertisement and affidavit of publication	Minnesota Rules, part 6132.1100, subpart 3, item A	To be filed after publication
Certificate of authority to transact business in Minnesota	Minnesota Rules, part 6132.1100, subpart 3, item B	Appendix (App.) 1
Certificate of insurance	Minnesota Statutes, section 93.481, subdivision 1(a)(2); Minnesota Rules, part 6132.1100, subpart 3, item C	App. 1
Financial assurance documents	Minnesota Rules, part 6132.1100, subpart 3, item D; Minnesota Rules, part 6132.1200, subpart 2	Section 16 and App. 15
Application fee of $50,000	Minnesota Statutes, section 93.481, subdivision 1(a)(3)	Previously submitted
Supplemental application fee (if any) for processing application	Minnesota Statutes, section 93.482, subdivision 2	N/A
Organizational Structure		
Post office address	Minnesota Rules, part 6132.1100, subpart 4, item A	Section 2
Organizational structure, including parent companies, owners, principal stockholders, partners, and joint venturers	Minnesota Rules, part 6132.1100, subpart 4, item B	Section 2
Managing agents or subsidiaries involved in operations	Minnesota Rules, part 6132.1100, subpart 4, item C	N/A
Organizational relationships among joint applicants	Minnesota Rules, part 6132.1100, subpart 4, item D	N/A
Environmental Setting		
Copy of FEIS and all environmental reports	Minnesota Rules, part 6132.1100, subpart 5, item A	Appendix 16
Environmental setting maps	Minnesota Rules, part 6132.1100, subpart 5, item B	Section 5
• Bedrock geology	Minnesota Rules, part 6132.1100, subpart 5, item B(1)	Section 5.1 Figures 5-1 through 5-3
• Water basins, water courses, and wetlands that may be affected by mining	Minnesota Rules, part 6132.1100, subpart 5, item B(2)	Sections 5.2 and 5.3 Figures 5-4 through 5-7
• Boundaries of watersheds that may be affected by mining	Minnesota Rules, part 6132.1100, subpart 5, item B(3)	Section 5.2 Figure 5-4 through 5-6
• Hydrogeologic information, including plan view and cross section maps and description of features on the maps	Minnesota Rules, part 6132.1100, subpart 5, item B(4), including (a) and (b)	Section 5.4 Figures 5-8 through 5-20

Required Content	Applicable Regulatory Citation	Location in Application
• Description of hydrogeological information, including overburden and rock features, well locations, well logs, uses, pumping rates and capacities	Minnesota Rules, part 6132.1100, subpart 5, item B (4) (a) and (b)	Section 5.4 Appendix 16
• Surface water and groundwater compliance monitoring sites and water quality and toxicity standards	Minnesota Rules, part 6132.1100, subpart 5, item B(5)	Section 5.5 Figures 5-21 through 5-26
• Soil inventory	Minnesota Rules, part 6132.1100, subpart 5, item B(6)	Section 5.6 Figure 5-27
• Recorded locations of rare, endangered, and threatened species	Minnesota Rules, part 6132.1100, subpart 5, item B(7)	Section 5.7 Figure 5-28
• Past mining facilities	Minnesota Rules, part 6132.1100, subpart 5, item B(8)	Section 5.8 Figure 5-29
• Recorded archaeological or historic sites	Minnesota Rules, part 6132.1100, subpart 5, item B(9)	Section 5.9 Figures 5-30 and 5-31
• Known surface and subsurface uses	Minnesota Rules, part 6132.1100, subpart 5, item B(10)	Section 5.10 Figures 5-32 through 5-34
• Siting, exclusion, prohibition, and restriction areas	Minnesota Rules, part 6132.1100, subpart 5, item B(11)	Section 5.11 Figure 5-35
• Applicable zoning ordinances and associated land use plans	Minnesota Rules, part 6132.1100, subpart 5, item B(12)	Section 5.12 Figure 5-36
• Surface and mineral rights ownership	Minnesota Rules, part 6132.1100, subpart 5, item B(13)	Sections 5.13 Figure 1-5, Figure 1-6, and Figure 4-1
Mining and Reclamation Plan		
Operating life of mine, including mine rate and anticipated changes to mine rate	Minnesota Rules, part 6132.1100, subpart 6, item A	Sections 3 and 7
Mining activities: types, amounts, sequence, and schedule of mining and storage piling	Minnesota Rules, part 6132.1100, subpart 6, item B(1)	Sections 3, 7, and 10
Mining activities: ore beneficiating process, including type and amount of added chemicals, amounts, sequence, schedule, and means of tailings disposal	Minnesota Rules, part 6132.1100, subpart 6, item B(2)	Sections 3, 8, and 10

Required Content	Applicable Regulatory Citation	Location in Application
Engineering design, methods, sequence, and schedules of reclamation, including closure and postclosure maintenance	Minnesota Rules, part 6132.1100, subpart 6, item C	Sections 3 and 15; Appendices 3 to 14
Mine waste characterization	Minnesota Rules, part 6132.1000, subpart 3, item A; Minnesota Rules, part 6132.1100, subpart 6, item D	Sections 3 and 10; Appendix 2
Wetland replacement plan	Minnesota Statutes, section 103G.222, subdivision 1; Minnesota Rules, part 6132.5300, subpart 2	Appendix 18
Mining and Reclamation Maps		
Shape and extent of ore body that will support the operating life of mine	Minnesota Rules, part 6132.1100, subpart 7, item A	Figure 7-2
Lands proposed for use as vegetative reference areas	Minnesota Rules, part 6132.1100, subpart 7, item B	Figure 15-4
Detailed drainage patterns for waters that may contact reactive mine waste	Minnesota Rules, part 6132.1100, subpart 7, item C	Figures 11-12 and 11-15
Status of mining ore body	Minnesota Rules, part 6132.1100, subpart 7, item D	Figure 7-7
Status of watershed and hydogeologic modification	Minnesota Rules, part 6132.1100, subpart 7, item D	Figures 11-6 and 11-15
Status of construction of storage piles, tailings basin, mine, reservoir, dam, diversion channel, drainage control, settling basin, heap and dump leaching facility, and auxiliary facilities	Minnesota Rules, part 6132.1100, subpart 7, item D	Figure 7-7 and Figure 10-6
First Year of Operations		
Detailed plan of activities for first year of operations	Minnesota Rules, part 6132.1100, subpart 8	Appendix 13
First Year: Anticipated rate of mining	Minnesota Rules, part 6132.1100, subpart 8; 6132.1300, subpart 3, item A	Appendix 13
First Year: Anticipated mining activities	Minnesota Rules, part 6132.1100, subpart 8; 6132.1300, subpart 3, item B	Section 16; Appendix 13
First Year: Anticipated reclamation	Minnesota Rules, part 6132.1100, subpart 8; 6132.1300, subpart 3, item C	Section 16; Appendix 13
First Year: Notification of intent to close mining area, if applicable	Minnesota Rules, part 6132.1100, subpart 8; 6132.1300, subpart 3, item D	Section 16; Appendix 13
First Year: Discussion of how anticipated activities differ from approved mining and reclamation plan	Minnesota Rules, part 6132.1100, subpart 8; 6132.1300, subpart 3.E	Section 16; Appendix 13
First Year: Evidence of liability insurance compliance	Minnesota Rules, part 6132.1100, subpart 8; 6132.1300, subpart 3.F	Section 16; Appendix 13
First Year: Anticipated changes in ownership and organizational structure, if applicable	Minnesota Rules, part 6132.1100, subpart 8; 6132.1300, subpart 3.G	Appendix 13

Required Content	Applicable Regulatory Citation	Location in Application
First Year: Approved wetland replacement plan	Minnesota Rules, part 6132.1100, subpart 8; 6132.1300, subpart 3.H	Appendix 13, when approved
Contingency Reclamation Plan: Methods, sequence, and schedule of reclamation	Minnesota Rules, part 6132.1100, subpart 8; 6132.1300, subpart 4, item A	Section 16; Appendix 15
Contingency Reclamation Plan: Maps and cross sections depicting construction of each area affected by mining	Minnesota Rules, part 6132.1100, subpart 8; 6132.1300, subpart 4,B	Section 16; Appendix 15
Contingency Reclamation Plan: Cost estimates and financial mechanisms necessary to implement contingency reclamation plan if operations cease in first year	Minnesota Rules, part 6132.1100, subpart 8; 6132.1300, subpart 4, item C	Section 16; Appendix 15
Corrective Action: Actual corrective action conducted in previous year	Minnesota Rules, part 6132.1100, subpart 8; 6132.1300, subpart 5, item A	Section 16; Appendix 13
Corrective Action: Anticipated corrective action for first year	Minnesota Rules, part 6132.1100, subpart 8; 6132.1300, subpart 5, item B	Section 16; Appendix 13
Corrective Action: Corrective action cost estimate for first year	Minnesota Rules, part 6132.1100, subpart 8; 6132.1300, subpart 5, item C	Section 16; Appendix 13
Maps showing status of mining, construction, and reclamation for the first year	Minnesota Rules, part 6132.1100, subpart 8; 6132.1300, subpart 6	Section 16; Appendices 13 and 15

Abbreviations:
PTM = Permit to Mine

Table 1-2 Potentially Applicable Permits

Regulatory Agency	Permit/Action	Permit Basis
Federal		
USACE	Section 404 Permit	For affected waters within the jurisdiction of the USACE under the CWA, 40 CFR Part 230: Section 404(b)(1)
	Section 106 NHPA Compliance (Minnesota Historic Preservation Office)	Necessary due to the NorthMet Mining Project and Land Exchange being a federal undertaking, 36 CFR Part 800
USFWS	Section 7 Endangered Species Act (ESA) Compliance	Necessary due to the NorthMet Mining Project and Land Exchange being a federal undertaking, 50 CFR 402
USFS	Land Exchange	To resolve the conflict between surface and mineral estates
	Section 106 NHPA Compliance (Minnesota Historic Preservation Office)	Necessary due to the NorthMet Mining Project and Land Exchange being a federal undertaking, 36 CFR Part 800
State		
MDNR	Permit to Mine	Required for all nonferrous metallic mining operations, Minnesota Rules, chapter 6132
	Endangered Species Taking Permit (if required)	If there are state-listed species that may be taken by the NorthMet Project, Minnesota Rules, parts 6212.1800-6212.2300 and chapter 6134
	Water Appropriations Permit	For withdrawal of water from Colby Lake for plant make-up water; for mine and construction dewatering; for stream augmentation; Minnesota Rules, part 6115
	Dam Safety Permit	For the Tailings Basin, Hydrometallurgical Residue Facility, and potentially the water retention dikes at the Mine Site (e.g., water treatment plant pond dikes), Minnesota Rules, parts 6115.0300-6115.0520
	Permit for Work in Public Waters	For possible modifications and diversions of local streams in constructing the West Pit outfall; Minnesota Rules, part 6115
	Wetland Replacement Plan approval under WCA	For affected wetlands within the scope of the WCA or that constitute "public wetlands"
	Burning Permit (if required)	If vegetative material would need to be burned on-site during times with no snow cover

Regulatory Agency	Permit/Action	Permit Basis
MPCA	Section 401 Water Quality Certification/Waiver	Required in conjunction with the Section 404 Permit
	National Pollutant Discharge Elimination System and State Disposal System (NPDES/SDS) Permits	For construction and industrial activity that would disturb 1 acre or more of land, and the management, treatment and/or discharge of process wastewater to surface water or groundwater
	Solid Waste Permit	For construction debris
	Air Emissions Permit (Part 70 Permit)	For emissions of regulated air pollutants
	Waste Tire Storage Permit (if required)	For storage of waste tires generated from NorthMet Project-related vehicles
	General Storage Tank Permit	For multiple NorthMet Project aboveground storage tanks
MDH	Radioactive Material Registration	For measuring instruments
	Permit for Non-Community Public Water Supply System and a Wellhead Protection Plan (if proposed)	Existing Plant Site potable water treatment plant to be refurbished
	Permit for Public On-site Sewage Disposal System	For sewage waste generated during construction and operation that would be disposed of on-site
MDPS	Permit for explosives use	For usage of explosives during blasting activities
City of Hoyt Lakes	Zoning Permit	
City of Babbitt	Building Permit	
St. Louis County	Zoning Permit	

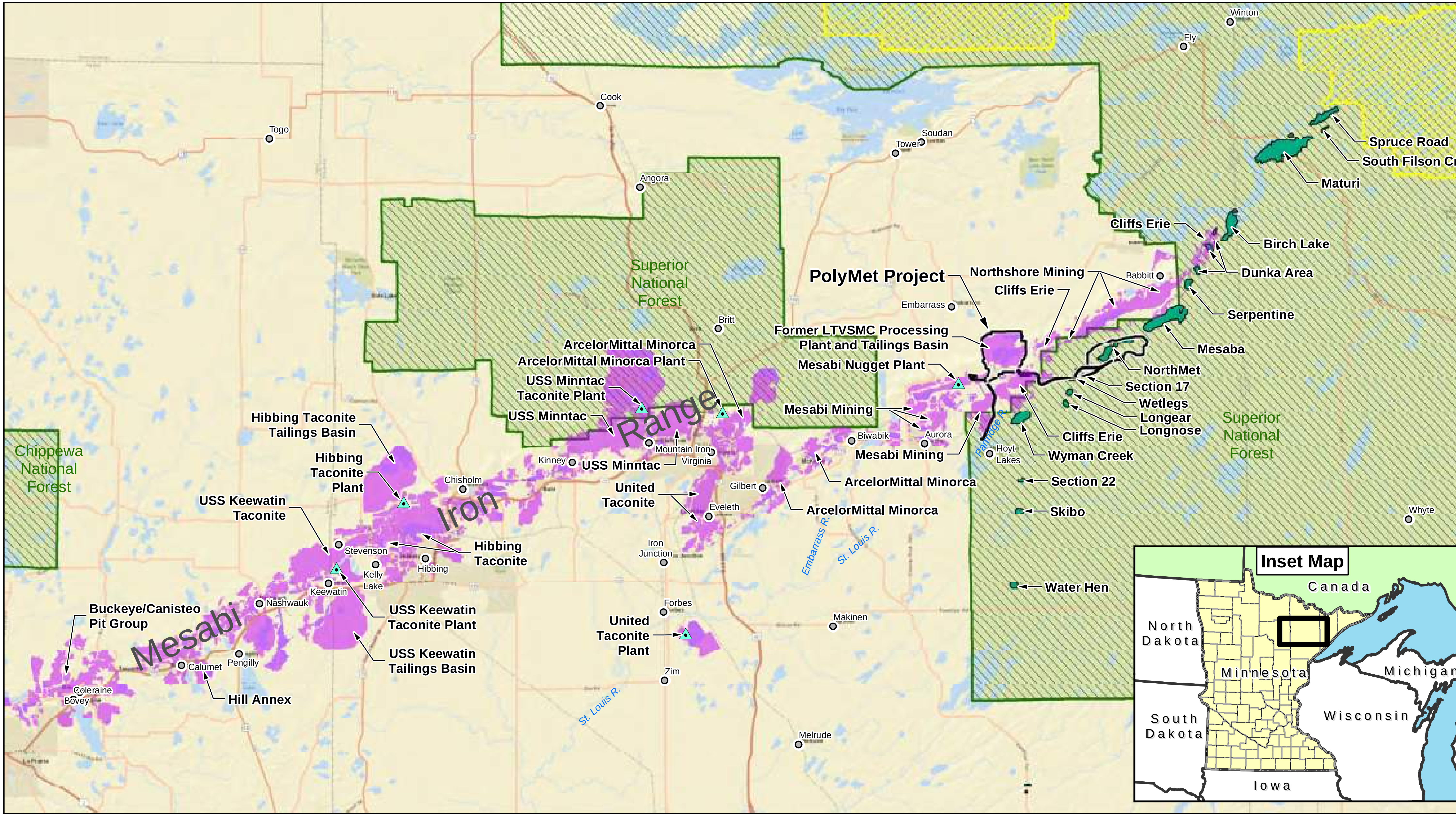
Abbreviations:
CFR = Code of Federal Regulations
CWA = Clean Water Act
ESA = Endangered Species Act
MDH = Minnesota Department of Health
MDNR = Minnesota Department of Natural Resources
MPCA = Minnesota Pollution Control Agency
MDPS = Minnesota Department of Public Safety
NHPA = National Historic Preservation Act
NPDES/SDS = National Pollutant Discharge Elimination System and State Disposal System
USACE = United States Army Corp of Engineers
USFS = United States Forest Service
USFWS = United States Fish and Wildlife Service
WCA = Wetland Conservation Act

Source: Adapted from Appendix 16.1

Table 1-3 Application Procedural Requirements

Procedural Requirement	Statutory/Regulatory Source	Date/Timeframe	Discussion in Application
Mine waste characterization conference with MDNR	Minnesota Rules, part 6132.1000, subpart 1	2004/2005	Appendix 1
Preapplication conference with MDNR	Minnesota Rules, part 6132.1100, subpart 1; 6132.4000, subpart 1	April 19, 2016	Appendix 1
Site visit with MDNR	Minnesota Rules, part 6132.1100, subpart 1; 6132.4000, subpart 1	April 19, 2016	Appendix 1
MDNR Public Informational Meeting	Minnesota Rules, part 6132.1100, subpart 1	April 19, 2016	
Submission of application in duplicate	Minnesota Rules, part 6132.1100, subpart 2	September 2016	
MDNR completeness determination followed by publication in State Register and EQB by MDNR	Minnesota Rules, part 6132.4000, subpart 1	TBD from MDNR	
PolyMet's Publication of Advertisement in a qualified newspaper for four weeks once application is determined complete	Minnesota Rules, part 6132.1100, subpart 1; 6132.4000, subpart 1	To coincide with MDNR publication in State Register and EQB	
Submission of advertisement and affidavit of publication	Minnesota Rules, part 6132.1100, subpart 3; 6132.4000, subpart 1	TBD	
Application deemed filed	Minnesota Rules, part 6132.4000, subpart 1	TBD	

Abbreviations:
MDNR = Minnesota Department of Natural Resources
EQB = Environmental Quality Board
TBD = to be determined



Notes

1. Basemap from Esri and its data suppliers.
2. Boundary data from the MDNR.
3. Mining related data from MDNR Division of Lands and Minerals via email.
4. Coordinate system is NAD 1983 UTM Zone 15N.

Legend

- Existing Taconite Plant
- Place Name
- Mesabi Range Mining Features (Existing Pits, Tailings Basins, Stockpiles and other Mine Features)
- Duluth Complex Deposits
- Boundary Waters Canoe Area Wilderness
- Superior National Forest Administrative Boundary (does not indicate surface ownership)
- PolyMet's Facility Boundary

N

POLYMET MINING

Foth

Foth Infrastructure & Environment, LLC			
REVISED	DATE	BY	DESCRIPTION

PREPARED BY:	DAT	DATE:	AUG. '16
REVIEWED BY:	JSL	DATE:	AUG. '16
APPROVED BY:	CED1	DATE:	AUG. '16

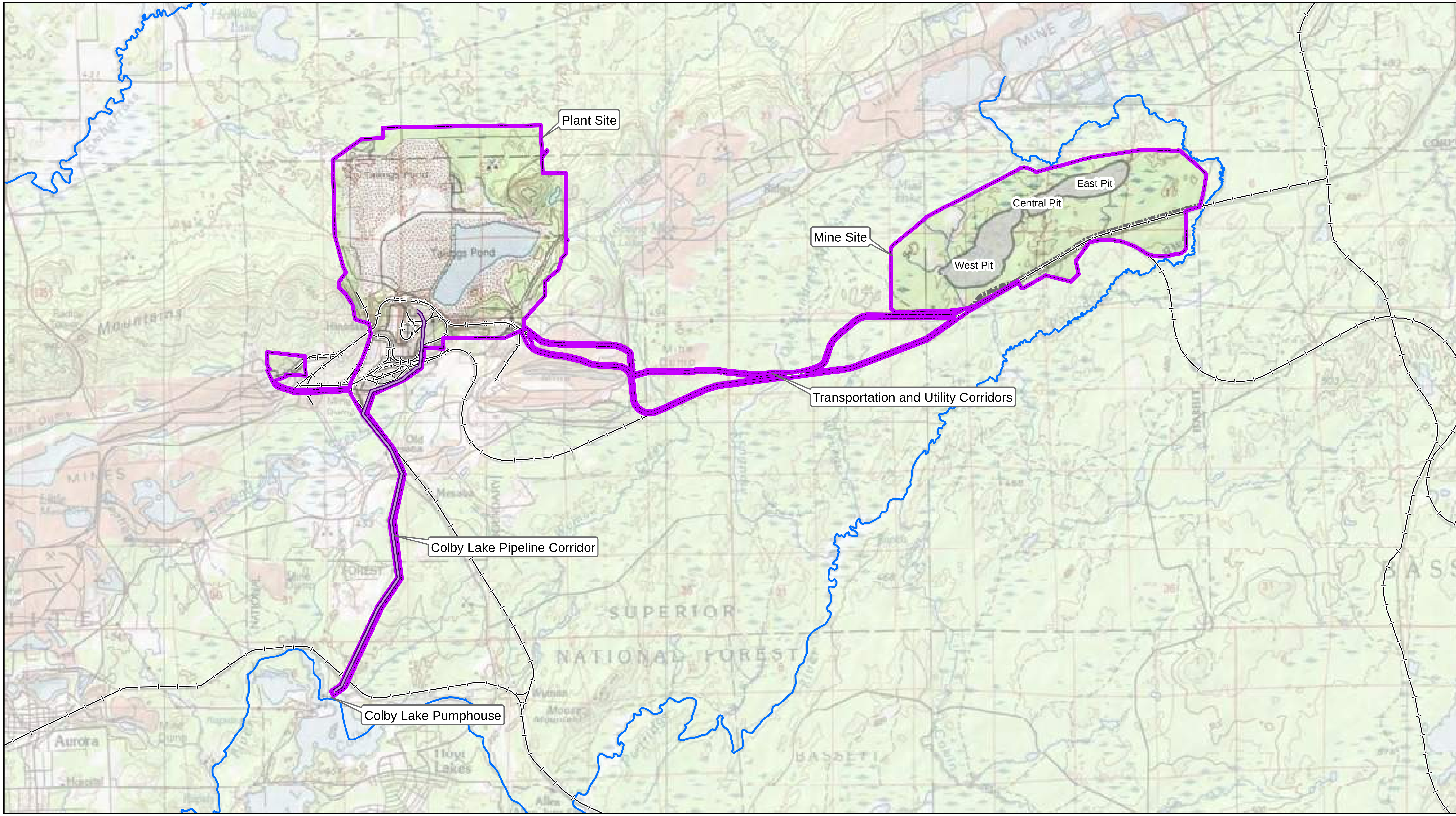
POLYMET MINING

FIGURE 1-1

PROJECT LOCATION
PERMIT TO MINE APPLICATION
HOYT LAKES, MINNESOTA

Scale: 0 3 6 Miles		Date:	AUGUST 2016
Drafted by:	DAT	Project No:	12P778

Path: X:\GB\IE\2012\12P778\GIS\mxd\PMA\Figure 1-1 Project Location.mxd Date: 9/2/2016



Notes
1. Basemap from Esri and its data suppliers.
2. Project features supplied by Barr Engineering Company.
3. Tailings pond and other features shown in basemap are existing and not NorthMet Project.

Legend
- Existing Private Railroad
- Colby Lake Pipeline
- Dunka Road
- Embarrass and Partridge Rivers
- Mine Pits
- Facility Boundary

POLYMET MINING

Foth

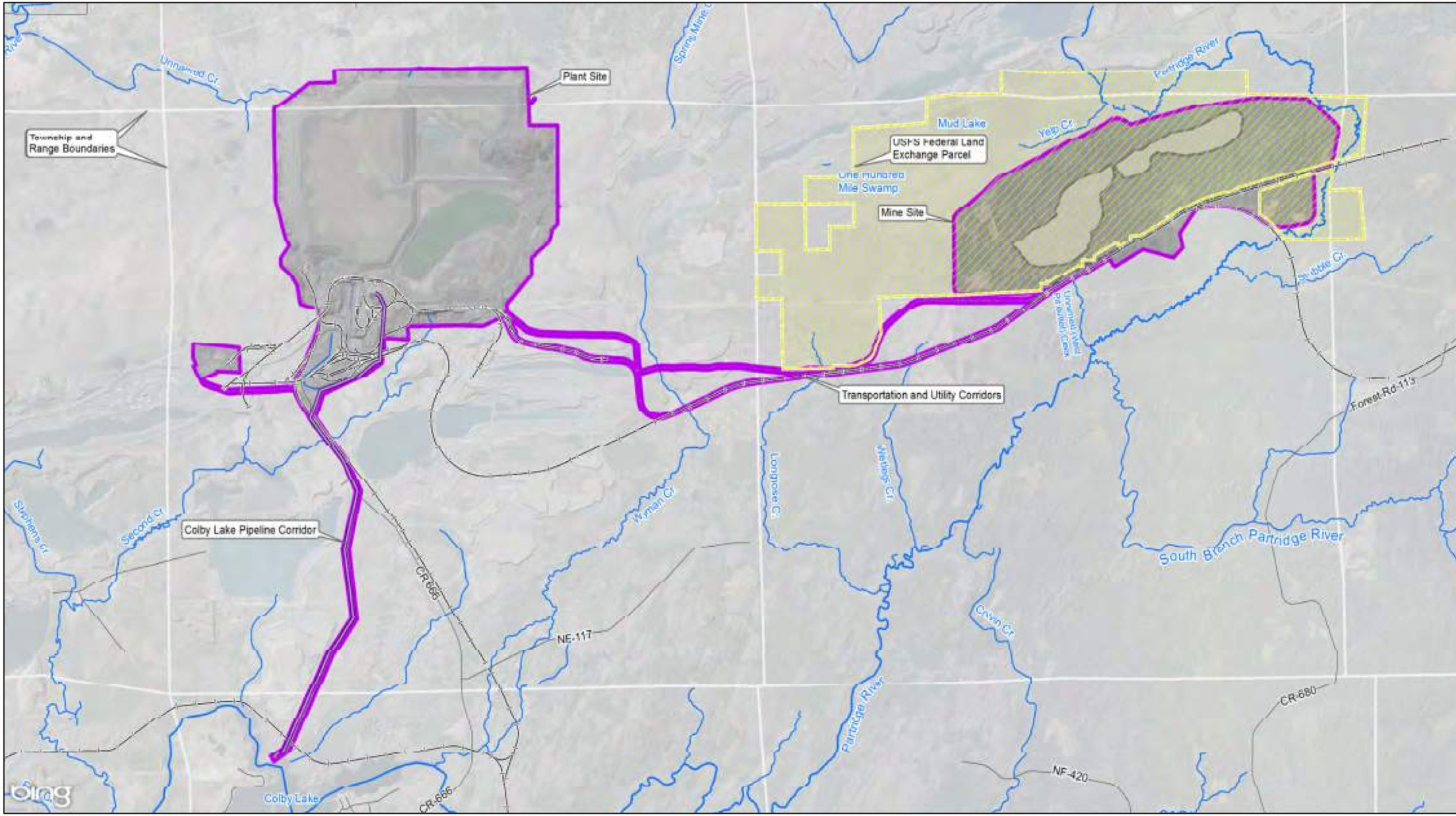
Foth Infrastructure & Environment, LLC			
REVISED	DATE	BY	DESCRIPTION
PREPARED BY: DAT			DATE: AUG. '16
REVIEWED BY: JSL			DATE: AUG. '16
APPROVED BY: CED1			DATE: AUG. '16

POLYMET MINING

FIGURE 1-2
SITE LAYOUT
PERMIT TO MINE APPLICATION
HOYT LAKES, MINNESOTA

Scale: 0 3,000 6,000 Feet	Date: AUGUST 2016
Drafted by: DAT	Project No: 12P778

Path: X:\GB\IE\2012\12P778\GIS\mxd\PMA\Figure 1-2 Site Layout.mxd Date: 9/1/2016



Notes
1. Basemap from Esri and its data suppliers.
2. Project features supplied by Barr Engineering Company.
3. NHD features are created from MDNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance, data sources may show watercourses that no longer exist.
4. Superior National Forest Boundary from the Minnesota Geospatial Information Office (MnGeo).

Legend
- Roads
- Dunka Road
- Existing Private Railroad
- Colby Lake Pipeline
- Rivers and Streams[3]
- USFS Federal Land Exchange Parcels
- Townships
- Mine Pits
- Facility Boundary

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REVISED	DATE	BY	DESCRIPTION

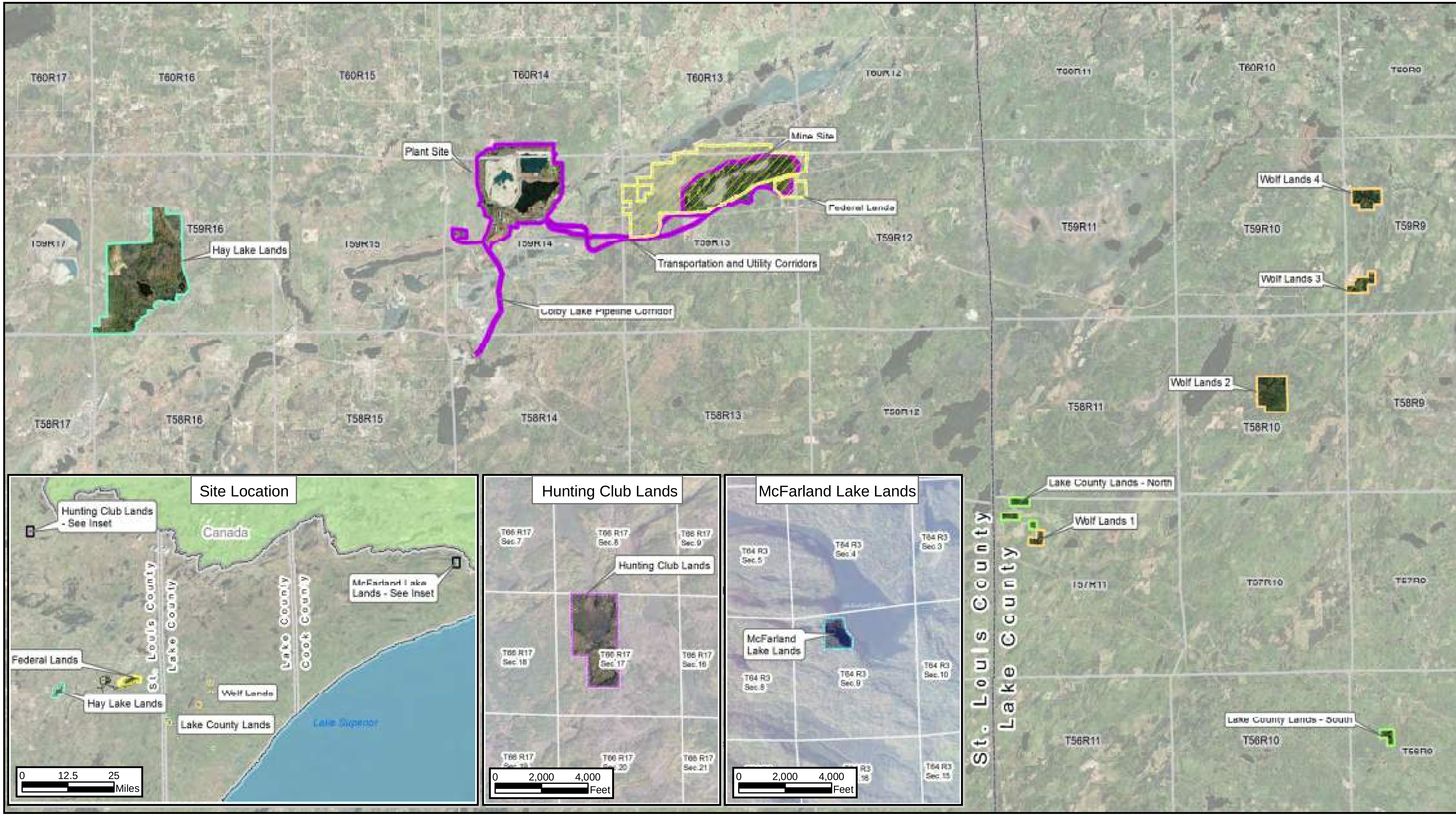
PREPARED BY:	DAT	DATE: AUG. '16
REVIEWED BY:	JSL	DATE: AUG. '16
APPROVED BY:	CED1	DATE: AUG. '16

POLYMET MINING

FIGURE 1-3
FEDERAL LAND EXCHANGE PARCEL
PERMIT TO MINE APPLICATION
HOYT LAKES, MINNESOTA

Scale: 0 2,500 5,000 Feet	Date: AUGUST 2016
Drafted by: DAT	Project No: 12P778

Path: X:\GB\IE\2012\12P778\GIS\mxd\PMA\Figure 1-3 Land Exchange Parcels.mxd Date: 9/1/2016



Notes
1. Basemap from Esri and its data suppliers.
2. Project features supplied by Barr Engineering Company.
3. Boundary data from the MDNR.

Legend

Non-Federal Lands
- Hay Lake Lands
- Lake County Lands
- Wolf Lands
- Hunting Club Lands
- McFarland Lake Lands
- USFS Federal Land Exchange Parcels
- Township Boundary
- County
- Mine Pits
- Facility Boundary

N

Foth Infrastructure & Environment, LLC

REVISED	DATE	BY	DESCRIPTION

PREPARED BY:	DAT	DATE:	AUG. '16
REVIEWED BY:	JSL	DATE:	AUG. '16
APPROVED BY:	CED1	DATE:	AUG. '16

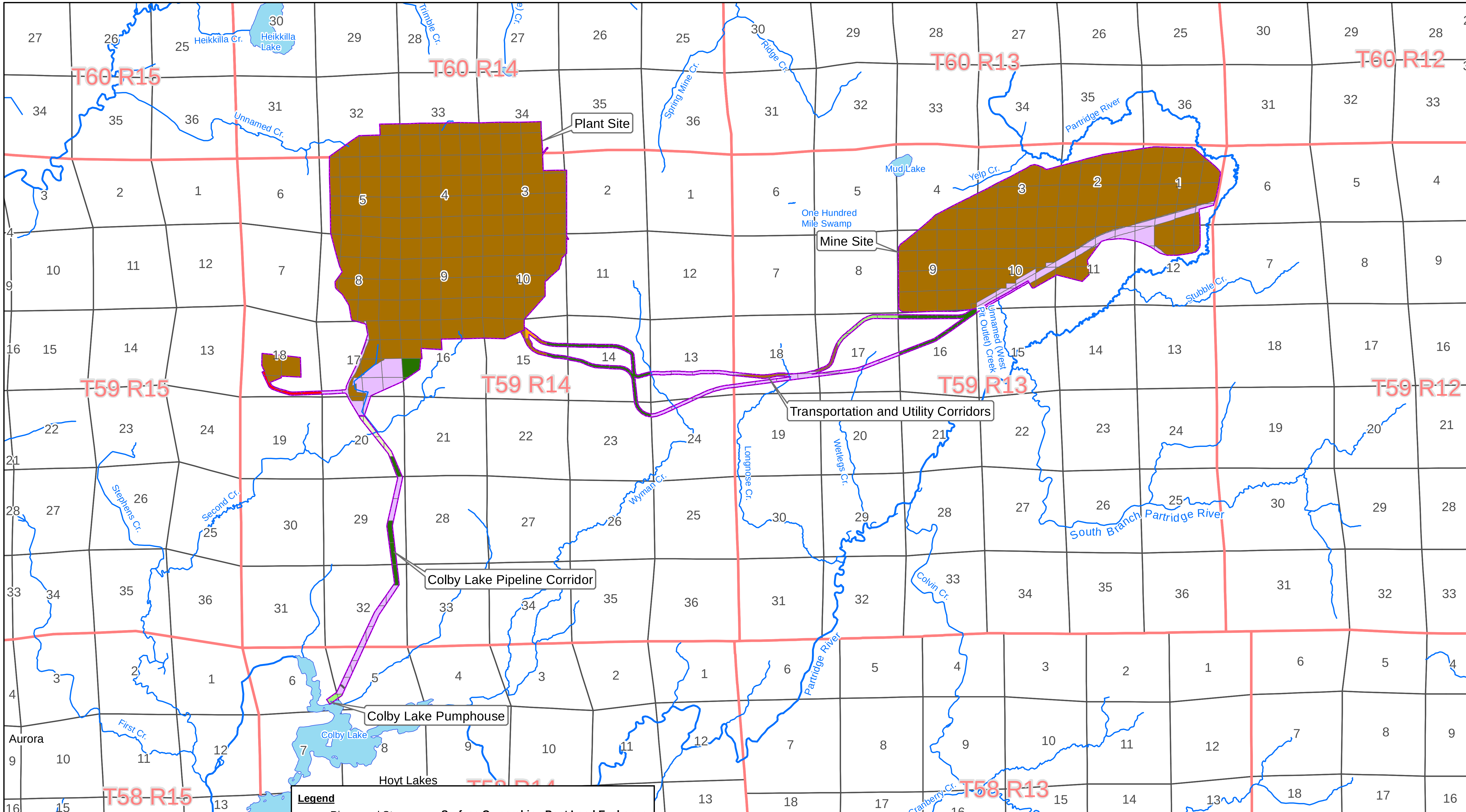
POLYMET MINING

FIGURE 1-4

POLYMET LAND EXCHANGE PARCELS
PERMIT TO MINE APPLICATION
HOYT LAKES, MINNESOTA

Scale: 0 1.5 3 Miles		Date:	AUGUST 2016
Drafted by:	DAT	Project No:	12P778

Path: X:\GB\IE\2012\12P778\GIS\mxd\PMA\Figure 1-4 Land Exchange Parcels to be Conveyed to USFS.mxd Date: 9/2/2016



Legend

- Rivers and Streams
- Lakes
- Townships
- Sections
- Facility Boundary

Surface Ownership - Post Land Exchange

- Allete
- Cliffs Erie
- Du Nord Land Company
- Mesabi Nugget
- PolyMet
- Railroad
- RGGS LAND
- State of Minnesota

Notes

1. This drawing is neither a legally recorded map nor a survey and is not intended to be used as one. This drawing is a compilation of records, information and data used for reference purposes only.
2. Surface ownership dataset supplied by PolyMet.
3. Certain parcels may have fractionalized ownership, and in such circumstances, this map shows the majority owner.
4. Consistent with Minnesota Rules, Part 6132.1100, this map depicts ownership as a matter of record as well as PolyMet's equitable ownership of lands subject to Contracts for Deed, but does not reflect private party agreements that grant PolyMet rights and control over the lands (e.g. easements, licenses, etc.)

POLYMET MINING

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Foth Infrastructure & Environment, LLC

REVISED	DATE	BY	DESCRIPTION

PREPARED BY:	DAT	DATE:	AUG. '16
REVIEWED BY:	JSL	DATE:	AUG. '16
APPROVED BY:	CED1	DATE:	AUG. '16

POLYMET MINING

FIGURE 1-5
SURFACE OWNERSHIP - AFTER POLYMET-CLIFFS CLOSING AND USFS LAND EXCHANGE
PERMIT TO MINE APPLICATION
HOYT LAKES, MINNESOTA

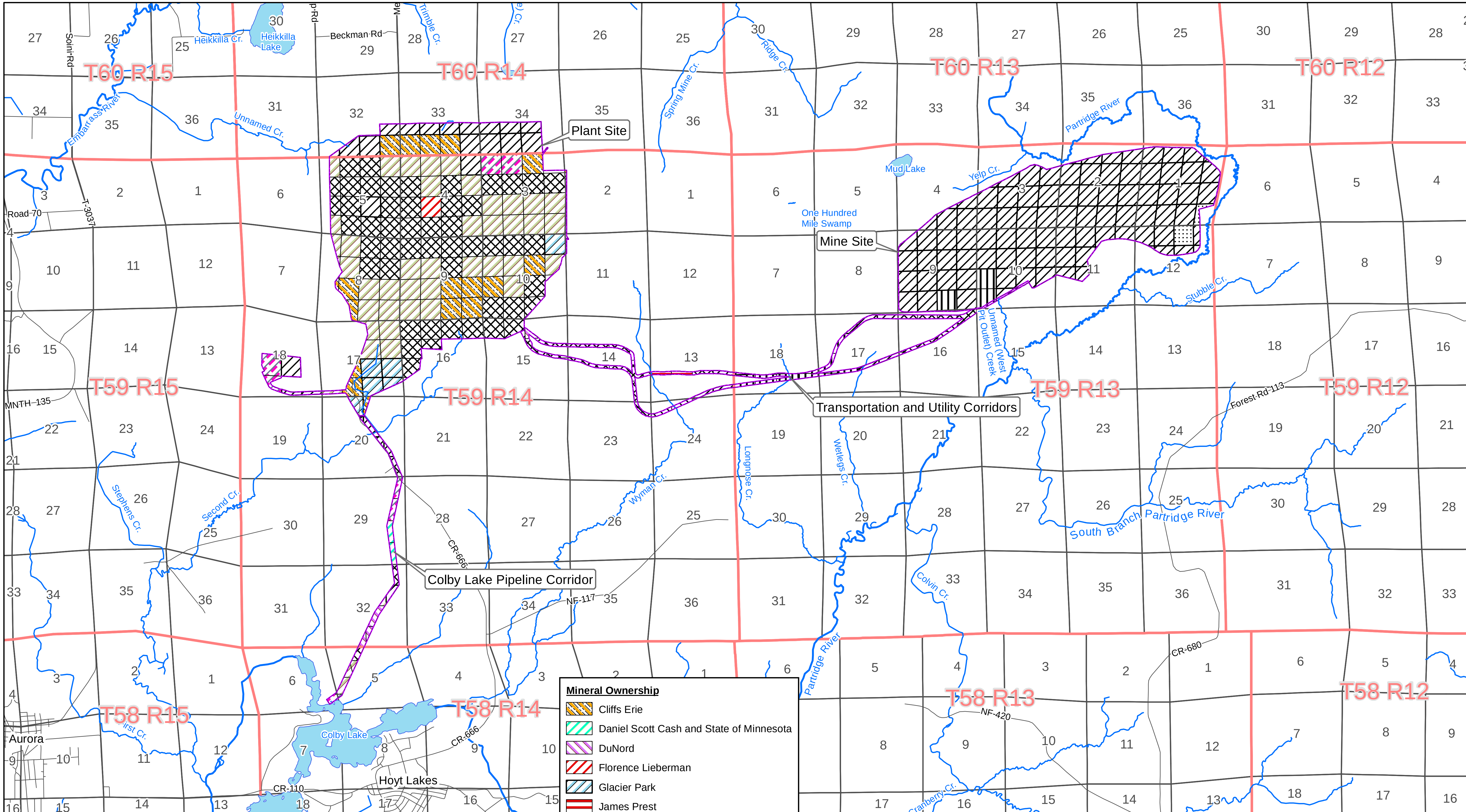
Scale: 0 3,000 6,000 Feet

Date: AUGUST 2016

Drafted by: DAT

Project No: 12P778

Path: X:\GB\IE\2012\12P778\GIS\mxd\PMA\Figure 1-5 Surface Ownership Post Land Exchange.mxd Date: 9/2/2016



Notes

1. This drawing is neither a legally recorded map nor a survey and is not intended to be used as one. This drawing is a compilation of records, information and data used for reference purposes only.
2. Mineral ownership dataset supplied by PolyMet.
3. Certain parcels may have fractionalized ownership, and in such circumstances, this map shows the majority owner.
4. Consistent with Minnesota Rules, Part 6132.1100, this map depicts ownership as a matter of record as well as PolyMet's equitable ownership of lands subject to Contracts for Deed, but does not reflect private party agreements that grant PolyMet rights and control over the lands (e.g. easements, licenses, etc.)

Legend

- Rivers and Streams
- Lakes
- Townships
- Sections
- Facility Boundary

POLYMET MINING

Foth

Foth Infrastructure & Environment, LLC			
REVISED	DATE	BY	DESCRIPTION

PREPARED BY:	DAT	DATE:	AUG. '16
REVIEWED BY:	JSL	DATE:	AUG. '16
APPROVED BY:	CED1	DATE:	AUG. '16

POLYMET MINING

FIGURE 1-6

MINERAL RIGHTS OWNERSHIP
PERMIT TO MINE APPLICATION
HOYT LAKES, MINNESOTA

Scale: 0 3,000 6,000 Feet		Date:	AUGUST 2016
Drafted by:	DAT	Project No:	12P778

Path: X:\GB\IE\2012\12P778\GIS\mxd\PMA\Figure 1-6 Mineral Ownership.mxd Date: 9/2/2016

2 PolyMet Organizational Information and Documents

Consistent with the applicable regulatory requirements, this section provides information about PolyMet's organizational structure, including its post office address; its parent company, owners, principal stockholders, partners, and joint venturers; any managing agents or subsidiaries involved in operations; and any organizational relationships among joint applicants as set forth in Minnesota Rules, part 6132.1100, subpart 4.

2.1 Applicant Name, Address, and Required Certificates

The applicant for this Application is Poly Met Mining, Inc., which is referred to in this Application as PolyMet. The post office address of PolyMet is:

Poly Met Mining, Inc.
444 Cedar Street, Suite 2060
St. Paul, MN 55101

PolyMet is incorporated in Minnesota, and as a domestic corporation is not required to file a certificate of authority to transact business. PolyMet's certificate of good standing and its certificate of public liability insurance is provided in Appendix 1.

2.2 Organizational Structure

PolyMet is a private company that is the wholly-owned subsidiary of PolyMet Mining Corporation, which is a publicly traded company listed on the New York Stock Exchange (symbol: PLM) and the Toronto Stock Exchange (symbol: POM). Organizational information is summarized below:

Parent Company:
PolyMet Mining Corporation
First Canadian Place
100 King Street West, Suite 5700
Toronto, ON M5X 1C7
416.915.4149

Subsidiary Company:
Poly Met Mining, Inc.
Executive Office
444 Cedar Street, Suite 2060
St. Paul, MN 55101
651.389.4100

Operational Headquarters
P.O. Box 475, 6500 County Road 666
Hoyt Lakes, MN 55750
218.471.2150

None of the following relationships or entities are associated with PolyMet as the applicant for this Application:

- Partners
- Joint venture relationships
- Owners
- Principal stockholders
- Managing agents or subsidiaries involved in mining operations
- Joint applicants

PolyMet's 2016 annual report is included in Appendix 1. The annual report can also be found at:

http://www.polymetmining.com/wp-content/uploads/2013/02/SEDAR-2016-01-31-Annual-Report-on-Form-20F.pdf

PolyMet will file ongoing annual report filings with System for Electronic Document Analysis and Retrieval (SEDAR).

2.3 Qualifications to Hold Permit to Mine

PolyMet is qualified under Minnesota Statutes, chapter 93, and Minnesota Rules, chapter 6132 to apply for and obtain a nonferrous Permit to Mine. A person intending to "engage in or carry out a mining operation for metallic minerals within the state" must apply for and then obtain a Permit to Mine from the MDNR before commencing operations (Minnesota Statutes, section 93.481, subdivision 1; Minnesota Rules, part 6132.0300, subpart 1). Under Minnesota rules, the person intending to "conduct a mining operation for nonferrous metallic minerals . . . must possess capital and provide financial and operational decision making necessary to conduct the mining operation." (Minnesota Rules, part 6132.0300).

First, PolyMet is a "person" (defined to include corporations and other legal entities) intending to conduct mining operations, and has the required decision-making authority for financial and operations matters. Second, because the value of the insitu resource of the deposit to be mined are estimated at 10 billion dollars, PolyMet expects to have the necessary capital for the NorthMet project. The financial assurance provided by PolyMet before issuance of the Permit to Mine will provide a source of funds for MDNR to use in the unlikely event that mining operations cease in the first year of the permit term.

3 Overview of the Project's Mining and Reclamation Plan

The Project encompassed within the Mining Area consists of the Mine Site, Plant Site, Transportation and Utility Corridors, and the Colby Lake Pipeline Corridor as shown on Figure 3-1 through Figure 3-3. PolyMet has, consistent with Minnesota Rules, part 6132.1000 and 6132.1100, subparts 6 and 7, prepared a Mining and Reclamation Plan for the Project. This section provides an overview of the Mining and Reclamation Plan, which is discussed in more detail in Sections 7-11 and 15, along with related tables, figures, and appendices. The Mining and Reclamation Plan sections are organized as follows:

- Section 3 presents a high-level overview of the Project, including the general configuration, construction activities, major materials to be managed, and schedule.
- Section 7 describes the Mine Site facilities and operations.
- Section 8 describes the Plant Site facilities and operations.
- Section 9 describes the Transportation and Utility Corridors and Colby Lake Pipeline Corridor, along with auxiliary facilities.
- Section 10 describes PolyMet's waste characterization program, mine waste materials, and the management of these materials.
- Section 11 describes water management facilities and operations.
- Section 15 provides an overview of reclamation, closure, and postclosure maintenance, with references to relevant portions of other sections and specific appendices.

For the analyses and activities set forth in Section 3 through 16, including the Mining and Reclamation Plan, references to PolyMet include its consultants, contractors, and other technical persons working on its behalf.

The Mining and Reclamation Plan presents PolyMet's current expectations regarding the proposed Project construction and operations, including the information required under Minnesota Rules 6132.1100, subpart 6. Consistent with the nonferrous PTM regulations and MDNR practice, the Mining and Reclamation Plan contemplates that the specific details of the proposed mining operations may vary in a particular year based on operational considerations and market conditions. As part of its Annual Report under the Permit to Mine, PolyMet will submit, among other things, information regarding the anticipated rate of mining, specific mining operations, reclamation for the upcoming year, and discussion of any changes to the mining and reclamation plan set forth in this application. Minnesota Rules, part 6132.1300.

The Mining and Reclamation Plan incorporates the outcome-based approach contemplated by the PTM Regulations, as well as PolyMet's business standard for continuous improvement. The PTM Regulations require that mining operations minimize adverse impacts on the environment. Accordingly, each section of the Mining and Reclamation Plan identifies the applicable permitting goals for components of the Project and then describes how the Project will meet the applicable regulatory requirements so as to achieve these permitting goals. Adaptive management is one of the main tools PolyMet will use to achieve and maintain compliance using the outcome-based approach. Adaptive management is a structured approach to decision-making that emphasizes accountability and site-specific information. This approach establishes a systematic approach to improve performance, achieve compliance, and avoid unmitigable negative effects.

3.1 Project Configuration Overview

Mine Site

The Mine Site is shown on Figure 3-1 and when fully operational will consist of the following features:

- Three mine pits will be referred to as the East Pit, Central Pit, and West Pit.
- The Category 1 Waste Rock Stockpile will contain the waste rock with the lowest sulfur content. It will be a permanent, engineered stockpile that includes a Groundwater Containment System (GCS). As part of progressive reclamation, PolyMet will install an engineered cover to minimize precipitation percolating through the stockpile.
- The Category 2/3 Waste Rock Stockpile will contain waste rock with a sulfur content that is higher than Category 1 waste rock and lower than Category 4 waste rock. This stockpile will be a temporary, engineered structure with a liner and drainage collection system at the base to collect precipitation that percolates through the stored waste rock. PolyMet will backfill the Category 2/3 waste rock into the East Pit.
- The Category 4 Waste Rock Stockpile will contain waste rock with a sulfur content that is greater than Category 2/3 waste rock. This stockpile will be a temporary, engineered structure with a liner and drainage collection system at the base of the stockpile to collect precipitation that percolates through the stored waste rock. PolyMet will backfill the Category 4 waste rock in the East Pit, enabling development of the Central Pit.
- The Ore Surge Pile (OSP) will provide temporary storage of ore at the Mine Site. The OSP will be an engineered stockpile with a liner and drainage collection system.
- The Overburden Storage and Laydown Area (OSLA) will be used to screen, sort and temporarily stockpile unsaturated mineral overburden and peat.
- The Rail Transfer Hopper (RTH) will be a raised structure used to transfer ore from trucks to rail cars.
- A new, approximately 6,000-foot railroad spur and loadout area will connect the RTH and OSP to an existing private rail line for transport of ore from the Mine Site to the Plant Site (the Mine Spur).
- Lined waste water storage ponds and associated piping and pumps will allow for storage of mine water prior to treatment.

- The waste water treatment facility (WWTF) will treat mine water before it is pumped to the Flotation Tailings Basin (FTB).
- The Central Pumping Station (CPS) will pump water from the Mine Site to the Plant Site.
- The Mine Site Fueling and Maintenance Facility (MSFMF) will service mobile mine equipment.
- Haul Roads will support transport of ore and waste rock.
- Stormwater ponds and associated ditches will be located and sized to manage stormwater. These ponds will collect a mixture of stormwater that, depending on the Mine Year and the pond location, may include construction stormwater, industrial stormwater, and non-contact stormwater from the Mine Site.
- Existing and proposed electric power transmission lines will provide electricity to the Mine Site.
- Perimeter dikes will separate the Mine Site from adjacent lands.

Plant Site

The Plant Site is shown on Figure 3-2 and when fully operational will consist of the following features:

- The Beneficiation Plant will combine new and existing LTVSMC buildings and equipment. Ore processing will be accomplished by crushing, grinding, flotation, and concentrate dewatering, followed by product loadout.
- The FTB will be constructed on top of the existing LTVSMC tailings basin. The FTB will manage Flotation Tailings produced by the Project. The Tailings Basin, in this Application, refers to the combined LTVSMC tailings basin and the FTB.
- FTB seepage capture systems will manage seepage from the Tailings Basin.
- A Hydrometallurgical Plant and a Hydrometallurgical Residue Facility (HRF) are expected to be built several years after mining and ore processing commence. The Hydrometallurgical Plant will further process concentrate to produce a value-added product. The HRF will store Residue from the hydrometallurgical process.
- The waste water treatment plant (WWTP) will facilitate compliance with water quality standards through proven control technologies such as reverse osmosis (RO) or similar membrane separation technology and associated systems.
- Vibratory Shear Enhanced Processing (VSEP) platform where concentrated brine will be routed via rail from the WWTP to the WWTF.
- The Sewage Treatment System will consist of stabilization ponds and associated piping.
- The Potable Water Facility will provide potable water for the Plant Site.
- Existing maintenance and repair facilities including the General Shops, the Rebuild Shop, Area 1 Shop facilities, and Area 2 Shop facilities will service Project vehicles and equipment.

- Additional auxiliary facilities and supporting infrastructure will include roads, electrical transmission lines and equipment, and rail connections within the boundaries of the Plant Site.

Note that Flotation Tailings and residues generated by the hydrometallurgical process (Residue) are separate materials. As defined in this Application, tailings do not include the Residue generated by the Hydrometallurgical Plant and stored in the HRF.

Transportation and Utility Corridors

The Railroad Corridor is shown on Figure 3-3 and encompasses the rail line between the Mine Site and Plant Site. The Dunka Road and Utility Corridor runs between the two sites. Features of the corridors include:

- a private portion of Dunka Road; all of the Dunka Road is private
- new electrical transmission lines
- the Treated Water Pipeline (TWP)
- the existing Cliff's Erie private rail line between the Mine Site and Plant Site (Main Rail Line)
- a new, approximately 5,575 foot spur track running between the existing track on the north side of Area 2 Pit to the Main Rail Line (Plant Spur)

Construction of roads and improvements/upgrades of rail lines will include verifying that rail lines will be suitable for ore transport and installing the necessary culverts and other infrastructure. In addition to constructing new roads, PolyMet will upgrade the existing Dunka Road to accommodate vehicles associated with mine activity.

Colby Lake Pipeline Corridor

The Colby Lake Pipeline Corridor is shown on Figure 3-3 and consists of:

- an existing pipeline that delivers water from Colby Lake to the Plant Site
- an existing pump house located at Colby Lake
- existing electrical transmission lines

3.2 Project Timeline

The Project timeline, for this Application, is broken into five separate phases: construction, operations, reclamation, closure, and postclosure maintenance. A description of the overall Project timeline is presented on Figure 3-4. The Project timeline is the basis for most of the scheduling information in this Application unless otherwise noted.

Although construction is anticipated to take 18 to 24 months, for simplicity, construction is accounted for in this Application as beginning in Construction Year 1 extending through Construction Year 2. Section 3.3 describes construction activities.

The operations phase will commence on the first day of production blasting within the open pit (Mine Year 1) and extend through the end of Mine Year 20. The operations phase is also referred to as the Life of Mine (LOM). Section 3.4 presents an overview of the operations phase activities.

The reclamation phase will encompass activities such as demolition of structures, regrading and revegetating footprints of the demolished structures and other mine features, and fencing perimeter areas. Project reclamation is planned to begin in Mine Year 21 and extend for four years through Mine Year 24.

Closure, as defined in Minnesota Rules, part 6132.0200, subpart 6, item C is "the process of terminating and completing final steps in reclaiming any specific portion of a mining operation." The permit to mine prescribes that closure begins when there will be no renewed use or activity by the permittee." PolyMet anticipates commencing closure activities when final reclamation activities are complete, which is presently projected at the end Mine Year 24. The Project will transition from the closure period to the postclosure maintenance period when the West Pit is full of water and PolyMet begins discharging water from the mine pits in approximately Mine Year 54.

At the end of the closure period, PolyMet will commence postclosure maintenance activities. As defined in Minnesota Rules, part 6132.0200, subpart 26, postclosure maintenance includes any "activity that may be required to sustain reclamation after cessation of a mining operation." PolyMet anticipates beginning postclosure maintenance activities in Mine Year 55, and will continue those activities until no longer necessary under the applicable statutes and regulations.

The duration of the postclosure maintenance phase will depend upon compliance with applicable water quality standards as enforced through the NorthMet Project National Pollutant Discharge Elimination System/State Disposal System (NPDES/SDS) Permit. Further discussion of the reclamation, closure, and postclosure maintenance activities is presented in Section 3.5.

This Application delineates and describes Project phases slightly differently than the FEIS and other PolyMet permit applications, as shown in Table 3-1.

The balance of this section presents an overview of the Project phases, as defined for this Application.

3.3 Construction Phase

This section of the Application describes the construction activities that PolyMet currently anticipates conducting during the first 18 to 24 months of the permit term. In other words, the Construction Phase will begin after a permit to mine is issued. Between now and then, the permitting process and final design may result in refinements to the construction activities, descriptions, and schedules.

Construction activities will be conducted in a manner consistent with applicable permit conditions. Water management during construction will be consistent with the requirements of the state of Minnesota's NPDES/SDS Construction Stormwater General Permit (Permit No. MNR100001 (Construction Stormwater General Permit).

The Permit Application Support Drawings in Appendix 3 through Appendix 10 depict the construction details of various major facilities associated with the Project. Major structures include Mine Site structures, Plant Site structures, including beneficiation and ore processing facilities, the FTB, the HRF, and associated water management facilities. These Permit Application Support Drawings, together with Appendix 2, provide information about the materials used for construction based on PolyMet's Mine Waste Characterization. In addition, this Application describes auxiliary facilities associated with major structures to the extent necessary to facilitate proper construction management.

3.3.1 Mine Site Construction Activities

Activities at the Mine Site during the construction phase will include:

- tree cutting
- construction of haul roads and Mine Spur
- initial overburden stripping of portions of the pit area footprints
- initial construction of the temporary stockpile liners
- construction of the initial Category 1 Waste Rock Stockpile foundation and GCS
- initial construction of the WWTF
- construction of the CPS
- construction of mine water ponds
- construction and installation of electrical and mechanical systems
- construction of the OSLA
- construction of the stormwater management systems

3.3.2 Plant Site Construction Activities

Activities at the Plant Site during the construction phase will include:

- construction of the WWTP

- installation and refurbishment of the Flotation Tailings discharge system and the return water system
- construction and installation of the power distribution system
- construction of the first lift of the FTB dams
- installation of cement deep soil mixing
- installation of the FTB Seepage Containment System
- construction, modification, and refurbishment of the Beneficiation Plant and other Plant Site buildings
- modification and refurbishment of the Plant Site shops
- construction and refurbishment of the Sewage Treatment System
- upgrades to the Colby Lake Pipeline and the Plant Site Reservoir
- construction, refurbishment and upgrades of the stormwater management systems

3.3.3 Transportation and Utility Corridors Construction Activities

Activities in the Transportation and Utility Corridors during the construction phase will include:

- upgrades to Dunka Road
- installation and upgrades of electrical power distribution lines
- construction of the TWP
- refurbishing the existing private Main Rail Line
- constructing the Plant Spur

3.3.4 Colby Lake Pipeline Corridor Construction Activities

The existing Colby Lake Pipeline will deliver water from Colby Lake, located approximately four miles south of the Plant Site. The pipeline facilities are already in place as depicted on Figure 3-3. PolyMet will inspect the pumphouse and pipeline and refurbish, as necessary, before use. Construction activities along the Colby Lake Pipeline Corridor will thus include an evaluation and recommissioning of the existing Colby Lake Pipeline and pumphouse.

3.3.5 Excavation, Earthwork Movement, and Earthwork Balance

Development of the Project will involve excavating, moving, and stockpiling unconsolidated earth materials. General earthwork material movement for the Project is presented on Figure 3-5. PolyMet has prepared an earthwork material balance for the Project, which is based on current data and will be continually updated and refined as more data are developed during operations. Additional details on the earthwork material balance are included in Appendix 3.

3.3.6 Construction Materials

Construction activities will maximize, to the extent practical and permissible, the use of on-site excavated material. Potential on-site construction materials include saturated mineral overburden, unsaturated mineral overburden, and peat.

3.3.6.1 Saturated Mineral Overburden

Saturated mineral overburden encompasses all mineral overburden located below the water table, including the zone of soil formation. Classification of this material will be based on the location of the water table as the primary criterion. Due to geochemical characteristics of saturated mineral overburden, PolyMet proposes to use this material:

- in a permanently saturated zone
- above temporary membrane liners before ultimate disposal in a permanently saturated zone
- in an area where the water that contacts the saturated mineral overburden will be collected and sent to treatment
- immediately below a temporary membrane liner before being ultimately disposed in a permanently saturated zone (soil liner application only)

Saturated mineral overburden not used for construction will be stored in lined stockpiles, or later in the East Pit. Section 10 provides further details on management of these materials.

PolyMet has currently identified the following potential construction applications for saturated mineral overburden:

- stockpile foundation material below the water table (Categories 2/3 and 4 Waste Rock Stockpiles, OSP)
- Category 1 Waste Rock Stockpile GCS
- Temporary stockpile drainage layer (Categories 2/3 and 4 Waste Rock Stockpiles)
- Top dressing for ramps and roads in pits
- Mine water pond liner cover material
- Soil liner below temporary geomembrane liners

3.3.6.2 Unsaturated Mineral Overburden

The mine waste characterization shows that unsaturated mineral overburden has been oxidized and is no longer reactive. PolyMet will use unsaturated mineral overburden as an unrestricted, general construction material at the Mine Site and Plant Site and possibly within the corridors as needed. Temporary storage will take place in the OSLA. To meet construction specifications, PolyMet may screen and/or compact unsaturated mineral overburden. While PolyMet will not crush non-granite cobbles and boulders, it will crush granite boulders and use them for haul road cover and railroad ballast. PolyMet will conduct additional geotechnical and geochemical confirmation sampling of unsaturated mineral overburden as needed to verify the material is suitable for the intended construction.

3.3.6.3 Peat

Peat includes organic matter that is formed by the partial decomposition of plant material under saturated conditions. PolyMet will excavate peat from construction sites and stockpile it in the OSLA for later use as a soil amendment when the Category 1 Waste Rock Stockpile and other Mine Site areas are reclaimed. PolyMet will also use the peat for wetland mitigation within the Project site boundaries. Peat will be mixed with unsaturated mineral overburden to meet construction specifications for certain materials that are used in construction or reclamation.

3.3.6.4 Additional Construction Material Sources

PolyMet may need additional construction materials beyond what is available on-site. Prior to use, PolyMet will analyze potential borrow sources for geotechnical and geochemical suitability and discuss the results with MDNR.

3.4 Operations Phase

The Project Timeline shown on Figure 3-4 provides an overview of activities that will occur during operations.

3.4.1 Mine Site Operations

Figure 3-6 displays the layout of the mine site operations during the following intervals: Mine Year 1, Mine Year 11, and Mine Year 20.

During the operations phase, or LOM, the major Mine Site operations will include:

- stripping the open pits
- blasting waste rock and ore
- stockpiling ore and waste rock
- operating the WWTF and the CPS
- progressive reclamation of stockpiles, and relocation of waste rock to the East Pit
- stormwater and mine water management
- monitoring surface water and groundwater quality in the vicinity of the Mine Site

Section 7 provides additional information regarding the anticipated mining rate, sequence, and schedule.

3.4.2 Plant Site Operations

Plant Site operations will begin in Mine Year 1, with the exception of the Hydrometallurgical Plant and HRF, which are anticipated to begin operation several years after Mine Year 1. The precise timing for construction of the hydrometallurgical facilities will depend on Project economics and other factors.

During the LOM, the major Plant Site operations will include:

- Operating the WWTP, Sewage Treatment System, and Potable Water Treatment Plant
- Flotation Tailings deposition and dam raises at the FTB
- Processing ore at the Beneficiation Plant
- HRF and Hydrometallurgical Plant construction and operations
- Loading concentrate for shipment
- Progressive reclamation of areas of the Plant Site as soon as practical
- Stormwater management
- Monitoring surface water and groundwater quality in the vicinity of the Plant Site

Further discussion of Plant Site operations is presented in Section 8.

3.4.3 Transportation and Utility Corridors and Colby Lake Corridor Operations

During operations, ore will be transported by rail from the Mine Site to the Plant Site. Regular inspection and maintenance and periodic upgrades will be performed on the Dunka Road, existing ditches, railways, TWP, and Colby Lake Pipeline. Surface water quality will be monitored in the vicinity of the Transportation and Utility Corridors.

3.5 Reclamation, Closure, and Postclosure Maintenance Phases

The reclamation, closure, and postclosure maintenance schedule of activities is shown on Figure 3-4. The reclamation phase will be completed in accordance with requirements specified at Minnesota Rules, part 6132.3200. Timeframes for reclamation, closure, and postclosure maintenance are described in Section 3.2.

3.5.1 Mine Site Reclamation, Closure, and Postclosure Maintenance Activities

Section 15 describes Mine Site reclamation, closure, and postclosure maintenance, which will include the following major activities:

- demolishing structures
- fencing the perimeters of the Mining Area and implementing necessary site management and security measures
- sloping and seeding the overburden portion of the pit walls
- constructing the East Pit outlet structure
- completing the shaping and covering of the Category 1 Waste Rock Stockpile
- reclaiming and vegetating the temporary stockpile footprints
- removing culverts, dikes, ditches, and ponds, followed by grading and seeding
- continuing to operate the WWTF
- completing the flooding of the backfilled East Pit and cycling East Pit water through the WWTF to flush constituents from the pit water

- constructing wetlands over the backfilled combined East/Central Pit
- flooding the West Pit, supplemented with water from the Plant Site to accelerate pit flooding
- transitioning to postclosure treatment at the WWTF and discharge to the Partridge River via the unnamed creek (West Pit outlet)
- conducting water quality and wetland monitoring in the vicinity of the Mine Site through the reclamation and closure phases, and into the postclosure maintenance phase as required under terms of applicable permits (Section 14)

Figure 3-7 depicts the water management and treatment plan for the Mine Site during reclamation and closure. Figure 3-8 shows postclosure water management at the Mine Site using mechanical water treatment, and Figure 3-9 shows postclosure water management at the Mine Site after the transition to non-mechanical water treatment.

3.5.2 Plant Site Reclamation, Closure, and Postclosure Maintenance Activities

Section 15 describes Plant Site reclamation, closure, and postclosure maintenance, which will include the following major activities:

- demolishing structures, including the Beneficiation Plant, Hydrometallurgical Plant, and associated facilities
- fencing the perimeters of the Mining Area and implementing necessary site management and security measures
- removing culverts, dikes, ditches, and ponds, followed by grading and seeding
- dewatering and covering the HRF
- reseeding areas at the Mining Area
- reclaiming the Tailings Basin, including amending the final beaches and pond bottom with bentonite
- continuing to operate the seepage capture systems
- continuing to operate the HRF drainage collection system
- continuing to operate the WWTP
- conducting water quality, wetland, and dam safety monitoring in the vicinity of the Plant Site through the reclamation and closure phases, and into the postclosure maintenance phase as required under terms of applicable permits (Section 14)

Figure 3-10 depicts the water management and treatment plan for the Plant Site during reclamation and the earlier years of closure. Figure 3-11 depicts the plan for the later years of closure. Figure 3-12 shows postclosure water management at the Plant Site using mechanical water treatment, and Figure 3-13 shows postclosure water management at the Plant Site after the transition to non-mechanical water treatment.

3.5.3 Transportation and Utility Corridors Reclamation, Closure, and Postclosure Activities

Transportation and Utility Corridors infrastructure that is not being utilized for reclamation activities will be reclaimed and vegetated during the reclamation phase. Reclamation will include:

- removal of road segments that are not required for closure and postclosure
- removal of rail line components
- removal of power lines and other utilities not required for closure and postclosure
- site grading and revegetation

Maintenance of the portions of Transportation and Utility Corridors that remain in use will continue through the closure and postclosure periods.

3.5.4 Colby Lake Pipeline Corridor Reclamation, Closure, and Postclosure Activities

Colby Lake Pipeline will be decommissioned and reclaimed once no longer necessary. The disturbed area will be reclaimed to meet the approved reclamation standards. This area will be monitored during closure and postclosure to assess and maintain the reclamation standards.

3.6 Adaptive Management and Contingency Mitigation

Adaptive management is a system of management practices, based on clearly defined outcomes and monitoring requirements, that assesses whether actions are meeting the desired outcomes, and, if not, follows pre-established processes to improve performance, achieve compliance, and meet the defined outcomes.

Adaptive management processes and provisions will be carried out in accordance with the agencies' approval, will continue to achieve compliance, and will include testing to demonstrate the performance of any modification before it would be implemented. Listed below is a summary of the adaptive management processes that have been developed to date for the Project for water quality and for FTB stability. Adaptive management measures will continue to be developed and evaluated throughout every phase of the Project.

Contingency mitigation measures are technically feasible options that could be undertaken should engineering controls (fixed or adaptive) be unable to achieve compliance with applicable standards. If monitoring or refined modeling were to indicate that contingency mitigation would be needed, these measures would be employed as appropriate and approved by the agencies.

Monitoring will be a critical component of the Project to monitor potential impacts, to inform facility operation and maintenance actions, and to select and implement possible adaptive management or contingency mitigation measures. Monitoring is outlined in Section 14.

3.6.1 Water Quality: Adaptive Management and Contingency Mitigation

Project water management systems will encounter natural variability in water quantity and quality. Adaptive management anticipates uncertainty and natural variability by using flexible engineering controls that can be adjusted to continue achieving compliance with applicable water quality standards and permit conditions when site-specific conditions vary.

Adaptive management establishes a systematic process to improve performance in case water quality objectives are not met by Project water management systems:

1. undertake studies to determine the root cause of the problem
2. modify the design or operation of existing (or planned) Project engineering controls to remedy the root cause
3. if modifying the design or operation of Project engineering controls is not sufficient, then take contingency mitigation actions
4. monitor outcomes, and as appropriate, evaluate outcomes with water modeling
5. if the issue persists, begin Step 1 again

Contingency mitigations are available if water quality monitoring or the refined model estimates show that, with adaptive management, water quality objectives may not be met. Potential contingency mitigation actions for water management systems are described in the Water Management Plan – Mine, and the Water Management Plan – Plant, which are included in Appendix 16.

3.6.2 Dam Stability: Adaptive Management and Contingency Mitigation

Adaptive management practices for the FTB are founded on the Observational Method, which provides for FTB design or operation to be modified, if needed, based on operational experience. Tailings characteristics and dam performance monitoring data will routinely be collected and reviewed, and stability models will be updated as new information becomes available. If updated stability models project that the planned or constructed FTB dams may not meet required factors of safety, adaptive management steps will include some or all of the following:

1. Initiate any field or laboratory studies that may be necessary to update material strength parameters.
2. Update stability modeling using as-built dimensions and on-site observations. If factors of safety in updated model do not meet requirements proceed to Step 3
3. Conduct stability modeling to estimate the effects of potential operational changes such as adjusting tailings deposition procedures to modify beach width or modifying the pond elevation to modify phreatic surface conditions within the dam.
4. If operational changes (such as change to slurry density, change to dam lift timing, modified pond operations) can achieve the required factors of safety, implement that change.

5. If stability modeling indicates that operational changes cannot achieve the required factors of safety, implement contingency mitigation that will restore required factors of safety, and update the contingency mitigation plan
6. Monitor and model to estimate dam stability effects with new or adjusted engineering control.
7. If issue persists, begin Step 1 again.

Contingency mitigations are available if monitoring or the refined model estimates show that, with operational changes, the FTB dams may not meet required factors of safety. In general, stability can be modified by:

- modifying buttressing to modify resisting force at the toe of the FTB
- including free-draining underdrain layers or drains to reduce the phreatic surface in the FTB dams
- adjusting the overall slope angle of future lifts to modify driving force at the toe
- adjusting bench widths of future dam lifts
- adjusting future dam lift offsets, and/or
- adjusting future dam lift heights and/or rate of construction

The mitigation measures listed above can be implemented individually or in combinations as needed to achieve the required mitigation outcomes.

Adaptive management and contingency mitigation do not apply to unexpected and potentially hazardous conditions threatening the integrity and performance of the FTB. These conditions are addressed in the FTB Contingency Action Plan, which is Attachment F to the Flotation Tailings Basin Management Plan (Appendix 16). The purpose of the FTB Contingency Action Plan is to define responsibilities and provide procedures for identifying and responding to unexpected and potentially hazardous conditions threatening the integrity and performance of the FTB. It is anticipated that PolyMet will have an overall project-wide Emergency Action Plan and the FTB Contingency Action Plan will be incorporated into the overall plan.

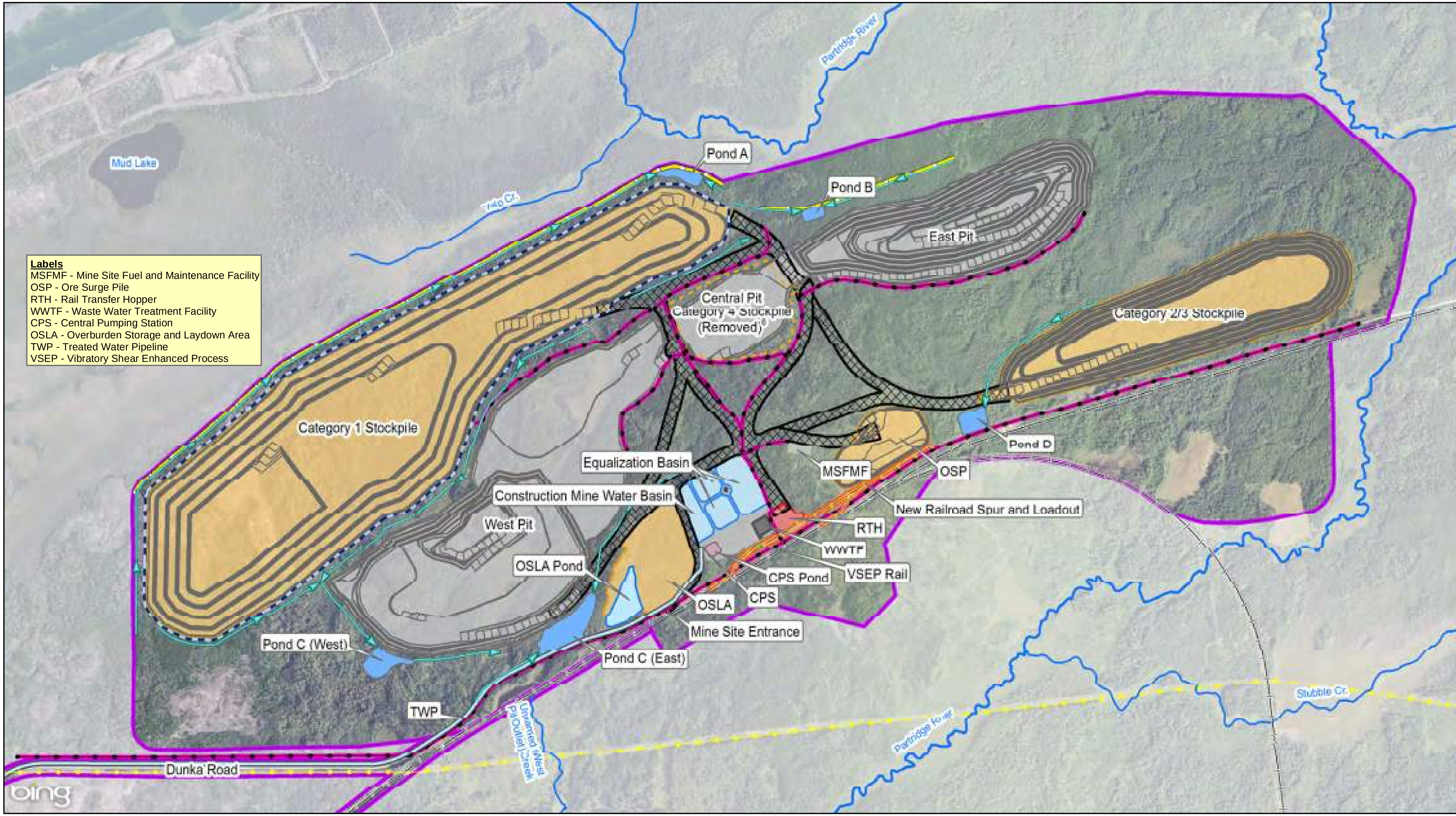
Table 3-1 Terminology for Project Phases in Various Project Documents

Mine Year	Construction Year (PTM only)	Project Phase in Permit to Mine	Project Phase in FEIS and supporting documents, and in environmental permit applications(1)
-2 to -1	1-2	Construction	Pre-Operation Construction
1 to 20		Operations	Operation
21 to ~24		Reclamation(2)	Reclamation
24 to ~54(3)		Closure	
55+		Post-Closure Maintenance	Long-Term Closure

(1) Water appropriations permit application, NPDES/SDS permit application, Air permit application, Dam safety permit application

(2) Phase ends when structures are demolished, footprints are revegetated, and perimeters are fenced, as described in Section 3.2

(3) Phase ends when the West Pit is fully flooded and water is discharged to the environment at the Mine Site, as described in Section 3.2



Notes

1. Basemap from Esri and its data suppliers.
2. Project features supplied by Barr Engineering Company.
3. Entire map extent is outside the Rainy River Watershed.
4. Minnesota Power Power Lines supplied by the Minnesota Geospatial Information Office (MnGeo).
5. For clarity not all of the sumps, ditches, piping, and overflows are shown.
6. The Category 4 stockpile is removed, enabling the development of the Central Pit.
7. Mine Water Ponds are lined with the exception of the OSLA Pond and Construction Mine Water Basin.

Legend

- Proposed Railroad Track
- Existing Private Railroad
- Groundwater Containment System
- Existing Electric Power Line[4]
- Proposed Transmission Line
- Rivers and Streams
- Stormwater Ponds
- Treated Mine Water Pond (Lined)
- Mine Water Ponds[7]
- WWTF Buildings
- Haul Roads
- Active Stockpile
- Removed Stockpile
- Mine Pits
- Facility Boundary

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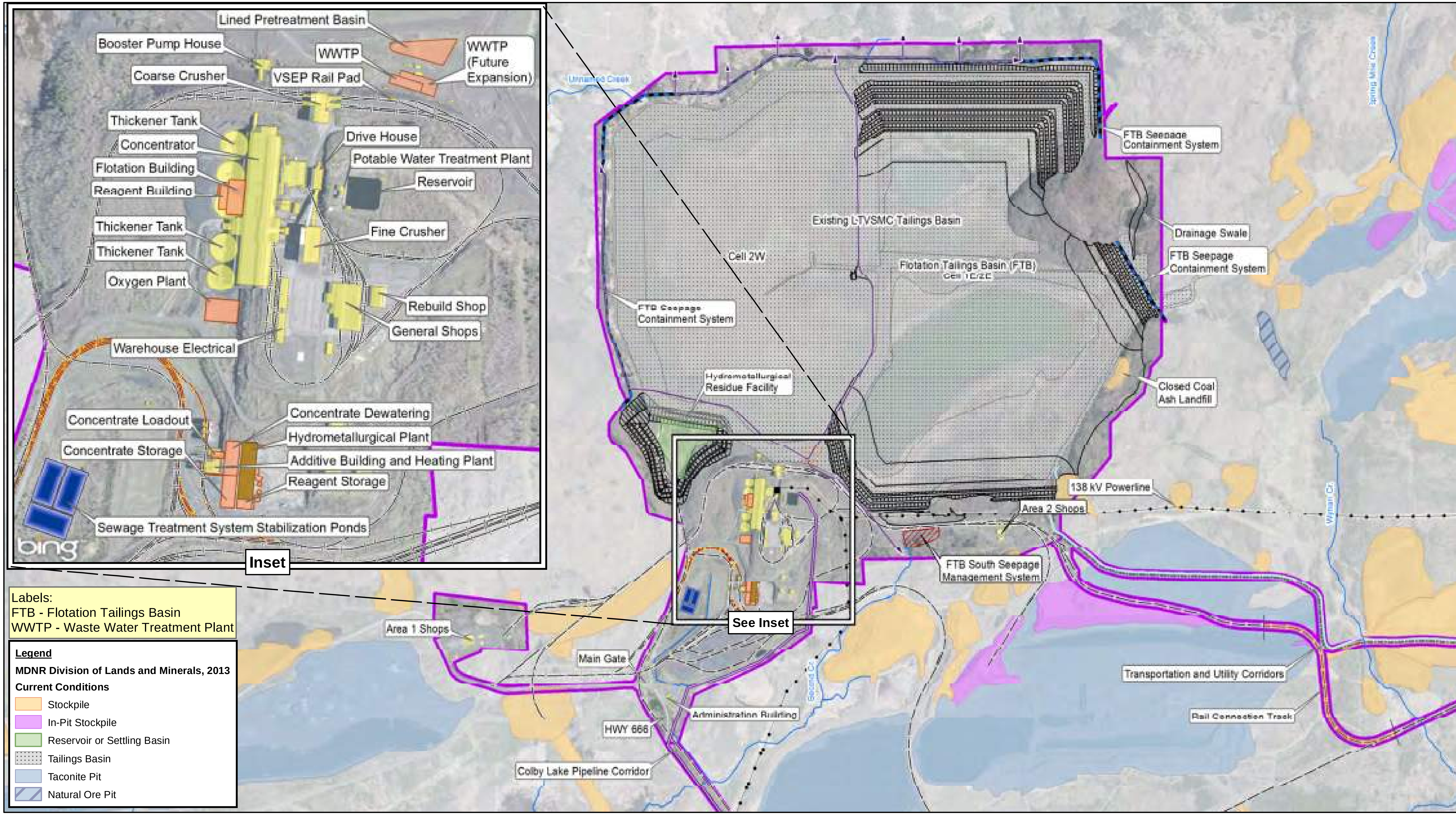
APPROVED BY: JOS1			DATE: AUG. '16

POLYMET MINING

FIGURE 3-1
MINE SITE - MINE YEAR 11
PERMIT TO MINE APPLICATION
HOYT LAKES, MINNESOTA

Scale: 0 750 1,500 Feet
Date: AUGUST 2016
Drafted by: DAT
Project No: 12P778

Path: X:\GB\IE\2012\12P778\GIS\mxd\PMA\Figure 3-1 Mine Site.mxd Date: 9/1/2016



Notes

1. Basemap from Esri and its data suppliers.
2. Project features, pipelines and details supplied by Barr Engineering Company.
3. NHD features are created from MDNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance, data sources may show watercourses that no longer exist.
4. Minnesota Power Substations and Power Lines supplied by the Minnesota Geospatial Information Office (MnGeo).

Legend

- Electric Substation[4]
- Existing Electric Power Line[4]
- Dunka Road
- Proposed Railroad Track
- Existing Private Railroad
- Rivers, Streams and Ditches[3]
- Colby Lake Pipeline
- FTB Seepage Containment System
- Treated Water Pipeline
- Treated Water Discharge Pipe
- Proposed Plant Site Buildings and Related Facilities
- Proposed Hydromet Plant
- Existing Buildings
- Sewage Treatment System Stabilization Ponds
- Facility Boundary

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APPROVED BY: JOS1			DATE: AUG. '16

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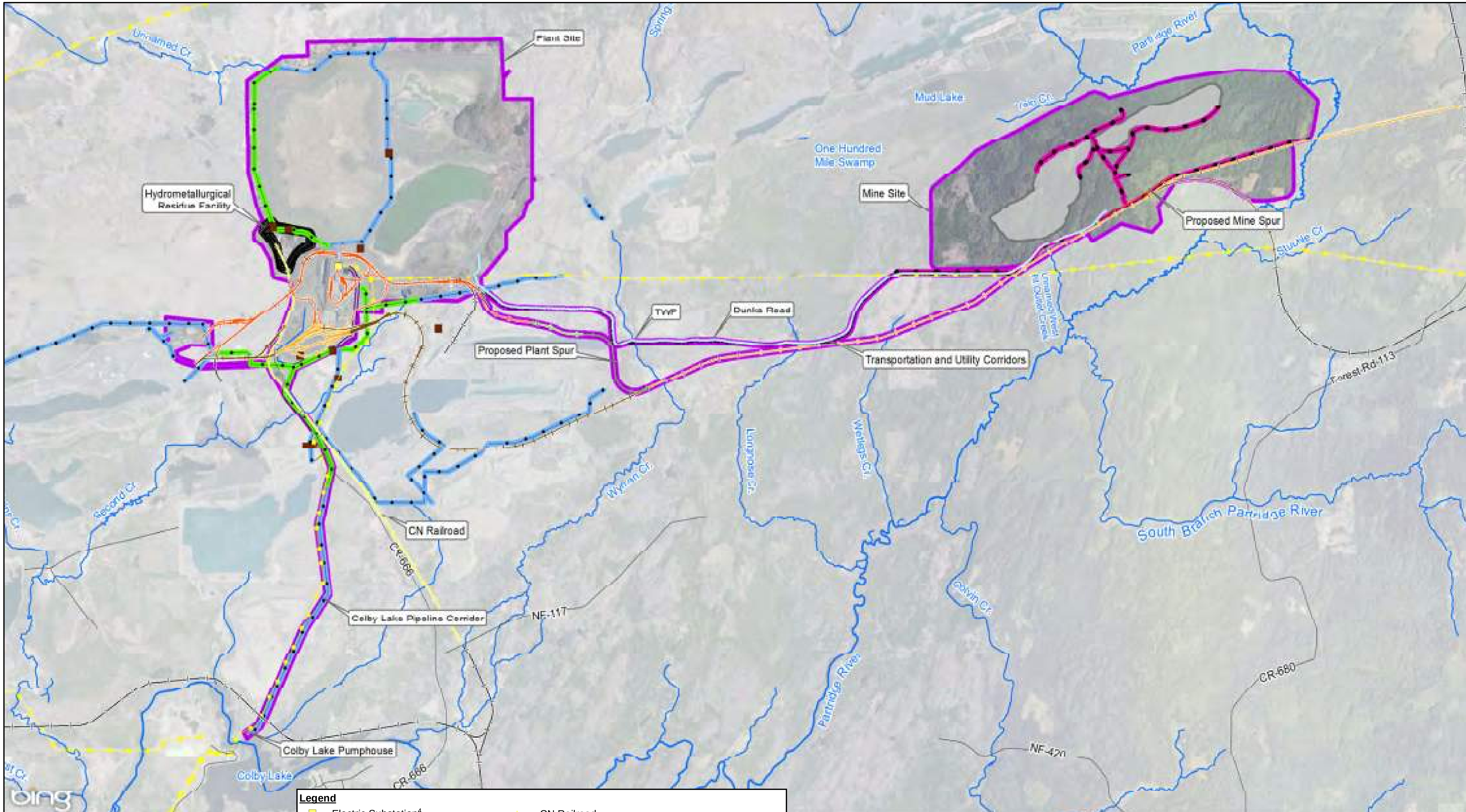
FIGURE 3-2
PLANT SITE - MINE YEAR 20
PERMIT TO MINE APPLICATION
HOYT LAKES, MINNESOTA

Scale: 0 1,250 2,500 Feet | Date: AUGUST 2016
Drafted by: DAT | Project No: 12P778

Path: X:\GB\IE\2012\12P778\GIS\mxd\PMA\Figure 3-2 Plant Site.mxd Date: 9/12/2016



Legend

Electric Substation[4]	CN Railroad
Existing Substations	Cliffs Erie Owned
Existing Power Lines In Use	Cliffs Erie Owned with Agreement in Place to Use
Existing Power Lines Not In Use	PolyMet Owned and Maintained
Existing Electric Power Line[4]	State of MN Land with Agreement in Progress to Use
Proposed Transmission Line	Existing Private Railroad
Treated Water Pipeline (TWP)	Mine Pits
Roads	Facility Boundary
Rivers and Streams[3]	

Notes

1. Basemap from Esri and its data suppliers.
2. Project features supplied by Barr Engineering Company.
3. NHD features are created from MDNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance, data sources may show watercourses that no longer exist.
4. Minnesota Power Substations and Power Lines supplied by the Minnesota Geospatial Information Office (MnGeo).

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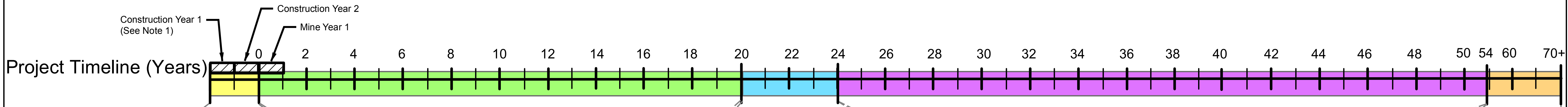
REVIEWED BY:	MJV2	DATE:	AUG. '16
APPROVED BY:	JOS1	DATE:	AUG. '16

POLYMET MINING

FIGURE 3-3
TRANSPORTATION AND UTILITY CORRIDORS AND COLBY LAKE PIPELINE CORRIDOR
PERMIT TO MINE APPLICATION
HOYT LAKES, MINNESOTA

Scale: 0 2,500 5,000 Feet	Date: AUGUST 2016
Drafted by: DAT	Project No: 12P778

Path: X:\GB\IE\2012\12P778\GIS\mxd\PMA\Figure 3-3 Transportation Corridor.mxd Date: 9/9/2016



Mine Phase

Construction

Mine Site
- Haul road development
- Pre-stripping of open pits
- Power distribution system construction
- Maintenance, mechanical and electrical systems construction
- Waste rock and ore stockpile liner construction
- Category 1 stockpile GCS construction
- Mine water and stormwater system development
- Initial WWTF construction
- Rail spur construction
- Perimeter dikes construction

Plant Site
- WWTP construction
- Treated water and tailings pipeline and pumping system installation
- FTB Seepage Containment System construction
- Process plant modifications
- FTB dams and buttress construction
- Rail line construction
- Stormwater system and sewage treatment system construction and improvements

Transportation and Utility Corridors
- Dunka Road and rail upgrade
- TWP construction
- Power distribution system construction
- Rail Connection Track Construction

Colby Lake Pipeline Corridor
- Pipeline and pumphouse evaluation and recommissioning

Operations (Life of Mine)

Mine Site
- Operation of WWTF
- Stripping of open pits
- Blasting of rock for mining
- Mining of open pits
- Stockpiling of waste rock
- Stockpiling of ore
- Operation of CPS/TWP
- Operation of Category 1 stockpile GCS
- Category 1 stockpile cover installation (progressive)
- Relocation of Category 2/3 and 4 waste rock to East Pit
- Partial flooding of East Pit
- Water quality monitoring
- Progressive reclamation
- Rail spur maintenance
- Monitoring per each environmental permit
- Category 2/3 and 4 Stockpile liner removal and restoration
- Haul road maintenance

Plant Site
- WWTP operation and discharge
- Tailings deposition at FTB
- Processing of ore
- Hydrometallurgical Plant construction and Operation
- HRF construction and Operation
- Monitoring per each environmental permit
- Increase height of FTB dams in lifts
- Rail line maintenance
- FTB dam bentonite amendment
- HRF and FTB Progressive Reclamation (Slopes)

Transportation and Utility Corridors
- Dunka Road maintenance and upgrades
- Operation and maintenance of TWP
- Rail connection track maintenance

Colby Lake Pipeline Corridor
- Pipeline maintenance as needed

Reclamation[2] (Mine Years 21-24)

Mine Site
- Security fence construction
- Pit wall reclamation
- Category 1 stockpile cover completion
- Modify WWTF for East Pit flushing load
- WWTF treatment of East Pit flushing load
- OSLA restoration
- Maintenance, mechanical, and electrical system removal and restoration
- Mine water and stormwater pond removal and restoration
- Water quality monitoring
- OSP Removal
- Buildings, Roads and Parking Lots Removal
- Category 2/3 Stockpile Restoration
- RTH Removal
- Monitoring per each environmental permit

Plant Site
- Modify WWTP for closure and postclosure
- WWTP treatment of initial Plant Site closure load
- Tailings pipline and pumping system restoration
- Stormwater pond restoration
- Bentonite amendment to FTB beach and pond bottom
- Closure outlet structure construction
- Building and structures demolition and reclamation
- Monitoring per each environmental permit
- HRF cover construction

Transportation and Utility Corridors
- Dunka Road and rail reclamation
- Power lines removal

Colby Lake Pipeline Corridor
- Pipeline and pumphouse decommission/ restoration

Closure[2] (Mine Years 25-54)

Mine Site
- East and West pit overflow structures construction
- WWTF treatment of East Pit flushing load
- Flooding of West Pit
- CPS decommissioning and reclamation
- VSEP Rail reclamation
- Water quality monitoring
- General site maintenance and monitoring
- Monitoring per each environmental permit

Plant Site
- WWTP treatment of initial Plant Site closure load
- Monitoring per each environmental permit
- TWP decommissioning and reclamation
- General site maintenance and monitoring
- HRF Cover Construction

Postclosure Maintenance (Mine Years 55+)

Mine Site
- Postclosure WWTF treatment
- Discharge to Partridge River
- Water quality monitoring
- General site maintenance and monitoring

Plant Site
- Postclosure WWTP treatment of Plant Site process water
- Discharge to Embarrass River
- Water quality monitoring
- Dam safety monitoring
- General site maintenance and monitoring

NOTES
1. The Contingency Reclamation Estimate (CRE) has been prepared for Construction Year 1 and will be updated each subsequent year. The CRE is provided in Section 15.2.
2. The reclamation phase is assumed to begin at the start of Mine Year 21. The closure phase is complete when the West Pit is flooded, and postclosure water treatment is initiated (Mine Year 55).

ABBREVIATIONS
CRE - Contingency Reclamation Estimate
GCS - Groundwater Containment System
FTB - Flotation Tailings Basin
HRF - Hydrometullurgical Residue Facility
OSLA - Overburden Storage Laydown Area
WWTF - Waste Water Treatment Facility
WWTP - Waste Water Treatment Plant
RTH - Rail Transfer Hopper
OSP - Ore Surge Pile

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APPROVED BY: JOS1			DATE: SEP. '16

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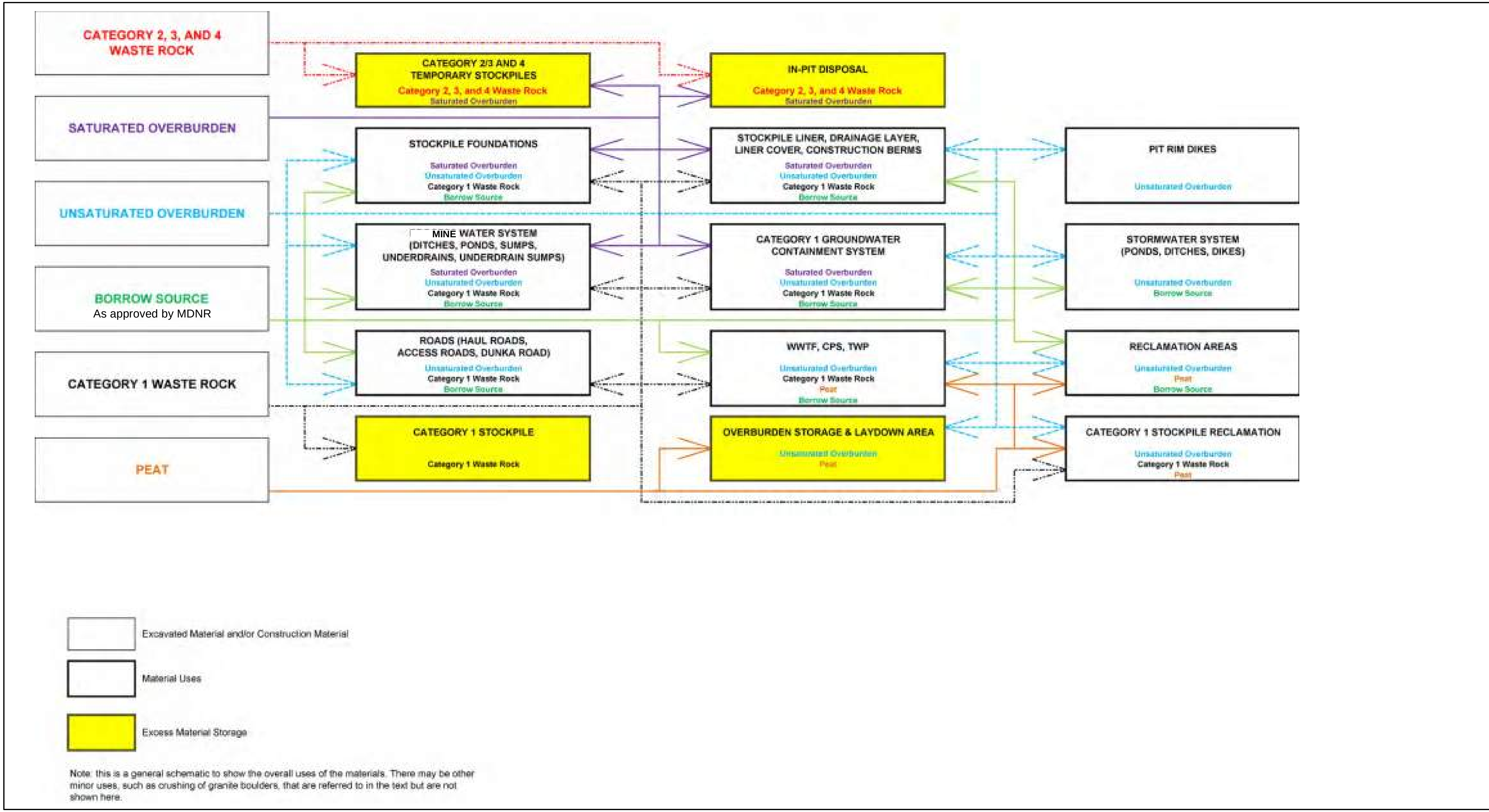
FIGURE 3-4
PROJECT TIMELINE
PERMIT TO MINE APPLICATION
HOYT LAKES, MINNESOTA

Scale: NOT TO SCALE	Date: SEPTEMBER 2016
Drafted by: DAT	Project No: 12P778



NOTES
1. Adaped from Rock and Overburden Management Plan, V8, 2016, included in Appendix 16 of the Application.

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APPROVED BY: JOS1			DATE: AUG.'16

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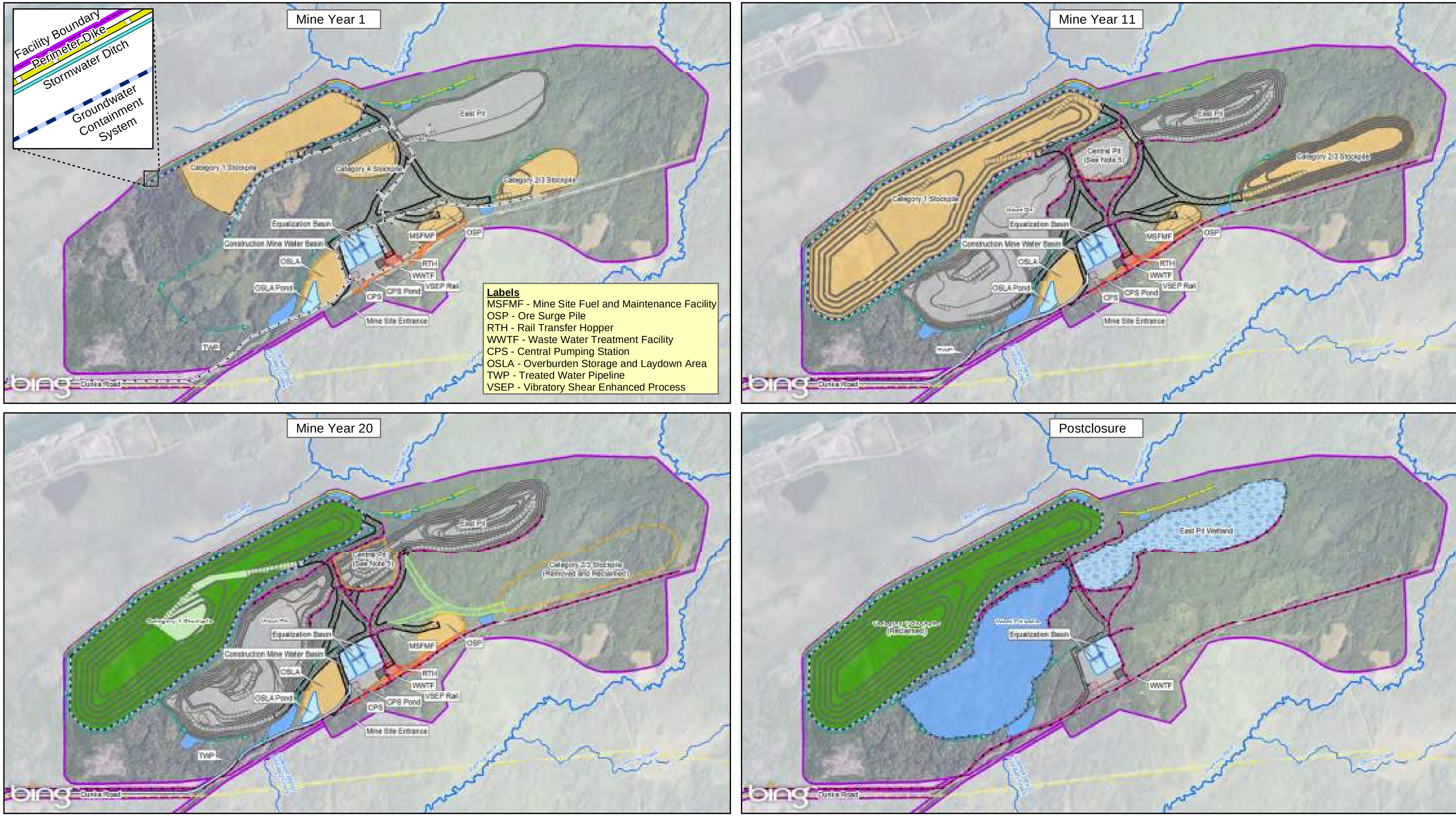
FIGURE 3-5
OVERBURDEN AND WASTE ROCK USE AND STORAGE DIAGRAM
PERMIT TO MINE APPLICATION
HOYT LAKES, MINNESOTA

Scale: NOT TO SCALE	Date: AUGUST 2016
Drafted by: DAT	Project No: 12P778

Path: X:\GB\IE\2012\12P778\GIS\mxd\PMA\Figure 3-5 Rock and Overburden Management Plan.mxd Date: 9/1/2016



Notes

1. Basemap from Esri and its data suppliers.
2. Project features from Barr Engineering Company.
3. Minnesota Power Substations and Power Lines supplied by the Minnesota Geospatial Information Office (MnGeo).
4. For clarity not all of the sumps, ditches, piping, and overflows are shown.
5. The Category 4 stockpile is removed, enabling the development of the Central Pit.
6. WWTF outfall pipeline installed during the postclosure maintenance phase.
7. Mine Water Ponds are lined with the exception of the OSLA Pond and Construction Mine Water Basin.

Legend

- Rivers and Streams
- Existing Electric Power Line[3]
- Proposed Transmission Lines (Mine Year 1)
- Proposed Transmission Lines (Post Mine Year 11)
- Treated Water Pipeline
- WWTF Outfall Pipeline[6]
- Stormwater Ditch
- Groundwater Containment System
- Perimeter Dike
- New Railroad Spur and Loadout
- Treated Mine Water Pond (Lined)
- Facility Footprint
- Mine Water Ponds[7]
- WWTF Buildings
- Haul Roads
- Active Stockpile
- Removed Stockpile
- Mine Pits
- Facility Boundary

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APPROVED BY:	JOS1	DATE: SEP. '16

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FIGURE 3-6

MINE DEVELOPMENT AND LAYOUT SEQUENCE
MINE YEARS 1, 11, 20 AND POSTCLOSURE
PERMIT TO MINE APPLICATION
HOYT LAKES, MINNESOTA

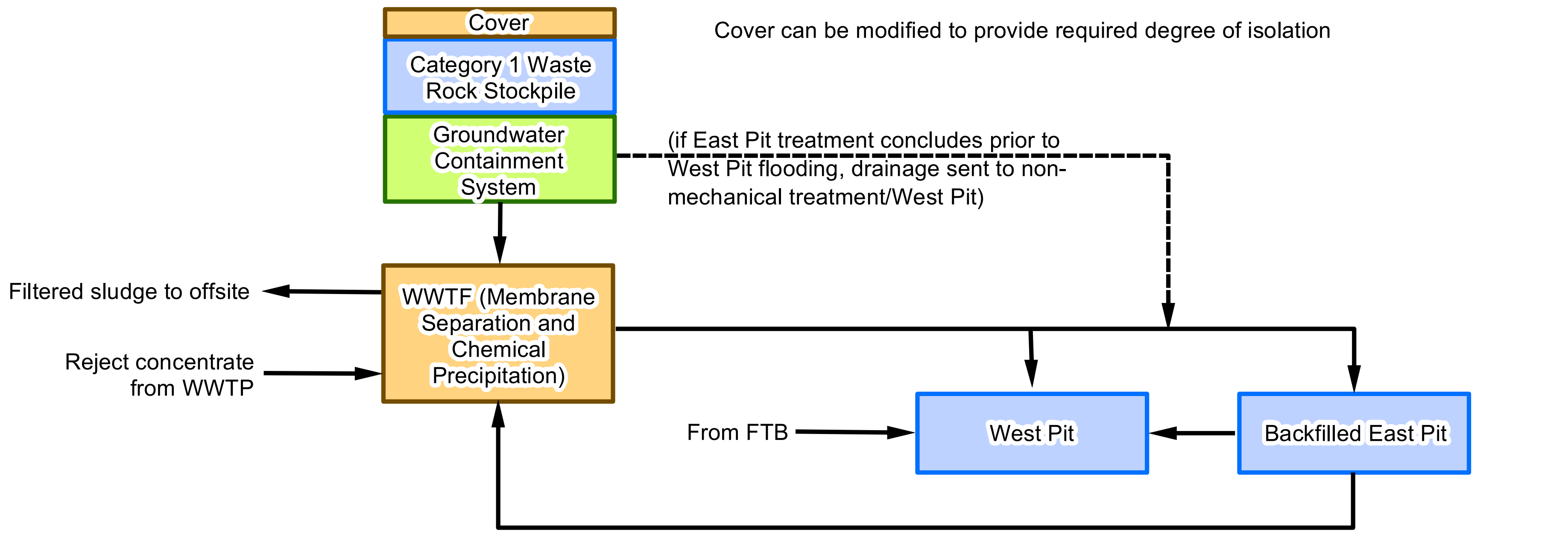
Scale: 0 1,500 3,000 Feet

Date: SEPTEMBER 2016

Drafted by: DAT

Project No: 12P778

Path: X:\GB\IE\2012\12P778\GIS\mxd\PMA\Figure 3-6 Life of Mine Layout.mxd Date: 9/7/2016



WWTF can operate for different durations to remove flushing load from backfilling and wall inundations, and can be expanded to treat more water or treatment capabilities modified if additional treatment capacity is required.

*Category 1 Waste Rock Stockpile covering begins in Year 14 and is completed by Year 21

Legend

- Project Feature
- Fixed Engineering Control
- Adaptive Engineering Control

Source

1. Adapted from NorthMet Project Adaptive Water Management Plan, V10, July, 2016 included in Appendix 16 of the Application.

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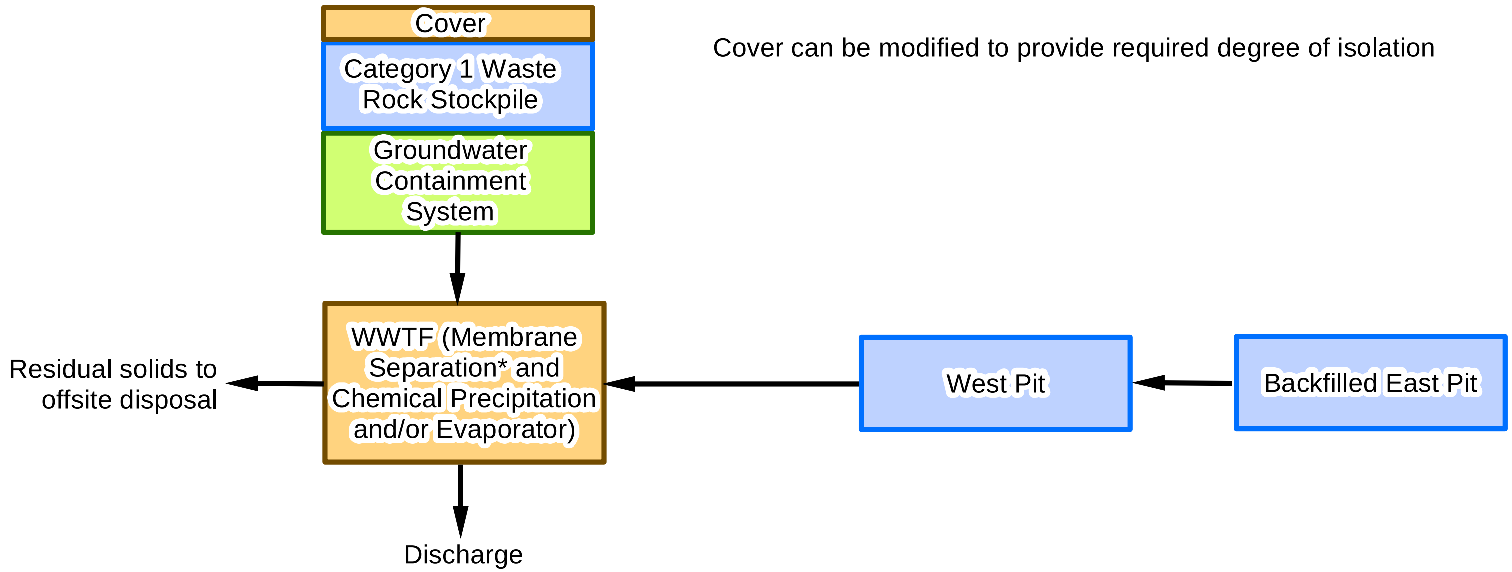
FIGURE 3-7
MINE SITE WATER MANAGEMENT SCHEMATIC – RECLAMATION AND CLOSURE (APPROXIMATELY MINE YEAR 21 THROUGH MINE YEAR 55)
PERMIT TO MINE APPLICATION
HOYT LAKES, MINNESOTA

Scale:	NOT TO SCALE	Date:	AUGUST 2016
Drafted by:	DAT	Project No:	12P778

Path: X:\GB\IE\2012\12P778\GIS\mxd\PMA\Figure 3-7 Mine Site Water Management Schematic – Reclamation.mxd Date: 9/1/2016



WWTF can operate for different durations to remove flushing load from backfilling and wall inundations, and can be expanded to treat more water or treatment capabilities modified if additional treatment capacity is required.

*Reverse osmosis or equivalent technology that will meet water quality targets

Legend

- Project Feature
- Fixed Engineering Control
- Adaptive Engineering Control

Source

1. Adapted from NorthMet Project Adaptive Water Management Plan, V10, July, 2016 included in Appendix 16 of the Application.

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REVIEWED BY:	MJV2	DATE: AUG. '16
APPROVED BY:	JOS1	DATE: AUG. '16

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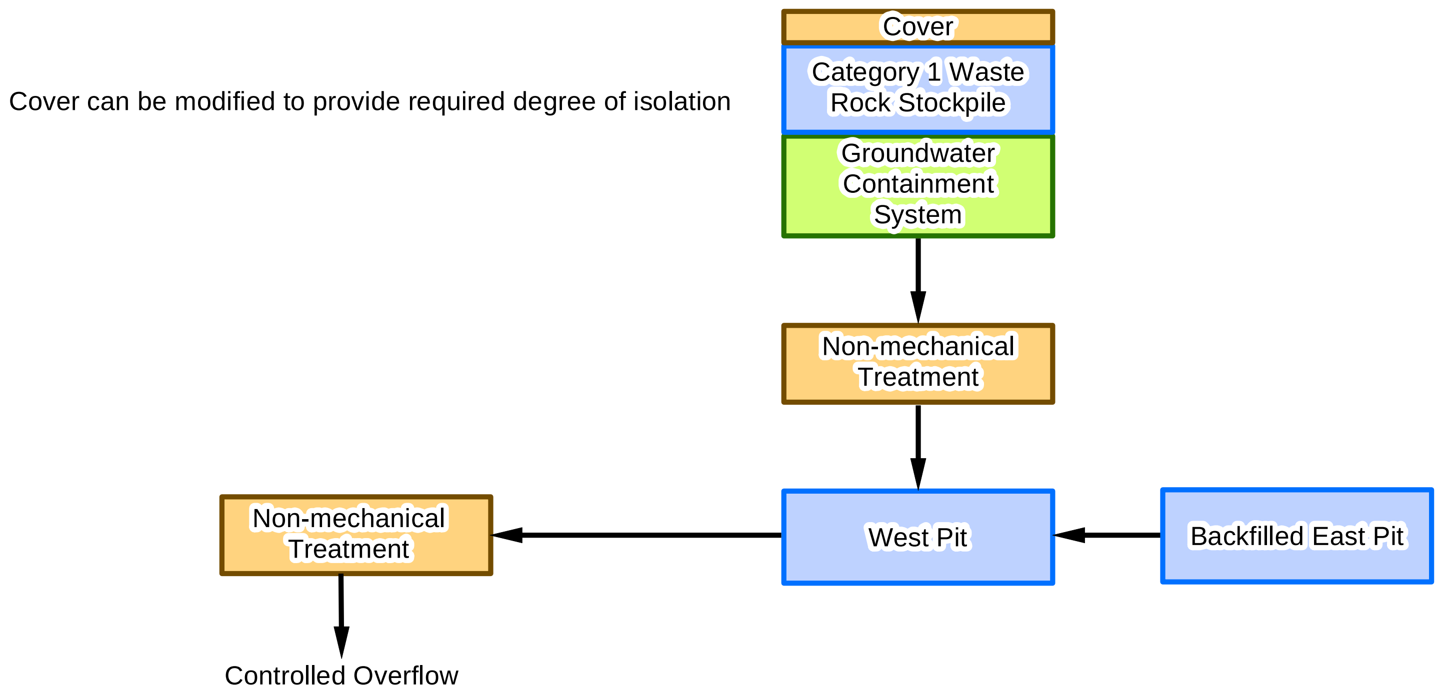
FIGURE 3-8
MINE SITE WATER MANAGEMENT SCHEMATIC - POSTCLOSURE MAINTENANCE:
LONG-TERM MECHANICAL TREATMENT
PERMIT TO MINE APPLICATION
HOYT LAKES, MINNESOTA

Scale:	NOT TO SCALE	Date:	AUGUST 2016
Drafted by:	DAT	Project No:	12P778



Legend

- Project Feature
- Fixed Engineering Control
- Adaptive Engineering Control

Source

1. Adapted from NorthMet Project Adaptive Water Management Plan, V10, July, 2016 included in Appendix 16 of the Application.

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APPROVED BY: JOS1	DATE: AUG. '16	

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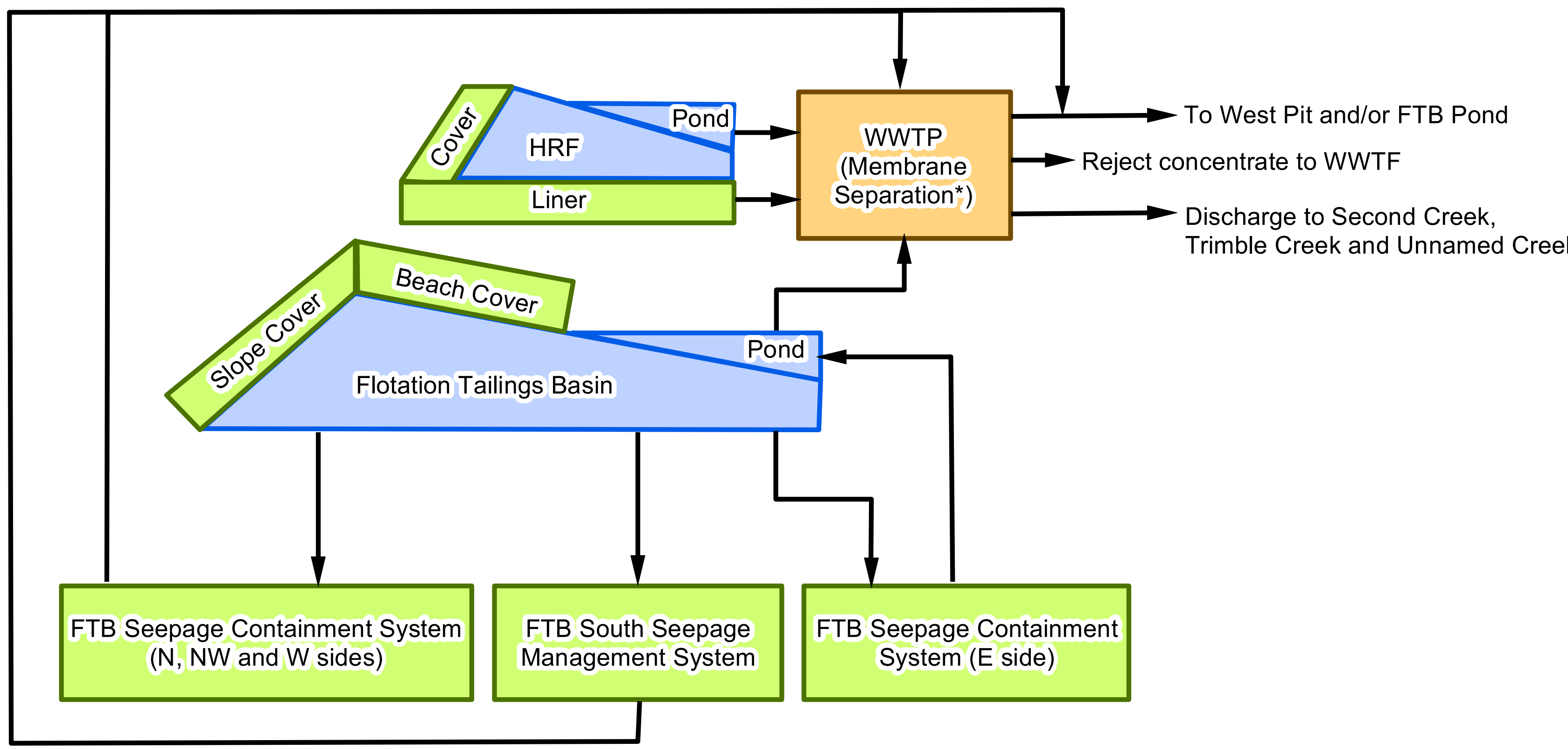
FIGURE 3-9
MINE SITE WATER MANAGEMENT SCHEMATIC -
POSTCLOSURE MAINTENANCE:
LONG-TERM NON-MECHANICAL TREATMENT
PERMIT TO MINE APPLICATION
HOYT LAKES, MINNESOTA

Scale: NOT TO SCALE	Date: AUGUST 2016
Drafted by: DAT	Project No: 12P778



WWTP can be expanded to treat more water or treatment capabilities modified if additional treatment capacity is required.

*Reverse osmosis or equivalent technology that will meet water quality targets

Legend

- Project Feature
- Fixed Engineering Control
- Adaptive Engineering Control

Source

1. Adapted from NorthMet Project Adaptive Water Management Plan, V10, July, 2016 included in Appendix 16 of the Application.

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REVISED	DATE	BY	DESCRIPTION

PREPARED BY:	JSL	DATE: AUG. '16
REVIEWED BY:	MJV2	DATE: AUG. '16
APPROVED BY:	JOS1	DATE: AUG. '16

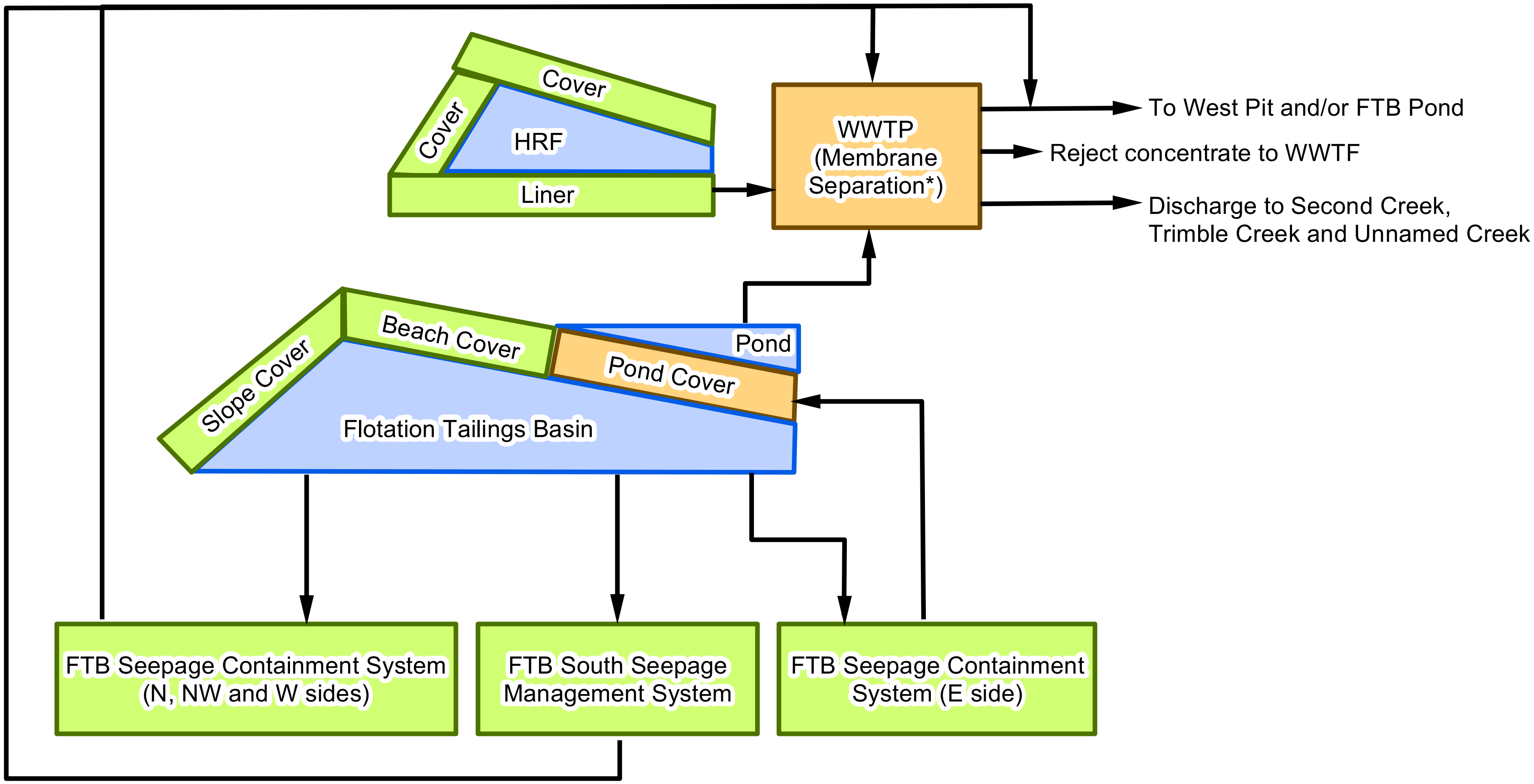
POLYMET MINING

FIGURE 3-10

PLANT SITE WATER MANAGEMENT SCHEMATIC – RECLAMATION AND CLOSURE: HRF DEWATERING (APPROXIMATELY MINE YEAR 21 THROUGH MINE YEAR 30)
PERMIT TO MINE APPLICATION
HOYT LAKES, MINNESOTA

Scale:	NOT TO SCALE	Date:	AUGUST 2016
Drafted by:	DAT	Project No:	12P778

Path: X:\GB\IE\2012\12P778\GIS\mxd\PMA\Figure 3-10 Plant Site Water Management Schematic – Reclamation.mxd Date: 9/1/2016



WWTP can be expanded to treat more water or treatment capabilities modified if additional treatment capacity is required.

*Reverse osmosis or equivalent technology that will meet water quality targets

Legend

- Project Feature
- Fixed Engineering Control
- Adaptive Engineering Control

Source

1. Adapted from NorthMet Project Adaptive Water Management Plan, V10, July, 2016 included in Appendix 16 of the Application.

Foth Infrastructure & Environment, LLC

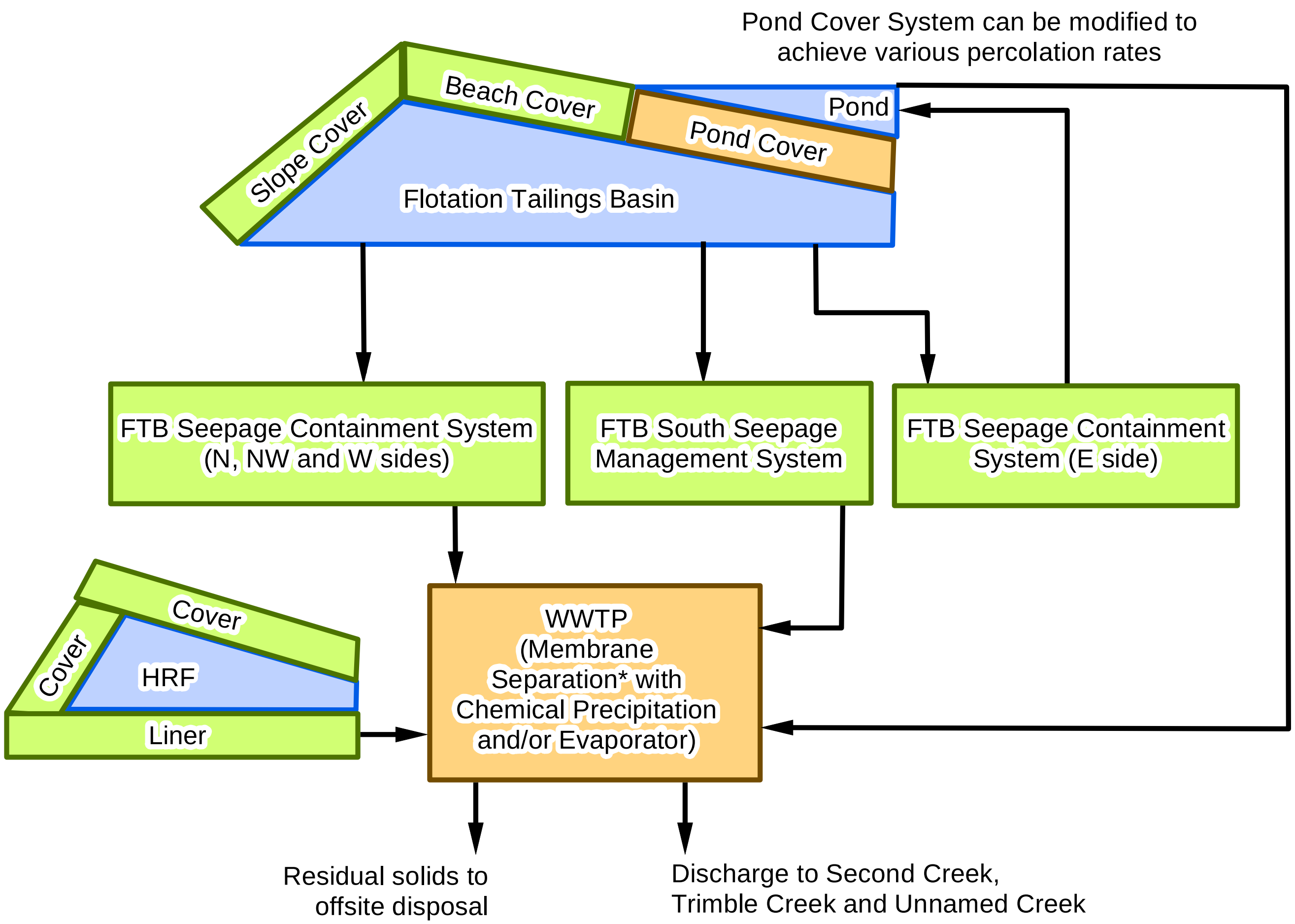
REVISED	DATE	BY	DESCRIPTION

PREPARED BY: JSL DATE: AUG. '16
REVIEWED BY: MJV2 DATE: AUG. '16
APPROVED BY: JOS1 DATE: AUG. '16

POLYMET MINING

FIGURE 3-11
PLANT SITE WATER MANAGEMENT SCHEMATIC – CLOSURE: HRF AND FTB (APPROXIMATELY MINE YEAR 31 THROUGH MINE YEAR 55)
PERMIT TO MINE APPLICATION
HOYT LAKES, MINNESOTA

Scale: NOT TO SCALE | Date: AUGUST 2016
Drafted by: DAT | Project No: 12P778



WWTP can be expanded to treat more water or treatment capabilities modified if additional treatment capacity is required.

*Reverse osmosis or equivalent technology that will meet water quality targets

Legend

- Project Feature
- Fixed Engineering Control
- Adaptive Engineering Control

Source

1. Adapted from NorthMet Project Adaptive Water Management Plan, V10, July, 2016 included in Appendix 16 of the Application.

Foth Infrastructure & Environment, LLC

REVISED	DATE	BY	DESCRIPTION

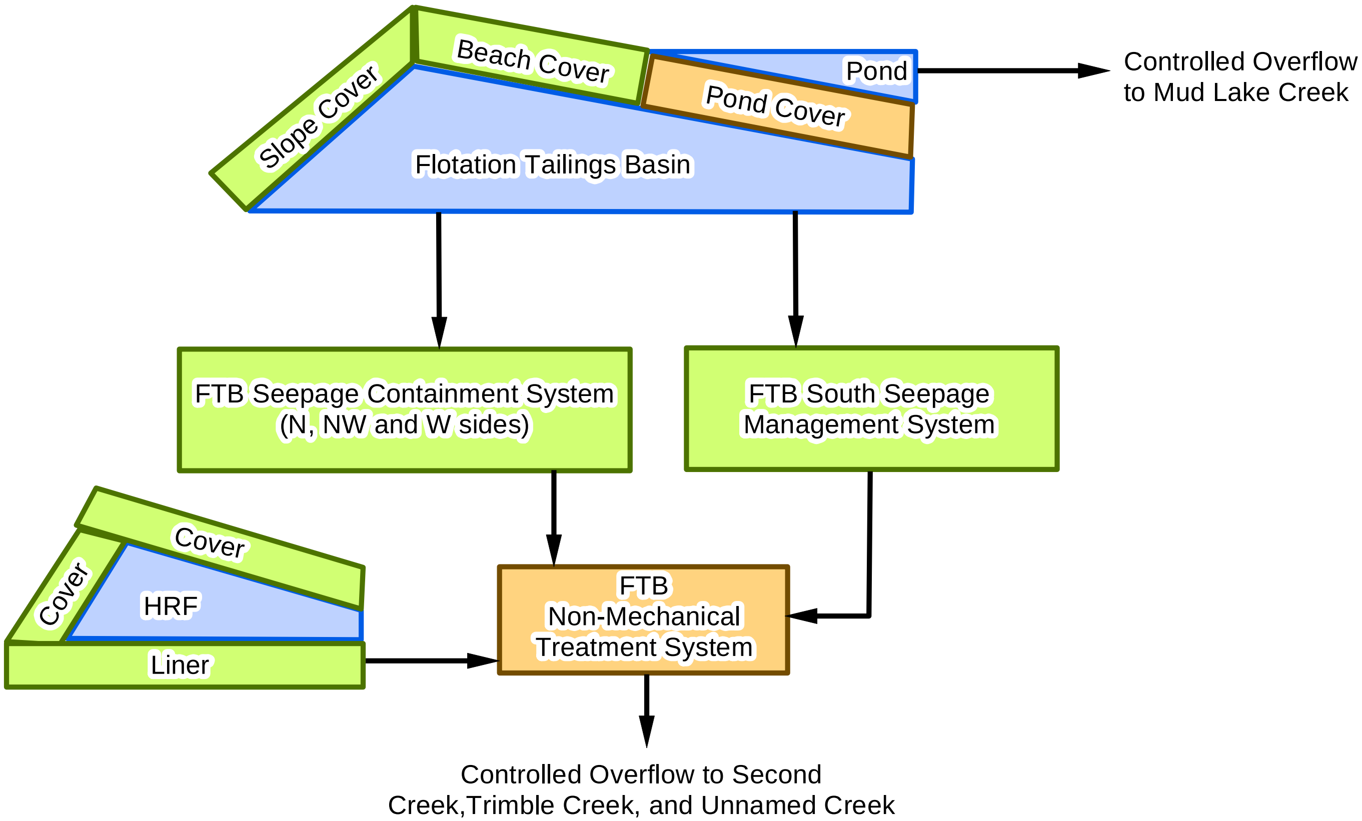
PREPARED BY: JSL DATE: AUG. '16
REVIEWED BY: MJV2 DATE: AUG. '16
APPROVED BY: JOS1 DATE: AUG. '16

POLYMET MINING

FIGURE 3-12
PLANT SITE WATER MANAGEMENT SCHEMATIC - POSTCLOSURE MAINTENANCE:
LONG-TERM MECHANICAL TREATMENT
PERMIT TO MINE APPLICATION
HOYT LAKES, MINNESOTA

Scale: NOT TO SCALE Date: AUGUST 2016
Drafted by: DAT Project No: 12P778

Path: X:\GB\IE\2012\12P778\GIS\mxd\PMA\Figure 3-12 Plant Site Water Management Schematic - Postclosure Mechanical Treatment.mxd Date: 9/1/2016



Legend

Project Feature

Fixed Engineering Control

Adaptive Engineering Control

Source

1. Adapted from NorthMet Project Adaptive Water Management Plan, V10, July, 2016 included in Appendix 16 of the Application.

Foth Infrastructure & Environment, LLC

REVISED	DATE	BY	DESCRIPTION

PREPARED BY:	JSL	DATE: AUG. '16
REVIEWED BY:	MJV2	DATE: AUG. '16
APPROVED BY:	JOS1	DATE: AUG. '16

POLYMET MINING

FIGURE 3-13
PLANT SITE WATER MANAGEMENT SCHEMATIC - POSTCLOSURE MAINTENANCE:
LONG-TERM NON-MECHANICAL TREATMENT
PERMIT TO MINE APPLICATION
HOYT LAKES, MINNESOTA

Scale:	NOT TO SCALE	Date:	AUGUST 2016
Drafted by:	DAT	Project No:	12P778

Path: X:\GB\IE\2012\12P778\GIS\mxd\PMA\Figure 3-13 Plant Site Water Management Schematic - Postclosure Non-mechanical Treatment.mxd Date: 9/1/2016

4 Land Management

4.1 Land Exchange, Land Ownership, and Mineral Ownership

This section provides an overview of PolyMet's interest in the surface lands and minerals within the vicinity of the Mining Area. This section also describes PolyMet's rights with respect to each portion of the Project:

- the Mine Site (minerals and surface)
- the Plant Site (surface)
- the Transportation and Utility Corridors (surface)
- the Colby Lake Pipeline Corridor (surface)

4.1.1 Mine Site Mineral and Surface Rights

PolyMet has control of the mineral rights necessary for the Project. Figure 1-6 shows PolyMet's mineral interests within those portions of the Mine Site that PolyMet proposes to mine during the LOM: the West Pit, the Central Pit, and the East Pit (collectively, the Mine Pits). The Mine Pits include approximately 527 acres of minerals, all of which are privately owned minerals leased by PolyMet.

RGGS owns the mineral and mining rights within the Mine Pit area, and PolyMet currently holds a lease granting it the exclusive right to explore, mine, remove, beneficiate or process, and dispose of all minerals owned by RGGS (RGGS Lease). The remaining private minerals within the Mine Pits are owned by Longyear Mesaba Company. PolyMet also holds a private lease for these minerals (Longyear Lease), which authorizes the exploration, development, and mining of these minerals.

Collectively, the RGGS Lease and the Longyear Lease provide PolyMet with the necessary rights to conduct the mining operations associated with this Project for the entire LOM. In addition, the proposed operations comply with the terms and conditions of these leases. These terms and conditions include, consistent with Minnesota's nonferrous mining policies, requirements that PolyMet conduct its operations in a skillful and workmanlike manner in accordance with generally accepted standards and practices for the mining industry. The RGGS Lease and Longyear Lease also both require that PolyMet comply with applicable laws, including environmental statutes and regulations.

The Mine Site includes approximately 3,015 acres of surface lands, which include approximately 81 acres of private lands held by PolyMet. PolyMet holds various legal interests (including equitable title, leasehold interests, use rights, and other interests) to certain surface lands within the Mine Site pursuant to several agreements with Cliffs Erie and its affiliates (the Cliffs Agreements) as further described in the discussion of Plant Site surface lands. Pursuant to the

Cliffs Agreements, PolyMet currently has all necessary rights to gain access to, utilize, and otherwise possess and operate on the private surface lands subject to these Cliffs Agreements.

The majority of surface lands within the Mine Site are owned by the federal government and administered by the USFS. Because PolyMet holds private mineral leases for the minerals underlying the federal surface, PolyMet takes the position that it has a legal right to conduct mining operations on the overlying federal surface. The USFS has taken a different view. Therefore, in 2007, PolyMet entered into discussions with the USFS to acquire through a land exchange fee title to surface lands overlying PolyMet's private mineral lease.

Figure 4-1 shows the current surface rights for lands within the Mining Area, including those lands subject to the Cliffs Agreements and the land exchange parcels. Figure 4-1 depicts those lands that PolyMet is acquiring as part of the land exchange together with those lands that PolyMet is conveying to USFS (lands purchased by PolyMet within the boundaries of the Superior National Forest). Figure 1-5 depicts surface rights within the Mining Area after PolyMet acquires full fee title and other interests to these lands. PolyMet expects to have full fee title interests to these surface lands before commencing the operations described in this Application. Section 6.2 includes an overview of the regulatory process associated with the land exchange.

4.1.2 Surface Rights for the Plant Site

PolyMet has the rights to all surface lands within the Plant Site necessary to conduct the operations associated with the Project. The Plant Site includes approximately 4,728 acres of surface lands, and Figure 4-1 shows the current rights to these lands. These lands are subject to the Cliffs Agreements, including option agreements (which have been exercised), contracts for deed, and other agreements providing PolyMet rights to the surface lands within the Plant Site, as well as certain additional lands within the Mine Site, the Transportation and Utility Corridors, and the Colby Lake Pipeline Corridor. The Cliffs Agreements variously provide PolyMet with title interests, licenses, easements, rights-of-way, access rights, use and permit rights, and other legally-binding interests. The Cliffs Agreements cover not only surface lands, but also buildings, fixtures, and other improvements; infrastructure and equipment such as roadways, railroad lines, electrical power lines, and gas pipeline and water facilities; and intangibles such as permits and licenses, which are necessary to enable production at the Plant Site. The Cliffs Agreements provide PolyMet with the necessary rights to access, utilize, and otherwise possess, control, and operate on the private surface lands within the Plant Site. Figure 1-5 depicts the surface ownership of the lands at the Plant Site post-land exchange.

4.1.3 Surface Rights for the Transportation and Utility Corridors

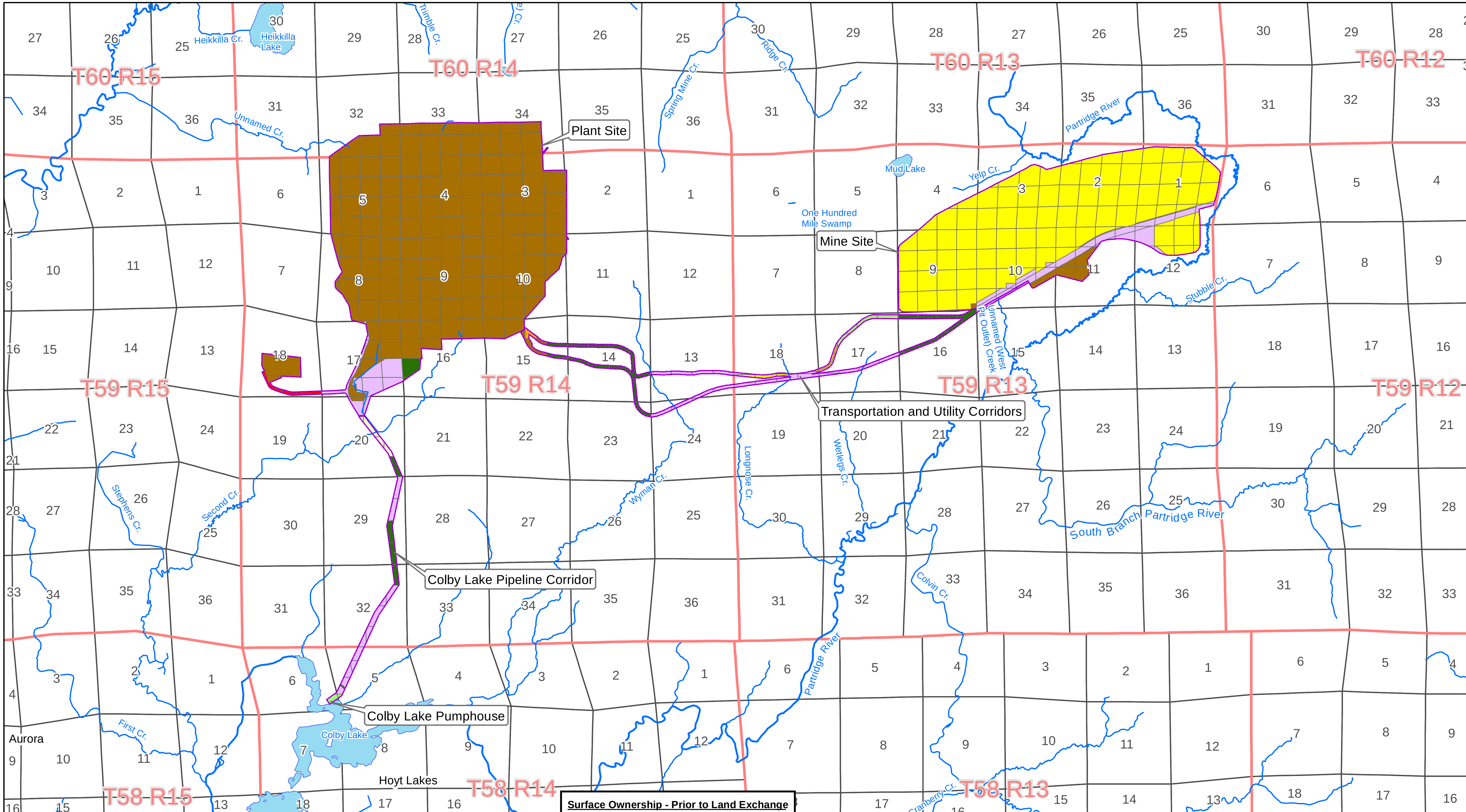
The Transportation and Utility Corridors connect the Plant Site and the Mine Site and these corridors include approximately 120 acres of surface rights. Figure 4-1 shows the current surface ownership for the corridors.

PolyMet has acquired the necessary property interests and rights (including, among other things, title interests, easements, rights-of-way, licenses, access rights, use rights and other rights) in land and infrastructure in the Transportation and Utility Corridors. The primary existing infrastructure within the Transportation and Utility Corridors are the Dunka Road and the Main Rail Line. The Dunka Road and Main Rail Line diverge in some points as shown on Figure 4-1. Water pipelines, transmission lines and equipment, and other utilities will also be constructed within the corridors in connection with the Project.

Most of the land and infrastructure within the Transportation and Utility Corridors is subject to the Cliffs Agreements described in Section 4.1.2. Other surface owners within the corridors are Minnesota Power/ALLETE, the state of Minnesota, and the United States (administered by USFS). Before construction commences, PolyMet will have all necessary agreements in place with these various entities for PolyMet to own or use the land and infrastructure within the Transportation and Utility Corridors. Figure 1-5 depicts the surface rights for lands within the Transportation and Utility Corridors after the land exchange and final closing on the Cliffs Agreements.

4.1.4 Surface Rights for the Colby Lake Pipeline Corridor

The Cliffs Agreements also provide PolyMet with various legal interests (including title, licenses and permits, use rights, rights-of-way and other rights) in the Colby Lake Pipeline Corridor, including the existing pumphouse. The properties include land, infrastructure (pipeline and power line), utilities and equipment, and buildings, among other things. Before Project construction commences, PolyMet will have all necessary rights to utilize the lands within this corridor as necessary for Colby Lake to supply water needed for Project operations. Figure 1-5 depicts the surface rights of lands within the Colby Lake Pipeline Corridor after the land exchange and closing on the Cliffs Agreements.



Notes

1. This drawing is neither a legally recorded map nor a survey and is not intended to be used as one. This drawing is a compilation of records, information and data used for reference purposes only.
2. Surface ownership dataset supplied by PolyMet.
3. Certain parcels may have fractionalized ownership, and in such circumstances, this map shows the majority owner.
4. Consistent with Minnesota Rules, Part 6132.1100, this map depicts ownership as a matter of record as well as PolyMet's equitable ownership of lands subject to Contracts for Deed, but does not reflect private party agreements that grant PolyMet rights and control over the lands (e.g. easements, licenses, etc.)

Legend

- Rivers and Streams
- Lakes
- Townships
- Sections
- Facility Boundary

Surface Ownership - Prior to Land Exchange

- Allete
- Cliffs Erie, LLC
- Du Nord Land Company
- Mesabi Nugget
- PolyMet (contract for deed lands)
- Railroad
- RGGS LAND
- State of Minnesota
- USA

POLYMET MINING

Foth

Foth Infrastructure & Environment, LLC

REVISED	DATE	BY	DESCRIPTION

PREPARED BY:	DAT	DATE:	AUG. '16
REVIEWED BY:	JSL	DATE:	AUG. '16
APPROVED BY:	CED1	DATE:	AUG. '16

POLYMET MINING

FIGURE 4-1
SURFACE OWNERSHIP
PRIOR TO LAND EXCHANGE
PERMIT TO MINE APPLICATION
HOYT LAKES, MINNESOTA

Scale: 0 3,000 6,000 Feet
Date: AUGUST 2016
Drafted by: DAT
Project No: 12P778

Path: X:\GB\IE\2012\12P778\GIS\mxd\PMA\Figure 4-1 Surface Ownership Prior to Land Exchange.mxd Date: 9/2/2016

5 Environmental Setting Information

Minnesota's nonferrous metallic mineral mining rules require that PolyMet submit as part of its application specific information relating to the environmental setting of the proposed Mining Area. First, PolyMet must include a copy of an environmental impact statement and environmental reports prepared relative to the mining operations. To satisfy this requirement, PolyMet has included a copy of the FEIS and associated environmental reports in Appendix 16. Second, PolyMet is required to include in its application a series of environmental setting maps that are based on currently available information and that delineate the Mining Area and adjacent lands to show the areas directly or indirectly affected by mining. This section of the Application and the supporting appendices contain this information.

Appendix 16 of the Application contains a copy of the joint federal-state FEIS completed for the Project together with the management plans and data packages that support the FEIS and constitute the environmental reports prepared for the Project. As discussed in Section 6, PolyMet is filing the FEIS, rather than a draft EIS, in support of this Application. As a result, PolyMet's Application incorporates the information about the environmental setting for the Mining Area developed through the environmental review process. While this section provides, consistent with the applicable rules, a brief overview of the environmental setting so as to describe the information presented in the required maps, Chapter 4 of the FEIS provides substantially more information regarding the environmental setting for the Mining Area. Moreover, the FEIS contains details about the potential environmental impacts associated with the Project and the associated mitigation measures.

Minnesota Rules, part 6132.1100, subpart 5, contemplates that the Environmental Impact Statement (EIS) will provide detailed background on the environmental setting, which will be depicted on the requisite maps. Therefore, this section focuses on providing a brief description of the environmental setting maps rather than restating information contained in the FEIS. PolyMet is providing copies of the environmental setting maps in both hard copy and digital format. As directed by the MDNR, the hard copies of the environmental setting maps are 11x17 inch maps of the same scale as 7-1/2 minute U.S. Geological Survey (USGS) quadrangle maps, and these maps depict the environmental setting for the Mining Area as defined by the applicable rules.

Table 5-1 summarizes environmental setting requirements of Minnesota Rules, part 6132.1100, subpart 5, item B and the location of this information in Section 5 figures. This section describes the environmental setting maps and how they comply with the requirements of Minnesota Rules, part 6132.1100, subpart 5. Consistent with the PTM Regulations, certain maps include more detailed information and description of data.

5.1 Geology

As required under Minnesota Rules, part 6132.1100, subpart 5, item B(1), Figure 5-1 through Figure 5-3 are environmental setting maps showing bedrock geology, including the general shape of the ore body and appropriate cross-sections that show the horizontal and vertical relationships. The ore body is located in the approximate location of the proposed open pits that will be excavated at the Mine Site. The ore body follows the Animikie series from the southwest to northeast along these deposits. Figure 5-1 shows bedrock geology of the area with the ore body and Figure 5-2 and Figure 5-3 show geologic cross-sections.

Surficial Geology

The surficial deposits range in thickness from 0 to 60 feet in the vicinity of the Mine Site and are on the order of 25 to 50 feet near the Tailings Basin at the Plant Site. North and northwest of the Tailings Basin, surficial deposits thicken to as much as 150 feet (Reference (4)). Upland areas are commonly underlain by local bedrock highs, which are overlain by relatively thin mantles of till. Lowlands are commonly characterized by wetlands with peat accumulations several feet thick.

Bedrock Geology

Generalized bedrock geology of the area around the Project is shown on Figure 5-1. The Project is located along the northwestern edge of the Mid-Continent Rift System, which came in contact and partially assimilated a portion of the Virginia Formation. The Duluth Complex displays a generally layered fabric that dips to the southeast. The mineral constituents that make up the Duluth Complex form an interlocking igneous texture and fabric with no primary porosity or incipient discontinuity in the rock mass. The NorthMet Deposit occurs in troctolitic and gabbroic rocks of the Partridge River Intrusion (PRI). In this area, the PRI is subdivided into seven igneous stratigraphic units. The lowest unit, Unit 1, directly overlies the Virginia Formation. Geologic cross-sections and longitudinal sections through the Mine Pits are shown on Figure 5-2 and Figure 5-3, respectively.

Geotechnical drilling by Golder Associates (Golder) indicated core recoveries near 100% and excellent rock quality designation (RQD), typically exceeding 95% (Reference (5)). The higher the number, the less fractured the rock. Golder conducted additional geotechnical testing, including Uniaxial Compressive Strength and Young's modulus (Reference (5). In addition, RQD was recorded for more than 217,000 feet of core during the resource drilling within the proposed pits. When combined with core recovery and RQD, the quality of the rock mass was good to excellent. This indicates the bedrock has a low fracture frequency.

5.2 Surface Water Hydrology and Watersheds

Minnesota Rules, part 6132.1100, subpart 5, item B(2), specifies that the application include environmental setting maps showing water basins and water courses that are or could be affected by mining (Section 5.3 addresses the requirement to show wetlands). Subpart 5, item B(3) similarly requires maps showing boundaries of watersheds that are or could be affected by mining. Figure 5-4 through Figure 5-6 depict the water basins, water courses, and watersheds in which the Project is located. Significantly, while the maps depict the boundaries of these water features in relation to the Mining Area, the Project is not expected to impact the entire geographic extent of the water features shown on these maps. The FEIS filed with this Application contains a thorough discussion of potential environmental impacts to these water resources.

The Mining Area is within one major basin as classified by the MDNR: the Great Lakes Basin. Based on the analysis completed in support of the FEIS, the potential impacts associated with mining operations for the Project are confined to the Great Lakes Basin. No other major water basin is anticipated to be affected by mining.

During the preparation of the FEIS, it was suggested that groundwater from the Mine Site could potentially flow north into the Rainy River Basin. The Co-lead agencies considered this possibility, and concluded that such northward flow was possible, but not reasonably foreseeable. Following publication of the FEIS, additional comments were submitted regarding the possibility of northward flow. MDNR’s adequacy decision concluded that even if northward flow were to occur, it would be possible to detect and prevent effects within the Rainy River Basin. The USFS similarly concluded that northward flow to the Rainy River Basin was unlikely, and that any potential northward flow could be detected and prevented.

The Mining Area is located within one major watershed (8-digit Hydrologic Unit Code (HUC) scale): the St. Louis River watershed. Within the St. Louis River watershed, the Mining Area sits within two intermediate watersheds: the Partridge River watershed and the Embarrass River watershed. The Mine Site, the Transportation and Utility Corridors, and the Colby Lake Pipeline Corridor are located within the Partridge River watershed. The Plant Site is primarily contained within the Embarrass River watershed, except for a small portion at the southern end of the Plant Site that drains to Second Creek, a tributary to the Partridge River. Figure 5-4 shows the Mining Area (identified as the Facility Boundary) and its location within the boundaries of these two watersheds. Figure 5-5 and Figure 5-6 provide expanded views of the Partridge and Embarrass River watersheds, respectively. Figure 5-4 through Figure 5-6 also depict the water courses located within several miles of the Mining Area. These water courses include the Partridge River, Embarrass River, and several creeks. Both the Partridge River and the Embarrass River are tributary to the St. Louis River, which ultimately discharges into Lake Superior. The FEIS describes the potential effects the Project may have on some portion of these watersheds and on reaches of these water courses and how PolyMet intends to mitigate any such impacts.

Major hydrological features of the watersheds and water courses depicted in Figure 5-4 to Figure 5-6 include:

- Partridge River Watershed

  - **River course and tributary streams**. The Partridge River forms just south of the Northshore Mining Company's Peter Mitchell Mine, which comprises the headwaters of the river. It then flows approximately 32 miles south/southwest to its confluence with the St. Louis River. Approximately five miles of the Partridge River flows around the northern and central perimeter of the Mine Site. Colby Lake, located approximately four miles southwest of the Plant Site, is a dammed portion of the river created when Erie Mining Company constructed the Whitewater Reservoir in 1955. The lake and reservoir together comprise approximately 1,749 acres. Tributary streams upstream of Colby Lake include Wetlegs Creek, Colvin Creek, Longnose Creek, Yelp Creek, Wyman Creek, Stubble Creek, Second Creek, Unnamed (West Pit Outfall) Creek, and the South Branch of the Partridge River.
  - **Physical setting and uses**. The Partridge River varies from sluggish marshy reaches to large open ponds to steep boulder rapids. The watershed is interspersed with a mixture of upland forest (comprising 39% of the watershed), lowlands and aquatic environments (27%), shrubland (22%), cropland /grassland (2%), and some development (10%). The river drains an area that has been significantly hydrologically modified by a long history of mining and municipal uses. Current withdrawals and discharges from the river include the Peter Mitchell Mine dewatering operation, the city of Hoyt Lakes water withdrawals from Colby Lake, and Minnesota Power's Laskin power plant withdrawals from the Whitewater Reservoir.
  - **Baseflow estimation.** There are several USGS gaging stations along the river. USGS gaging station 04015475, located downstream of the Project but just upstream of Colby Lake, is the station that best represents flows from the Mining Area. Data from this station are available from the years 1978 to 1988, but there have not been any significant land cover or other changes in the watershed since then that would render the data unrepresentative. These flow data indicate generally low flows from late fall through the winter, a sharp rise during spring snowmelt and receding flows over the summer, except for occasional heavy storms. According to these USGS data, the minimum 30-day average flow between January and February at this location was 3.8 cubic feet per second (cfs). These data include discharges to the river from Peter Mitchell Mine dewatering operations.

- Embarrass River Watershed

  - **River course and tributary streams**. The Embarrass River originates just south of the city of Babbitt, flowing approximately 23 miles southwest to its confluence with the St. Louis River. Approximately 20% of the Plant Site, including the Beneficiation

Plant and shops, drain to Second Creek, a significant tributary to the river. Other tributaries include Unnamed (Mud Lake) Creek, Trimble Creek, and the Embarrass River Chain of Lakes (Sabine Lake, Wynne Lake, and Embarrass Lake).

- **Physical setting and uses.** The Embarrass River watershed drains approximately 171 square miles. Overflow and seepage from several former mining operations flow into tributaries of the river. The city of Babbitt discharges water from its waste water treatment plant to the Embarrass River headwaters. The watershed is dominated by upland forest (44%), with lowland forest and aquatic environments (23%), crop/grassland (8%), scrub/shrub areas (21%), and development (4%).
- **Base flows**. There are two USGS gaging stations along the Embarrass River, with station 04017000 being the closest to the Project. Base flows at USGS station 04017000 are estimated at 4.0 cfs.

5.3 Wetlands

Minnesota Rules, part 6132.1100, subpart 5, item B(2) requires that the application include environmental setting maps showing wetlands that are or could be affected by mining. Figure 5-7 shows delineated wetlands for the Mining Area, which includes the Mine Site and the Plant Site.

Additionally, small acreages of wetlands are found in the Transportation and Utility Corridors and the Colby Lake Pipeline Corridor (Figure 5-7). Section 12 of this Application has more information on the wetland delineation in each of these areas. Table 5-2 summarizes the wetland acreages and wetland types for the Project. As shown in Table 5-2, bogs are the most prevalent wetland type by acreage. The majority of the wetlands at the Mine Site are identified as high quality wetlands. The Plant Site and Colby Lake Pipeline have larger proportions of medium and low quality wetlands due to existing disturbances associated with prior development.

Wetland hydrology at the Mine Site is driven primarily by precipitation and local surface runoff, as evidenced by several years of monitoring data documenting fluctuations in water levels that closely mirror precipitation patterns. These data are consistent with hydrogeologic conditions in the area. Both the Partridge River and Embarrass River watersheds consist of a thin layer of glacial till (typically ranging from 0 to 33 feet in thickness) underlain by fractured bedrock. Bedrock outcrops frequently alter local groundwater flow paths in the surficial aquifer. These flow paths are generally short, with upland recharge areas located close to wetland discharge areas. Within the surficial aquifer organic and mineral soils tend to lay over silty sands and clays, resulting in perched wetlands. There is a general lack of connectivity between the shallow water table in wetlands and the deeper bedrock aquifer, and lateral flow within wetland soils in the area is typically very slow. As the FEIS explains in more detail, these factors tend to minimize the potential for indirect drawdown impacts associated with mining activity.

Section 12 of the Application describes the acreage of wetlands that may be affected by mining operations and PolyMet's avoidance, minimization, and mitigation of wetland impacts in conformance with federal and state law. Appendix 18.1 contains the wetland mitigation plans.

5.4 Groundwater and Hydrogeology

Minnesota Rules, part 6132.1100, subpart 5, item B(4) provides that the application must include environmental setting maps that identify and describe hydrogeological information including, but not limited to: (a) plan view and cross-section maps of overburden and rock features; and (b) features on maps including, but not limited to, well locations, uses, well logs, pumping rates and capacities. Figure 5-8 through Figure 5-10 depict these hydrogeological features and wells, and this section describes the map features. Appendix 16 in this Application includes various background documents on groundwater flow and hydrogeology, including Water Management Plans for both the Mine and Plant Site, the Water Characterization Package, and the Water Modeling Data Package for both the Mine and Plant Sites.

Hydrogeology of Mine Site

Depth to bedrock at the Mine Site ranges from zero (at the surface) in outcrop areas to approximately 60 feet below ground surface, based on the data available from the wells located at the Mine Site and in the surrounding area. Figure 5-8 shows depth to bedrock. Depth to groundwater at the Mine Site is typically 5 feet or less, with the water table near the ground surface in topographic lows occupied by wetlands. Figure 5-9 presents contours of groundwater elevations within the surficial aquifer at the Mine Site. Figure 5-9 also shows the location of surficial aquifer monitoring wells at the Mine Site as well as other wells in the vicinity that are archived in Minnesota's "County Well Index" (Reference (6)).

Figure 5-10 shows existing groundwater elevations in bedrock underlying the surficial aquifer. Figure 5-11 through Figure 5-15 present cross-sections showing ground surface, groundwater elevations, and the elevation of the top of bedrock.

As depicted in these figures, the hydrogeologic conditions for the Mine Site can be summarized as follows:

- **Surficial Aquifer.** The surficial aquifer is generally thin, with layers of low hydraulic conductivity. Pumping tests of wells penetrating the entire sequence of glacial material, however, show relatively high conductivities over most of the area, ranging between 0.012 to 31 feet/day. Groundwater at the Mine Site flows from the north/northwest to the south/southwest toward the Partridge River. Groundwater elevations vary seasonally between 3 and 10 feet below ground surface. No domestic uses of groundwater exist in the vicinity of the Mine Site.
- **Bedrock Aquifer.** The Biwabik, Virginia, and Duluth formations underlie the Mine Site. Hydraulic conductivities in all three formations are generally low, with the Biwabik

having the highest conductivities and the Duluth formation the lowest. Also, conductivities decline quickly with depth. Flow direction and water level fluctuations tend to mirror the surficial aquifer in the uppermost bedrock units. The hydraulic connection between the surficial aquifer and bedrock, however, is weak, with insignificant vertical gradients in the bedrock units.

Hydrogeology of Plant Site

The groundwater system at the Plant Site exhibits the same basic characteristics as those present at the Mine Site. The main distinction is the presence of the large saturated tailings basin remaining from past LTVSMC operations. The saturated tailings deposit sits on top of relatively undisturbed tills and has raised groundwater elevations within the footprint of the LTVSMC tailings basin to elevations above the former natural ground level.

Depth to bedrock at the Plant Site is less than 45 feet in the vicinity of the LTVSMC tailings basin, with an average thickness at the toe of the tailings basin of approximately 20 feet and ranging from 3 to 45 feet based on site borings. Figure 5-16 shows a contour map of the uppermost bedrock surface in the vicinity of the Plant Site. Groundwater elevation contours show groundwater flow is largely directed north and northwest from the LTVSMC tailings basin towards the Embarrass River and its tributaries north of the Plant Site (Figure 5-17). Additionally, seepage has also been collected from the south-southeastern side of the LTVSMC tailings basin, which forms the headwaters of Second Creek, a tributary to the Partridge River.

Cross-sections showing the relationship between ground surface, surficial groundwater, and top of bedrock elevations are located on Figure 5-18 through Figure 5-20. As depicted in these figures, the hydrogeologic conditions for the Plant Site can be summarized as follows:

- **Surficial Aquifer**. The LTVSMC tailings basin is the dominating feature of the surficial aquifer at the Plant Site. Conductivities in the area vary significantly in the native units underlying the basin, ranging between 0.4 to 65 feet/day. Groundwater flows generally northward to the Embarrass River in the area, although groundwater in some areas near the Tailings Basin flows south to form the headwaters of Second Creek, which then flows to the Partridge River. Contributions from tailings basin seepage to the aquifer are estimated at 2,020 gallons per minute (gpm). Because this flow rate exceeds the capacity of the aquifer to transmit water in the immediate area of the tailings basin, upwelling has created wetlands around the basin, particularly north of the basin. Groundwater elevations in the area range from 0.33 to 4.6 feet below ground surface.
- **Bedrock**. The Giants Range Granite underlies the surficial deposits at the Plant Site. The geometric mean of hydraulic conductivity values obtained from the packer tests performed in the bedrock borings in 2014 is 0.16 feet/day. This value is judged to be the best estimate characterizing the top 20 feet of bedrock around the Plant Site; it is similar

to a geometric mean of hydraulic conductivity values quoted in literature for the Giants Range Granite. It was observed that a density of fractures often decreases with an increasing core depth, indicating hydraulic conductivity decreasing with depth.

5.5 Surface Water and Groundwater Compliance Monitoring

Minnesota Rules, part 6132.1100, subpart 5, item B(5) requires that the application include environmental setting maps showing the location of surface and groundwater compliance monitoring locations. Additionally, the rules require the application to include water quality and toxicity standards applicable to surface and groundwater as established by other regulatory authorities. The requested water quality and toxicity standards will be regulated under the MPCA’s NPDES/SDS Permit, which will incorporate, as appropriate, applicable federal and state water quality and toxicity standards administered by the MPCA. PolyMet has submitted an NPDES/SDS Permit Application to the MPCA.

The environmental setting maps showing the surface and groundwater compliance monitoring stations proposed in the Project’s NPDES/SDS Permit Application are included as Figures 5-21 through Figure 5-26. Section 14 of the Application summarizes the environmental monitoring programs for the Project including groundwater and surface water monitoring programs regulated under the media-specific permits.

Mine Site and Transportation and Utility Corridors

Figure 5-21 and Figure 5-22 depict the proposed groundwater compliance monitoring stations at and near the Mine Site for the surficial aquifer and bedrock, respectively. Figure 5-23 shows the locations of proposed surface water compliance monitoring stations at and near the Mine Site and along the Transportation and Utility Corridors.

Plant Site

Proposed groundwater compliance monitoring stations at and near the Plant Site are shown on Figure 5-24 for the surficial aquifer and on Figure 5-25 for bedrock. Proposed surface water compliance monitoring stations for the Plant Site are presented on Figure 5-26.

5.6 Soil Inventory

Figure 5-27 is an environmental setting map that shows a soil inventory that includes soil type, extent, and thickness in compliance with Minnesota Rules, part 6132.1100, subpart 5, item B(6). This soil inventory map distinguishes hydric from non-hydric soils. With respect to the Mine Site, the USFS has classified the soils using the Superior National Forest Ecological Classification System, which classifies by different categories of Ecological Land Types (ELT). Table 5-3 shows the ELTs present at the Mine Site and the soil descriptions. For remaining sections of the Mining Area, including the Plant Site, the Colby Lake Pipeline, and most of the Transportation and Utility Corridors, the National Resources Conservation Service (NRCS) has mapped the soils. The NRCS soil names and descriptions for the Project Area are shown in Table 5-4. Soil thicknesses are shown on Figure 5-27.

5.7 Rare, Threatened, and Endangered Species

PolyMet conducted database searches and field surveys to evaluate the presence of protected plant and wildlife species in the vicinity of the Project, as summarized in the Wetland Replacement Plan and FEIS. The Co-Lead Agencies for the FEIS have examined the potential impact, if any, on these species, as part of the required federal and state consultation process, and developed appropriate mitigation measure to address potential impacts. Section 6 of the Application briefly describes this consultation process in support of the FEIS. The focus of these studies was to identify species listed by the State of Minnesota as endangered, threatened, or special concern or listed by the United States Fish and Wildlife Service (USFWS) as endangered or threatened.

5.7.1 Plants

As summarized in Section 5.2.4 of the FEIS, there are no federally-listed plant species identified in the Project area. There are eleven state-listed plant species identified within the Project area, one of which is state-endangered (floating marsh marigold; Caltha natans; Figure 5-28) and ten of which are state-special-concern (Table 5-5). All eleven species will be directly affected by the Project, including the state-endangered Caltha natans. Effects to the eleven directly affected species will involve the complete loss of individuals or colonies within a population as a result of excavation of the mine pits, burial under stockpiles, or disturbance during infrastructure construction.

PolyMet will work with the MDNR and other appropriate agencies to determine acceptable mitigation for directly impacted species.

5.7.2 Wildlife

As summarized in Section 5.2.5 of the FEIS, the Project is expected to affect three federally-listed wildlife species, including Canada lynx (*Lynx canadensis*), gray wolf (*Canis lupus*), and northern long-eared bat (*Myotis septentrionalis*). The Biological Assessment for the Project, submitted by the USACE and the USFS Superior National Forest in April, 2015, found that the Project may affect and is likely to adversely affect Canada lynx, Canada lynx critical habitat, gray wolf, gray wolf critical habitat (Figure 5-28), and northern long-eared bat. The subsequent Biological Opinion issued by the USFWS in February 2016 for the Project (Appendix 18.2) was based on the BA and found that the Project, as proposed, is not likely to jeopardize the continued existence of Canada lynx, gray wolf, or northern long-eared bat. It is also not likely to adversely modify critical habitat for lynx or wolf.

Both the Canada lynx and northern long-eared bat are also state-listed as species of special concern. During Project design, PolyMet has avoided and minimized impacts to Canada lynx, gray wolf, and northern long-eared bat habitats to the extent practicable. PolyMet participated in consultation with the USFWS under Section 7 of the Endangered Species Act (ESA) of 1973, as amended, 16 U.S.C. 1531 *et seq*., to develop and finalize conservation measures in the Biological Opinion to further reduce potential impacts to these species.

In order to preserve and protect undisturbed habitat adjacent to the Project areas, conservation measures in the Biological Opinion stated that PolyMet will manage these areas to provide suitable habitat for use by Canada lynx, gray wolf, and northern long-eared bat. These forestlands would likely be used by Canada lynx and gray wolf as a travel corridor between lands adjacent to the Project area, and for foraging and roosting habitat by northern long-eared bat.

PolyMet intends to clear trees outside of the bat's pup season, which is from June 1 through July 31, to the extent practicable, in order to avoid potential indirect take of the northern long-eared bat, per the Final 4(d) rule published on January 14, 2016. In the event that trees need to be cleared during the pup season, PolyMet will contact USFWS prior to any tree clearing, to determine whether any known, occupied maternal roost trees are documented within 150 feet of the proposed tree clearing. PolyMet will not remove any known occupied maternal roost trees or other trees within 150 feet of a known occupied roost tree during the pup season.

Neither the Partridge River watershed nor the Embarrass River watershed have any recorded locations of federally-listed or state-listed threatened or endangered fish or macroinvertebrate species (Reference (7)).

5.8 Past Mining Facilities

Figure 5-29 is an environmental setting map showing past mining facilities including stockpiles, tailings basins, mine pits, and beneficiating plants in compliance with Minnesota Rules, part 6132.1100, subpart 5, item B(8).

Mining in the vicinity of the Mining Area began with the development of natural iron ore deposits near Aurora around 1907. The Mining Area includes the following past mining facilities: the former LTVSMC taconite processing plant and associated LTVSMC tailings basin, the Area 1 and Area 2 shops (see Figure 3-2 for locations), along with a number of former taconite mining pits that are identified on the figure that were from the former LTVSMC operations and its immediate predecessor Erie Mining Company. As discussed in Sections 8 through 10, the Project is using a number of these existing facilities in its operations consistent with Minnesota's policies encouraging the reuse of existing mining facilities.

5.9 Archeological and Historic Sites

Figure 5-30 and Figure 5-31 include environmental setting maps related to the evaluation of archeological and historic sites within the Mining Area.

The area in which potential effects on cultural resources, including archaeological and historic sites, was evaluated is called the Area of Potential Effects (APE). The APE for the NorthMet Site, which was discussed extensively in Section 4.2.9 of the FEIS, is shown on Figure 5-30. The determination of the APE took into consideration direct effects from surface disturbance, as well as indirect effects related to viewshed, noise, aesthetics, air, and water.

Figure 5-31 shows the numerous cultural resource studies performed within or adjacent to the Facility Boundary. Table 5-6 (and Table 4.2.9-1 of Appendix 16.1) list the properties that were identified within the APE and if the properties were deemed eligible for listing in the National Register of Historic Places (NRHP). Table 5-7 (and Table 4.2.9-2 of Appendix 16.1) list the sites within the APE that are contributing components of the Erie Mining Company Historic District and identifies if the components were deemed eligible for listing in the NRHP.

5.10 Surface and Subsurface Uses

Figure 5-32 through Figure 5-34 are environmental setting maps that show the known surface and subsurface uses, such as pipelines and cables, within the Mining Area. The maps comply with Minnesota Rules, part 6132.1100, subpart 5, and item B(10).

Figure 5-32 shows aboveground and underground facilities and land uses known to exist in the vicinity of the Mine Site, and Figure 5-33 and Figure 5-34 show surface and subsurface facilities known to exist in the vicinity of the Plant Site. The most common land uses in the Mining Area are those associated with mining, including taconite pits, pit lakes, and overburden and rock stockpiles. Additional facilities and uses include several private railroad lines, overhead power lines, various pipelines, and public and private roads. Numerous buildings and aboveground ore processing infrastructure are located in the southern portion of the Plant Site (Figure 5-34). North and west of the Plant Site, land use includes residences and small-scale agricultural operations located approximately one mile away.

5.11 State Mining Excluded, Prohibited, and Restricted Areas

Consistent with Minnesota Rules, part 6132.1100, subpart 5, item B(11), Figure 5-35 shows the Mining Area and those areas where Minnesota Rules, part 6132.2000 excludes, prohibits, or restricts certain mining or surface activities.

As Sections 7 through 10 describe in more detail, the Project facilities comply with the exclusions, prohibitions, and restrictions described in Minnesota Rules, part 6132.2000. Figure 5-35 depicts the Mining Area and various prohibited and restricted areas. Excluded areas are not found within the vicinity of the Project. Specific requirements are summarized in Table 5-8, categorized by the rule subparts.

5.12 Zoning Ordinances and Applicable Land Use Plans

Figure 5-36 is an environmental setting map showing the zoning ordinances and land use plans applicable to the Mining Area as required by Minnesota Rules, part 6132.1100, subpart 5, item B(12).

The Mine Site and the eastern portions of the Transportation and Utility Corridors are within the incorporated limits of the city of Babbitt. This area of Babbitt is zoned for mineral mining activities, including exploration, extraction, processing, and tailings disposal.

The majority of the Plant Site and the west portions of the Transportation and Utility Corridors are within the incorporated limits of the city of Hoyt Lakes. The portion of the Project within the city of Hoyt Lakes is currently zoned for mining and mining-related activities. The northernmost portion of the Plant Site is in Waasa Township and is regulated by the St. Louis County zoning requirements. This area is currently zoned for industrial use under the St. Louis County Comprehensive Land Use Plan. Accordingly, the Project is consistent with applicable zoning ordinances.

The St. Louis River Management Plan identifies guidelines for the development of the St. Louis River and its adjacent (within 0.5 mile) lands. While the Project is greater than 0.5 mile from the St. Louis River shoreline, the St. Louis River Management Plan is part of the St. Louis County Comprehensive Land Use Plan. The Project complies with the St. Louis River Management Plan and the St. Louis County Comprehensive Land Use Plan because it meets specified setbacks for development.

5.13 Surface and Mineral Ownership

Figure 4-1 depicts the surface ownership within the Mining Area based on currently-available information of record in the St. Louis County Recorder’s Office. Figure 4-1 focuses almost exclusively on fee title of record. As discussed in Section 4, PolyMet is party to a number of agreements that provide it various property rights to the surface lands necessary to construct and operate the Project. In addition, the USFS is considering a land exchange that would make PolyMet the fee title owner of much of the federal land within the Mining Area.

Figure 1-6 shows the mineral ownership within the Mining Area based on information of record in the St. Louis County recorder’s office. As discussed in Section 4, PolyMet holds private mineral leases that provide the company with the necessary rights to develop the minerals as proposed in this Application.

Figure 5-37 and Figure 5-38 show the surface and mineral ownership for the transportation and utility corridors and the Colby Lake Pipeline corridor.

Table 5-1 Index of Minnesota Rules, part 6132.1100, subpart 5, item B Environmental Settings Information and Corresponding Figure Numbers

Minnesota Rules, part 6132.1100, subpart 5, item B Environmental Settings Required Information	Corresponding Figure(s) Number
(1) bedrock geology, including the general shape of the ore body and appropriate cross sections that show the horizontal and vertical relationships	5-1 through 5-3[(1)]
(2) water basins, water courses, and wetlands that are or could be affected by mining	5-4 through 5-7
(3) boundaries of watersheds that are or could be affected by mining	5-4 through 5-6
(4) identification and description of hydrogeologic information including, but not limited to: (a) plan view and cross section maps of overburden and rock features; and (b) description of features on maps including, but not limited to, well locations, uses, well logs, pumping rates and capacities[(2)]	5-8 through 5-20
(5) surface water and groundwater compliance monitoring sites as well as water quality and toxicity standards established by other regulatory authorities[(3)]	5-21 through 5-26
(6) a soil inventory including soil type, extent, and thickness	5-27
(7) recorded locations of rare, endangered, and threatened species	5-28
(8) past mining facilities including storage piles, tailings basins, mines, and beneficiating plants	5-29
(9) recorded archeological or historic sites	5-30, 5-31
(10) all known surface and subsurface uses, such as pipelines and cables	5-32 through 5-34
(11) excluded areas identified under part 6132.2000	5-35
(12) zoning ordinances and associated land use plans applicable to the proposed mining area	5-36
(13) surface and mineral rights ownership within the mining area based on information of record in the county recorder's office	1-5, 1-6, 4-1

Notes:

[1] Based on discussions with MDNR, the required maps are provided as 11x17-inch maps.

[2] Pumping rates and capacities are not applicable or available and are not shown.

[3] Water quality and toxicity standards are presented in the NPDES/SDS Permit Application.

Table 5-2 Wetland Summary by Acreage, Quality, Type for Project Areas

Project Area	Wetland Acreage (acres)	Wetland Quality (H = High; M = Moderate; L = Low) (percent)	Dominant Eggers and Reed Wetland Community [1,3] (percent)
Mine Site	1,297.8	H = 92 M = 8	Coniferous Bog = 67 Shrub Swamp = 13 Coniferous Swamp = 10 Sedge/Wet Meadow = 3 Shallow Marsh = 3 Other = 4
Flotation Tailings Basin	238.3	M = 10 L = 90	Deep Marsh = 45 Shallow Marsh = 42 Coniferous Swamp = 6 Shrub Swamp = 6 Other = 1
Hydrometallurgical Residue Facility	36.1	L = 2	Shallow Marsh = 100
Dunka Road and Utility Corridor	6.8	H = 21	Shrub Swamp = 56 Coniferous Swamp = 23 Coniferous Bog = 13 Shallow marsh = 8
Railroad Connection Corridor	0.44	H = 4	Shrub Swamp = 68 Coniferous Swamp = 16 Shallow Marsh = 16
Colby Lake Pipeline	7.0	M = 7 L = 93	Shallow Marsh = 37 Shrub Swamp = 30 Wet Meadow = 19 Deep Marsh = 14

Notes:

1 Shrub swamp includes alder thicket and shrub-carr communities.

2 Wetland information source: PolyMet, 2016. NorthMet Project - Wetland Replacement Plan. Large Table 1. September 2016. Included in Appendix 18.1 of this Application.

3 Reference (8)

Table 5-3 USFS Soils Label Index – Mine Site

USFS Label	USFS Label Description
Non-hydric Soils	
16	Upland Shallow Loamy Dry
Hydric Soils	
1	Lowland Loamy Moist
2	Lowland Loamy Wet
6	Lowland Organic Acid to Neutral
Other	
89	Water (Lake or River), Intermittent Water Body

Notes:
USFS = United States Forest Service
Labels and descriptions are based on the Superior National Forest Ecological Classification System

Table 5-4 NRCS Soils Label Index – Plant Site, Transportation and Utility Corridors, and Colby Lake Pipeline

Map Unit Symbol	NRCS Map Unit Name	Geomorphic Description
Non-hydric Soils		
1003B	Udorthents, loamy (cut and fill land)	fills on moraines, beveled cuts on moraines
F11B	Eaglesnest stony loam, 2 to 8 percent slopes, bouldery	till plains
F12B	Eaglesnest-Babbitt complex, 1 to 8 percent slopes, bouldery	till plains
F13A	Babbitt, bouldery-Aquepts, rubbly, complex, 0 to 3 percent slopes	till plains
F14D	Eveleth stony loam, 8 to 18 percent slopes, bouldery	till plains
F165C	Insula, very bouldery-Rock outcrop-Wahlsten, very bouldery, complex, 2 to 12 percent slopes	drainageways on moraines
F177C	Eveleth-Eaglesnest complex, 2 to 20 percent slopes, very bouldery	moraines
F1C	Eaglesnest stony loam, 4 to 12 percent slopes, very bouldery	moraines, moraines
F22F	Eveleth-Conic complex, 20 to 50 percent slopes, very bouldery	moraines
F26E	Shagawa-Beargrease complex, 8 to 30 percent slopes, extremely bouldery	end moraines
F2B	Eaglesnest-Wahlsten complex, 2 to 8 percent slopes, bouldery	moraines
F30G	Conic, very bouldery-Insula, very bouldery-Rock outcrop complex, 20 to 70 percent slopes	moraines
F35D	Eveleth, bouldery-Conic, bouldery-Aquepts, rubbly, complex, 0 to 18 percent slopes	till plains
F3D	Eveleth-Eaglesnest-Conic complex, 6 to 18 percent slopes, bouldery	moraines
F4E	Eveleth-Conic, bouldery-Rock outcrop complex, 18 to 30 percent slopes	moraines
F5B	Babbitt, bouldery-Wahlsten, bouldery-Aquepts, rubbly, complex, 0 to 8 percent slopes	moraines
F6B	Soudan-Eaglesnest-Babbitt complex, 1 to 8 percent slopes, bouldery	moraines
F9B	Cloquet loam, 2 to 8 percent slopes	outwash plains
Hydric Soils		
1020A	Bowstring and Fluvaquents, loamy, 0 to 2 percent slopes, frequently flooded	flats on flood plains
1021A	Rifle soils, 0 to 1 percent slopes	swamps on end moraines, outwash and till plains
1022A	Greenwood soils, 0 to 1 percent slopes	bogs on end moraines, outwash plains, till plains
F34A	Cathro muck, depressional, 0 to 1 percent slopes	rims on end moraines, outwash and till plains
F129A	Tacoosh mucky peat, 0 to 1 percent slopes	rims on end moraines, outwash and till plains

Map Unit Symbol	NRCS Map Unit Name	Geomorphic Description
F166A	Aquepts, rubbly-Tacoosh-Rifle complex, 0 to 2 percent slopes	drainageways on moraines
Other		
1048	Dumps, iron mine	Not applicable
1049	Pits, iron mine	Not applicable
1050	Tailings basin	Not applicable
W	Water	Not applicable

Notes:
NRCS = National Resources Conservation Service

Reference (9)

Table 5-5 Summary of State-Listed Plants

Scientific Name	Common Name	Minnesota Status	Reference
Caltha natans	Floating Marsh Marigold	Endangered	Walton (2004)(1)
Botrychium campestre	Prairie moonwort	Special Concern	Barr (2011)(2)
Botrychium pallidum	Pale moonwort	Special Concern	Johnson-Groh (2004)(3), Barr (2008)(4)
Botrychium rugulosum	St. Lawrence moonwort	Special Concern	Barr (2007)(5), Johnson-Groh (2004)(3)(6)
Botrychium simplex	Least moonwort	Special Concern	Johnson-Groh (2004)(4), Barr (2011)(2)
Eleocharis nitida	Neat Spikerush	Special Concern	Walton (2004)(1), Barr (2011)(2), Foth Van Dyke (1999)(7)
Juncus stygius var. americanus	Bog Rush	Special Concern	Barr (2011)(2)
Platanthera clavellata	Club-spur Orchid	Special Concern	Barr (2011)(2)
Pyrola minor	Small Shinleaf	Special Concern	Barr (2011)(2)
Ranunculus lapponicus	Lapland Buttercup	Special Concern	Walton (2004)(1)
Torreyochloa pallida	Pale Manna Grass	Special Concern	Walton (2004)(1)

(1) Reference (10)
(2) Reference (11)
(3) Reference (12)
(4) Reference (13)
(5) Reference (14)
(6) Johnson-Groh *Botrychium rugulosum* plants were documented in one location in the Mine Site (Sections 2 and 11 of Township 59N, Range 13W); however, it is not certain that the plants identified at either location are *Botrychium rugulosum*.
(7) Reference (15)

Table 5-6 Cultural Resources Identified in the NorthMet Project Area

Resource ID	Resource Name	Resource Type	NRHP Determination by Co-lead Agencies	SHPO Concurrence with Co-lead Agencies' Findings
SL-HLC-002/040	Erie Mining Company Coarse Crusher	Architectural Property	Not Eligible	Concur
SL-HLC-003/041	Erie Mining Company Fine Crusher	Architectural Property	Not Eligible	Concur
SL-HLC-004/042	Erie Mining Company Conveyor and Drive House	Architectural Property	Not Eligible	Concur
SL-HLC-005/043	Erie Mining Company General Shops	Architectural Property	Not Eligible	Concur
SL-HLC-006/044	Erie Mining Company_Reservoir	Architectural Property	Not Eligible	Concur
SL-HLC-007/045	Erie Mining Company Water Tower	Architectural Property	Not Eligible	Concur
SL-HLC-008/046	Erie Mining Company Concentrator Building	Architectural Property	Eligible	Concur
SL-HLC-009/047	Erie Mining Company Tailings Thickener Tank	Architectural Property	Not Eligible	Concur
SL-HLC-010/048	Erie Mining Company Pelletizing Building (razed)	Architectural Property	Not Eligible	Concur
SL-HLC-011/049	Erie Mining Company Central Heating Plant	Architectural Property	Not Eligible	Concur
SL-HLC-012/050	Erie Mining Company Fuel Oil Tanks	Architectural Property	Not Eligible	Concur
SL-HLC-013/051	Erie Mining Company Pellet Stockpile and Stacker	Architectural Property	Not Eligible	Concur
SL-HLC-014/052	Erie Mining Company Mine Area No. 2 Shops	Architectural Property	Not Eligible	Concur

Resource ID	Resource Name	Resource Type	NRHP Determination by Co-lead Agencies	SHPO Concurrence with Co-lead Agencies' Findings
SL-HLC-015/053	Erie Mining Company Railroad Mine and Plant Track, Main Line Segment, and Dunka Railroad Segment	Architectural Property	Eligible	Concur
SL-HLC-016/054	Erie Mining Company Tailings Basin	Architectural Property	Not Eligible	Concur
SL-HLC-017/055	Erie Mining Company Mine Area No. 1 Shops	Architectural Property	Not Eligible	Concur
SL-HLC-018/056	Erie Mining Company Concentration Plant Complex	Historic District	Not Eligible	Concur
SL-HLC-pending	DM&IR Segment	Architectural Property	Eligible	Concur
SL-HLC-pending	Erie Mining Company Colby Lake Pumping Station and Pipeline	Architectural Property	Not Eligible	Concur
SL-HLC-pending	Erie Mining Company Administration Building	Architectural Property	Eligible	Concur
SL-HLC-pending	Spring Mine and Stockpiles	Architectural Property	Not Eligible	Concur
SL-HLC-pending	Erie Mining Company Mine Area No. 2	Architectural Property	Not Eligible	Concur
SL-HLC-pending	Erie Mining Company Mine Area No. 3	Architectural Property	Not Eligible	Concur
SL-HLC-pending	Erie Mining Company Mine Area No. 5	Architectural Property	Not Eligible	Concur
SL-HLC-pending	Erie Mining Company Dunka Road Segment	Architectural Property	Not Eligible	Concur
SL-HLC-pending	Erie Mining Company High Voltage Transmission Line Segment	Architectural Property	Not Eligible	Concur

Resource ID	Resource Name	Resource Type	NRHP Determination by Co-lead Agencies	SHPO Concurrence with Co-lead Agencies' Findings
SL-HLC-pending	Reserve Crusher No. 2 (Northshore Mining)	Architectural Property	Not Eligible	Concur
SL-HLC-pending	Erie Mining Company Hoyt Lakes Operation Mining Landscape Historic District	Historic District	Eligible	Concur
21SLpending	Spring Mine Lake Sugarbush	Archaeological Site	Eligible	Concur
SL-HLC-065	*Mesabe Widjiu* (Laurentian Divide)	Cultural Landscape	Eligible	Concur
SL-HLC-pending	Overlook	Natural Feature	Not Eligible	Concur
SL-HLC-069	BBLV Trail Segment[1]	Archaeological Site	Eligible	Concur
21SLpending	NorthMet Archaeological Site	Archaeological Site	Not Eligible	Concur
21SLmn	Knot Logging Camp	Archaeological Site	Not Eligible	Concur

Note: Table 4.2.9-1 of Appendix 18.1

1. USFS designation BBLV Trail Segment #1 (USFS #01-569)

Table 5-7 Historic Resources Associated with the Erie Mining Company Historic

Resource ID	Resource Name	Individual Eligibility	Landscape District
SL-HLC-002/040	Erie Mining Company Coarse Crusher	Not Eligible	Contributing
SL-HLC-003/041	Erie Mining Company Fine Crusher	Not Eligible	Contributing
SL-HLC-004/042	Erie Mining Company Conveyor and Drive House	Not Eligible	Contributing
SL-HLC-005/043	Erie Mining Company General Shops	Not Eligible	Contributing
SL-HLC-006/044	Erie Mining Company Reservoir	Not Eligible	Contributing
SL-HLC-007/045	Erie Mining Company Water Tower	Not Eligible	Contributing
SL-HLC-008/046	Erie Mining Company Concentrator Building	Eligible	Contributing
SL-HLC-009/047	Erie Mining Company Tailings Thickener Tanks	Not Eligible	Contributing
SL-HLC-010/048	Erie Mining Company Pelletizing Building (razed)	Demolished	*NIA*
SL-HLC-011/049	Erie Mining Company Central Heating Plant	Not Eligible	Contributing

Resource ID	Resource Name	Individual Eligibility	Landscape District
SL-HLC-012/050	Erie Mining Company Fuel Oil Tanks	Not Eligible	Contributing
SL-HLC-013/051	Erie Mining Company Pellet Stockpile and Stacker	Not Eligible	Contributing
SL-HLC-014/052	Erie Mining Company Mine Area No. 2 Shops	Not Eligible	Contributing
SL-HLC-015/053	Erie Mining Company Railroad Mine and Plant Track, Main Line Segment, and Dunka Railroad Segment	Eligible	Contributing
SL-HLC-016/054	Erie Mining Company Tailings Basin	Not Eligible	Contributing
SL-HLC-017/055	Erie Mining Company Mine Area No. 1 Shops	Not Eligible	Contributing
SL-HLC-018/056	Erie Mining Company Concentration Plant Complex	Not Eligible	Contributing
SL-HLC-pending	Erie Mining Company Colby Lake Pumping Station and Pipeline	Not Eligible	Contributing
SL-HLC-pending	Erie Mining Company Administration Building	Eligible	Contributing
SL-HLC-pending	Spring Mine and Stockpiles	Not Eligible	Non-Contributing
SL-HLC-pending	Erie Mining Company Mine Area No. 2	Not Eligible	Contributing
SL-HLC-pending	Erie Mining Company Mine Area No. 3	Not Eligible	Non-Contributing
SL-HLC-pending	Erie Mining Company Mine Area No. 5	Not Eligible	Non-Contributing
SL-HLC-pending	Erie Mining Company Dunka Road Segment	Not Eligible	Non-Contributing
SL-HLC-pending	Erie Mining Company High Voltage Transmission Line Segment	Not Eligible	Contributing

Note: Table 4.2.9-2 of Appendix 18.1

Table 5-8 Areas Excluded, Prohibited, and Restricted from Mining

Considerations for Mining Exclusion Areas Minnesota Rules, part 6132.2000 Siting			
Subpart 2 Mining Exclusion Areas[1]	**Subpart 3 Surface Disturbance Prohibition Areas[1]**	**Subpart 4 Mining Restricted Areas[1]**	**Comments on Applicability[2]**
A. BWCAW	A. BWCAW	A. Within national wildlife refuge, national waterfowl production area, or national trail.	The Proposed Project is not within close proximity to the BWCAW.
B. Voyageurs National Park	B. Voyageurs National Park		The Proposed Project is not within close proximity to Voyageurs National Park.
C. State wilderness areas	C. State wilderness areas	B. Within state wildlife management area or state designated trail.	The Proposed Project is approximately 2 miles from the Darwin S. Myers state wildlife management area.
D. Agassiz and Tamarac National Wilderness areas, Pipestone and Grand Portage National Monuments	D. Agassiz and Tamarac National Wilderness areas, Pipestone and Grand Portage National Monuments		The Proposed Project is not within close proximity to the Agassiz and Tamarac National Wilderness areas, Pipestone and Grand Portage National Monuments.
E. State scientific and natural areas	E. State scientific and natural areas		The Proposed Project is not within close proximity to SNAs.
F. State peatland scientific and natural areas		C. Peatlands identified as peatland watershed protection areas.	The Proposed Project is not within these areas (Reference (16)).
G. Calcareous fens	G. Calcareous fens		There are no calcareous fens identified in St. Louis or Lake Counties (Reference (17)).
H. A state park	F. State parks		The Proposed Project is not within close proximity to state parks.
	H. Sites Registered in the National Register of Historic Places		There are no sites listed in the National Register of Historic Places in the Mining Area.
	I. Sites Registered in the Registry of State Historic Sites		There are no sites listed in the State Register of Historic Places in the Mining Area.
	J. National wild, scenic, or recreational river districts of a national wild, scenic or recreational river		The Proposed Project is not within close proximity to a national wild, scenic, or recreational river. Segments of the St. Croix River are the only Minnesota waterways listed nationally. (Reference (18)).
	K. Designated state land use districts of a state wild, scenic, or recreational river.		The Proposed Project is not within close proximity to state wild, scenic, or recreational rivers (Reference (16), Reference (19)).
	L. Adjacent to the north shore of Lake Superior		The Proposed Project is not within close proximity to the Lake Superior north shore.
	M. Within 500 feet of a dwelling, or other community building; within 100 feet of a cemetery or outside right-of-way line of a public roadway.[3]		The Proposed Project is not within 500 feet of dwellings or buildings listed. The Colby Lake Pipeline is at some locations in close proximity to CR 666, especially in the vicinity of the Plant entrance.[4]
		D. Within waters identified in the public waters inventory	The Proposed Project area boundary is not in close proximity (within 300 feet of a river/stream; within 1,000 feet of a pond/lake/flowage) to any public waters (Reference (20), Reference (21).

Notes:

1 See the rule for the full description of the requirement.

2 The Proposed Project is considered to not be within close proximity to exclusion, prohibition, and restricted areas if the distance between the Proposed Project and the area is greater than 2 miles.

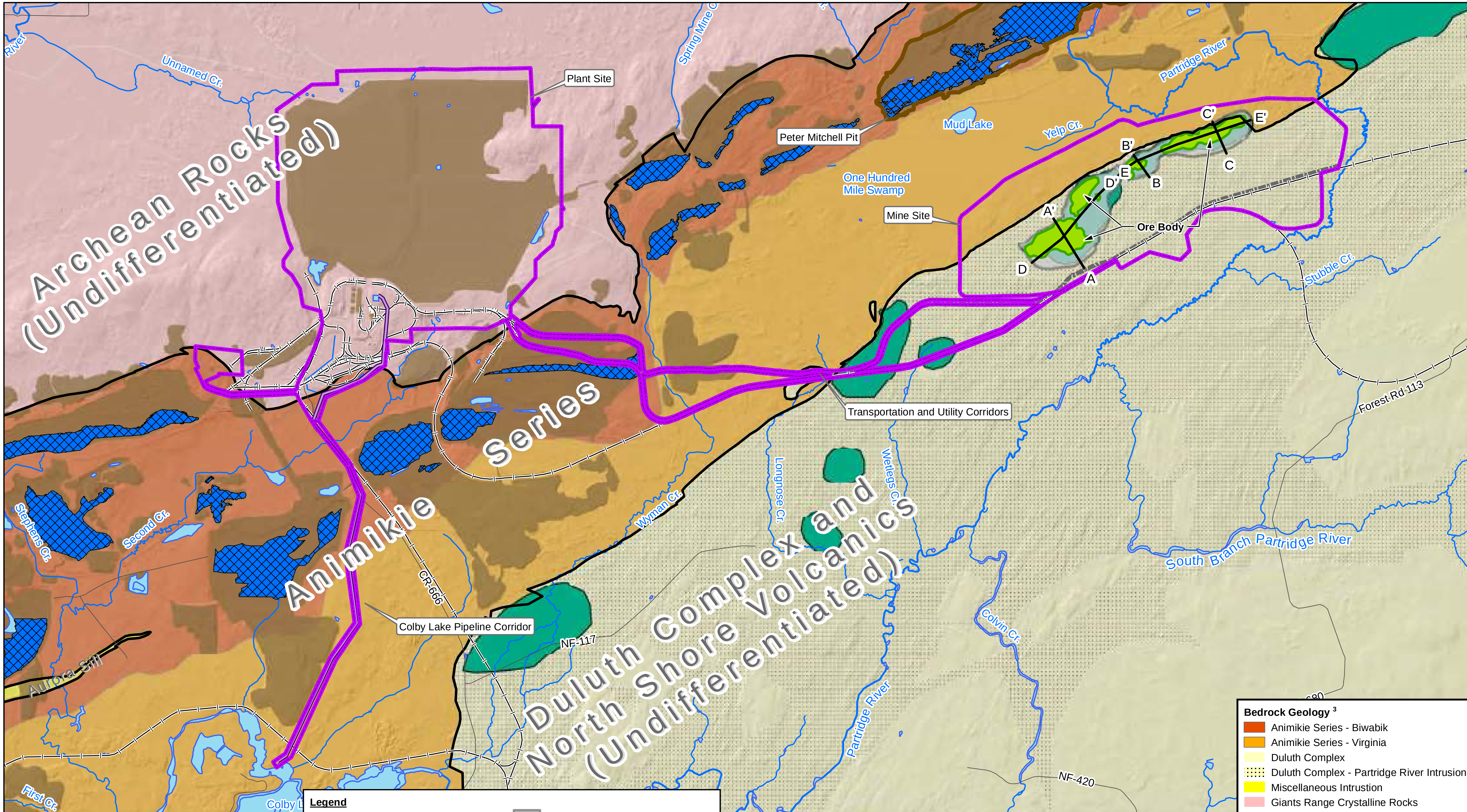
3 Minnesota Rule, part 6132.2000 Subpart 3 M(2) states the outside right-of-way line of a public roadway, except where mine access or haul roads cross the right-of-way.

4 Both the Colby Lake Pipeline and CR 666 were constructed to support previous mining activates and are utilitarian in nature (not an active mining area).

Abbreviations:

BWCAW = Boundary Waters Canoe Area Wilderness

SNA = scientific and natural areas



Notes
1. Project features supplied by Barr Engineering Company.
2. Boundary data from the MnDNR Data Deli.
3. Geology Sources: Jirsa, M.A., Chandler, V.W., and Lively, R.S.,2005, Bedrock Geology of the Mesabi Iron Range, Minnesota: Minnesota Geological Survey Miscellaneous Map M-163, scale 1:100,000. Severson, M.J., and Miller, J.D. Jr., 1999, Bedrock Geology of the Allen Quadrangle: Minnesota Geological Survey Miscellaneous Map 91, scale 1:24,000.
4. Pit Cross sections are shown on Figures 5-2 and 5-3.

Legend
- Roads
- Dunka Road
- Existing Private Railroad
- Colby Lake Pipeline
- Mine Site Cross Section Locations
- Rivers and Streams
- Pit Lakes
- Natural Lakes
- Mine Pits
- Mesabi Range Mining Features (Existing Pits,Tailings Basins, Stockpiles and other Mine Features)
- Duluth Complex Deposits
- Mine Site Block Model Ore Body
- Peter Mitchell Pit
- Facility Boundary

POLYMET MINING

Foth

Foth Infrastructure & Environment, LLC

REVISED	DATE	BY	DESCRIPTION

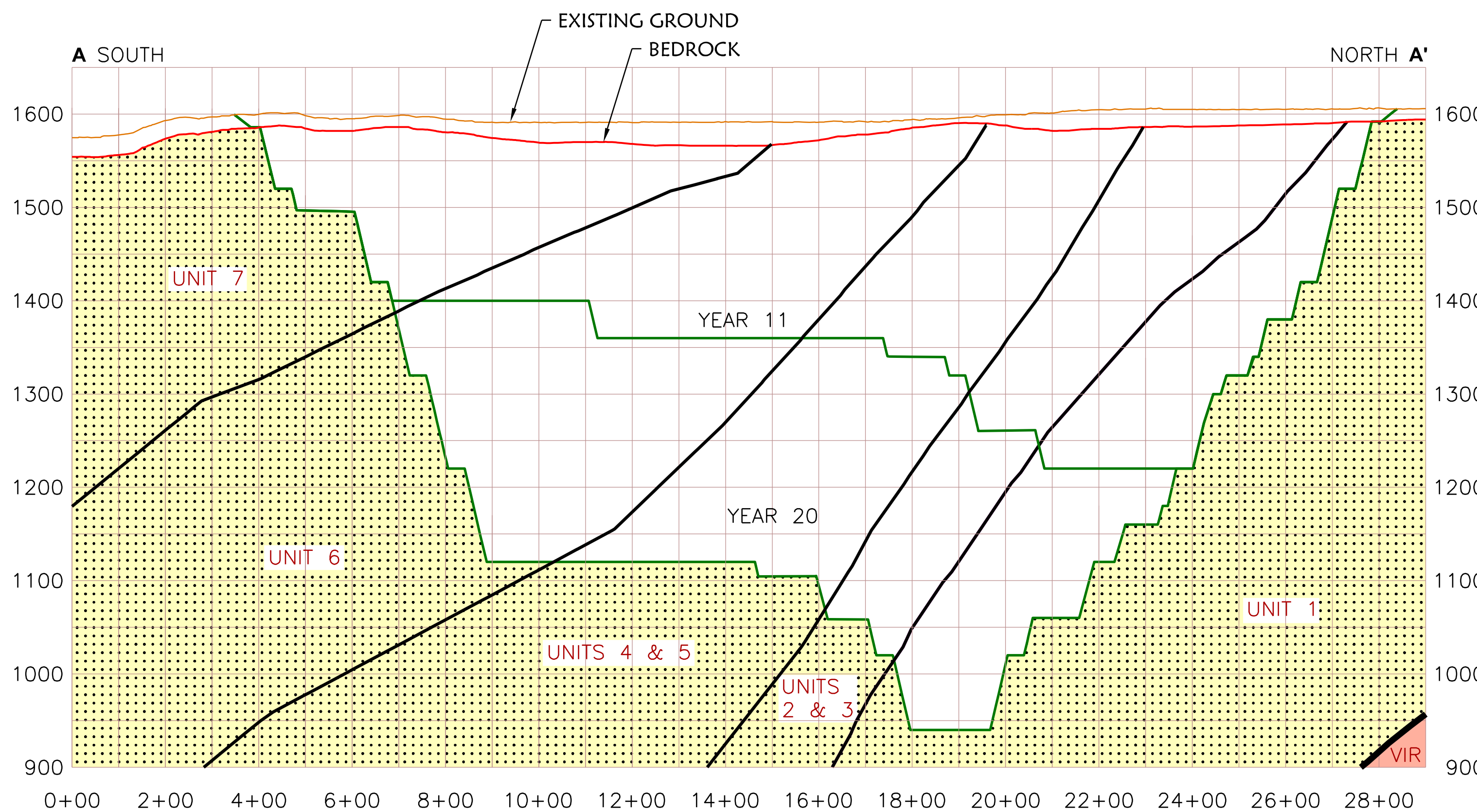
PREPARED BY:	MCC2	DATE:	AUG. '16
REVIEWED BY:	JSL	DATE:	AUG. '16
APPROVED BY:	DRD	DATE:	AUG. '16

POLYMET MINING

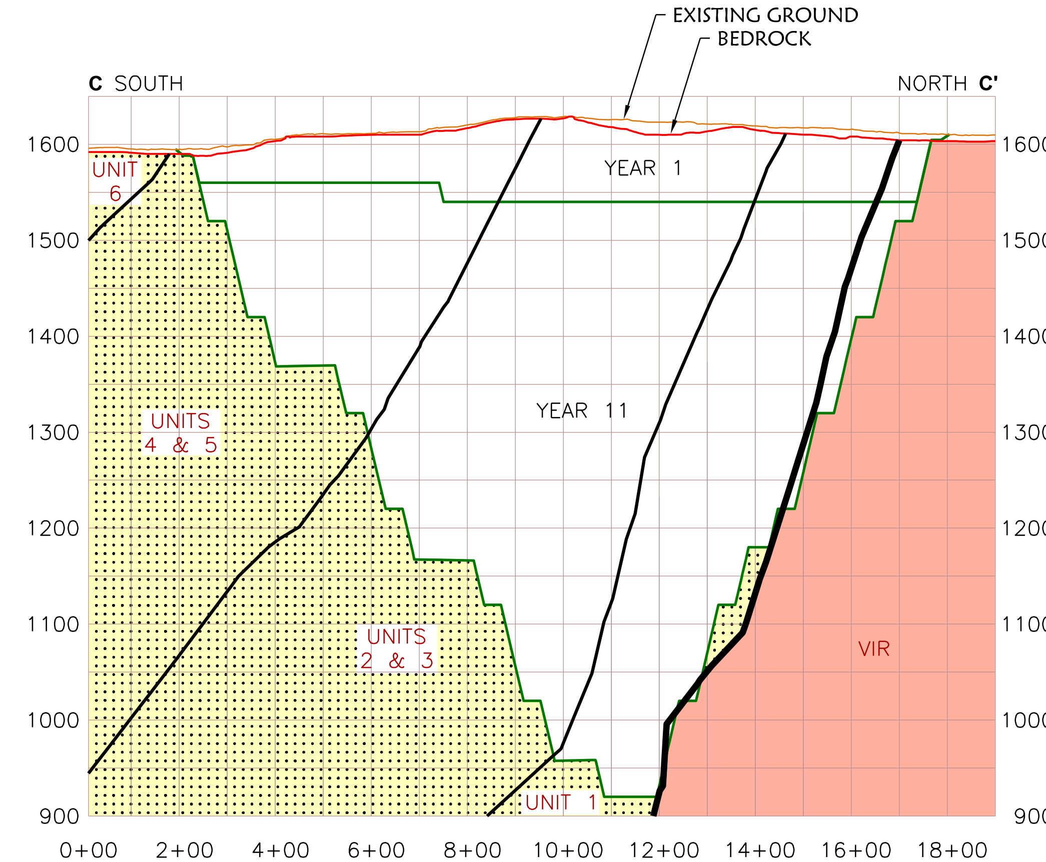
FIGURE 5-1
BEDROCK GEOLOGY
PERMIT TO MINE APPLICATION
HOYT LAKES, MINNESOTA

Scale: 0 2,500 5,000 Feet		Date:	AUGUST 2016
Drafted by:	DAT	Project No:	12P778

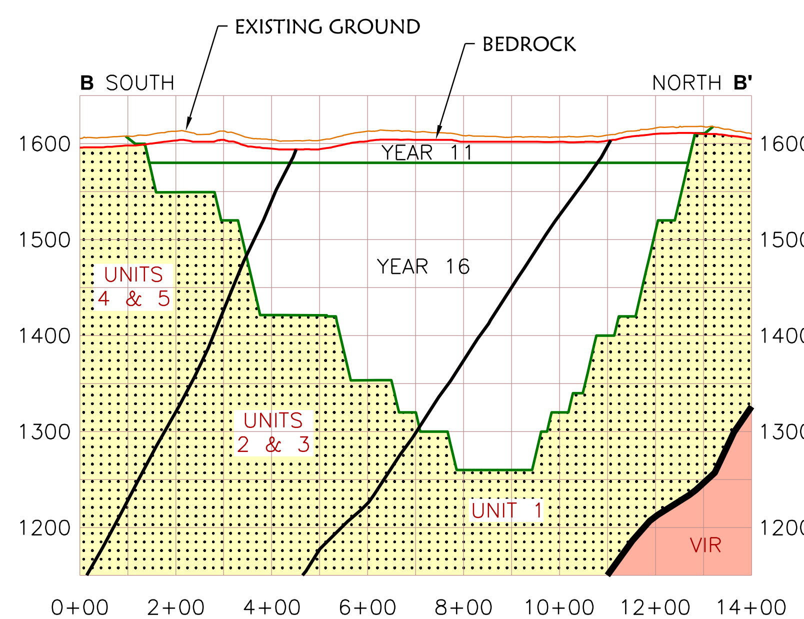
Path: X:\GB\IE\2012\12P778\GIS\mxd\PMA\Figure 5-1 Bedrock Geology.mxd Date: 9/1/2016



A SECTION: WEST PIT
2:1 VERTICAL EXAGGERATION



C SECTION: EAST PIT
2:1 VERTICAL EXAGGERATION



B SECTION: CENTRAL PIT
2:1 VERTICAL EXAGGERATION

LEGEND

UNIT 1-7	PARTRIDGE RIVER INTRUSION DULUTH COMPLEX
VIR	VIRGINIA FORMATION ANIMIKIE SERIES
	GEOLOGIC CONTACT

NOTES:

1. CROSS SECTION LOCATIONS SHOWN ON FIGURE 5-1.
2. FIGURE ADAPTED FROM ROCK AND OVERBURDEN MANAGEMENT PLAN. VERSION 8, JULY 2016 IN APPENDIX 16 OF THE APPLICATION.
3. CENTRAL PIT MINING WOULD BE COMPLETED IN MINE YEAR 16.
4. EAST PIT WILL BE BACKFILLED AS PART OF PROGRESSIVE RECLAMATION BEGINNING IN MINE YEAR 11.

HORIZONTAL 0 400 800
SCALE IN FEET

VERTICAL 0 200 400
SCALE IN FEET

POLYMET MINING

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REVISED	DATE	BY	DESCRIPTION

PREPARED BY: MCC2	DATE:	AUG. '16
REVIEWED BY: JSL	DATE:	AUG. '16
APPROVED BY: DRD	DATE:	AUG. '16

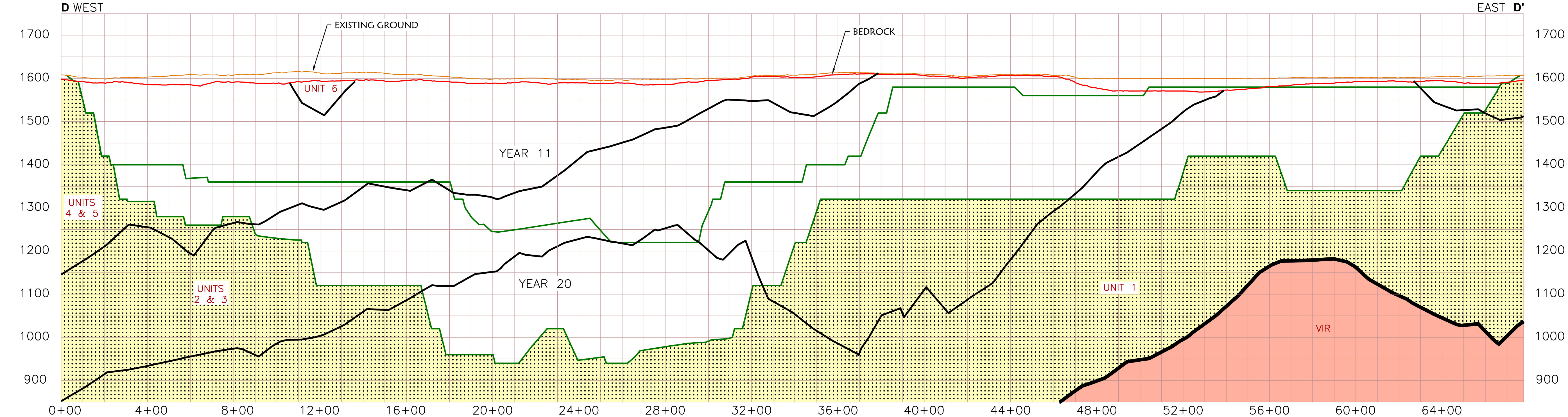
POLYMET MINING

FIGURE 5-2

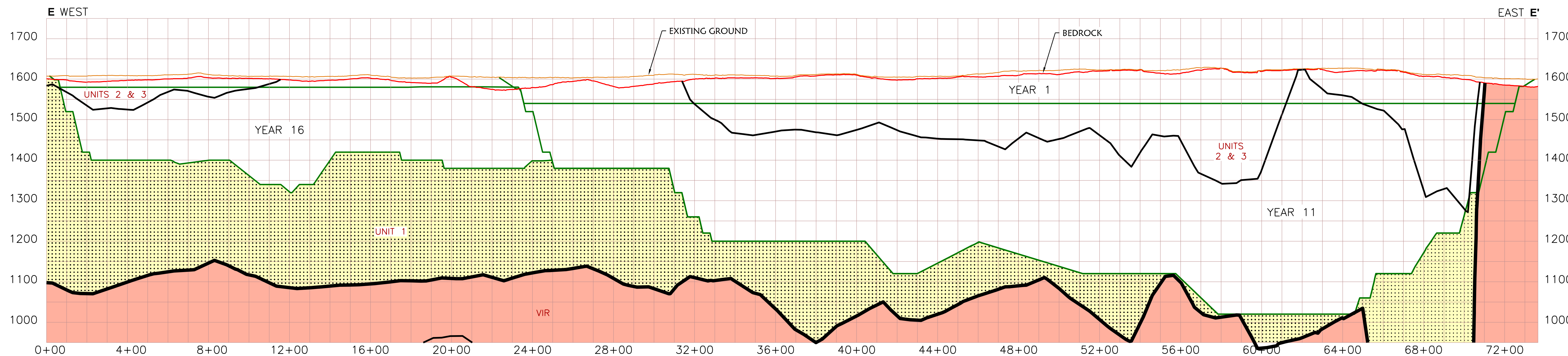
PIT CROSS SECTIONS A, B, C
HOYT LAKES, MINNESOTA

Scale:	NOT TO SCALE	Date:	AUGUST 2016
Drafted By:	JOW	Project No:	12P778

X:\GB\IE\2012\12P778\cad\figures\PMA\Figure 5-2_Geo cross sections A-B-C.dgn
9/1/2016 12:36:51 PM dat



D SECTION: WEST PIT
2:1 VERTICAL EXAGGERATION



E SECTION: EAST PIT
2:1 VERTICAL EXAGGERATION

LEGEND

- UNIT 1-7 — PARTRIDGE RIVER INTRUSION DULUTH COMPLEX
- VIR — VIRGINIA FORMATION ANIMIKIE SERIES
- GEOLOGIC CONTACT

NOTES:

1. CROSS SECTION LOCATIONS SHOWN ON FIGURE 5-1.
2. FIGURE ADAPTED FROM ROCK AND OVERBURDEN MANAGEMENT PLAN, VERSION 8, JULY 2016 IN APPENDIX 16 OF THE APPLICATION.
3. CENTRAL PIT MINING WOULD BE COMPLETED IN MINE YEAR 16.
4. EAST PIT WILL BE BACKFILLED AS PART OF PROGRESSIVE RECLAMATION BEGINNING IN MINE YEAR 11.

HORIZONTAL 0 500 1,000 SCALE IN FEET

VERTICAL 0 250 500 SCALE IN FEET

POLYMET MINING

Foth

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PREPARED BY:	MCC2	DATE: AUG. '16
REVIEWED BY:	JSL	DATE: AUG. '16
APPROVED BY:	DRD	DATE: AUG. '16

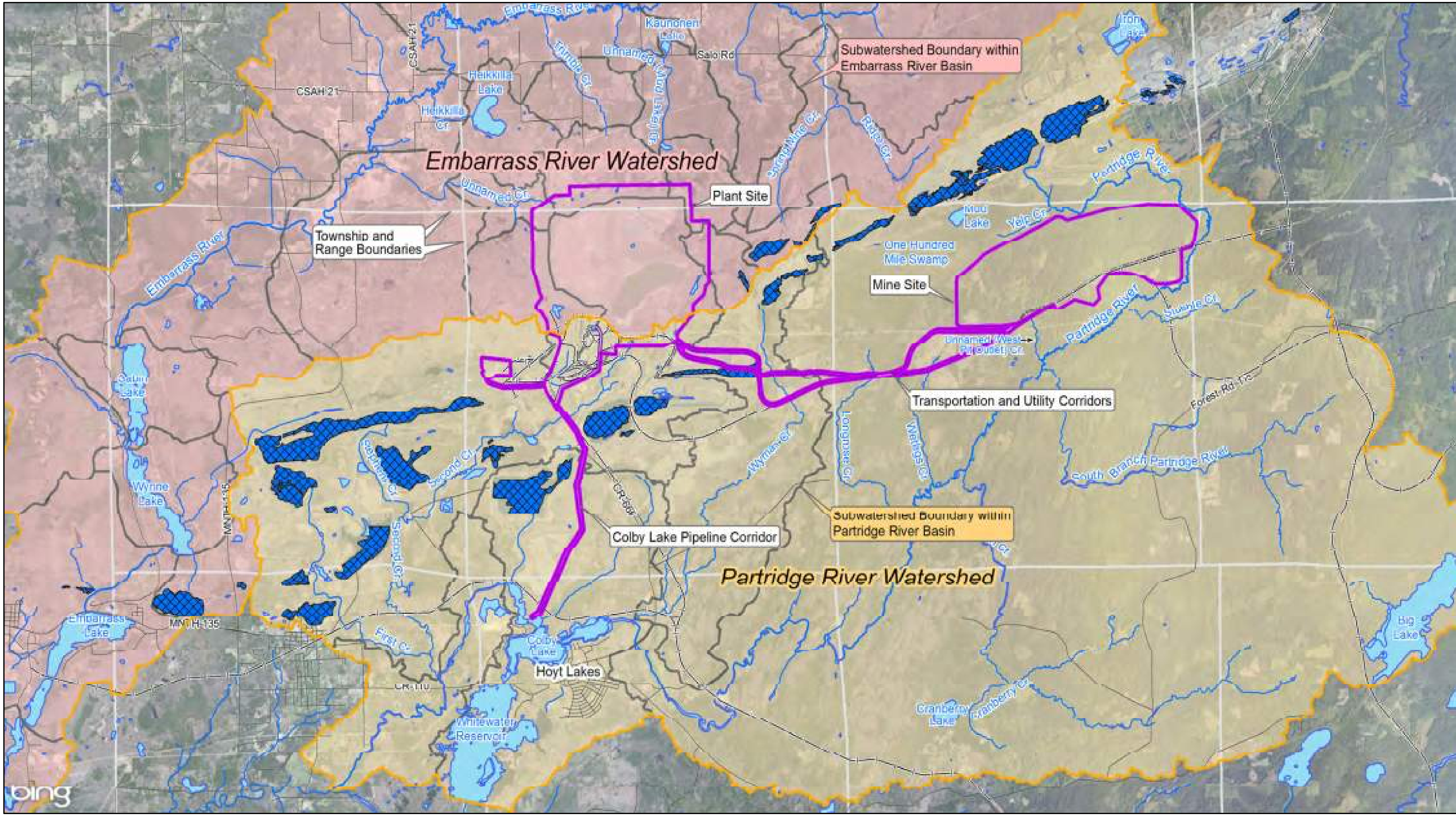
POLYMET MINING

FIGURE 5-3

PIT CROSS SECTIONS D, E
HOYT LAKES, MINNESOTA

Scale:	NOT TO SCALE	Date:	AUGUST 2016
Drafted By:	JOW	Project No:	12P778

X:\GB\IE\2012\12P778\cad\figures\PMA\Figure 5-3 Geo cross sections D-E.dgn
9/1/2016 12:38:01 PM dat



Notes

1. Basemap from Esri and its data suppliers.
2. NHD features are created from MDNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance, data sources may show watercourses that no longer exist.
3. Boundary data from the MnDNR Data Deli.
4. Watershed boundaries correspond to state databases and water quality modeling subdivisions.
5. This map depicts watershed boundaries and water basins, does not depict potential impacts.

Legend

- Roads
- Dunka Road
- Existing Private Railroad
- Colby Lake Pipeline
- Rivers and Streams[2]
- Existing Pit Lakes
- Lakes and Open Water
- Watershed Basin Boundary
- Partridge River Watershed
- Embarrass River Watershed
- Townships
- Facility Boundary

N

POLYMET MINING

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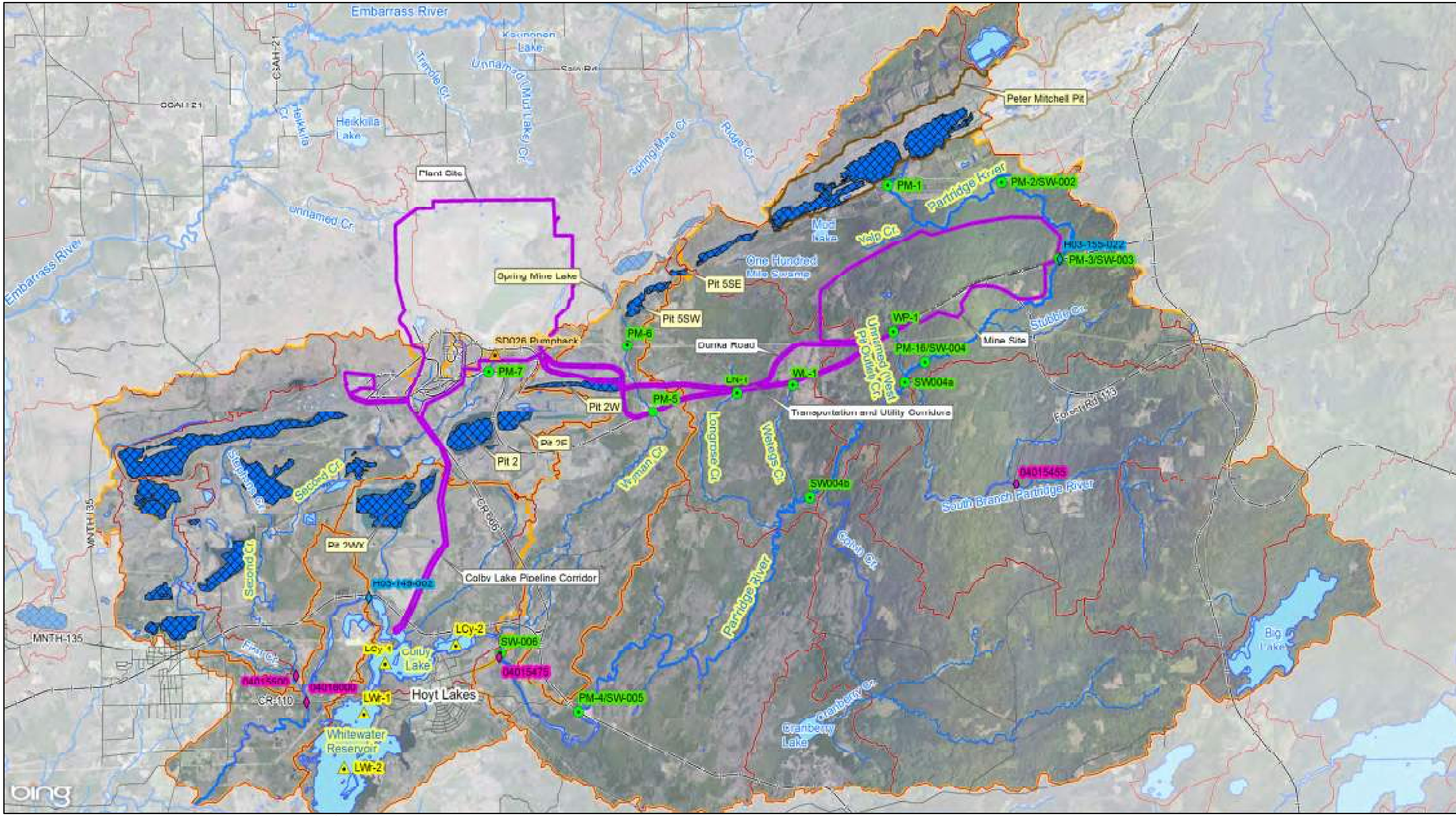
POLYMET MINING

FIGURE 5-4
PROJECT AREA - WATER BASINS AND WATERSHEDS
PERMIT TO MINE APPLICATION
HOYT LAKES, MINNESOTA

Scale: 0 4,000 8,000 Feet	Date: AUGUST 2016
Drafted by: DAT	Project No: 12P778

Path: X:\GB\IE\2012\12P778\GIS\mxd\PMA\Figure 5-4 Watershed Boundaries.mxd Date: 9/1/2016



Notes

1. Basemap from Esri and its data suppliers.
2. NHD features are created from MDNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance, data sources may show watercourses that no longer exist.
3. USGS gaging stations supplied by United States Geological Survey.
4. Watershed boundaries correspond to state databases and water quality modeling subdivisions.
5. This map depicts watershed boundaries and water basins, does not depict potential impacts.

Legend

- Existing USGS Gaging Station
- Existing MDNR Gaging Station
- Existing Surface Water Sampling and/or Modeling Locations
- Existing Lake Sampling and/or Modeling Location
- Existing Seep Temporary Pumpback System
- Roads
- Existing Private Railroad
- Colby Lake Pipeline
- Rivers and Streams[2]
- Existing Pit Lakes
- Lakes and Open Water
- Partridge River Subwatershed Boundary
- MN DNR Catchments (2009)
- Facility Boundary

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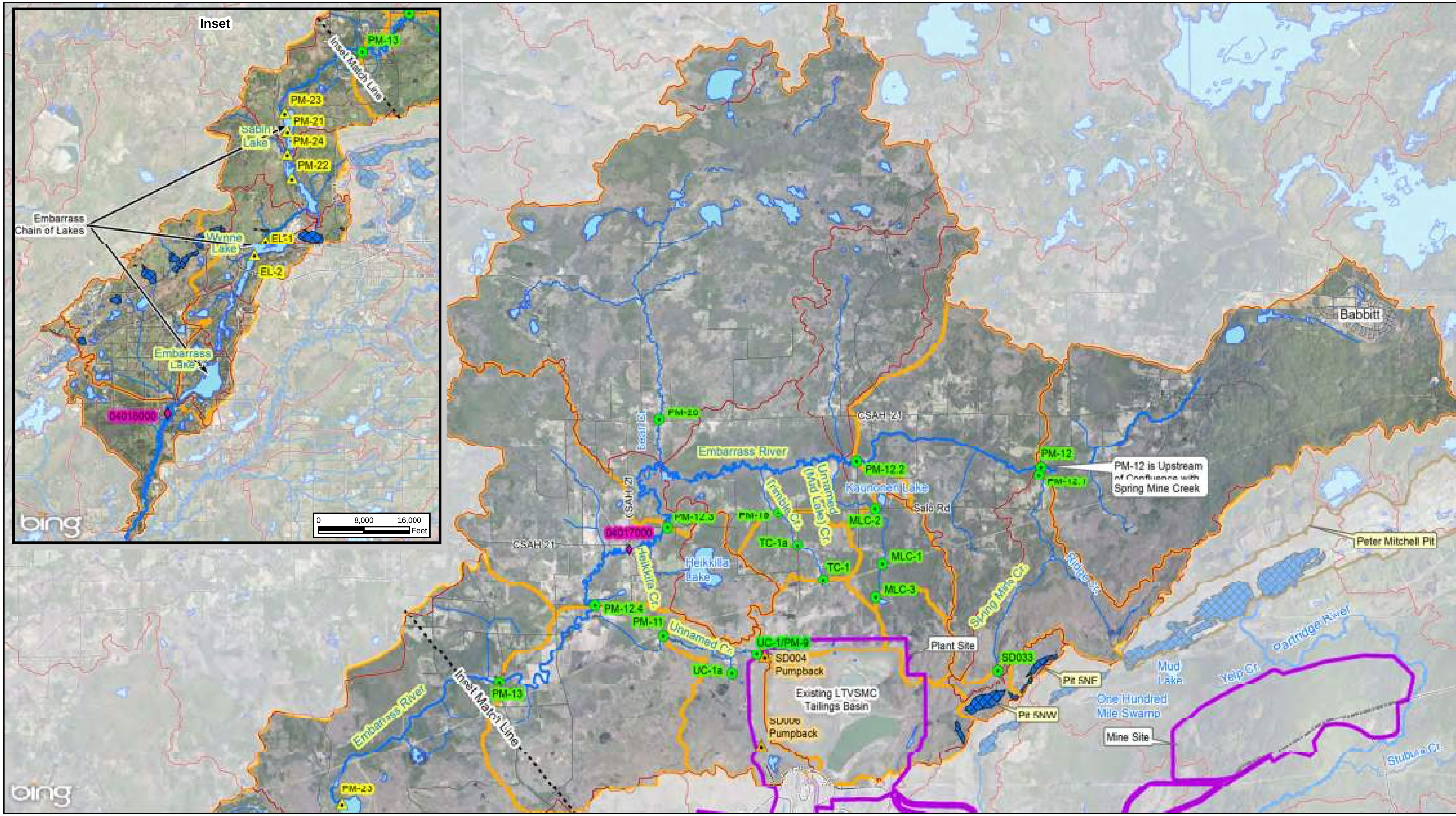
POLYMET MINING

FIGURE 5-5
PROJECT AREA - WATER COURSES IN PARTRIDGE RIVER WATERSHED
PERMIT TO MINE APPLICATION
HOYT LAKES, MINNESOTA

Scale: 0 4,000 8,000 Feet	Date: AUGUST 2016
Drafted by: DAT	Project No: 12P778

Path: X:\GB\IE\2012\12P778\GIS\mxd\PMA\Figure 5-5 Partridge River Watershed.mxd Date: 9/2/2016



Notes

1. Basemap from Esri and its data suppliers.
2. NHD features are created from MDNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance, data sources may show watercourses that no longer exist.
3. USGS gaging stations supplied by United States Geological Survey.
4. Watershed boundaries correspond to state databases and water quality modeling subdivisions.
5. This map depicts water courses and water basins, does not depict potential impacts.

Legend

- Existing USGS Gaging Station
- Existing Surface Water Sampling and/or Modeling Locations
- Existing Lake Sampling and/or Modeling Locations
- Existing Seep Temporary Pumpback System
- Roads
- Existing Private Railroad
- Colby Lake Pipeline
- Rivers and Streams[2]
- Existing Pit Lakes
- Lakes and Open Water
- Embarrass River Subwatershed Boundary
- MN DNR Catchments (2009)
- Facility Boundary

N

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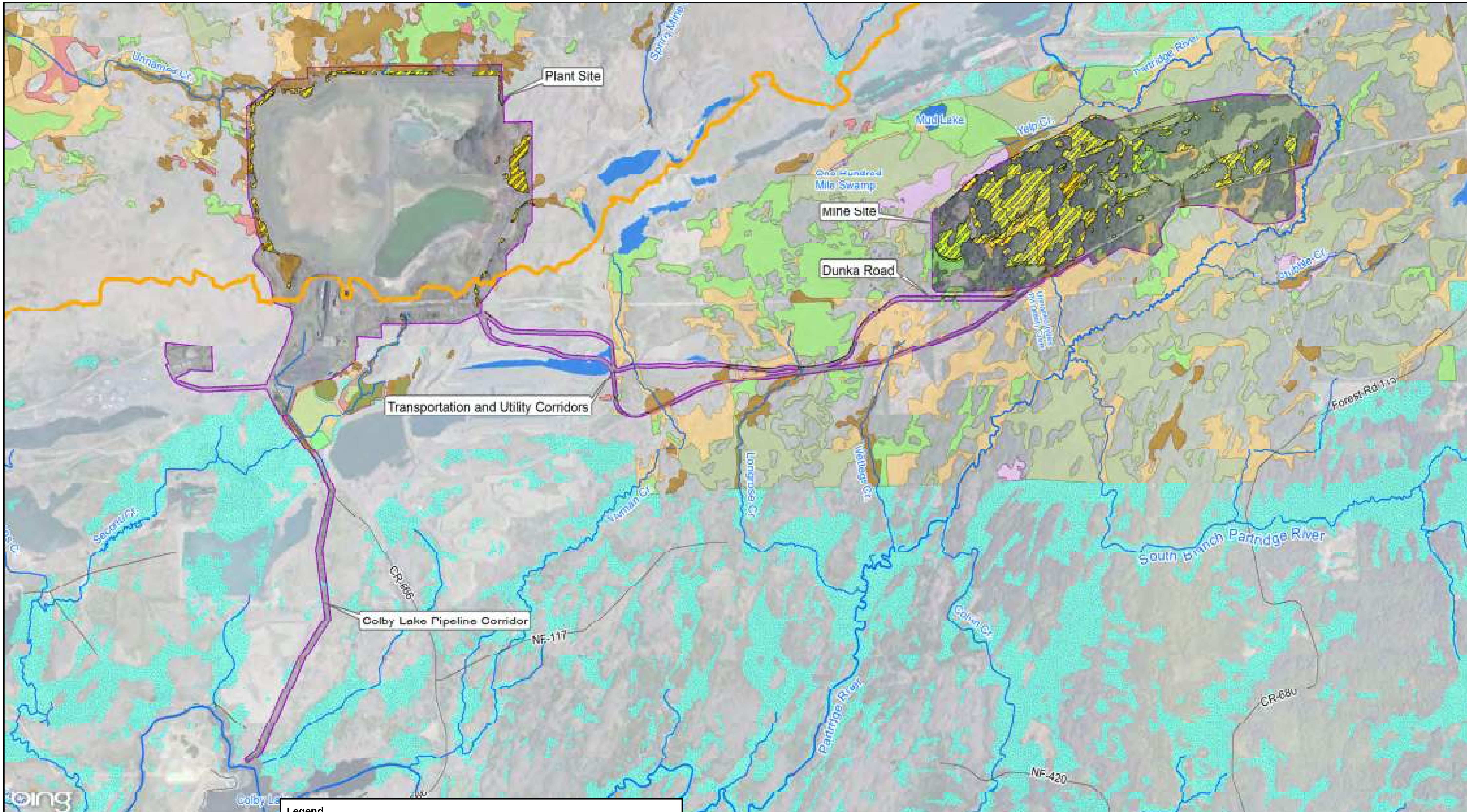
APPROVED BY: DRD		DATE: AUG. '16

POLYMET MINING

FIGURE 5-6
PROJECT AREA - WATER COURSES IN EMBARRASS RIVER WATERSHED
PERMIT TO MINE APPLICATION
HOYT LAKES, MINNESOTA

Scale: 0 4,000 8,000 Feet	Date: AUGUST 2016
Drafted by: DAT	Project No: 12P778

Path: X:\GB\IE\2012\12P778\GIS\mxd\PMA\Figure 5-6 Embarrass River Watershed.mxd Date: 8/24/2016



Notes

1. Basemap from Esri and its data suppliers.
2. NHD features are created from MDNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance, data sources may show watercourses that no longer exist.
3. Boundary data from the MnDNR Data Deli.
4. Wetland data from Wetland Data Package, V 11, April 2015, in Appendix 16 of the Application.

Legend

- Roads
- Rivers and Streams[2]
- Watershed Basin Boundary
- Facility Boundary

National Wetlands Inventory

- Undifferentiated Wetlands
- Direct Wetland Impacts

Eggers & Reed Wetland Types

- Shrub Swamp (Alder thicket & Shrub-carr)
- Coniferous bog
- Coniferous swamp
- Deep marsh; Shallow marsh
- Hardwood swamp
- Open water (Shallow, open water & lakes)
- Open bog
- Sedge meadow; Wet meadow

POLYMET MINING

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REVIEWED BY:	JSL	DATE:	AUG '16
APPROVED BY:	DRD	DATE:	AUG '16

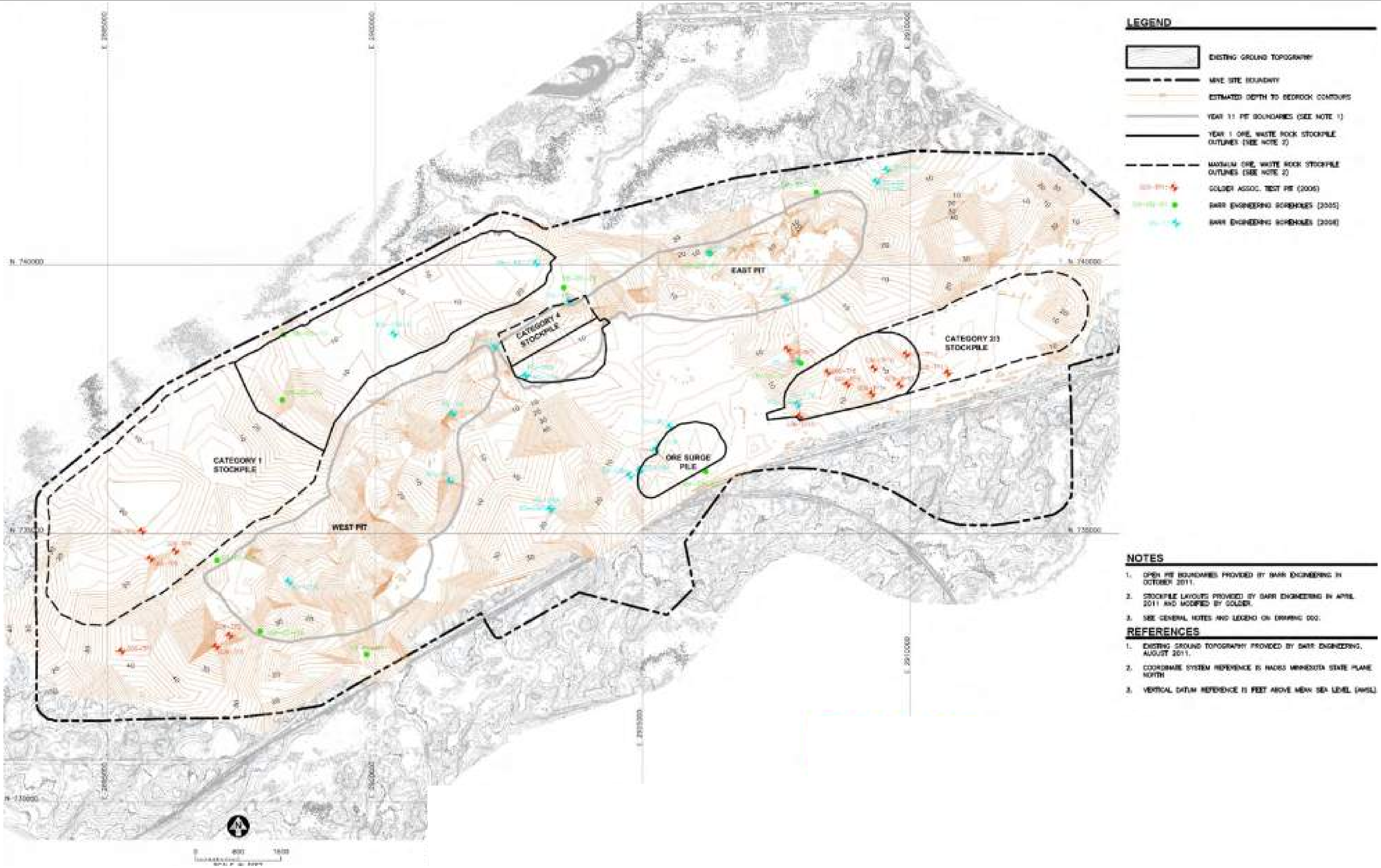
POLYMET MINING

FIGURE 5-7

PROJECT AREA WETLANDS
SHOWING DIRECT WETLAND IMPACTS
PERMIT TO MINE APPLICATION
HOYT LAKES, MINNESOTA

Scale: 0 2,500 5,000 Feet	Date: AUGUST 2016
Drafted by: DAT	Project No: 12P778

Path: X:\GB\IE\2012\12P778\GIS\mxd\PMA\Figure 5-7 Water and Wetlands.mxd Date: 9/1/2016



NOTES
1. Source: Permit Support Drawings - Categories 1, 2/3 and 4 Stockpiles and Ore Surge Pile Design, included in Appendix 4 of the Application.

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PREPARED BY: MJV2			DATE: AUG. '16
REVIEWED BY: RXW			DATE: AUG. '16
APPROVED BY: JOS1			DATE: AUG. '16

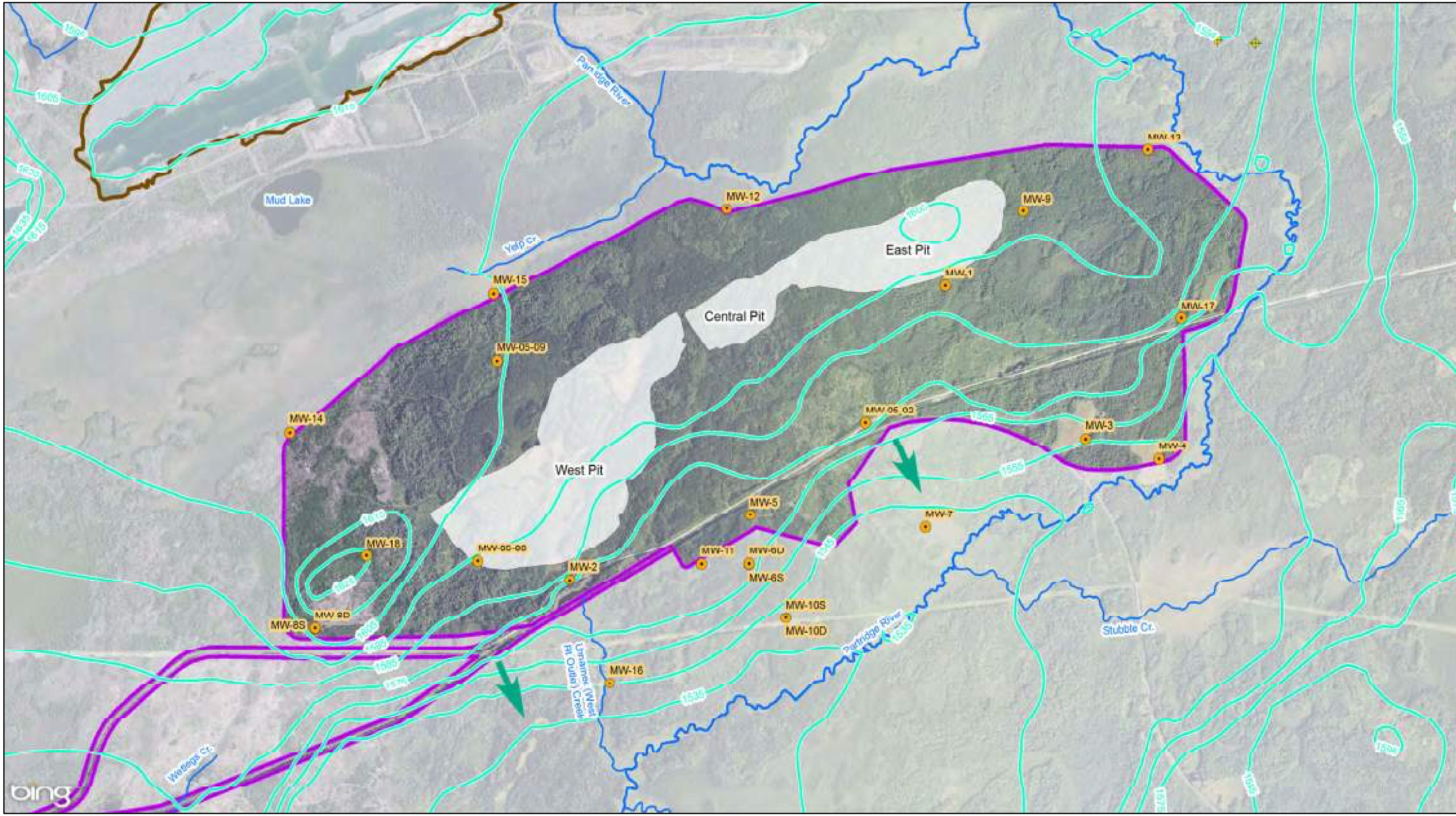
POLYMET MINING

FIGURE 5-8

MINE SITE DEPTH TO BEDROCK
PERMIT TO MINE APPLICATION
HOYT LAKES, MINNESOTA

Scale: AS SHOWN	Date: AUGUST 2016
Drafted by: DAT	Project No: 12P778

Path: X:\GB\IE\2012\12P778\GIS\mxd\PMA\Figure 5-8 Mine Site Depth to Bedrock Contours.mxd Date: 9/1/2016



Notes

1. Basemap from Esri and its data suppliers.
2. Project features supplied by Barr Engineering Company.
3. NHD features are created from MDNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance, data sources may show watercourses that no longer exist.
4. Groundwater elevations shown are based on actual measured elevations near wells in the vicinity of the mine site. Contours are based on modeled groundwater elevations where wells are absent.

Legend

- Monitoring Wells - County Well Index
- Existing Surficial Groundwater Monitoring Location
- 1610 10-Foot Surficial Groundwater Contours
- Rivers and Streams[3]
- Groundwater Flow Direction
- Mine Pits
- Peter Mitchell Pit
- Facility Boundary

POLYMET MINING

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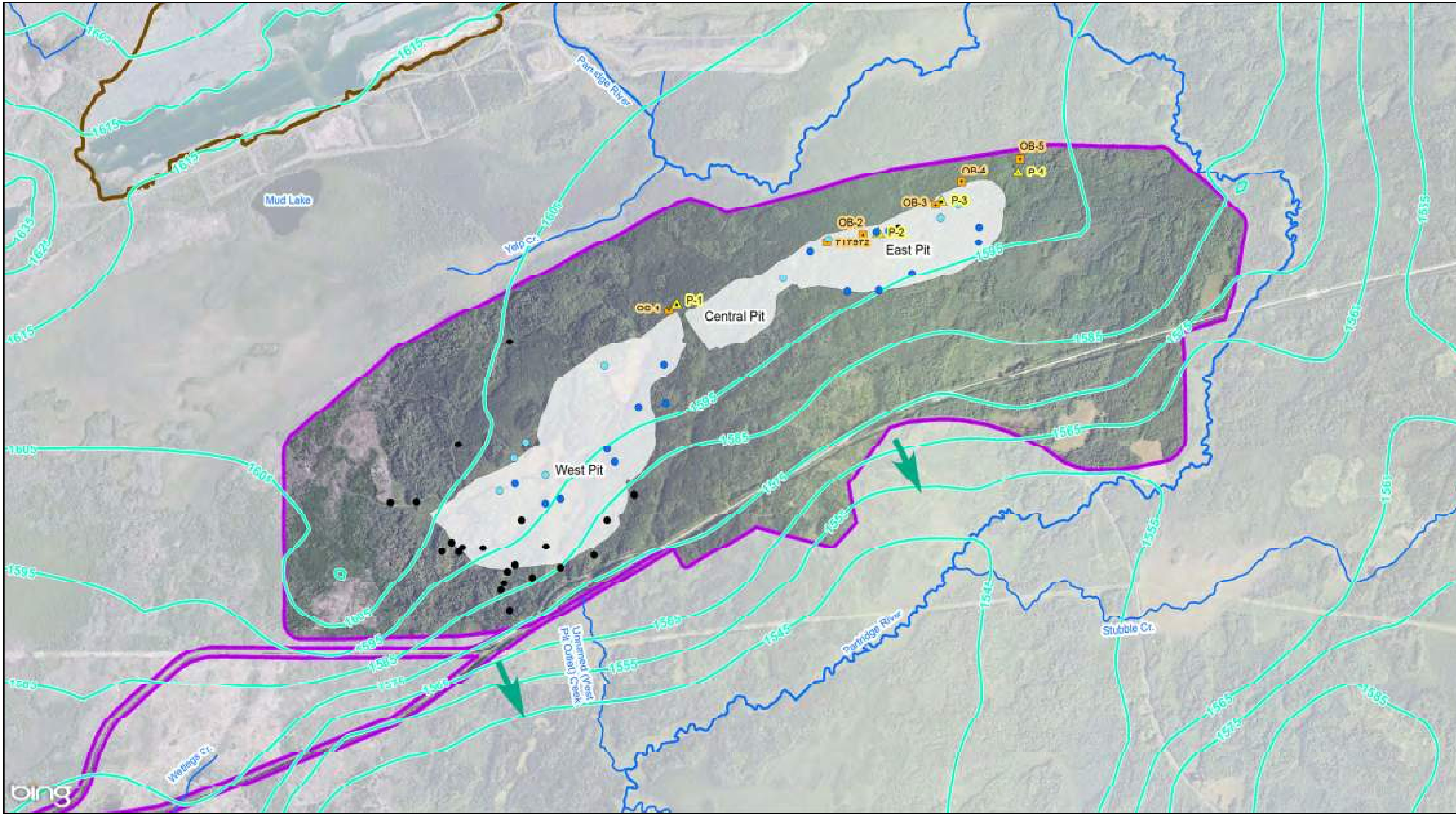
REVIEWED BY: JSL			DATE: AUG. '16
APPROVED BY: DRD			DATE: AUG. '16

POLYMET MINING

FIGURE 5-9
MINE SITE SURFICIAL AQUIFER,
EXISTING GROUNDWATER ELEVATIONS
PERMIT TO MINE APPLICATION
HOYT LAKES, MINNESOTA

Scale: 0 1,000 2,000 Feet	Date: AUGUST 2016
Drafted by: DAT	Project No: 12P778

Path: X:\GB\IE\2012\12P778\GIS\mxd\PMA\Figure 5-9 Mine Site Surficial Aquifer Groundwater Contours.mxd Date: 8/24/2016



Notes

1. Basemap from Esri and its data suppliers.
2. Project features supplied by Barr Engineering Company.
3. NHD features are created from MDNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance, data sources may show watercourses that no longer exist.
4. Groundwater elevations shown are based on actual measured elevations near wells in the vicinity of the mine site. Contours are based on modeled groundwater elevations where wells are absent and away from mine site.

Legend

- Bedrock Aquifer Testing Location - 2005
- Bedrock Groundwater Elevation Measurement - 2006
- Exploratory Borehole Sump Logging Location - 2010
- Existing Deep Bedrock Well
- Existing Shallow Bedrock Well
- 1610 10-Foot Bedrock Groundwater Contours
- Rivers and Streams[3]
- Mine Pits
- Peter Mitchell Pit
- Facility Boundary
- Groundwater Flow Direction

N

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PREPARED BY: MCC2			DATE: AUG. '16
REVIEWED BY: JSL			DATE: AUG. '16
APPROVED BY: DRD			DATE: AUG. '16

POLYMET MINING

FIGURE 5-10
MINE SITE BEDROCK
EXISTING GROUNDWATER ELEVATIONS
PERMIT TO MINE APPLICATION
HOYT LAKES, MINNESOTA

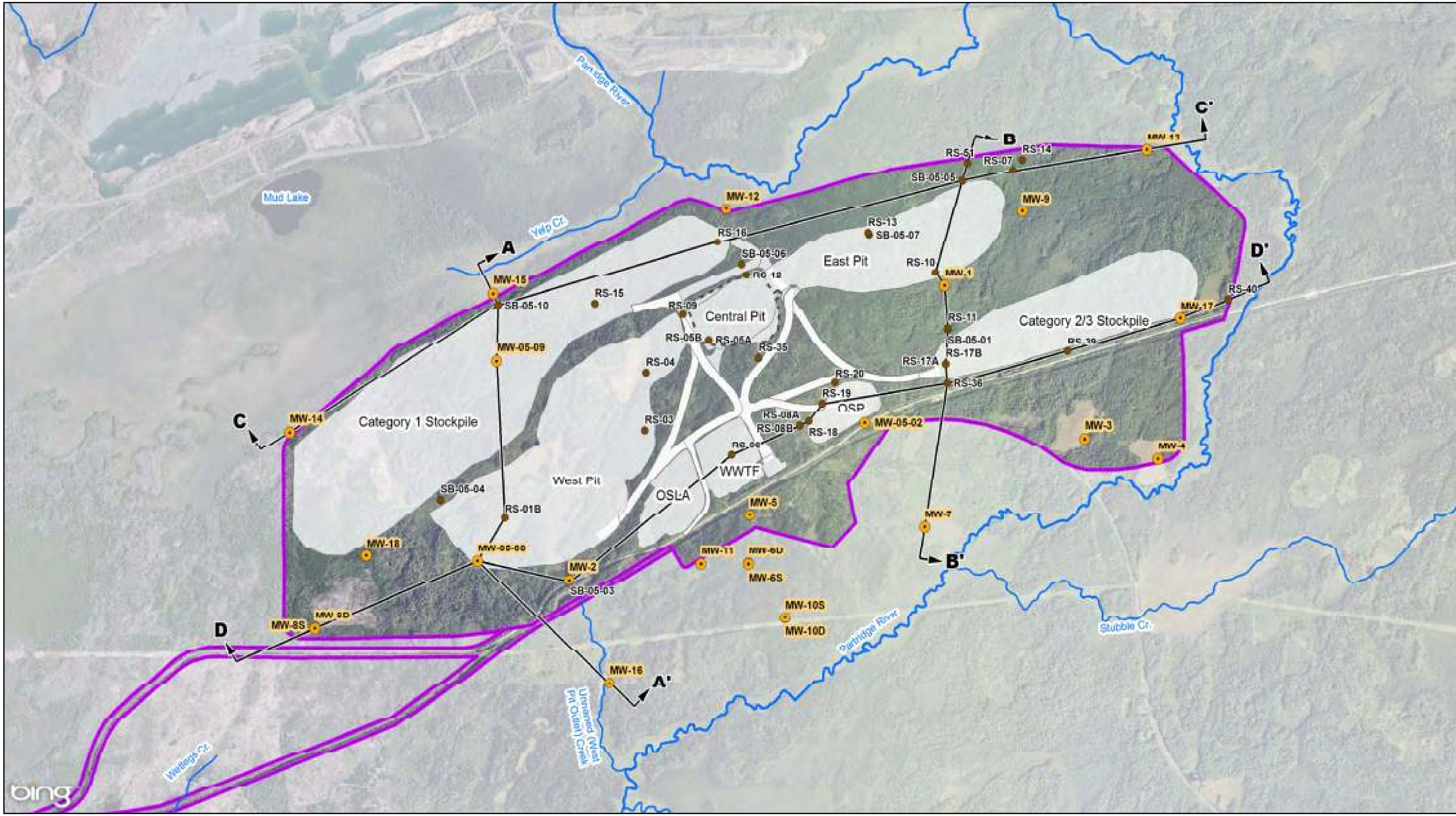
Scale: 0 1,000 2,000 Feet

Date: AUGUST 2016

Drafted by: DAT

Project No: 12P778

Path: X:\GB\IE\2012\12P778\GIS\mxd\PMA\Figure 5-10 Mine Site Bedrock Groundwater Contours.mxd Date: 8/24/2016



Notes

1. Basemap from Esri and its data suppliers.
2. Project features and borehole locations supplied by Barr Engineering Company.
3. NHD features are created from MDNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance, data sources may show watercourses that no longer exist.

Legend

- Existing Monitoring Well Locations
- Existing Geotechnical Drillholes
- Rivers and Streams[3]
- Cross Section Locations
- Mine Site Features
- Category 4 Stockpile
- Facility Boundary

POLYMET MINING

Foth

N

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REVISED	DATE	BY	DESCRIPTION
PREPARED BY: MCC2			DATE: AUG. '16
REVIEWED BY: JSL			DATE: AUG. '16
APPROVED BY: DRD			DATE: AUG. '16

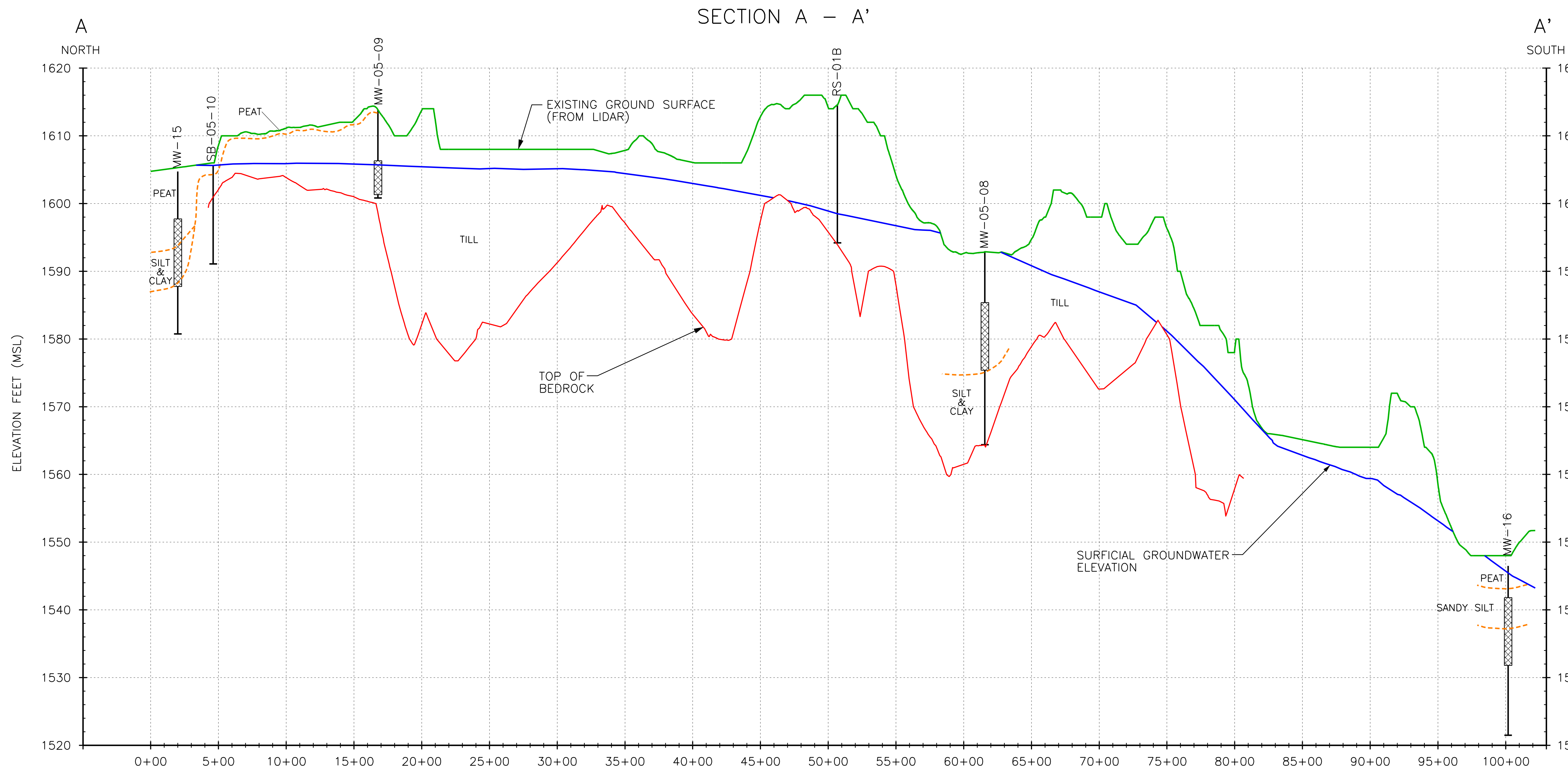
POLYMET MINING

FIGURE 5-11

MINE SITE CROSS SECTION LOCATIONS
PERMIT TO MINE APPLICATION
HOYT LAKES, MINNESOTA

Scale: 0 1,000 2,000 Feet	Date: AUGUST 2016
Drafted by: DAT	Project No: 12P778

Path: X:\GB\IE\2012\12P778\GIS\mxd\PMA\Figure 5-11 Mine Site Cross Section Locations.mxd Date: 8/24/2016

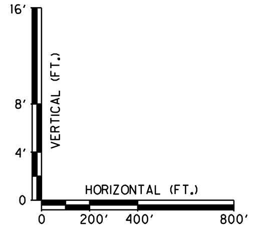


LEGEND:

- EXISTING GROUND
- BEDROCK SURFACE
- SURFICIAL GROUNDWATER ELEVATION
- DENOTES VARIOUS UNCONSOLIDATED TILL FACIES AND PEAT CONTACTS
- WELL SCREEN
- BORING EXTENT

NOTES:

1. LIDAR SOURCE: AEROMETRIC, INC., 2010.
2. GROUNDWATER ELEVATIONS ARE BASED ON ACTUAL MEASURED ELEVATIONS NEAR WELLS IN THE VICINITY OF THE MINE SITE. ELEVATIONS ARE BASED ON MODELED GROUNDWATER ELEVATIONS WHERE WELLS ARE ABSENT.
3. GROUNDWATER AND BEDROCK SURFACES PREPARED BY FOTH WITH BOREHOLE AND MONITORING WELL DATA PROVIDED BY BARR ENGINEERING COMPANY AND POLYMET.
4. CROSS SECTION LOCATIONS ARE SHOWN ON FIGURE 5-11.



SCALE
(50x VERTICAL EXAGGERATION)

POLYMET MINING

Foth

Foth Infrastructure & Environment, LLC			
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PREPARED BY:	BJW1	DATE:	AUG. '16
REVIEWED BY:	JSL	DATE:	AUG. '16
APPROVED BY:	DRD	DATE:	AUG. '16

POLYMET MINING

FIGURE 5-12
MINE SITE CROSS SECTION A – A'
PERMIT TO MINE APPLICATION

Scale:	SEE BAR SCALE	Date:	AUGUST 2016
Drafted By:	JOW	Project No:	12P778

X:\GB\IE\2012\12P778\cad\figures\PMA\Figure 5-12 mine site cross sections A-A'.dgn
8/24/2016 10:55:04 AM bjw1

LEGEND

- EXISTING GROUND
- BEDROCK SURFACE
- SURFICIAL GROUNDWATER ELEVATION
- DENOTES VARIOUS UNCONSOLIDATED TILL FACIES AND PEAT CONTACTS
- WELL SCREEN
- BORING EXTENT

NOTES:

1. LIDAR SOURCE: AEROMETRIC, INC., 2010.
2. GROUNDWATER ELEVATIONS ARE BASED ON ACTUAL MEASURED ELEVATIONS NEAR WELLS IN THE VICINITY OF THE MINE SITE. ELEVATIONS ARE BASED ON MODELED GROUNDWATER ELEVATIONS WHERE WELLS ARE ABSENT.
3. GROUNDWATER AND BEDROCK SURFACES PREPARED BY FOTH WITH BOREHOLE AND MONITORING WELL DATA PROVIDED BY BARR ENGINEERING COMPANY AND POLYMET.
4. CROSS SECTION LOCATIONS ARE SHOWN ON FIGURE 5-11.

16'
8'
4'
0
VERTICAL (FT.)
HORIZONTAL (FT.)
0 200' 400' 800'
SCALE
(50x VERTICAL EXAGGERATION)

POLYMET MINING

Foth

Foth Infrastructure & Environment, LLC			
REVISED	DATE	BY	DESCRIPTION

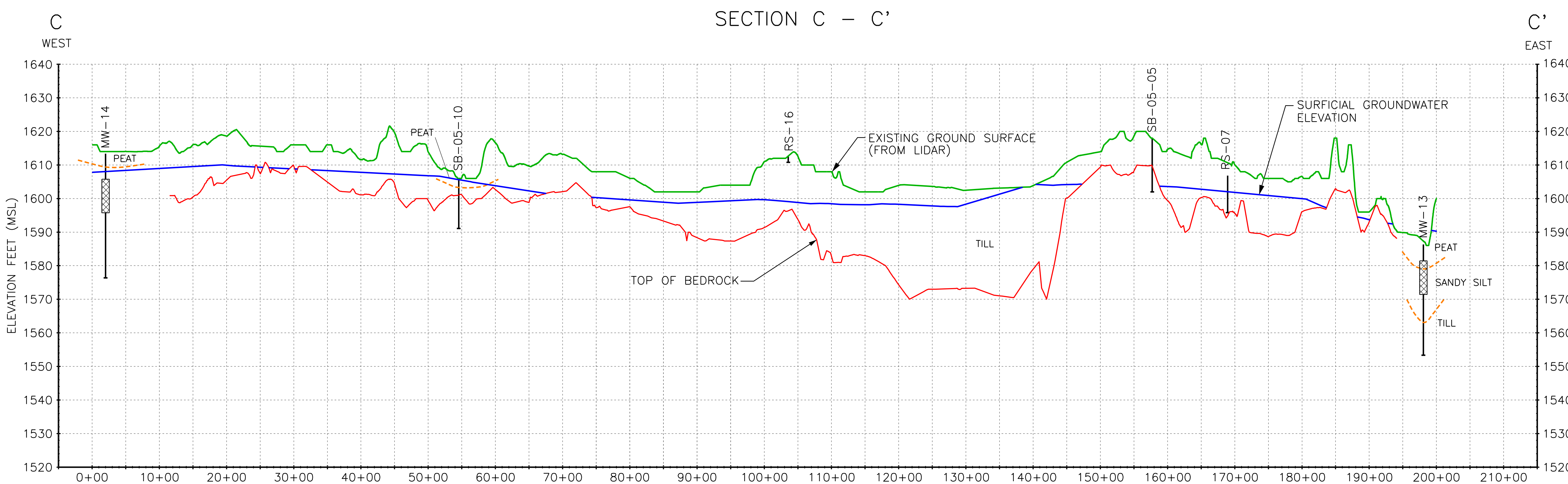
PREPARED BY:	BJW1	DATE: AUG. '16
REVIEWED BY:	JSL	DATE: AUG. '16
APPROVED BY:	DRD	DATE: AUG. '16

POLYMET MINING

FIGURE 5-13
MINE SITE CROSS SECTION B – B'
PERMIT TO MINE APPLICATION

Scale:	SEE BAR SCALE	Date:	AUGUST 2016
Drafted By:	JOW	Project No:	12P778

X:\GB\IE\2012\12P778\cad\figures\PMA\Figure 5-13 mine site cross sections B-B'.dgn
8/24/2016 10:54:12 AM bjw1



LEGEND

EXISTING GROUND

BEDROCK SURFACE

SURFICIAL GROUNDWATER ELEVATION

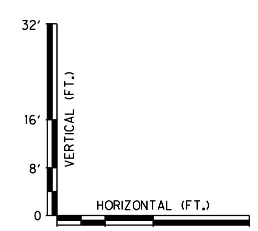
DENOTES VARIOUS UNCONSOLIDATED TILL FACIES AND PEAT CONTACTS

WELL SCREEN

BORING EXTENT

NOTES:

1. LIDAR SOURCE: AEROMETRIC, INC., 2010.
2. GROUNDWATER ELEVATIONS ARE BASED ON ACTUAL MEASURED ELEVATIONS NEAR WELLS IN THE VICINITY OF THE MINE SITE. ELEVATIONS ARE BASED ON MODELED GROUNDWATER ELEVATIONS WHERE WELLS ARE ABSENT.
3. GROUNDWATER AND BEDROCK SURFACES PREPARED BY FOTH WITH BOREHOLE AND MONITORING WELL DATA PROVIDED BY BARR ENGINEERING COMPANY AND POLYMET.
4. CROSS SECTION LOCATIONS ARE SHOWN ON FIGURE 5-11.



SCALE
(50x VERTICAL EXAGGERATION)

POLYMET MINING

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PREPARED BY:	BJW1	DATE: AUG. '16
REVIEWED BY:	JSL	DATE: AUG. '16
APPROVED BY:	DRD	DATE: AUG. '16

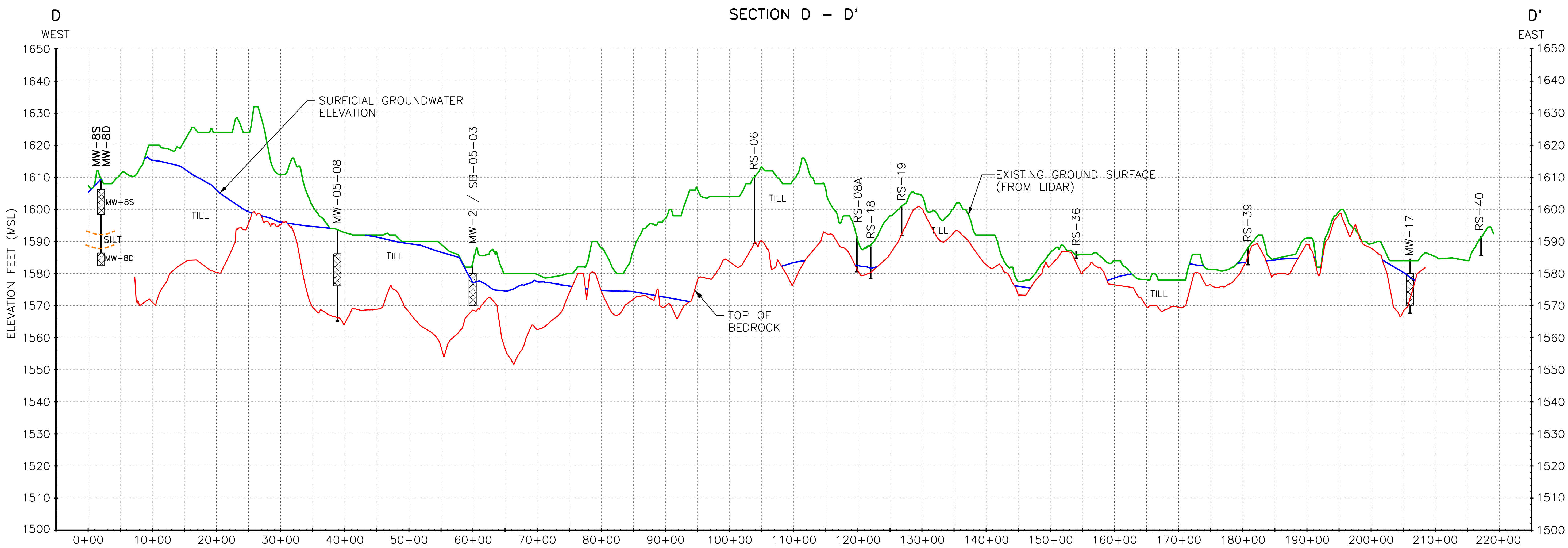
POLYMET MINING

FIGURE 5-14

MINE SITE CROSS SECTION C – C'
PERMIT TO MINE APPLICATION

Scale: SEE BAR SCALE	Date: AUGUST 2016
Drafted By: JOW	Project No: 12P778

X:\GB\IE\2012\12P778\cad\figures\PMA\Figure 5-14 mine site cross sections C-C'.dgn
8/22/2016 3:38:09 PM bjw1



LEGEND

EXISTING GROUND

BEDROCK SURFACE

SURFICIAL GROUNDWATER ELEVATION

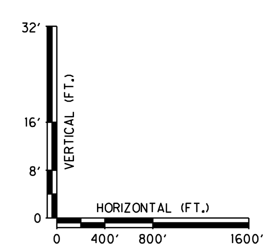
DENOTES VARIOUS UNCONSOLIDATED TILL FACIES AND PEAT CONTACTS

WELL SCREEN

BORING EXTENT

NOTES:

1. LIDAR SOURCE: AEROMETRIC, INC., 2010.
2. GROUNDWATER ELEVATIONS ARE BASED ON ACTUAL MEASURED ELEVATIONS NEAR WELLS IN THE VICINITY OF THE MINE SITE. ELEVATIONS ARE BASED ON MODELED GROUNDWATER ELEVATIONS WHERE WELLS ARE ABSENT.
3. GROUNDWATER AND BEDROCK SURFACES PREPARED BY FOTH WITH BOREHOLE AND MONITORING WELL DATA PROVIDED BY BARR ENGINEERING COMPANY AND POLYMET.
4. CROSS SECTION LOCATIONS ARE SHOWN ON FIGURE 5-11.



SCALE
(50x VERTICAL EXAGGERATION)

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REVIEWED BY:	JSL	DATE: AUG. '16
APPROVED BY:	DRD	DATE: AUG. '16

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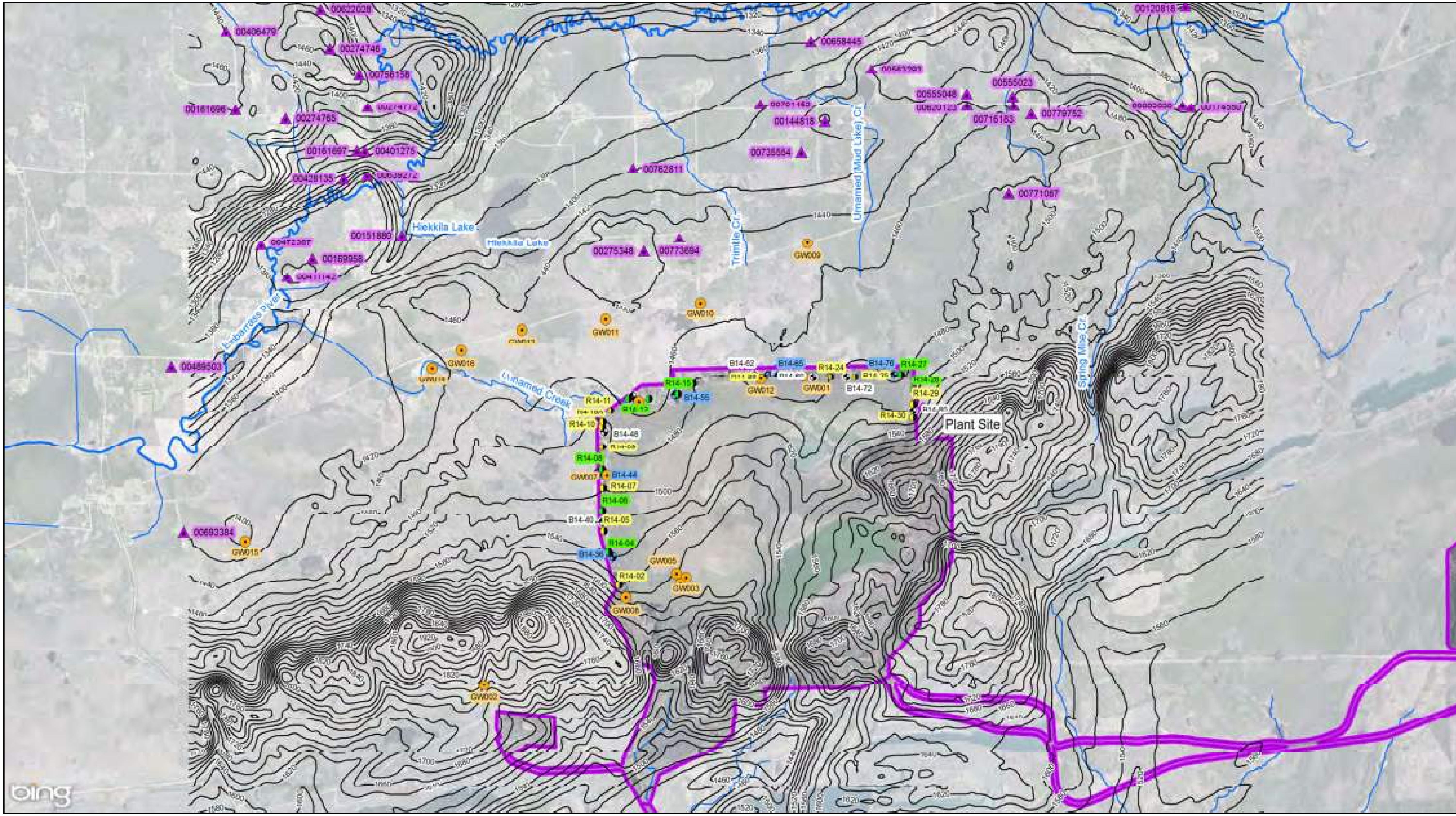
FIGURE 5-15

MINE SITE CROSS SECTION D – D'
PERMIT TO MINE APPLICATION

Scale:	SEE BAR SCALE	Date:	AUGUST 2016
Drafted By:	JOW	Project No:	12P778

X:\GB\IE\2012\12P778\cad\figures\PMA\Figure 5-15 mine site cross sections D-D'.dgn
8/22/2016 3:40:24 PM bjw1



Notes

1. Basemap from Esri and its data suppliers.
2. Bedrock elevations were calculated using a combined bedrock data set, derived from a regional, 30-meter resolution MGS bedrock surface[3], into which local bedrock data were incorporated.
3. Jirsa, Mark, D. Setterholm, B. Bloomgren, E. Bauer, and R. S. Lively. 2005. Minnesota Geological Survey Map M-158, scale 1:100,000.
4. Monitoring well locations supplied by Barr Engineering Company.
5. Geotechnical boring locations from Figure B-1 (Attachment B) from Geotechnical Data Package Vol 1 (FTB) v6.

Legend

- Existing Monitoring Wells
- 2014 Rotasonic Location
- 2014 Rotasonic Location with a Piezometer
- 2014 Boring Locations
- 2014 Boring Locations with a Packer
- Residential Wells from County Well Index
- 20-Foot Bedrock Surface Contours
- Rivers and Streams
- Facility Boundary

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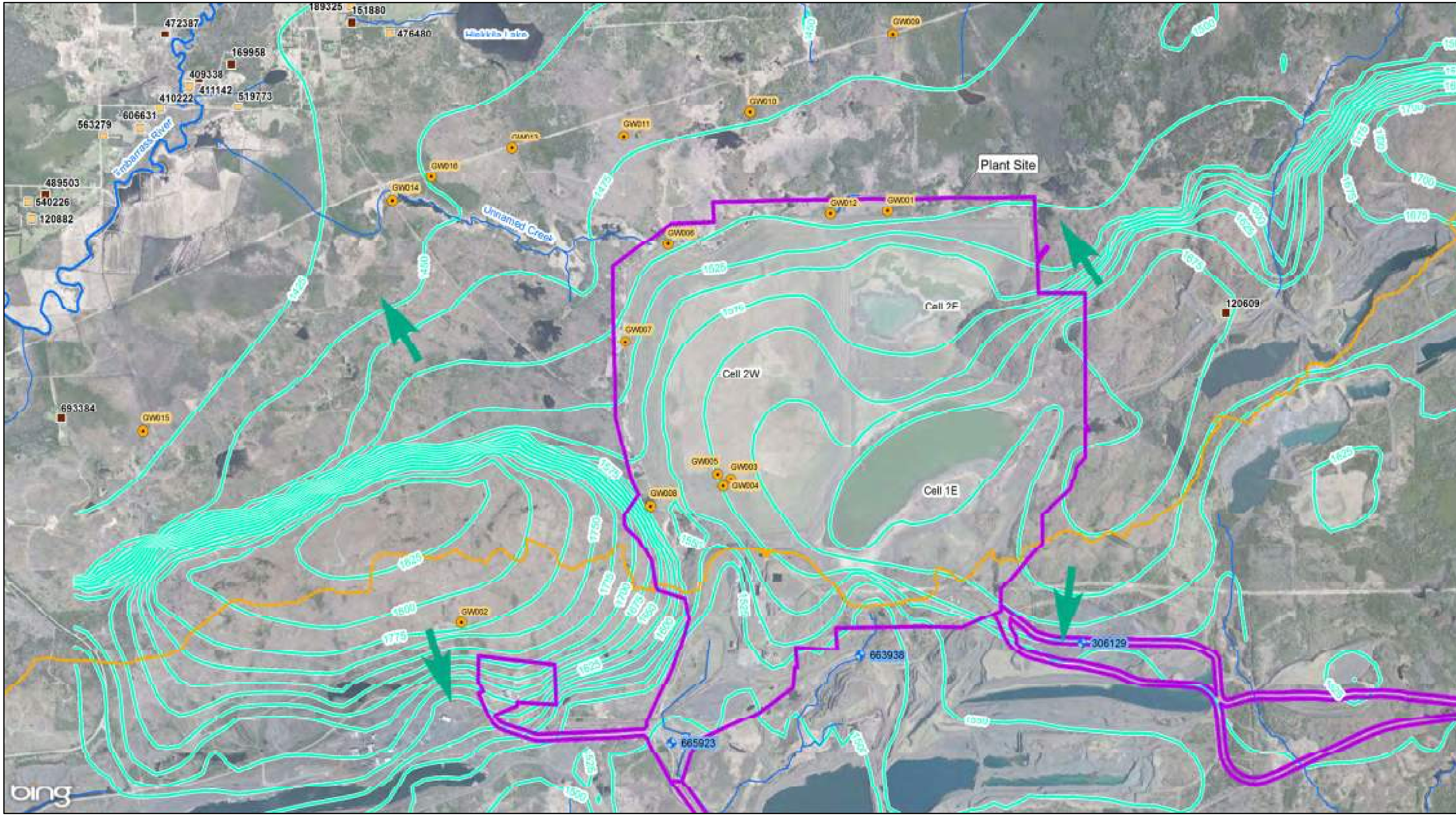
POLYMET MINING

FIGURE 5-16

PLANT SITE BEDROCK CONTOURS
PERMIT TO MINE APPLICATION
HOYT LAKES, MINNESOTA

Scale: 0 2,000 4,000 Feet
Date: AUGUST 2016
Drafted by: BJW1
Project No: 12P778

Path: X:\GB\IE\2012\12P778\GIS\mxd\PMA\Figure 5-16 Plant Site Bedrock Surface Contours.mxd Date: 8/31/2016



Notes

1. Basemap from Esri and its data suppliers.
2. Project features supplied by Barr Engineering Company.
3. Boundary data from the MnDNR Data Deli.
4. Well records from Minnesota Department of Health and Minnesota Geological Survey. County Well Index (CWI) Online (http://www.health.state.mn.us/divs/eh/cwi/)
5. Inferred water table contours were developed using the Plant Site MODFLOW model. Contours are water levels calibrated to current conditions measured values (Barr, WMDP-PS v11).

Legend

- Test Holes from County Well Index [4]
- Existing Monitoring Wells
- CWI Water Supply Well Completed in Bedrock
- CWI Water Supply Well Completed in Surficial Material
- 1600 25ft Surficial Groundwater Contours[5]
- Rivers and Streams
- Watershed Basin Boundary
- Facility Boundary
- Groundwater Flow Direction

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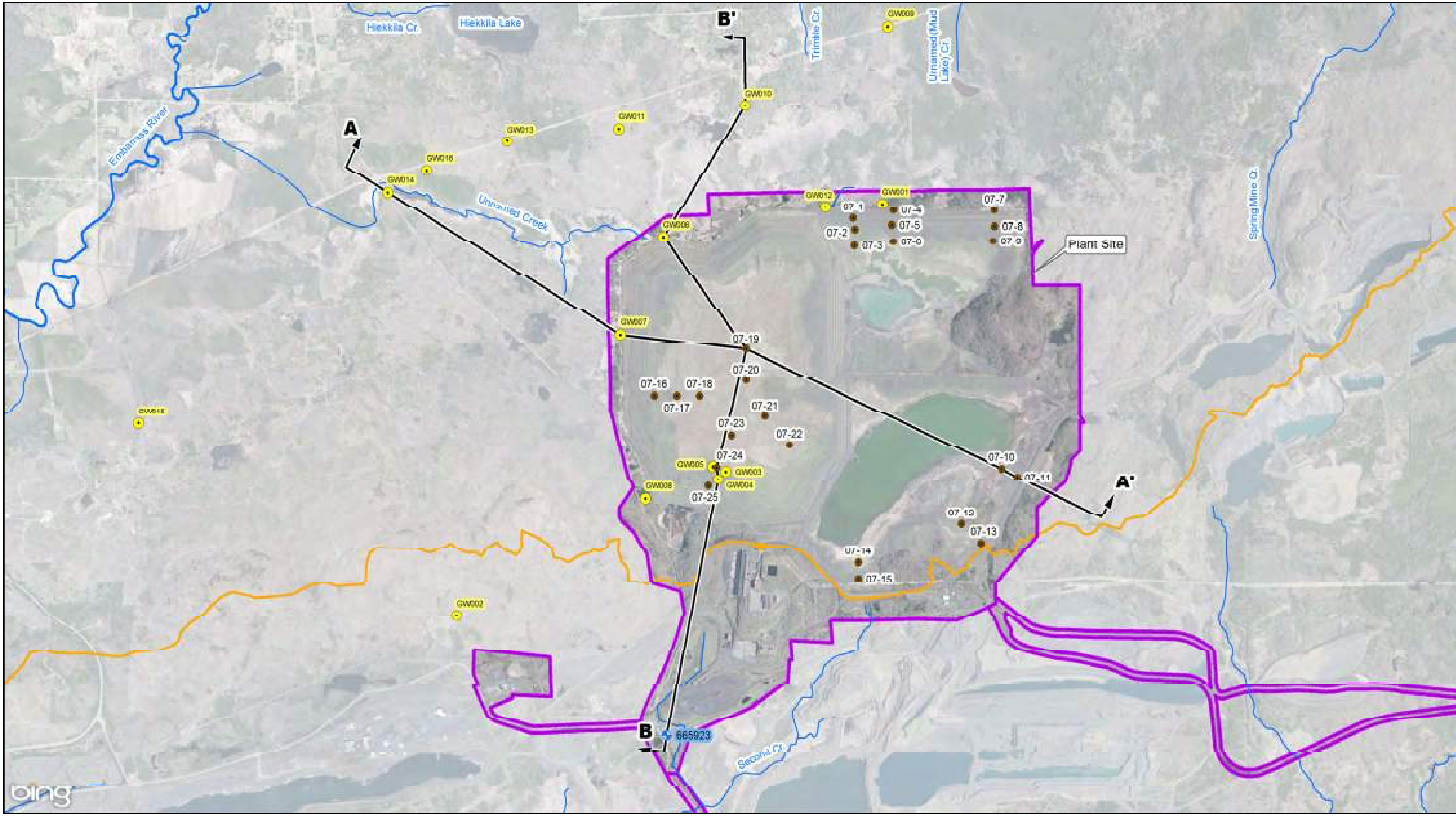
POLYMET MINING

FIGURE 5-17
PLANT SITE, EXISTING SURFICIAL GROUNDWATER ELEVATIONS AND CWI WELL LOCATIONS
PERMIT TO MINE APPLICATION
HOYT LAKES, MINNESOTA

Scale: 0 1,500 3,000 Feet	Date: AUGUST 2016
Drafted by: DAT	Project No: 12P778

Path: X:\GB\IE\2012\12P778\GIS\mxd\PMA\Figure 5-17 Plant Site Surficial Aquifer Groundwater Contours.mxd Date: 8/31/2016



Notes

1. Basemap from Esri and its data suppliers.
2. Boundary data from the MnDNR Data Deli.
3. NHD features are created from MDNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance, data sources may show watercourses that no longer exist.
4. County wells from Minnesota Department of Health Well Log Reports.
5. Geotechnical boring locations from Geotechnical Data Package Volume1: Flotation Tailings Basin V7, July 2016 in Appendix 16 of the Application.

Legend

- Select Test Holes from County Well Index 4
- Select Geotechnical Boring Locations 5
- Existing Monitoring Wells
- Plant Site Cross Sections
- Rivers and Streams 3
- Watershed Basin Boundary
- Facility Boundary

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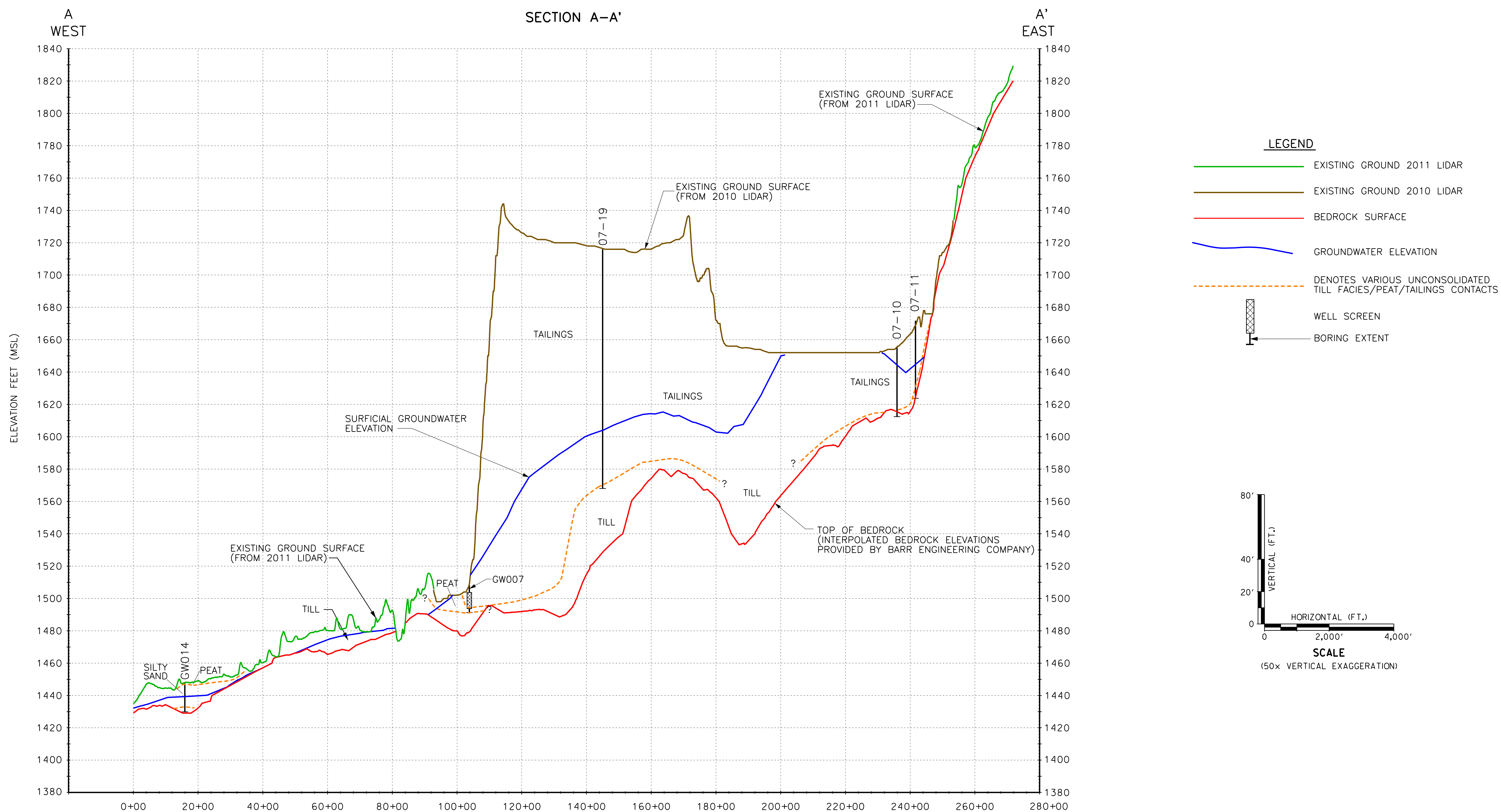
POLYMET MINING

FIGURE 5-18

PLANT SITE CROSS SECTION LOCATIONS
PERMIT TO MINE APPLICATION
HOYT LAKES, MINNESOTA

Scale: 0 1,500 3,000 Feet	Date: AUGUST 2016
Drafted by: DAT	Project No: 12P778

Path: X:\GB\IE\2012\12P778\GIS\mxd\PMA\Figure 5-18 Plant Site Cross Section Location Map.mxd Date: 9/8/2016



NOTES:

1. LIDAR SOURCE: MINNESOTA GEOSPATIAL INFORMATION OFFICE, 2011 AND AEROMETRIC, 2010.
2. GROUNDWATER AND BEDROCK SURFACES PREPARED BY FOTH WITH BOREHOLE AND MONITORING WELL DATA PROVIDED BY BARR ENGINEERING COMPANY AND OBTAINED FROM STATE WELL/BOREHOLE RECORDS.
3. CROSS SECTION LOCATIONS ARE SHOWN ON FIGURE 5–18.

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APPROVED BY:	DRD	DATE: AUG. '16

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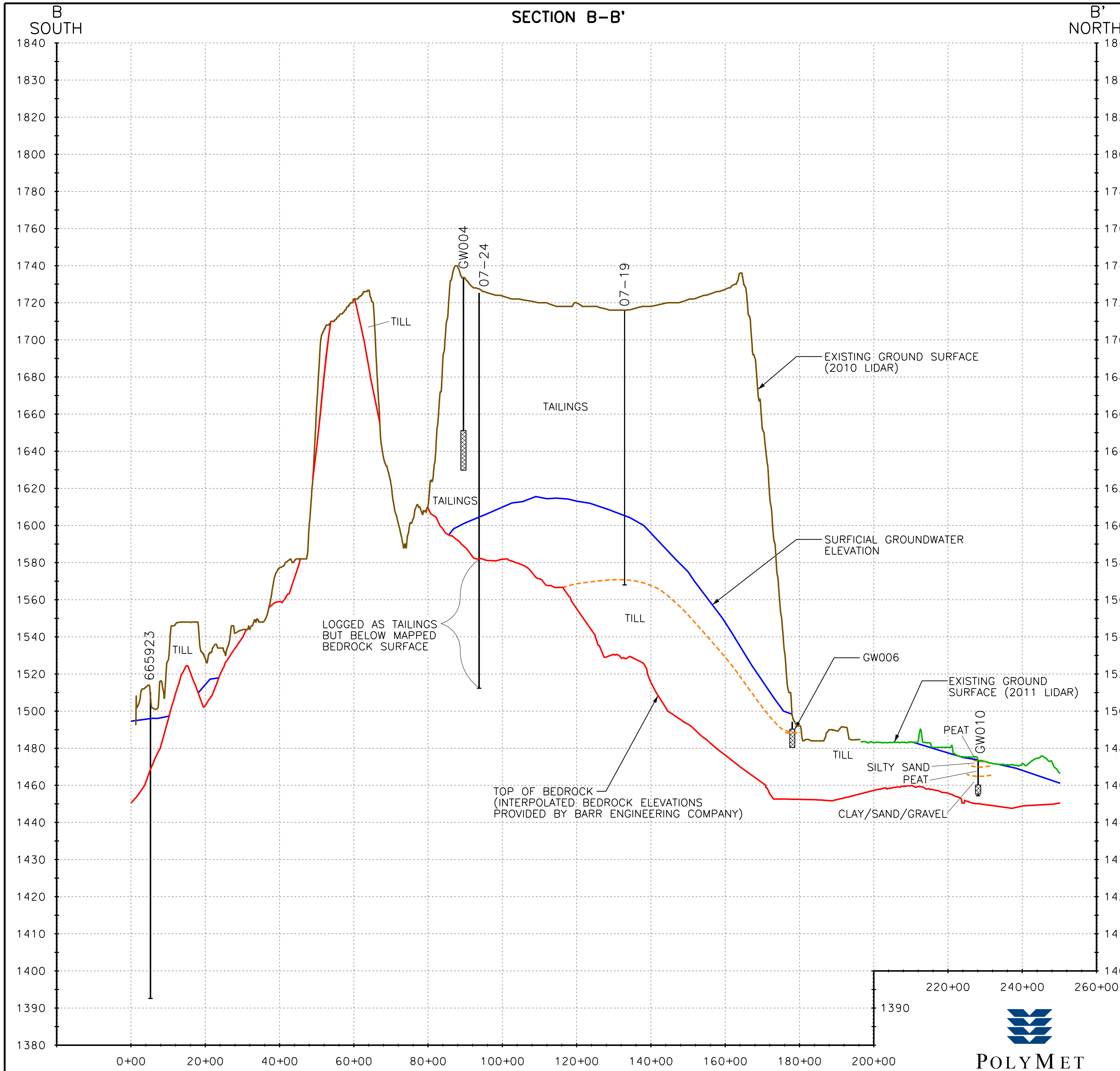
FIGURE 5–19

PLANT SITE CROSS SECTION A–A'
PERMIT TO MINE APPLICATION

Scale:	SEE BAR SCALE	Date:	AUGUST 2016
Drafted By:	JOW	Project No:	12P778

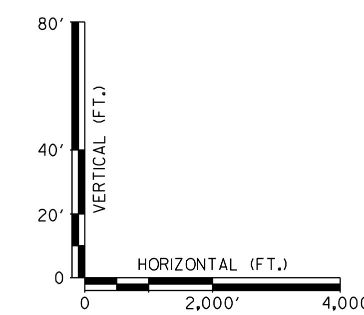


LEGEND

- EXISTING GROUND 2011 LIDAR
- EXISTING GROUND 2010 LIDAR
- BEDROCK SURFACE
- GROUNDWATER ELEVATION
- DENOTES VARIOUS UNCONSOLIDATED TILL FACIES/PEAT/TAILINGS CONTACTS
- WELL SCREEN
- BORING EXTENT

NOTES:

1. LIDAR SOURCE: MINNESOTA GEOSPATIAL INFORMATION OFFICE, 2011 AND AEROMETRIC, 2010.
2. GROUNDWATER AND BEDROCK SURFACES PREPARED BY FOTH WITH BOREHOLE AND MONITORING WELL DATA PROVIDED BY BARR ENGINEERING COMPANY AND OBTAINED FROM STATE WELL/BOREHOLE RECORDS.
3. BEDROCK ELEVATIONS CONFLICT WITH KNOWN LITHOLOGICAL DATA AT SELECT BOREHOLES AND WITH LIDAR GROUND ELEVATIONS IN SOME AREAS.
4. CROSS SECTION LOCATIONS ARE SHOWN ON FIGURE 5-18.



SCALE
(50x VERTICAL EXAGGERATION)

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APPROVED BY:	DRD	DATE:	AUG. '16

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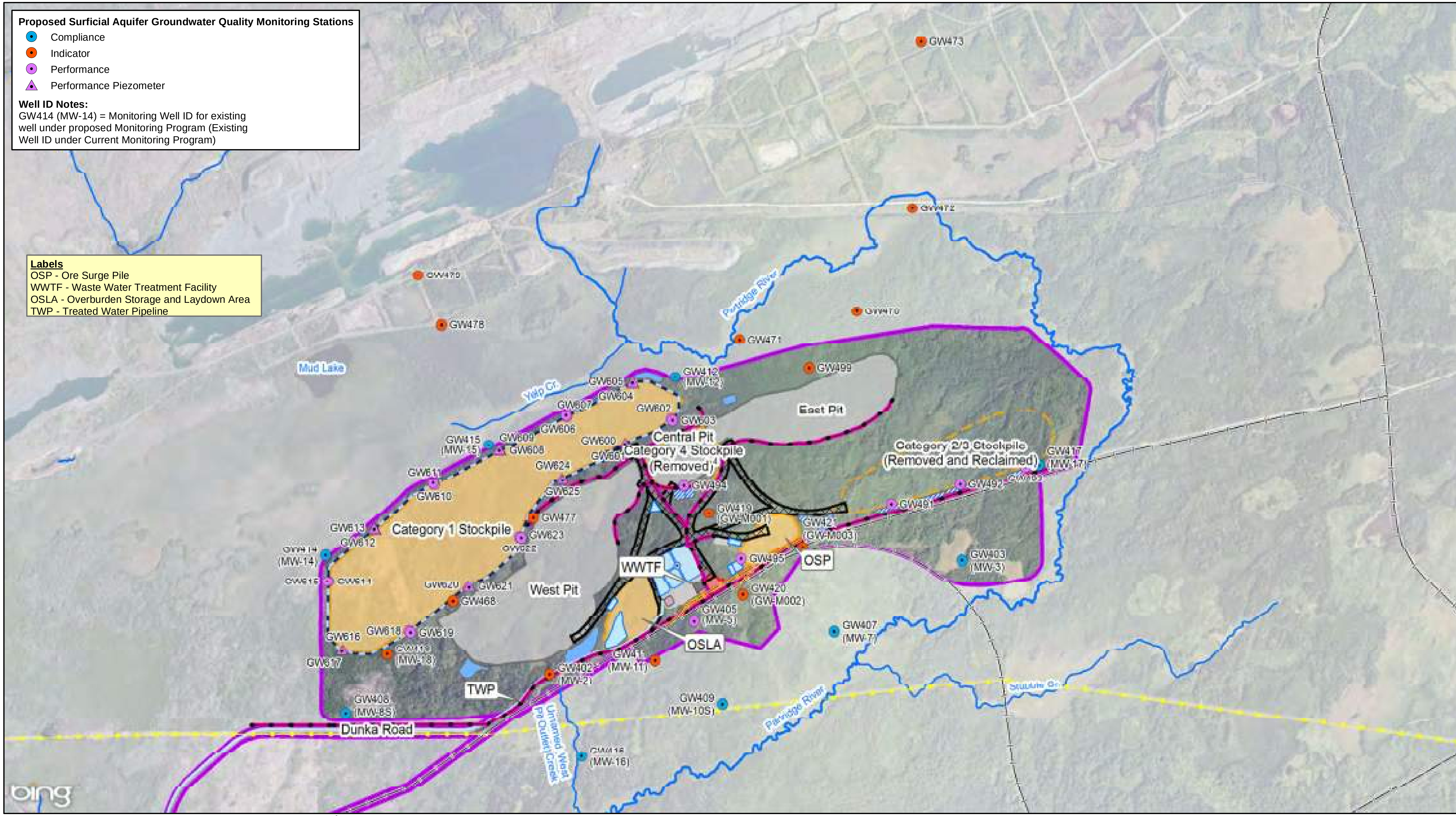
FIGURE 5-20

PLANT SITE CROSS SECTION B-B'
PERMIT TO MINE APPLICATION

Scale:	SEE BAR SCALE	Date:	AUGUST 2016
Drafted By:	JOW	Project No:	12P778

X:\GB\IE\2012\12P778\cad\figures\PMA\Figure 5-20 plant site cross sections B-B'.dgn
8/22/2016 3:53:47 PM bjw1



Notes

1. Basemap from Esri and its data suppliers.
2. Project features supplied by Barr Engineering Company.
3. Minnesota Power Power Lines supplied by the Minnesota Geospatial Information Office (MnGeo).
4. The Category 4 stockpile is removed, enabling the development of the Central Pit.
5. For clarity not all of the sumps, ditches, piping, and overflows are shown.
6. Monitoring station data from Barr Engineering Company.
7. These monitoring points are proposed locations for water quality (MPCA NPDES/SDS) permit application and may be modified through the permit process.
8. Mine Water Ponds are lined with the exception of the OSLA Pond and Construction Mine Water Basin.

Legend

- Proposed Railroad Track
- Existing Private Railroad
- Groundwater Containment System
- Existing Electric Power Line[3]
- Proposed Transmission Line
- Rivers and Streams
- Stormwater Ponds
- Reclaimed Ponds
- Treated Mine Water Pond (Lined)
- Mine Water Ponds[8]
- WWTF Buildings
- Haul Roads
- Active Stockpile
- Removed Stockpile
- Mine Pits
- Facility Boundary

POLYMET MINING

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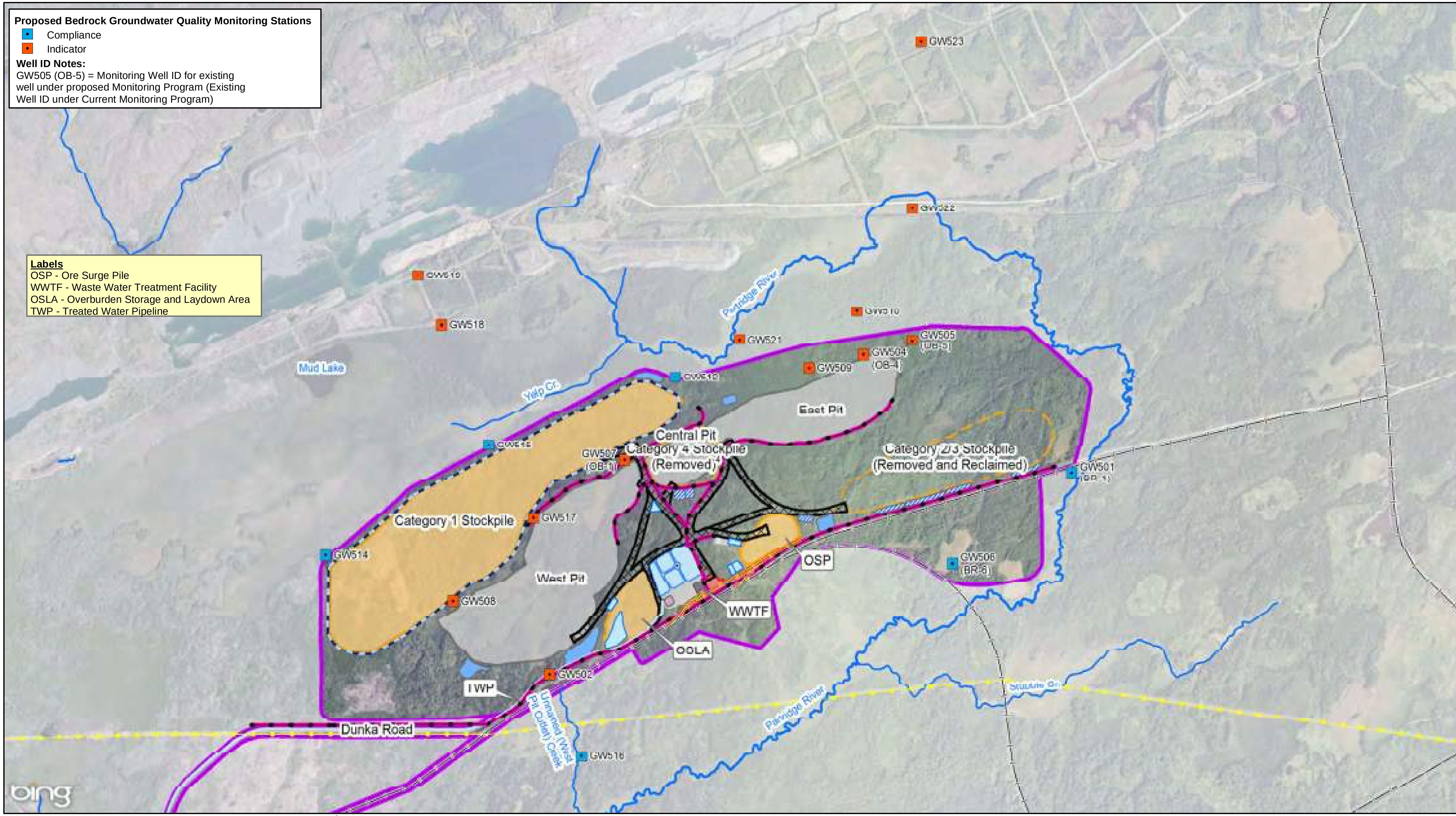
REVISED	DATE	BY	DESCRIPTION
PREPARED BY: DAT			DATE: AUG. '16
REVIEWED BY: JSL			DATE: AUG. '16
APPROVED BY: DRD			DATE: AUG. '16

POLYMET MINING

FIGURE 5-21
PROPOSED SURFICIAL AQUIFER GROUNDWATER QUALITY MONITORING STATIONS AT THE MINE SITE
HOYT LAKES, MINNESOTA

Scale: 0 1,250 2,500 Feet	Date: AUGUST 2016
Drafted by: DAT	Project No: 12P778

Path: X:\GB\IE\2012\12P778\GIS\mxd\PMA\Figure 5-21 Proposed Surficial GW Monitoring Mine Site.mxd Date: 9/1/2016



Notes

1. Basemap from Esri and its data suppliers.
2. Project features supplied by Barr Engineering Company.
3. Minnesota Power Power Lines supplied by the Minnesota Geospatial Information Office (MnGeo).
4. The Category 4 stockpile is removed, enabling the development of the Central Pit.
5. For clarity not all of the sumps, ditches, piping, and overflows are shown. Construction mine water basin and OSLA pond are not lined.
6. Monitoring station data from Barr Engineering Company.
7. These monitoring points are proposed locations for water quality (MPCA NPDES/SDS) permit application and may be modified through the permit process.
8. Mine Water Ponds are lined with the exception of the OSLA Pond and Construction Mine Water Basin.

Legend

- Proposed Railroad Track
- Existing Private Railroad
- Groundwater Containment System
- Existing Electric Power Line[3]
- Proposed Transmission Line
- Rivers and Streams
- Stormwater Ponds
- Reclaimed Ponds
- Treated Mine Water Pond (Lined)
- Mine Water Ponds[8]
- WWTF Buildings
- Haul Roads
- Active Stockpile
- Removed Stockpile
- Mine Pits
- Facility Boundary

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REVISED	DATE	BY	DESCRIPTION
PREPARED BY: DAT			DATE: AUG. '16
REVIEWED BY: JSL			DATE: AUG. '16
APPROVED BY: DRD			DATE: AUG. '16

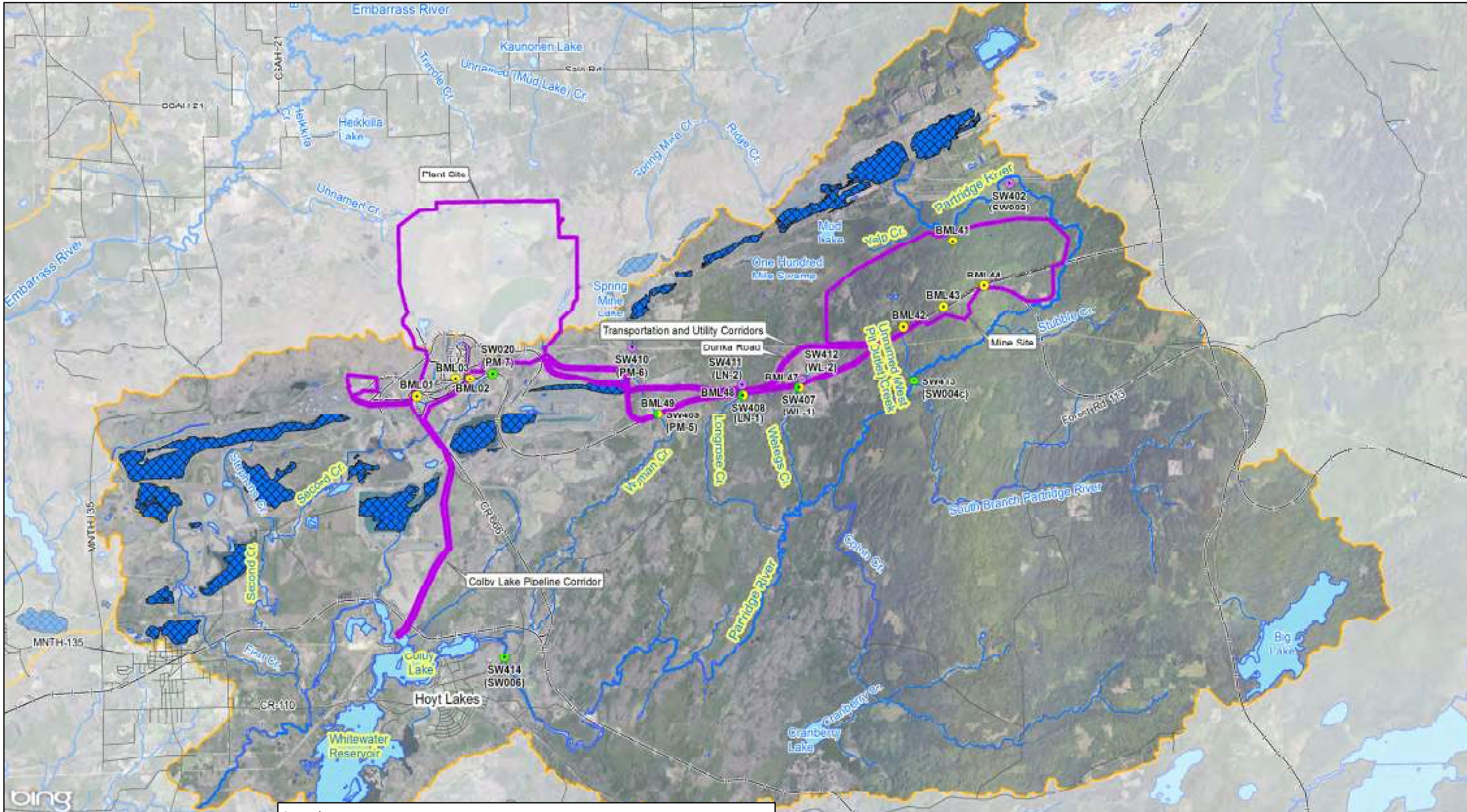
POLYMET MINING

FIGURE 5-22

PROPOSED BEDROCK GROUNDWATER QUALITY MONITORING STATIONS AT THE MINE SITE
HOYT LAKES, MINNESOTA

Scale: 0 1,250 2,500 Feet | Date: AUGUST 2016
Drafted by: DAT | Project No: 12P778

Path: X:\GB\IE\2012\12P778\GIS\mxd\PMA\Figure 5-22 Proposed Bedrock GW Monitoring Mine Site.mxd Date: 9/1/2016



Notes
1. Basemap from Esri and its data suppliers.
2. Streams and lakes supplied by Minnesota Data Deli.
3. Boundary data from the MnDNR Data Deli.
4. Watershed boundaries correspond to state databases and water quality modeling subdivisions.
5. Monitoring station data from Barr Engineering Company.
6. These monitoring points are proposed locations for water quality (MPCA NPDES/SDS) permit application and may be modified through the permit process.

Legend
- Roads
- Existing Private Railroad
- Colby Lake Pipeline
- Rivers and Streams
- Existing Pit Lakes
- Lakes and Open Water
- Partridge River Subwatershed Boundary
- Facility Boundary

Proposed Surface Water Quality Monitoring Stations
- Background
- Surface Water Compliance
- Surface Water Monitor Only
- Surface Water Monitor Only & Benchmark
- Benchmark Stormwater

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PREPARED BY:	DAT	DATE:	AUG. '16
REVIEWED BY:	JSL	DATE:	AUG. '16
APPROVED BY:	DRD	DATE:	AUG. '16

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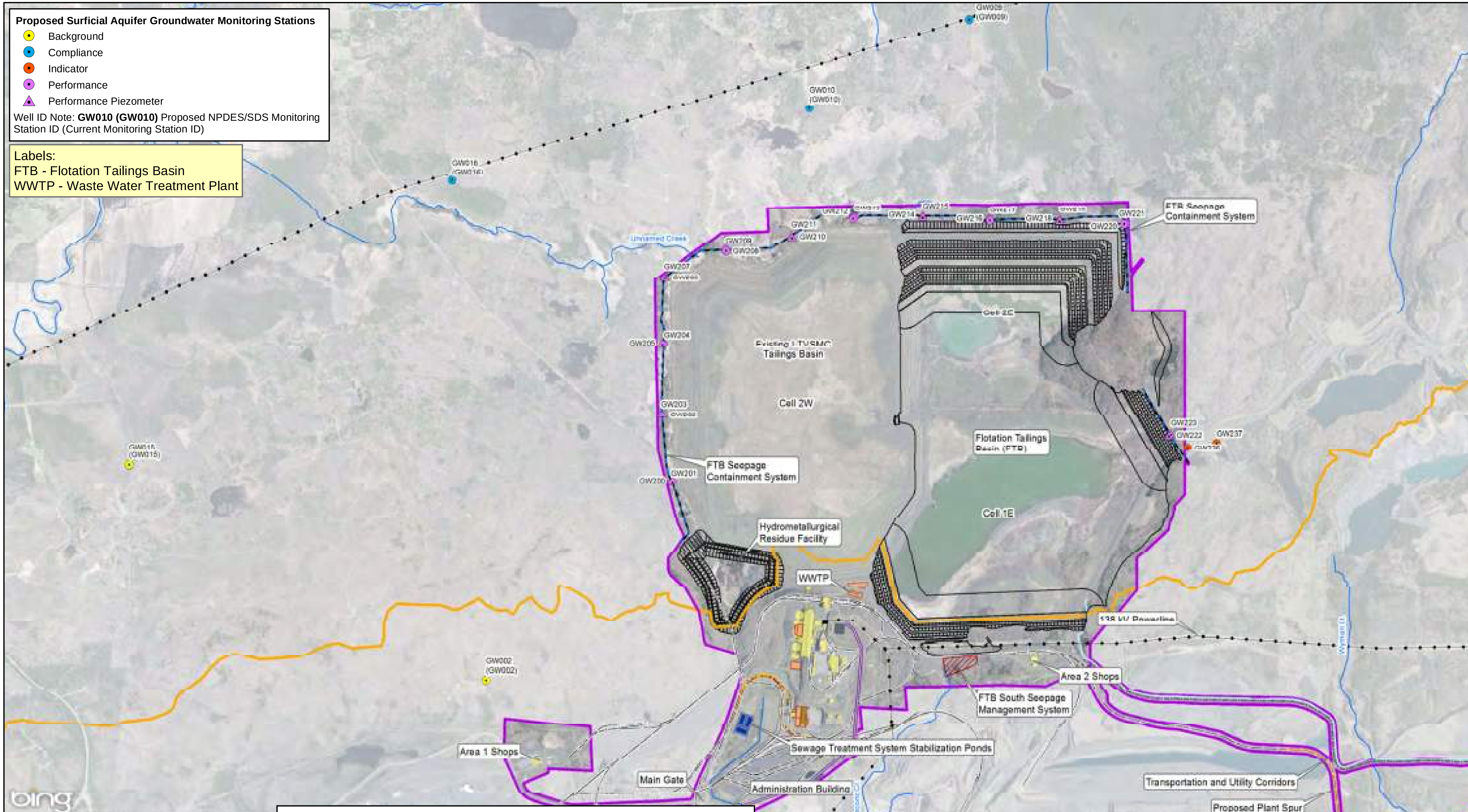
FIGURE 5-23
PROPOSED SURFACE WATER QUALITY MONITORING STATIONS, PARTRIDGE RIVER WATERSHED
PERMIT TO MINE APPLICATION
HOYT LAKES, MINNESOTA

Scale: 0 4,000 8,000 Feet | Date: AUGUST 2016
Drafted by: DAT | Project No: 12P778

Path: X:\GB\IE\2012\12P778\GIS\mxd\PMA\Figure 5-23 Proposed Partridge River Watershed.mxd Date: 9/1/2016



Notes
1. Basemap from Esri and its data suppliers.
2. Project features, pipelines and details supplied by Barr Engineering Company.
3. NHD features are created from MDNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance, data sources may show watercourses that no longer exist.
4. Minnesota Power Substations and Power Lines supplied by the Minnesota Geospatial Information Office (MnGeo).
5. Monitoring station data from Barr Engineering Company.
6. These monitoring points are proposed locations for water quality (MPCA NPDES/SDS) permit application and may be modified through the permit process.

Legend
- Existing Electric Substation[4]
- Existing Electric Power Line[4]
- Dunka Road
- Proposed Railroad Track
- Existing Private Railroad
- Rivers and Streams[3]
- Colby Lake Pipeline
- Treated Water Pipeline
- FTB Groundwater Containment System
- Proposed Plant Site Buildings and Related Facilities
- Proposed Hydromet Plant
- Existing Buildings
- Sewage Treatment System Stabilization Ponds
- Watershed Basin Boundary
- Facility Boundary

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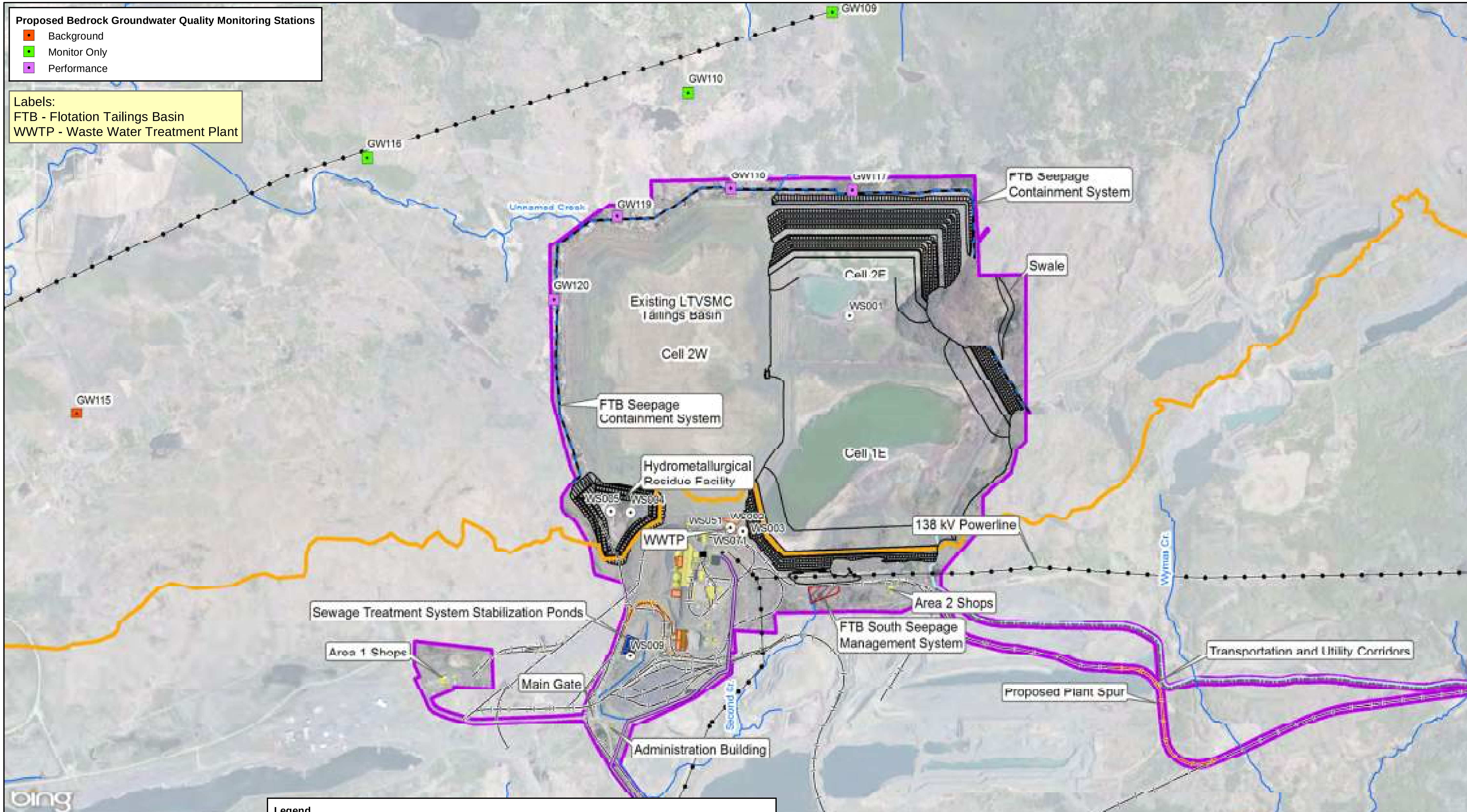
PREPARED BY: MCC2 DATE: SEP. '16
REVIEWED BY: JSL DATE: SEP. '16
APPROVED BY: DRD DATE: SEP. '16

POLYMET MINING

FIGURE 5-24
PROPOSED SURFICIAL AQUIFER GROUNDWATER QUALITY MONITORING STATIONS AT THE PLANT SITE
HOYT LAKES, MINNESOTA

Scale: 0 1,250 2,500 Feet
Date: SEPTEMBER 2016
Drafted by: DAT
Project No: 12P778

Path: X:\GB\IE\2012\12P778\GIS\mxd\PMA\Figure 5-24 Proposed Surficial GW Monitoring Plant Site.mxd Date: 9/9/2016



Notes

1. Basemap from Esri and its data suppliers.
2. Project features, pipelines and details supplied by Barr Engineering Company.
3. NHD features are created from MDNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance, data sources may show watercourses that no longer exist.
4. Minnesota Power Substations and Power Lines supplied by the Minnesota Geospatial Information Office (MnGeo).
5. Monitoring station data from Barr Engineering Company.
6. These monitoring points are proposed locations for water quality (MPCA NPDES/SDS) permit application and may be modified through the permit process.

Legend

- Internal Waste Stream Monitor Only
- Existing Electric Substation[4]
- Existing Electric Power Line[4]
- Dunka Road
- Proposed Railroad Track
- Existing Private Railroad
- Rivers and Streams[3]
- Colby Lake Pipeline
- Treated Water Pipeline
- FTB Groundwater Containment System
- Proposed Plant Site Buildings and Related Facilities
- Proposed Hydromet Plant
- Existing Buildings
- Sewage Treatment System Stabilization Ponds
- Watershed Basin Boundary
- Facility Boundary

N

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APPROVED BY: DRD			DATE: SEP.'16

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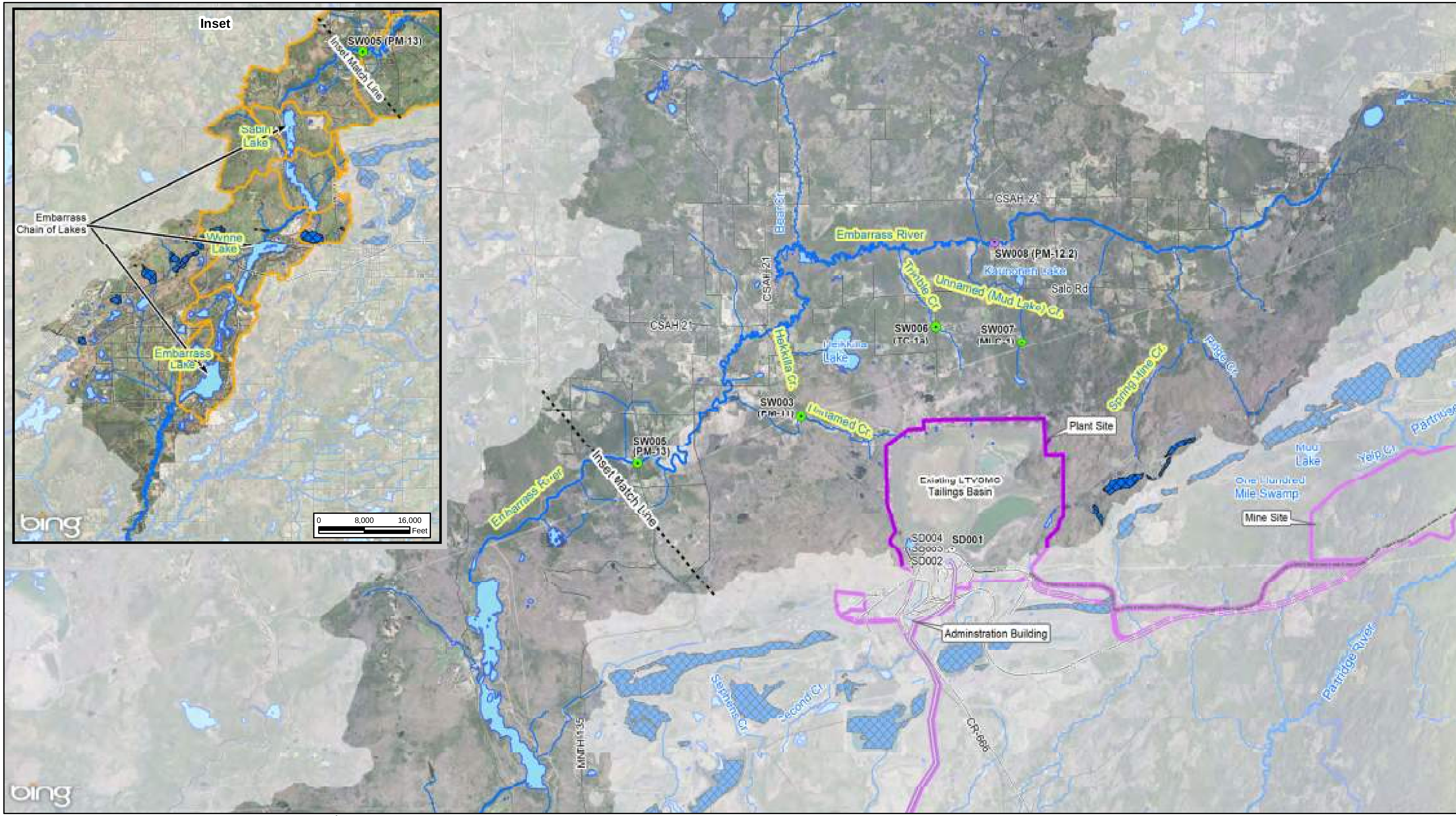
FIGURE 5-25

PROPOSED BEDROCK GROUNDWATER QUALITY MONITORING STATIONS AT THE PLANT SITE
HOYT LAKES, MINNESOTA

Scale: 0 1,500 3,000 Feet	Date: SEPTEMBER 2016
Drafted by: DAT	Project No: 12P778

Path: X:\GB\IE\2012\12P778\GIS\mxd\PMA\Figure 5-25 Proposed Bedrock GW Monitoring Plant Site.mxd Date: 9/9/2016



Notes

1. Basemap from Esri and its data suppliers.
2. Streams and lakes supplied by Minnesota Data Deli.
3. Boundary data from the MnDNR Data Deli.
4. USGS gaging stations supplied by United States Geological Survey.
5. Watershed boundaries correspond to state databases and water quality modeling subdivisions.
6. Monitoring station data from Barr Engineering Company.
7. These monitoring points are proposed locations for water quality (MPCA NPDES/SDS) permit application and may be modified through the permit process.

Legend

- Roads
- Existing Private Railroad
- Colby Lake Pipeline
- Rivers and Streams
- Existing Pit Lakes
- Lakes and Open Water
- Embarrass River Subwatershed Boundary
- Facility Boundary

Proposed Surface Water Quality Monitoring Stations

- Surface Water Discharge
- Background
- Surface Water Compliance
- Surface Water Monitor Only
- Surface Water Monitor Only & Benchmark
- Benchmark Stormwater

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PREPARED BY: MCC2			DATE: SEP. '16
REVIEWED BY: JSL			DATE: SEP. '16
APPROVED BY: DRD			DATE: SEP. '16

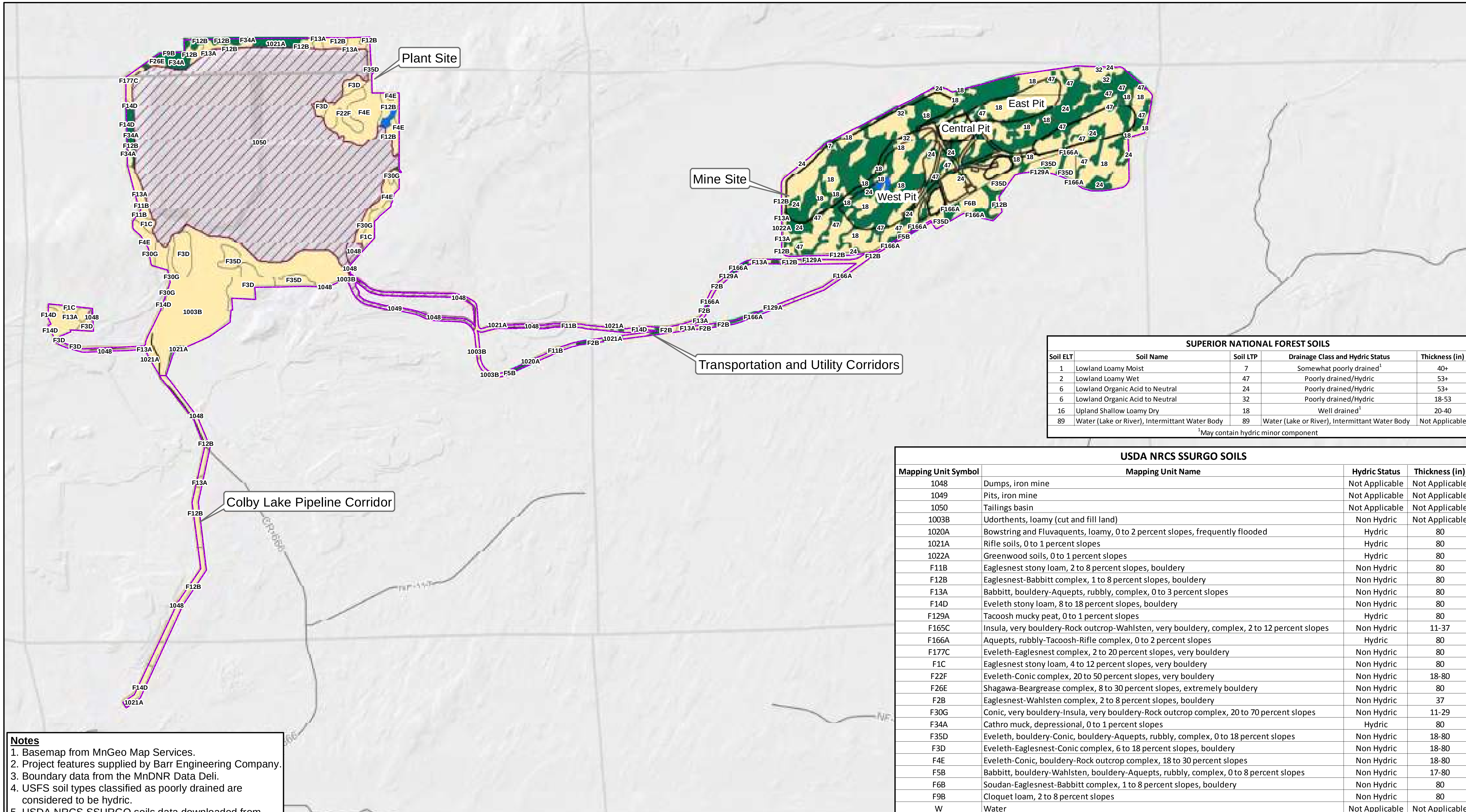
POLYMET MINING

FIGURE 5-26

PROPOSED SURFACE WATER QUALITY MONITORING STATIONS, EMBARRASS RIVER WATERSHED
PERMIT TO MINE APPLICATION
HOYT LAKES, MINNESOTA

Scale: 0 4,000 8,000 Feet	Date: SEPTEMBER 2016
Drafted by: DAT	Project No: 12P778

Path: X:\GB\IE\2012\12P778\GIS\mxd\PMA\Figure 5-26 Proposed Embarrass River Watershed.mxd Date: 9/7/2016



SUPERIOR NATIONAL FOREST SOILS

Soil ELT	Soil Name	Soil LTP	Drainage Class and Hydric Status	Thickness (in)
1	Lowland Loamy Moist	7	Somewhat poorly drained[1]	40+
2	Lowland Loamy Wet	47	Poorly drained/Hydric	53+
6	Lowland Organic Acid to Neutral	24	Poorly drained/Hydric	53+
6	Lowland Organic Acid to Neutral	32	Poorly drained/Hydric	18-53
16	Upland Shallow Loamy Dry	18	Well drained[1]	20-40
89	Water (Lake or River), Intermittant Water Body	89	Water (Lake or River), Intermittant Water Body	Not Applicable

[1]May contain hydric minor component

USDA NRCS SSURGO SOILS

Mapping Unit Symbol	Mapping Unit Name	Hydric Status	Thickness (in)
1048	Dumps, iron mine	Not Applicable	Not Applicable
1049	Pits, iron mine	Not Applicable	Not Applicable
1050	Tailings basin	Not Applicable	Not Applicable
1003B	Udorthents, loamy (cut and fill land)	Non Hydric	Not Applicable
1020A	Bowstring and Fluvaquents, loamy, 0 to 2 percent slopes, frequently flooded	Hydric	80
1021A	Rifle soils, 0 to 1 percent slopes	Hydric	80
1022A	Greenwood soils, 0 to 1 percent slopes	Hydric	80
F11B	Eaglesnest stony loam, 2 to 8 percent slopes, bouldery	Non Hydric	80
F12B	Eaglesnest-Babbitt complex, 1 to 8 percent slopes, bouldery	Non Hydric	80
F13A	Babbitt, bouldery-Aquepts, rubbly, complex, 0 to 3 percent slopes	Non Hydric	80
F14D	Eveleth stony loam, 8 to 18 percent slopes, bouldery	Non Hydric	80
F129A	Tacoosh mucky peat, 0 to 1 percent slopes	Hydric	80
F165C	Insula, very bouldery-Rock outcrop-Wahlsten, very bouldery, complex, 2 to 12 percent slopes	Non Hydric	11-37
F166A	Aquepts, rubbly-Tacoosh-Rifle complex, 0 to 2 percent slopes	Hydric	80
F177C	Eveleth-Eaglesnest complex, 2 to 20 percent slopes, very bouldery	Non Hydric	80
F1C	Eaglesnest stony loam, 4 to 12 percent slopes, very bouldery	Non Hydric	80
F22F	Eveleth-Conic complex, 20 to 50 percent slopes, very bouldery	Non Hydric	18-80
F26E	Shagawa-Beargrease complex, 8 to 30 percent slopes, extremely bouldery	Non Hydric	80
F2B	Eaglesnest-Wahlsten complex, 2 to 8 percent slopes, bouldery	Non Hydric	37
F30G	Conic, very bouldery-Insula, very bouldery-Rock outcrop complex, 20 to 70 percent slopes	Non Hydric	11-29
F34A	Cathro muck, depressional, 0 to 1 percent slopes	Hydric	80
F35D	Eveleth, bouldery-Conic, bouldery-Aquepts, rubbly, complex, 0 to 18 percent slopes	Non Hydric	18-80
F3D	Eveleth-Eaglesnest-Conic complex, 6 to 18 percent slopes, bouldery	Non Hydric	18-80
F4E	Eveleth-Conic, bouldery-Rock outcrop complex, 18 to 30 percent slopes	Non Hydric	18-80
F5B	Babbitt, bouldery-Wahlsten, bouldery-Aquepts, rubbly, complex, 0 to 8 percent slopes	Non Hydric	17-80
F6B	Soudan-Eaglesnest-Babbitt complex, 1 to 8 percent slopes, bouldery	Non Hydric	80
F9B	Cloquet loam, 2 to 8 percent slopes	Non Hydric	80
W	Water	Not Applicable	Not Applicable

Notes

1. Basemap from MnGeo Map Services.
2. Project features supplied by Barr Engineering Company.
3. Boundary data from the MnDNR Data Deli.
4. USFS soil types classified as poorly drained are considered to be hydric.
5. USDA NRCS SSURGO soils data downloaded from http://websoilsurvey.sc.egov.usda.gov on 6/27/16.
6. USFS soils provided by USDA-USFS Terrestrial Ecological Unit surveys completed on 4/15/2011.
7. USDA NRCS SSUROGO soil depths from SSURGO database published on 11/11/2014. Depths taken from Physical Soil Properties report, St. Louis County, Minnesota, Embarrass Part, Survey Version Area 8.
8. Superior National Forest soils depths from TEU (Terrestrial Ecological Unit) Subset metadata table. Final update of coverage completed on 4/15/2011.

Legend

- Hydric Soils (18%)
- Non Hydric Soils (44%)
- Previously Disturbed Area (38%)
- Water (<1%)
- Roads
- Mine Site Features
- Townships
- Facility Boundary

POLYMET MINING

Foth

Foth Infrastructure & Environment, LLC

REVISED	DATE	BY	DESCRIPTION

PREPARED BY:	MCC2	DATE:	AUG. '16
REVIEWED BY:	JSL	DATE:	AUG. '16
APPROVED BY:	DRD	DATE:	AUG. '16

POLYMET MINING

FIGURE 5-27
SOIL INVENTORY
PERMIT TO MINE APPLICATION
HOYT LAKES, MINNESOTA

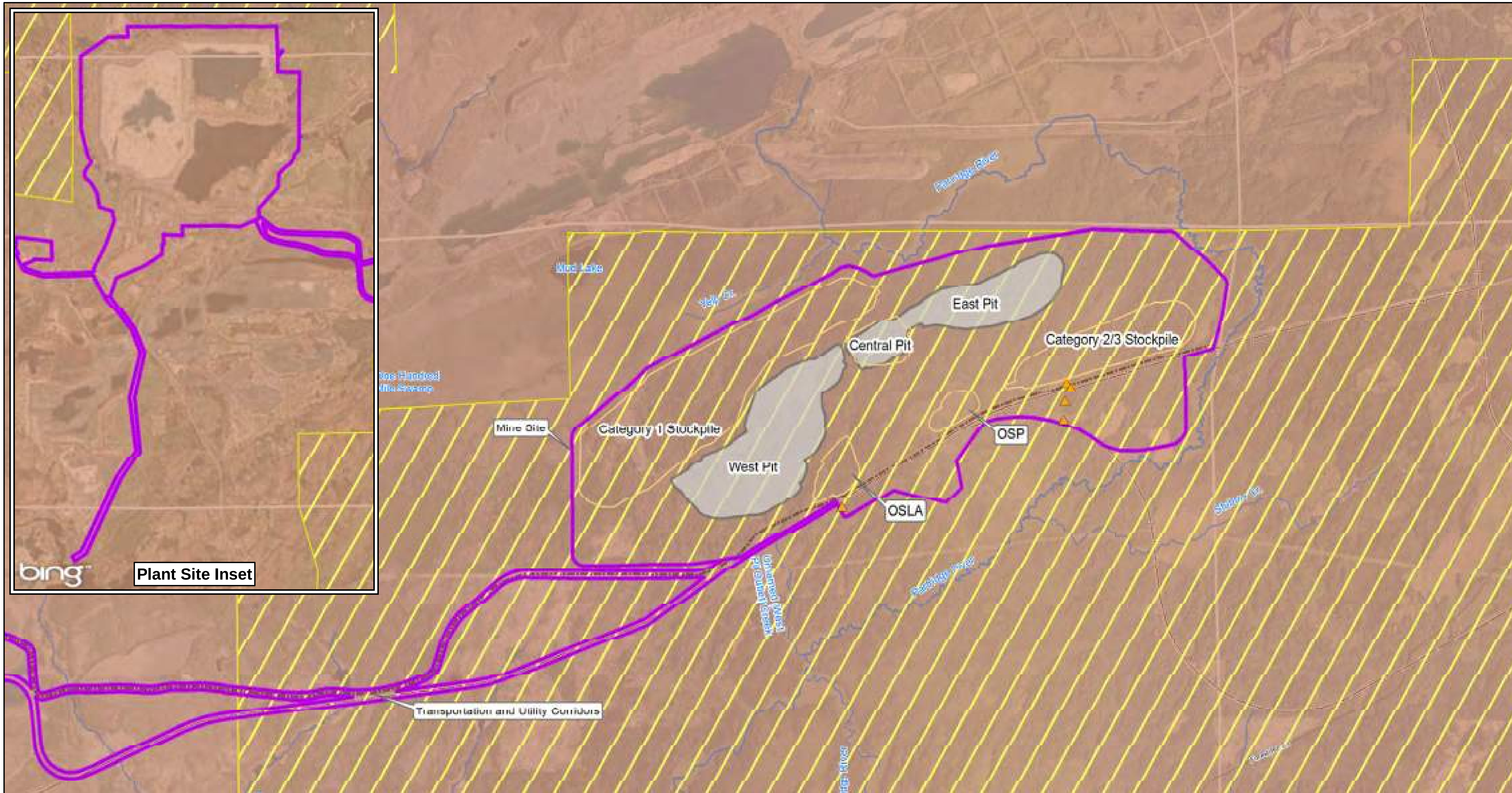
Scale: 0 2,500 5,000 Feet

Date: AUGUST 2016

Drafted by: DAT

Project No: 12P778

Path: X:\GB\IE\2012\12P778\GIS\mxd\PMA\Figure 5-27 Soils Types.mxd Date: 9/1/2016



Legend

- Canada Lynx Critical Habitat
- Gray Wolf Critical Habitat
- **Minnesota NHIS Rare Natural Features[3]**
- **Minnesota Protection Status**
  - Endangered
- **Element Occurrences**
- **Minnesota Protection Status**
  - Endangered
- Roads
- Dunka Road
- Existing Private Railroad
- Rivers and Streams[3]
- Stockpiles [4]
- Mine Pits
- Townships
- Facility Boundary

Notes
1. Basemap from Esri and its data suppliers.
2. Project features supplied by Barr Engineering Company.
3. Natural Heritage Information System Rare Features Data Supplied by State of Minnesota Department of Natural Resources in June 2016.
4. Maximum extent of stockpiles and mine pits shown.
5. Recorded rare, threatened and endangered species located within the facility boundary are shown. Species located outside of the facility boundary will not be directly or indirectly affected by mining, and are not shown.

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REVIEWED BY:	JSL	DATE:	AUG '16
APPROVED BY:	DRD	DATE:	AUG '16

POLYMET MINING

FIGURE 5-28
RECORDED RARE, THREATENED AND ENDANGERED SPECIES
PERMIT TO MINE APPLICATION
HOYT LAKES, MINNESOTA

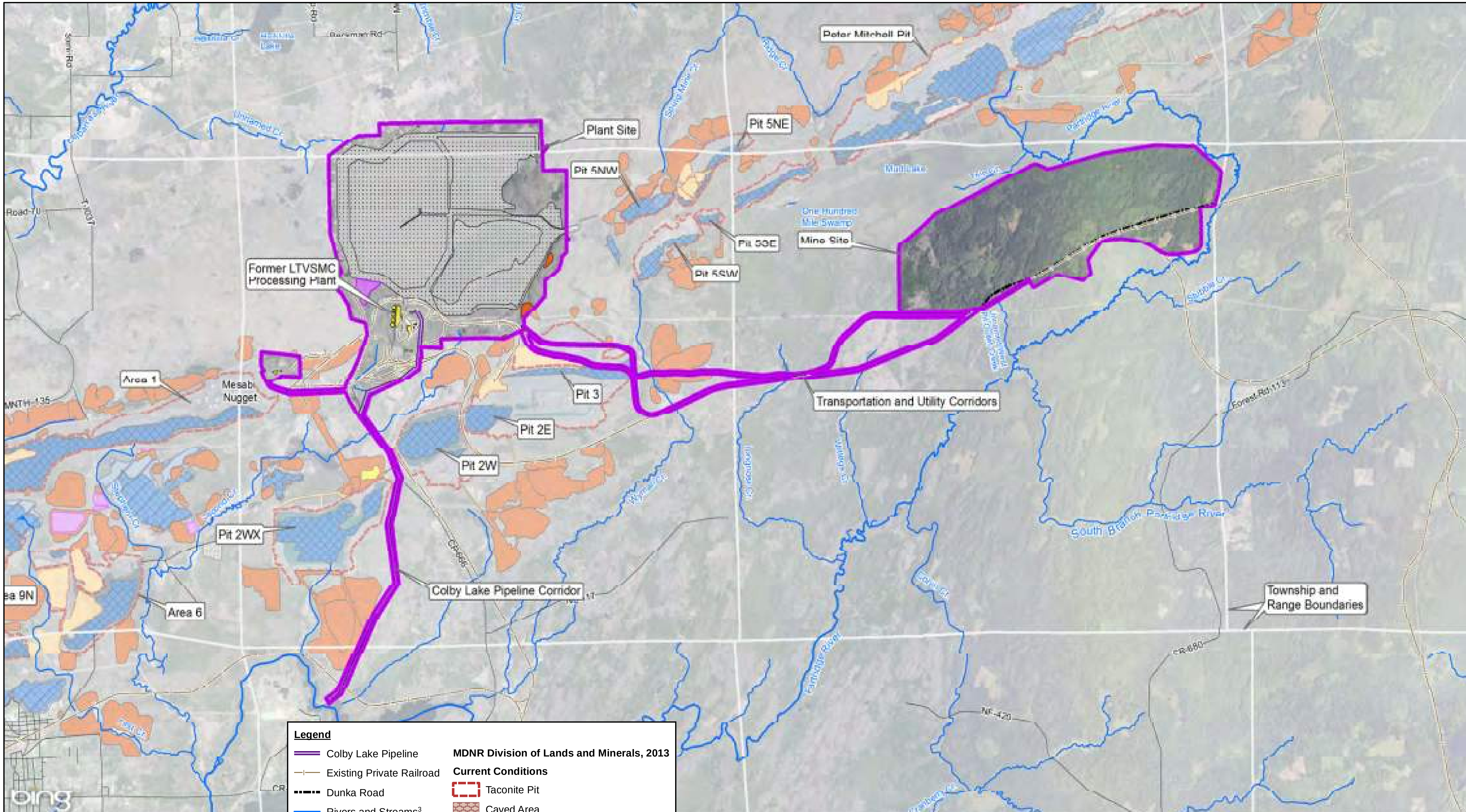
Scale: 0 1,500 3,000 Feet

Date: AUGUST 2016

Drafted by: DAT

Project No: 12P778

Path: X:\GB\IE\2012\12P778\GIS\mxd\PMA\Figure 5-28 Natural Resource Sites.mxd Date: 9/15/2016



Legend

- Colby Lake Pipeline
- Existing Private Railroad
- Dunka Road
- Rivers and Streams[3]
- Pit Lakes
- Townships
- Facility Boundary

MDNR Division of Lands and Minerals, 2013

Current Conditions

- Taconite Pit
- Caved Area
- Haul Road
- Stockpile
- In-Pit Stockpile
- Plant or Shop Area
- Reservoir or Settling Basin
- Tailings Basin
- Natural Ore Pit

Notes

1. Basemap from Esri and its data suppliers.
2. Project features supplied by Barr Engineering Company.
3. NHD features are created from MnDNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance, data sources may show watercourses that no longer exist.
4. Mesabi Range Mine Lands supplied by MDNR Division of Lands and Minerals via email March 2015.

POLYMET MINING

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PREPARED BY:	MCC2	DATE:	AUG. '16
REVIEWED BY:	JSL	DATE:	AUG. '16
APPROVED BY:	DRD	DATE:	AUG. '16

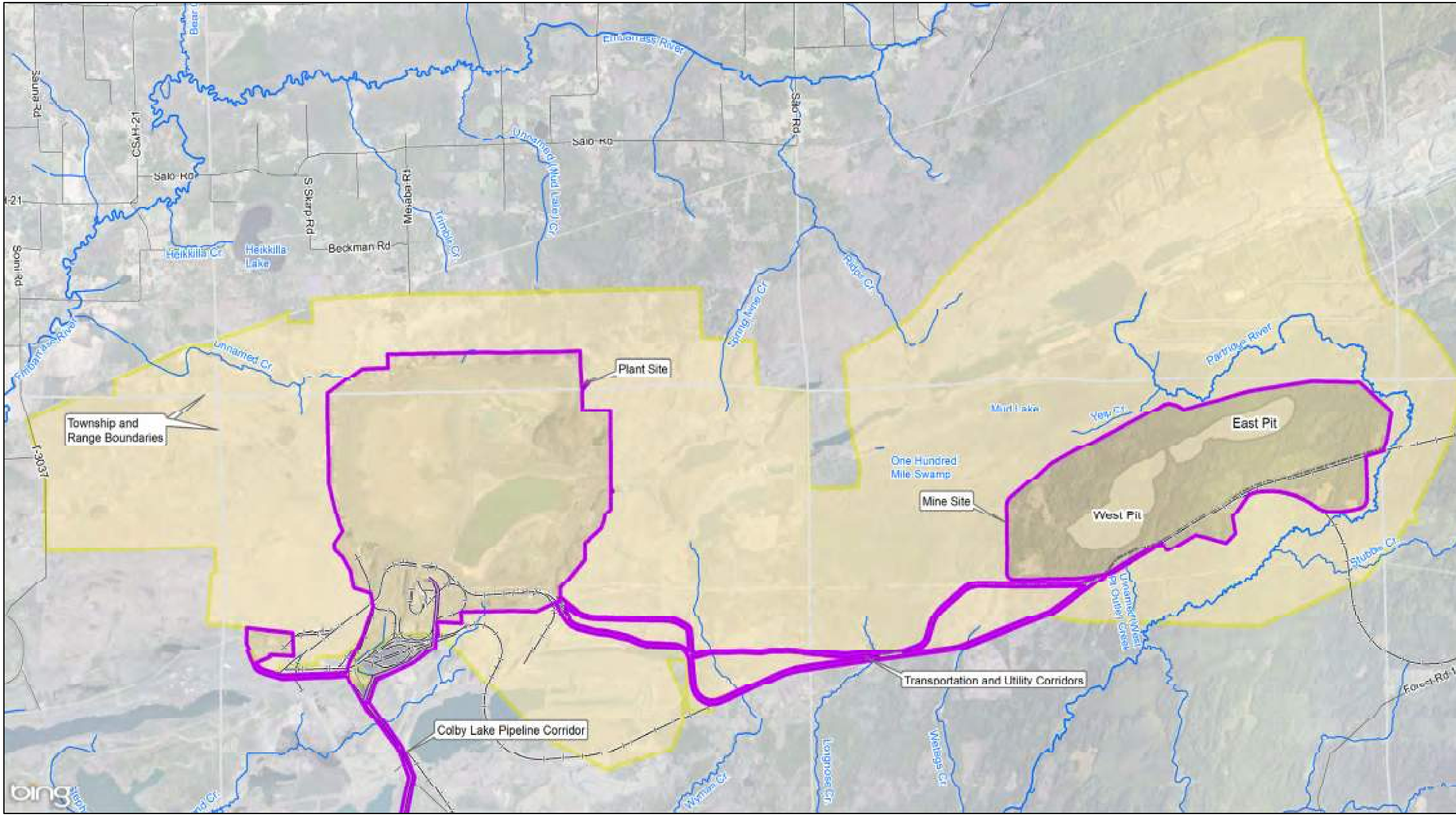
POLYMET MINING

FIGURE 5-29

PAST MINING FACILITIES
PERMIT TO MINE APPLICATION
HOYT LAKES, MINNESOTA

Scale: 0 3,000 6,000 Feet	Date: AUGUST 2016
Drafted by: DAT	Project No: 12P778

Path: X:\GB\IE\2012\12P778\GIS\mxd\PMA\Figure 5-29 Past Mining Facilities.mxd Date: 9/9/2016



Notes

1. Basemap from Esri and its data suppliers.
2. Project features supplied by Barr Engineering Company.
3. Boundary data from the MnDNR Data Deli.
4. NHD features are created from MDNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance, data sources may show watercourses that no longer exist.
5. Area of Potential Effect Boundary supplied by Barr Engineering Company.

Legend

- Colby Lake Pipeline
- Dunka Road
- Roads
- Existing Private Railroad
- Rivers and Streams[4]
- Cultural Resources Area of Potential Effect
- Mine Pits
- Townships
- Facility Boundary

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REVISED	DATE	BY	DESCRIPTION

PREPARED BY:	MCC2	DATE:	AUG. '16
REVIEWED BY:	JSL	DATE:	AUG. '16
APPROVED BY:	DRD	DATE:	AUG. '16

POLYMET MINING

FIGURE 5-30
CULTURAL RESOURCES ANALYSIS -
AREA OF POTENTIAL EFFECT
PERMIT TO MINE APPLICATION
HOYT LAKES, MINNESOTA

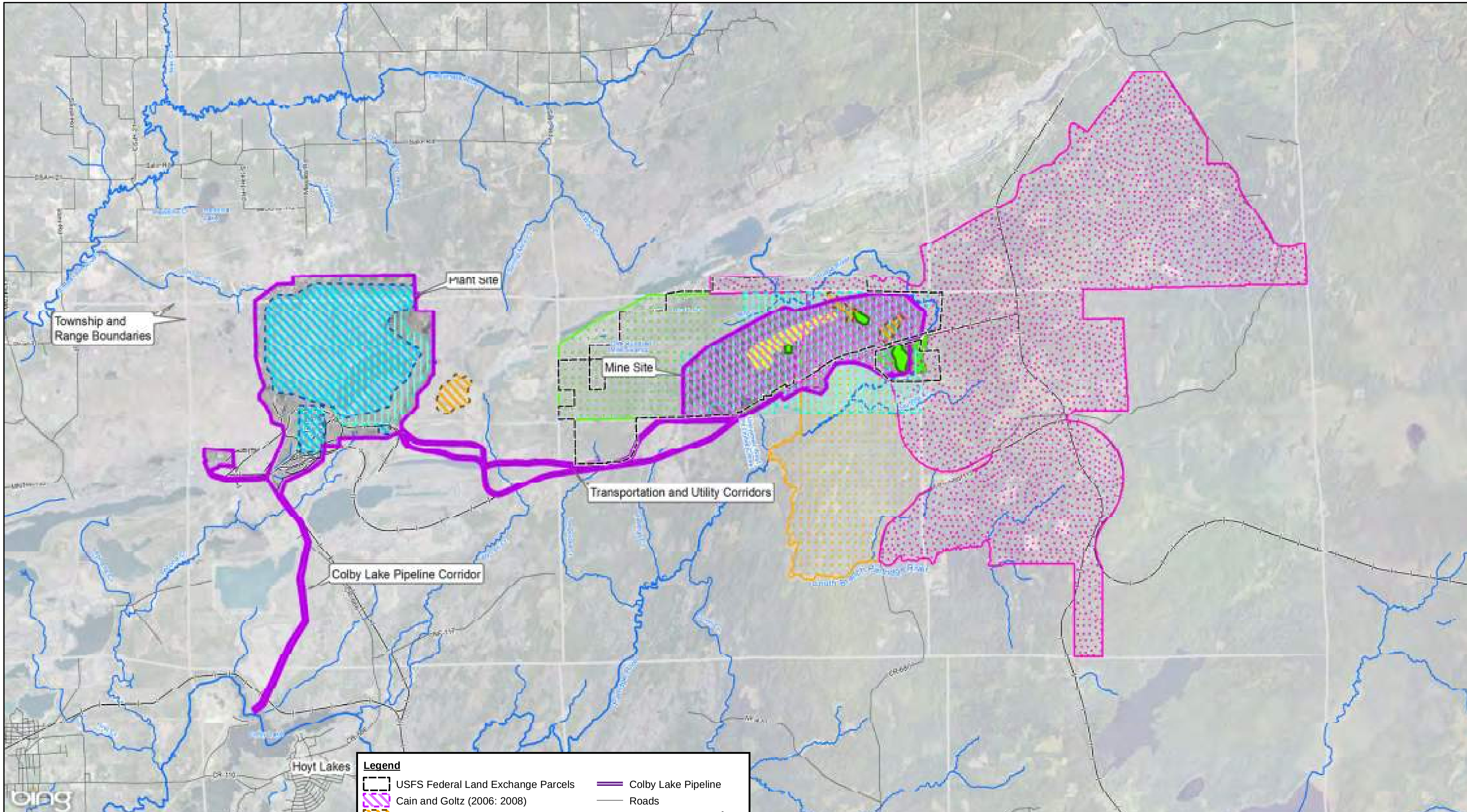
Scale: 0 2,500 5,000 Feet

Date: AUGUST 2016

Drafted by: DAT

Project No: 12P778

Path: X:\GB\IE\2012\12P778\GIS\mxd\PMA\Figure 5-30 Cultural Resource Analysis Potential Effect.mxd Date: 9/1/2016



Legend

- USFS Federal Land Exchange Parcels
- Cain and Goltz (2006: 2008)
- USACE (2010)
- USFS (2012)
- Zellie (2007)
- Ketz and Kloss (2004)
- USFS (2011)
- Foth and Van Dyke Survey Area (1999)
- Stubble Creek Timber Sale (USFS 1990)
- Yelp Creek Timber Sale (USFS 1985)
- 1997 Laurentian Projects (USFS 1997)
- Colby Lake Pipeline
- Roads
- Rivers and Streams[3]
- Existing Private Railroad
- Townships
- Facility Boundary

Notes

1. Basemap from Esri and its data suppliers.
2. Project features supplied by Barr Engineering Company.
3. NHD features are created from MDNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance, data sources may show watercourses that no longer exist.
4. Cultural Resource datasets supplied by Barr Engineering Company.

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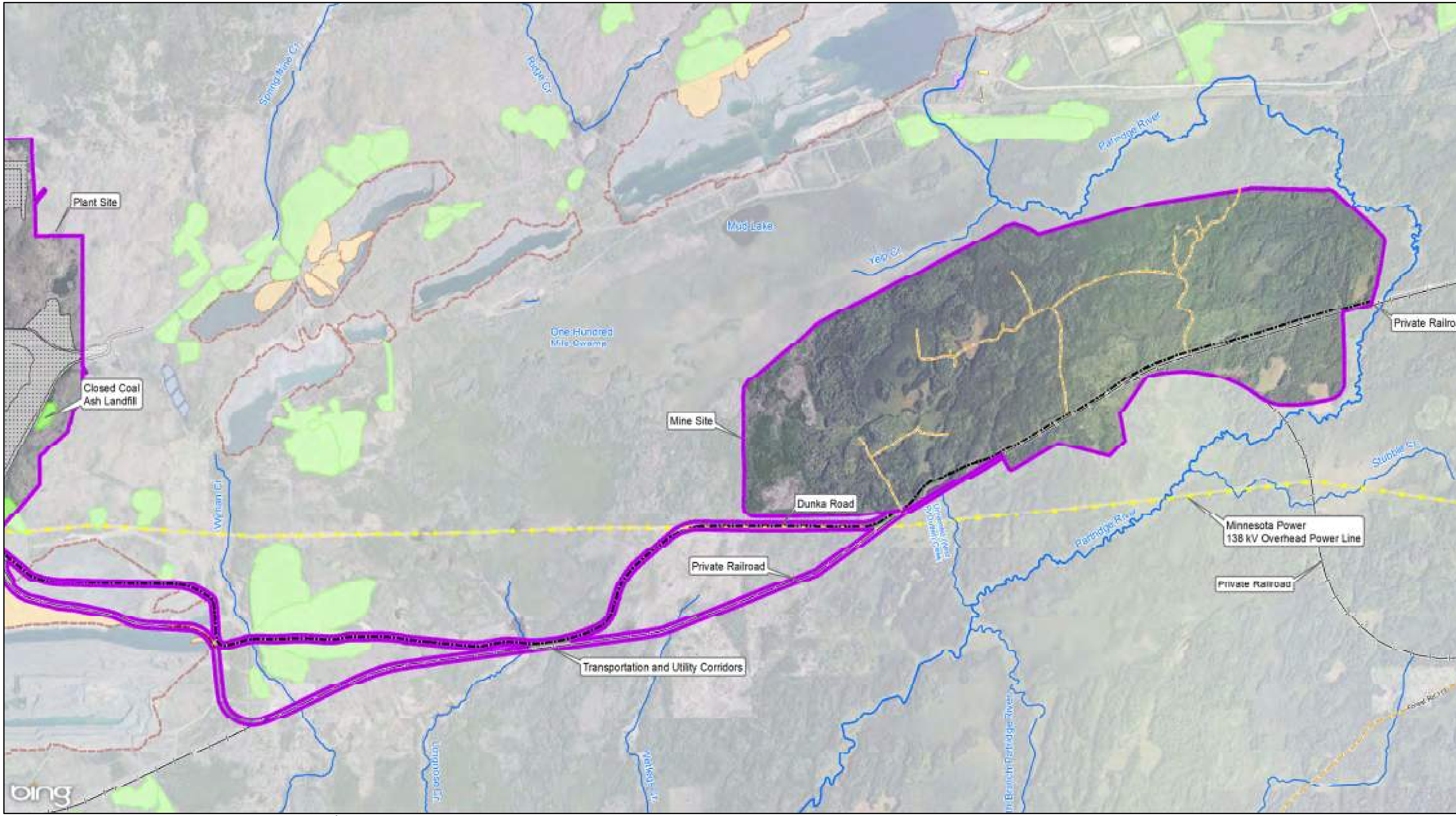
PREPARED BY: MCC2			DATE: AUG. '16
REVIEWED BY: JSL			DATE: AUG. '16
APPROVED BY: DRD			DATE: AUG. '16

POLYMET MINING

FIGURE 5-31
CULTURAL RESOURCES ANALYSIS - PREVIOUS INVESTIGATIONS
PERMIT TO MINE APPLICATION
HOYT LAKES, MINNESOTA

Scale: 0 4,000 8,000 Feet	Date: AUGUST 2016
Drafted by: DAT	Project No: 12P778

Path: X:\GB\IE\2012\12P778\GIS\mxd\PMA\Figure 5-31 Cultural Resource Analysis Previous Investigations.mxd Date: 9/9/2016



Notes

1. Basemap from Esri and its data suppliers.
2. Project features supplied by Barr Engineering Company.
3. Due to previous disturbance, data sources may show watercourses that no longer exist.
4. Minnesota Power Substations and Power Lines supplied by the Minnesota Geospatial Information Office (MnGeo).
5. Mesabi Range Mine Lands supplied by MDNR Division of Lands and Minerals via email March 2015.
6. National Forest system roads data supplied by the Superior National Forest.

Legend

- Roads
- National Forest System Road
- Dunka Road
- Existing Private Railroad
- Existing Electric Power Line[4]
- Rivers and Streams[3]
- Facility Boundary

MDNR Division of Lands and Minerals, 2013 [5]

Mesabi Range Mine Lands - Current Conditions

- Stockpile
- In-Pit Stockpile
- Plant or Shop Area
- Reservoir or Settling Basin
- Tailings Basin
- Taconite Pit
- Natural Ore Pit

POLYMET MINING

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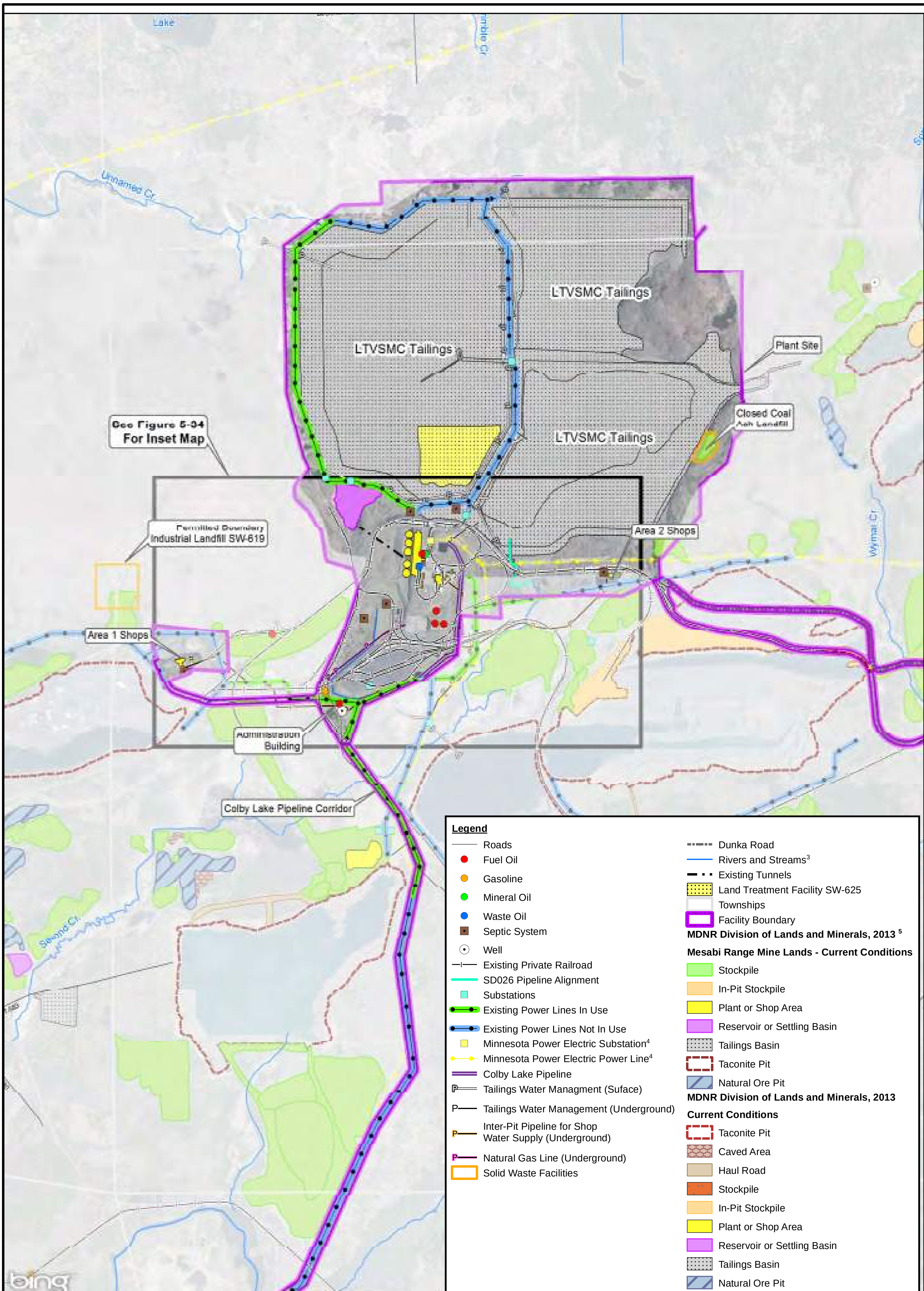
Foth Infrastructure & Environment, LLC			
REVISED	DATE	BY	DESCRIPTION
PREPARED BY: MCC2			DATE: AUG. '16
REVIEWED BY: JSL			DATE: AUG. '16
APPROVED BY: DRD			DATE: AUG. '16

POLYMET MINING

FIGURE 5-32
EXISTING SURFACE AND SUBSURFACE LAND USES, MINE SITE
PERMIT TO MINE APPLICATION
HOYT LAKES, MINNESOTA

Scale: 0 1,500 3,000 Feet	Date: AUGUST 2016
Drafted by: DAT	Project No: 12P778

Path: X:\GB\IE\2012\12P778\GIS\mxd\PMA\Figure 5-32 Mine Site Existing Uses.mxd Date: 9/1/2016



Notes

1. Basemap from Esri and its data suppliers.
2. Project features supplied by Barr Engineering Company.
3. NHD features are created from MnDNR 24K Streams and 1:24,000 USGS quadrange Maps. Due to previous disturbance, data sources may show watercourses that no longer exist.
4. Minnesota Power Substations and Power Lines supplied by the Minnesota Geospatial Information Office (MnGeo).
5. Mesabi Range Mine Lands supplied by MDNR Division of Lands and Minerals via email March 2015.

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Foth Infrastructure & Environment, LLC

REVISED	DATE	BY	DESCRIPTION

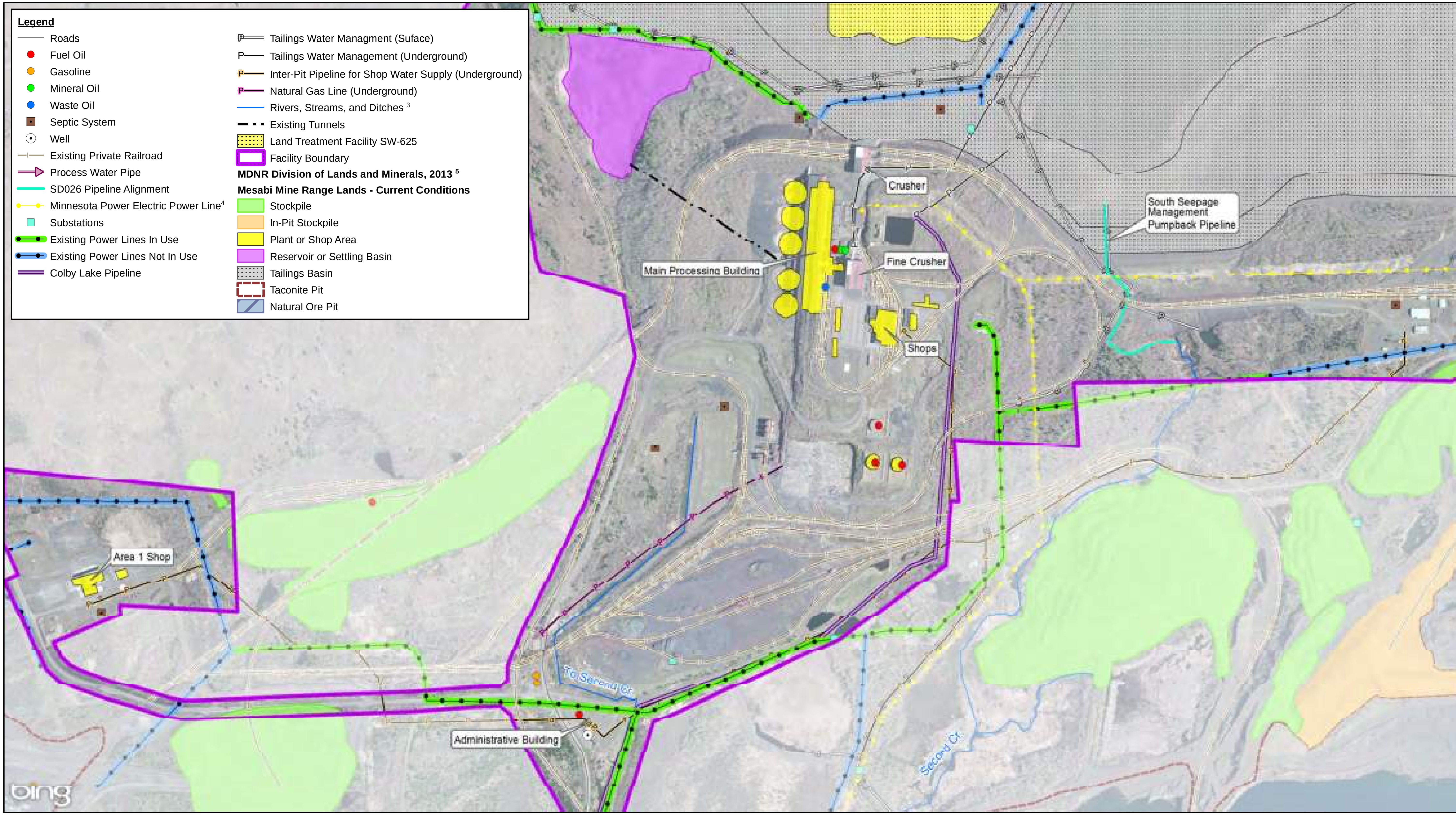
PREPARED BY:	MCC2	DATE:	AUG. '16
REVIEWED BY:	JSL	DATE:	AUG. '16
APPROVED BY:	DRD	DATE:	AUG. '16

POLYMET MINING

FIGURE 5-33
EXISTING SURFACE AND SUBSURFACE LAND USES, PLANT SITE
PERMIT TO MINE APPLICATION
HOYT LAKES, MINNESOTA

Scale: 0 1,500 3,000 Feet | Date: AUGUST 2016
Drafted by: DAT | Project No: 12P778

Path: X:\GB\IE\2012\12P778\GIS\mxd\PMA\Figure 5-33 Plant Site Existing Uses.mxd Date: 8/25/2016



Notes
1. Basemap from Esri and its data suppliers.
2. Project features supplied by Barr Engineering Company.
3. NHD features are created from MnDNR 24K Streams and 1:24,000 USGS quadrange Maps. Due to previous disturbance, data sources may show watercourses that no longer exist.
4. Minnesota Power Substations and Power Lines supplied by the Minnesota Geospatial Information Office (MnGeo).
5. Mesabi Range Mine Lands supplied by MDNR Division of Lands and Minerals via email March 2015.

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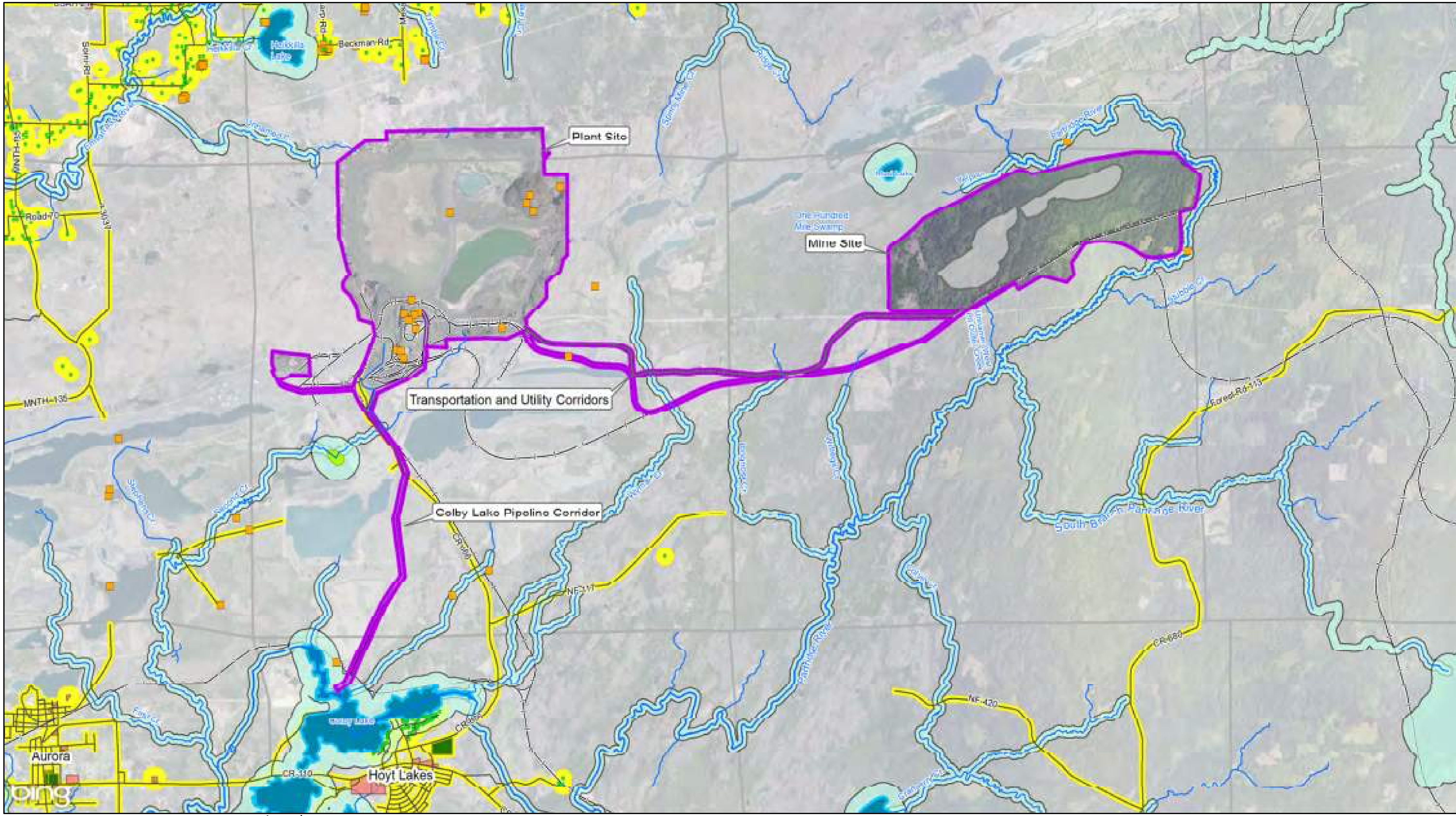
PREPARED BY: MCC2 DATE: AUG. '16
REVIEWED BY: JSL DATE: AUG. '16
APPROVED BY: DRD DATE: AUG. '16

POLYMET MINING

FIGURE 5-34
EXISTING SURFACE AND SUBSURFACE LAND USES, PLANT SITE INSET
PERMIT TO MINE APPLICATION
HOYT LAKES, MINNESOTA

Scale: 0 500 1,000 Feet
Date: AUGUST 2016
Drafted by: DAT
Project No: 12P778

Path: X:\GB\IE\2012\12P778\GIS\mxd\PMA\Figure 5-34 Plant Site Existing Uses Inset.mxd Date: 9/1/2016



Notes

1. Basemap from Esri and its data suppliers.
2. Boundary data from the MnDNR Data Deli.
3. NHD features are created from MDNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance, data sources may show watercourses that no longer exist.
4. Exclusion and avoidance datasets supplied by Barr Engineering Company.

Legend

- Dwellings
- Registry of State Historic Places Data (Restricted)
- Roads
- Dunka Road
- Rivers and Streams[3]
- Cemetery
- Public Institution
- Surface Disturbance Prohibited

Mining Restricted Areas

- Public Waters Inventory Basin (Restricted)
- Public Waters Inventory Wetland (Restricted)
- Approximate Shoreland Area
- Colby Lake Pipeline
- Existing Private Railroad
- NorthMet Mine Pits
- Townships
- Facility Boundary

POLYMET MINING

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Foth Infrastructure & Environment, LLC			
REVISED	DATE	BY	DESCRIPTION
PREPARED BY: DAT			DATE: AUG. '16
REVIEWED BY: JSL			DATE: AUG. '16
APPROVED BY: DRD			DATE: AUG. '16

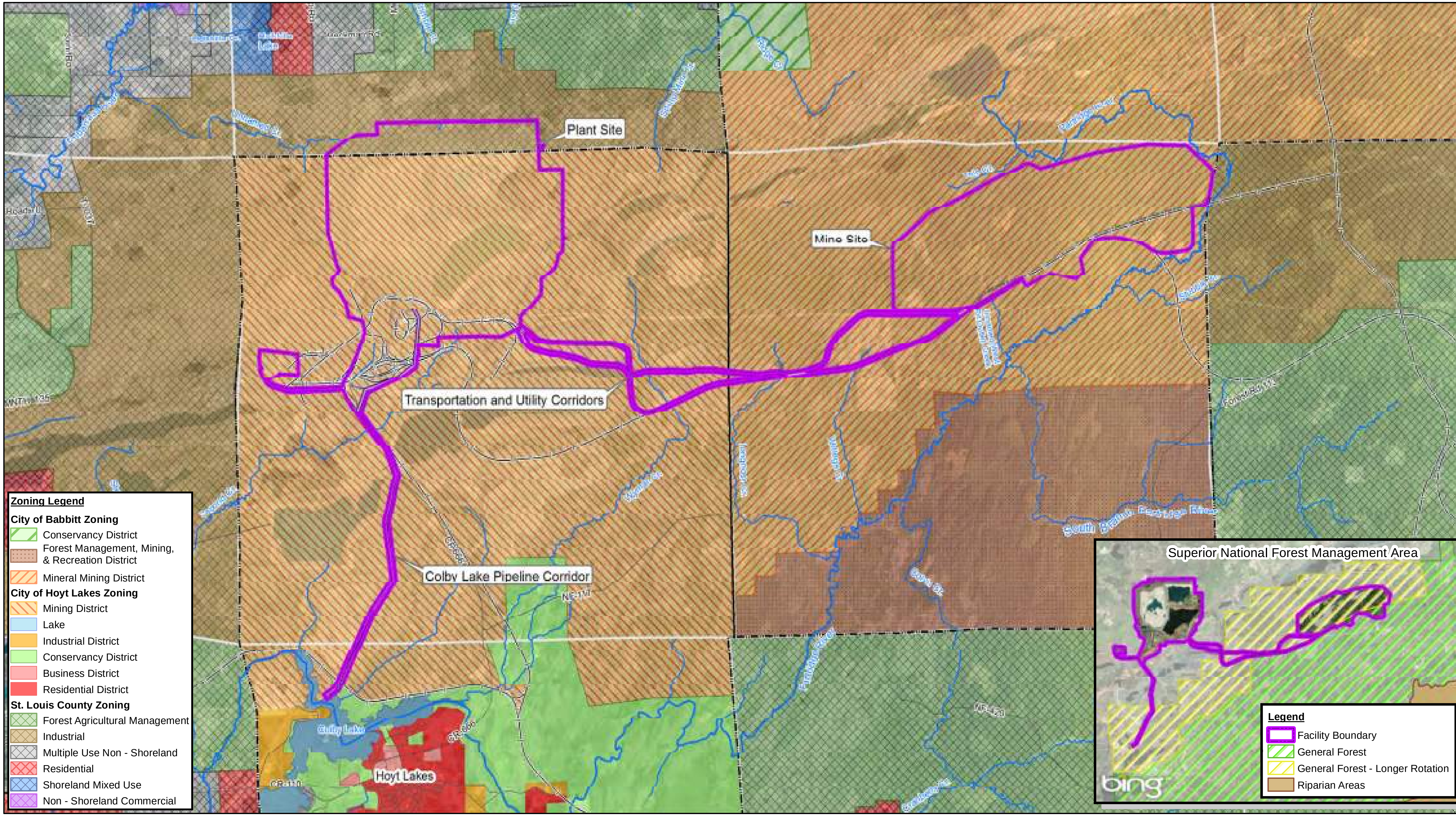
POLYMET MINING

FIGURE 5-35

PROHIBITED AND RESTRICTED AREAS
PERMIT TO MINE APPLICATION
HOYT LAKES, MINNESOTA

Scale: 0 3,000 6,000 Feet	Date: AUGUST 2016
Drafted by: DAT	Project No: 12P778

Path: X:\GB\IE\2012\12P778\GIS\mxd\PMA\Figure 5-35 Prohibited and Restricted Areas.mxd Date: 9/2/2016



Notes

1. Basemap from Esri and its data suppliers.
2. NHD features are created from MDNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance, data sources may show watercourses that no longer exist.
3. Zoning datasets supplied by Barr Engineering Company.

Legend

- Colby Lake Pipeline
- Existing Private Railroad
- Roads
- Dunka Road
- Rivers and Streams[2]
- City Boundaries
- Townships
- Facility Boundary

Foth Infrastructure & Environment, LLC

REVISED	DATE	BY	DESCRIPTION

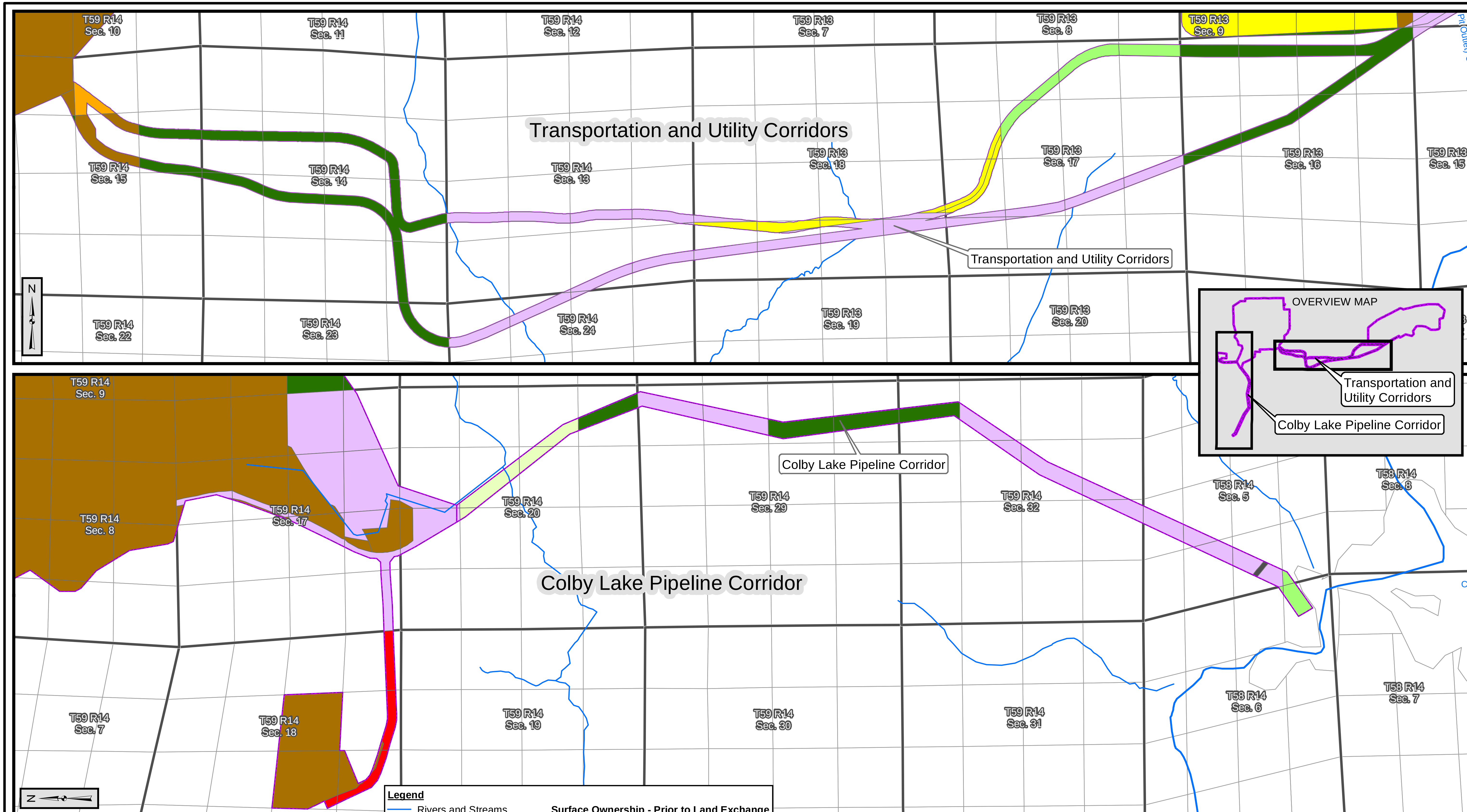
PREPARED BY:	MCC2	DATE:	AUG. '16
REVIEWED BY:	JSL	DATE:	AUG. '16
APPROVED BY:	DRD	DATE:	AUG. '16

POLYMET MINING

FIGURE 5-36
ZONING ORDINANCES
PERMIT TO MINE APPLICATION
HOYT LAKES, MINNESOTA

Scale: 0 3,000 6,000 Feet	Date: AUGUST 2016
Drafted by: DAT	Project No: 12P778

Path: X:\GB\IE\2012\12P778\GIS\mxd\PMA\Figure 5-36 Zoning Ordinances.mxd Date: 9/2/2016



Notes

1. This drawing is neither a legally recorded map nor a survey and is not intended to be used as one. This drawing is a compilation of records, information and data used for reference purposes only.
2. Surface ownership dataset supplied by PolyMet.
3. Certain parcels may have fractionalized ownership, and in such circumstances, this map shows the majority owner.
4. Consistent with Minnesota Rules, Part 6132.1100, this map depicts ownership as a matter of record as well as PolyMet's equitable ownership of lands subject to Contracts for Deed, but does not reflect private party agreements that grant PolyMet rights and control over the lands (e.g. easements, licenses, etc.)

POLYMET MINING

Foth

Foth Infrastructure & Environment, LLC			
REVISED	DATE	BY	DESCRIPTION

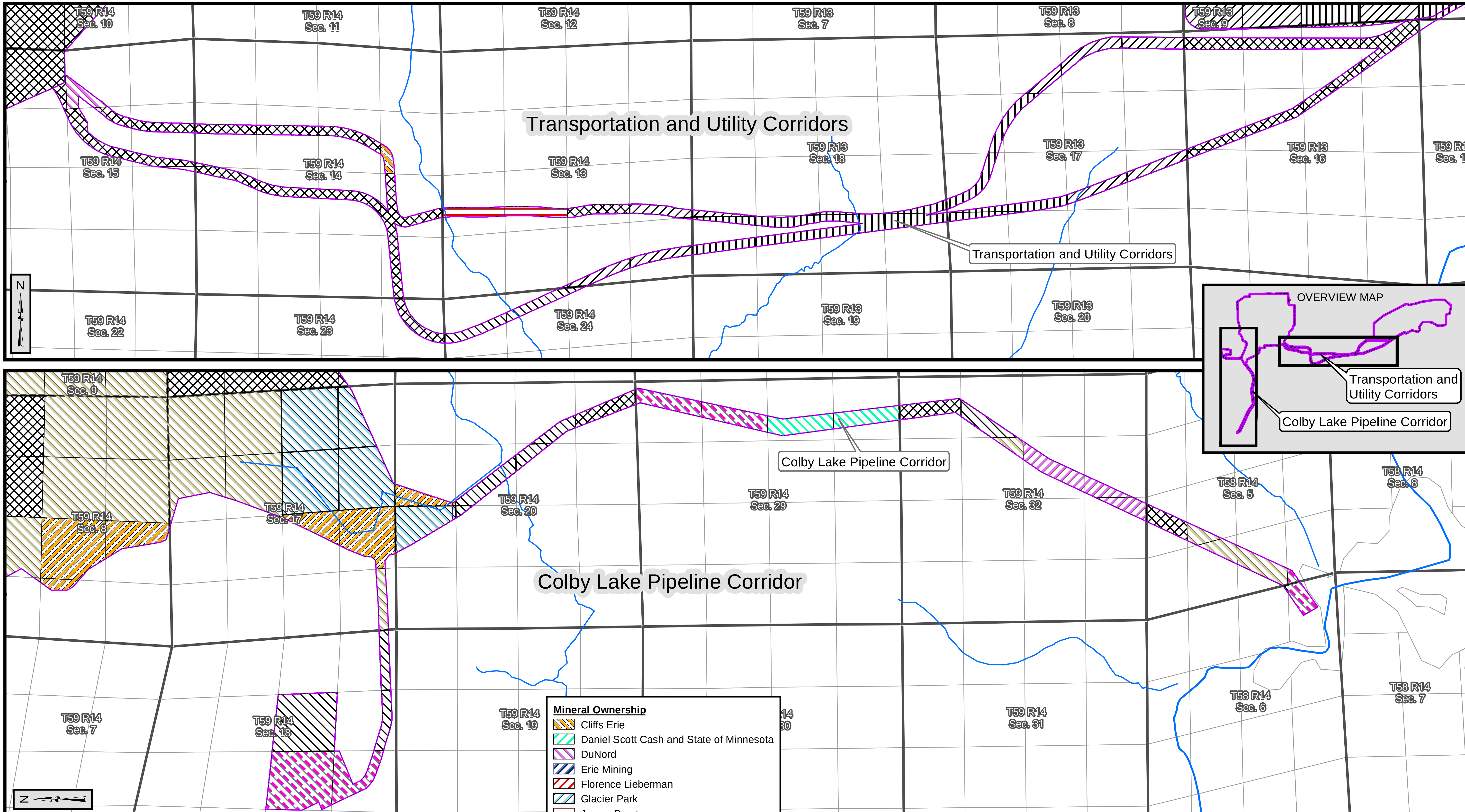
PREPARED BY:	DAT	DATE:	AUG. '16
REVIEWED BY:	JSL	DATE:	AUG. '16
APPROVED BY:	CED	DATE:	AUG. '16

POLYMET MINING

FIGURE 5-37
SURFACE OWNERSHIP PRIOR TO LAND EXCHANGE, COLBY LAKE PIPELINE CORRIDOR AND TRANSPORTATION AND UTILITY CORRIDORS
PERMIT TO MINE APPLICATION
HOYT LAKES, MINNESOTA

Scale: 0 1,000 2,000 Feet		Date:	AUGUST 2016
Drafted by:	DAT	Project No:	12P778

Path: X:\GB\IE\2012\12P778\GIS\mxd\PMA\Figure 5-37 Surface Ownership Prior to Land Exchange Insets.mxd Date: 9/2/2016



Mineral Ownership

- Cliffs Erie
- Daniel Scott Cash and State of Minnesota
- DuNord
- Erie Mining
- Florence Lieberman
- Glacier Park
- James Prest
- LTV Steel
- Longyear/Longyear Mesaba
- Minnesota Power
- RGGS
- RGGS - Encampment
- State of Minnesota
- Stephens Family
- USA
- Fractionalized Owners

Notes

1. This drawing is neither a legally recorded map nor a survey and is not intended to be used as one. This drawing is a compilation of records, information and data used for reference purposes only.
2. Mineral ownership dataset supplied by PolyMet.
3. Certain parcels may have fractionalized ownership, and in such circumstances, this map shows the majority owner.
4. Consistent with Minnesota Rules, Part 6132.1100, this map depicts ownership as a matter of record as well as PolyMet's equitable ownership of lands subject to Contracts for Deed, but does not reflect private party agreements that grant PolyMet rights and control over the lands (e.g. easements, licenses, etc.)

Legend

- Rivers and Streams
- Sections
- Quarter Quarter Sections
- Facility Boundary

POLYMET MINING

Foth

Foth Infrastructure & Environment, LLC			
REVISED	DATE	BY	DESCRIPTION
PREPARED BY: DAT			DATE: SEP.'16
REVIEWED BY: JSL			DATE: SEP.'16
APPROVED BY: DRD			DATE: SEP.'16

POLYMET MINING

FIGURE 5-38
MINERAL OWNERSHIP
COLBY LAKE PIPELINE CORRIDOR AND TRANSPORTATION AND UTILITY CORRIDORS
PERMIT TO MINE APPLICATION
HOYT LAKES, MINNESOTA

Scale: 0 1,000 2,000 Feet	Date: SEPTEMBER 2016
Drafted by: DAT	Project No: 12P778

Path: X:\GB\IE\2012\12P778\GIS\mxd\PMA\Figure 5-38 Mineral Ownership Insets.mxd Date: 9/7/2016

6 Related Environmental Review and Permitting

Under Minnesota's law governing nonferrous mining, the Application is intended to demonstrate that the Project will promote the orderly development of mining, encourage the use of good mining practices, preserve and protect natural resources, eliminate or control potential adverse environmental effects, and facilitate planning of future land utilization. To achieve these objectives, Minnesota Statutes, chapter 93 and Minnesota Rules, chapter 6132 require the use of mining methods, mine waste management, and passive reclamation that maximize physical, chemical, and biological stabilization of areas disturbed by mining, along with the use of active treatment technologies when necessary.

Minnesota law contemplates that the Permit to Mine framework will evaluate environmental considerations from the initial planning stages of mining through ongoing operations and ultimately to reclamation, closure, and postclosure maintenance. The PTM Regulations achieve this result through "outcome-based" regulation that allows site-specific tailoring of operations in the Permit to Mine rather than by setting blanket performance standards for mining operations without regard for specific operational considerations. This approach appropriately allows other permitting programs, such as MPCA's water quality program, to develop and apply necessary performance-based standards to achieve specific regulatory objectives. Accordingly, PolyMet's Application is focused on demonstrating that the Project meets the goals set forth in the applicable nonferrous mining rules, complies with the regulatory requirements established by MDNR to advance such goals, and protects natural resources and the environment.

This Application and the ultimate Permit to Mine are informed by the associated environmental review and media permitting for the Project. As prescribed in the Minnesota Rules 4410.0300, subpart 3, the detailed environmental analysis, mitigation measures, and changes to the Project that emerged from the EIS process are to be used as guides in considering this Application. The related federal and state environmental permitting and regulatory approval processes provide an additional basis for this Application to show compliance with the MDNR requirements. These related permits which include, among others, permits for wetlands, water quality, air quality, dam safety, and water appropriation are the mechanism by which the responsible agency or agencies can develop and apply performance-based standards for Project operations. These standards will supplement the Permit to Mine and help achieve the goals of the nonferrous rules and the PTM Regulations. This Application includes many conditions that PolyMet anticipates will emerge from these related permitting and regulatory processes and acknowledges that, as the independent review of PolyMet's other permit applications proceeds, it will further inform the Permit to Mine.

Given the relationship between the FEIS, regulatory approvals like those required for the federal land exchange, and other permitting processes, Section 6 provides a high-level overview of these other regulatory frameworks.

6.1 Environmental Review

PolyMet's proposed Project triggered environmental review under both NEPA and MEPA, which specified completion of an EIS before the Co-Lead Agencies (MDNR, USACE, and USFS) could issue regulatory decisions for the proposed mining operations (MDNR), federal Clean Water Act (CWA) Section 404 permit (USACE), and federal land exchange (USFS). Therefore, consistent with the Minnesota Statutes and rules governing nonferrous mining, NEPA, MEPA, and the implementing rules promulgated by the federal Council on Environmental Quality and the Minnesota Environmental Quality Board, the Co-Lead Agencies worked over the course of ten years to complete a comprehensive EIS for the Project. The FEIS, for which MDNR issued an adequacy determination under MEPA on March 3, 2016, establishes a foundation for the related environmental permitting and regulatory approvals. Among other things, the FEIS considers:

- the Project as currently proposed by PolyMet, including its purpose and need, facility configuration, construction plan, operating protocols, and specified mitigation measures
- a range of alternatives to the Project (including other facility siting options, alternative technologies, changes in design/layout, and different scales of operations as required by federal and state law)
- existing environmental conditions relevant to the Project based on baseline data developed over extended periods of time
- potential impacts of the Project and the identified alternatives to natural resources and the environment, human health, and socioeconomic considerations
- mitigation measures to avoid or minimize potential adverse impacts
- the relevant permits and other authorizations necessary for construction and operation of the Project
- financial assurance requirements that will be applicable to the Project

The MDNR, as the Responsible Governmental Unit (RGU) under MEPA, completed its regulatory process for the FEIS by issuing its determination on the adequacy of the FEIS under Minnesota law. The MDNR and the MPCA are now proceeding with the applicable permitting processes to allow them to determine whether, and on what conditions, to issue final state permits for the Project. The USACE will use the analysis developed in the FEIS to prepare a Record of Decision (ROD) for the pending CWA Section 404 permit application. The USFS has already issued a Draft ROD for the proposed land exchange, and will complete its administrative review process before a Final ROD.

Section 6.1.1 summarizes the public process that culminated in the FEIS. Section 6.1.2 provides a brief overview of certain FEIS outcomes that informed this Application.

6.1.1 Public Involvement in EIS Process

Consistent with NEPA and MEPA requirements, the process for developing the FEIS included multiple opportunities for involvement by federal and state agencies, interested Native American groups (herein referred to as the "Bands"), local governments, and members of the public. Some of these agencies, including the federal U.S. Environmental Protection Agency (USEPA) and three Bands, served as cooperating agencies during the EIS process. Other agencies, like MPCA, participated in the process at appropriate points.

To provide a full and fair opportunity for meaningful public participation, the Co-Lead Agencies undertook the following actions, among others, during the EIS process:

- Completed scoping: The Co-Lead Agencies followed statutory scoping procedures to identify the parameters of the relevant issues (including potential impacts, alternatives, and mitigation measures) to be analyzed during the environmental review process. The agencies obtained public input during scoping for the Draft EIS in 2005 and the Supplemental Draft EIS in 2010.
- Identified permits and other regulatory authorizations: The FEIS identified federal and state mining, natural resource, and environmental permitting requirements; federal land exchange procedures; local land-use protocols; and other regulatory authorizations.
- Implemented consultation: The Co-Lead Agencies consulted with:

    - The Bands, agencies and other interested parties on matters of cultural, archaeological, and historical significance pursuant to the National Historic Preservation Act; and
    - The USFWS and other agencies with expertise with respect to endangered and threatened species, wildlife, plant, and aquatic resources pursuant to the federal Endangered Species Act and similar state laws.

- Provided opportunities for public review and comment: The Co-Lead Agencies utilized public hearings and other procedures to obtain extensive public input on the Project and the environmental review documents (including scoping documentation, the Draft EIS, and the Supplemental Draft EIS (SDEIS)) that preceded the FEIS. In addition, under MEPA, members of the public had an additional opportunity to comment on the FEIS before the MDNR issued its adequacy determination.
- In addition to this public engagement, the USEPA provided substantive input as a cooperating agency during the EIS process, in addition to submitting comments on the Draft EIS, the SDEIS, and the FEIS. USEPA will continue to collaborate with the appropriate federal and state agencies during permitting on specific issues for which the USEPA has particular expertise (e.g., air or water permits). The Co-Lead Agencies

worked closely with USEPA to address USEPA's comments and views regarding the analyses set forth in the FEIS.

- Responded to public comments: After considering comments on the draft EIS from USEPA and other agencies, the Bands, local governmental authorities, the public, and PolyMet, the Co-Lead Agencies completed the SDEIS. Release of the SDEIS was followed by providing additional specific responses to comments received to the SDEIS to satisfy the requirements of NEPA and MEPA. Only after completing this public process did the Co-Lead Agencies issue the FEIS.

For additional information, Section 1.0 of the FEIS details the roles and responsibilities of the Co-Lead Agencies, the Cooperating Agencies (the Bands, supported by the Great Lakes Indian Fish & Wildlife Commission, and USEPA), and other agencies (USFWS, MPCA, and Minnesota Department of Health [MDH]) in the EIS process. Section 2.0 of the FEIS summarizes the multiple opportunities for public participation (including public meetings and formal notice and comment procedures) that were available over the multiple EIS stages.

This EIS process not only resulted in revisions to the environmental review documents, but also refined the Project as presented in this Application.

6.1.2 Environmental Review Outcomes

During the course of their environmental review process, Co-Lead Agencies considered numerous alternatives and mitigation measures (including those relating to siting, technology, modifications to designs and layouts, among others) to avoid, minimize, and mitigate potential adverse impacts. In conjunction with this process, PolyMet made numerous refinements to incorporate benefits and avoidance or mitigation measures that will produce substantial environmental benefits and other advantages to the Project. The full alternatives analysis discussion is located in FEIS Section 3.2.3. Project refinements made in connection with the 2013 SDEIS process include, among other things, the following:

- inclusion of a semi-autonomous grinding mill at the Plant Site for more efficient grinding and reduced air emissions
- removal of the existing LTVSMC Coal Ash Landfill from within the FTB footprint prior to inundation
- additions to the seepage capture systems for the Tailings Basin
- modification to the stream augmentation plan such that only treated water will be discharged to three streams downstream from the Tailings Basin
- refurbishment of existing rail cars to reduce potential for ore spillage
- stability enhancements to strengthen the existing LTVSMC tailings basin dams

In sum, the Project configuration as analyzed in the FEIS will both minimize potential environmental impacts and facilitate permit compliance. The various permits and authorizations summarized in the following sections, together with the Permit to Mine, are designed to assure that Minnesota's statutory goals for nonferrous mining will be met.

6.2 Federal Land Exchange

In addition to providing information concerning potential environmental effects relevant to the Application and related environmental permits and approvals, the FEIS incorporates an analysis of the proposed federal land exchange. The proposed land exchange between the United States, acting through the USFS, and PolyMet is an assembled land exchange in which PolyMet will convey rights to several non-contiguous parcels of land to the United States. As described in its Draft Record of Decision, the USFS is proposing to convey approximately 6,495 acres (GIS) of Superior National Forest lands encompassing the ore deposit and the adjacent land to PolyMet. In exchange, PolyMet will convey approximately 7,075 acres (GIS) of private land within the Superior National Forest to the USFS. The proposed exchange facilitates PolyMet's use of the surface overlying its mineral rights and allows PolyMet to own these surface lands in fee title.

As described in the USFS's November 2015 Draft ROD, the land exchange will also advance USFS objectives consistent with agency guidance. First, the land exchange meets the USFS's stated purpose and need by meeting desired conditions in the Superior National Forest Land and Resource Management Plan, including by eliminating existing conflict. The land exchange also meets the Purpose and Need by facilitating production of mineral resources in an environmentally sound manner contributing to economic growth. In addition, the land exchange results in a 40-acre net gain in National Forest System (NFS) lands, improves the spatial arrangement of NFS lands by reducing the length of ownership boundaries to be managed by 33 miles; improves management effectivenss by acquiring lands with public overland access; and saves money by eliminating two easements and their associated administrative costs.

The USFS land exchange process is ongoing. This Application, however, is not dependent on the land exchange.

6.3 Media Permits

PolyMet will need to obtain, in addition to the Permit to Mine, a number of other environmental permits that will inform both the Permit to Mine and PolyMet's construction, operations, reclamation, closure and postclosure maintenance activities. These other permits are largely independent of the Permit to Mine process and, in many instances, subject to the jurisdiction of other agencies. The exercise of independent regulatory oversight for areas such as air and water quality, wetland protection, water appropriations, and dam safety may, in some instances, result in conditions for these related permits that exceed Permit to Mine requirements or are not related to MDNR's PTM Regulations.

Thus, while issuance of the Permit to Mine is not dependent on these other permitting programs, refinement of the Project and imposition of permit conditions by the appropriate agencies on separate permits (e.g., performance criteria, monitoring obligations, reporting duties) will further demonstrate that the Project meets the requirements of Minnesota's PTM Regulations. The following subsections provide a high-level summary of general scope and process for the other primary environmental permits.

6.3.1 Wetland Requirements

Wetlands in Minnesota are regulated under an overlapping set of federal and state statutes and rules, including Section 404 of the CWA and the Minnesota Wetland Conservation Act (WCA) of 1991. The USACE, MDNR, and local governmental authorities in Minnesota typically coordinate their permitting processes.

As summarized in Section 12, PolyMet’s Project will impact wetlands. Before constructing and operating the Project, PolyMet will need to obtain both a CWA Section 404 permit from the USACE and MDNR approval of a wetland mitigation plan under WCA and the PTM Regulations.

Under WCA (including both the applicable statutes and regulations) and the PTM statutes and regulations, MDNR is responsible for approving PolyMet's wetland mitigation plans (for three different wetland mitigation sites), which PolyMet is submitting as part of this Application. PolyMet will continue to coordinate with MDNR and USACE on wetland permitting both in relation to WCA, the PTM Regulations, and under the separate Section 404 process. Section 12 discusses the wetland mitigation plans, which are included in Appendix 18.1.

In addition to USACE and MDNR oversight, some aspects of wetland permitting will involve coordination with both MPCA and USEPA. Under CWA Section 401, MPCA must certify that dredge and fill activities to be conducted under the proposed Section 404 permit will comply with applicable state water quality standards. USEPA's formal role in wetland permitting is more indirect, but PolyMet will continue to coordinate with the USEPA.

6.3.2 Water Quality

Minnesota has numerous programs to protect water resources. The primary permits with respect to water discharges are the NPDES program, which is grounded in the federal CWA, and the SDS program, which is governed by Minnesota Statutes, section 115.04.

The NPDES program regulates industrial waste water and stormwater discharges from point sources into surface waters such as lakes, streams, and wetlands. The SDS program applies to the construction and operation of waste water disposal systems discharging to surface waters and/or groundwater. Under Minnesota law, these programs protect waters for uses such as drinking water, aquatic life, and recreation. To effectuate these protections, the State has established water quality standards limiting the amount of certain pollutants that may be discharged into receiving waters. As part of its permitting process, MPCA may develop effluent limitations and monitoring requirements that are incorporated into a NPDES permit or SDS permit (or a combined NPDES/SDS Permit) to ensure that applicable water quality standards are met.

As discussed in Section 11, PolyMet has designed the Project to meet applicable state and federal water-protection requirements. PolyMet anticipates that NPDES and/or SDS permitting requirements will apply to, among other things, discharges from mining and processing operations, mine dewatering, waste water management, stormwater control, and storage of Flotation Tailings and Residue. Compliance with the performance-based water quality standards under the NPDES and SDS programs will independently confirm that the Project minimizes hydrologic impacts as required under the PTM Regulations.

6.3.3 Water Appropriation

To preserve state water resources, Minnesota law requires operations that will consume significant volumes of a water of the state to obtain a water appropriations permit from MDNR to withdraw water from most surface waters and groundwater. State law encourages conservation and recycling of water resources, and imposes various restrictions on water appropriations. Among other things, the MDNR regulations create preferences for the use of certain water sources over others, limit the volume of water that may be appropriated from various areas, and require the temporary suspension of appropriation of water when water levels are decreasing in a variety of circumstances. MDNR imposes these regulatory requirements through its water appropriation permitting program.

As discussed in Section 11, PolyMet intends to withdraw water from several sources, including Colby Lake, to meet Project water supply needs. Consistent with Minnesota law, PolyMet will obtain approvals for its water appropriations. Through this permitting approach, PolyMet can minimize hydrologic impacts from its operations, and comply with both the water appropriation permitting requirements and those set forth in the PTM Regulations.

6.3.4 Air Quality

The federal Clean Air Act (CAA) and associated rules promulgated by USEPA and MPCA create numerous standards and requirements to protect air quality. MPCA is responsible for administering both the federal and state air quality programs under authority delegated by USEPA.

MPCA’s air program standardizes the permitting process, and allows the issuance of either a single air emissions construction and operating permit or staged permits that separately authorize construction and operations. Permits typically include, among other things, federal and state performance standards and emissions limits, specific requirements for hazardous air pollutants, and monitoring and testing obligations. Under these permitting requirements, MPCA may, among other things, impose process or equipment controls, emission limits, and obligations for monitoring, reporting, and record keeping.

As discussed in Section 13, PolyMet anticipates that the Project will be permitted as a synthetic minor source under the federal/state program for New Source Review – Prevention of Significant Deterioration (PSD), a Part 70 permit, or a Title V permit. PolyMet has designed its planned activities to comply with these various air permitting requirements, and, as a result, the Project will also meet the air quality goals articulated in the PTM Regulations.

6.3.5 Dam Safety

Minnesota law regulates the construction and operation of dams, including those used as tailings impoundments in mining operations. MDNR administers the dam safety programs, and issues permits for construction of new dams, as well as for enlargement, repair, or alteration of existing dams.

To ensure dam safety, MDNR requires permit applicants to submit detailed construction information, including structural, geotechnical, geological, and topographical data. In the permitting process, MDNR also reviews design, engineering, safety, maintenance, and operational information; contingency planning; and detailed plans and specifications. The dam safety program also includes comprehensive MDNR inspections and company record keeping and reporting obligations.

PolyMet has filed two separate applications for dam safety permits: one for the FTB and one for the HRF. In support of these Dam Safety Permit applications and this Application, PolyMet has conducted detailed technical analysis, including more than ten years of waste characterization and geotechnical studies, and has developed its dam designs under the direction of MDNR. Based on this technical analysis and consistent with MDNR's guidance, PolyMet has designed its dams to achieve long-term stability, to prevent overtopping, and to protect water and other environmental resources. Consequently, as discussed in Section 10 of this Application, PolyMet's dams will comply with the substantive requirements of both the dam safety permit program and the Permit to Mine Regulations.

6.3.6 Legacy Environmental Conditions

The Project incorporates, consistent with Minnesota policy, the refurbishment and use of existing ferrous mining facilities at the Plant Site. These existing ferrous mining facilities remain subject to a several permits issued to Cliffs Erie, including a ferrous permit to mine for closure activities and two existing NPDES/SDS permits issued by MPCA for closure purposes. These existing permits generally are not applicable to the Project, and they include many facilities and locations that will not be used in the Project.

This Application does not cover the former LTVSMC areas that will not be used in the Project. PolyMet understands that MDNR and MPCA may maintain Cliffs Erie's existing ferrous permit to mine and NPDES/SDS permits, respectively, until PolyMet has completed construction and begins mining, and that the State is evaluating transition of the current ferrous financial assurance under those existing permits, which is in the form of a corporate guarantee, after the permits are no longer in effect. This Application, however, focuses on new nonferrous-related operations and environmental conditions.

7 Mine Site and Mining Facilities

In coordination with a team of qualified technical experts who meet regulatory qualifications for the state of Minnesota, PolyMet has developed a Mining and Reclamation Plan that is tailored to the environmental setting in which the Project will operate. The Mining and Reclamation Plan evolved substantially through the EIS process, and the resulting plan balances operational needs with advanced environmental controls to minimize adverse environmental impacts. In addition, it incorporates design elements that are responsive to input provided by the Co-Lead Agencies, cooperating agencies, the Bands, and members of the public.

Through MDNR's role as a Co-Lead for the FEIS as well as the pre-application conference associated with this Application, the agency has had the opportunity to direct PolyMet's efforts to develop a Mining and Reclamation Plan whose components (1) are based on a significant public process with substantial technical review, and (2) meet the regulatory standards for the Permit to Mine and environmental permitting.

The Mining and Reclamation Plan described in Section 3, and set forth in more detail in Sections 7 through 11 and 15, is designed to achieve the goals of the PTM Regulations by complying with each of the associated requirements, and to further Minnesota's policies on mineral development and the environment. The related environmental permits address, where applicable, specific performance standards of water quality, wetlands, air quality, and other environmental media. Specific information related to the Mining and Reclamation Plan is provided as follows:

- This section focuses on the Mine Site, including the operating life of the mine; the mining method; and the mine rate, sequence, and schedule
- Section 8 provides details regarding operations at the Plant Site, including PolyMet's beneficiation process
- Section 9 addresses the Transportation and Utility Corridors and the Colby Lake Pipeline Corridor
- Section 10 describes the characterization and management of waste materials, including overburden, waste rock, and Flotation Tailings
- Section 11 describes water management
- Section 15 presents the design, methods, sequence, and schedule of reclamation, closure, and postclosure maintenance activities
- Section 16 describes the financial assurance information

The associated appendices included in this Application provide specifics regarding the engineering and technical design elements for construction and the operational plans at the Mine Site. Construction appendices provide permit application support drawings for construction and development activities at the Mine Site, such as; earthwork design, stockpile design, Category 1

Stockpile Groundwater Containment System design, mine water infrastructure design, and stormwater pond design. Specific construction appendices for Mine Site and Plant Site facilities are as follows:

- Appendix 3 Mine Site and Dunka Road Earthwork Permit Application Support Drawings
- Appendix 4 Categories 1, 2/3, and 4 Stockpiles and Ore Surge Pile Design and Category 1 Stockpile Groundwater Containment System Permit Application Support Drawings
- Appendix 5 Mine Site Stormwater Permit Application Support Drawings
- Appendix 6 Flotation Tailings Basin and FTB Seepage Containment and Stream Augmentation Systems Permit Application Support Drawings
- Appendix 7 Hydrometallurgical Residue Facility Permit Application Support Drawings
- Appendix 8 Mechanical Infrastructure Permit Application Support Drawings
- Appendix 9 Sewage Treatment System Permit Application Support Drawings
- Appendix 10 Plant Site Stormwater Permit Application Support Drawings
- Operational appendices outline the plans for the management and monitoring the facilities at the Mine Site and Plant Site. Ancillary operational appendices outline the approach for air quality management, water management and monitoring, and wetland mitigation monitoring. Specific operational appendices include:
- Appendix 11 Mine Site: Management and Monitoring Plans Outlines
- Appendix 12 Plant Site: Management and Monitoring Plans Outlines
- Appendix 13 Annual Report
- Appendix 14

The balance of this section is structured as follows:

- Section 7.1 provides an overview of the location of the Mine Site and its compliance with applicable siting and buffer criteria
- Section 7.2 presents the NorthMet Deposit ore body
- Section 7.3 summarizes the LOM as well as the currently anticipated mining rate, amount, sequence, and schedule
- Section 7.4 describes the construction activities necessary before operations commence at the Mine Site, including preparation of the overburden portion of pit walls
- Section 7.5 discusses the mining operations PolyMet expects to conduct at the Mine Site, including blasting activities

7.1 Overview of Mine Site

The NorthMet Deposit, which drives the location of the Mine Site, is located in Sections 1, 2, 3, 4, 9, 10, 11, and 12 of Township 59N Range 13W. Figure 7-1 shows the Mine Site and the surrounding lands, which primarily include existing mining facilities and minerals underlying surface lands located within the Superior National Forest.

The Mine Site is designed to meet the applicable siting and buffer requirements set forth in the PTM Regulations. The design for the Mine Site minimizes adverse impacts on natural resources and the public and includes, as needed, setbacks or separations to comply with air, water, and noise pollution standards and other applicable requirements. The Mine Site will be compatible with surrounding non-mining uses and will maintain separations between the Project and adjacent conflicting land uses (which are minimal given the NorthMet Deposit's location in an existing iron mining area). Specifically, the Mine Site is located within the Mesabi Iron Range, with numerous iron mining operations in the general area. The closest residential areas are Hoyt Lakes to the southwest and Babbitt to the northeast.

Figure 7-1 shows the proposed location of the Mine Pits, the surface facilities, and the infrastructure at the Mine Site at the point it is fully operational. This section of the Application lists the facilities and infrastructure located at the Mine Site and, for those items not addressed in detail in a separate section, describes how each facility or infrastructure complies with the applicable general siting and buffer requirements. Mining and surface disturbances will not occur in excluded or prohibited areas, and mining operations comply with the additional restrictions applicable to mining per Minnesota Rules, part 6132.2000.

While the location of the pits for accessing the ore body drove much of the design, where PolyMet has flexibility in site selections, PolyMet analyzed alternative locations for siting as part of the EIS process and ultimately sited facilities, to the extent practicable, to minimize the following:

- impacts on the public and natural resources due to wind erosion, noise, and air emissions
- potential damage to property and natural resources or injury due to floods, caving, or slope failure
- major modification of watersheds and subwatersheds, including diversions of surface water and alterations of groundwater levels
- water quality and quantity impacts on surface water and groundwater
- wetland impacts
- conflicts with natural and historical heritage sites identified during the environmental review process

This section describes, among other things, how the siting of facilities complies with the criteria listed above. The following list summarizes PolyMet's current expectations regarding major facilities and some of the associated siting criteria for the Mine Site during operations.

- Three mine pits consisting of the East Pit, Central Pit, and West Pit. Given the location of the ore body, PolyMet does not have flexibility in the siting of the three pits. Nonetheless, where practicable, siting considerations were incorporated into the design of each of the pits. Impacts to the public will be minimal due to the pits' remote location. Slope design will meet criteria specified in Minnesota Rules, chapter 6132, with water collected in the pits managed such that, during operations, discharge off-site does not occur without on-site water treatment. To meet buffer criteria, the pits will be constructed such that they are compatible with surrounding non-mining uses. Revegetated berms and stormwater and mine water control and management will be used to accomplish this goal.
- The Categories 1, 2/3, and 4 Waste Rock Stockpiles, OSP, and OSLA, which Section 10 describes in detail, include applicable siting criteria.
- An RTH consisting of a raised structure that facilitates transfer of ore from trucks to rail cars. The RTH will meet general siting criteria in that surface water runoff from this area will be collected and managed on-site during operations. This will minimize potential impacts to property and/or watersheds. Operations will be conducted to minimize fugitive dust by using effective dust suppression techniques. The RTH will meet buffer criteria due to its location within the Mine Site.
- The new Mine Spur and loadout area connecting the RTH and the OSP to the existing Main Rail Line. To meet general siting criteria, use of the existing private rail line will minimize additional impacts to the surrounding non-mining areas. The Mine Spur will be compatible with the overall design of the Mine Site, with surface water runoff from this area collected and managed. This will minimize potential impacts to property and/or watersheds. The Mine Spur will be incorporated into the overall design of the Mine Site, which was designed to meet the buffer criteria.
- Mine water sumps and ponds. The mine water infrastructure will meet siting criteria in that this infrastructure will minimize potential impacts to surface water and groundwater. Buffer criteria will be met by incorporating the structures into overall Mine Site design, which was designed to meet the buffer criteria.
- A WWTF consisting of chemical precipitation and membrane filtration treatment trains and associated lined equalization basins and Construction Mine Water Basin. The WWTF will meet general siting criteria through treatment of mine water. This will minimize potential impacts. Buffer criteria will be met by incorporating the structures into overall Mine Site design to minimize impacts to the surrounding non-mining areas.
- A CPS and pond to pump treated mine water from the Mine Site to the Plant Site. The CPS will meet siting criteria by providing a method to pump excess water from the Mine

Site to the Plant Site to make use of such water in operations at the Plant Site. This will provide for beneficial re-use of this excess water and minimize potential impacts to property and the watershed. Buffer criteria will be met by incorporating the CPS and CPS Pond into overall Mine Site design to minimize impacts to the surrounding non-mining areas.

- A Mine Site Fueling and Maintenance Facility. The Fueling and Maintenance Facility will be designed to meet general siting criteria by incorporating secondary containment and spill and leak collection structures into the design. Use of spill and containment systems in the design will minimize potential impacts to property and the watershed. As required, the facility will be operated in accordance with a Spill Prevention, Control, and Countermeasure (SPCC) Plan before commencement of operations. Buffer criteria will be met by incorporating the Fueling and Maintenance Facility into overall Mine Site design to minimize impacts to the surrounding non-mining areas.
- Stormwater ponds located and sized to manage non-contact stormwater, construction stormwater, and industrial stormwater. Stormwater ponds will be located as shown on Figure 7-1. They will meet siting criteria by directing stormwater to these locations to maintain existing hydrologic patterns and provide appropriate retention for settling of TSS. The design allows for this retention up to an appropriate design event, with controlled discharge from the Mine Site up to and above this design event. This will minimize potential impacts to downstream property and watershed. Buffer criteria will be met by incorporating the ponds into the overall Mine Site design to minimize impacts to the surrounding non-mining area.
- Existing electric power transmission lines and proposed electric power transmission lines. To meet siting criteria, existing electric power transmission lines will be utilized, when possible, and along existing corridors otherwise. New power lines will connect existing lines to portions of the Mine Site that will require power. Use of this approach will minimize disturbance of the surrounding non-mining area and adjacent property. Buffer criteria will be met by incorporating the connecting power lines into the overall design of the Mine Site.

7.2 Description of Ore Body

The NorthMet Deposit contains an ore body that is depicted on Figure 7-2. This ore body will support the full operating life of the mine as described in Section 7.5.

The ore body is located in portions of Sections 2, 3, 9, and 10 of Township 59N Range 13W. The extent and shape of the Mine Pits are constrained by the contact between the Duluth Complex, which hosts the mineral deposit, and the underlying, un-mineralized Virginia Formation. The mineralization is generally parallel to this contact and dips southeast at about 25°.

The overall pit design for the Mine Pits takes into account the existing rock conditions, safety, and efficiency of mining. The pit configuration and mining plan are based on a numerical block model, a computer model based in part on exploration drilling information and assay data. Ongoing data collected from drilling conducted before the start of mining and during mining operations will provide additional information that will inform revisions to the Block Model and, subsequently, the mine schedule. Section 7.5 describes the East, West, and Central Pits.

7.3 Operating Life of Mine and Mine Rate, Amount, Sequence, and Schedule

The Project contemplates a 20-year LOM. This Mining and Reclamation Plan presents the anticipated mine rate, estimates on the volume of ore mined during the LOM, the planned sequence of mining operations, and the mining schedule. Over time, prices of metals, energy, labor, and other factors may present opportunities to make adjustments and optimize economic and environmental performance. If such opportunities arise, PolyMet will present potential refinements as part of the Annual Report.

The Mining and Reclamation Plan will provide a steady and reliable supply of ore to the Beneficiation Plant and methods to dispose of mine waste (rock and overburden) in a manner calculated to comply with safety and environmental regulations. During operations, PolyMet expects to mine approximately 533 million tons of rock over 20 years, which includes approximately 225 million tons of ore and about 308 million tons of waste rock. After the initial ramp-up period, the anticipated annual average ore production rate will be 32,000 tons per day. Table 7-1 describes the estimated annual production rates of ore and waste rock.

Mining is planned in the East Pit from Mine Years 1 through 11, in the Central Pit from Mine Years 11 through 16, and in the West Pit from Mine Years 2 through 20 (Table 7-2). As mining of the Central Pit commences in Mine Year 11, it will extend into the East Pit, thereby joining the pits. The combined pit (after Mine Year 13) will be referred to as the East Pit.

Waste rock will be stored in stockpiles located on the surface of the Mine Site. PolyMet plans to segregate waste rock into three stockpiles, based on sulfur content, placing the more reactive waste rock in temporary stockpiles (Categories 2/3 and 4 Waste Rock Stockpiles), and the least reactive waste rock in a permanent stockpile (Category 1 Waste Rock Stockpile). As part of its progressive reclamation practices, PolyMet will begin backfilling waste rock into the East Pit after mining in that pit is finished. PolyMet anticipates that it will relocate material from the temporary Category 4 Waste Rock Stockpile to the East Pit in approximately Mine Year 11. The material located in the Category 2/3 Waste Rock Stockpile will be relocated to the East Pit after backfilling with the Category 4 Waste Rock Stockpile is complete. The East Pit will be allowed to flood with water after mining is completed and water levels in this pit will be managed to allow safe backfill. Section 10.4 provides more detail regarding waste rock characterization, and stockpile design, construction, and operation. Section 15.3 describes stockpile reclamation.

Figure 7-3 and Figure 7-4 present Mine Site cross-sections for the following time periods: Mine Years 1, 11, 20, and postclosure maintenance. These figures also show the status of the Mine Pits, stockpiles, and OSP during these intervals. The Mine Year 1 cross-section shows the first year of mining. Mine Year 11 reflects the year when the footprint of the stockpiles and pits are currently expected to be at their largest extent. Mine Year 20 represents the end of mining. After Mine Year 20, PolyMet will conduct final reclamation, closure, and postclosure maintenance as described in Section 15. Section 15.3 discusses the reclamation of the Mine Pits.

7.4 Construction of Mine Site Infrastructure and Facilities

This section presents an overview of activities that PolyMet will undertake at the Mine Site before mining commences as well as the infrastructure and facilities required to conduct mining operations. PolyMet will excavate, manage, and store unconsolidated materials to expose the ore body and prepare the site for construction of new facilities. These unconsolidated materials are classified as overburden. Overburden is further classified as peat or unsaturated or saturated mineral overburden, depending on whether it is situated above or below the water table. All mining and excavation activities will be done to support open pit mining; no underground mining or construction to support underground mining will take place at the Mine Site. This mining method minimizes potential for subsidence as contemplated in Minnesota Rules, part 6132.3000, as subsidence is typically associated with underground mining. In the unlikely event that PolyMet identifies the potential for subsidence, PolyMet will implement mining techniques to minimize hazardous conditions and otherwise comply with the applicable rule.

Before mining operations begin, PolyMet will strip the pit area and construct infrastructure and facilities. Initial activities will consist of clearing, grubbing, and harvesting of marketable biomass and timber. Stripping work will remove the unconsolidated surface overburden, consisting of glacial till and organic wetland soils (i.e., Peat), where necessary. PolyMet will stockpile excavated Peat in the OSLA until it can be reused for on-site reclamation or off-site wetland mitigation activities. Table 7-3 provides the estimated excavated overburden volumes by type and location. Section 7.5 provides additional information about development of the Mine Pits as operations commence.

As designed, the overburden portion of the pit walls will be structurally sound during stripping, operations, and reclamation, and will meet the applicable slope requirements as set forth in Minnesota Rules, part 6132.2300. Overburden stripping will expose an area of the underlying rock that is large enough to safely accommodate mining as well as provide adequate area to conform to reclamation rules. Figure 7-5 depicts the stripping limits for each of the proposed pits.

The toe of the overburden will be set back at about 30 feet (and in no event less than 20 feet) from the crest of the blasted pit wall (Figure 7-6). This setback will allow the installed drainage ditches along the toe of the overburden slope to intercept and direct runoff water to drainage control structures. Table 7-3 provides the overburden volumes estimated to be removed to enable construction of the listed mine features.

Operations will grade final overburden bank slopes at a horizontal (H) to vertical (V) slope not steeper than 2.5H:1V. Available borehole data indicates that the overburden thickness along the perimeter of the open pits ranges from 5 feet to 29 feet, and this thickness should be sufficient to allow lift heights to be no higher than 60 feet, as required with Minnesota Rules, part 6132.2300. In addition, PolyMet will select lift heights based on the following regulatory considerations:

- public safety considerations
- the location of the pit wall in relation to surrounding land uses
- the soil types and their erosion characteristics
- the variability of overburden thickness, and the potential use

After final grading of the overburden bank slopes, PolyMet will vegetate the slopes to prevent excessive erosion and promote progressive reclamation. Figure 7-5 shows a plan view of the pit pre-stripping boundaries.

7.4.1 Mine Site Infrastructure

Figure 7-1 depicts the Mine Site infrastructure. The subsequent subsections provide details regarding the construction of this infrastructure.

7.4.1.1 Site Access and Mine Site Roads

PolyMet will construct haul roads at the Mine Site to transport ore, waste rock, and overburden between the Mine Pits, stockpiles, RTH, OSP, and OSLA. Source and destination of material moved between these facilities will depend on the current mine plan and production schedule. Appendix 3 provides permit application support drawings for the Mine Site earthwork.

The main access to the Mine Site will be from Dunka Road, which originates at the Plant Site and is located in the Transportation and Utility Corridors. Appendix 3 shows a plan view and typical cross-sections of the haul roads and site access road. PolyMet will be transporting ore to the Plant Site on the existing Main Rail Line.

The design for the Mine Site haul roads will support the largest mobile equipment planned for use at the site. PolyMet will construct Mine Site roads with berms as required by applicable Mine Safety and Health Administration (MSHA) regulations. The roadway will be sloped to allow water to flow into constructed mine water ditches running parallel to the roadway. PolyMet will manage the haul roads to control dust during both construction and operations.

7.4.1.2 Miscellaneous Utilities

Propane suppliers will provide the heating fuel required by Mine Site facilities (WWTF, CPS, RTH, and MSFMF) and railroad switch heaters. PolyMet does not anticipate the use of natural gas service or the use of heating oil storage tanks at the Mine Site. Section 9 discusses the transmission line that will provide electrical power to the Mine Site facilities.

Potable drinking water will be supplied by a bottled water supplier. None of the existing wells on-site are potable water wells. Sanitary services will be provided by a qualified vendor.

7.4.2 Mine Site Facilities

This subsection describes the Mine Site support facilities. Section 11 provides details regarding Mine Site water management features including the WWTF, CPS System, and mine water ponds.

7.4.2.1 Rail Transfer Hopper and Ore Surge Pile

The purpose of the RTH is to transfer ore from the Mine Site to rail cars for delivery to the Coarse Crusher Building at the Plant Site.

The RTH will consist of a raised platform from which haul trucks dump into a hopper over a pan feeder. The pan feeder will pass through an opening in a retaining wall and load rail cars positioned under the feeder outlet. The pan feeder and the control gate will be hydraulically powered. The locomotive operator will control both the pan feeder and the control gate using controls located in the RTH operator's cab and will also control the locomotive using remote controls.

The RTH will be located to the south of the mine pits and will be connected to the existing Main Rail Line by the new Mine Spur.

The OSP will be constructed near the RTH to facilitate delivery of a consistent flow and a uniform grade of ore to the Beneficiation Plant. PolyMet may place ore on the OSP if the mining rate exceeds the loadout rate at the RTH and may temporarily store ore at the OSP as needed, to meet mine and plant operations. Ore will flow into and out of this pile during operations as needed to meet mine and plant operating conditions. The alignment of the spur track to the RTH will allow direct loading of rail cars by a front-end loader at the OSP should the RTH be unavailable due to maintenance. The current design of the OSP has a capacity of 2.5 million tons in one 40-foot lift with side slopes at the angle of repose. Additional lifts can be constructed to increase storage capacity as necessary.

The design specifies a lined foundation for the OSP. The ore will have a sulfur content similar to Category 4 waste rock, and the liner system will therefore meet Category 4 Waste Rock Stockpile construction specifications. Drainage from the OSP will be collected on the liner and routed to a sump for pumping to the WWTF. At the completion of mining activities, PolyMet will remove the ore from the OSP and the footprint will be reclaimed. Section 10.4 provides more details regarding the OSP.

7.4.2.2 Mine Site Fueling and Maintenance Facility

Equipment fueling and minor service and repair work will occur at the MSFMF, which will be located north of the RTH. This facility will consist of two buildings: one for fueling mobile equipment (Fueling Station), and the second for mobile equipment maintenance (Maintenance Building).

Minor mobile equipment maintenance will take place at the maintenance building. These maintenance activities will include oil changes, filter changes, maintenance of fluid levels, tire changes, lamp changes, haul truck box welding, and other short duration maintenance that can be done without the need of a large overhead crane.

PolyMet will perform major scheduled maintenance and repair work on mobile equipment such as haul trucks, front end loaders, rubber tired dozers, and motor graders in the refurbished and reactivated former LTVSMC Area 1 Shops, located about one mile west of the Beneficiation Plant. Because of the size and weight of the primary excavators and blast hole drill rigs, as well as the distance to the Area 1 Shops, most of their maintenance and repair work will be done at the Mine Site.

Storage, handling, and use of oil and related products at the Fueling and Maintenance Facility will be consistent with the Project's SPCC Plan, which will be developed before the commencement of operations.

7.4.2.3 Overburden Storage and Laydown Area

PolyMet will construct the OSLA to the west of the RTH and will grade it to provide a well-drained site. This area will serve to screen, sort, and temporarily store peat and unsaturated mineral overburden that may be used for future construction or reclamation purposes. Grading of the site will direct drainage to an unlined pond in the southwest corner of the OSLA. Section 10.4.3 provides additional detail on the design of the OSLA.

7.4.2.4 Environmental Controls

Environmental controls will be in place to minimize environmental impact during construction activities. Mine Site environmental controls will include stormwater and erosion control features that will prevent sedimentation and stormwater runoff to adjacent land. Appendix 5 provides details on Mine Site stormwater features. These controls will be constructed during initial site clearing work and will include installing erosion and sediment controls, constructing berms and ditches, and sedimentation ponds. Stormwater and erosion controls will be installed as part of the Project Construction Stormwater Pollution Prevention Plan(s) (SWPPPs). Environmental controls will also include measures to minimize fugitive dust from Mine Site development as described in Section 13. Storage, handling, and use of oil and related products will be consistent with the facility's SPCC Plan to be developed prior to the commencement of operations. Measures to protect against contamination of stormwater from oil and related product storage and handling is further provided in the Construction SWPPPs to meet the requirements of the Construction General Stormwater Permit. The Construction SWPPPs will include Best Management Practices (BMPs) to reduce the potential for erosion from impacting stormwater, and Section 11 describes the SWPPPs and BMPs more fully.

7.4.2.5 Waste Water Treatment Facility

The WWTF will be constructed before operational activities and will be available to treat mine water. The WWTF design and operation are detailed in the NPDES/SDS Permit Application. It will consist of chemical precipitation and membrane filtration treatment trains. Treated mine water from the WWTF will be pumped through the TWP to the FTB for use at the Plant Site. Additional information on the WWTF is provided in Section 11.3.2.

7.5 Mining Operational Activities

The Project will use open pit mining methods similar to those currently in use at ferrous metallic mining operations on the Iron Range. The Project will transition from construction to operations with the commencement of production blasting at the Mine Site to allow for the excavation of ore. PolyMet will haul ore to the RTH and the OSP. PolyMet will haul waste rock to the appropriate stockpile based on the waste characterization and classification completed for the Project. This section provides details on open pit mining methods, drilling and blasting, excavation and hauling, and auxiliary equipment.

7.5.1 Open Pit Mining

The Project will include three separate open pits known as the East, Central, and West Pits. For approximately the first half of operations, mining will take place in the East and West Pits simultaneously. PolyMet anticipates that the sequence of mining will proceed as described in Section 7.3, and its Annual Report will detail the anticipated mining sequence for the upcoming year.

The Beneficiation Plant feed rate will progressively increase as plant operations ramp up in the first year of production. PolyMet will schedule ore production to match the Process Plant feed rate to provide an adequate supply of ore and a continuous supply of plant feed. Consistent with the nature of mining as recognized by the nonferrous mining rules, PolyMet will progressively refine the pit configuration, mine schedule, and stockpile layout throughout the projected 20-year life of the mine. Figure 7-7 shows the progression of pit development and the anticipated final pit configuration, before backfilling the East Pit with waste rock. At its ultimate size, each pit is projected to have the approximate footprint area and depth shown in Table 7-4. The progressive development of stockpiles over the 20-year LOM is depicted on Figure 7-7. Figure 7-8 through Figure 7-10 show cross-sections of the stockpiles.

7.5.2 Open Pit Rock Slope Design

PolyMet retained Golder to develop an open pit rock slope design (Reference (5)). This section presents a summary of the open pit rock slope design development. Appendix 16.22 contains a more complete discussion of the investigation and findings of the open pit rock slope design.

7.5.2.1 Geotechnical Investigation

Golder collected rock cores and discontinuity data from 16 geotechnical drill holes in the proposed West Pit and East Pit areas. All drill holes were inclined. Golder logged all 16 geotechnical holes for recovery, RQD, and fractures per run. Recovery was very close to 100% and RQD is excellent, typically exceeding 95% in all rock units. In addition, the cores were logged for the Roughness Parameter and Joint Alteration Index in accordance to Barton's Q-System (Reference (22)).

The following field and laboratory data are included in Reference (5):

- geotechnical profiles of the drill holes, rock core photographs, and geotechnical and intact rock mass properties
- plots of discontinuity data (stereonets - abbreviations used for various discontinuity types are listed in Table 7-5)
- kinematic assessment based on oriented core data

Before commencing operations, PolyMet anticipates performing additional geotechnical work to inform final designs.

7.5.2.2 Kinematics Assessments and Slope Design Recommendations

Golder also provided kinematics assessments and pit slope recommendations (Reference (5)). Based on the results of kinematic assessments, the West Pit and East Pit ultimate slope design recommendations are summarized in Table 7-6 and Table 7-7, respectively and detailed in Reference (5).

Table 7-6 and Table 7-7 list calculated inter-ramp angle recommendations for the West and East Pits respectively on the basis of 30-meter (m) benches and 10-m berms for bench face angles of 65° and 70°. To date, pit design has been based on a 51° inter-ramp angle in all parts of both pits. Therefore, based on current design, adequate berms (10-m) can be maintained.

7.5.2.3 Pit Slope Design During Operation

Consistent with industry standard practice, PolyMet will base final pit slope design on pit slope monitoring, geotechnical recommendations, ongoing mapping, and data collection. PolyMet will perform analysis from the commencement of mining operations. This analysis will allow PolyMet to refine the current preliminary design (based on core logging) to update and modify slope designs on the basis of "real-time" data and field measurements.

PolyMet will manage pit slopes on an ongoing basis consistent with the plan outlined in Appendix 11. This pit slope management plan describes mapping, data collection, and analysis PolyMet will perform during operations to maintain safe and effective pit slopes and design mitigation procedures as necessary. Because the mine will deepen gradually, there will be adequate time before pit walls reach their ultimate position to modify slope angles and berm widths, if necessary.

PolyMet will maintain the stability of the pit slope over the LOM by modifying, as necessary, the pit slope design to account for groundwater inflow conditions. The open pit geometries will assume adequate dewatering of the rock slopes. Once mining is initiated, PolyMet will evaluate the need for additional dewatering of pit slopes, based on field conditions. A Pit Inflow Mitigation Plan that includes grouting which will be implemented, if needed, is included in Appendix 11.

7.5.3 Drilling and Blasting

Blasthole drilling will be done before blasting. Because the ore has physical characteristics that are similar to the waste rock, a common drilling fleet will be utilized for both ore and waste rock drilling. To conduct drilling operations, PolyMet will use conventional electric or diesel powered rotary drilling rigs. It is modeled that the blast pattern design parameters will be slightly different between ore and waste rock, but the diameter of the blasthole will likely be the same. Drill pattern design will evolve over time as each blast provides information on how to refine the designs of subsequent blast patterns. Drill logs of blastholes will be maintained and attached to each Blast Report.

PolyMet will also undertake blast design studies in each pit to determine optimum drilling and blasting methods. Table 7-8 presents the general blasting parameters, based on drilling and blasting models. By monitoring and videotaping blasts periodically, PolyMet will refine drilling and blasting parameters over time to minimize the effects of overpressure and ground vibrations from production blasts and avoid adverse effects to human health or welfare and property outside the Mining Area.

Based on currently anticipated annual ore movement rates and modeled blast design parameters, it is estimated that ore blasting will use 8 million pounds of blasting agents annually, consisting of emulsion blends and ammonium nitrate and fuel oil (ANFO), not including initiators and blasting accessories. The planned annual waste rock movement will use an additional 7.3 million pounds of blasting agents consisting of emulsion blends and ANFO, not including initiators and blasting accessories.

Blasting operations are anticipated to take place approximately every 2 to 3 days. This will usually include separate blasts of ore and waste rock benches totaling about 200,000 to 300,000 tons of broken material per blast. A blasting contractor is likely to be utilized. No explosives will be stored on-site.

After blastholes are drilled and explosive loading begins, limited activities will be permitted within the blast pattern. Activities directly related to the blasting operations, as well as surveying, mapping, and sampling of geology will be allowed following established procedures.

Near the completion of the blast pattern, explosive loading mine staff will be informed of the upcoming blasts through meetings and communication with the blasting coordinators and their supervisors and by warning signs. A set of warning signs for blasting and/or flagging will be developed and prominently displayed around the blast site to prevent unauthorized entry. Signs informing employees will also be posted the day of the blast.

Loading and blasting will be conducted as a continuous process with the blast fired as soon as possible after being loaded.

Secondary breaking of oversize pieces will be done in the pit using a wheel loader or excavator-mounted drop weight hammer.

7.5.4 Excavation and Haulage

After drilling and blasting, the ore and waste rock will be loaded by excavators into haul trucks that will transport the ore to the RTH or OSP and the waste rock to stockpiles or the East Pit after Mine Year 11. Electric-hydraulic excavators will be the primary rock loading tools in the mining fleet with a large diesel front-end loader available to provide operational flexibility and additional loading capacity. The haul truck fleet will initially consist of conventional diesel-powered rear dump trucks. Haul trucks may be re-assigned between excavators loading ore and waste rock.

7.5.5 Mine Auxiliary Equipment

Mine operations will also require auxiliary equipment. Table 7-9 lists the vehicle and equipment currently anticipated as the fleet. Once operations commence, PolyMet may adjust its fleet based on operational considerations.

Table 7-1 Estimated Annual Production Rates – Waste Rock and Ore

Mine Year	Ore (tons)	Category 1 (tons)	Category 2 (tons)	Category 3 (tons)	Category 4 (tons)	Total Waste Rock (tons)
1	4,285,400	18,707,500	4,674,400	564,300	1,489,200	25,435,500
2	11,680,000	15,016,700	3,821,800	611,100	762,500	20,212,000
3	11,680,000	16,139,000	3,739,800	557,300	1,127,700	21,563,900
4	11,680,000	12,796,600	3,275,700	379,900	827,500	17,279,700
5	11,680,000	11,741,300	2,384,800	30,300	441,900	14,598,200
6	11,680,000	16,842,200	3,914,200	434,800	665,600	21,856,800
7	11,680,000	10,405,000	2,382,800	183,200	549,000	13,520,100
8	11,680,000	16,939,800	3,883,900	448,300	110,600	21,382,700
9	11,680,000	12,556,200	4,147,800	512,400	133,500	17,349,800
10	11,680,000	12,974,200	3,589,900	480,600	76,800	17,121,600
11	11,680,000	10,180,400	3,717,400	286,500	22,400	14,206,700
12	11,680,000	10,773,100	4,253,100	531,600	50,100	15,607,800
13	11,680,000	8,133,600	5,050,000	662,900	36,300	13,882,700
14	11,680,000	8,474,200	3,258,300	378,200	66,900	12,177,700
15	11,680,000	6,166,000	4,288,500	401,300	94,100	10,949,900
16	11,680,000	4,444,100	2,875,900	912,900	866,300	9,099,300
17	11,680,000	4,022,300	1,841,900	563,100	528,200	6,955,500
18	11,680,000	5,592,500	2,628,000	321,000	300,200	8,841,600
19	11,680,000	6,944,600	4,296,300	483,000	220,300	11,944,200
20	10,754,600	7,845,300	5,303,900	711,400	267,400	14,128,000
Total	225,280,000	216,694,700	73,328,300	9,454,000	8,636,600	308,113,700

Estimates subject to change based on metal prices and other factors.
Source: PolyMet, 2016. *NorthMet Project - Mine Plan, Version 5.* July 2016. Included in Appendix 16.20 of the Application.

Table 7-2 Pit Activities Over Life of Mine – Mining and Waste Rock Placement

Mine Year	East Pit	Central Pit	West Pit
1	M		
2	M		M
3	M		M
4	M		M
5	M		M
6	M		M
7	M		M
8	M		M
9	M		M
10	M		M
11	M / WR	M	M
12	WR	M	M
13	WR	M	M
14	WR	M	M
15	WR	M	M
16	WR	M	M
17	WR	WR	M
18	WR	WR	M
19	WR	WR	M
20	WR	WR	M

Notes:
M - Mining
WR - Waste rock placement
East and Central Pits merge in approximately Mine Year 14.

Table 7-3 Volume and Types of Overburden to be Excavated Prior to Construction

Location	Area (acres)	Saturated Mineral Overburden (bcy)[1]	Unsaturated Mineral Overburden (bcy)[1]	Peat (bcy)[1]	Total Volume (bcy)[1]
Ore Surge Pile	31	21,000	202,000	4,000	227,000
Category 1 Waste Rock Stockpile[2]	526[(2)]	0	0	220,500[(2)]	220,500[(2)]
Category 2/3 Waste Rock Stockpile	180	27,000	274,000	462,000	763,000
Category 4 Waste Rock Stockpile[3]	57	3,000	53,000	43,000	99,000
West Pit	321	4,491,000	1,193,000	1,498,000	7,182,000
East/Central Pits[3]	207	1,047,000	1,450,000	227,000	2,724,000
TOTAL[3]	1,275[(3)]	5,589,000	3,172,000	2,454,500	11,215,500

Notes:

1 bcy - bank cubic yard. Bcy is the volume of material in-place. Excavation will generally increase the volume measurement of a material.

2 The Category 1 Waste Rock Stockpile overburden excavation volumes include excavation of peat within 100 feet from the outer edge of the stockpile for stockpile stability.

3 The Category 4 Waste Rock Stockpile footprint overlaps with the Central Pit footprint. The individual areas are greater than the total, which takes into account the overlap. The volumes listed for the East/Central Pits only include the volumes in excess of the stockpile.

Estimates subject to change based on metal prices and other factors.

Source: PolyMet, 2016. *NorthMet Project Mine Plan, Version 5.* July 2016. Included in Appendix 16.20 of the Application.

Table 7-4 Maximum Pit Dimensions

Mine Pit	Area (acres)	Maximum Depth (feet below ground surface)
West	321	630
Central	52	356
East	155	696

Estimates subject to change based on metal prices and other factors.

Source: PolyMet, 2016. *NorthMet Project - Mine Plan, Version 5,* July 2016. Included in Appendix 16.20 of the Application.

Table 7-5 List of Abbreviations for Describing Discontinuities

Abbreviation	Definition
BD	bedding
CL	cleavage
CO	contact
FLT	fault
FO	foliation
FO IN HNF INCL IN	foliation in Hornfels
JN	joint
JN/VN	joint or vein
SHR	shear
VN	vein

Table 7-6 West Pit Ultimate Slope Design Recommendations

Material	Sector and Wall Dip Directions	Maximum Vertical Bench Separation (m)	Bench Face Angle (º)	Bench Width (m)	Inter-Ramp Angle (º)
Unit 1 on Footwall, Unit 1 and overlying units on other walls	Sector I Footwall 090º to 160º	30	65(1)	10	51.4
	Sector II East Wall 170º to 260º	30	65	10	51.4(2)(3) *(53.8)*
	Sector IIIa Hanging Wall 260º to 020º	30	65	10	51.4(2) *(53.8)*
	IIIb West Wall/Footwall 020º to 090º	30	70	10	55.1

Notes:

[1] On the Footwall, the Bench Face Angle is limited to 65° to control steep potential wedges. Flat sets (dip less than 35°) dipping out of the wall are also prevalent. While estimated friction angle on the joints of these sets is on the order of phi = 35° based on Jr and Ja logging, localized failures involving these features may still occur, in particular if adequate slope depressurization is not achieved and/or if joint surfaces are significantly altered.

[2] On West Pit Sectors II and IIIa, there is upside potential for slope steepening, if lack of adverse structure can be verified, by reducing the bench width to 8m or increasing the Bench Face Angle to 70° or better, provided that experience with initial slopes, confirmed by mapping, indicates that adverse wedges and planes with dips in the 47° to 51° range are not problematic. Reducing the bench width from 10m to 8m, with BFA=65° would provide IRA=53.8°.

[3] The East Wall of the proposed West Pit is significant enough in length and height for consideration of further drilling investigation at the detailed design stage. Drilling of a geotechnical borehole (oriented core) with NE azimuth would be the best way of justifying steeper slopes in advance of experience with initial benches. Geotechnical boreholes from the present study have azimuths parallel to the strike of this proposed wall.

Abbreviations:
m = meter
º = degree

Source: Adapted from Appendix 16.22

Table 7-7 East Pit Ultimate Slope Design Recommendations

Material	Sector and Wall Dip Directions	Maximum Vertical Bench Separation (m)	Bench Face Angle (º)	Bench Width (m)	Inter-Ramp Angle (º)
Unit 1 and Virginia on Footwall and East Wall, Unit 1 and overlying units on other walls	Sector I Footwall 200º to 115º	30	65	10	51.4(1) (47)
	Sectors II, III, and IV East(2) South (Hanging Wall(3) and West Walls 115º to 200º	30	65	10	51.4

Notes:

1 The East Pit Footwall Design of IRA=51° is considered aggressive because of kinematically possible wedges (plunges 47° to 51°) and also because of kinematically possible plane failures (dip 43° to 59°). This more adverse fabric arrangement appears to be related to steeper apparent dips of the Virginia and overlying Duluth Complex Units. If these features are problematic on initial benches, then the IRA should be reduced to 47° by decreasing the Bench Face Angle to 60°. Adequate dewatering is essential. Concerns are mitigated by the presence of ramps and step outs on the footwall, which will help to control any localized instabilities.

2 Slope design on the East wall is controlled by the potential for steep wedges (plunge 60 to 66° and 41°) involving assumed potentially continuous structures. This interpretation is conservative. There is upside potential to steepen the East Pit East Wall from 51° to 53° by reducing the bench width from 10m to 8m, provided experience with initial benches confirms that the initial assumptions are conservative. Similarly, bench face angles could be steepened based on operational experience and good blasting. As an alternative, an oriented core hole with NE azimuth directed into the east wall could be considered at the detail design stage of the project. See also Note 3 of Table 5.3-3.

3 Oriented core drillholes in the East Pit Hanging Wall area consistently indicate the presence of a NW dipping set (dip 38° to 40°) that could be result in plane failures. This is interpreted to be a joint set roughly orthogonal to the apparent dip of the Duluth Complex layering. It does not appear to occur in the West Pit data. Kinematically possible wedges ranging from plunge 46° to 66° are indicated from stereographic projections. Both the planes and wedges are considered discontinuous features. While the recommended bench configuration (IRA = 51.4°) is intended to control most of these features, localized instabilities may still occur.

Abbreviations:
m = meter
º = degree

Source: Adapted from Appendix 16.22

Table 7-8 Blasting Parameters

Blasting Parameters	Specifications
Blast hole diameter (range)	10-16 inch
Explosive type/blasting agent	ANFO, emulsion, and emulsion blends
Burden (distance from free face) and spacing (distance between holes)	Approximately 25 feet x 28 feet with 5 feet of subdrilling for ore and 29 feet x 33 feet with 6 feet of subdrilling for waste rock, based on a 12-1/4 inch diameter blast hole
Powder factor	Approximately 0.69 pounds per ton for ore and 0.45 pounds per ton for waste rock, based on a 12-1/4 inch diameter blast hole
Drilling rate - approximate (Assumed drilling time per rig, 24 hours per day)	50 to 70 feet per hour based on a 12-1/4 inch diameter drill bit
Feet drilled per month	Average of 34,425 feet per month
Drilling rigs required	2 drill rigs

Abbreviations:
ANFO = ammonium nitrate fuel oil

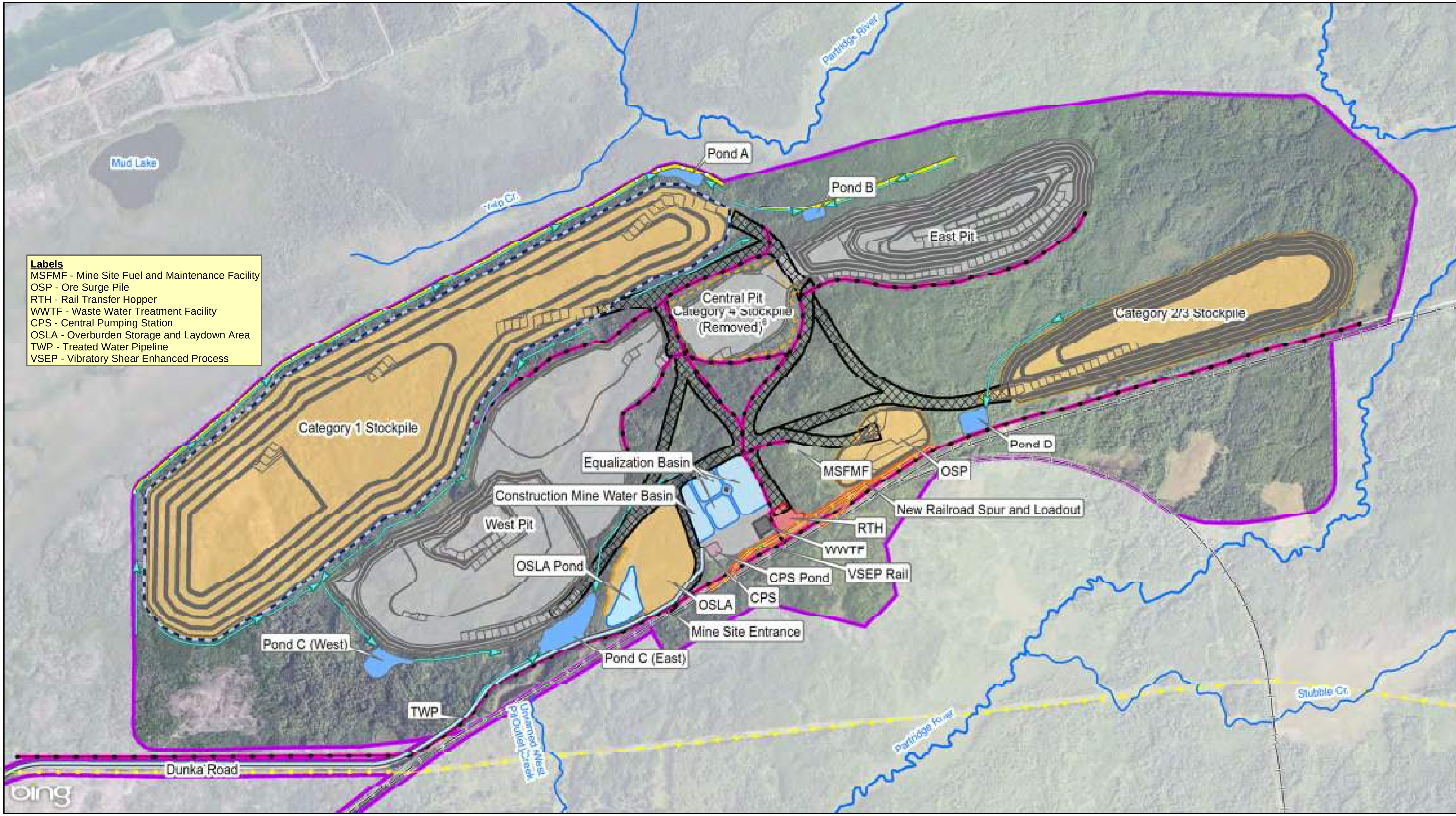
Source: PolyMet, 2016. NorthMet Project - Mine Plan, Version 5. July 2016. Included in Appendix 16.20 of the Application.

Table 7-9 Mine Auxiliary Equipment

Typical Machine Type	Power[1]	Duties
Cat D10R tracked dozer or equivalent	582 hp	Stockpile maintenance, construction, stockpile reclamation
Cat 834G wheel dozer or equivalent	450 hp	Cleanup at the pit loading faces and the RTH
Cat 16H Grader or equivalent	275 hp	Haul road maintenance
Cat 777D Water Truck or equivalent	937 hp	Haul road maintenance, dust suppression, auxiliary firefighting duties
Cat 992G Wheel Loader or equivalent	800 hp	General purpose loading, site reclamation
Cat 446D Backhoe with Hammer or equivalent	110 hp	Secondary breakage
Cat IT62H Integrated Tool Carrier or equivalent	230 hp	Miscellaneous tasks (e.g., snow plowing, forklift, sweeper, etc.)
Field service trucks	114 hp	Field maintenance flatbed trucks fitted with hydraulic arm lift
Fuel truck	150 hp	Field fueling of mobile equipment and drills
Line truck	100 hp	Powerline maintenance, excavator, and RTH service
Off-road lowboy trailer and tractor	200 hp	Transporting equipment around mine and to service area/workshops
Drills	Electric and/or 1,600 hp	Blasthole drilling for waste rock and ore
Excavators	Electric	Excavation of ore and waste materials (waste rock and overburden)
Haul Trucks	2,500 hp	Haulage of ore and waste materials (waste rock and overburden)
Haul truck retriever	1,120 hp	Retrieving and transporting haul trucks unable to move under their own power
Light vehicles (pickups and SUVs)	150-250 hp	Supervisors' transport, general duties

Notes:
[1] Equipment subject to change.
Abbreviations:
Cat = Caterpillar
hp = horsepower
RTH = Rail Transfer Hopper
SUV = sport utility vehicle

Source: PolyMet, 2016. *NorthMet Project - Mine Plan, Version 5.* July 2016. Included in Appendix 16.20 of the Application.



Notes

1. Basemap from Esri and its data suppliers.
2. Project features supplied by Barr Engineering Company.
3. Entire map extent is outside the Rainy River Watershed.
4. Minnesota Power Power Lines supplied by the Minnesota Geospatial Information Office (MnGeo).
5. For clarity not all of the sumps, ditches, piping, and overflows are shown.
6. The Category 4 stockpile is removed, enabling the development of the Central Pit.
7. Mine Water Ponds are lined with the exception of the OSLA Pond and Construction Mine Water Basin.

Legend

- Proposed Railroad Track
- Existing Private Railroad
- Groundwater Containment System
- Existing Electric Power Line[4]
- Proposed Transmission Line
- Rivers and Streams
- Stormwater Ponds
- Treated Mine Water Pond (Lined)
- Mine Water Ponds[7]
- WWTF Buildings
- Haul Roads
- Active Stockpile
- Removed Stockpile
- Mine Pits
- Facility Boundary

POLYMET MINING

Foth

Foth Infrastructure & Environment, LLC

REVISED	DATE	BY	DESCRIPTION

PREPARED BY: MCC2	DATE: AUG. '16	
REVIEWED BY: JSL	DATE: AUG. '16	Scale: 0 750 1,500 Feet
APPROVED BY: JOS1	DATE: AUG. '16	Drafted by: DAT

POLYMET MINING

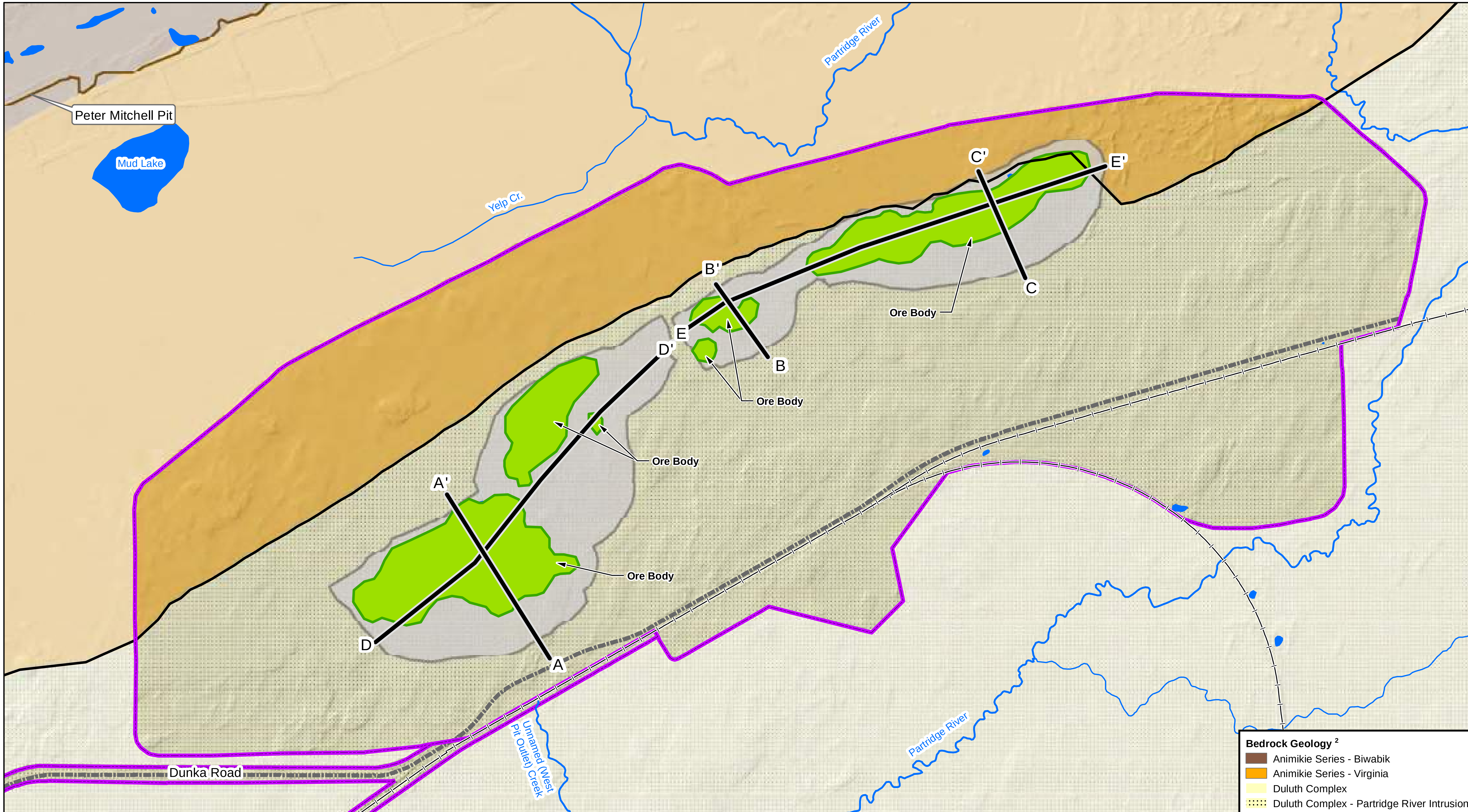
FIGURE 7-1

MINE SITE - MINE YEAR 11
PERMIT TO MINE APPLICATION
HOYT LAKES, MINNESOTA

Date: AUGUST 2016

Project No: 12P778

Path: X:\GB\IE\2012\12P778\GIS\mxd\PMA\Figure 7-1 Mine Site.mxd Date: 9/2/2016



Notes

1. Project features supplied by Barr Engineering Company.
2. Geology Sources: Jirsa, M.A., Chandler, V.W., and Lively, R.S.,2005, Bedrock Geology of the Mesabi Iron Range, Minnesota: Minnesota Geological Survey Miscellaneous Map M-163, scale 1:100,000. Severson, M.J., and Miller, J.D. Jr., 1999, Bedrock Geology of the Allen Quadrangle: Minnesota Geological Survey Miscellaneous Map 91, scale 1:24,000.
3. Cross Sections shown on Figures 7-3 and 7-4.

Legend

- Roads
- Dunka Road
- Existing Private Railroad
- Cross Section Locations Mine Site
- Rivers and Streams
- Natural Lakes
- Mine Pits
- Mine Site Block Model Ore Body
- Facility Boundary

POLYMET MINING

Foth

Foth Infrastructure & Environment, LLC

REVISED	DATE	BY	DESCRIPTION

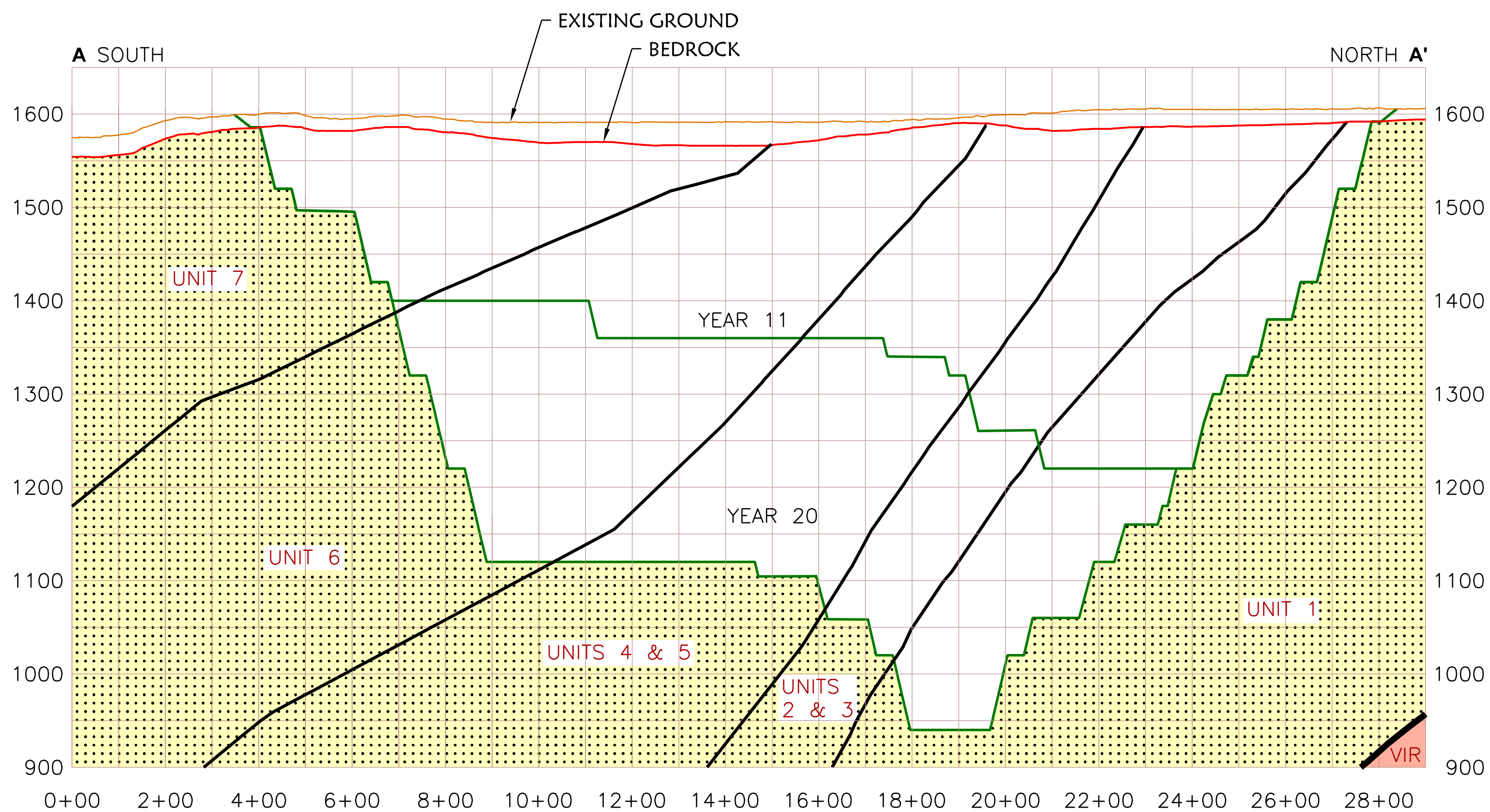
PREPARED BY:	MCC2	DATE:	AUG. '16
REVIEWED BY:	JSL	DATE:	AUG. '16
APPROVED BY:	JOS1	DATE:	AUG. '16

POLYMET MINING

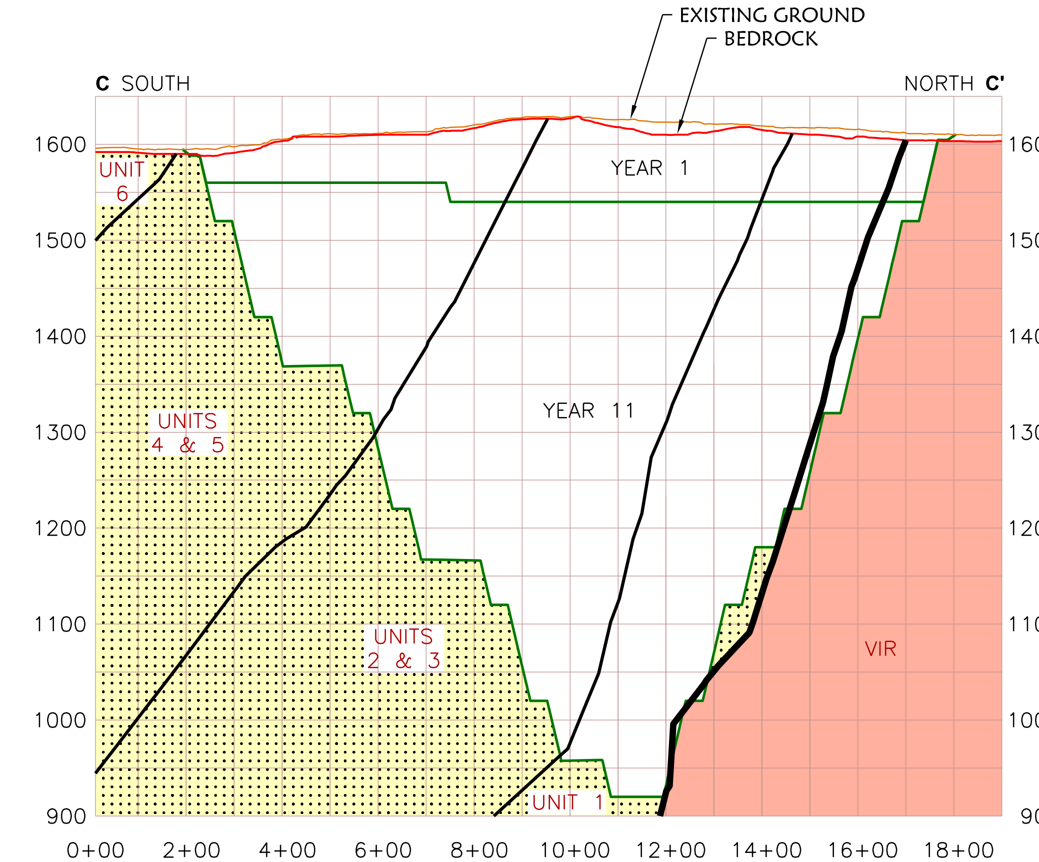
FIGURE 7-2
BEDROCK GEOLOGY
PERMIT TO MINE APPLICATION
HOYT LAKES, MINNESOTA

Scale: 0 750 1,500 Feet	Date: AUGUST 2016
Drafted by: DAT	Project No: 12P778

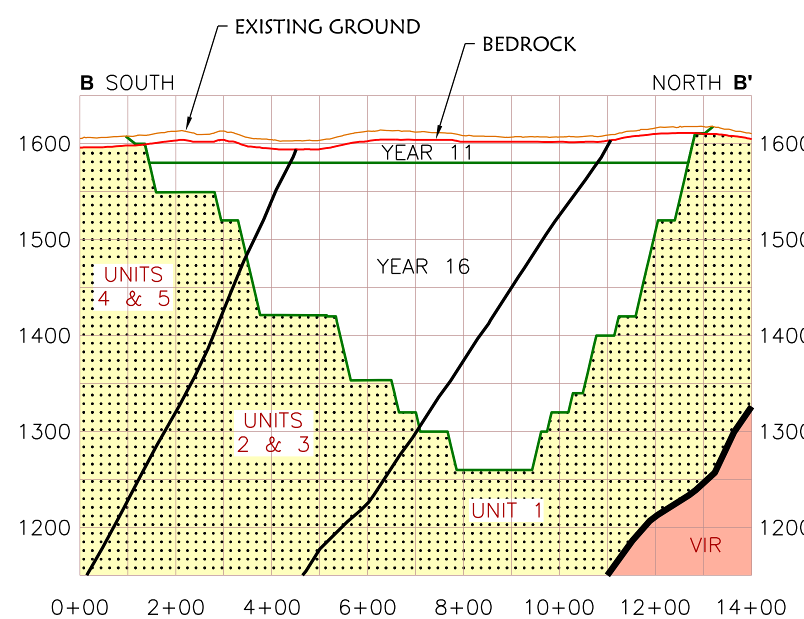
Path: X:\GB\IE\2012\12P778\GIS\mxd\PMA\Figure 7-2 Bedrock Geology.mxd Date: 8/24/2016



A SECTION: WEST PIT
2:1 VERTICAL EXAGGERATION



C SECTION: EAST PIT
2:1 VERTICAL EXAGGERATION



B SECTION: CENTRAL PIT
2:1 VERTICAL EXAGGERATION

LEGEND

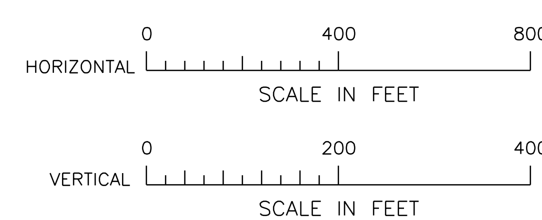
UNIT 1-7 — PARTRIDGE RIVER INTRUSION DULUTH COMPLEX

VIR — VIRGINIA FORMATION ANIMIKIE SERIES

GEOLOGIC CONTACT

NOTES:

1. CROSS SECTION LOCATIONS SHOWN ON FIGURE 7-2.
2. FIGURE ADAPTED FROM ROCK AND OVERBURDEN MANAGEMENT PLAN. VERSION 8, JULY 2016 IN APPENDIX 16 OF THE APPLICATION.
3. CENTRAL PIT MINING WOULD BE COMPLETED IN MINE YEAR 16.
4. EAST PIT WILL BE BACKFILLED AS PART OF PROGRESSIVE RECLAMATION BEGINNING IN MINE YEAR 11.



POLYMET MINING

Foth

Foth Infrastructure & Environment, LLC

REVISED	DATE	BY	DESCRIPTION

PREPARED BY:	MCC2	DATE:	AUG. '16
REVIEWED BY:	JSL	DATE:	AUG. '16
APPROVED BY:	JOS1	DATE:	AUG. '16

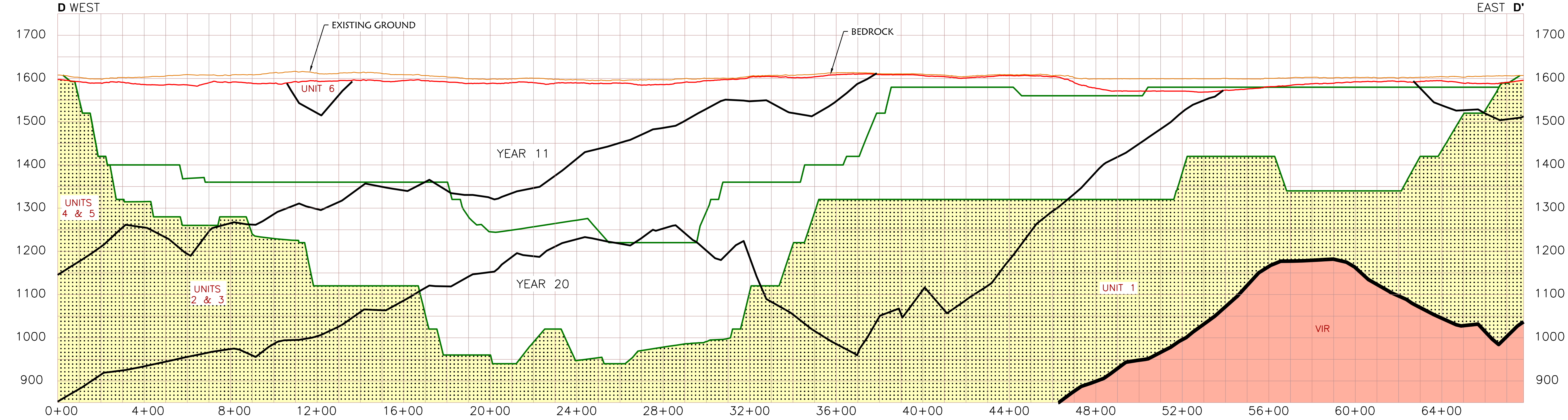
POLYMET MINING

FIGURE 7-3

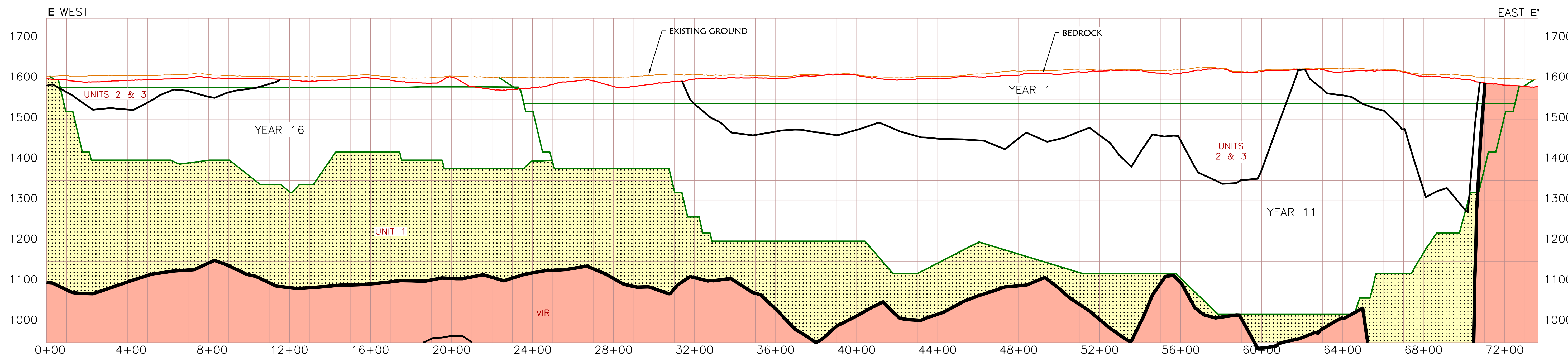
PIT CROSS SECTIONS A, B, C
HOYT LAKES, MINNESOTA

Scale:	NOT TO SCALE	Date:	AUGUST 2016
Drafted By:	JOW	Project No:	12P778

X:\GB\IE\2012\12P778\cad\figures\PMA\Figure 7-3 Geo cross sections A-B-C.dgn
9/2/2016 8:20:47 AM jow



D — SECTION: WEST PIT
2:1 VERTICAL EXAGGERATION



E — SECTION: EAST PIT
2:1 VERTICAL EXAGGERATION

LEGEND

UNIT 1-7	PARTRIDGE RIVER INTRUSION DULUTH COMPLEX
VIR	VIRGINIA FORMATION ANIMIKIE SERIES
	GEOLOGIC CONTACT

NOTES:

1. CROSS SECTION LOCATIONS SHOWN ON FIGURE 7-2.
2. FIGURE ADAPTED FROM ROCK AND OVERBURDEN MANAGEMENT PLAN, VERSION 8, JULY 2016 IN APPENDIX 16 OF THE APPLICATION.
3. CENTRAL PIT MINING WOULD BE COMPLETED IN MINE YEAR 16.
4. EAST PIT WILL BE BACKFILLED AS PART OF PROGRESSIVE RECLAMATION BEGINNING IN MINE YEAR 11.

HORIZONTAL 0 500 1,000
SCALE IN FEET

VERTICAL 0 250 500
SCALE IN FEET

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REVISED	DATE	BY	DESCRIPTION

PREPARED BY:	MCC2	DATE: AUG. '16
REVIEWED BY:	JSL	DATE: AUG. '16
APPROVED BY:	DRD	DATE: AUG. '16

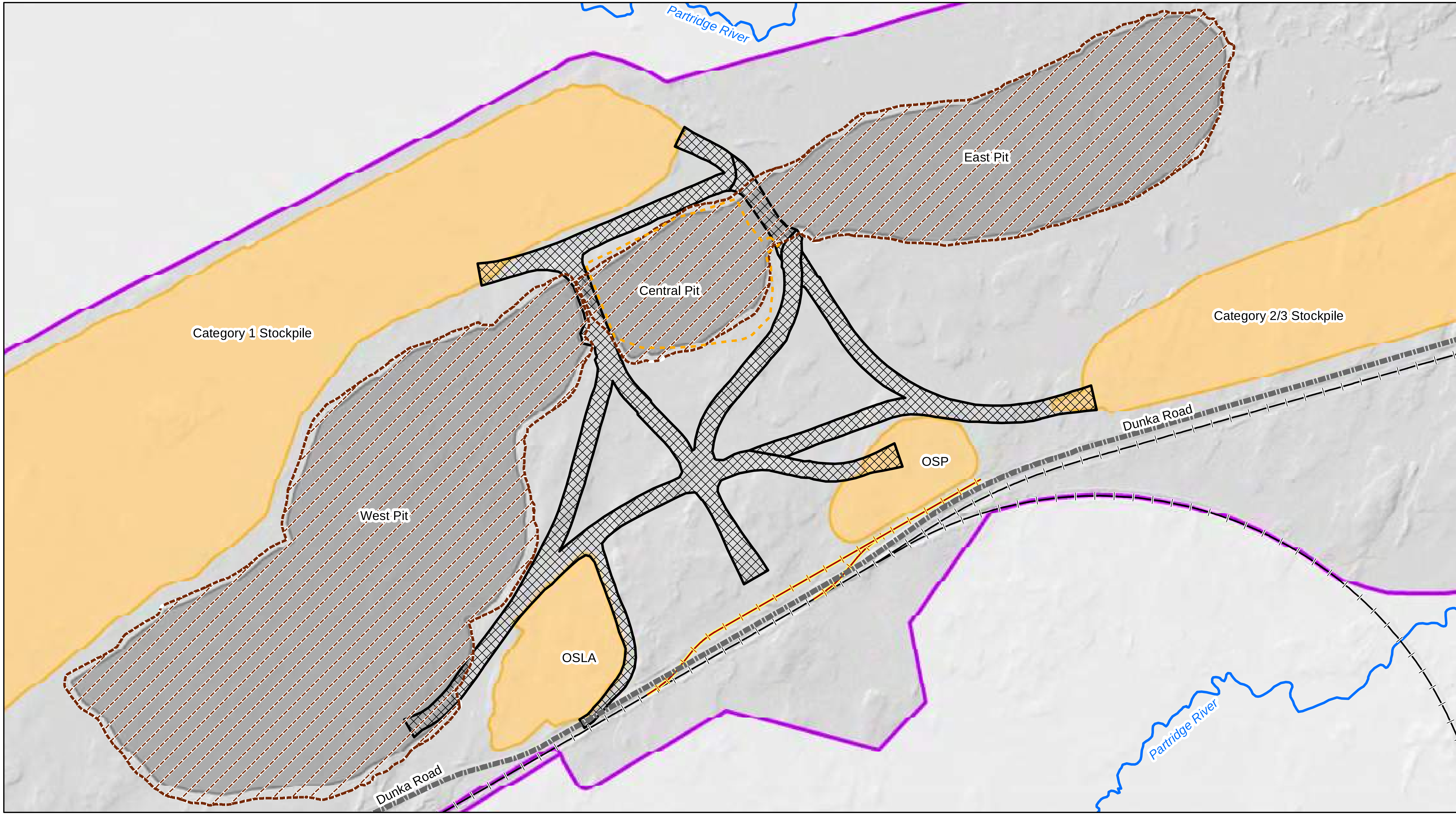
POLYMET MINING

FIGURE 7-4

PIT CROSS SECTIONS D, E
HOYT LAKES, MINNESOTA

Scale:	NOT TO SCALE	Date:	AUGUST 2016
Drafted By:	JOW	Project No:	12P778

X:\GB\IE\2012\12P778\cad\figures\PMA\Figure 7-4 Geo cross sections D-E.dgn
9/2/2016 8:22:23 AM jow



Notes
1. Basemap from Esri and its data suppliers.
2. Project features supplied by Barr Engineering Company.
3. Pre-stripping would occur in stages as the mine pits are developed.
4. The Category 4 stockpile is removed, enabling the development of the Central Pit.

Legend
- Proposed Railroad Track
- Existing Private Railroad
- Rivers and Streams
- Pre-Stripping Limits
- Category 4 Stockpile (Removed)[4]
- Haul Roads
- Mine Pits
- Active Stockpile
- Facility Boundary

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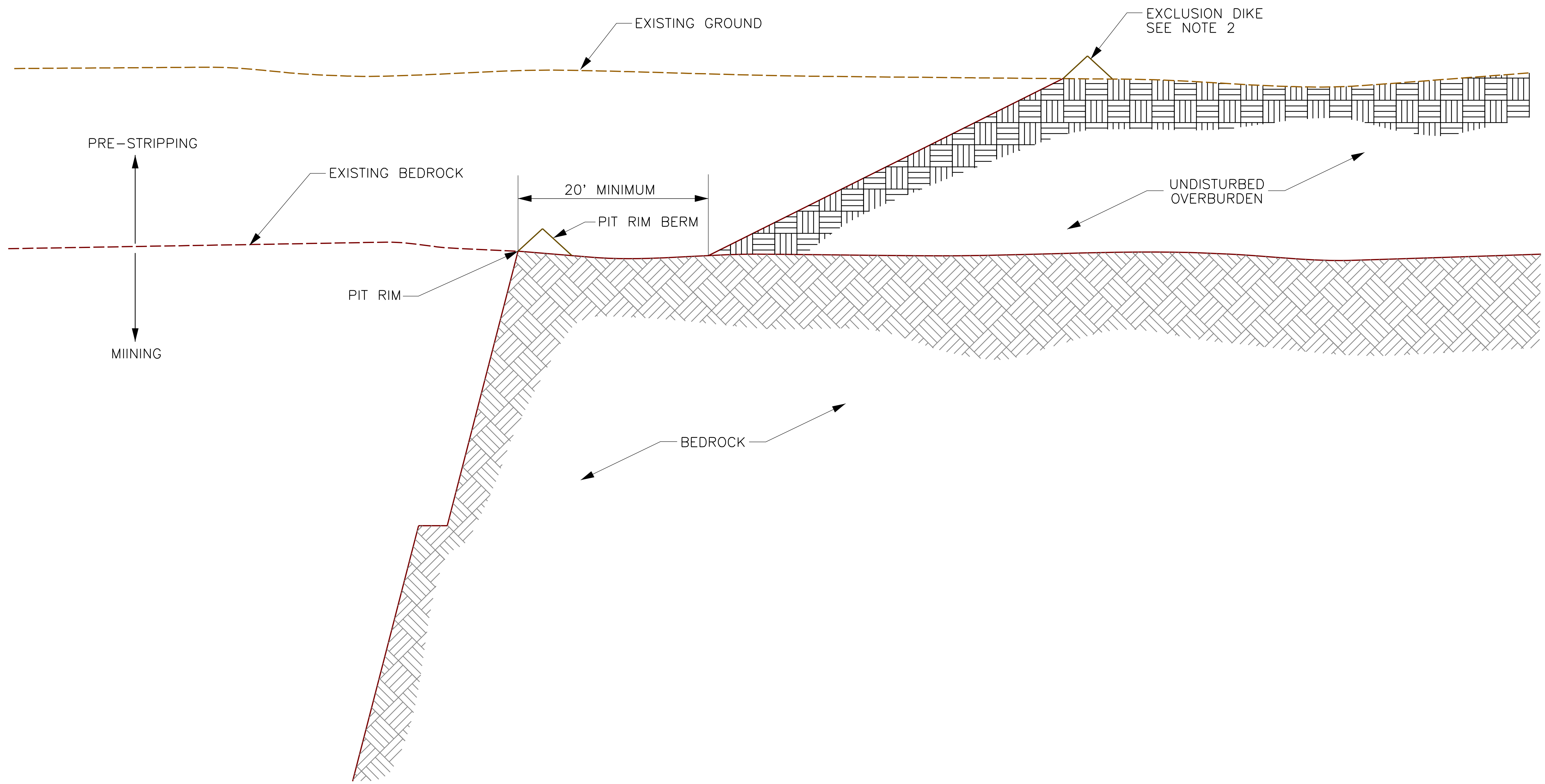
REVISED	DATE	BY	DESCRIPTION
PREPARED BY: MCC2			DATE: AUG. '16
REVIEWED BY: JSL			DATE: AUG. '16
APPROVED BY: JOS1			DATE: AUG. '16

POLYMET MINING

FIGURE 7-5
MINE SITE PIT PRE-STRIPPING LIMITS
PERMIT TO MINE APPLICATION
HOYT LAKES, MINNESOTA

Scale: 0 500 1,000 Feet
Date: AUGUST 2016
Drafted by: DAT
Project No: 12P778

Path: X:\GB\IE\2012\12P778\GIS\mxd\PMA\Figure 7-5 Mine Site Pre-Stripping Limits.mxd Date: 8/26/2016



NOTES:

1. SOURCE: PERMIT APPLICATION SUPPORT DRAWINGS-MINE SITE AND DUNKA ROAD EARTHWORK, MAY 2015, INCLUDED IN APPENDIX 3 OF THE APPLICATION.
2. CONSTRUCT BERMS AROUND PIT PERIMETER TO BLOCK SURFACE RUNOFF INTO PIT.

Foth Infrastructure & Environment, LLC

REVISED	DATE	BY	DESCRIPTION

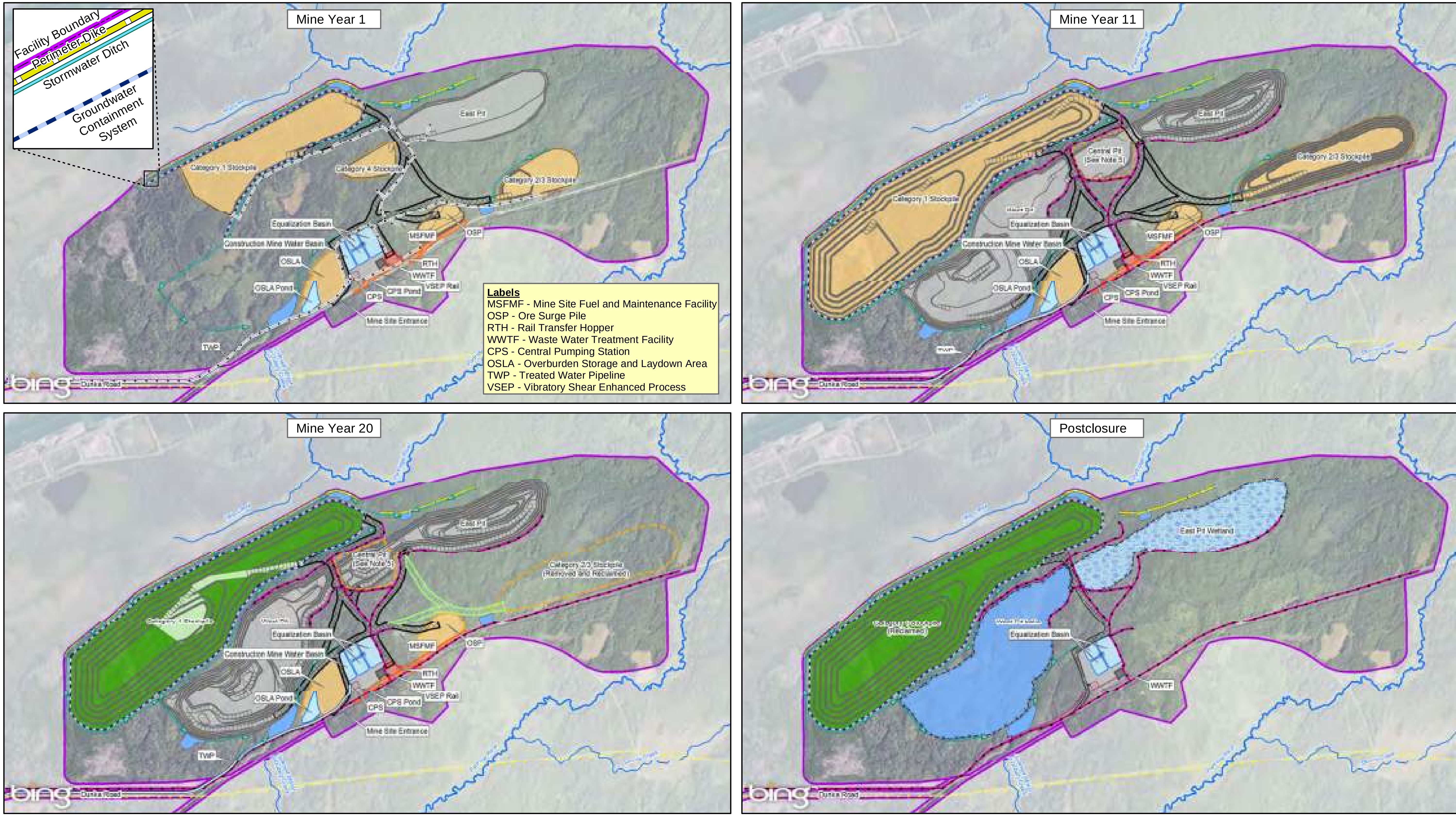
PREPARED BY:	MCC2	DATE:	AUG. '16
REVIEWED BY:	JSL	DATE:	AUG. '16
APPROVED BY:	JOS1	DATE:	AUG. '16

POLYMET MINING

FIGURE 7-6
TYPICAL PIT PRE-STRIPPING CROSS SECTION
PERMIT TO MINE APPLICATION
HOYT LAKES, MINNESOTA

Scale:	NOT TO SCALE	Date:	AUGUST 2016
Drafted By:	JOW	Project No:	12P778

X:\GB\IE\2012\12P778\cad\figures\PMA\Figure 7-6 Pit Typical Section.dgn
8/24/2016 1:08:49 PM bjw1



Notes

1. Basemap from Esri and its data suppliers.
2. Project features from Barr Engineering Company.
3. Minnesota Power Substations and Power Lines supplied by the Minnesota Geospatial Information Office (MnGeo).
4. For clarity not all of the sumps, ditches, piping, and overflows are shown.
5. The Category 4 stockpile is removed, enabling the development of the Central Pit.
6. WWTF outfall pipeline installed during the postclosure maintenance phase.
7. Mine Water Ponds are lined with the exception of the OSLA Pond and Construction Mine Water Basin.

Legend

- Rivers and Streams
- Existing Electric Power Line[3]
- Proposed Transmission Lines (Mine Year 1)
- Proposed Transmission Lines (Post Mine Year 11)
- Treated Water Pipeline
- WWTF Outfall Pipeline[6]
- Stormwater Ditch
- Groundwater Containment System
- Perimeter Dike
- New Railroad Spur and Loadout
- Treated Mine Water Pond (Lined)
- Facility Footprint
- Mine Water Ponds[7]
- WWTF Buildings
- Haul Roads
- Active Stockpile
- Removed Stockpile
- Mine Pits
- Facility Boundary

N

Foth Infrastructure & Environment, LLC

REVISED	DATE	BY	DESCRIPTION

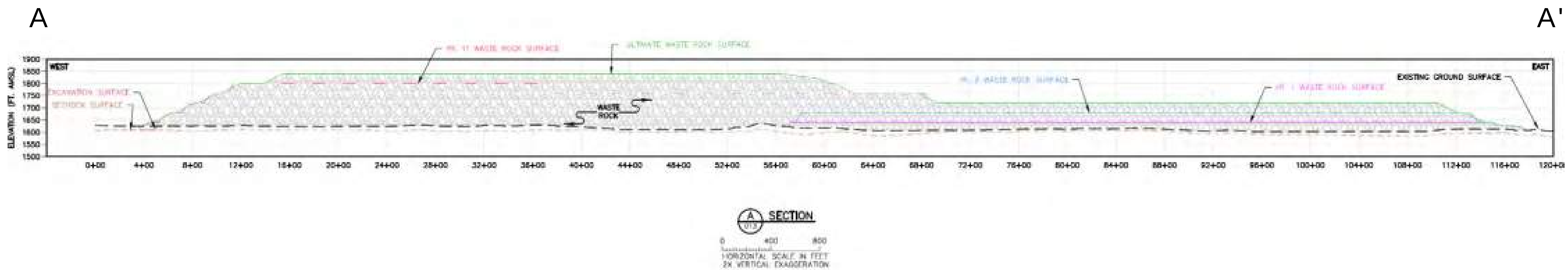
PREPARED BY:	JSL	DATE:	SEP. '16
REVIEWED BY:	MJV2	DATE:	SEP. '16
APPROVED BY:	JOS1	DATE:	SEP. '16

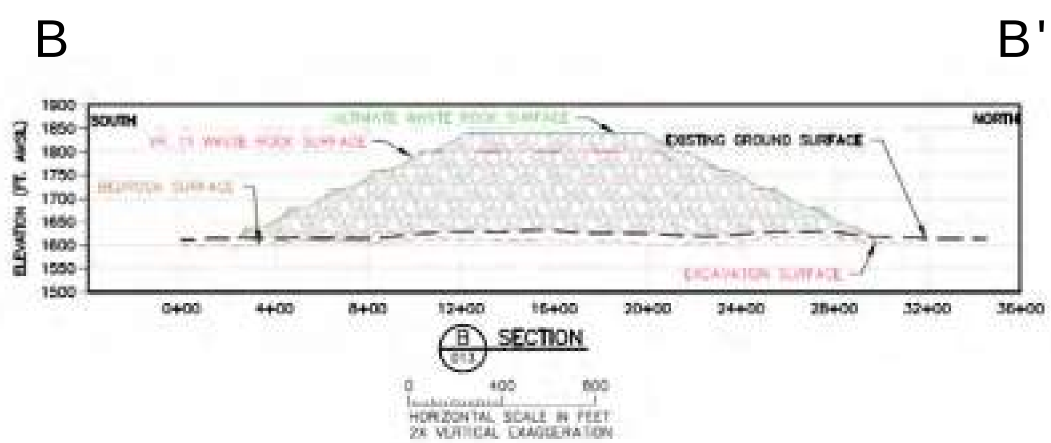
POLYMET MINING

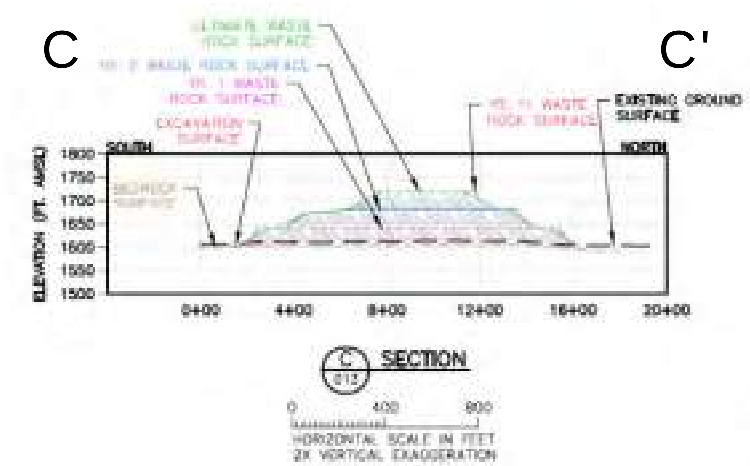
FIGURE 7-7
MINE DEVELOPMENT AND LAYOUT SEQUENCE
MINE YEARS 1, 11, 20 AND POSTCLOSURE
PERMIT TO MINE APPLICATION
HOYT LAKES, MINNESOTA

Scale: 0 1,500 3,000 Feet	Date: SEPTEMBER 2016
Drafted by: DAT	Project No: 12P778

Path: X:\GB\IE\2012\12P778\GIS\mxd\PMA\Figure 7-7 Life of Mine Layout.mxd Date: 9/7/2016







LEGEND

- YEAR 1 LIMITS
- YEAR 2 LIMITS
- YEAR 11 LIMITS
- YEAR 21, ULTIMATE LIMITS
- EXISTING GROUND SURFACE
- BEDROCK SURFACE
- EXCAVATION SURFACE

NOTE

1. SEE GENERAL NOTES AND LEGEND ON DRAWING D02.
2. UNSUITABLE SOILS TO BE EXCAVATED WITHIN FIRST 100 FEET FROM THE ULTIMATE STOCKPILE BOUNDARIES. GEOTECHNICAL PROPERTIES OF THE FOUNDATION SOILS WILL BE CONFIRMED PRIOR TO FINAL DESIGN.

Notes

1. Source: Permit Support Drawings - Categories 1, 2/3 and 4 Stockpiles and Ore Surge Pile Design, included in Appendix 4 of the Application.
2. Cross section locations shown on Figure 7-7.

POLYMET MINING

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REVISED	DATE	BY	DESCRIPTION	
PREPARED BY:	JSL			DATE: AUG. '16
REVIEWED BY:	RXW			DATE: AUG. '16
APPROVED BY:	JOS1			DATE: AUG. '16

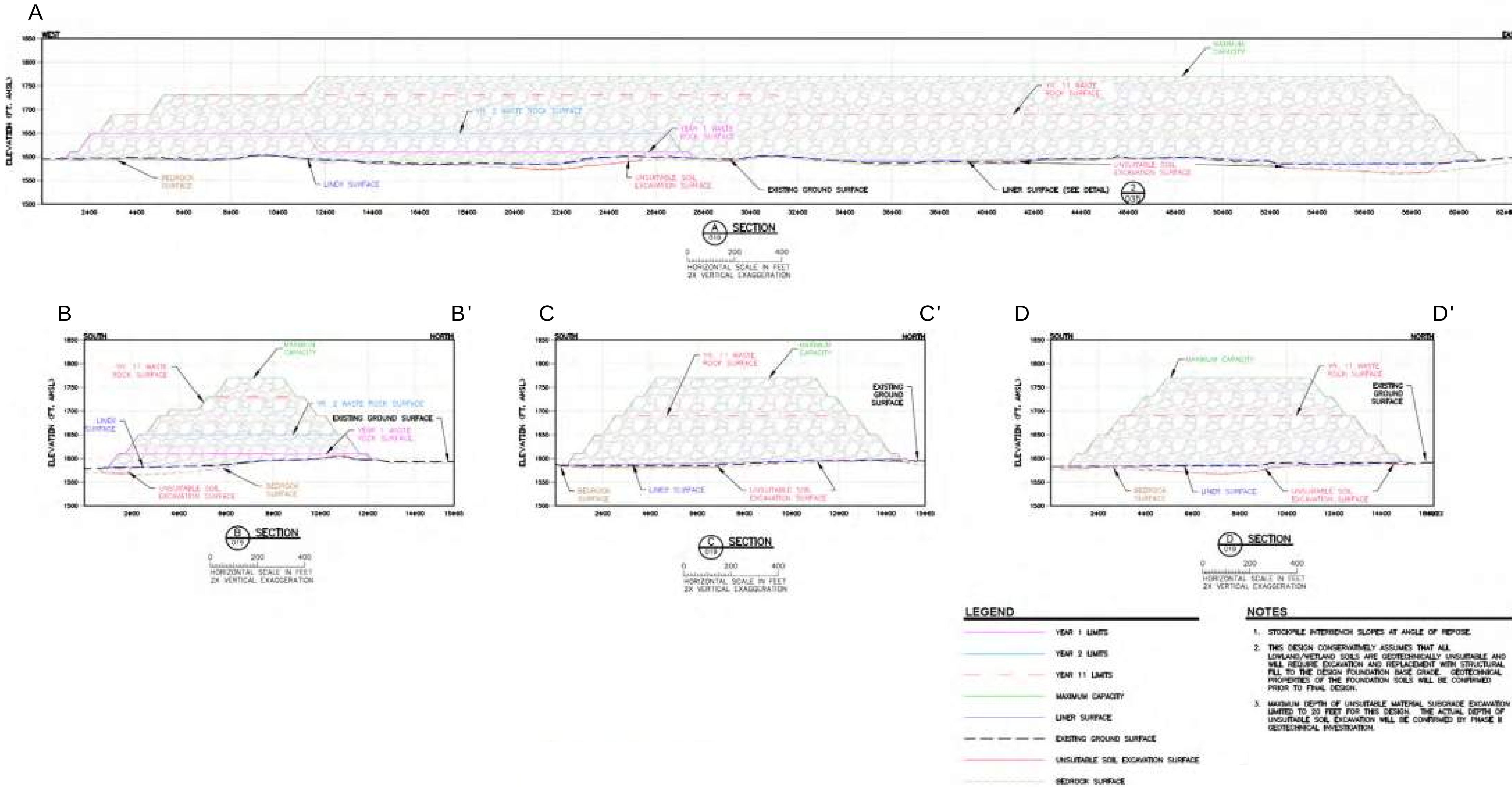
POLYMET MINING

FIGURE 7-8

CATEGORY 1 STOCKPILE CROSS SECTIONS
PERMIT TO MINE APPLICATION
HOYT LAKES, MINNESOTA

Scale: AS SHOWN	Date: AUGUST 2016
Drafted by: DAT	Project No: 12P778

Path: X:\GB\IE\2012\12P778\GIS\mxd\PMA\Figure 7-8 Category 1 Stockpile Showing Mining Intervals.mxd Date: 9/2/2016

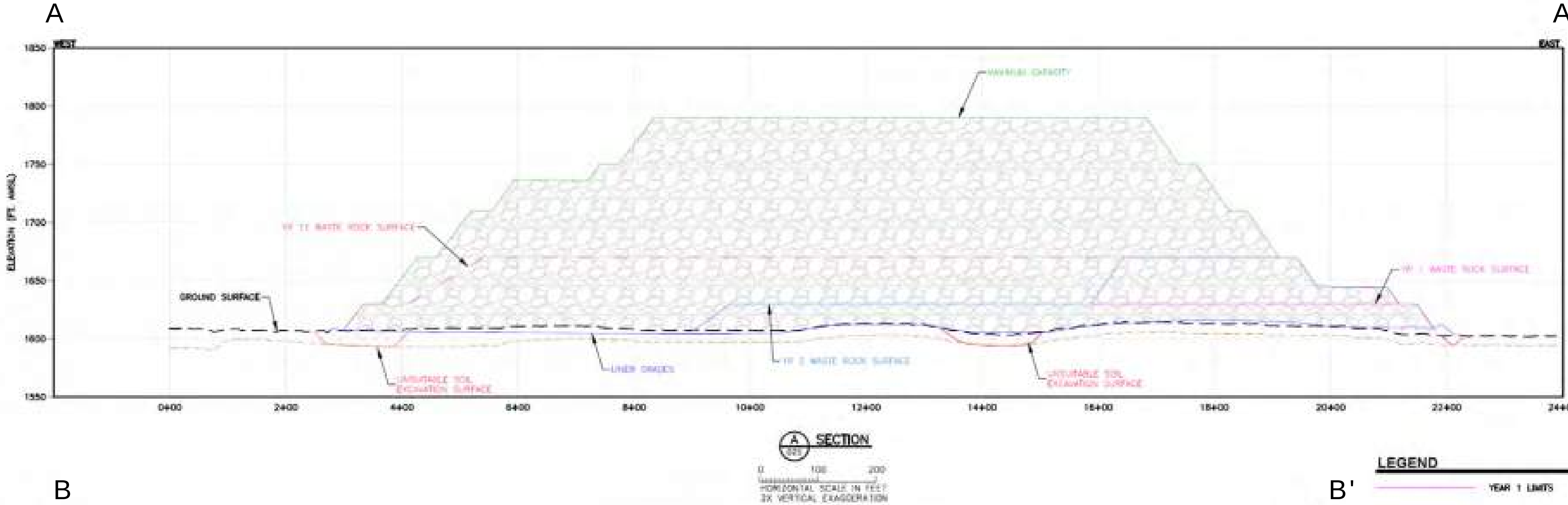


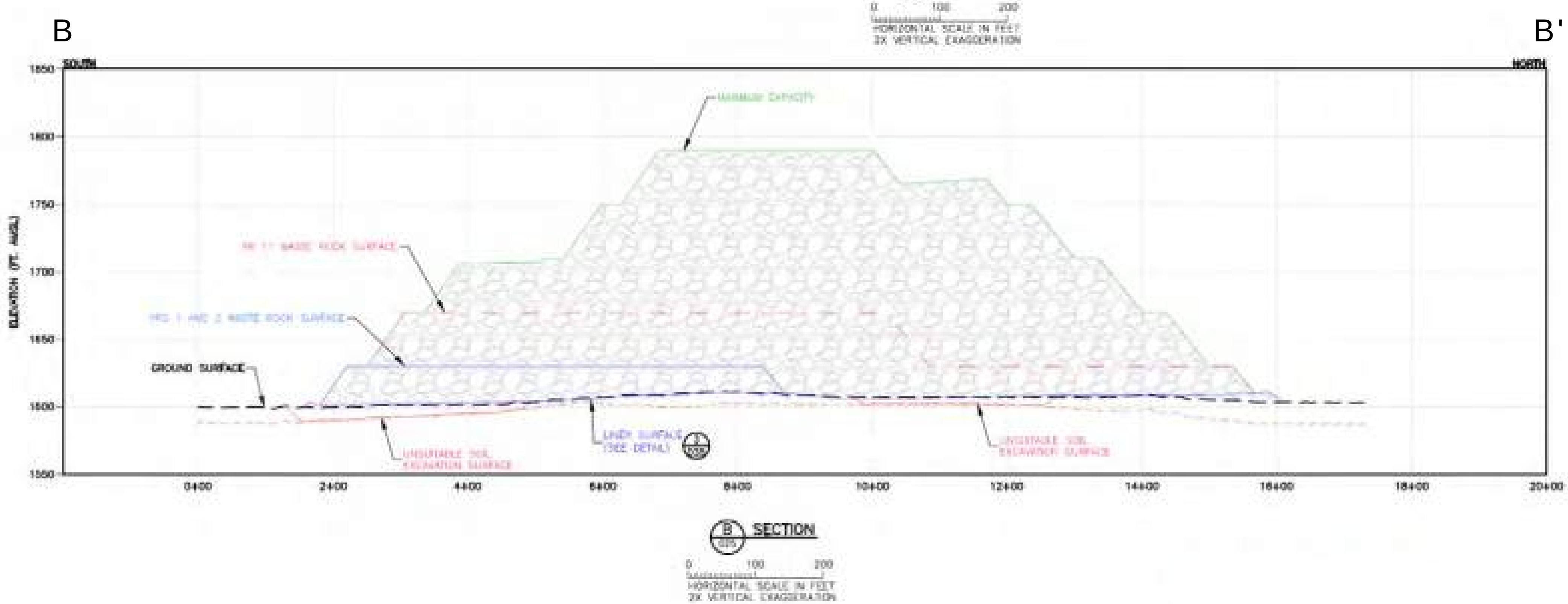
Notes

1. Source: Permit Support Drawings - Categories 1, 2/3 and 4 Stockpiles and Ore Surge Pile Design, included in Appendix 4 of the Application.
2. Cross section locations shown on Figure 7-7.

Foth Infrastructure & Environment, LLC				POLYMET MINING
REVISED	DATE	BY	DESCRIPTION	
PREPARED BY: JSL			DATE: AUG. '16	FIGURE 7-9 CATEGORY 2/3 STOCKPILE CROSS SECTIONS PERMIT TO MINE APPLICATION HOYT LAKES, MINNESOTA
REVIEWED BY: RXW			DATE: AUG. '16	Scale: AS SHOWN / Date: AUGUST 2016
APPROVED BY: JOS1			DATE: AUG. '16	Drafted by: DAT / Project No: 12P778

Path: X:\GB\IE\2012\12P778\GIS\mxd\PMA\Figure 7-9 Category 2-3 Stockpiles Showing Mining Intervals.mxd Date: 9/2/2016





LEGEND

- YEAR 1 LIMITS
- YEAR 2 LIMITS
- YEAR 11 LIMITS
- MAXIMUM CAPACITY
- LINER SURFACE
- EXISTING GROUND SURFACE
- UNSUITABLE SOIL EXCAVATION SURFACE
- BEDROCK SURFACE

NOTES

1. STOCKPILE INTERBENCH SLOPES AT ANGLE OF REPOSE.
2. THIS DESIGN CONSERVATIVELY ASSUMES THAT ALL LOWLAND/WETLAND SOILS ARE GEOTECHNICALLY UNSUITABLE AND WILL REQUIRE EXCAVATION AND REPLACEMENT WITH STRUCTURAL FILL TO THE DESIGN FOUNDATION BASE GRADE. GEOTECHNICAL PROPERTIES OF THE FOUNDATION SOILS WILL BE CONFIRMED PRIOR TO FINAL DESIGN.
3. MAXIMUM DEPTH OF UNSUITABLE MATERIAL SUBGRADE EXCAVATION LIMITED TO 20 FEET FOR THIS DESIGN. THE ACTUAL DEPTH OF UNSUITABLE SOIL EXCAVATION WILL BE CONFIRMED BY PHASE II GEOTECHNICAL INVESTIGATION.

Notes

1. Source: Permit Support Drawings - Categories 1, 2/3 and 4 Stockpiles and Ore Surge Pile Design, included in Appendix 4 of the Application.
2. Cross section locations shown on Figure 7-7.

N

POLYMET MINING

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Foth Infrastructure & Environment, LLC

REVISED	DATE	BY	DESCRIPTION
PREPARED BY:	JSL		DATE: AUG. '16
REVIEWED BY:	RXW		DATE: AUG. '16
APPROVED BY:	JOS1		DATE: AUG. '16

POLYMET MINING

FIGURE 7-10

CATEGORY 4 STOCKPILE CROSS SECTIONS
PERMIT TO MINE APPLICATION
HOYT LAKES, MINNESOTA

Scale:	AS SHOWN	Date:	AUGUST 2016
Drafted by:	DAT	Project No:	12P778

8 Plant Site and Ore Processing Facilities

This section of the Application provides the information relating to the ore beneficiating process that is required for the mining and reclamation plan pursuant to Minnesota Rules, part 6132.1100, subpart 6. This section also provides information addressing the siting and performance requirements of Minnesota Rules, parts 6132.2000-3200 applicable to the Plant Site and ore processing facilities and operations, including related infrastructure and general plant facilities.

The location, construction, and operation of the Plant Site are designed to comply with the requirements set forth in Minnesota Rules, chapter 6132, including those requirements relating to siting and buffers. Specifically, no Plant-Site operations or surface disturbance will occur in excluded or prohibited areas, and operations will comply with the additional restrictions applicable to mining sites. All facilities and operations will meet the design, construction, and maintenance requirements for buffers and vegetative cover of Minnesota Rules, parts 6132.2100 and 2700. Additionally, the design, construction, and maintenance of the Plant Site will be compatible with surrounding non-mining uses, and the existing terrain, vegetation, and/or revegetated buffers will reduce impacts from Plant Site activities. The private residences nearest the Plant Site are located 5 miles to the south and agricultural lands are located 2.8 miles northwest of the facility. The existing buffers and vegetation are compatible with non-mining areas. If necessary, PolyMet will construct additional buffers prior to commencing operations.

The Plant Site design and layout will also facilitate compliance with specific operating requirements of Minnesota Rules, parts 6132.2200, 2500, and 2800, applicable to Plant Site operations, including, for example, waste management, dust suppression, Tailings Basin design and operation, and Beneficiation Plant operation.

To a substantial extent, PolyMet's operations at the Plant Site will reuse the existing taconite processing infrastructure rather than undisturbed areas. PolyMet will refurbish buildings, equipment, and infrastructure to meet the mineral processing requirements of the ore. It is anticipated that the necessary upgrades such as re-wiring, new equipment, and/or structural refurbishments will occur within the footprint of the existing LTVSMC plant. The Plant Site layout is shown on Figure 8-1.

The design and operation of the Plant Site will comply with the policies set forth both in the PTM Regulations (Minnesota Rules, part 6132.2000, subpart 5, item G) and in the ferrous permit to mine regulations (Minnesota Rules, part 6130.1100). Figure 8-1 shows the past mining infrastructure that PolyMet will use at the Plant Site.

8.1 Plant Site Operations Overview

Key features of the Plant Site during operations will include:

- Beneficiation Plant. The plant will include a combination of new and existing buildings and equipment. Ore processing will include crushing, grinding, flotation, and concentrate dewatering, followed by product loadout.
- Tailings Basin. PolyMet will construct the FTB on top of the former LTVSMC taconite tailings basin. The FTB will store Flotation Tailings produced by the Project. The Tailings Basin refers to the combined LTVSMC tailings basin and the FTB.
- FTB seepage capture systems. These systems will include the FTB Seepage Containment System and the FTB South Seepage Management System, both of which capture seepage from the Tailings Basin.
- Hydrometallurgical Plant and HRF. PolyMet will construct these facilities several years after mining and ore processing commence. The hydrometallurgical process provides additional refining of the concentrate on-site.
- WWTP. This plant will use RO or similar membrane separation technology and associated systems.
- Maintenance and Repair Facilities. PolyMet will use the former LTVSMC maintenance facilities, including the General Shops, the Rebuild Shop, Area 1 Shop facilities, and Area 2 Shop facilities.
- Support Infrastructure. This infrastructure will consist of roads, electrical transmission lines and equipment, rail facilities, a Potable Water Treatment Plant, and a Sewage Treatment System which principally are existing facilities, but some of which will require upgrading and new construction.

The following sections of the Application and appendices contain additional information relating to Plant Site operations:

- Section 10.2 and Appendix 6 address the design of the FTB.
- Section 10.3 and Appendix 7 address the design of the HRF.
- Appendix 12 addresses management and monitoring plans for the FTB and HRF.
- Section 11.4 and Appendix 10 address Plant Site stormwater management.
- Section 11.2 addresses the Project water balance.
- Section 11.4 addresses Plant Site water management and infrastructure.
- Section 12 addresses wetland management and Appendix 18 presents the wetland mitigation plans.
- Section 13 addresses air quality management.
- Section 14 summarizes the overall Project monitoring programs.
- Appendix 9 provides the design of the sewage treatment system.

8.2 Plant Design and Layout

As summarized above, the Plant design and layout is intended to facilitate compliance with specific operating requirements necessary for the reclamation plan applicable to the ore beneficiating process, including, among other things, requirements relating to dust suppression, utilization of vegetative cover to prevent excessive erosion, and appropriate tailings storage.

8.2.1 Plant Site Infrastructure

Plant Site infrastructure includes the following: roads, rail track, and power lines and related equipment.

Roads

The Main Gate to the Plant Site is located at the north end of County Road 666. The Administration Building is located outside of the Main Gate. The rest of the Plant Site can only be accessed after passing through security at the Main Gate. PolyMet will realign, regrade, and resurface existing roadways as necessary to support vehicle traffic around the Plant Site facilities.

Rail Track

PolyMet will upgrade the existing railroad network at the Plant Site and will utilize existing private rail to transport ore to the Coarse Crusher at the Plant Site and to move rail cars to and from maintenance facilities. Consumables will be received at and concentrates shipped from the existing interchange point (located south of the Beneficiation Plant) to CN’s railroad line. The Company will utilize the existing General Shops and Area 2 Shop facilities for re-fueling, routine inspection, and maintenance on ore cars and locomotives.

Power Lines and Equipment

Two Minnesota Power Company 138 kilovolt transmission lines serve the Plant Site. Minnesota Power will extend new lateral transmission lines to existing buildings as they are refurbished and to new buildings when they are constructed.

8.2.2 General Plant Site Facilities

This subsection describes the general Plant Site facilities and services, including the Sewage Treatment System, Potable Water Treatment Plant, WWTP, Area 1 and Area 2 Shops, and related services. The beneficiation facilities and process are described in Section 8.3.

8.2.2.1 Sewage Treatment System

PolyMet will replace the existing sewage treatment plant and replace or upgrade the associated sewage collection infrastructure with a Sewage Treatment System to meet current performance standards. PolyMet will size the plant to meet the anticipated treatment demand. Section 11.4

and Appendix 9 contain additional descriptions of sewage management and facilities at the Plant Site.

8.2.2.2 Plant Site Potable Water Treatment Plant

PolyMet will refurbish the existing Potable Water Treatment Plant, located just east of the Concentrator Building as shown on Figure 8-1, to provide potable water to the Plant Site. This water will be used for showers and sinks and will be treated (chlorinated) to be drinkable. The Plant Reservoir will supply water to the Potable Water Treatment Plant.

8.2.2.3 Waste Water Treatment Plant

PolyMet will construct the WWTP on the north side of the Beneficiation Plant (see inset to Figure 8-1), adjacent to the existing LTVSMC tailings basin. The WWTP will provide treatment needed to support the water demands of ore processing operations and to maintain compliance with water quality standards for water discharged to the environment. WWTP reject concentrate will be sent to the WWTF for solute removal. Section 11.4, along with PolyMet's NPDES/SDS Permit Application to the MPCA, provide further descriptions of the WWTP design and operations.

8.2.2.4 Stream Augmentation

The FTB seepage capture systems, when completed, will significantly reduce the amount of seepage leaving the Tailings Basin relative to existing conditions, thereby reducing the amount of stream flow available to four downstream creeks: Unnamed Creek, Trimble Creek, Unnamed (Mud Lake) Creek, and Second Creek. PolyMet will augment flow to the watershed of three of these creeks (Unnamed Creek, Trimble Creek, and Second Creek) through discharge of treated water from the WWTP to offset the seepage reductions. Unnamed (Mud Lake) Creek will be augmented by diverting runoff that currently flows into the LTVSMC tailings basin, so that it flows to the Unnamed (Mud Lake) Creek watershed via a drainage swale. Section 11.4.6 provides additional discussion on stream augmentation.

8.2.2.5 Area 1 Shops

The Area 1 Shops include a fully enclosed maintenance facility built specifically by previous operators to handle maintenance and repair of mobile equipment. PolyMet will utilize a heavy-duty low bed transporter and tractor to transport some equipment (e.g., dozers and front end loaders) to the Area 1 Shops from the Mine Site. PolyMet will drive or tow haul trucks to the Area 1 Shops for major repair and maintenance. A haul truck retriever (large scale tow truck) will tow haul trucks that are unable to move on their own. PolyMet anticipates performing major repairs approximately twice per year on each haul truck. To access the Area 1 Shops, mine vehicles will follow an existing route utilizing existing roads from the Mine Site to the Plant Site.

PolyMet will collect and store used oils, used antifreeze/coolant, and residue from steam cleaning equipment at the Area 1 Shop. PolyMet will use a third-party contractor to manage recyclable materials. PolyMet will collect and store non-recyclable used filters, oily rags, and other oil products at the Area 1 Shop for subsequent off-site disposal in suitably licensed disposal facilities. PolyMet will manage petroleum and oil products collected in the Area 1 Shop in accordance with its SPCC Plan, which will be finalized before operations commence.

8.2.2.6 Area 2 Shops

PolyMet will renovate the former LTVSMC Area 2 Shops facilities, located approximately one mile east of the Plant Site, to provide office space for mining and railroad operations, supervision, and management. The Area 2 Shops will include change-house facilities, toilets, lunchrooms, first aid facility, emergency response center, and training and meeting rooms for mining and railroad crews. The Area 2 Shops facilities will also include a Locomotive Fueling Station, Locomotive Service Building, and Mine Reporting Building. The Locomotive Fueling Station, where locomotives will be fueled and lubricated, has a roof and sides but is open at the ends to facilitate access and egress. The concrete floor, equipped with drip trays, will collect spilled fuel and route it to a collection sump for proper disposal. It will also have a new 15,000-gallon aboveground diesel storage tank with containment systems. PolyMet will collect, store, and handle petroleum and other oil products at the Area 2 Shops in the same manner as described above for the Area 1 Shop, including managing the materials accordance with an approved SPCC Plan.

8.2.2.7 Plant Site Support Services

Operations at the Plant Site will require various support services such as compressed air, steam, fuel storage, fire protection, and an oxygen plant. These services are summarized in Table 8-1.

Locomotive fueling and routine inspection facilities used by LTVSMC at the Area 2 Shops will be renovated and recommissioned. Locomotives needing major repair will be repaired in the renovated and recommissioned General Shops or sent off-site to be repaired by a contractor. The ore cars will be maintained at the General Shops. General Shops will provide other maintenance expertise to support Plant Site and Mine Site operations.

8.3 Beneficiation Facilities

The beneficiation process will produce saleable copper and nickel concentrates. PolyMet will sell and ship copper concentrate to customers. Nickel concentrates of various grades will be sold and shipped to customers, used as a feedstock to the hydrometallurgical process, or divided for both uses.

Throughout operations, PolyMet will use the Plant Site to produce flotation concentrates through a beneficiation process. Figure 8-2 shows a simplified process flow diagram for the beneficiation process. In a future phase, PolyMet anticipates adding hydrometallurgical processing facilities, which are discussed in Section 8.4.

Beneficiation includes ore crushing, grinding, flotation, and dewatering. PolyMet will perform crushing and grinding in the existing Coarse Crusher and Concentrator Buildings, respectively. Ore will be conveyed from the secondary crusher in the Coarse Crusher Building to a semi-autogenous grinding (SAG) mill and ball mill in the Concentrator Building. Flotation will take place in a new Flotation Building located immediately to the west of the Concentrator Building. The consumables associated with the flotation process are described in Table 8-2 and the hydrometallurgical processing facility consumables are described in Table 8-3. PolyMet will construct and operate a new Concentrate Dewatering, Storage, and Load-out facility to prepare concentrate for shipping to off-site refiners. Section 11.4 includes additional details regarding water management and infrastructure relating to the beneficiation process and the FTB at the Plant Site.

8.3.1 Ore Crushing

PolyMet will move ore pieces as large as approximately 48 inches in diameter by rail from the Mine Site to the Coarse Crusher Building. Rail cars of ore will dump into the primary crusher at an average feed rate of 1,667 tons per hour. From the primary crusher, ore will move by gravity to four secondary crushers. From the secondary crushers, a conveyor system will move the ore, approximately 80% of which will be smaller than 4.25 inches, to the ore storage bins located in the Concentrator Building.

8.3.2 Ore Grinding

The crushed ore will be conveyed into a new SAG mill and ball mill installed in the existing Concentrator Building to reduce the ore particle size such that 80% will be less than 120 microns (4.7×10^{-3} inches). The SAG mill output slurry will feed the ball mill via cyclone feed pumps. The ground ore will re-circulate through the milling circuit until the particle size is the proper size for the flotation process.

PolyMet will repair or replace the existing dust collection systems in the Concentrator Building to meet the applicable emission standards. To reduce space-heating requirements, PolyMet will recycle a portion of the emission control system exhaust to the process buildings. The dust collection operating procedures include collecting mixing collected particulate matter with water and then adding the slurry to the milling circuit. No solid waste management will be required. This operating system will not require particulate emission control systems downstream of the feed to the SAG mill because water will be added to the mill lines and the beneficiation process will be wet from that point forward. Section 13 and PolyMet's Air Permit application to MPCA provide further information on dust collection control systems and management.

In the event of a power failure, PolyMet will contain process fluids within the process piping and tanks, and will then recycle the fluids within plant operations when power is restored.

8.3.3 Flotation

The ground ore will be processed in flotation cells to recover the base and precious metal minerals. Figure 8-2 depicts the various stages of the flotation process. PolyMet will construct a new Flotation Building in which the copper and nickel concentrates are produced.

In flotation, PolyMet will achieve separation of the target minerals using a collector/frother combination. Air will be injected into each flotation cell and the cell will be mechanically agitated to create air bubbles that will pass upward through the slurry in the cell. The frother (methyl isobutyl carbinol [MIBC] and MIBC/DF250) provides strength to the bubbles and the collector (potassium amyl xanthate [PAX]) causes the sulfide minerals to attach to the air bubbles. The material attached to the bubbles is concentrate and the material remaining in the slurry is tailings. Table 8-2 contains additional information on consumables used in this process.

Stages of the flotation process, as depicted in Figure 8-2, include Rougher Flotation, Scavenger Flotation, Cleaner Flotation, and Separation Flotation. The Rougher Flotation Tailings will go to Scavenger Flotation where collector and frother will be added, along with copper sulfate as a flotation activator. The activator will promote recovery of the particles that would be difficult to float (i.e., contain minor amounts of sulfide) in the concentrate, which reduces the total sulfur content of the tailings. The Scavenger Flotation concentrate will go through Scavenger Regrind to Cleaner 2 Flotation. Cleaner 2 Flotation Tailings will go back to Scavenger Flotation feed, while the nickel rich Cleaner 2 flotation concentrate will be sent through Fine Grinding 2 to the Hydrometallurgical Plant or directly to Concentrate Dewatering. The Flotation Tailings from Scavenger Flotation will be sent to the FTB. Rougher Flotation concentrate will be fed through Rougher Regrind to Cleaner 1 Flotation. Cleaner 1 Flotation Tailings will go back to Rougher Flotation feed, while the concentrate will be sent through Fine Grinding 1 to Separation Flotation. Separation Flotation will produce a copper concentrate and two nickel concentrates. The copper concentrate will go to Concentrate Dewatering. The nickel concentrates will go to Concentrate Dewatering or to the Hydrometallurgical Plant. A pH Modifier (hydrated lime) will be added in Separation Flotation which will result in a highly basic process water stream. Because this stream will be combined with other process water streams and make-up water, buildup of basicity is not expected. If there is a buildup of basicity, the basicity can be neutralized at the highly basic process water stream before it is combined with other process water streams.

The Scavenger Flotation Tailings will be pumped to the FTB where the solids will settle and be stored permanently. The decanted water will be re-circulated to the mill process water system.

In the event of a power failure, process fluids will be contained within the Flotation Building and recycled to the process when power has been restored. This same containment and recycle system will contain and control any minor spills.

8.3.4 Dewatering, Storage, and Shipping Facility

Concentrate Dewatering/Storage

PolyMet will utilize Concentrate Dewatering, Storage, and Shipping Facilities to dewater and store copper and nickel concentrates and to load those concentrates into covered rail cars. PolyMet will dewater and store concentrate in the new Concentrate Dewatering/Storage Building. The copper and nickel concentrates will each be delivered to separate dewatering lines equipped with filters that will reduce concentrate moisture content to approximately 8 to 10%. The process will return the water removed by the filters to the Beneficiation Plant.

The operations will convey each filtered concentrate to separate stockpiles within the enclosed 10,000-ton Concentrate Storage Facility for loading into covered rail cars. The storage facility will store about 15 days of production during the periods when both flotation concentrates are directed to Concentrate Dewatering/Storage and about 32 days of production during the periods when only copper flotation concentrate is directed to Concentrate Dewatering/Storage. The storage facility will prevent concentrates from being tracked out of the facility by having a concrete floor and operational systems to wash wheeled equipment.

In the event of a leak or power failure, PolyMet will contain process fluids within the process piping and tanks, and will then recycle the fluids to the processing system when operation is resumed.

8.3.5 Processing Parameters for the Beneficiation Process

Table 8-4 shows estimates for daily production rates and size reduction through the processing steps in the beneficiation process. These rates and sizes represent the design basis values for the Beneficiation Plant piping and equipment.

Water needed for the grinding and flotation circuits will primarily be return water from the FTB Pond. Water in the FTB Pond will include process water from the Beneficiation Plant, treated mine water from the Mine Site, captured tailings basin seepage, and precipitation. PolyMet will use water from the Plant Reservoir, which is drawn from Colby Lake using an existing pump station and pipeline, to make up any shortfall in water requirements. The average annual make-up water drawn from Colby Lake will vary throughout operations between 260 and 1,760 gpm, with an average annual demand of 760 gpm. This amount represents total potential raw water demand from both the Beneficiation Plant and the Hydrometallurgical Plant. Section 11.4 presents additional discussion on water demand for the beneficiation process and use of Colby Lake water.

8.4 Hydrometallurgical Plant Facility

The second phase of mineral processing at the Plant Site will involve construction and operation of the Hydrometallurgical Plant. PolyMet will base its decisions on the timing for construction of the plant on equipment delivery schedules, customer requirements, and overall Project economics. Figure 8-3 contains a simplified process flow diagram for the hydrometallurgical process.

PolyMet will use hydrometallurgical technology to process the nickel concentrates. This process involves pressure and temperature autoclave leaching followed by solution purification to extract and isolate platinum group, precious metals, and base metals. PolyMet will locate the hydrometallurgical-process equipment in a newly-constructed Hydrometallurgical Plant. Should spillage of process fluids occur, PolyMet will contain the fluids within the Hydrometallurgical Plant and return them to the appropriate process streams. Once the Hydrometallurgical Plant becomes operational, PolyMet will utilize some of the concentrates produced in the Beneficiation Plant as feedstock to the hydrometallurgical process. The feedstock will be a combination of the separate nickel concentrates produced by the Beneficiation Plant. PolyMet will decide whether to ship or process concentrates based on customer requirements and overall Project economics.

Section 11.4.7 contains additional information regarding water management associated with the hydrometallurgical process and facilities. Appendix 7 and Appendix 16.16 provide further details concerning the HRF design.

8.4.1 Autoclave

An Autoclave is a mineral processing pressure vessel used for conducting chemical reactions such as sulfide mineral oxidation and leaching of metals. Before feeding the nickel concentrate into the Autoclave, PolyMet will add WWTF filtered sludge and hydrochloric acid to the nickel concentrate. The sludge has recoverable metals. The hydrochloric acid is added to maintain the chloride concentration in the solution to enable leaching of the gold and platinum group metals. The system requires oxygen gas to be injected into the Autoclave at a rate that will be controlled to completely oxidize the sulfur in the concentrate. PolyMet will construct an Oxygen Plant to supply the oxygen for the autoclave.

The Autoclave process oxidizes and dissolves the sulfide minerals in the concentrate to produce a metal-rich slurry and an insoluble solid residue. Gold and platinum group metals in the nickel concentrate will dissolve as soluble chloride salts. The system will route the slurry discharging from the Autoclave to the Leach Residue Thickener where solids will be settled with the aid of a flocculant. The Leach Residue Thickener underflow will be filtered to produce a filter cake, which will be washed, re-pulped, combined with other hydrometallurgical residues, and pumped to the HRF. The Leach Residue Thickener overflow will be routed to gold and platinum group metals (Au/PGM) recovery.

8.4.2 Gold and Platinum Group Metals

Gold and Platinum Group Metals Recovery will create a marketable product (a filter cake) consisting of a mixed gold and platinum group metals precipitate. The operation will route the remaining solution to Copper Cementation. PolyMet will package the gold and PGM filter cake in either bulk bags or drums for sale to a third party refinery.

8.4.3 Copper Cementation

Copper concentrate from dry concentrate storage would be re-pulped, and the solution from Au/PGE recovery would be combined with the re-pulped copper concentrate. Copper would precipitate mostly in the form of copper sulfide. The enriched copper concentrate would be filtered and placed back into dry concentrate storage. The remaining solution would then go to Solution Neutralization. Figure 8-3 shows how materials flow through the process.

8.4.4 Solution Neutralization

The process next routes the solution from Copper Cementation to Solution Neutralization, a process that neutralizes acids formed as a result of the upstream process. Calcium in the form of either limestone or lime will be added. The result of the calcium addition will be the formation of gypsum that will be filtered to produce a gypsum filter cake. The process will wash and re-pulp this filter cake, combine it with other hydrometallurgical residues, and then pump the combined Residue to the HRF. The solution remaining after neutralization will be directed to Iron and Aluminum Removal.

The effluent from the Solution Neutralization process will feed Iron and Aluminum Removal. The process adds limestone, steam, and air to precipitate the aluminum and iron. The precipitated metals will be filtered to produce a filter cake, which will be washed, re-pulped, combined with other hydrometallurgical residues, and pumped to the HRF. The remaining solution will be sent to Mixed Hydroxide Product Recovery.

8.4.5 Nickel Cobalt Hydroxide Precipitate

The solution from Iron and Aluminum Removal is mixed with magnesium hydroxide. The reaction will produce a nickel and cobalt precipitate. The precipitated metals will be filtered to produce a filter cake. The final mixed hydroxide product (MHP) will have an approximate composition of 97% nickel and cobalt hydroxides with the remainder as magnesium hydroxide. PolyMet will package this high quality mixed hydroxide filter cake for sale and shipment to a third party refiner. The process will direct the remaining solution to Magnesium Removal.

8.4.6 Mixed Hydroxide Product Recovery

The process adds lime slurry to the solution from MHP Recovery to facilitate magnesium precipitation. The resulting slurry will be pumped to the HRF along with other residues. The solids will settle in the HRF for storage, while the clear water will be reclaimed continuously in the Hydrometallurgical Plant process water system.

8.4.7 Magnesium Removal

Lime slurry would be added to the solution from MHP Recovery to facilitate magnesium precipitation. The resulting slurry would be pumped to the HRF along with other residues. The solids would settle in the HRF to be stored permanently while the clear water would be reclaimed continuously to the Hydrometallurgical Plant process water system.

8.4.8 Process Water System

The Hydrometallurgical Plant operating system requires a separate process water distribution system due to the different nature of the process solutions involved in the hydrometallurgical and beneficiation processes. Hydrometallurgical process water will contain significant levels of chloride relative to the Beneficiation Plant process water. The Hydrometallurgical Plant process water system will distribute water to various water addition points throughout the Hydrometallurgical Plant and will receive water from the HRF. Water contained in the nickel concentrates, and raw water from the Plant Reservoir will provide the additional make-up water for the Hydrometallurgical Plant.

8.5 Consumable Materials

Both the beneficiation and hydrometallurgical processes will require the addition and consumption of raw materials. These consumables are summarized below, along with details regarding transportation and handling of those materials.

8.5.1 Beneficiation Process Consumables

Table 8-2 identifies the reagents that will be consumed in the beneficiation process. The table provides information regarding anticipated quantities, delivery methods, and storage details. The information provided in the table is intended to meet the requirements of Minnesota Rules, part 6132.1100, subpart 6, item B.

8.5.2 Hydrometallurgical Consumables

Table 8-3 identifies the reagents that will be consumed in the hydrometallurgical process. The table provides information regarding quantities, delivery methods, and storage details. The information provided in the table is intended to meet the requirements of Minnesota Rules, part 6132.1100, subpart 6, item B.

8.6 Transportation and Handling of Consumables and Products

PolyMet will utilize a switching locomotive to transfer loaded and empty cars carrying process consumables and concentrates.

Copper and nickel concentrates will be shipped in solid bottom (gondola) rail cars with weather tight covers. PolyMet will inspect these rail cars for structural integrity before loading. Concentrates will be loaded into the rail cars via a conveyor system in a new building that will be located to the south of the Concentrate Building. PolyMet will inspect car exteriors before they leave the buildings and any significant residual concentrate on the car exterior will be recovered and returned to storage. PolyMet anticipates the concentrate will have an 8 to 10% moisture content and will not generate fugitive dust during loading. PolyMet will ship Phase 2 products nickel/cobalt hydroxide and precious metal precipitate to customers in sealed bulk bags or sealed containers.

Table 8-1 Plant Site Support Services

Service	Source	Location	Needed for
Compressed Air	Duty/standby arrangement of rotary screw type compressors	General Shops	Provide air at a pressure of 100 pounds per square inch gauge (PSIG) for plant services
Instrument Air	Receiver/accumulation/filter package	General Shops	Provide air for instruments
Steam	Natural gas-fired boiler	Hydrometallurgical Plant	Generates heat needed for startup of the autoclave
Diesel Fuel Storage	Existing Locomotive Fuel Oil facility	Area 2 Shop	Diesel for locomotives
Gasoline Storage	Existing storage facility – two 6,000 gallon tanks	Main Gate	Gasoline for vehicles
Make-up Water	Water from Colby Lake via an existing pumping station and pipeline	Stored in the Plant Reservoir	Plant fire protection systems, water for potable water treatment, make-up water for grinding and flotation process water, Hydrometallurgical Plant process water, and stream flow augmentation, if required
Potable Water Treatment	Existing potable water treatment plant would be refurbished and reactivated	Near the Plant Reservoir	Water distribution system
Fire Protection	Existing fire protection system will be refurbished, reactivated	Plant Reservoir	Area 1 Shop and Area 2 Shop have independent fire protection systems
Oxygen	770 tons per day via Oxygen Plant. Plant process takes in ambient air, compresses it, and separates the oxygen from nitrogen and other trace atmospheric gases. Liquid will be pumped to plant processes and nitrogen and trace gases will be returned to the atmosphere or used in the Hydrometallurgical Plant.	Adjacent to Concentrator	Plant processes including complete oxidation of sulfides in the autoclave

Source: Adapted from Appendix 18.2

Table 8-2 Beneficiation Plant Consumables

Chemical	Purpose	Location of chemical addition in process	Amount/duration/ frequency of addition[1]	Average rate of use	Maximum rate of use	Storage Location	Storage Capacity	Tank Description	Secondary Containment	Fate and Transport	Properties	Potential effect on dissolution[2]
SIPX (Sodium isopropyl xanthate	Collector: Used to selectively adsorb minerals based on hydrophobicity of the collector and mineral	Flotation Circuit, specifically the Flotation Roughers, Scavengers, and Cleaner Circuits	Continuous	2.74 tons per day (1,000 tons per year)	4.79 tons per day (1,750 tons per year)	Flotation Reagents Building	Bulk (< 20 ton, 100% SIPX), AST (0.5% concentration in water)	Storage Tank: 25,000 gal AST	Building containment	Sodium will be transported to the WWTP and be discharged to the receiving water body. The alcohol component of SIPX will be biodegraded within the Flotation Tailings Basin (FTB). Xanthate primarily will be oxidized to sulfate and be removed by the WWTP. Some xanthate may be included within the concentrate. Decomposes to carbon disulfide, trithiocarbinate, isopropyl alcohol.	pH 13 at 10%-H_2O, SG 1.263, salts of carbonic acids dithio esters, soluble in water, hydrophobic	Unlikely to have significant effect on mineral dissolution in the FTB due to low proposed concentration and rapid degradation of xanthates.
PAX (Potassium Amyl Xanthate)	Collector: Used to selectively adsorb minerals based on hydrophobicity of the collector and mineral	Flotation Circuit, specifically the Flotation Roughers, Scavengers, and Cleaner Flotation Cells	Continuous	2.74 tons per day (1,000 tons per year)	4.79 tons per day (1,750 tons per year)	Flotation Reagents Building	Bulk (< 20 ton, 100% PAX), AST (0.5% concentration in water)	Storage Tank: 25,000 gal AST	Building containment	Potassium will be transported to the WWTP and be discharged to the receiving water body. The alcohol component of SIPX will be biodegraded within the FTB. Xanthate primarily will be oxidized to sulfate and be removed by the WWTP. Some xanthate may be included within the concentrate. Decomposes to carbon disulfide. Absorbs to concentrate particles and not the tailing.	pH 10.5 at 10%-H_2O, salts of carbonic acids dithio esters, soluble in water, hydrophobic	Unlikely to have significant effect on mineral dissolution in the FTB due to low proposed concentration and rapid degradation of xanthates.
MIBC (Methyl isobutyl carbinol, 100% solution)	Frother: Used to improve stability of froth bubbles as they rise through the flotation cells	Flotation Circuit, specifically the Flotation Roughers, Scavengers, and Cleaner Flotation Cells	Continuous	2.88 tons per day (1,050 tons per year)	4.11 tons per day (1,500 tons per year)	Flotation Reagents Building	AST (100% solution)	Two Tanks: 15,000-gal AST 3,000-gal AST	Building containment	This product will attach to the concentrate and collector. It is composed of alcohols, which will be biodegraded within the FTB. Decomposes to carbon monoxide and carbon dioxide.	pH 10.5, SG 0.85, aliphatic alcohols, soluble in water	Unlikely to have significant effect on mineral dissolution in the FTB because it will mostly remain with the concentrate rather than report to the FTB.
Frother (F-160-05)	Frother: Used to improve stability of froth bubbles as they rise through the flotation cells. (Potential substitute for MIBC)	Flotation Circuit, specifically the Flotation Roughers, Scavengers, and Cleaner Flotation Cells	Continuous	2.88 tons per day (1,050 tons per year)	4.11 tons per day (1,500 tons per year)	Flotation Reagents Building	AST (100% solution)	Two Tanks: 15,000-gal AST 3,000-gal AST	Building containment	This product will attach to the concentrate and collector. It is not classified as dangerous to the environment (per the SDS) and will be readily biodegraded within the FTB. Decomposes to carbon monoxide, carbon dioxide, aldehydes, ketones, organic acids.	pH 10 at 5%-H_2O, SG 0.96, polyglycol ethers, soluble in water	Unlikely to have significant effect on mineral dissolution in the FTB because it will mostly remain with the concentrate rather than report to the FTB.

Chemical	Purpose	Location of chemical addition in process	Amount/duration/ frequency of addition[1]	Average rate of use	Maximum rate of use	Storage Location	Storage Capacity	Tank Description	Secondary Containment	Fate and Transport	Properties	Potential effect on dissolution[2]
Frother (F-160-13)	Frother: Used to improve stability of froth bubbles as they rise through the flotation cells. (Potential substitute for MIBC)	Flotation Circuit, specifically the Flotation Roughers, Scavengers, and Cleaner Flotation Cells	Continuous	2.88 tons per day (1,050 tons per year)	4.11 tons per day (1,500 tons per year)	Flotation Reagents Building	AST (100% solution)	Two Tanks: 15,000-gal AST 3,000-gal AST	Building containment	This product will attach to the concentrate and collector. It is not classified as dangerous to the environment (per the SDS) and will be readily biodegraded within the FTB. Decomposes to carbon monoxide, carbon dioxide, aldehydes, ketones, organic acids.	pH 10 at 5%-H_2O, SG 0.98-1.05, mixed glycol ethers, soluble in water	Unlikely to have significant effect on mineral dissolution in the FTB because it will mostly remain with the concentrate rather than report to the FTB.
Frother (DVS4U038)	Frother: Used to improve stability of froth bubbles as they rise through the flotation cells. (Potential substitute for MIBC)	Flotation Circuit, specifically the Flotation Roughers, Scavengers, and Cleaner Flotation Cells	Continuous	2.88 tons per day (1,050 tons per year)	4.11 tons per day (1,500 tons per year)	Flotation Reagents Building	AST (100% solution)	Two Tanks: 15,000-gal AST 3,000-gal AST	Building containment	This product will attach to the concentrate and collector. This chemical additive is not classified as dangerous to the environment (per the SDS) and will be readily biodegraded within the FTB. Decomposes to carbon oxides.	SG 0.85, alcohols, aldehydes, esters, soluble in water	Unlikely to have significant effect on mineral dissolution in the FTB because it will mostly remain with the concentrate rather than report to the FTB.
Copper sulphate ($CuSO_4$)	Activator: Used to increase the available adsorption sites on the mineral to allow for adsorption by the Collector	Flotation Circuit, specifically the Scavenger Cells	Continuous	1.71 tons per day (625 tons per year)	2.05 tons per day (750 tons per year)	Flotation Reagents Building	Bulk: (< 30 ton pentahydrate crystals); AST (< 10% concentration in water)	Storage Tank: 17,000 gal AST	Building containment	The copper component of this chemical additive will precipitate with iron oxide or as an oxide. The sulfate will be precipitated as gypsum. These precipitates will be included in the sludge that will initially be transported to an off-site landfill. Following start-up of the HydroMet, the sludge will be transported to the HydroMet Residue Facility (HRF).	SG 2.284 solid, soluble in water, acidic in solution	Unlikely to have significant effect on mineral dissolution in the FTB because it will mostly be removed to a solid phase in flotation process rather than report to the FTB.
Flocculant (Magnafloc 10)	Flocculant: Used to promote flocculation of suspended particles in liquors	Flotation Circuit, specifically the Concentrate Thickeners	Continuous	0.082 tons per day (30 tons per year)	0.14 tons per day (50 tons per year)	Flotation Reagents Building	Bulk (< 5 ton, 100% M10), AST (< 1% concentration in water)	Storage Tank: 15,000 gal AST	Building containment	The flocculant chemical additives will adsorb to the solids material in several process thickeners to improve settling rates and productivity (concentrate and hydrometallurgical thickeners). The flocculants will be transported with the solids from these thickeners to intermediate and final products. These flocculants will not report with the Flotation Tailings to the FTB. All recovered water from these thickeners is reused in the process facility. This product is biodegradable within the process.	pH 4-9 at 5g/l, polyacrylamide, anionic,	Unlikely to have significant effect on mineral dissolution in FTB due to its low concentration and recovery, reuse, and degradation within the process facility.

Chemical	Purpose	Location of chemical addition in process	Amount/duration/ frequency of addition[1]	Average rate of use	Maximum rate of use	Storage Location	Storage Capacity	Tank Description	Secondary Containment	Fate and Transport	Properties	Potential effect on dissolution[2]
Flocculant (Magnafloc 455)	Flocculant: Used to promote flocculation of suspended particles in liquors (Potential substitute for Magnafloc 10)	Flotation Circuit, specifically the Concentrate Thickeners	Continuous	0.07 tons per day (25 tons per year)	0.14 tons per day (50 tons per year)	Flotation Reagents Building	Bulk (< 5 ton, 100% M455), AST (< 1% concentration in water)	Storage Tank: 12,500 gal AST	Building containment	The flocculant chemical additives will adsorb to the solids material in several process thickeners to improve settling rates and productivity (concentrate and hydrometallurgical thickeners). The flocculants will be transported with the solids from these thickeners to intermediate and final products. These flocculants will not report with the Flotation Tailings to the FTB. All recovered water from these thickeners is reused in the process facility. This product is biodegradable within the process.	polyacrylamide, anionic	Unlikely to have significant effect on mineral dissolution in FTB due to its low concentration and recovery, reuse, and degradation within the process facility.
Flocculant (Neo NS 6655)	Flocculant: Used to promote flocculation of suspended particles in liquors (Potential substitute for MagnaFloc 10/455)	Flotation Circuit, specifically the Concentrate Thickeners	Continuous	0.07 tons per day (25 tons per year)	0.14 tons per day (50 tons per year)	Flotation Reagents Building	Bulk (< 5 ton, 100% M455), AST (< 1% concentration in water)	Storage Tank: 12,500 gal AST	Building containment	The flocculant chemical additives will adsorb to the solids material in several process thickeners to improve settling rates and productivity (concentrate and hydrometallurgical thickeners). The flocculants will be transported with the solids from these thickeners to intermediate and final products. These flocculants will not report with the Flotation Tailings to the FTB. All recovered water from these thickeners is reused in the process facility. This product is biodegradable within the process.	pH 4 - 9 at 5 g/L, completely miscible in water	Unlikely to have significant effect on mineral dissolution in FTB due to its low concentration and recovery, reuse, and degradation within the process facility.
Flocculant (NALCO: 83949)	Flocculant: Used to promote flocculation of suspended particles in liquors (Potential substitute for MagnaFloc 10/455)	Flotation Circuit, specifically the Concentrate Thickeners	Continuous	0.07 tons per day (25 tons per year)	0.14 tons per day (50 tons per year)	Flotation Reagents Building	Bulk (< 5 ton, 100% M455), AST (< 1% concentration in water)	Storage Tank: 12,500 gal AST	Building containment	The flocculant chemical additives will adsorb to the solids material in several process thickeners to improve settling rates and productivity (concentrate and hydrometallurgical thickeners). The flocculants will be transported with the solids from these thickeners to intermediate and final products. These flocculants will not report with the Flotation Tailings to the FTB. All recovered water from these thickeners is reused in the process facility. This product is biodegradable within the process.	pH 7.4 at 0.3 %, soluble in water	Unlikely to have significant effect on mineral dissolution in FTB due to its low concentration and recovery, reuse, and degradation within the process facility.

Chemical	Purpose	Location of chemical addition in process	Amount/duration/ frequency of addition[1]	Average rate of use	Maximum rate of use	Storage Location	Storage Capacity	Tank Description	Secondary Containment	Fate and Transport	Properties	Potential effect on dissolution[2]
Flocculant (NALCO: 9877 Pulv)	Flocculant: Used to promote flocculation of suspended particles in liquors (Potential substitute for MagnaFloc 10/455)	Flotation Circuit, specifically the Concentrate Thickeners	Continuous	0.07 tons per day (25 tons per year)	0.14 tons per day (50 tons per year)	Flotation Reagents Building	Bulk (< 5 ton, 100% M455), AST (< 1% concentration in water)	Storage Tank: 12,500 gal AST	Building containment	The flocculant chemical additives will adsorb to the solids material in several process thickeners to improve settling rates and productivity (concentrate and hydrometallurgical thickeners). The flocculants will be transported with the solids from these thickeners to intermediate and final products. These flocculants will not report with the Flotation Tailings to the FTB. All recovered water from these thickeners is reused in the process facility. This product is biodegradable within the process.	pH 5.5 - 7.5 at 1%, insoluble in water	Unlikely to have significant effect on mineral dissolution in FTB due to its low concentration and recovery, reuse, and degradation within the process facility.
CMC (Carboxyl methyl cellulose)	Depressant: Used to depress gangue minerals in flotation cells to improve selectivity towards Cu Ni minerals	Flotation Circuit, specifically Rougher and Pyrhotite Cleaner Flotation Cells	Continuous	3.29 tons per day (1,200 tons per year)	4.79 tons per day (1,750 tons year)	Flotation Reagents Building	Bulk (< 25 ton, 100% CMC), AST (< 1% concentration in water)	Storage Tank: 70,000 gal AST	Building containment	This chemical additive is an organic compound, which will be broken down within the FTB. It is an anionoic water soluble polymer derived from cellulose and is mainly used for silicate gangue inhibitors.	pH 6-12, SG 0.6-0.9, soluble in water	Unlikely to have significant effect on mineral dissolution in the FTB due to its low concentration.
Lime slurry	pH Modifier: Used to regulate pH in the flotation circuit	Flotation Circuit, specifically the Separation Cleaner Flotation Cells	Continuous	28.15 tons per day as hydrated lime (10,274 tons per year as hydrated lime)	41.10 t/day as hydrated lime (15,000 t/year as hydrated lime)	Flotation Reagents Building	Bulk (< 400 ton, 100% Hydrated Lime), AST (< 15% solution in water)	Storage Tank: 80,000 gal AST	Building containment	The calcium within this chemical additive will either be precipitated or neutralized. The calcium will be precipitated as gypsum and included in the sludge that will initially be transported to an off-site landfill. Following start-up of the HydroMet Plant, the sludge will be transported to the HRF.	pH 12.45 at saturation, SG 2.3-2.4, soluble in water	Unlikely to have significant effect on mineral dissolution in the FTB because it will precipitate or be neutralized within the process rather than report to the FTB.

Notes:

1 The amount of chemicals used will be optimized for the production, so that all chemicals added will be consumed. The fate and transport and the effect on dissolution are intended to describe the effects of the minor amounts (if any) of chemicals that are not consumed in the process.

2 Screening criteria for potential mineral dissolution impacts looked for reagents that (1) are oxidizers, (2) would substantially raise or lower net pH upon discharge to the Flotation Tailings Basin (FTB), (3) have been demonstrated at other sites, at the concentration discharged to the FTB, to impact microbial communities with respect to their ability to enhance mineral dissolution, and/or (4) have been demonstrated at other sites, at the concentration discharged to the FTB, to enhance dissolution rates through complexation or surface modification.

Adapted from: Large Table 1 of Reference (23)

Table 8-3 Hydrometallurgical Plant Consumables

Chemical	Purpose	Location of chemical addition in process	Amount/duration/ frequency of addition[1]	Average rate of use	Maximum rate of use	Storage Location	Storage Capacity	Tank Description	Secondary Containment	Fate and Transport	Potential effect on dissolution
Sodium hydrosulfide (30% solution)	Cementation of copper from solution as CuS	Hydromet, specifically copper cementation	Continuous	3.17 tons per day (1,160 tons per year)	4.10 tons per day (1,750 tons per year)	Hydromet Reagents Area	AST (30% concentration in water)	25,000-gal AST	Building Containment	This additive is part of the Hydromet circuit, which is a closed-loop system with no discharge.	Mineral dissolution is completed under the specific conditions of the hydrometallurgical process in the Hydromet Plant. No further or on-going effect on mineral dissolution of the residue within the HRF is anticipated.
Caustic soda (Sodium hydroxide, 50% solution)	Increase pH of off-gases by removing traces of H_2S and SO_2 in vent scrubbers	Hydromet, specifically the plant scrubber	Continuous	57.53 gallons per day (21,000 gallons per year)	82.19 gallons per day (30,000 gallons per year)	Hydromet Reagents Area	AST (50% concentration in water)	7,000-gal AST	Building Containment	This additive is part of the Hydromet circuit, which is a closed-loop system with no discharge.	Mineral dissolution is completed under the specific conditions of the hydrometallurgical process in the Hydromet Plant. No further or on-going effect on mineral dissolution of the residue within the HRF is anticipated.
Sulfuric acid (93% solution)	Used as wash water for leach residue filter	Hydromet, specifically the residue filter wash water	Continuous	0.47 tons per day (170 tons per year)	0.68 tons per day (250 tons per year)	Hydromet Reagents Area	AST (93% concentration in water)	12,500-gal AST	Yes, and building containment	This additive is part of the Hydromet circuit, which is a closed-loop system with no discharge.	Mineral dissolution is completed under the specific conditions of the hydrometallurgical process in the Hydromet Plant. No further or on-going effect on mineral dissolution of the residue within the HRF is anticipated.
Hydrochloric acid (32% solution)	Addition of chloride used to promote mineral leaching	Hydromet, specifically the autoclave	Continuous	13.70 tons per day (5,000 tons per year)	20.55 tons per day (7,500 tons per year)	Hydromet Reagents Area	AST (32% concentration in water)	60,000-gal AST	Yes, and building containment	This additive is part of the Hydromet circuit, which is a closed-loop system with no discharge.	Mineral dissolution is completed under the specific conditions of the hydrometallurgical process in the Hydromet Plant. No further or on-going effect on mineral dissolution of the residue within the HRF is anticipated.
Flocculant (MagnaFloc 342)	Promote flocculation of suspended particles in liquors	Hydromet, specifically mixed hydroxide precipitation	Continuous	0.06 tons per day (21 tons per year)	0.11 tons per day (40 tons per year)	Hydromet Reagents Area	Bulk (<5 ton, 100% reagent), AST (< 1% concentration in water)	Storage Tank: 7,000 gal AST	Building Containment	This additive is part of the Hydromet circuit, which is a closed-loop system, with no discharge. The flocculant will attach to the solids and end up in the concentrates.	Mineral dissolution is completed under the specific conditions of the hydrometallurgical process in the Hydromet Plant. No further or on-going effect on mineral dissolution of the residue within the HRF is anticipated.

Chemical	Purpose	Location of chemical addition in process	Amount/duration/ frequency of addition[1]	Average rate of use	Maximum rate of use	Storage Location	Storage Capacity	Tank Description	Secondary Containment	Fate and Transport	Potential effect on dissolution
Flocculant (NALCO 9877 PULV)	Promote flocculation of suspended particles in liquors (Potential substitute for MagnaFloc 342)	Hydromet, specifically mixed hydroxide precipitation	Continuous	0.11 tons per day (40 tons per year)	0.21 tons per day (75 tons per year)	Hydromet Reagents Area	Bulk (< 5 ton, 100% reagent), AST (< 1% concentration in water)	Storage Tank: 7,000 gal AST	Building Containment	This additive is part of the Hydromet circuit, which is a closed-loop system with no discharge. The flocculant will attach to the solids and end up in the concentrates.	Mineral dissolution is completed under the specific conditions of the hydrometallurgical process in the Hydromet Plant. No further or on-going effect on mineral dissolution of the residue within the HRF is anticipated.
Flocculant (MagnaFloc 155)	Promote flocculation of suspended particles in liquors	Hydromet, specifically mixed hydroxide precipitation	Continuous	0.11 tons per day (40 tons per year)	0.21 tons per day (75 tons per year)	Hydromet Reagents Area	Bulk (< 5 ton, 100% reagent), AST (< 1% concentration in water)	Storage Tank: 7,000 gal AST	Building Containment	This additive is part of the Hydromet circuit, which is a closed-loop system with no discharge. The flocculant will attach to the solids and end up in the concentrates.	Mineral dissolution is completed under the specific conditions of the hydrometallurgical process in the Hydromet Plant. No further or on-going effect on mineral dissolution of the residue within the HRF is anticipated.
Flocculant (Neo NS 6670)	Promote flocculation of suspended particles in liquors (Potential substitute for MagnaFloc 342 or 155)	Hydromet, specifically mixed hydroxide precipitation	Continuous	0.11 tons per day (40 tons per year)	0.21 tons per day (75 tons per year)	Hydromet Reagents Area	Bulk (< 5 ton, 100% reagent), AST (< 1% concentration in water)	Storage Tank: 7,000 gal AST	Building Containment	This additive is part of the Hydromet circuit, which is a closed-loop system with no discharge. The flocculant will attach to the solids and end up in the concentrates.	Mineral dissolution is completed under the specific conditions of the hydrometallurgical process in the Hydromet Plant. No further or on-going effect on mineral dissolution of the residue within the HRF is anticipated.
Flocculant (NALCO 8173 PULV)	Promote flocculation of suspended particles in liquors (Potential substitute for MagnaFloc 342 or 155)	Hydromet, specifically mixed hydroxide precipitation	Continuous	0.11 tons per day (40 tons per year)	0.21 tons per day (75 tons per year)	Hydromet Reagents Area	Bulk (< 5 ton, 100% reagent), AST (< 1% concentration in water)	Storage Tank: 7,000 gal AST	Building Containment	This additive is part of the Hydromet circuit, which is a closed-loop system with no discharge. The flocculant will attach to the solids and end up in the concentrates.	Mineral dissolution is completed under the specific conditions of the hydrometallurgical process in the Hydromet Plant. No further or on-going effect on mineral dissolution of the residue within the HRF is anticipated.
Flocculant (MagnaFloc 351)	Promote flocculation of suspended particles in liquors	Hydromet, specifically in the leach residue thickener, PGM thickener, and CuS cementation thickener	Continuous	0.27 tons per day (100 tons per year)	0.41 tons per day (150 tons per year)	Hydromet Reagents Area	Bulk (< 10 ton, 100% M351), AST (< 1% concentration in water)	Storage Tank: 17,500 gal AST	Building Containment	This additive is part of the Hydromet circuit, which is a closed-loop system with no discharge. The flocculant will attach to the solids and end up in the concentrates.	Mineral dissolution is completed under the specific conditions of the hydrometallurgical process in the Hydromet Plant. No further or on-going effect on mineral dissolution of the residue within the HRF is anticipated.

Chemical	Purpose	Location of chemical addition in process	Amount/duration/ frequency of addition[1]	Average rate of use	Maximum rate of use	Storage Location	Storage Capacity	Tank Description	Secondary Containment	Fate and Transport	Potential effect on dissolution
Flocculant (Neo NS 6500)	Promote flocculation of suspended particles in liquors (Potential substitute for MagnaFloc 351)	Hydromet, specifically in the leach residue thickener, PGM thickener, and CuS cementation thickener	Continuous	0.41 tons per day (150 tons per year)	0.55 tons per day (200 tons per year)	Hydromet Reagents Area	Bulk (< 10 ton, 100% reagent), AST (< 1% concentration in water)	Storage Tank: 17,500 gal AST	Building Containment	This additive is part of the Hydromet circuit, which is a closed-loop system with no discharge. The flocculant will attach to the solids and end up in the concentrates.	Mineral dissolution is completed under the specific conditions of the hydrometallurgical process in the Hydromet Plant. No further or on-going effect on mineral dissolution of the residue within the HRF is anticipated.
Flocculant (NALCO 9876 PULV)	Promote flocculation of suspended particles in liquors (Potential substitute for MagnaFloc 351)	Hydromet, specifically in the leach residue thickener, PGM thickener, and CuS cementation thickener	Continuous	0.41 tons per day (150 tons per year)	0.68 tons per day (250 tons per year)	Hydromet Reagents Area	Bulk (< 10 ton, 100% reagent), AST (< 1% concentration in water)	Storage Tank: 17,500 gal AST	Building Containment	This additive is part of the Hydromet circuit, which is a closed-loop system with no discharge. The flocculant will attach to the solids and end up in the concentrates.	Mineral dissolution is completed under the specific conditions of the hydrometallurgical process in the Hydromet Plant. No further or on-going effect on mineral dissolution of the residue within the HRF is anticipated.
Sulfur dioxide (liquid)	Reduce ferric ions to ferrous ions	Hydromet, specifically iron reduction and PGM precipitation	Continuous	4.14 tons per day (1,510 tons per year)	6.16 tons per day (2,250 tons per year)	Hydromet Reagents Area - outside	AST	AST: 17,500 gal	Yes	This additive is part of the Hydromet circuit, which is a closed-loop system with no discharge.	Mineral dissolution is completed under the specific conditions of the hydrometallurgical process in the Hydromet Plant. No further or on-going effect on mineral dissolution of the residue within the HRF is anticipated.
Limestone (lump)	Promote precipitation of Fe and Al	Hydromet, specifically in iron removal	Continuous	276.71 tons per day (101,000 tons per year)	410.96 tons per day (150,000 t/year)	Outdoor Stockpile near Concentrate Loadout	Stockpile (50,000 st); silo: (500 st); AST (37.5% concentration)	AST: 150,000 gal	Building Containment	This additive is part of the Hydromet circuit, which is a closed-loop system, with no discharge.	Mineral dissolution is completed under the specific conditions of the hydrometallurgical process in the Hydromet Plant. No further or on-going effect on mineral dissolution of the residue within the HRF is anticipated.
Limestone (ground)	Promote precipitation of Fe and Al (Potential substitute for lump limestone)	Hydromet, specifically in iron removal	Continuous	276.71 tons per day (101,000 tons per year)	410.96 tons per day (150,000 t/year)	Outdoor Stockpile near Concentrate Loadout	Stockpile (50,000 st); silo: (500 st); AST (37.5% concentration)	AST: 150,000 gal	Building Containment	This additive is part of the Hydromet circuit, which is a closed-loop system, with no discharge.	Mineral dissolution is completed under the specific conditions of the hydrometallurgical process in the Hydromet Plant. No further or on-going effect on mineral dissolution of the residue within the HRF is anticipated.

Chemical	Purpose	Location of chemical addition in process	Amount/duration/ frequency of addition[1]	Average rate of use	Maximum rate of use	Storage Location	Storage Capacity	Tank Description	Secondary Containment	Fate and Transport	Potential effect on dissolution
Lime (dry)	Promote precipitation of Ni and Co sulfates as Ni and Co hydroxides (mixed hydroxide precipitate)	Hydromet, specifically mixed hydroxide precipitation	Continuous	10.55 tons per day as CaO) (3,850 tons per year as CaO)	16.44 tons per day as CaO (6,000 tons per year as CaO)	Hydromet Reagents Area	Bulk (< 40 ton - CaO, 100%), AST (22% concentration in water)	AST: 20,000 gal	Building Containment	This additive is part of the Hydromet circuit, which is a closed-loop system with no discharge.	Mineral dissolution is completed under the specific conditions of the hydrometallurgical process in the Hydromet Plant. No further or on-going effect on mineral dissolution of the residue within the HRF is anticipated.
Magnesium hydroxide (60% slurry)	Promote precipitation of Ni and Co sulfates as Ni and Co hydroxides (mixed hydroxide precipitate)	Hydromet, specifically mixed hydroxide precipitation	Continuous	16.44 tons per day (6,000 tons per year)	24.66 tons per day (9,000 tons per year)	Hydromet Reagents Area	AST: Received as 60-65% slurry; diluted to 30%	AST: 85,000 gal	Building Containment	This additive is part of the Hydromet circuit, which is a closed-loop system with no discharge.	Mineral dissolution is completed under the specific conditions of the hydrometallurgical process in the Hydromet Plant. No further or on-going effect on mineral dissolution of the residue within the HRF is anticipated.
Magnesium hydroxide (dry)	Used to promote precipitation of Ni and Co sulfates as Ni and Co hydroxides (mixed hydroxide precipitate) (Potential substitute for magnesium hydroxide (60% slurry))	Hydromet, specifically mixed hydroxide precipitation	Continuous	16.44 tons per day (6,000 tons per year)	24.66 tons per day (9,000 tons per year)	Hydromet Reagents Area	Received dry bulk, diluted to 30%	AST: 85,000 gal	Building Containment	This additive is part of the Hydromet circuit, which is a closed-loop system with no discharge.	Mineral dissolution is completed under the specific conditions of the hydrometallurgical process in the Hydromet Plant. No further or on-going effect on mineral dissolution of the residue within the HRF is anticipated.

Notes:
[1] The amount of chemicals used will be optimized for the production, so that all chemicals added will be consumed. The fate and transport and the effect on dissolution are intended to describe the effects of the minor amounts (if any) of chemicals that are not consumed in the process.

Source: Large Table 1 of Reference (24)

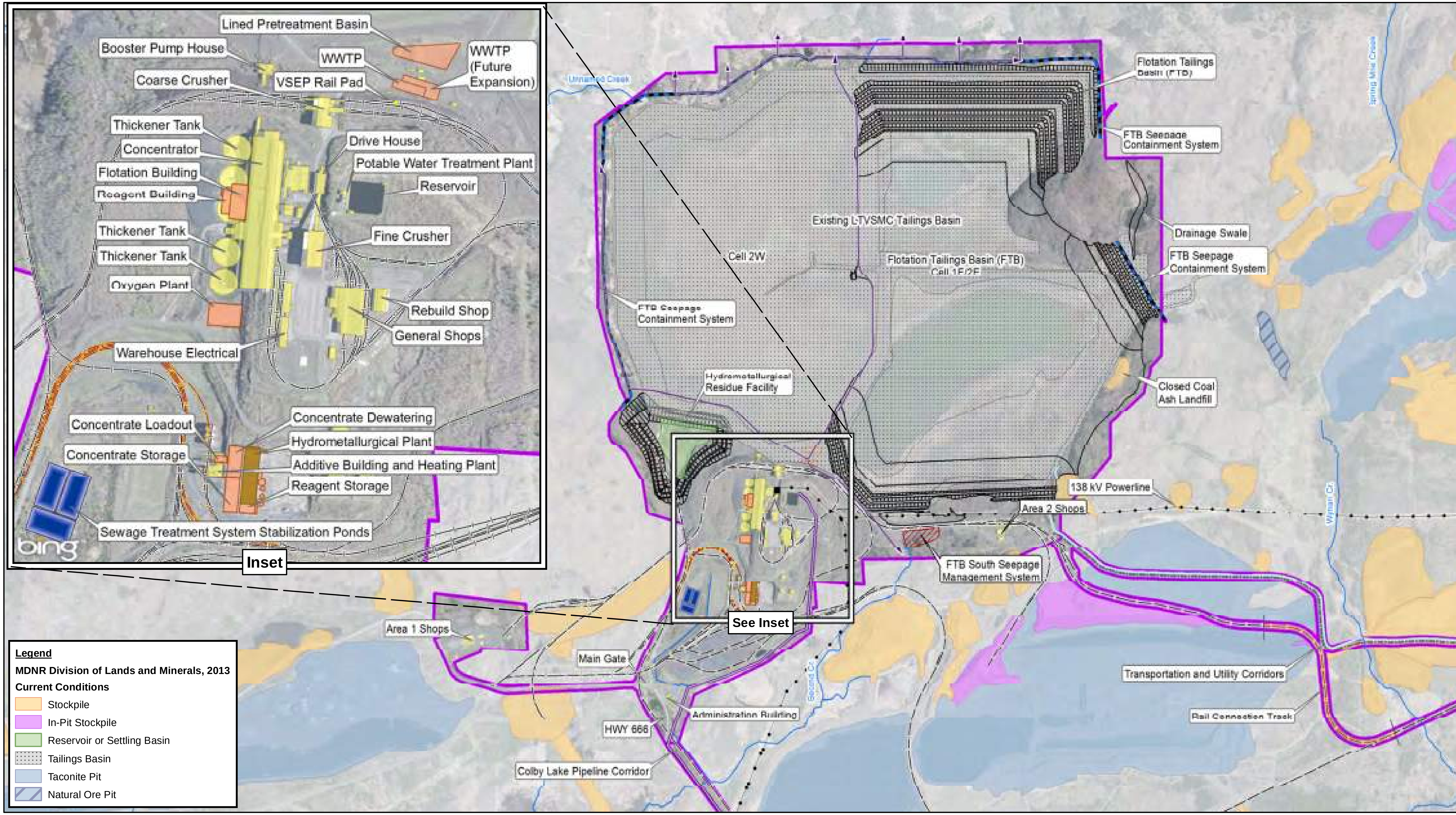
Table 8-4 Design Processing Parameters

Process	Input			Output		
	Material	Rate (tons per day)	Size (inches)	Material	Rate (tons per day)	Size (inches)
Ore Crushing	Ore	32,000	48	Ore	32,000	4
Ore Grinding	Ore	32,000	4	Ore	32,000	4.7×10^{-3}
Flotation	Ore	32,000	4.7×10^{-3}	Concentrate	374 to Hydrometallurgical Plant and 286 to Concentrate Dewatering; or 660 to Concentrate Dewatering	Varies depending on concentrate stream and next process step
				Flotation Tailings	31,340	4.7×10^{-3}
Concentrate Dewatering	Concentrate	660	Varies depending on concentrate stream[1]	Dried nickel and copper concentrate	286 copper and 374 nickel	Same as input[1]

Notes:

[1] Flotation step has two fine grinding stages that produce a defined size. One nickel concentrate stream to Concentrate Dewatering does not pass through a fine grinding stage, but all concentrates to the Hydrometallurgical Plant pass through a fine grinding stage. Therefore, the average output for Flotation does not coincide with the average input for Concentrate Dewatering.

Source: Adapted from Appendix 18.2



Notes

1. Basemap from Esri and its data suppliers.
2. Project features, pipelines and details supplied by Barr Engineering Company.
3. NHD features are created from MDNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance, data sources may show watercourses that no longer exist.
4. Minnesota Power Substations and Power Lines supplied by the Minnesota Geospatial Information Office (MnGeo).

Legend

- Electric Substation[4]
- Existing Electric Power Line[4]
- Dunka Road
- Proposed Railroad Track
- Existing Private Railroad
- Rivers, Streams and Ditches[3]
- Colby Lake Pipeline
- FTB Seepage Containment System
- Treated Water Pipeline
- Treated Water Discharge Pipe
- Proposed Plant Site Buildings and Related Facilities
- Proposed Hydromet Plant
- Existing Buildings
- Sewage Treatment System Stabilization Ponds
- Facility Boundary

N

POLYMET MINING

Foth

Foth Infrastructure & Environment, LLC

REVISED	DATE	BY	DESCRIPTION

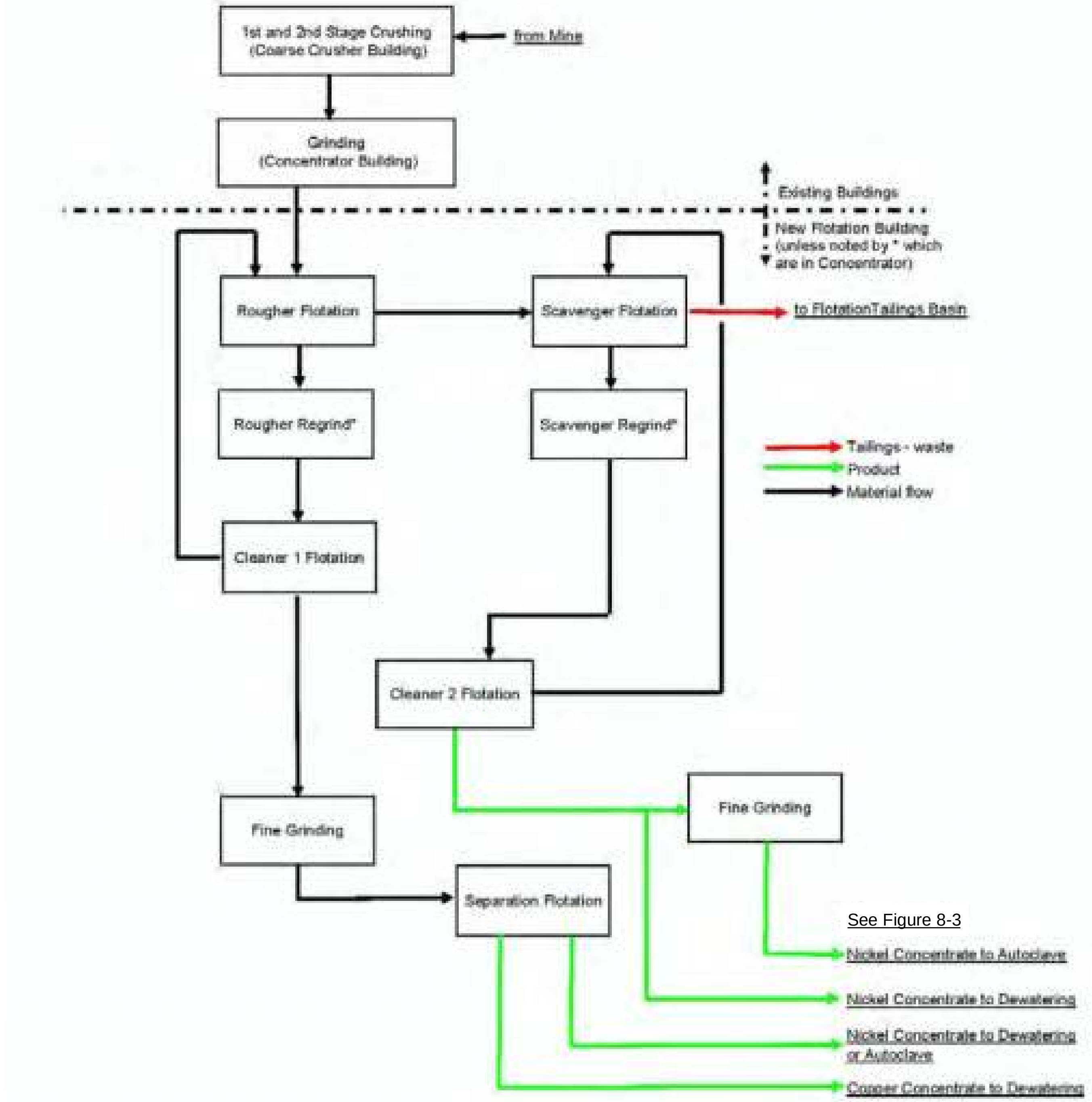
PREPARED BY:	JSL	DATE:	AUG. '16
REVIEWED BY:	MJV2	DATE:	AUG. '16
APPROVED BY:	JOS1	DATE:	AUG. '16

POLYMET MINING

FIGURE 8-1
PLANT SITE - MINE YEAR 20
PERMIT TO MINE APPLICATION
HOYT LAKES, MINNESOTA

Scale: 0 1,250 2,500 Feet		Date:	AUGUST 2016
Drafted by:	DAT	Project No:	12P778

Path: X:\GB\IE\2012\12P778\GIS\mxd\PMA\Figure 8-1 Plant Site.mxd Date: 9/12/2016



Source
1. Project Description, V9, February 2015 included in Appendix 16 of the Application

POLYMET MINING

Foth

Foth Infrastructure & Environment, LLC

REVISED	DATE	BY	DESCRIPTION

PREPARED BY:	JSL	DATE: SEP.'16
REVIEWED BY:	RXW	DATE: SEP.'16
APPROVED BY:	JOS1	DATE: SEP.'16

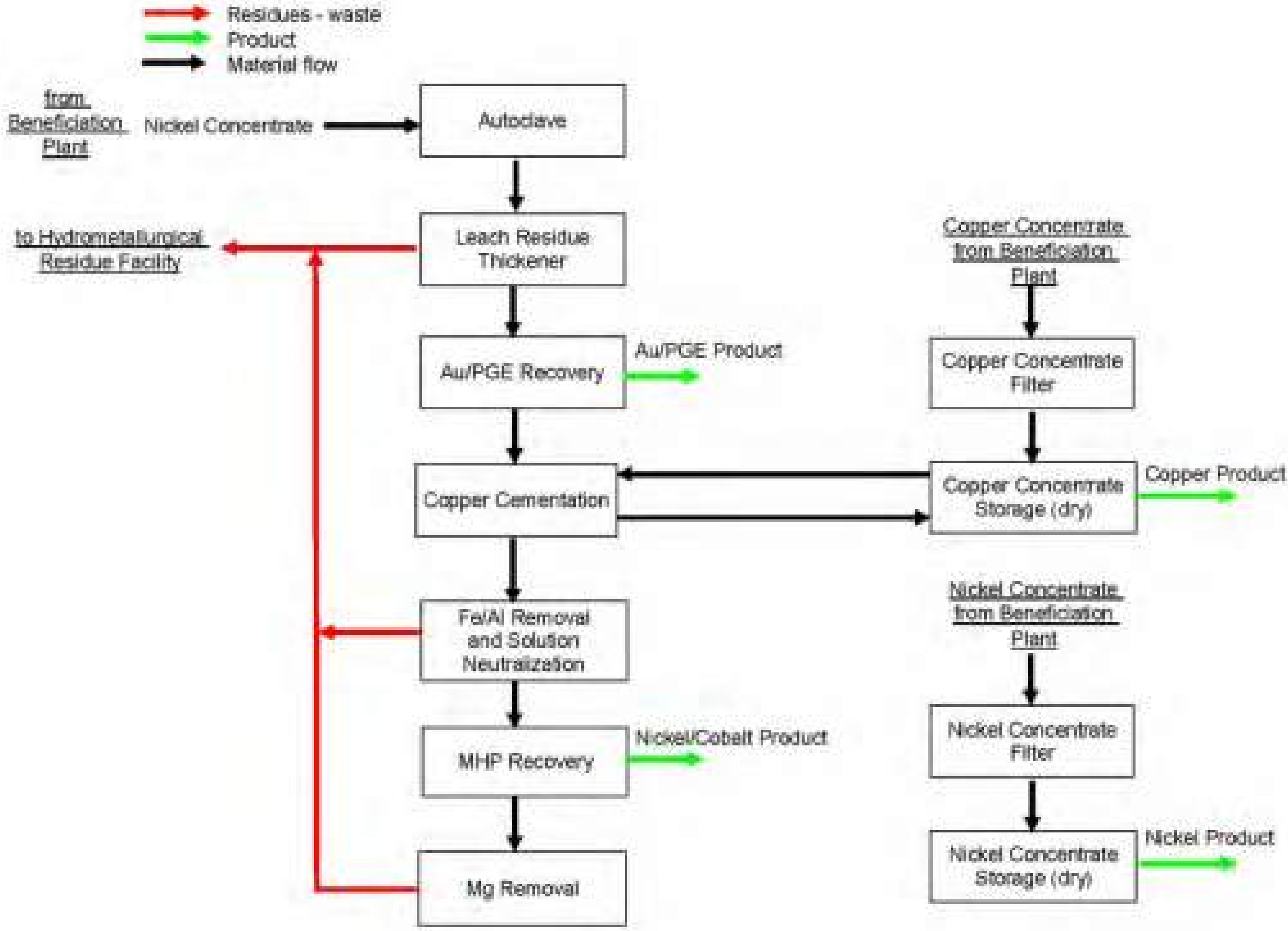
POLYMET MINING

FIGURE 8-2

BENEFICIATION PLANT PROCESS FLOW DIAGRAM
PERMIT TO MINE APPLICATION
HOYT LAKES, MINNESOTA

Scale:	NOT TO SCALE	Date:	SEPTEMBER 2016
Drafted by:	DAT	Project No:	12P778

Path: X:\GB\IE\2012\12P778\GIS\mxd\PMA\Figure 8-2 Beneficiation Plant Simplified Process Flow Diagram.mxd Date: 9/9/2016



Fe/Al Removal - Iron Aluminum Removal
MHP Recovery - Mixed Hydroxide Product Recovery
MG Removal - Magnesium Removal

Source
1. NorthMet Project Description, V9. February, 2015, in Appendix 16 of the Application.

Foth Infrastructure & Environment, LLC				POLYMET MINING	
REVISED	DATE	BY	DESCRIPTION	**FIGURE 8-3** HYDROMETALLURGICAL PLANT PROCESS FLOW DIAGRAM PERMIT TO MINE APPLICATION HOYT LAKES, MINNESOTA	
PREPARED BY: JSL			DATE: SEP.'16		
REVIEWED BY: RXW			DATE: SEP.'16	Scale: NOT TO SCALE	Date: SEPTEMBER 2016
APPROVED BY: JOS1			DATE: SEP.'16	Drafted by: DAT	Project No: 12P778

Path: X:\GB\IE\2012\12P778\GIS\mxd\PMA\Figure 8-3 Hydrometallurgical Plant Process Flow Diagram.mxd Date: 9/7/2016

9 Transportation and Utility Corridors and Colby Lake Pipeline Corridor

In addition to the Mine and Plant Sites, the Mining Area also includes the Transportation and Utility Corridors and the Colby Lake Pipeline Corridor. Figure 9-1 shows the location of these two corridors. The Transportation and Utility Corridors span approximately 8 miles, and include Dunka Road, the existing Main Rail Line, the new Plant Spur, new transmission lines that will be constructed along a portion of Dunka Road, and the TWP. The existing Colby Lake Pipeline will supply water to the Plant Site as needed by pumping water drawn from Colby Lake, approximately four miles south of the Plant Site.

The location, construction, and operation of the Transportation and Utility Corridors and Colby Lake Pipeline Corridor is designed to comply with the requirements set forth in Minnesota Rules, chapter 6132, including those requirements relating to siting and buffers. Specifically, no mining or surface disturbance will occur in prohibited areas, and mining operations will comply with the additional siting restrictions applicable to mining sites. Additionally, the design, construction, and maintenance of the corridors will be compatible with surrounding non-mining uses, and the existing terrain, vegetation, and/or revegetated berms will diminish impacts from mining activities. PolyMet will construct necessary buffers in advance of commencing operations.

The Project will reuse the existing taconite mining infrastructure for its operations in preference to using areas undisturbed by mining. In this way, it is designed to advance the policies set forth both in the nonferrous PTM rules (Minnesota Rules, part 6132.2000, subpart 5, item G) and in the ferrous PTM rules (Minnesota Rules, part 6130.1100 and 6130.4100). Figure 9-1 shows the past mining infrastructure PolyMet will use within its corridors. In addition, Figure 9-1 depicts the existing and known pipelines, cables, and utilities.

9.1 Transportation and Utility Corridor Components

9.1.1 Dunka Road

Dunka Road is an existing gravel road connecting the Mine Site to the Plant Site. PolyMet will upgrade Dunka Road to accommodate the anticipated traffic associated with the Project. To comply with the requirements of MSHA Standard 56.9300, PolyMet will widen the driving surface and construct safety berms as needed. The finished road surface will be similar to the existing road profile. The road will follow the existing alignment with a few modifications to straighten curves and allow space to construct the TWP and safety berms. As required by applicable MSHA regulations, PolyMet will construct safety berms along the road to accommodate the travel of the largest piece of mobile equipment that will be using the road. PolyMet will extend existing culverts to accommodate the road widening and will construct meeting bays at selected locations to allow for the haul trucks used for mine development traveling in opposite directions to pass each other. Appendix 3 includes additional details on the Dunka Road upgrade including typical cross-sections.

9.1.2 Power Distribution

Electrical service will be provided to the Mine Pits, WWTF, CPS, RTH, pit dewatering pumps, mine water pond pumps, stockpile foundation pumps, and the MSFMF.

9.1.3 Treated Water Pipeline

The TWP will be constructed along the Dunka Road and Utility Corridor (Figure 9-1) to move treated mine water from the Mine Site to the FTB. PolyMet will monitor and operate the TWP in accordance with required operational plans to prevent potential leaks and spills.

The TWP will route the treated mine water from the CPS to the FTB for use as process water in the Beneficiation Plant. The TWP will generally run parallel to the existing Dunka Road alignment for a total length of approximately seven miles. This route provides easy access for maintenance and regular inspection.

9.1.4 Railroad and Rail Cars

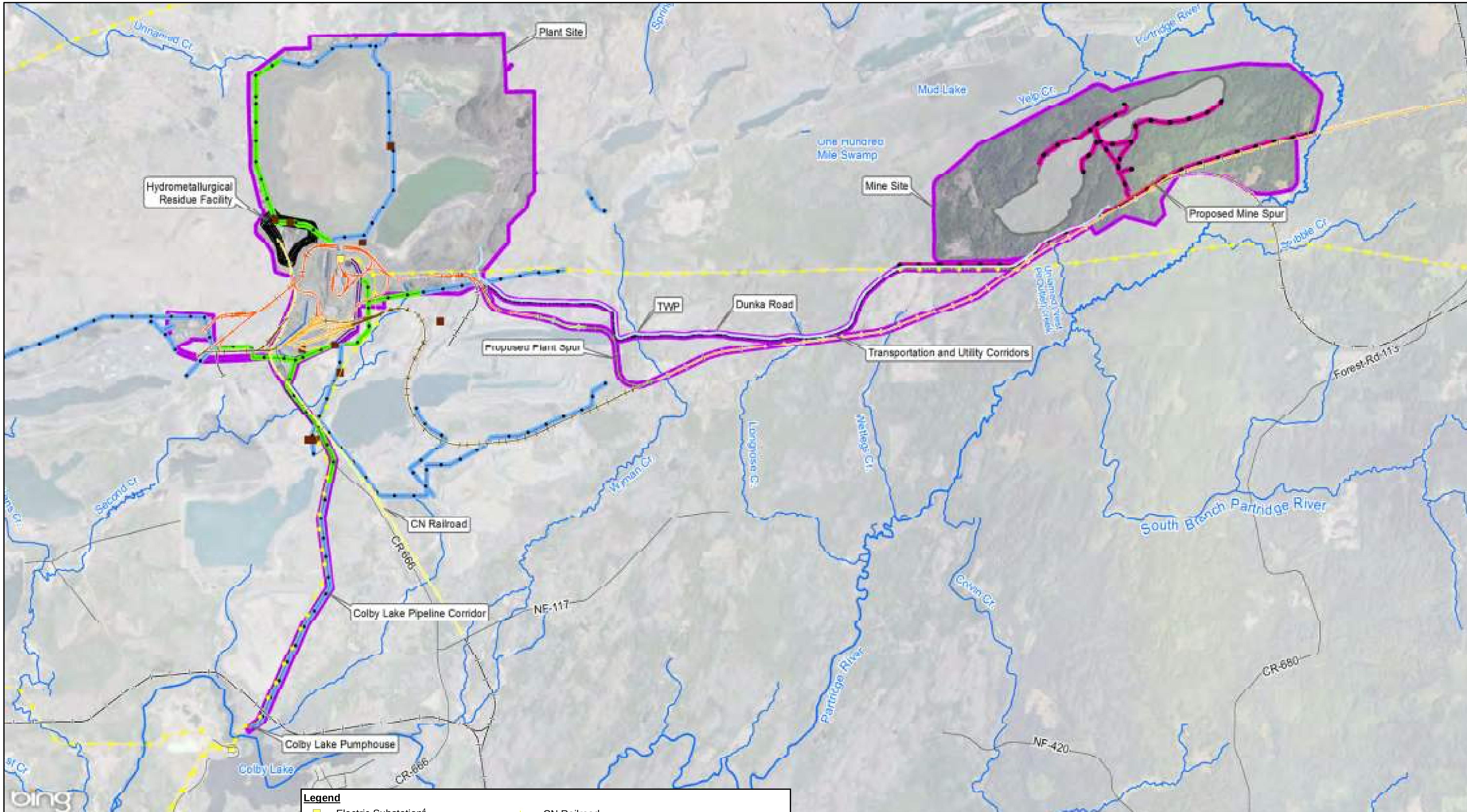
PolyMet will refurbish the existing Main Rail Line that connects the Mine Site to the Plant Site between mile posts 3.9 and 8.4. PolyMet plans to build the new Plant Spur, to connect the Main Rail Line to the existing track that serves the Coarse Crusher Building at the Beneficiation Plant. Figure 9-1 shows the location of the Main Rail Line and Plant Spur.

Trains will move ore from the Mine Site to the Coarse Crusher Building at the Beneficiation Plant along the private railroad system. Each train will consist of 16 to 20 side-dumping ore cars and one locomotive. PolyMet will refurbish and reuse the side-dumping ore cars that were used in the previous LTVSMC operation. To minimize and prevent ore spillage, PolyMet will inspect the existing ore cars and replace worn linkages, pins, and bushings as needed. The rail cars will be inspected regularly for structural integrity.

If needed, PolyMet will use a water cannon system for dust suppression during loading at the RTH to reduce the potential for dust generation as the ore cars are loaded. Planned monitoring and management activities are included in the Transportation and Utility Corridors Management and Monitoring Plan (Appendix 11).

9.2 Colby Lake Pipeline

The existing Colby Lake Pipeline will deliver water from Colby Lake, located approximately four miles south of the Plant Site, to the Plant Site. PolyMet will inspect the pump house and pipeline and refurbish, as necessary, before use. The water will be stored in the existing Plant Reservoir, which will provide an on-site water source for Beneficiation Plant fire protection systems, water supply to the Area 1 Shops and the Area 2 Shops, potable water, and make-up water as needed for the Beneficiation Plant and Hydrometallurgical Plant. Section 11 discusses water management for the Project. Water appropriation and water management details are covered in the media-specific applications for the Water Appropriation Permit (MDNR) and the NPDES/SDS Permit (MPCA), respectively.



Legend

Electric Substation[4]	CN Railroad
Existing Substations	Cliffs Erie Owned
Existing Power Lines In Use	Cliffs Erie Owned with Agreement in Place to Use
Existing Power Lines Not In Use	PolyMet Owned and Maintained
Existing Electric Power Line[4]	State of MN Land with Agreement in Progress to Use
Proposed Transmission Line	Existing Private Railroad
Treated Water Pipeline (TWP)	Mine Pits
Roads	Facility Boundary
Rivers and Streams[3]	

Notes

1. Basemap from Esri and its data suppliers.
2. Project features supplied by Barr Engineering Company.
3. NHD features are created from MDNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance, data sources may show watercourses that no longer exist.
4. Minnesota Power Substations and Power Lines supplied by the Minnesota Geospatial Information Office (MnGeo).

POLYMET MINING

Foth

Foth Infrastructure & Environment, LLC

REVISED	DATE	BY	DESCRIPTION

PREPARED BY:	DAT	DATE: AUG. '16
REVIEWED BY:	JSL	DATE: AUG. '16
APPROVED BY:	JOS1	DATE: AUG. '16

POLYMET MINING

FIGURE 9-1
TRANSPORTATION AND UTILITY CORRIDORS AND COLBY LAKE PIPELINE CORRIDOR
PERMIT TO MINE APPLICATION
HOYT LAKES, MINNESOTA

Scale: 0 2,500 5,000 Feet	Date: AUGUST 2016
Drafted by: DAT	Project No: 12P778

Path: X:\GB\IE\2012\12P778\GIS\mxd\PMA\Figure 9-1 Transportation Corridor.mxd Date: 9/9/2016

10 Characterization and Management of Mine Waste

PolyMet has designed its Project so that mine waste generated from its mining and processing operations will be appropriately managed, in accordance with applicable federal and state laws, to minimize potential environmental impacts. Based on approximately 10 years of mine waste characterization testing, PolyMet has developed a Project in which reactive and non-reactive mine waste will be mined, stored, and reclaimed so as to prevent the release of substances that may result in adverse impacts to natural resources. PolyMet's proposed design, construction, operation, and reclamation of the stockpiles, FTB, and HRF will, consistent with the PTM Regulations, be structurally sound, minimize hydrologic impacts, control air emissions, enhance the survival and propagation of vegetation, control erosion, promote progressive reclamation, and conserve mineral resources.

For over ten years, PolyMet has conducted a MDNR-supervised mine waste characterization program and has worked with the Co-Lead Agencies on developing an FEIS that analyzes the alternatives for managing this waste. During this period, and in close collaboration with MDNR, PolyMet worked with a team of qualified technical experts, including professional engineers, geochemists, and hydrogeologists, to conduct this technical analysis, which included, among other things, an evaluation of:

- the geochemical and geotechnical properties of the overburden, waste rock, ore, Flotation Tailings, and Residue
- the geochemical and geotechnical properties of the existing LTVSMC tailings
- the existing environmental setting, including climate, precipitation, topography, drainage, subsurface conditions, hydrogeology, and seismology
- potential storage methods for different categories of mine waste, including whether tailings should be stored in a dry or slurry form
- various alternatives for design and construction of dams and storage piles
- the application of industry standard engineering and environmental practices to the specific context of the Project
- the use of ongoing monitoring, maintenance, and management practices

PolyMet and its engineering team utilized the results of these studies and analyses to design facilities that, through proposed management practices, can be constructed, operated, and reclaimed so as to be structurally sound and minimize environmental impacts. As detailed in this section, PolyMet's mine waste management is configured to achieve multiple objectives, including:

- safe permanent disposal and storage of mine waste produced over the 20-year LOM
- efficient and effective process water, mine water, and stormwater management
- successful reclamation, closure, and postclosure maintenance

- compliance with statutory and regulatory criteria for structural stability during operations and after closure
- minimization of environmental impacts

This section, which is part of PolyMet's Mining and Reclamation Plan for the Project, summarizes the technical analyses developed through the mine waste characterization, FEIS and related processes to demonstrate how the Project will conform to the applicable regulatory standards. Because the specific characteristics of the mine waste informs the design and construction of the facilities used to manage it, this section first discusses the characterization of the mine waste and then explains how that characterization informed the proposed design, construction, operations, and reclamation activities. Accordingly, this section is structured as follows:

- Section 10.1 describes PolyMet's mine waste characterization program, including the technical professionals responsible for performing the work, the process for developing the program, the materials analyzed, the methods of analysis, and the results.
- Section 10.2 summarizes the management and disposal of the Flotation Tailings at the FTB located at the Plant Site, including the FTB's design, relevant construction and operational activities, and reclamation.
- Section 10.3 explains the management and disposal of Residue generated by the Hydrometallurgical Plant at the HRF located at the Plant Site, including the HRF's design, relevant construction and operational activities, and reclamation.
- Section 10.4 discusses the management and disposition of overburden, waste rock, and ore at the Mine Site, including methods for identifying and segregating different classes of waste rock and overburden; the design and management of the OSLA, waste rock stockpiles, and OSP; the potential use of overburden and waste rock in construction activities; and the backfilling of the East Pit in Mine Year 11.

Appendix 2 includes additional information regarding the mine waste characterization program and the results of that program. Appendix 3 through Appendix 7 include permit application support drawings for the earthwork, the waste rock stockpiles and OSP, the FTB, and the HRF, respectively. The management plans and data packages developed during the EIS process provide a summary of the information in the permit application support drawings. Appendix 11 through Appendix 13 discuss the ongoing operations and management practices for these facilities.

10.1 Mine Waste Characterization

Minnesota Rules, parts 6132.1000 and 6132.2200 require geochemical characterization of "mine wastes" from nonferrous mining projects to support the Application process. Mine waste is defined broadly by Minnesota Rules, part 6132.0100, subpart 16 to mean a "material, such as surface overburden, rock, lean ore, leached ore, or tailings that in the process of mining and beneficiation has been exposed or removed from the earth.” Given this broad regulatory definition, PolyMet has characterized ore in addition to all types of mine waste. If the mine waste characterization program shows that the certain mine wastes will "release substances that adversely impact natural resources", then the regulations define such waste to qualify as "reactive mine waste" and impose specific requirements on the management of those wastes per Minnesota Rules, part 6132.0100, subpart 28; and part 6132.2200.

The PTM Regulations impose requirements relating to the development of the mine waste characterization program and specify the analyses that an applicant must perform. In addition, the regulations require that the applicant submit the mine waste characterization and the results of the analysis as part of the Application's Mining and Reclamation Plan (Minnesota Rules, part 1100, subpart 6D). Accordingly, this subsection describes PolyMet's compliance with these characterization requirements, and Appendix 2 provides more detailed information regarding the characterization program and results, as required by the regulations.

10.1.1 Development of the Mine Waste Characterization Program

Minnesota law requires that an applicant for a nonferrous Permit to Mine meet with the MDNR "to outline chemical and mineralogical analyses and laboratory tests to be conducted for mine waste characterization," which the MDNR will then use in "evaluation of the applicant's mining and reclamation plan" (Minnesota Rules, part 6132.1000, subpart 1). In addition, the MDNR must approve the persons conducting the mine waste characterization and these persons must have "demonstrated proficiency in such analysis” (Minnesota Rules, part 6132.1000, subpart 2).

In accordance with these regulatory requirements, in 2004 PolyMet initiated a series of mine waste characterization conferences and other exchanges with the Lands and Minerals Division of the MDNR to develop a mine waste characterization program for the Project. These interactions included PolyMet's consultants, SRK Consulting (SRK) and Barr Engineering Co. (Barr), both of which had demonstrated proficiency in conducting mine waste characterization, and which were responsible for carrying out the mine waste characterization program.

Over this series of conferences and exchanges, which continued into 2010, MDNR provided PolyMet guidance and direction in developing geochemical characterization plans that served as the primary documents to outline the parameters of the waste characterization program for the Project including the Waste Rock and Lean Ore Geochemical Characterization Plan, the Flotation Tailings and the Hydrometallurgical Residue Geochemical Characterization Plan, the Overburden Geochemical Characterization Plan, and other targeted studies and analyses to support the waste characterization program (collectively, Characterization Plans). These Characterization Plans included chemical, physical, and mineralogical analyses and laboratory procedures to test the weathering and dissolved solids release from Project materials defined as mine waste, which are described in further detail in Appendix 2.

As indicated by these Characterization Plans, developed in consultation with the MDNR, Steve Day, PGeo, Corporate Consultant (Geochemistry) from SRK, with demonstrated proficiency in mine waste characterization, was responsible for the design and oversight of the characterization programs. The laboratories that were selected to conduct the required analyses were also identified in the Characterization Plans and have demonstrated proficiency in conducting mine waste characterization.

Development of the Characterization Plans was an iterative process with MDNR in which MDNR reviewed the Characterization Plans and evaluated results of preliminary sampling and testing, requested that PolyMet provide supplemental information in certain instances, provided PolyMet with comments and requested revisions to the Characterization Plans, and provided PolyMet with further direction on sampling and testwork. Appendix 2 contains additional information and materials relating to the development of the mine waste characterization program, including a comparison to other recent mine waste characterization programs.

10.1.2 Contents of the Mine Waste Characterization Program

Consistent with the regulatory requirements, PolyMet's mine waste characterization program is "based on chemical, physical, and mineralogical analyses and laboratory tests of material generated by exploration, preproduction sampling, and process testing." (Minnesota Rules, part 6132.1000, subpart 2). The mine waste characterization program includes: (1) chemical analysis of mine waste; (2) mineralogical and petrological analysis of mine waste; and (3) laboratory tests describing acid generation potential and dissolved solids released from mine waste. In addition, PolyMet's mine waste characterization program provides information regarding the reagents associated with Flotation Tailings and Residue, including their chemical composition, mass to be used, and where applicable, the degradation and transport characteristics as well as the effects on mineral dissolution.

Section 10.1 summarizes the analyses and studies that PolyMet completed as part of its geochemical characterization of overburden, waste rock, ore, Flotation Tailings, LTVSMC tailings, and Residue as well as the results of this characterization. Appendix 2 contains additional detailed information regarding this characterization. In addition, the FEIS and associated management plans and data packages (included in Appendix 16) summarize these analyses.

10.1.3 Mine Waste Characterization Program Implementation and Results

PolyMet began implementing the analyses and studies that comprise the mine waste characterization program in 2005. PolyMet has used the opportunity provided by ongoing environmental review to have SRK continue aspects of the mine waste characterization program, such as kinetic tests (humidity cells), which would indicate long-term acid generation and metal leaching potential of mine waste, if present. MDNR has exercised oversight over the mine waste characterization conducted to date as well as the characterization work that remains ongoing.

PolyMet submitted the results of its mine waste characterization program to the MDNR, MPCA, and USEPA as part of the EIS process. As required by Minnesota Rules, part 6132.1000, subpart 3, PolyMet is resubmitting these results as part of this Mining and Reclamation Plan. PolyMet's Annual Report will also contain additional information on the mine waste characterization.

This subsection presents the characterization results for each type of mine waste, as well as combinations of these various wastes, including:

- Overburden
- Waste rock and ore
- Flotation Tailings
- LTVSMC tailings
- Residue
- Reagents associated with Flotation Tailings and Residue

The Waste Rock and Lean Ore Geochemical Characterization Plan and the reporting from this program in the year 2007, includes a type of mine waste termed "lean ore", defined in Minnesota Rules, part 6132.1000, subpart 14, as, "rock containing metallic mineralization that is not profitable to process using technologies that exist at the mining operation." The current Mining and Reclamation Plan does not separate out a category of rock that would be considered lean ore. Therefore, PolyMet reclassified the samples originally identified as lean ore as waste rock in the current mine plan and has included them in Subsection 10.3.1.2. If a material were to be re-classified as lean ore in the future based on a change in economic conditions or technological changes, it would be a subset of the waste rock, which has already been part of the geochemical characterization process. PolyMet has used the results of the mine waste characterization tests to design its Mining and Reclamation Plan, including those facilities and engineering controls needed to store and manage the wastes so as to minimize environmental impacts.

10.1.3.1 Overburden

PolyMet has analyzed the overburden that the Project will generate to determine its chemical and physical properties and to develop an overburden management plan. Surface overburden is the unconsolidated earth material overlying bedrock. PolyMet's mine waste characterization program included geochemical and leach testing of the three types of overburden that will be generated by the Project: unsaturated mineral overburden, saturated mineral overburden, and peat (organic soils). Peat and the two types of mineral overburden exhibit different physical and geochemical properties, which necessitate different management approaches. Table 10-1 briefly summarizes overburden types, properties, and management approaches.

10.1.3.2 Waste Rock and Ore

PolyMet has characterized the waste rock and ore (including lean ore) that the Project will generate to determine their chemical and physical properties and to develop waste rock and ore management plans. As described in the Waste Characterization Data Package provided in Appendix 16, the waste rock and ore characterization includes an evaluation of bulk chemical analyses from approximately 18,800 drill core samples. Results of the evaluation are used to identify relationships between release rates of select chemical constituents. These analyses also provide the basis for sulfur distribution in the Project block model which is used to estimate the sulfur content of waste rock piles and the mine pit walls. In addition, PolyMet has conducted detailed characterization of 82 waste rock samples, which were selected to represent the waste rock generated by the Project, based on the following chemical, physical, and mineralogical analyses and laboratory tests:

- optical mineralogical and petrological characterization: reporting includes mineral identification, mineral abundance, grain sizes, and petrologic determination
- sub-optical mineral characterization: trace element content of major minerals via electron microprobe analysis
- acid-base accounting: total sulfur content, carbonate content, and paste pH
- bulk chemical composition of whole rock samples: ICP analyses of 27 elements following four-acid digestion, ICP analyses of 34 elements following aqua regia digestion; whole rock oxides
- bulk chemical composition of size-fractionated samples: total sulfur and ICP analyses of 27 elements following four acid digestion
- specific gravity (G_s)and particle size distribution
- "kinetic" testing: whole rock samples were subjected to humidity cell testing (American Society for Testing and Materials [ASTM] Procedure D 5744); size-fractionated portions of splits from five of the whole rock samples were also tested using a laboratory test method developed by the MDNR ("MDNR Reactor" experiments)

Based on data from the test program and MDNR guidance, PolyMet has classified waste rock by sulfur content as shown in Table 10-2.

Consistent with the regulatory requirement to characterize material generated by, among other things, process testing, PolyMet subjected three ore composites prepared for pilot-plant testing for static and whole sample chemical characterization and kinetic testing as part of material characterization. The characterized ore samples represent blended ore composite samples, similar to the mixed ore material that will be in the OSP. Kinetic testing results indicate this material will generate acid and release metals.

Appendix 16, which includes the Waste Characterization Data Package, shows the humidity cell trend analysis graphs from the kinetic tests and presents a summary of the behavior of copper, nickel, other trace metals, pH, and sulfate within the various waste rock categories and ore. Within the trend graphs, the potential for the generation of acidic leachate and/or the release of metals over time are portrayed visually.

Based on these characterization results, PolyMet will, during Project operations, segregate waste rock at the Mine Site based on the results of characterization testing and will manage the rock as follows:

- *Category 1 waste rock* – Characterization testing indicates this material will not produce acidic leachate, but may release metals. Some of this waste rock may be used for construction purposes. PolyMet will send Category 1 waste rock not used for construction to one of two destinations: the Category 1 Waste Rock Stockpile in early mine years and the East Pit once backfilling commences. The Category 1 Waste Rock Stockpile will have a groundwater containment system to capture mine water draining through the stored waste rock, which in turn will be routed to WWTF. PolyMet will allow the East Pit to flood shortly after disposal of backfilled waste rock (subaqueous disposal), which will limit oxidation and metals release.
- *Category 2/3 waste rock* – Characterization testing indicates this material may produce acidic leachate if allowed to weather for several years, and is likely to release metals to a greater degree than Category 1 waste rock. Due to their similar levels of reactivity, PolyMet will manage Category 2 and Category 3 waste rock together. The Project will store Category 2/3 waste rock in the temporary Category 2/3 Waste Rock Stockpile, which will include a liner system that allows PolyMet to collect and treat stockpile drainage. This waste rock will ultimately be relocated to the East Pit for subaqueous disposal to minimize oxidation of sulfide minerals and release of metals.
- *Category 4 waste rock* – Characterization testing indicates this material will produce acidic leachate and will release metals. Due to expected reactivity, PolyMet will temporarily store Category 4 waste rock in the Category 4 Waste Rock Stockpile with a liner system that allows for collection and treatment of stockpile drainage. This waste rock will ultimately be relocated to the East Pit for subaqueous disposal to limit oxidation of sulfide minerals and release of metals.
- *Ore* – Characterization of the ore indicates that it has potential to generate both acidic leachate and metals. PolyMet may temporarily store ore in the OSP before processing. The OSP includes a geomembrane liner system. PolyMet will capture and treat water that contacts the OSP.

Section 10.4 provides additional information regarding the stockpiles and East Pit backfilling used to manage this waste rock, including geotechnical information, and the design and operations facilities. Reclamation of these facilities is discussed in Section 15.

10.1.3.3 Flotation Tailings

At the Plant Site, the froth flotation process will produce Flotation Tailings throughout the LOM. PolyMet has characterized the Project's Flotation Tailings to determine their chemical and physical properties. PolyMet used these characterization results to design the FTB and to develop management practices that minimize environmental impacts and comply with applicable standards.

PolyMet conducted pilot-plant processing of Project bulk ore samples at the SGS Lakefield facility in Lakefield, Ontario to produce Flotation Tailings for characterization. PolyMet's team collected samples of the Flotation Tailings from pilot-tests run in 2005, 2006, 2008, and 2009 for laboratory testing to determine geochemical and geotechnical characteristics. The 2005 pilot-test represented the beneficiation process flowsheet proposed for the Project. The initial trials during the 2005 pilot-test did not include copper sulfate to activate the pyrrhotite; however, all subsequent trials have done so. PolyMet completed additional flotation process optimization tests with the 2006 pilot-test and collected additional tailings samples. The 2008 pilot-test represented a refinement that increased grinding in the flotation area. The 2009 pilot-test represented a refinement that increased grinding in the flotation area and had a cleaner flotation process for the scavenger flotation step. PolyMet conducted characterization testing on a total of 33 tailings samples from all of these pilot-plant runs. The pilot-plant Flotation Tailings samples are representative of the Flotation Tailings expected from the Beneficiation Plant. They were subjected to the following chemical, physical, and mineralogical analyses and laboratory tests:

- density determinations and size fraction analysis
- mineralogical characterization via optical analyses of tailings thin sections
- acid-base accounting: total sulfur and sulfur speciation, paste pH, neutralization potential and carbonate content
- bulk chemical composition of whole rock samples: ICP analyses of 50 elements following aqua regia digestion; whole rock oxides
- “kinetic” testing: whole rock samples were subjected to humidity cell testing (ASTM Procedure D 5744); in addition, splits from samples were also tested using a laboratory test method developed by the MDNR (“MDNR Reactor” experiments)

PolyMet integrated the results of the geochemical testing, which included the long-term kinetic testing of Flotation Tailings, to develop an overall understanding of the tailings as follows:

- Flotation Tailings will not generate acid
- Flotation Tailings will have the potential to release constituents of interest

PolyMet will manage Flotation Tailings to account for both of these characteristics by processing ore using a bulk sulfide flotation process to minimize the amount of sulfides deposited with the Flotation Tailings. The Project specifies management of the Flotation Tailings in the FTB to allow collection and treatment of water contacting the tailings. During operations and reclamation, PolyMet will add a bentonite amendment to the FTB side slopes, final pond bottom, and final beaches to limit oxidation of sulfide minerals and release of metals. Section 10.2 provides additional information regarding the FTB and the management practices for the

Flotation Tailings, including geotechnical information, and the design construction, and operations of the Tailings Basin. Reclamation of the Tailings Basin is discussed in Section 15.

10.1.3.4 LTVSMC Tailings

The LTVSMC tailings do not constitute nonferrous mine waste that must be characterized under the nonferrous PTM rules. Nonetheless, given the proposed siting of the FTB on the existing LTVSMC tailings basin, PolyMet obtained representative samples of LTVSMC tailings from the existing tailings basin, and characterized these samples to determine their chemical and physical properties alone, as well as in combination with nonferrous Flotation Tailings. This characterization of the LTVSMC tailings in combination with the Flotation Tailings supported PolyMet's design of appropriate environmental controls for the FTB to address potential environmental concerns arising from the Project operations in light of existing environmental conditions at the Plant Site.

PolyMet initiated geochemical kinetic testing of LTVSMC tailings in 2010, using the same testing methods as for the Flotation Tailings samples. The results from this testing show that LTVSMC tailings chemistry is dominated by buffering from the dissolution of carbonate minerals. Kinetic testing of LTVSMC tailings show stable leachate chemistry with slightly basic pH.

PolyMet has tested the geochemical effects of NorthMet Flotation Tailings placed on top of LTVSMC tailings in laboratory column tests for over eight years. Results show that leachate from the Flotation Tailings has a slightly lower pH when compared to LTVSMC tailings. Also, leachate from the Flotation Tailings does not appear to influence leaching of the LTVSMC tailings. The LTVSMC tailings, however, appear to remove arsenic, vanadium and to a lesser extent, nickel, from Flotation Tailings leachate. This observed removal would be consistent with the effect of adsorption of these constituents to the LTVSMC tailings.

The waste characterization program results included in Appendix 2 provide detailed analysis of the geochemical properties of the LTVSMC tailings, and Section 10.2 presents the geotechnical analysis of the LTVSMC tailings.

10.1.3.5 Hydrometallurgical Residue

PolyMet characterized the Residue to be generated by the Hydrometallurgical Plant. PolyMet used these characterization results to design the HRF and to develop management practices that minimize environmental impacts and comply with applicable standards.

Consistent with the regulatory requirements, PolyMet undertook pilot-plant testing at SGS Lakefield Research Laboratories in Lakefield, Ontario to produce hydrometallurgical residue for testing. The hydrometallurgical process generates five individual types of residue:

- leach residue
- gypsum neutralization residue
- iron/aluminum residue
- magnesium removal residue
- raffinate neutralization residue

This pilot-plant testing program generated samples of all five types of hydrometallurgical residue for testing. PolyMet characterized both discrete and combined samples of the hydrometallurgical residues, including samples with and without the gypsum filter residue to allow for possible marketing of the gypsum filter residue. Accordingly, the samples produced by the pilot-plant testing for characterization are representative of the hydrometallurgical residues anticipated to result from the Project operations.

Consistent with the regulatory requirements, PolyMet subjected these hydrometallurgical residues to the following chemical, physical, and mineralogical analyses and laboratory tests:

- mineralogical characterization via quantitative X-ray diffraction to identify major and minor crystalline phases and estimate relative abundance of each;
- acid-base accounting: total sulfur and sulfur speciation, paste pH, neutralization potential and carbonate content;
- bulk chemical composition of whole rock samples: ICP analyses of 50 elements following aqua regia digestion; whole rock oxides;
- leachate characterization: chemistry of leachate measured after samples are subjected to TCLP, SPLP, and a sequential shake flask leach procedure;
- "kinetic" testing: samples were subjected to humidity cell testing (ASTM Procedure D 5744); in addition, splits from samples were also tested using a laboratory test method developed by the MDNR ("MDNR Reactor" experiments)

Humidity cell tests on residues show an initial rapid flush of acidity and metals as process water was rinsed from the residues. As the tests proceeded, the individual leachates remained acidic but leaching of metals and acidity decreased reflecting dissolution of the residue. Sulfate concentrations remained elevated due to ongoing dissolution of gypsum. Once gypsum is completely leached, sulfate leaching decreases and trace element leaching occurs.

PolyMet conducted leachate extraction testing of the individual residues and the combined Residue using the Toxicity Characteristic Leaching Procedure (TCLP) test to determine if they have leaching characteristics that exceed the Resource Conservation and Recovery Act (RCRA) hazardous waste thresholds. TCLP testing indicates that concentrations of metals are below RCRA hazardous waste thresholds and, therefore, the individual residues and the combined Residue are not classified as hazardous waste (Reference (25)).

The characterization results show that the combined Residue is nonacidic and dominated by gypsum. Characterization testing results further indicate combined Residue will release elevated levels of sulfate and could eventually produce acidic leachate if the neutralizing capacity is exceeded in the long term. The discrete magnesium residue is not acidic. It contains mostly gypsum (77%) but also 22% brucite, which is a source of alkalinity. The nonacidic nature of the combined Residue is due to the alkalinity that is contributed by the magnesium residue. The remaining four of the five discrete residues (leach residue, gypsum neutralization residue, iron/aluminum residue, and raffinate neutralization residue) are acidic. The leach residue consists dominantly of natrojarosite and hematite along with gypsum and residual plagioclase. The remaining gypsum neutralization, iron/aluminum, and raffinate neutralization residues consist mainly of gypsum (96 to 99.8%).

These characterization results inform PolyMet's proposed management practices and design for the HRF. As Section 10.3 discusses in more detail, because there is the potential for acid generation to exceed neutralizing capacity in the long term, PolyMet will blend lime or limestone with the Residue before disposal in the lined HRF. In addition, PolyMet will place the Residue in a double-lined facility for collection and treatment of water contacting the Hydrometallurgical Residue.

10.1.3.6 Reagents

PolyMet’s mine waste characterization program provides information regarding the reagents associated with the Flotation Tailings and Residue, in accordance with the Minnesota Rules, part 6132.1000, subpart 2. The lists of reagents associated with the hydrometallurgical and beneficiation processes are provided in Table 8-2 and Table 8-3. Only one of these reagents, copper sulfate, is expected to contribute to metal and sulfate concentrations. Process testwork showed that sulfur concentration in the Flotation Tailings can be expected to vary in response to changes in process conditions, and that the use of copper sulfate can be expected to lower the sulfur concentration in Flotation Tailings. Leachate residues generated both with and without the use of copper sulfate were tested for evaluation of the effects of copper sulfate. The results of this testing are provided in Appendix 2.

PolyMet also evaluated the potential to use a number of different reagents on waste rock stockpiles to eliminate the need to treat stockpile drainage for metals (primarily cobalt, nickel, copper, and zinc). These efforts concluded that chemical modifications had not been demonstrated at scale such that water treatment for metals could be eliminated, and no chemical modifications were recommended. Several chemical modifications technologies were identified, however, as potential measures to be evaluated during operations.

Additional information regarding the evaluation of reagents as part of the mine waste characterization program is provided in Appendix 2.

10.2 Flotation Tailings Basin

Consistent with the preferences in Minnesota law to reuse existing mining facilities, PolyMet will construct the FTB atop the existing LTVSMC tailings basin. PolyMet's FTB design is intended to achieve multiple objectives, including the following:

- safe permanent disposal of Flotation Tailings produced over the 20-year LOM
- efficient and effective process water management
- assurance of dam and slope stability during operations and after closure
- minimization of environmental impacts
- successful final closure at the end of the Project
- compliance with applicable regulatory requirements

With respect to regulatory compliance, the FTB is designed to minimize adverse impacts to natural resources and otherwise comply with the siting requirements of the MDNR nonferrous mining regulations. In particular, PolyMet has located and designed the FTB to minimize noise, dust, and air emissions, and to avoid major modifications to watersheds and otherwise protect water resources. The FTB also will meet the applicable buffer and vegetation requirements established in the PTM Regulations.

PolyMet designed the FTB, and will construct, operate, and reclaim it to be structurally sound, control air emissions, minimize hydrologic impacts, enhance the survival and propagation of vegetation, and conserve mineral resources, and promote progressive reclamation, in accordance with the requirements of Minnesota Rules, part 6132.2500. Also, PolyMet has designed and proposes to construct, operate, and reclaim the FTB to minimize the potential for a release of reactive mine waste that would adversely impact natural resources in accordance with Minnesota Rules, part 6132.2200.

This section describes the subsurface conditions at the Tailings Basin, including both native soils and the existing LTVSMC tailings basin, and the geotechnical properties of the Flotation Tailings. It then discusses how this information as well as other design criteria inform the FTB design and provides a summary of that design, including the type of dam, the form of tailings storage, and the seepage capture systems. This section then describes the operation of the FTB, focusing on the deposition of tailings and control of tailings basin water. Stormwater management, monitoring, and reclamation are discussed in Sections 11.4.6, 14.3.1, and 15.4, respectively. Together this information is intended to demonstrate the FTB's compliance with the requirements of Minnesota Rules, chapter 6132.

10.2.1 Subsurface Conditions at the Tailings Basin

The subsurface in the Tailings Basin area is composed of native soils and the existing LTVSMC tailings.

10.2.1.1 Native Soils

PolyMet conducted multiple field and laboratory testing programs to determine general geotechnical properties, hydraulic conductivities, and shear strength parameters of the native soils. Appendix 16.15 includes the results of the investigations. Figure 10-1 shows the investigation locations. Table 10-3 provides the shear strength and hydraulic conductivity parameters of the peat and glacial till used in stability analysis.

The overburden in the Tailings Basin area generally consists of native, unconsolidated, surficial deposits of dense silty sand and glacial till. In some areas, the till is overlain by up to 20 feet of peat. Bedrock is encountered ranging from 20 feet to 30 feet below the top of the till stratum.

The most recent geotechnical investigation for the FTB Seepage Containment System in 2014 along the northern and western toe of the existing LTVSMC tailings basin identified the following generalized subsurface conditions along the northern and western toe of the Tailings Basin dams:

- Peat – 0 to 20 feet thick
- Isolated tailings up to 17 feet thick
- Silty sand with clay – 0 to 6 feet thick
- Glacial till – 5 to 37 feet thick interspersed with cobbles and boulders
- Depth to bedrock ranges from 2 to 47 feet below existing ground surface

10.2.1.2 Existing Tailings Basin and LTVSMC Tailings

The FTB will be constructed on the existing LTVSMC tailings basin, and the LTVSMC tailings will be a source of dam construction material. LTVSMC ceased its tailings basin operations in January 2001. Cliffs Erie, which acquired various LTVSMC properties in 2001, is currently responsible for ongoing reclamation and remediation activities under a Consent Decree with MPCA and a MDNR-approved Closure Plan. Ongoing and future remediation and reclamation activities with respect to the former LTVSMC tailings basin are subject to these independent regulatory processes with MDNR and MPCA oversight.

The existing tailings basin was constructed in stages beginning in the 1950s. It was configured as a combination of three adjacent cells, identified as Cell 1E, Cell 2E, and Cell 2W. Construction began with perimeter starter dams followed by placement of tailings from the iron-ore process directly on native material. Perimeter dams, which were unlined, were initially constructed from rock, and subsequent perimeter dams were constructed of coarse tailings using upstream construction methods. Thus, the existing tailings basin dams consist of a shell of LTVSMC coarse tailings above a rock, sand, and gravel starter dam, with intermingling fingers of LTVSMC fine tailings and slimes. The interior of the cells consists primarily of LTVSMC fine tailings and slimes.

Historic and recent geotechnical explorations have been performed at the LTVSMC tailings basin, and multiple in-laboratory material tests have been conducted on LTVSMC tailings samples to determine their general geotechnical properties, hydraulic conductivities, and shear strength parameters. PolyMet utilized this data to aid understanding of how the materials in the FTB will transmit water and perform under load, and in developing its plans for construction of the new FTB dams.

There are five types of LTVSMC tailings as described below.

- LTVSMC coarse tailings – existing material typically located in the shell of the LTVSMC tailings basin, comprised of larger particles of tailings that settled out closer to the dam crest during hydraulic deposition, the outer/upper zone of which was reworked to form subsequent lifts for the LTVSMC dams.
- LTVSMC fine tailings – existing material typically located downstream of the coarse tailings, comprised of mid-size particles that commonly settled out in between the slimes and coarse tailings.
- LTVSMC slimes – existing material typically located near and in the center of the LTVSMC tailings basin, comprised of finer tailings particles.
- LTVSMC fine tailings/slimes – existing material, referring to tailings zones within the central portion of the LTVSMC tailings basin where fine tailings and slimes are so thoroughly interbedded they cannot be individually distinguished.
- LTVSMC bulk tailings – future material to be comprised of borrowed LTVSMC coarse tailings (with occasional inclusions of finer tailings) that will be used to construct the proposed FTB dams.

Table 10-3 and Table 10-4 contain laboratory test results concerning the general geotechnical properties and hydraulic conductivities of the LTVSMC tailings. The shear strength parameters of the LTVSMC tailings were evaluated through review of historic data, testing on undisturbed samples, and in-situ field testing. The shear strength was determined for drained conditions, undrained conditions, and liquefied conditions.

Table 10-3 identifies the shear strength parameters used in the stability analysis of the design of the FTB dams. The Geotechnical Data Package in Appendix 16.15 includes additional discussion of the geotechnical explorations and material testing performed as the basis for the permeability and shear strength of materials used in the seepage and stability evaluation for the FTB.

10.2.2 Properties of the Flotation Tailings

PolyMet's analysis of the geotechnical properties of the Flotations Tailings is based on its study of the Flotation Tailings generated during the pilot-plant processing of Project ore samples. The pilot-plant Flotation Tailings samples are considered representative of the tailings expected from the Beneficiation Plant. PolyMet arranged for laboratory testing of the tailings samples to determine geochemical and geotechnical parameters for use in water quality estimates, FTB planning, slope stability analyses, and staged-construction evaluations.

PolyMet conducted the laboratory tests at the SGS Lakefield facility in Lakefield, Ontario, Canada. Recent modifications to the ore processing plan, such as the addition of a semi-autogenous grinding mill, are not anticipated to significantly change the characteristics of the tailings relative to those derived from the pilot-plant processing.

PolyMet utilized pilot testing at the Lakefield facility to test two different grinds. The first grind was obtained in 2005 and the second grind was obtained in 2010. The 2010 grind is slightly finer than the 2005 grind. Nonetheless, the grinds are relatively similar and the differences between the two are within the anticipated range of gradations that are expected from the PolyMet Beneficiation Plant. Therefore, PolyMet performed testing on both samples, and evaluated the data for general geotechnical properties, hydraulic conductivities, and shear strength parameters required for FTB design.

Several tests were conducted on samples of pilot-plant Flotation Tailings in the laboratory to determine the material's index properties. The index properties describe the physical characteristics of the tailings and their state property (liquid state, plastic state and solid state). Index properties are unique to a material. Table 10-5 summarizes the test results. Additional details on the Flotation Tailings properties are provided Appendix 16.5.

Hydraulic Conductivity of Flotation Tailings

The hydraulic conductivity of a material is a measure of its ability to transmit water when submitted to a hydraulic gradient. The hydraulic conductivities of the Flotation Tailings are used for estimating seepage through the tailings.

The hydraulic conductivity of the Flotation Tailings will depend on depositional conditions. St. Anthony Falls Laboratory conducted a physical model study provided in Appendix 17. The study showed that, while there is some segregation of Flotation Tailings particles by grain size associated with hydraulic deposition, some fine particles are captured within the tailings matrix near the deposition point. Further, the Project deposition points will include multiple spigot locations around the FTB perimeter as well as deposition in the interior portions of the basin. Deposition of tailings within the interior of the FTB will differ from the more routine perimeter spigotting of tailings. PolyMet's proposed method of deposition is expected to minimize the hydraulic segregation of Flotation Tailings. While some segregation will occur during subaerial flow from the spigots, significant amounts of fines will be captured within the material matrix. Therefore, the Flotation Tailings were treated as a single material in modeling, rather than defining parameters for coarser and finer portions of the tailings.

Table 10-6 provides the results of the laboratory testing for hydraulic conductivity of the Flotation Tailings. Three different values for hydraulic conductivity were used in seepage modeling, based on the different expected hydraulic conductivity values at depth.

Shear Strength of Flotation Tailings

Appendix 16.15 describes the testing of the shear strength of the Flotation Tailings, which was evaluated through testing on bulk samples. Shear strength parameters were determined by performing triaxial compression tests on the samples under drained and undrained conditions. The data collected through triaxial testing were processed and used in selection of shear strength parameters. It was conservatively assumed that all Flotation Tailings are contractive and thus, liquefiable. The strength estimates are conservative because it is possible that some portion of the deposit will not be contractive, and thus, would not liquefy and would mobilize higher strengths.

Table 10-3 provides a summary of the geotechnical parameters used in seepage and slope stability analysis.

10.2.3 Design of the Flotation Tailings Basin

The FTB location and design are driven by multiple factors, including the geochemical and geotechnical properties of the Flotation Tailings and LTVSMC tailings, the existing site surface and subsurface conditions, the environmental setting of the Tailings Basin, FTB capacity requirements, in-basin hydrology, seepage water quality, and regulatory requirements.

Project-specific design and operating objectives include:

- using the existing LTVSMC tailings basin within the existing footprint for the FTB to minimize land disturbance and wetland impacts
- using existing coarse LTVSMC tailings for FTB dam construction to minimize borrow source development
- minimizing ongoing seepage to the environment from the LTVSMC tailings basin and the potential for future seepage from the FTB by installing seepage capture systems
- maximizing subaqueous disposal of tailings to minimize oxidation and potential water quality impacts from the Tailings Basin

To design the FTB and the FTB dams, PolyMet engaged independent professional engineers, registered in the state of Minnesota who are proficient in the design, construction, operation, and reclamation of tailings basins, dams, and reactive mine waste. The FTB design process evaluated alternative dam construction and tailing-disposal methods. The selected dam design utilizes the upstream construction method with use of existing LTVSMC coarse tailings to form the exterior shell of the dam. The LTVSMC tailings that will underlie the FTB will allow the deposited

Flotation Tailings to drain easily, are of suitable strength as a foundation for subsequent dam raises, and are sufficiently permeable to minimize phreatic water level increases within the dams.

The following subsections provide an overview of the FTB design requirements and overall design plans.

10.2.3.1 Storage Volume

PolyMet will generate approximately 11 million short tons of Flotation Tailings annually (approximately 10 million in-place cubic yards annually). Table 10-7 and Figure 10-2 present stage-storage calculations and relationships. The permit application support drawing set contained in Appendix 6 contains the layout plan and design of the FTB.

10.2.3.2 Geotechnical Stability

PolyMet will construct and operate the FTB in a manner that is estimated to achieve desired slope stability factors of safety, and in turn, immediate and long-term stability. Achieving the desired factors of safety is an iterative design process wherein the geometry of the dam, the seepage conditions within the dam, and the material characteristics of the dam foundation, the dam, and the tailings are analyzed in concert to arrive at a dam configuration of adequate stability. The design of the FTB dams is based on seepage and slope stability analyses of:

- the existing LTVSMC tailings basin
- the Tailings Basin, including the FTB dams at maximum height
- the Tailings Basin, including the FTB dams during construction
- the Tailings Basin, including the FTB dams subject to various potential liquefaction triggering events
- a flow liquefaction worst case scenario
- the Tailings Basin, including the FTB dams during closure and postclosure maintenance

Data used in these analyses, the methods used for seepage and stability modeling, the approach for selection of material strength design parameters, and modeling outcomes are presented Appendix 16.15.

The stability modeling determined that PolyMet's proposed Tailings Basin design meets required factors of safety for all expected conditions:

- existing conditions at the LTVSMC tailings basin (before the FTB is constructed)
- interim conditions (while the FTB is under construction), with normal operating conditions
- maximum height, with normal operating conditions of the Tailings Basin
- maximum height, with normal closure and postclosure maintenance conditions of the Tailings Basin

PolyMet's modeling also determined that the proposed Tailings Basin design meets required factors of safety for a series of possible, but increasingly less likely, conditions:

- maximum height, with a plugged drain, a rapid load, or erosion
- maximum height, with an unknown triggering event causing all contractive materials to liquefy
- maximum height, with a seismic event

To assess how these results might be affected by uncertainty and variability in the soil strength values, a sensitivity analysis was conducted. Sensitivity analysis results show the following:

- the likelihood that the factor of safety (FOS) is less than the required value when the dam is at maximum height, under normal operating conditions, is 0%
- cumulative probability that the FOS is less than the required value when the dam is at maximum height, with an unknown triggering event causing all contractive materials to liquefy, is less than 5%
- the likelihood of a dam failure would be many orders of magnitude smaller than the likelihood that the required FOS is exceeded

Slope stability analyses were carried out for critical dam cross-sections (F, G, and N) shown on Figure 10-3 with stratigraphy or soil profiles interpreted from boring information. Table 10-8 provides a summary of slope stability safety factors computed for each component of the stability analysis.

PolyMet will configure the FTB dams to have a FOS equal to or greater than 1.3 for undrained shear strength analysis of yield ($USSA_{yield}$) conditions and equal to or greater than 1.5 for effective strength stability analysis (ESSA) conditions. The FTB dam designs have an overall FOS equal to or greater than 1.1 against liquefaction triggering and equal to or greater than 1.1 for the worst-case fully liquefied shear strength analysis of liquefaction ($USSA_{liq}$) baseline case (at end of operations). To achieve stability required for the $USSA_{yield}$ condition, PolyMet incorporated a toe-of-dam buttress, underdrain, and mid-slope setback into the dam design; these are all common design features used for modifying dam stability. To achieve stability required for the $USSA_{liq}$ condition, the FTB design also incorporates internal shear walls within the existing LTVSMC slimes and fine tailings previously deposited in Cell 2E. The shear walls will be constructed using cement deep soil mixing (CDSM).

CDSM consists of drilling borings with an auger to inject cement into the slimes/fine tailings layer, where it will mix with the tailings to form overlapping, 3-foot diameter, columns parallel to the existing flow paths. The resulting interlocking cement-tailings columns will produce a shear wall to increase geotechnical stability and the overall resistance to slope movement. This design feature is included specifically to address the slope stability analysis modeling scenario wherein an unknown trigger causes the saturated LTVSMC and PolyMet tailings to liquefy. Even though a potential liquefaction-inducing trigger has not been identified, such an occurrence is still included in the overall slope stability analysis. Figure 10-4 contains a schematic of the CDSM shear wall. The permit application support drawings provided in in Appendix 6 identify the locations and typical details of the CDSM shear walls. The shear walls will be installed during the Construction Phase.

Finally, during construction of FTB dams, PolyMet will amend the exterior face of the dams with a bentonite layer. The bentonite layer will limit oxygen infiltration into the contained Flotation Tailings. The amendment will also reduce rainwater infiltration into the dams, which has a benefit in terms of increased slope stability safety factor, as shown on Drawing No. FTB-024 provided in Appendix 6.

10.2.3.3 Freeboard Requirements

The FTB design incorporates the freeboard required for the FTB to safely accommodate precipitation events without overtopping the dams. PolyMet conducted a hydrology study to determine the water (pond) level bounce (increase in stage due to flood flow or storm event) in the FTB Pond during the probable maximum precipitation (PMP), 1/3 PMP, and 2/3 PMP events. The hydrology study report is included as Attachment A of the Flotation Tailings Management Plan (Appendix 16.7). The elevation difference between the maximum pond elevation and planned dam elevation will yield freeboard ranging from 5.25 feet (for full PMP) to 26.5 feet (for 1/3 PMP) on the basis of the assumed starting water level elevations. PolyMet will manage the water level so that minimum freeboard, (i.e., 5.25 feet) will not be exceeded during operation.

The probability of a PMP event occurring during Project operations and reclamation is very low. The PMP does not have an assigned return period, but it is usually assumed by hydrologists to be on the order of 100 million to 10 billion years. Based on extrapolation of 72-hour rainfall depth data from United States Weather Bureau-Office of Hydrology Technical Paper TP 49, and the assumed return period of the PMP of 100 million years, a 1/3 PMP event could occur roughly once in 1,000 years and a 2/3 PMP could occur once in 500,000 years. Hence, despite the fact that pond elevations cannot be quickly adjusted in anticipation of a PMP event and elevations may vary from those used for the pond bounce computations, the probability of an emergency discharge occurring during the 20-year operating life of the FTB and prior to the cessation of WWTP operations is very low.

10.2.3.4 FTB Seepage Capture Systems

Water management is a key component of overall Flotation Tailings management. Within or surrounding a tailings basin, seepage containment or collection systems can serve several purposes, including water level control within the dams, and/or water collection for water quality purposes. For the FTB, seepage containment and collection is for water quality purposes, and for recycling water for process water needs, not for improvement of slope stability. The FTB seepage capture systems for this Project include both the FTB Seepage Containment System and the FTB South Seepage Management System, as described below.

The FTB Seepage Containment System will surround the western and northern sides of the Tailings Basin. A discontiguous segment will be built along a portion of the eastern side. Along the remaining portion of the eastern side of the Tailings Basin, high bedrock will prevent groundwater seepage. The FTB Seepage Containment System will collect tailings basin seepage via surface and shallow groundwater flow, as well as runoff from the exteriors of the north, west, and east dams and from the small area between the toes of the dams and the FTB Seepage Containment System.

The seepage containment system will consist of a cutoff wall (a low permeability hydraulic barrier) installed in the existing overburden soils down to bedrock, with a drainage collection system installed on the upgradient side. The drainage collection system will have a collection trench filled with granular drainage material and perforated drain pipe located near the bottom of the trench. Vertical risers extending aboveground surface from the drain pipe will collect surface seepage discharging upgradient of the containment system. The seepage containment system will also include a series of subsurface gravity drain pipes, sumps, and lift stations installed between the cutoff wall and the toe of the Tailings Basin dam. Water collected in the FTB Seepage Containment System will be conveyed to the FTB Pond or the WWTP.

The FTB Seepage Containment System will draw down the water table on the tailings basin side of the cutoff wall, maintaining an inward gradient and mitigating the potential for tailings basin seepage to pass through the cutoff wall (i.e., any seepage through the cutoff wall would be inward into the FTB Seepage Containment System). PolyMet will extend the cutoff wall to bedrock in order to minimize the amount of water drawn inward.

Figure 10-5 shows a conceptual layout and cross-section of the FTB Seepage Containment System. PolyMet carried out a geotechnical investigation along the alignment of the proposed FTB Seepage Containment System in 2014 to address design requirements. The FTB Geotechnical Data Package contains the results of the investigation and is provided in Appendix 16.15. Figure 10-1 identifies the boring locations. Appendix 6 contains the FTB Seepage Containment System permit application support drawings.

Along the southern side of the Tailings Basin, bedrock and surface topography create a narrow valley at the headwaters of Second Creek. Due to this topography and experience on the site, it is expected that existing seepage to the south from the Tailings Basin will emerge as surface seepage within a short distance of the embankment toe. An existing seepage management system, which is part of the Cliffs Erie Consent Decree, currently captures seepage leaving the LTVSMC tailings basin to the south. This system consists of a cutoff berm and trench placed approximately 200 to 250 feet downstream of the seepage face. A seepage collection sump, pump, and pipe system is being used to route this seepage back into the LTVSMC tailings basin pond.

PolyMet is working with Cliffs Erie and MPCA to evaluate possible improvements to this system that in turn will be incorporated into the FTB South Seepage Management System for collection of seepage during Project operations. During operations, PolyMet will pump seepage collected by the FTB South Seepage Management System to the FTB Pond or to the WWTP.

10.2.4 Dam Construction

The overall configuration of the FTB is based on multiple factors. These considerations include the mining plan, the initial and long-term stability of the existing and proposed dams, materials available for dam construction, phased development of the dams to aid in maintaining stability, water management requirements, and reclamation requirements. The permit application support drawings contained in Appendix 6 depict the sequential development of the FTB. Table 10-7 summarizes the FTB capacity and the staged construction design elevations along with the constructed dam material volumes and FTB capacity. Figure 10-6 shows the overall FTB development from existing conditions through Mine Year 20. This includes the FTB staged dam crest elevations and the tailings elevation in relation to the LOM.

Construction of the FTB dams will occur in increments over the 20-year operating life of the mine. PolyMet will construct the dams, via the upstream construction method, using routine earthwork techniques consisting of borrowing nearby LTVSMC coarse tailings, and placing the tailings in lifts with compaction to specified density to yield the desired dam lift height, geometry and strength. A bentonite amended oxygen barrier layer (at a depth of 30 inches from the surface of the dams) will be added on exterior sides of dams as part of construction. PolyMet will construct the dams in eight lifts (stages), with an approximate final crest elevation of 1,732 feet above mean sea level (amsl). Each lift of the FTB dams will consist of a 200-foot wide base with 4.5H:1V slopes on the outside of the FTB and 2H:1V slopes on the inside. The dams will be constructed of individual lifts 20 feet high. The dams will require approximately 18 million cubic yards of construction material to build the dams to the crest elevations required to store Flotation Tailings generated during the LOM. Appendix 6 contains the FTB permit application support drawings.

The historic and recent testing of the LTVSMC tailings discussed above demonstrates that these materials are suitable for construction of the FTB dams in compliance with applicable regulatory requirements, including both dam safety permitting and the nonferrous PTM regulations. Stage-volume calculations also demonstrate that the volume of LTVSMC coarse tailings readily available can meet this anticipated demand - there are roughly 20 million cubic yards of LTVSMC coarse tailings available. Drawing FTB-003 in Appendix 6 identifies the locations of the LTVSMC coarse tailings borrow. The tailings borrow will be mechanically placed and compacted.

10.2.5 Operation and Maintenance of the FTB

The operation of the FTB will begin when the Beneficiation Plant begins operation. The operational aspects include the control of processing through the various stages of the flotation process, the Flotation Tailings transportation and deposition system, the return water system, general maintenance, and winter operation. The Management and Monitoring Plan for the FTB is outlined in Appendix 12.

Flotation Tailings deposition is expected to begin in Cell 2E and last for approximately seven years, after which the Cell 2E elevation will reach the elevation of Cell 1E and the two cells will merge. From Mine Year 7 through the remainder of operations, PolyMet will deposit Flotation Tailings in the merged cell, Cell 1/2E.

PolyMet will deposit the Flotation Tailings in slurry form through a system of pumps and moveable pipelines. Flotation Tailings will be deposited by gravity flow over beaches when necessary and otherwise subaqueously via movable diffusers throughout the FTB Pond. The Flotation Tailings will settle out of the slurry, and the decanted water be returned to the beneficiation process by a barge pumpback system. PolyMet will move the return water pipelines as dams are raised to keep the pipelines at or near the top of the dam. Figure 10-7 shows stages of the development of the FTB.

10.2.5.1 Dam Classification

Under Minnesota Rules, part 6115.0340, dams are regulated by MDNR based on specified hazard classifications. MDNR has established the hazard classification for the FTB dams, and, as provided by Minnesota Rules, part 6115.0340, the classification is used to partially define FTB dam permitting, inspection, and reporting requirements applicable to the Project. PolyMet is applying for an MDNR-administered Dam Safety Permit for the Project that will contain information regarding the classification of the FTB and the basis for such classification.

10.2.5.2 Dam Safety Inspections

PolyMet's geotechnical monitoring activities will include regular dam safety inspections. Appendix 16.7 includes an FTB Dam Safety Inspection Plan to meet the requirements of Minnesota Rules, part 6132.2200, subpart 2, item C(3) and 6132.2500, subpart 2, item B(7).

10.2.5.3 Contingency Action Plan

PolyMet has prepared a contingency action plan (CAP) to provide initial guidance to on-site personnel and emergency responders in the case of unplanned occurrences, such as the threat of dam failure at the FTB. The CAP contained in Appendix 16.7 identifies and specifies initial actions in response to a variety of occurrences representing differing levels of severity and complexity.

10.3 Hydrometallurgical Residue Facility

PolyMet will utilize hydrometallurgical processing to recover metals from concentrate and the combined Residue will be placed in the HRF. The HRF will be a single cell constructed with a double liner system consisting of a geomembrane and geosynthetic clay liners. The Residue will settle out within the HRF and the decanted process water will be pumped from the HRF back to the Hydrometallurgical Plant. The HRF is designed to be a closed-loop system with water lost only to evaporation from the cell surface and entrapment within the Residue’s pore space.

PolyMet will construct the HRF on top of the historic LTVSMC Emergency Basin located to the northwest of the Plant Site ore processing facilities and near the southwest corner of the Tailings Basin. Figure 10-8 shows the location of the HRF. The permit application support drawings contained in Appendix 7 provide detailed information on the design of the HRF.

Depending on a variety of factors, including market demand, the Hydrometallurgical Plant will begin operation several years after mining commences. Once this operation begins, PolyMet will generate approximately 313,000 tons of Residue annually. The Residue will be a slurry of fine sand, silt, and clay-size particles, with individual particle diameter on the order of 0.5 mm or less. The HRF may also accept solids from water treatment and coal combustion residuals (coal ash) from an existing coal ash landfill near LTVSMC tailings basin Cell 1E.

The HRF is designed to minimize adverse impacts to natural resources and otherwise comply with the siting requirements of the MDNR nonferrous mining regulations. In particular, PolyMet has located and designed the HRF to minimize noise, dust, and air emissions, and to avoid major modifications to watersheds and otherwise protect water resources.

PolyMet designed, and will construct, operate, and reclaim the HRF to be structurally sound, control air emissions, minimize hydrologic impacts, enhance the survival and propagation of vegetation, conserve mineral resources, and promote progressive reclamation, in accordance with the requirements of Minnesota Rules, part 6132.2500. Also, because PolyMet's management of the Residue must take into account reactive mine waste, the HRF is designed and will be constructed, operated, and reclaimed so that such waste does not impermissibly release constituents of concern that would have adverse impacts on natural resources in accordance with Minnesota Rules, part 6132.2200.

This section provides an overview of Residue management and describes the design of the various components of the HRF such as foundation preparation, dams, and liner requirements. Water monitoring for the HRF is discussed in Section 14 and reclamation of the facility and closure is discussed in Section 15. Together this information is intended to demonstrate the HRF's compliance with the requirements of Minnesota Rules, chapter 6132.

10.3.1 Subsurface Conditions at the HRF

PolyMet advanced several borings in the vicinity of the proposed HRF to characterize the HRF foundation soils. The Geotechnical Data Package provided in Appendix 16.16 includes the results of the investigation. Figure 10-1 identifies the investigation locations. In General, subsurface conditions are similar to those described for the FTB in Section 10.2.1. As discussed further in Section 10.3.3.5, the former Emergency Basin will be preloaded to consolidate the HRF foundation soils and achieve adequate strength for construction.

10.3.2 Properties of Hydrometallurgical Residue

Geotechnical testing of the Hydrometallurgical Residue included grain-size and hydrometer analysis, Atterberg Limits determination, hydraulic conductivity tests, determination of specific gravities of various residue components, and a consolidation test on a sample of the combined Residue. Section 10.1.3.5 summarizes the geochemical characterization of the Hydrometallurgical Residue.

Table 10-9 summarizes the recommended geotechnical design parameters for the Hydrometallurgical Residue Facility, and includes the test results of the in-place dry density of the Residue. Table 10-10 presents the weighted average specific gravity of the combined Residue.

10.3.3 Design of Hydrometallurgical Residue Facility

To design the HRF, including its dams, PolyMet engaged independent professional engineers, registered in the state of Minnesota who are proficient in the design, construction, operation, and reclamation of tailings basins, dams, and facilities for storage of reactive mine waste. The design of the HRF is based on a number of factors including Residue properties, HRF capacity requirements, the environmental setting and site conditions, hydrology, geotechnical considerations (slope stability, strain in liner system, and leakage), HRF operating plans, and applicable regulatory requirements, including Minnesota Rules, parts 6132.2200 and 6132.2500 requirements.

Based on a review of historical data, a study of the Residue properties, and geotechnical evaluations, it is feasible to construct the HRF on the historic LTVSMC Emergency Basin site. Consistent with Minnesota Rules, part 6132.2000, subpart 5, item G, which establishes a preference for use of former mining areas, PolyMet will construct the HRF on mostly disturbed ground previously used by LTVSMC, and will take advantage of existing topographic features to reduce the material needed for dam construction.

To manage water resource impacts, the HRF will have a double liner system and a Leakage Collection System, and an additional Drainage Collection System and cover system at closure. These systems are designed to meet the requirements of Minnesota Rules, part 6132.2200, subpart 2, item B(2) regarding the prevention of water moving through reactive mine waste and collection and disposal of residual waters draining from reactive mine waste. Under the HRF design, leakage is considered water that leaks through the upper layer of the double liner system, but to the extent there is such leakage, virtually all of it will be captured by the Leakage Collection System and the lower layer of the double liner system. The HRF will also have a drainage collection system that will be used during reclamation to speed Residue dewatering. Drainage is considered water that flows through the Residue and is collected above the upper layer of the liner system. The following subsections provide an additional overview of the HRF design. Additional details including permit application support drawings for the HRF are provided in Appendix 7.

10.3.3.1 Dam Design

PolyMet will construct the HRF dams using downstream construction methods wherein the interior segments of each dam are constructed first, and then the dam is raised upward and outward from the center of the cell as additional HRF capacity is needed. The permit application support drawings contained in Appendix 7 show the dam development in plan view and cross-section.

The maximum height of each of the proposed dams is approximately 85 feet with a crest elevation of 1,650 feet amsl. PolyMet will construct the dams using soil borrow and possibly quarried rock from the hills adjoining the HRF to the southeast and southwest. PolyMet may also utilize LTVSMC coarse tailings if needed to supplement the other borrow sources. Southeast and southwest segments of the HRF dam will abut existing high ground. The northern HRF dam will abut Tailings Basin Cell 2W. The construction material will be placed in thin lifts approximately 12 to 18 inches in loose lift thickness and compacted to a minimum of 95% of their standard Proctor maximum dry density (ASTM D698).

PolyMet will raise the HRF dams and extend the liner in stages to allow for Residue deposition for the life of the cell. Exterior dam slopes will be 3H:1V to achieve adequate slope stability and to facilitate long-term maintenance. Interior dam slopes will be 4H:1V to facilitate cell liner construction and to achieve adequate liner stability. PolyMet will raise the dams in three primary construction phases as presented in Table 10-11. Thirty-foot horizontal benches will be provided at elevation 1,600 and 1,630 feet amsl. This design will accommodate phased liner installation. Because the dams for the HRF will be constructed in major increments before and during operations, PolyMet will relocate Residue discharge points into the cell as frequently as needed to utilize the full capacity of the cell, thereby extending the time between dam rises.

10.3.3.2 Geotechnical Stability

PolyMet carried out slope stability analyses for HRF dam design in accordance with the MDNR-approved Geotechnical Modeling Work Plan, provided in Appendix 16.16. The HRF perimeter dams were designed to meet a minimum FOS of 1.5 for ESSA. PolyMet used substantially the same analytical processes and relevant data discussed above regarding slope stability analyses for the FTB.

Stability analyses were carried out for the most critical section of the HRF southern dam and northern dam. In particular, the intermediate lifts of the HRF development and the end of operations configuration of the HRF were analyzed for all dam sections.

Table 10-12 summarizes the results of slope stability analysis. The detailed analysis is provided in Appendix 16.16. In summary, the analysis demonstrates that the HRF dams will be stable during all lifts. In view of these results, further analysis such as pseudostatic slope stability analyses were determined to be unnecessary.

Material in the constructed dams will be well compacted and the HRF liner system will preclude leakage through the dams. Therefore, PolyMet, with the concurrence of MDNR, did not perform undrained shear strength analysis (USSA) and liquefaction analyses. Appendix 16.16 discusses the basis for these conclusions in detail.

10.3.3.3 Double Liner System

The HRF will include a double liner system, which will consist of two barrier layers separated by a leakage collection layer. The liner cross-section, shown on Figure 10-9, will consist of:

- Drainage collection layer – granular drainage layer and geocomposite drainage net (geocomposite)
- Upper liner – 80-one thousandth of an inch (mil) linear low density polyethylene (LLDPE) geomembrane
- leakage collection layer – geocomposite drainage net (geocomposite)
- Lower liner – 60-mil LLDPE or high density polyethylene (HDPE) above a geosynthetic clay liner (GCL). The lower liner, with two barrier layer components (geomembrane liner and GCL) is commonly referred to as a composite liner.

The double liner system provides built-in redundancy and improved performance compared to that of a single liner or composite liner, and will be installed under an approved quality control plan to minimize installation defects. The following subsections describe the function of each component of this double liner system. Additional details are provided in Appendix 16.8.

Drainage Collection System

PolyMet will install the Drainage Collection System during the HRF construction. It will not be activated, however, until reclamation. Its purpose will be to accelerate dewatering. The Drainage Collection System is discussed in more detail in Section 15.4.2.3.

Upper Liner

The upper liner serves as the primary barrier to leakage from the HRF. Its thickness was selected for durability and to resist ice impacts in the event of a temporary shutdown of the hydrometallurgical process in winter months.

Leakage Collection System

The Leakage Collection System consists of granular drainage layer and geocomposite drainage net placed between the upper and lower liners. PolyMet designed the Leakage Collection System to intercept and recover substantially all of the leakage from the upper liner so that it will not reach the environment.

Lower Liner

The lower composite liner provides a virtually leak-free barrier to prevent leakage that may pass through the upper liner from leaving the HRF. Leakage retained above the lower liner will be collected by the Leakage Collection System.

The Leakage Collection System will discharge to a sump and pump system on the northwest side of the cell. PolyMet will install the Leakage Collection System during construction of the HRF and activated at the time its operation commences. Figure 10-9 illustrates the Leakage Collection System, which is further detailed in the permit application support drawings contained in Appendix 7.

During the time the HRF is in operation, the Leakage Collection System will recycle leakage back into the HRF pond. During reclamation, closure, and postclosure maintenance, the Leakage Collection System will continue to operate, and any leakage will be routed to the WWTP for treatment, although leakage will decrease after installation of the HRF final cover system during closure (Figure 10-10). The HRF final cover is described in Section 15.4.2.3.

10.3.3.4 Performance of GCL Liner

The selection of the GCL component of the HRF liner system will take into account the chemical properties of the Residue. PolyMet conducted a series of tests to evaluate the adequacy of performance of a GCL permeated by leachate from the Residue. This information is discussed in the Residue Management Plan that is provided in Appendix 16.8, which contains the results of the hydraulic conductivity testing performed on the liner are provided in. The test results indicate that the GCL performed well, with long-term hydraulic conductivities at or below approximately 1.5×10^{-9} centimeters per second (cm/sec).

PolyMet further conducted another series of tests to demonstrate adequacy of performance of a GCL permeated by leachate (Appendix 16.16). The test results indicate that the GCL performed well, with long-term hydraulic conductivities at or below approximately 1.5×10^{-9} cm/sec.

10.3.3.5 Liner System Strain Management

Adequate long-term performance of the HRF liner system will depend in part on its ability to tolerate the strain that it will undergo during the life of the facility. Strain is a measure of the change in length of a segment of liner relative to its original length expressed as a percentage.

The majority of strain on the liner system will be due to settlement of the foundation materials. To minimize strain due to settlement, PolyMet will place a preload to consolidate sediments in the historic LTVSMC Emergency Basin before constructing the HRF liner system and the dams. Before placement of the preload, a seepage collection drain will be installed in the footprint of the HRF. If the construction program does not allow timely consolidation of the sediments, a system of wick drains can be installed to accelerate the process. The purpose of the seepage collection drain and wick drains is to dissipate excess pore water pressure to consolidate sediments during preloading, and to dissipate future excess pore-water pressures in the HRF foundation for stability.

Appendix 16.16 includes the HRF Geotechnical Data Package. This document includes information relating to the design and modeling of the preload in the HRF. PolyMet will remove the preload once materials in the basin have been adequately consolidated. The estimated maximum settlement of the foundation material is 3.9 feet. The estimated further settlement of the foundation materials at the end of operation of the HRF is 1.4 feet.

During the preloading operation, a professional engineer registered in the state of Minnesota will monitor the settlements and confirm the removal of the preload fill per the requirements of Minnesota Rules, part 6132.2400, subpart 2, item A(1).

The maximum strain in the liner system is estimated to be 0.20% (Appendix 16.8), which is well below tolerable limits of most geosynthetics. Table 10-13 and the permit application support drawings contained in Appendix 7 include information relating to this strain analysis.

10.3.4 Operation and Maintenance of the HRF

Residue deposition in the HRF will commence when the Hydrometallurgical Plant begins operation. The HRF will function as a large-scale sedimentation basin. A pond will be maintained within the cell such that the solid fraction of the slurry (the Residue) settles out within the cell, while the majority of the liquid fraction is recovered and returned to the Hydrometallurgical Plant for reuse. The levels of both the solids and liquid within the cell will increase incrementally over time.

10.3.4.1 Dam Classification

Under Minnesota Rules, part 6115.0340, dams are regulated by MDNR based on specified hazard classifications. MDNR has established the hazard classification for the HRF dams, and, as provided by Minnesota Rules, part 6115.0340, the classification is used to partially define HRF dam permitting, inspection, and reporting requirements applicable to the Project. PolyMet is applying for an MDNR-administered Dam Safety Permit for the Project that will contain information regarding the classification of the HRF and the basis for such classification.

10.3.4.2 Dam Safety Inspections

PolyMet's geotechnical monitoring activities will include regular dam safety inspections. Appendix 16.8 includes an HRF Dam Safety Inspection Plan to meet the requirements of Minnesota Rules, part 6132.2200, subpart 2, item C(3) and 6132.2500, subpart 2, item B(7).

Contingency Action Plan

PolyMet has prepared a CAP to provide initial guidance to on-site personnel and emergency responders in the case of unplanned occurrences, such as the threat of dam failure at the HRF. The CAP contained in Appendix 16.8 identifies and specifies initial actions in response to a variety of occurrences representing differing levels of severity and complexity.

10.4 Management of Overburden, Waste Rock, and Ore in Stockpiles and the East Pit

PolyMet will manage overburden, waste rock, and ore to provide stable and safe storage of the Project's excavated materials in a manner that results in compliance with safety, mining, and environmental regulations. Figure 10-11 shows the layout and developments of the overburden and waste rock stockpiles throughout the life of the mine. Table 10-14 shows the waste rock production and placement schedule based on the mine plan described in Section 7. A graphical representation of the waste rock placement through the LOM is shown on Figure 10-12. This section provides an overview of the stockpile designs and material management practices to be employed at the Project.

PolyMet will stockpile overburden, waste rock, and ore in storage facilities as shown on Figure 10-11, which depicts the Mine Site in various stages of its 20-year life. These proposed stockpiles include the following:

- OSLA
- Category 1 Waste Rock Stockpile
- Category 2/3 Waste Rock Stockpile
- Category 4 Waste Rock Stockpile
- OSP (although not a stockpile, the OSP is discussed with the stockpiles due to similar design features)

The stockpile designs address specific requirements for the materials being stored as follows:

- The OSLA will have one or more temporary stockpiles of unsaturated mineral overburden and peat that may be suitable for a variety of uses during the LOM. These stockpile designs are consistent with that of typical stockpiles used for construction materials and are unlined.
- The Category 1 Waste Rock Stockpile has provisions for a groundwater containment system appropriate for the material type and for its permanent nature.
- The Categories 2/3 and 4 Waste Rock Stockpiles are temporary structures that will store potentially acid-generating material and are designed with composite liners and leachate collection systems.
- The OSP, a temporary surge pile, provides ore storage capacity to assist in a steady and reliable supply of ore to the Beneficiation Plant. It will have a composite liner and leachate collection system.

The OSLA will be located southeast of the West Pit. The Category 1 Waste Rock Stockpile, which will remain after closure, will be located to the north of the West Pit. The Categories 2/3 and 4 Waste Rock Stockpiles are temporary stockpiles that PolyMet will remove before mine closure. The Category 2/3 Waste Rock Stockpile will be located in the eastern portion of the Mine Site, south of the East Pit. The Category 4 Waste Rock Stockpile will be located between the East Pit and West Pit. The OSP will be located between the Category 2/3 Waste Rock Stockpile and the RTH, and will be removed upon mine closure.

Figure 10-11 shows the proposed layouts and development of the stockpiles for the following intervals: Mine Years 1, 11, 20, and the postclosure maintenance period. Mine Year 11 reflects the year when the mine's footprint is expected to be at its largest extent: PolyMet expects to have completed mining in the East Pit, commenced mining in the Central Pit, backfilled the Category 4 Waste Rock Stockpile into the East Pit, and established the maximum footprints of the Categories 1 and 2/3 Waste Rock Stockpiles and the West Pit. Mine Year 20 represents the end of mining: PolyMet will have established the ultimate depths and extents of the West Pit and maximum height of the permanent Category 1 Waste Rock Stockpile, and will have relocated the temporary Categories 2/3 and 4 Waste Rock Stockpiles to the East Pit. Table 10-15 provides estimates of the approximate area, height, and elevation each stockpile at its maximum size.

10.4.1 Regulatory Summary

PolyMet prepared its plans to manage overburden, waste rock, and ore to comply with the nonferrous PTM regulations. PolyMet retained an independent professional engineer, registered in the state of Minnesota, and proficient in the design, construction, operation, and reclamation of mining facilities, in connection with the location and design of the stockpiles.

The stockpile location and design are driven by multiple factors, including the environmental setting and site conditions, engineering and other technical criteria, the mining plan, and regulatory requirements. With respect to such regulatory matters, the stockpiles for the Project are designed to minimize adverse impacts to natural resources and otherwise comply with the siting requirements of the nonferrous mining regulations. In particular, PolyMet has located and designed the stockpiles to minimize noise, dust, and air emissions, and to avoid major modifications to watersheds and otherwise protect water resources. The stockpiles are designed to meet the applicable buffer and vegetation requirements established in the PTM Regulations.

PolyMet has designed, and will construct, operate and reclaim the stockpiles to be structurally sound, minimize hydrologic impacts, control erosion, enhance the survival and propagation of vegetation, and conserve mineral resources, and for permanent stockpiles, to promote progressive reclamation, in accordance with the requirements of Minnesota Rules, part 6132.2400. Also, because PolyMet's management of ore, waste rock, and overburden must take account reactive mine waste, PolyMet's stockpiles have been designed and will be constructed, operated and reclaimed so that waste does not release constituents of concern that would have adverse impacts on natural resources in accordance with Minnesota Rules, part 6132.2200.

The remainder of this section provides additional information as to how PolyMet will comply with specific requirements of Minnesota Rules, chapter 6132 relating to management of overburden, waste rock, and ore. This discussion includes information relating to both the use of overburden and waste rock, and the management, storage and disposal of such materials in stockpiles and elsewhere at the Mine Site. Appendix 4 provides the permit application support drawings for the Categories 1, 2/3, and 4 Waste Rock Stockpiles, Ore Surge Pile, and Category 1 Stockpile Groundwater Containment System.

10.4.2 Overburden Management

The Project will generate three types of overburden material: unsaturated mineral overburden, saturated mineral overburden, and peat (organic soils). Each type of overburden will be managed according to its characteristics.

Maximizing the use of overburden for construction and operation activities is typically beneficial. Appendix 16.12 provides outlined plans for segregating, using, and storing overburden materials. Unsaturated mineral overburden is the glacial material naturally in place above the water table. PolyMet's waste characterization results show that unsaturated mineral overburden has been oxidized so that metals have already been released and this material is suitable for general construction purposes. PolyMet will generally store unsaturated mineral overburden that exceeds immediate construction and reclamation needs in the OSLA. This storage will be similar to a typical stockpile on a construction site.

Saturated mineral overburden is the material that exists below the water table. It has not been exposed to air and is unoxidized, and therefore, will be used for more limited and specific on-site construction applications. PolyMet will place the saturated mineral overburden not used for construction with the other materials in the temporary waste rock stockpiles built with membrane liners or directly into the East Pit once mining in that pit has ceased.

PolyMet will use peat removed during Project construction or operation for reclamation activities. Peat will be segregated from the other overburden materials and stored in the OSLA or locations near planned reclamation sites.

10.4.2.1 Properties of Overburden

PolyMet performed a series of geotechnical investigations at the Mine Site. Figure 10-13 identifies these investigation locations. Investigation results and design details for the stockpiles are provided in the Stockpiles Geotechnical Data Package in Appendix 16.17. The overburden generally will consist of native, unconsolidated, surficial deposits of dense silty sand and glacial till. In low lying areas, the till is overlain by up to 15 feet of peat. The bedrock surface within the open pit footprints occurs at depths ranging from 8 feet to over 28 feet below the existing ground surface.

Based on the available boring information, the following overburden soils are expected to be encountered at the Mine Site:

Peat or Organic Clay

Peat or organic sandy clay is present in the lowland areas and ranges in thickness from 1 foot to 15 feet.

Silty Sand/Sand Silt

Silty sand and sandy silt comprise the majority of the overburden soils. Gravel and cobbles are also present within the soil. The gain size distribution of the silty sand and sandy silt are:

- Percent fines (-#200 sieve): minimum 19%; maximum 55%; average 30%
- Percent gravel (>#10 sieve): minimum 27%; maximum 52%; average 35%
- PolyMet will initiate a supplemental Mine Site geotechnical investigation to gather additional data on overburden and to confirm its suitability for construction uses. Appendix 17 contains the Geotechnical Investigation Work Plan.

10.4.2.2 Construction and Operations Uses of Overburden

Based on the geochemical analysis to date, the three categories of overburden can be used as described below. Operational overburden management is discussed further in Appendix 16.12.

Unsaturated Mineral Overburden

PolyMet will utilize unsaturated mineral overburden as a general construction material. In order to meet the specifications for certain construction specifications, PolyMet may screen unsaturated mineral overburden prior to use and compact it during construction. Crushing will not be necessary except for occasional granite boulders, which PolyMet may use as haul road cover and railroad ballast. PolyMet will store excess unsaturated mineral overburden in the OSLA or in some instances, near locations for future planned use.

In locations where unsaturated mineral overburden depths are very thin, it may not be practical to excavate the unsaturated mineral overburden separately from saturated mineral overburden. In these cases, PolyMet will treat the excavated mixed soils as saturated mineral overburden.

Saturated Mineral Overburden

Saturated mineral overburden is only usable for specific on-site construction applications. These applications include uses where contact water can be collected, where the material is placed in saturated conditions (i.e., under the water table), and where applicable surface and groundwater standards can be maintained. Figure 10-14 shows five potential uses of saturated mineral overburden. Table 10-16 shows the estimated quantities required for the proposed construction uses of saturated mineral overburden. PolyMet will store saturated mineral overburden in the lined Categories 2/3 and 4 Waste Rock Stockpiles, which are discussed below, or place this material directly into the East Pit at reclamation.

Peat

PolyMet will use peat for restoration and reclamation activities or in wetland reclamation activities. This use may include the development of wetlands in the East Pit and within the reclaimed temporary stockpile footprints. Peat may also be mixed with unsaturated mineral overburden to increase the organic content for reclamation uses, including the cover for the Category 1 Waste Rock Stockpile

10.4.2.3 Long-Term Storage and Disposal of Overburden

PolyMet anticipates that it will not be able to use all of the excavated overburden for construction and operations. Excess and unusable material will require storage and disposal.

Unsaturated Mineral Overburden

As discussed in Section 10.4.2, PolyMet will typically stage unsaturated mineral overburden in the OSLA for use in construction and operations. In some circumstances, PolyMet may place unsaturated mineral overburden in the temporary waste rock stockpiles, discussed below, for ultimate disposal in the East Pit.

Saturated Mineral Overburden

PolyMet at all times will commingle the saturated mineral overburden not used for construction with waste rock in the lined Categories 2/3 and 4 Waste Rock Stockpiles, which are discussed below, or place this material directly into the East Pit. Saturated mineral overburden in the stockpile subgrade could be used as wetland substrate if permanently saturated.

Peat

PolyMet will stockpile peat in the OSLA or in areas near its ultimate reclamation use. If permanent peat stockpiles outside of the OSLA become necessary, they will be built in upland areas with mine water collection similar to that planned for the OSLA and will comply with the design and siting requirements of Minnesota Rules, part 6132.2400, subpart 2(C), which specifically governs overburden stockpiles.

10.4.3 Overburden Storage and Laydown Area

With the exception of saturated mineral overburden, PolyMet will generally manage the overburden removed during Project activities at the OSLA, which will be developed southeast of the West Pit as shown on Figure 10-11. PolyMet will use the OSLA as a temporary staging area to screen, sort, and temporarily store peat and unsaturated mineral overburden for later use.

10.4.3.1 Subsurface Conditions at the OSLA

PolyMet performed geotechnical testing in the vicinity of the OSLA to characterize the foundation soils. The Stockpile Geotechnical Data Package provided in Appendix 16.17 includes the results of the investigation. Figure 10-13 shows the investigation locations. The subsurface conditions in the vicinity of the OSLA can be inferred to consist of native, unconsolidated, surficial deposits of dense silty sand and glacial till underlain by bedrock. PolyMet will initiate a supplemental geotechnical investigation at the Mine Site before commencing construction to gather additional data on subsurface conditions for use in final design. Appendix 17 contains the Geotechnical Investigation Work Plan.

10.4.3.2 Design of Overburden Storage and Laydown Area

PolyMet will grade the OSLA to facilitate drainage around storage and processing areas as shown on Figure 10-15. Grading will direct surface runoff and drainage to an unlined mine water pond in the southeast of the OSLA. PolyMet will pump the collected water to the FTB Pond via the CPS. The OSLA will be unlined, but will be compacted sufficiently to support equipment operation, maximize runoff, and minimize infiltration.

The OSLA Pond was designed to allow for storage of peat within the pond to limit oxidation of the peat and maintain the wetland characteristics of the peat for future reclamation.

Temporary stockpiles within the OSLA will be constructed with a slope not steeper than the angle of repose of the material.

If permanent stockpiles become necessary, PolyMet will configure the stockpile in accordance to Minnesota Rules, part 6132.2400, subpart 2, item C(2) (i.e., no lifts shall exceed 40 feet in height; no bench shall be less than 30 feet wide; interbench slope shall not be steeper than 2.5H:1V; and runoff water shall be temporarily stored on benches or removed by drainage control structures).

10.4.4 Waste Rock Management

This section provides an overview of PolyMet's plans for managing, storing, and disposing of waste rock. It includes a review of regulatory requirements for both the permanent Category 1 Waste Rock Stockpile, the temporary Categories 2/3 and 4 Waste Rock Stockpiles, and the temporary OSP. All stockpiles were designed to store a greater capacity of waste rock than the capacity that is currently estimated to be mined during the LOM to account for refinements to the mine plan that may occur as more information is gathered during mining. The maximum capacity of the waste rock storage areas was analyzed in the FEIS. Information relevant only to the specific types of stockpiles follows in Sections 10.4.5 and 10.4.6.

10.4.4.1 Properties of Waste Rock

The waste rock to be generated by the Project consists of blasted bedrock. Blasted rock typically consists of well graded angular rock fill made up of rock fragments ranging from soil sized particles to boulders. Figure 10-16 shows a simulated blast curve which estimates the particle size distribution of the waste rock. Section 10.1.3.2 provides information concerning the physical and geochemical properties of the waste rock. Appendix 16.12 provides additional detail on waste rock properties.

10.4.4.2 Segregation and Operations

As part of its operations, PolyMet will implement a program of routine inspection and surveying to monitor the waste rock stockpiles to evaluate compliance with PTM Regulations. As part of this monitoring, PolyMet will inspect for irregular surfaces that may be due to minor localized settlements in the stockpiles. PolyMet will address irregular surfaces that could impede surface drainage of the stockpile. In particular, the final grade of the Category 1 Waste Rock Stockpile surface, will allow the installation of the cover system as designed. Appendix 16.12 provides information outlining inspection and surveying of waste rock stockpiles.

10.4.4.3 Waste Rock Stockpile Design

PolyMet designed the waste rock stockpiles and the OSP to comply with Minnesota Rules, part 6132.2400 to minimize hydrologic impacts, be structurally sound, control erosion, and enhance the survival and propagation of vegetation. The permanent Category 1 Waste Rock Stockpile will also be designed to comply with Minnesota Rules, part 6132.2400, subpart 2, item B requirements for final slopes, benches, and lifts, including having a maximum lift of 40 feet, final bench width of 30 feet, and slopes between benches at the angle of repose of the waste rock. The final reclamation slopes for the permanent Category 1 Waste Rock Stockpile are discussed in Section 15.3.1, and depicted in Appendix 4.

PolyMet designed stormwater management and runoff control on active portions of the waste rock stockpiles and OSP to minimize erosion on the stockpile surface. The benches and top surfaces of each stockpile will be sloped away from the crests to minimize the potential for ponding and erosion due to breakout of ponded water. This type of design will facilitate erosion control on each stockpile. Drainage collection from active portions of the stockpiles is discussed below.

10.4.4.4 Geotechnical Stability of the Waste Rock Stockpiles and OSP

PolyMet performed slope stability analyses to develop a safe design for each of the waste rock stockpiles and the OSP. Slope stability is the resistance of the inclined stockpile surface to failure by sliding. The objective of the slope stability analysis was to confirm adequate slope stability FOS for global stability and acceptable foundation stability. The waste rock is a free draining material, and it is unlikely that a mounding phreatic surface within the stockpile will develop to undermine the slope stability.

PolyMet's stability analysis for the waste rock stockpiles and OSP was performed in accordance with the requirements of the NorthMet Geotechnical Modeling Work Plan (Appendix 16.17).

For each of the lined temporary waste rock stockpiles and the lined temporary OSP, the basic engineering design requires unsuitable foundation soils to be excavated and replaced with structural fill prior to the construction of the stockpile foundation and liner system. For the permanent Category 1 Waste Rock Stockpile, unsuitable foundation soils within the initial 100 feet inward from the groundwater containment system limits (i.e., within 100 feet of the stockpile perimeter) will be excavated and replaced with structural fill prior to the construction of the groundwater containment system for stability considerations. In accordance with Minnesota Rules, part 6132.2400, subpart 2, item A(1), the foundation condition and the final design of each of the waste rock stockpiles and OSP will be examined by appropriate professional engineers registered in Minnesota proficient in the design, construction, operation, and reclamation of facilities on unstable foundations before construction commences.

Slope stability analysis is based on the conventional "Limit Equilibrium Analysis" method, which evaluates the equilibrium of the soil or rock mass tending to slide down under the influence of gravity or a combination of gravity and external loads such as surcharges and earthquake loading. The result of slope stability analysis is expressed as a FOS which is defined as the ratio of the force to resist movement to the force driving the movement. A FOS of 1 means the slope of concern is at a state of imminent failure.

Golder performed analyses to evaluate the stability of the waste rock stockpiles and the OSP. The stability was evaluated under static and pseudo-static (to simulate earthquake loading) conditions. The results of the stability analyses for the Category 1 Waste Rock Stockpile design satisfy the mining FOS criteria. Table 10-17 contains a summary of the analytical results, and the full results are presented in Appendix 16.17.

Another aspect of the design of the Category 1 Waste Rock Stockpile is the cover system, which will be installed incrementally, as described in Section 15.3.1. Golder the designer of the Category 1 Waste Rock Stockpile, conducted a stability analysis for the cover system. The analysis concludes that adequate slope stability safety factor can be achieved using the geomembrane types and soil types proposed for the stockpile cover system. Appendix 16.17 provides this analytical report. Details of the cover system are depicted on Figure 10-17 and in the permit application support drawings contained in Appendix 4.

10.4.5 Category 1 Waste Rock Stockpile

The Category 1 Waste Rock Stockpile is the only permanent stockpile. It will be located to the north of the West Pit as shown on Figure 10-11. The design of the Category 1 Waste Rock Stockpile and permit application support drawings contained in Appendix 4 have been developed by professional engineers registered in Minnesota.

10.4.5.1 Subsurface Conditions at the Category 1 Waste Rock Stockpile

Thus far, PolyMet excavated a series of three test trenches and advanced nine boreholes in the Category 1 Waste Rock Stockpile area. Figure 10-13 shows the investigation locations. The Geotechnical Data Package provided in Appendix 16.17 contains the investigation results. These results show that the location of the Category 1 Waste Rock Stockpile will provide the necessary foundational support for the stockpile and allow it to be constructed in a structurally sound manner.

Generally, the overburden soils in the high ground are glacial in origin and typically consist of sandy silts and silty sands with varying amounts of coarser material and occasional layers of sandy clays. The low lying areas contain glacial, alluvial, and lacustrine deposits which are overlain by peat or organic clays and silts. PolyMet will conduct a supplemental geotechnical investigation at the Mine Site to gather additional data on subsurface conditions for use in final design of this stockpile and the associated GCS. Appendix 17 includes the Geotechnical Investigation Work Plan.

10.4.5.2 Additional Design Considerations for the Category 1 Waste Rock Stockpile

Sections 10.4.4.3 and 10.4.4.4 provide general information regarding the configuration for the Category 1 Waste Rock Stockpile. Based on the subsurface investigation results noted above, peat and other unsuitable soils will be removed prior to placement of waste rock. During the construction and operations phases, the slopes between benches will be at the angle of repose of the waste rock. For final reclamation, the slopes between benches will be regraded to allow construction of a stockpile cover. Figure 10-18 shows the proposed final slope configuration of the Category 1 Waste Rock Stockpile. A typical section of the Category 1 Waste Rock Stockpile during operation and regraded for reclamation is shown on Figure 10-19 and in the permit application support drawings contained in Appendix 4.

10.4.5.3 Groundwater Containment System

The Category 1 Waste Rock Stockpile contains waste rock that may release metals. Minnesota Rules, part 6132.2200, subpart 2, item B(2) requires the collection of water that drains from mine waste and does not preclude the construction of a groundwater containment system rather than a liner system. PolyMet will construct the groundwater containment system in stages around the Category 1 Waste Rock Stockpile to collect drainage as the stockpile is constructed. The system will convey the drainage to the WWTF for treatment.

The Category 1 Stockpile Groundwater Containment System will include a cutoff wall consisting of a low hydraulic conductivity (less than 1×10^{-6} cm/sec) barrier. The barrier may be a compacted low hydraulic conductivity soil placed in an excavated trench or in-situ type of construction such as a slurry wall. At full buildout, the drainage collection system will surround the stockpile near the stockpile toe. The final configuration of the groundwater containment system will completely encircle the stockpile as shown on Figure 10-20.

Appendix 4 includes the permit application support drawings for the Category 1 Stockpile Groundwater Containment System. The design meets the applicable requirements of Minnesota Rules, part 6132.2200, subpart 2, item B(2).

During operations, stockpile drainage collected by horizontal drain pipes will flow by gravity to two low points, one located near the northeast corner of the Category 1 Waste Rock Stockpile and one located in the southcentral portion of the stockpile. The water collected by the groundwater containment system will be treated at the WWTF and pumped to the FTB or to the East Pit to flood the pit. As the stockpile development progresses to the west, additional sections of the groundwater containment system will be added to collect and convey drainage to these two collection sumps by gravity where it will be pumped to the WWTF.

The groundwater containment system will collect stockpile drainage and draw down the water table on the stockpile side of the cutoff wall, thereby maintaining an inward gradient along the cutoff wall and eliminating the potential for stockpile drainage passing through the cutoff wall. Potential leakage through the cutoff wall, if it occurs, will be inward into the groundwater containment system. Figure 10-21 shows a schematic cross-section of the Category 1 Stockpile Groundwater Containment System.

10.4.5.4 Construction Uses of Category 1 Waste Rock

With MDNR approval, PolyMet may utilize Category 1 waste rock for construction material. Table 10-18 identifies potential construction uses for Category 1 waste rock. PolyMet understands that the criteria for using Category 1 waste rock in construction or operations activities will be based on whether (and how) the proposed application of the material will affect surface and groundwater quality.

10.4.6 Temporary Categories 2/3 and 4 Waste Rock Stockpiles and OSP

The stockpiles storing Category 2/3 and Category 4 waste rock and the OSP are lined temporary stockpiles. PolyMet will remove each of these stockpiles prior to closure. The locations of the stockpiles, as shown on Figure 10-11, are as follows:

- the Category 2/3 Waste Rock Stockpile will be located southeast of the East Pit, near Dunka Road
- the Category 4 Waste Rock Stockpile will be located west of the East Pit, over the Central Pit prior to its excavation
- the OSP will be located south of the East Pit along Dunka Road and east of the RTH

The temporary waste rock stockpiles will receive material from the Mine Pit development. After mining of the East Pit is complete, PolyMet will haul waste rock mined from the West and Central Pits directly to the East Pit for disposal. PolyMet also will use waste rock to backfill the Central Pit, after mining ceases in that pit. Once mining ceases in the East and Central pits, PolyMet will relocate the temporary waste rock stockpiles to these pits for ultimate disposal. Table 10-14 summarizes waste rock production and placement over the LOM.

The OSP provides storage for ore until it can be processed. Use of the OSP enhances the ability to manage a steady annual flow of a uniform grade of ore to the Plant Site ore processing facilities. PolyMet will transfer ore into and out of this pile to meet mine and plant operating needs. The OSP footprint is approximately 32 acres with capacity for 2.5 million tons for one 40-foot lift, and a maximum capacity of 4.4 million tons in three 40-foot lifts with side slopes at the angle of repose. PolyMet will remove the OSP at the completion of mining activities, with remaining ore processed at the Plant Site or placed in the East or Central Pits for ultimate disposal. Appendix 16.12 provides additional details on the OSP.

10.4.6.1 Subsurface Conditions at the Temporary Stockpiles

PolyMet conducted an initial geotechnical investigation in the vicinity of areas of the planned temporary stockpiles. Figure 10-13 shows the investigation locations. The Geotechnical Data Package provided in Appendix 16.17 contains the investigation results. These results show that the locations of the temporary stockpiles will provide the necessary foundational support for the stockpile and allow it to be constructed in a structurally sound manner.

PolyMet will conduct supplemental geotechnical investigations at the Mine Site to gather additional data on subsurface conditions for use in final design of the temporary stockpiles. Appendix 17 includes the Geotechnical Investigation Work Plan. Based on currently available data, the subsurface conditions of each of the temporary stockpile areas are described below.

Category 2/3 Waste Rock Stockpile

Borings advanced within the Mine Year 1 footprint of the Category 2/3 Waste Rock Stockpile indicate the overburden soils are mainly of silty sand with gravel and few cobbles. Bedrock underlies the silt sand deposit at depth ranging from 3.5 feet to 14.5 feet below the existing ground surface.

Category 4 Waste Rock Stockpile

Borings advanced in the vicinity or within the footprint of the Category 4 Waste Rock Stockpile indicate bedrock depths between 5 and 22 feet below the ground surface. The Category 4 Waste Rock Stockpile is primarily situated upon highland soils, which typically consist of sands and gravels with varying amounts of silt, cobbles, and boulders. The silts are non-plastic to slightly plastic.

Ore Surge Pile

Borings advanced in the highland areas along the northern perimeter of the footprint of the OSP indicate bedrock depths ranging from 5 to 11 feet below the ground surface. Based on available boring information, the subsurface conditions at the OSP site are highland soils, which typically consist of silty sands with gravels with varying amounts of silt, cobbles, and boulders. The silts are non-plastic to slightly plastic.

10.4.6.2 Design of Temporary Stockpiles

The stockpile design includes the foundation, underdrain system, liner system, and overliner drainage system. In preparation for building the temporary stockpiles, the sites will be cleared and grubbed, and geotechnically unsuitable soils (mainly peat) will be excavated as needed to support a stable foundation. Structural fill will then be placed, as needed, to meet the foundation grades designed to provide gravity drainage of water collected on the stockpile liners. In areas where elevated groundwater is encountered at or near the liner grades, PolyMet will construct foundation underdrain systems. The underdrain system will be above groundwater elevations as practical. After the underdrain system is installed, the liner will be constructed. In accordance to Minnesota Rules, part 6132.2400, subpart 2, item A(1), professional engineers registered in Minnesota will examine the foundation condition and the final design of these temporary storage piles. Appendix 4 includes the permit application support drawings for these temporary stockpiles.

10.4.6.3 Liner System

PolyMet will construct the Categories 2/3 and 4 Waste Rock Stockpiles and the OSP with liner systems to comply with Minnesota Rules, part 6132.2200, subpart 2, item B(2). Each liner system will be a composite liner consisting of an impermeable barrier (80 mil thick LLDPE geomembrane) underlain by a compacted soil liner (minimum 12 inches thick) which will limit the downward infiltration of water through the liner system. Details of the liner system are depicted on Figure 10-22 and in the permit application support drawings contained in Appendix 4.

PolyMet performed a series of liner load tests on the proposed 80 mil LLDPE geomembrane liner under the anticipated loading conditions of the waste rock stockpiles. The test results showed that the liner will meet design requirements. Appendix 16.17 provides the test results.

The soil liner barrier will be built to be commensurate with the level of environmental risk expected by the waste rock classification. The temporary soil liner will be composed of local materials screened of oversized materials such as cobbles and boulders that will be scarified, moisture-conditioned and compacted to meet maximum hydraulic conductivity requirement of the stockpile type, not more than $1x10^{-5}$ cm/sec for Category 2/3 material and not more than $1x10^{-6}$ cm/sec for Category 4 material (waste rock and ore). If there are not sufficient quantities of suitable soils available for liner construction, PolyMet will admix the soils with bentonite to meet the design specification.

Before construction commences, PolyMet will provide the final construction plans and liner specifications to MDNR for review. The supplemental geotechnical investigation at the Mine Site (Appendix 17), will provide additional information in support of the final design, construction plans, and liner specifications.

An underdrain system may be necessary in order to provide foundation drainage to facilitate construction of the liner system and to minimize the potential for development of excess foundation pore water pressures as the stockpiles are loaded. The purpose of the underdrain system is to provide gravity drainage for foundation materials in areas where elevated groundwater is encountered after routine construction dewatering has ceased, and to prevent or minimize the potential for excess pore water pressures to develop as the facility is loaded. The underdrain system may not be necessary in areas where structural fill uses Category 1 waste rock material or in areas where granular moraine soils are present.

PolyMet anticipates that the foundation water collected by the underdrain system will be of suitable water quality for off-site discharge through the stormwater system. Nonetheless, PolyMet will configure the underdrains to accommodate water conveyance to the overliner sumps from where the water can be pumped to the WWTF. The design intent of the underdrain system is not for leakage collection; however, the potential exists that liner leakage, if it occurs, would be captured by the underdrains.

PolyMet will construct an overliner drainage layer above the impermeable barrier layer to promote gravity conveyance of water reaching the barrier layer to collection sumps. Foundation underdrains will be used if necessary to provide gravity drainage where elevated groundwater is encountered to prevent or minimize the potential for excess pore pressures as the stockpile is loaded. The foundation underdrains will also be directed to collection sumps. PolyMet will pump the sump contents to the WWTF for treatment.

Table 10-1 Summary of Overburden Types

Type of Overburden	Physical and Geochemical Properties	Management
Unsaturated Mineral Overburden	Overburden that has been above the water table and has been oxidized so that metals have already been released.	Unsaturated mineral overburden will be used as general construction material and/or stored in unlined overburden stockpiles at the OSLA.
Saturated Mineral Overburden	Overburden that has remained below the water table, has not been oxidized, and has the potential to release metals when exposed to air and oxidized.	Saturated mineral overburden will be commingled and contained with Category 2/3 and 4 waste rock or used in limited construction applications.
Peat	Organic material that will not release metals associated with sulfide minerals but could potentially release mercury.	Peat will be stored at the OSLA and used in limited construction applications.

Abbreviations:
OSLA = Overburden Storage and Laydown Area

Source: Adapted from Appendix 16.12

Table 10-2 Summary of Waste Rock Properties

Waste Rock Categorization	Sulfur Content	Potential to Generate Acid and/or Release Metals
Category 1	≤0.12%	Will not generate acid but may release metals
Category 2	>0.12% and ≤0.31%	May generate acid and release metals at higher rates than Category 1
Category 3	>0.31% and ≤0.60%	Will eventually generate acid and release metals at higher rates than Category 2
Category 4[(1)]	>0.60%	Will generate acid and release metals at higher rates than Category 3

Notes:
[1] Includes all Virginia formation rock.
Abbreviations:
% = percent

Source: Adapted from Appendix 16.12

Table 10-3 Summary of Hydraulic Conductivity and Shear Strength Parameters for FTB Materials

Material	Saturated Hydraulic Conductivity	Saturated Unit Weight	Drained Conditions (ESSA)		Undrained Conditions (USSA)			
			Cohesion	Friction	Cohesion	Friction	$USSR_{yield}$	$USSR_{liq}$
			c'	f'	c_u	f_{cu}	Strength Ratio, USSR	
	cm/s	pcf	psf	degrees	psf	degrees	S_u/S_{vo}	$S_{u(liq)}/S_{vo}$
LTVSMC Coarse Tailings	2.4E-03	135	0	38.5	0	38.5	--	--
LTVSMC Fine Tailings (FT)	2.0E-05	130	0	33	--	--	0.25	0.1
LTVSMC Slimes	9.6E-07	120	0	33	--	--	0.22	0.1
LTVSMC FT/Slimes	3.1E-06	125	0	33	--	--	0.24	0.1
LTVSMC Bulk Tailings	8.0E-05	130	0	38.5	0	38.5	--	--
Glacial Till	1.6E-03	135	0	36.5	0	36.5	--	--
Virgin Peat	1.0E-03	70	0	27	--	---	0.23	--
Compressed Peat	3.6E-06	85	0	27	--	---	0.23	--
Rock Starter Dam	1.52	140	0	40	0	40	--	--
Flotation Tailings[1] - 0.45 psf	1.9E-04	125	0	33	--	--	0.26	0.12
Flotation Tailings[1] - 1.35 psf	5.6E-05							
Flotation Tailings[1] - 2.29 psf	2.0E-05							
Cement Deep Soil Mix (CDSM) Slimes	7.0E-07	125	9,600	0	--	--	--	--
Cement Deep Soil Mix (CDSM) Peat	2.6E-06	125	--	--	--	--	--	--
Fractured Bedrock	7.2E-04	140	0	45.0	0	--	--	--
Bedrock	1.9E-05	Impenetrable						
Rail Grade	1.5E+00	140	0	45.0	0	45.0	--	--

Notes:
1 Hydraulic conductivity of the Flotation Tailings was varied based on effective overburden pressures.
Abbreviations:
ESSA = effective shear strength analysis
S_u = undrained shear strength
ϕ = frictional angle
USSA = undrained shear strength analysis
$USSR_{liq}$ = undrained shear strength ratio liquefied
$USSR_{yield}$ = undrained shear strength ratio yield
σ_{vo} = initial overburden stress
$S_{u(liq)}$ = liquefied shear strength
psf = pounds per square foot
cm/s = centimeters per second

Source: Adapted from Appendix 16.15

Table 10-4 Summary of Index Properties for LTVSMC Tailings

Parameter	Minimum	Maximum	Average
Course Tailings			
% passing no. 200 sieve	3	19	13
Unit Weight $_{dry}$ (pcf)	104.2	125	116.1
Moisture Content (%)	2.2	17.5	7.1
Plastic Limit (PL, %)	NP	NP	NP
Liquid Limit (LL, %)	NP	NP	NP
Plasticity Index (PI, %)	NP	NP	NP
Specific Gravity (G_S)	2.69	2.93	2.80
Fine Tailings			
% passing no. 200 sieve	13.2	95.7	66.1
Unit Weight $_{dry}$ (pcf)	76.2	111.4	98.5
Moisture Content (%)	3.6	34.7	17.8
Plastic Limit (PL, %)	16.7	22.0	19.5
Liquid Limit (LL, %)	17.5	29.4	23.4
Plasticity Index (PI, %)	0.8	7.4	3.9
Specific Gravity (G_S)	2.62	3.03	2.94
Slimes			
% passing no. 200 sieve	90.4	99.9	97.7
Unit Weight $_{dry}$ (pcf)	77.9	111.5	91.6
Moisture Content (%)	11.0	58.2	32.6
Plastic Limit (PL, %)	16.5	27.6	21.0
Liquid Limit (LL, %)	18.6	37.9	26.9
Plasticity Index (PI, %)	2.1	10.3	5.9
Specific Gravity (G_S)	2.93	2.99	3.00

Abbreviations:
LTVSMC = LTV Steel Mining Company
NP = Non plastic
pcf = pounds per cubic foot
% = percent

Source: Adapted from Appendix 16.15

Table 10-5 Summary of Index Properties of Flotation Tailings

Parameter	Minimum	Maximum	Average	Standard Deviation	No. of Tests
Percent Fine (minus No. 200 sieve)	52.0	68.2	60.3	6.07	8
Plastic Limit (PL) %	16.4	16.4	16.4	--	1
Liquid Limit (LL) %	17.5	17.5	17.5	--	1
Plasticity Index (PI) %	1.1	1.1	1.1	--	1
Specific Gravity (G_S)	2.97	3.03	3.00	0.02	6

Notes:
minus No. 200 sieve = passing a No. 200 US standard sieve
Abbreviations:
% = percent

Source: Adapted from Appendix 16.15

Table 10-6 Range of Hydraulic Conductivity for the Flotation Tailings

	K (cm/sec)	K (ft/sec)	K (ft/day)
Minimum[1]	1.98E-05	6.50E-07	0.06
Maximum[2]	4.82E-04	1.58E-05	1.37

Notes:
[1] Confining Sress at 7.0 tons per square feet
[2] Confining Sress at 0.25 tons per square feet
Tests performed by Soils Engineering Inc. October 31, 2005.
Abbreviations:
cm/sec = centimeters per second
ft/day = feet per day
ft/sec = feet per second
K = hydraulic conductivity

Source: Adapted from Appendix 16.15

Table 10-7 FTB Stage Storage Relationship and Dam Volume

Mine Year (End of Year)	Area	Average Tailings Elevation (feet)	Cumulative Capacity (cubic yards)	Staged Dam Crest Elevation (feet)	Cumulative Dam Volume (cubic yards)
0	Cell 2E	1,570.0	--	--	--
1		1,585.0	21,600,000	1,602	2,480,000
3		1,609.0	38,100,000	1,622	4,180,000
5		1,633.0	54,650,000	1,642	5,840,000
7		1,658.0	71,450,000	1,662	7,440,000
7	Cell 1/2E	1,658.0	71,450,000	1,662	7,440,000
10		1,678.5	101,040,000	1,682	9,860,000
14		1,697.5	143,075,000	1,702	12,846,000
18		1,716.5	185,639,000	1,722	16,411,000
20		1,724.0	207,239,000	1,732	18,126,000

Abbreviations:
FTB = flotation tailings basin

Source: Adapted from Appendix 16.7

Table 10-8 Summary of Slope Stability Analyses for FTB Dams

Cross Section Location	Cross Section F			Cross Section G			Cross Section G		
Case	USSA yield	ESSA	USSA liquefied	USSA yield	ESSA	USSA liquefied	USSA yield	ESSA	USSA liquefied
Target Factor of Safety	**1.3**	**1.5**	**1.1**	**1.3**	**1.5**	**1.1**	**1.3**	**1.5**	**1.1**
Design Scenario - Steady Stage Seepage									
Existing Conditions	--	1.83	--	--	2.21	--	--	3.11	--
Interim Lift 2	1.89	3.12	--	2.28	3.43	--	--	--	--
Interim Lift 4	1.74	3.18	--	2.09	3.42	--	--	--	--
Interim Lift 6	1.88	3.18	--	1.93	3.43	--	1.88	4.43	--
Lift 8 w/ Normal Pool	1.69	3.07	--	1.86	3.44	--	2.00	4.58	--
Lift 8 w/ PMP Event	1.77	3.18	--	1.85	3.46	--	1.91	4.34	--
Long-Term Stability - Steady State Seepage									
End of Operation	--	3.07	--	--	--	--	--	--	--
20 Years after Closure	--	3.09	--	--	--	--	--	--	--
200 Years after Closure	--	3.21	--	--	--	--	--	--	--
2000 Years after Closure	--	3.15	--	--	--	--	--	--	--
Liquefaction Triggering Analysis									
Baseline	2.06	--	--	--	--	--	--	--	--
Plugged Drain Lift 1	1.91	--	--	--	--	--	--	--	--
Lift 1 Rapid Loading	--	--	1.78	--	--	--	--	--	--
Erosion	1.99	--	--	--	--	--	--	--	--
Plugged Drain Lift 8	2.06	--	--	--	--	--	--	--	--
Fully Liquefied with Unknown Trigger									
Operation Lift 8	--	--	1.10	--	--	1.25	--	--	1.16
20 Years after Closure	--	--	1.35	--	--	--	--	--	--
200 Years after Closure	--	--	1.45	--	--	--	--	--	--
2000 Years after Closure	--	--	1.53	--	--	--	--	--	--

Abbreviations:
ESSA = Effective Stress Stability Analysis
FTB = flotation tailings basin
PMP = probable maximum precipitation
USSA = Undrained Strength Stability Analysis
Source: Adapted from Appendix 16.15

Table 10-9 Summary of Recommended Geotechnical Design Parameters for Hydrometallurgical Residue Facility

Characteristic	Residue as Tested	Recommended Design Values
Specific Gravity (G_S)	2.75	2.75
Natural Water Content (%)	17.5	---
Liquid Limit (LL, %)	40.7	---
Plastic Limit (PL, %)	38.4	---
Plasticity Index (PI, %)	2.3	---
Sand Content (% by weight)	15	---
Silt Content (% by weight)	84	---
Clay Content (% by weight)	1	---
Effective Shear Strength Friction Angle (degrees)	No Test[1]	30
In-place Dry Density vs. Confining Stress	58.1 pcf at 0.01 tsf	Design Values for Liner Strain and/or Slope Stability Analysis: Dry Unit Wt. = 80 pcf Sat. Unit Wt. = 115 pcf Design Values for Initial Cell Sizing: Dry Unit Wt. = 73 pcf
	61.5 pcf at 0.1 tsf	
	71.0 pcf at 1.0 tsf	
	76.5 pcf at 2.0 tsf	
	77.1 pcf at 3.0 tsf[2]	

Notes:

[1] Residual shear strength parameters were not tested due to their limited role in determining dam safety but were selected based on the relation between liquid limit and friction angle.

[2] In-Place density at 3.0 tsf is estimated from projection of Void Ratio vs. Log of Pressure Curve to 3.0 tsf.

% = percent

Abbreviations:

HRF = Hydrometallurgical Residue Facility

tsf = tons per square foot

pcf = pounds per cubic foot

Source: Adapted from Appendix 16.16

Table 10-10 Computed Specific Gravity of Hydrometallurgical Residue

Residue Component	Tons/Year (approximation)	% of Total	Specific Gravity (G_S)	Tons/Year x Specific Gravity (G_S)
Gypsum	208,326	66.6%	2.33	485,400
Natrojarosite	67,158	21.5%	3.30	221,621
Hematite	18,548	5.9%	5.30	98,304
Plagioclase	6,183	2.0%	2.75	17,003
Talc	4,157	1.3%	2.75	11,432
Quartz	3,804	1.2%	2.65	10,081
Brucite	2,975	1.0%	2.40	7,140
Goethite	1,542	0.5%	3.80	5,860
Halite	107	0.0%	2.17	232
Subtotal	312,800 (A)			857,073 (B)
Hydrometallurgical Residue Weighted Average Specific Gravity (G_S) = 2.74 (=B/A)				

Abbreviations:
% = percent

Source: Adapted from Appendix 16.16

Table 10-11 HRF Stage Storage Relationship

Phase	Crest Elevation	Approximate Cumulative Residue Capacity (cubic yards)
1	1,600	1,090,000
2	1,630	3,760,000
3	1,650	6,170,000

Notes:
Approximate Cumulative Capacity is cubic yards for Residue. Capacity for water clarification and freeboard is above and beyond the Residue capacity presented.
Abbreviations:
HRF = Hydrometallurgical Residue Facility

Source: Adapted from Appendix 16.8

Table 10-12 Summary of Slope Stability Analyses for HRF

Analysis	Cross Section A-A' ESSA (South Dam)	Cross Section A-A' ESSA (North Dam)	Cross Section C-C' ESSA (Northwest Dam)
Target FS	1.5	1.5	1.5
Lift 1 – Computed FS	2.34	2.72	N/A
Lift 2 – Computed FS	2.32	N/A	N/A
Lift 3 - End of Operations (Year 20) – Computed FS	2.32	N/A	2.27

Abbreviations:
ESSA = Effective Stress Stability Analysis
FS = factor of safety
N/A = not applicable

Source: Adapted from Appendix 16.16

Table 10-13 Typical Strain Values for Geosynthetic Components

Name(1)	Allowable Strain (%)	Elongation at Break (%)	Tensile Strength at Break (lb/in)
GSE HD Textured Geomembrane (60 mil)	12	100	115
GSE HD Textured Geomembrane (80 mil)	12	100	155
GSE Ultra Flex (LLDPE) Textured Geomembrane (60 mil)	N/A	500	168
GSE Ultra Flex (LLDPE) Textured Geomembrane (80 mil)	N/A	500	224
Geosynthetic Clay Liner (GCL)	1 to 19(2,3)	N/A	25 to > 50(3)

Notes:
1 GSE Geomembrane data used for reference; actual geomembrane supplier may vary.
2 Allowable strain in GCL liner depends on GCL type and installation procedures.
3 GCL Tensile Strength at Break depends on GCL type (Qian, X.D., Koerner, R.M. and Grey, D.H. *Geotechnical Aspect of Landfill Design and Construction*, New Jersey: Prentice Hall Inc. 2011.

Abbreviations:
% = percent
GCL = geosynthetic clay liner
GSE = GSE Environmental
HD = high density
lb/in = pounds per inch
LLDPE = linear low-density polyethylene
mil = one thousandth of an inch
N/A = not applicable

Source Adapted from Appendix 16.16

Table 10-14 Waste Rock Production Placement Schedule

Mine Year	Category 1 Waste Rock Stockpile[1] (Million tons)	Category 2/3 Waste Rock Stockpile[1] (Million tons)	Category 4 Waste Rock Stockpile[1] (Million tons)	Backfilling East Pit				Total Rock Moved (Million tons)
				Re-handing from Cat. 2/3 Stockpile to East Pit (Million tons)	Re-handing from Cat. 4 Stockpile to East Pit (Million tons)	Waste Rock from West Pit and Central Pit to East Pit (Million tons)	Total Placement in East Pit (Million tons)	
1	18.7	5.2	1.5	0	0	0	0	25.4
2	15.0	4.4	0.8	0	0	0	0	20.2
3	16.1	4.3	1.1	0	0	0	0	21.6
4	12.8	3.7	0.8	0	0	0	0	17.2
5	11.7	2.4	0.4	0	0	0	0	14.6
6	16.8	4.3	0.7	0	0	0	0	21.8
7	10.4	2.6	0.5	0	0	0	0	13.6
8	16.9	4.3	0.1	0	0	0	0	21.3
9	12.6	4.7	0.1	0	0	0	0	17.4
10	13.0	4.1	0.1	0	0	0	0	17.2
11	10.2	4.0	0.02	0	6.2	0	6.2	20.4
12	10.8	0	0	5.7	0	4.8	10.6	21.4
13	2.9	0	0	5.7	0	11.0	16.8	19.7
14	0	0	0	5.7	0	12.2	17.9	17.9
15	0	0	0	5.7	0	10.9	16.7	16.7
16	0	0	0	5.7	0	9.1	14.8	14.8
17	0	0	0	5.7	0	7.0	12.7	12.7
18	0	0	0	5.7	0	8.8	14.6	14.6
19	0	0	0	3.8	0	11.9	15.8	15.8
20	0	0	0	0	0	14.1	14.1	14.1
Total	168.0	44.0	6.2	44.0	6.2	90.0	140.2	358.3

Notes:
1 Category 1 Stockpile is permanent; Category 2/3 and Category 4 Stockpiles are temporary.

Estimates subject to change based on metal prices and other factors.
Source: Adapted from Appendix 16.22

Table 10-15 Maximum Stockpile Dimensions

Stockpile	Mine Year of Maximum Footprint	Maximum Area (acres)	Maximum Height (feet)	Maximum Elevation (feet above sea level)
Category 1	21	526	240	1,880
Category 2/3	6	180	200	1,770
Category 4	3	57	180	1,790
Ore Surge Pile (OSP)	N/A[1]	31	120	1,690

Notes:

[1] The OSP is a surge pile that will have ore moving in and out as needed to meet mine and plant operating requirements.

Abbreviations:

N/A = not applicable

Estimates subject to change based on metal prices and other factors.

Source: Adapted from Appendix 16.12

Table 10-16 Proposed Construction Application for Saturated Mineral Overburden

Application	Water Quality Rationale	Estimated Quantity (cubic yards)
1. Stockpile Foundation Material	Operations: Overburden will remain below the water table. Postclosure: Overburden will remain below the water table.	823,000
2. Groundwater Containment System	Operations: Water contacting this material will be within the groundwater containment system and routed to the WWTF. Postclosure: Water contacting this material will be within the groundwater containment system and routed to treatment.	249,000
3. Temporary Stockpile (Category 2/3 and 4 and Ore Surge Pile) Drainage Layer	Operations: Water draining through this material will be collected and treated. Postclosure: This material will be removed prior to removal of the liner during stockpile reclamation.	1,045,000
4. In-Pit Haul Road Top Dressing	Operations: Water contacting this material will flow into the pit and be collected and treated, or used to fill the East Pit. Postclosure: Most of this material will be below the water table within the pits.	10,000
5. Process Water Pond and WWTF Pond Liner Cover Material	Operations: Most of this material will be submerged; drainage through this material will be collected and treated. Postclosure: These ponds may be reclaimed as wetlands. This material will either remain submerged in a wetland or be placed below the water level in the pits.	66,000
6. Soil Liner Below a Temporary Geomembrane Liner	Operations: Geomembrane liner will prevent water from draining through this material. Postclosure: This material will be removed with the geomembrane liner during stockpile reclamation.	421,000
Total		2,614,000

Abbreviations:
WWTF = Waste Water Treatment Facility

Source: Adapted from Appendix 16.12

Table 10-17 Summary of Slope Stability Analyses for Category 1 Waste Rock Stockpile

Slope Configuration	Static or Seismic	Surface Type	Computed FS	Minimum FS Design Criteria
Initial operational configuration (a single lift of waste rock with a maximum height of 40 feet placed at the angle of repose)	Static	Circular	1.53	1.3
	Static	Block	1.56	1.3
	Seismic	Circular	1.45	1
Operational configuration at ultimate buildout prior to reclamation (assume four lifts to 160 feet)	Static	Circular	1.93	1.3
	Static	Block	2.09	1.3
	Seismic	Circular	1.78	1
Final reclaimed configuration with interbench slopes regraded to 3.75H:1V and ultimate slope height 240 feet	Static	Circular	2.31	1.5
	Seismic	Circular	2.07	1.1

Abbreviations:
FS = factor of safety

Source: Adapted from Appendix 16.17

Table 10-18 Potential Construction Uses of Category 1 Waste Rock

Application	Water Quality Rationale
Category 1 Waste Rock Stockpile Perimeter Foundation	Operations: Water contacting the rock would be within the groundwater containment system and routed to the WWTF. Postclosure: Water contacting the rock would be within the groundwater containment system and routed to the WWTF.
Temporary Stockpile Foundations (Category 2/3 and 4 and OSP)	Operations: Minimal water would contact the rock because it would be below a geomembrane liner. Postclosure: Some of this material would be removed during reclamation of the temporary stockpile foundations. The remaining material would be reclaimed with a soil cover, with runoff directed off-site.
Temporary Stockpile Drainage Layer (Category 2/3 and 4 and OSP)	Operations: Water contacting this rock would be collected on the geomembrane liner. Postclosure: This material would be located above the geomembrane liner and would be removed in reclamation.
Groundwater Containment System Material	Operations: Water contacting this rock will be within the groundwater containment system and routed to the WWTF. Postclosure: Water contacting the rock will be within the groundwater containment system and routed to the WWTF.
Ramps and Roads in Pit	Operations: Water contacting this rock will be pit water, which is collected and treated or used to fill the East/Central pits. Postclosure: Most of this material will be below the water table as the pits are filled with water.
Haul Roads from Pits to Stockpiles and Rail Transfer Hopper	Operations: Runoff from haul road surfaces will be collected and treated. Runoff from reclaimed side slopes will be handled as stormwater and directed off-site. Postclosure: Many of the haul roads will be removed and reclaimed or reclaimed in-situ, with runoff directed off-site.
Rail Transfer Hopper	Operations: Runoff from active surfaces will be collected and treated. Runoff from reclaimed side slopes will be handled as storm water and directed off-site. Postclosure: The rock portion of the structure will be sloped and reclaimed, with runoff directed off-site.
Railroad Maintenance Ballast	Operations: Runoff from railroad surfaces will be handled as stormwater and directed off-site. Postclosure: Runoff from railroad surfaces will be handled as stormwater and directed off-site.

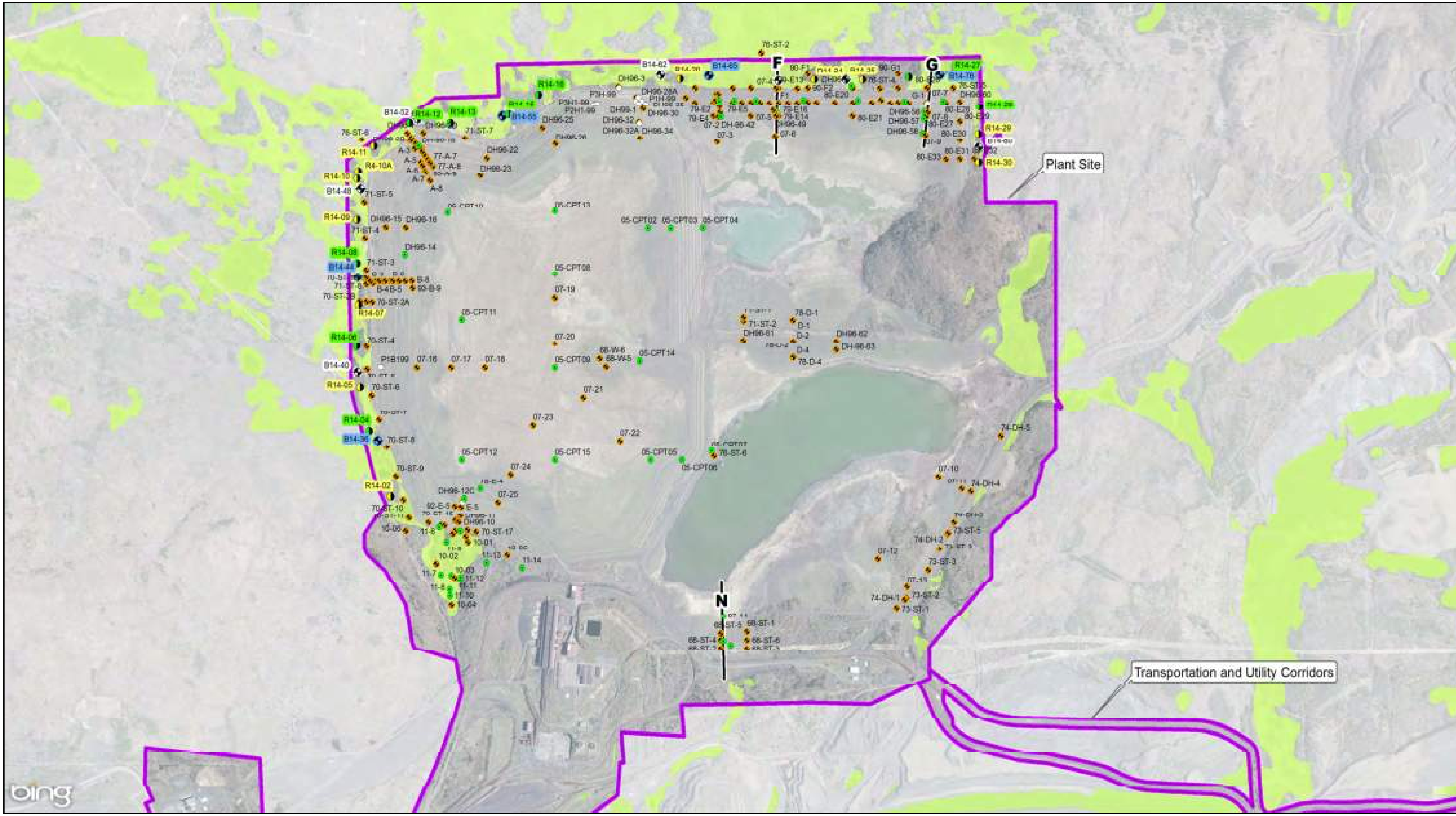
Abbreviations:
OSP = ore surge pile
WWTF = wastewater treatment facility

Source: Adapted from Appendix 16.12

Table 10-19 Sequence of East Pit Backfilling

Mine Year	Waste Rock Relocated to East Pit (million tons)	Origin of Waste Rock
11	6.2	Category 4 Stockpile
12 to 19	44.0	Category 2/3 Stockpile
12 to 20	90.0	West and Central Pits

Source: Adapted from Appendix 16.12



Notes

1. Basemap from Esri and its data suppliers.
2. Project features supplied by Barr Engineering Company.
3. Additional details provided in Geotechnical Data Package, Volume 1: Flotation Tailings Basin V7, July 2016 in Appendix 16 of the Application.
4. Cross Sections shown on Figure 10-3.

Legend

- 2014 Rotasonic Location
- 2014 Rotasonic Location with a Piezometer
- 2014 Boring Locations
- 2014 Boring Locations with a Packer

Historic Test Locations

- Other/Unknown
- CPT Location
- SPT Location

- Cross Section Locations
- Wetlands
- Facility Boundary

POLYMET MINING

Foth

Foth Infrastructure & Environment, LLC

REVISED	DATE	BY	DESCRIPTION

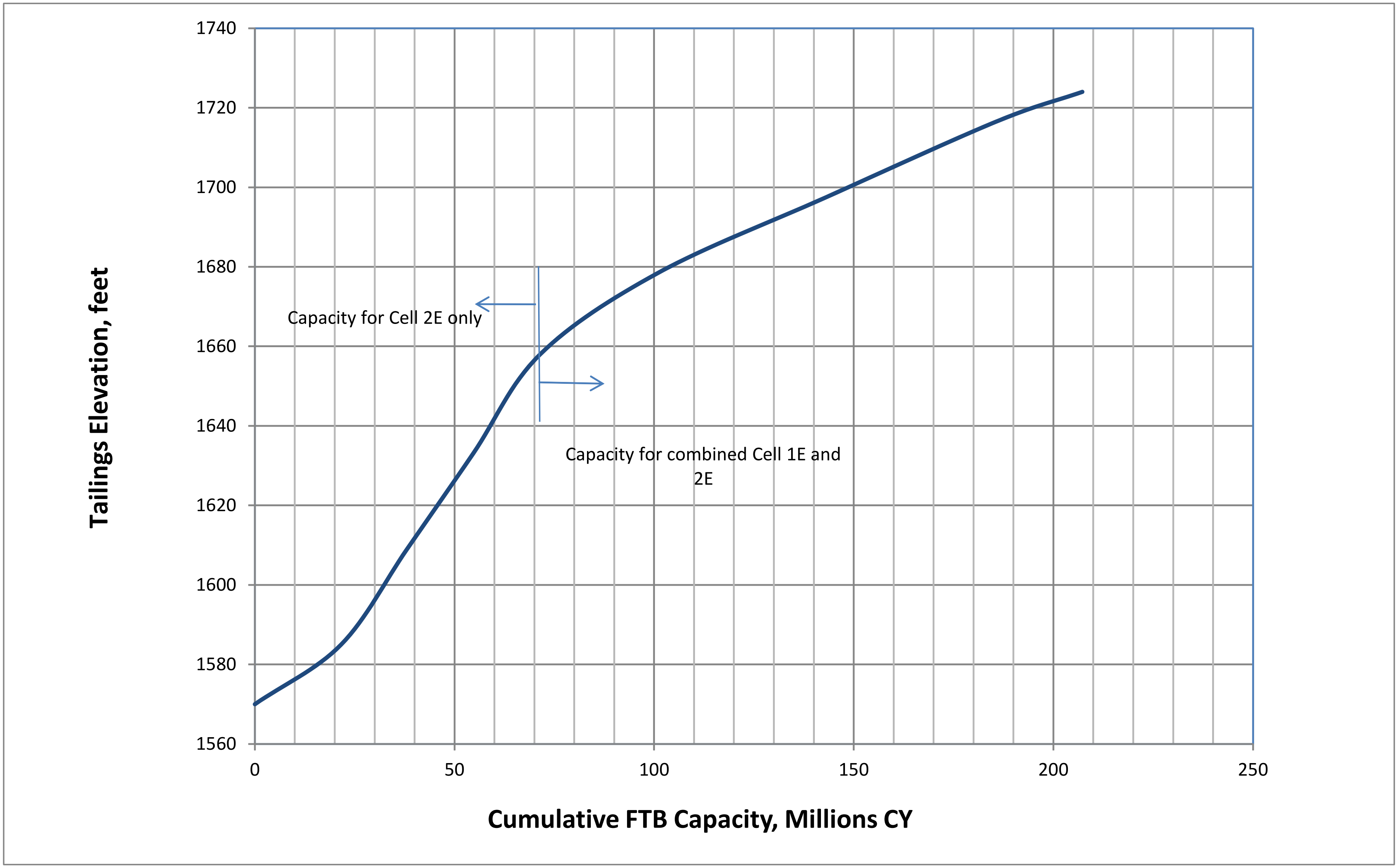
PREPARED BY:	DRD	DATE: AUG. '16
REVIEWED BY:	JSL	DATE: AUG. '16
APPROVED BY:	JOS1	DATE: AUG. '16

POLYMET MINING

FIGURE 10-1
PLANT SITE
GEOTECHNICAL INVESTIGATION LOCATIONS
PERMIT TO MINE APPLICATION
HOYT LAKES, MINNESOTA

Scale: 0 1,000 2,000 Feet	Date: AUGUST 2016
Drafted by: DAT	Project No: 12P778

Path: X:\GB\IE\2012\12P778\GIS\mxd\PMA\Figure 10-1 Flotation Tailings Basin Geotechnical Investigation Plan.mxd Date: 9/2/2016

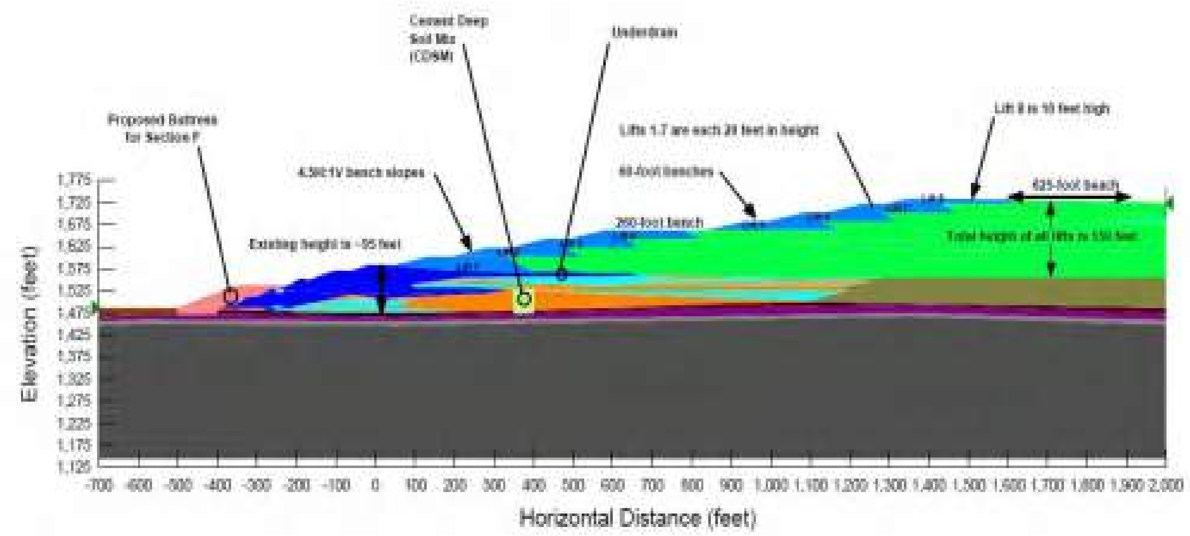


Notes

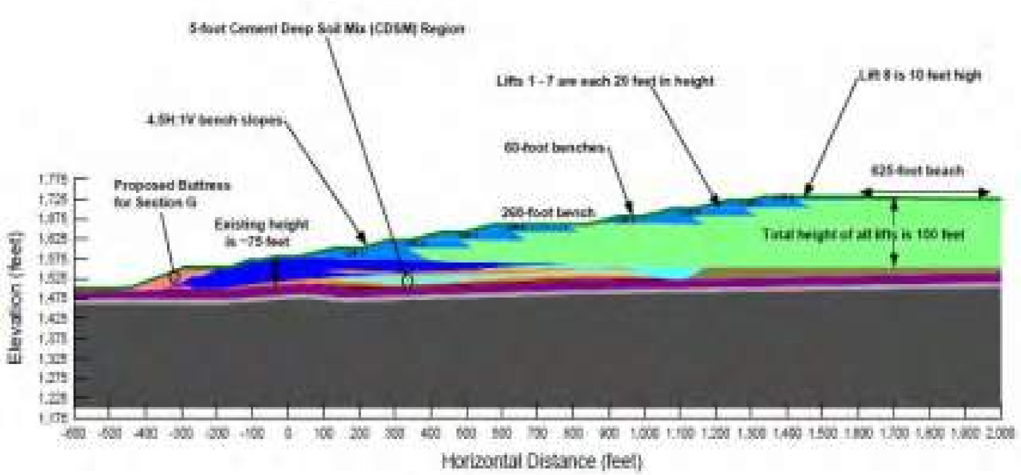
1. Figure adapted from FlotationTailings Management Plan, V5, March, 2015 included in Appendix 16 of the Application.

Foth Infrastructure & Environment, LLC				POLYMET MINING
REVISED	DATE	BY	DESCRIPTION	**FIGURE 10-2** FLOTATION TAILINGS BASIN STAGE STORAGE CURVE PERMIT TO MINE APPLICATION HOYT LAKES, MINNESOTA
PREPARED BY: JSL			DATE: AUG. '16	
REVIEWED BY: RXW			DATE: AUG. '16	Scale: NOT TO SCALE — Date: AUGUST 2016
APPROVED BY: JOS1			DATE: AUG. '16	Drafted by: DAT — Project No: 12P778

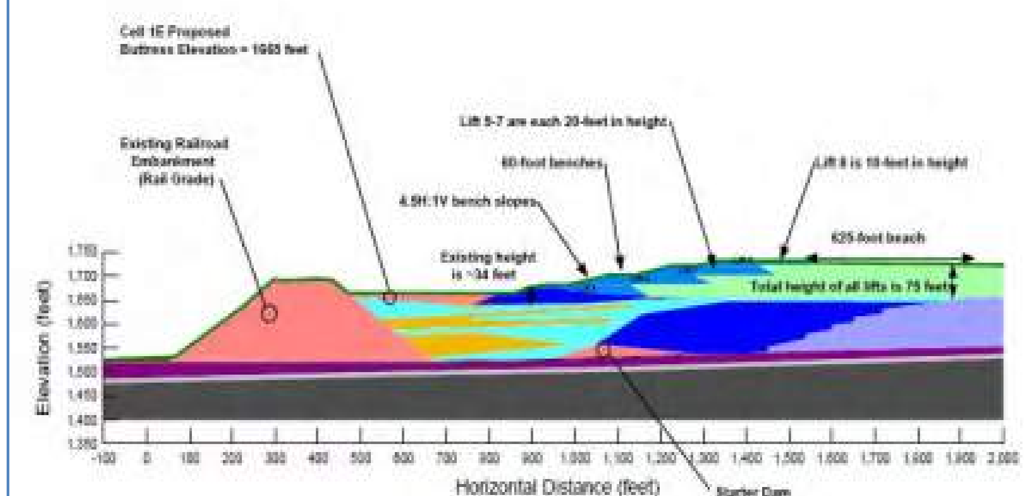
Path: X:\GB\IE\2012\12P778\GIS\mxd\PMA\Figure 10-2 Flotation Tailings Stage Storage Curve.mxd Date: 9/2/2016



Large Figure 16. Cross-Section F Proposed FTB Design Mine Year 20



Large Figure 18. Cross-Section G Proposed FTB Design Mine Year 20



Large Figure 19. Cross-Section N Proposed FTB Design Mine Year 20

Notes
1. Source: Geotechnical Data Package Volume 1: Flotation Tailings Bain V7, July 2016, included in Appendix 16 of the Application.
2. Cross-section locations show on Figure 10-1.

POLYMET MINING

Foth

Foth Infrastructure & Environment, LLC			
REVISED	DATE	BY	DESCRIPTION
PREPARED BY: JSL			DATE AUG. '16
REVIEWED BY: RXW			DATE AUG. '16
APPROVED BY: JOS1			DATE AUG. '16

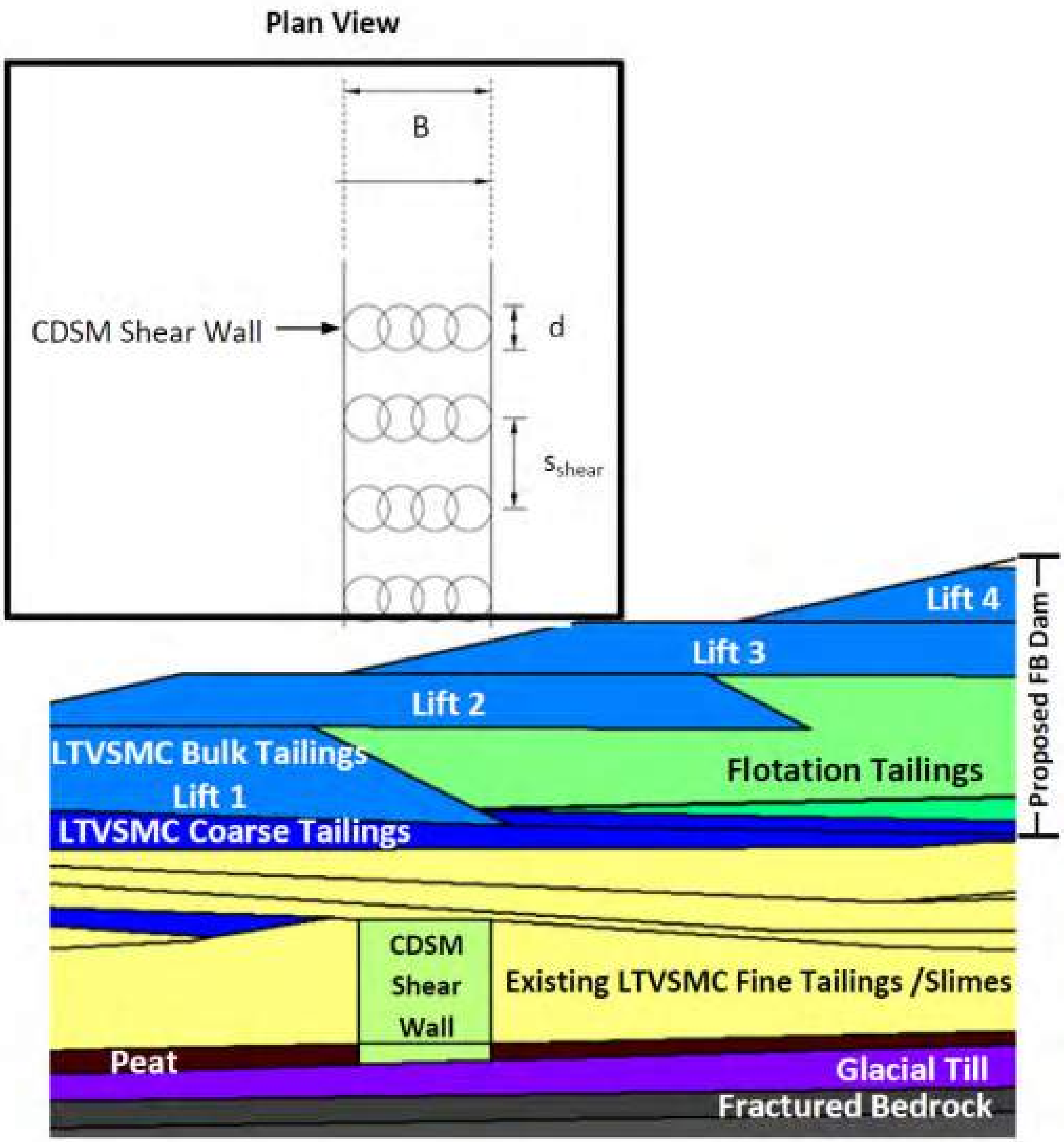
POLYMET MINING

FIGURE 10-3

CRITICAL DAM SECTIONS USED FOR STABILITY ANALYSIS
PERMIT TO MINE APPLICATION
HOYT LAKES, MINNESOTA

Scale: NOT TO SCALE	Date: AUGUST 2016
Drafted by: DAT	Project No: 12P778

Path: X:\GB\IE\2012\12P778\GIS\mxd\PMA\Figure 10-3 Critical Dam Sections used for Stability Analysis.mxd Date: 9/2/2016



Notes

1. Adapted from Geotechnical Data Package Volume 1 - Flotation Tailings Basin V7, July 2016, included in Appendix 16 of the Application.

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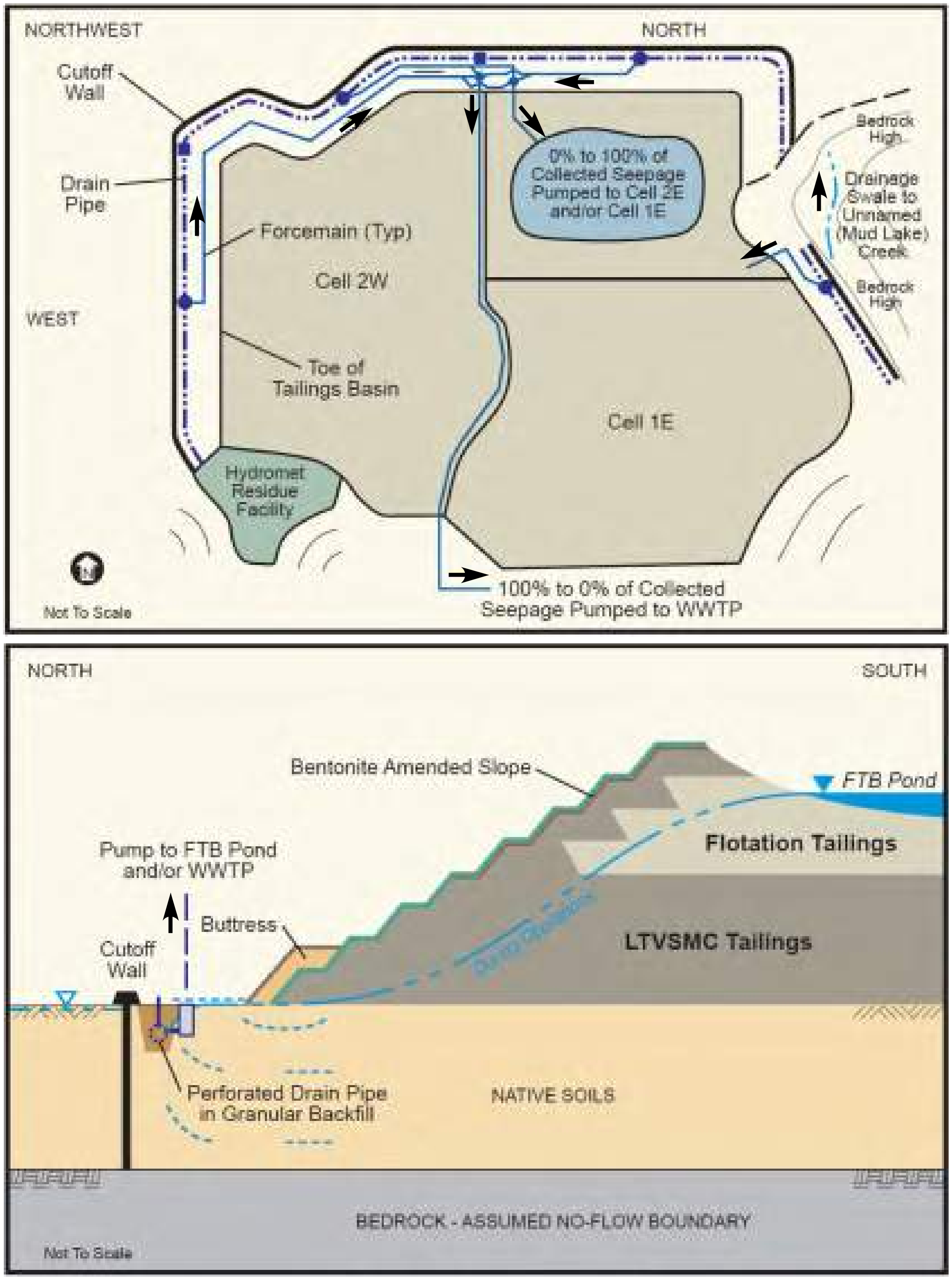
PREPARED BY:	DRD	DATE:	AUG. '16
REVIEWED BY:	JSL	DATE:	AUG. '16
APPROVED BY:	JOS1	DATE:	AUG. '16

FIGURE 10-4
SCHEMATIC CDSM SHEAR WALL
BENEATH FTB DAM
PERMIT TO MINE APPLICATION
HOYT LAKES, MINNESOTA

Scale:	NOT TO SCALE	Date:	AUGUST 2016
Drafted by:	BJW1	Project No:	12P778



Notes

1. Adapted from Water Management Plan - Plant V5, July 2016, included in Appendix 16 of the Application.

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PREPARED BY: JSL DATE: AUG. '16
REVIEWED BY: RXW DATE: AUG. '16
APPROVED BY: JOS1 DATE: AUG. '16

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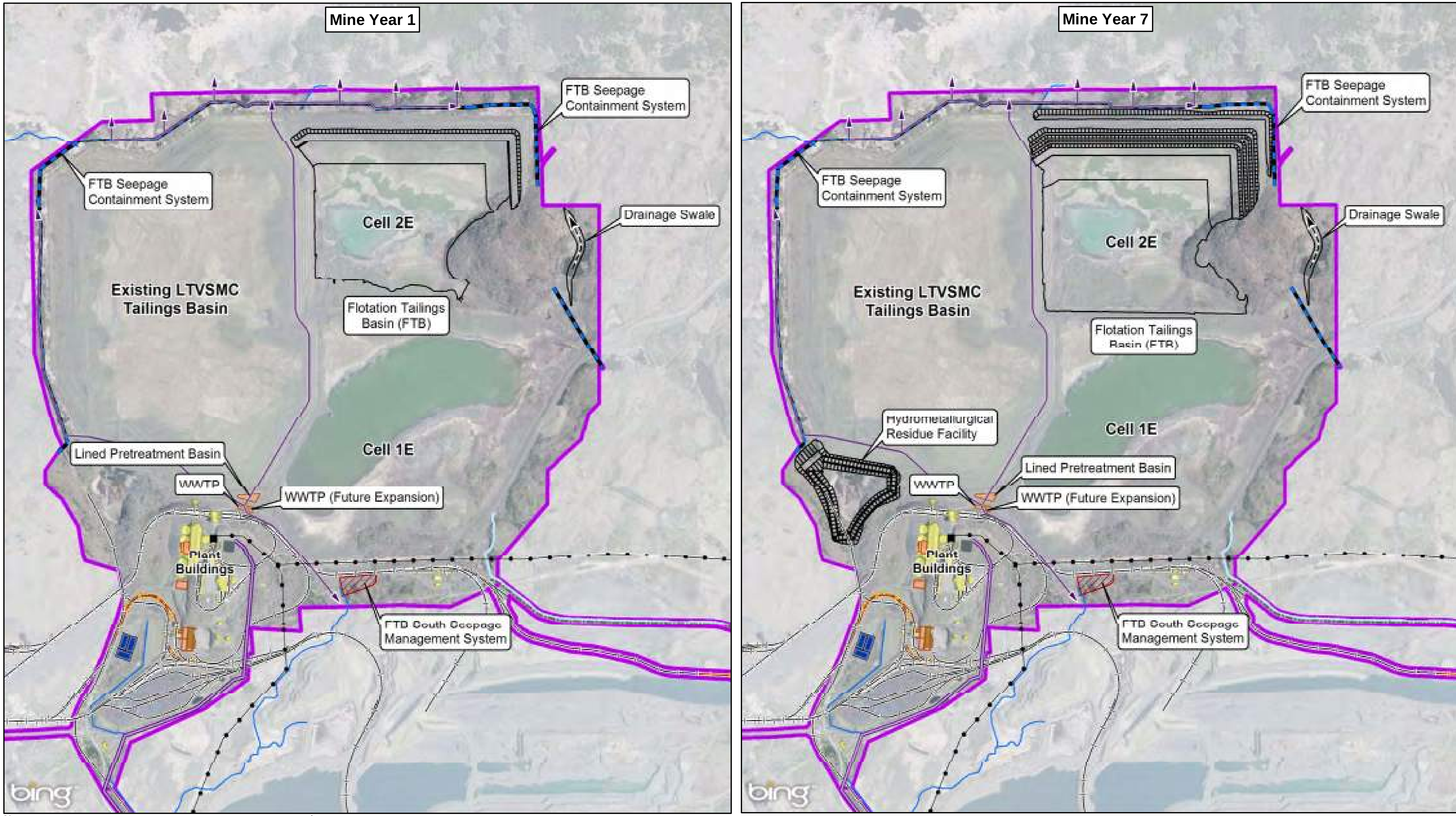
FIGURE 10-5
SCHEMATIC LAYOUT AND CROSS SECTION OF THE FTB SEEPAGE CONTAINMENT SYSTEM
PERMIT TO MINE APPLICATION
HOYT LAKES, MINNESOTA

Scale: NOT TO SCALE | Date: AUGUST 2016
Drafted by: BJW1 | Project No: 12P778

Path: X:\GB\IE\2012\12P778\GIS\mxd\PMA\Figure 10-5 FTB schematic cross section.mxd Date: 9/2/2016



Notes

1. Basemap from Esri and its data suppliers.
2. Project features, pipelines and details supplied by Barr Engineering Company.
3. NHD features are created from MDNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance, data sources may show watercourses that no longer exist.
4. Minnesota Power Substations and Power Lines supplied by the Minnesota Geospatial Information Office (MnGeo).

Legend

- Electric Substation[4]
- Existing Electric Power Line[4]
- Dunka Road
- Proposed Railroad Track
- Existing Private Railroad
- Rivers, Streams and Ditches[3]
- Colby Lake Pipeline
- FTB Seepage Containment System
- Treated Water Pipeline
- Treated Water Discharge Pipe
- Existing Buildings
- Proposed Plant Site Buildings and Related Facilities
- Proposed Hydromet Plant
- Sewage Treatment System Stabilization Ponds
- Hydromet Residue and Tailings Dam
- Facility Boundary

POLYMET MINING

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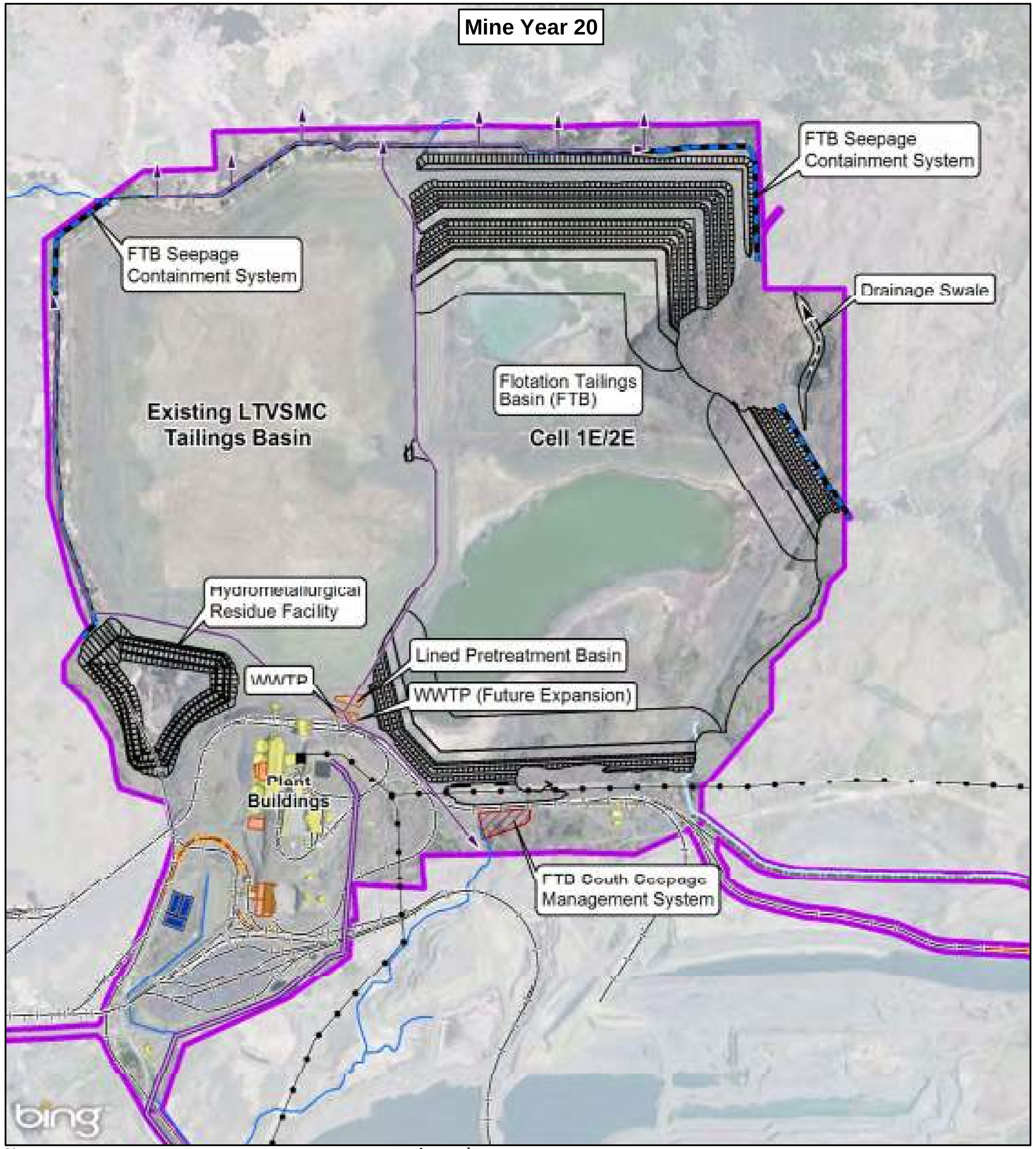
PREPARED BY:	JSL	DATE:	AUG. '16
REVIEWED BY:	MJV2	DATE:	AUG. '16
APPROVED BY:	JOS1	DATE:	AUG. '16

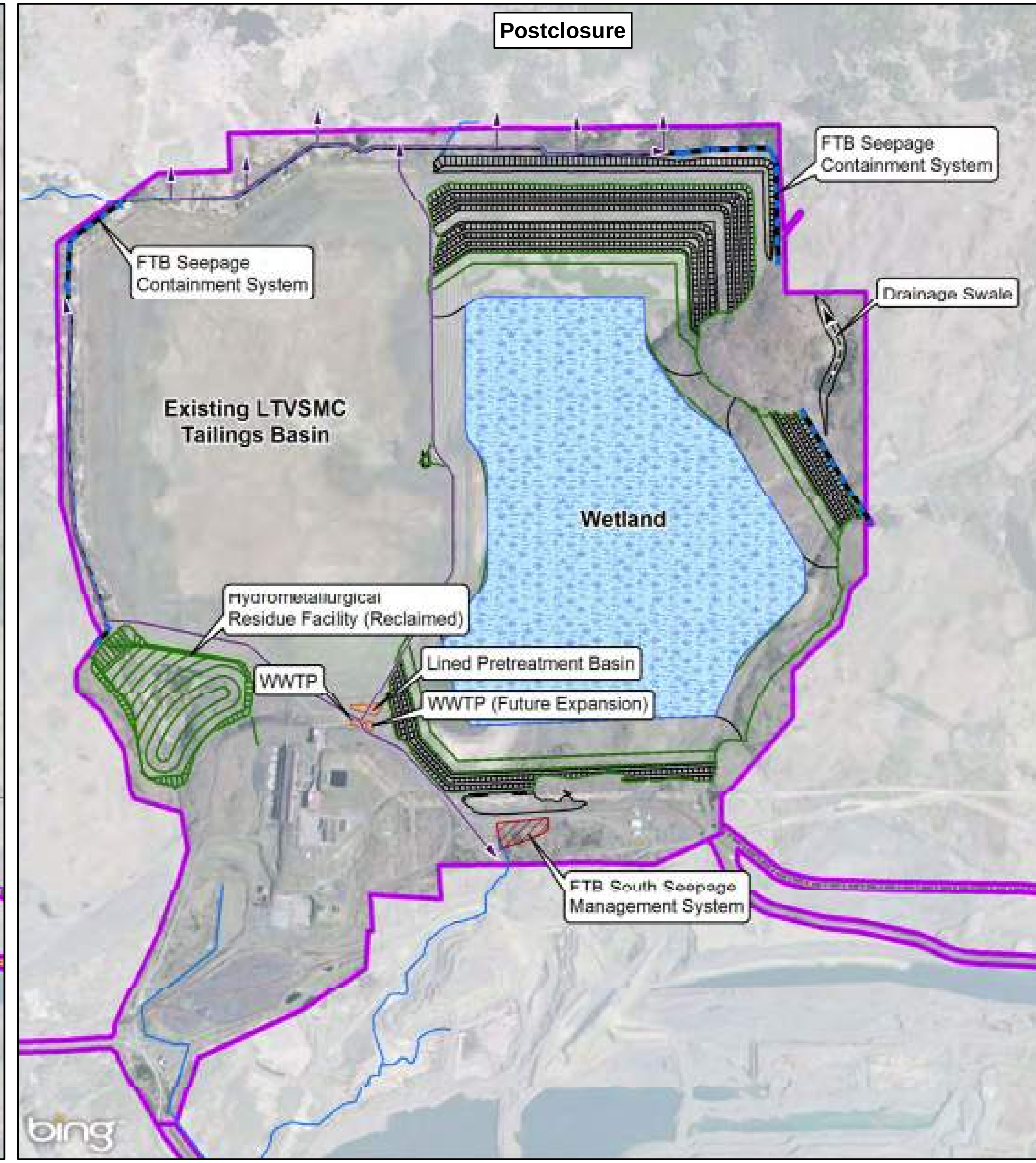
POLYMET MINING

FIGURE 10-6a
PLANT DEVELOPMENT AND LAYOUT SEQUENCE, MINE YEARS 1 AND 7
PERMIT TO MINE APPLICATION
HOYT LAKES, MINNESOTA

Scale: 0 1,250 2,500 Feet	Date: AUGUST 2016
Drafted by: DAT	Project No: 12P778

Path: X:\GB\IE\2012\12P778\GIS\mxd\PMA\Figure 10-6a Plant Site Mine Year 1 and Mine Year 7.mxd Date: 9/9/2016





Notes

1. Basemap from Esri and its data suppliers.
2. Project features, pipelines and details supplied by Barr Engineering Company.
3. NHD features are created from MDNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance, data sources may show watercourses that no longer exist.
4. Minnesota Power Substations and Power Lines supplied by the Minnesota Geospatial Information Office (MnGeo).

Legend

- Electric Substation[4]
- Existing Electric Power Line[4]
- Dunka Road
- Proposed Railroad Track
- Existing Private Railroad
- Rivers, Streams and Ditches[3]
- Colby Lake Pipeline
- FTB Seepage Containment System
- Treated Water Pipeline
- Existing Buildings
- Proposed Plant Site Buildings and Related Facilities
- Proposed Hydromet Plant
- Sewage Treatment System Stabilization Ponds
- Hydromet Residue and Tailings Dam
- Facility Boundary

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REVIEWED BY: MJV2			DATE: AUG. '16
APPROVED BY: JOS1			DATE: AUG. '16

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FIGURE 10-6b
PLANT DEVELOPMENT AND LAYOUT SEQUENCE, MINE YEAR 20 AND POSTCLOSURE
PERMIT TO MINE APPLICATION
HOYT LAKES, MINNESOTA

Scale: 0 1,250 2,500 Feet	Date: AUGUST 2016
Drafted by: DAT	Project No: 12P778

Path: X:\GB\IE\2012\12P778\GIS\mxd\PMA\Figure 10-6b Plant Site Mine Year 20 and Postclosure.mxd Date: 9/9/2016

Notes

1. Source: Flotation Tailings Management Plan, V6, July 2016, included in Appendix 16 of the Application.

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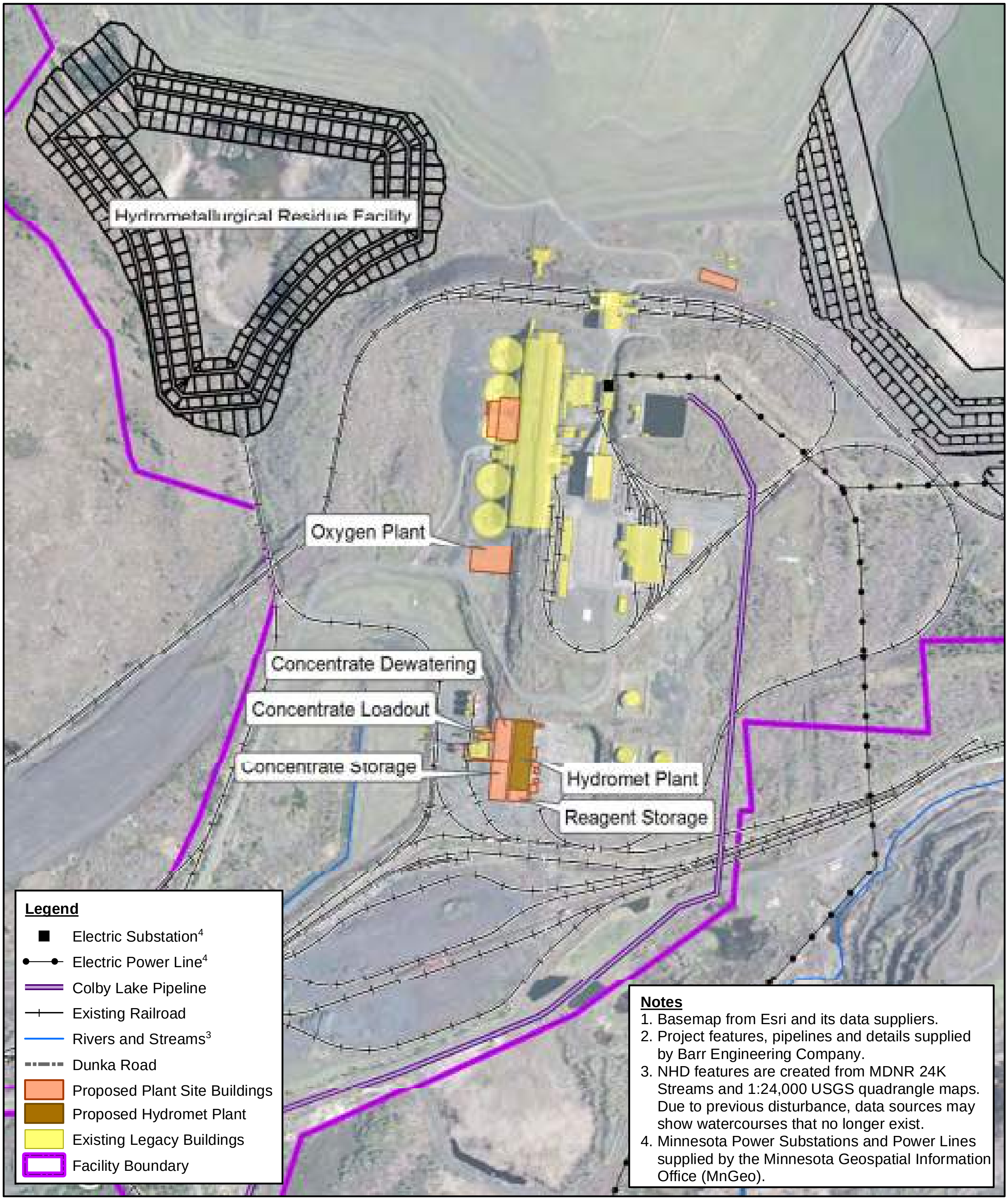
PREPARED BY:	JSL			DATE: AUG. '16
REVIEWED BY:	RXW			DATE: AUG. '16
APPROVED BY:	JOS1			DATE: AUG. '16

POLYMET MINING	
FIGURE 10-7 STAGED FLOTATION TAILINGS BASIN DAM CREST AND TAILINGS ELEVATION PERMIT TO MINE APPLICATION HOYT LAKES, MINNESOTA	
Scale: NOT TO SCALE	Date: AUGUST 2016
Drafted by: DAT	Project No: 12P778



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REVIEWED BY: RXW		DATE: AUG. '16
APPROVED BY: JOS1		DATE: AUG. '16

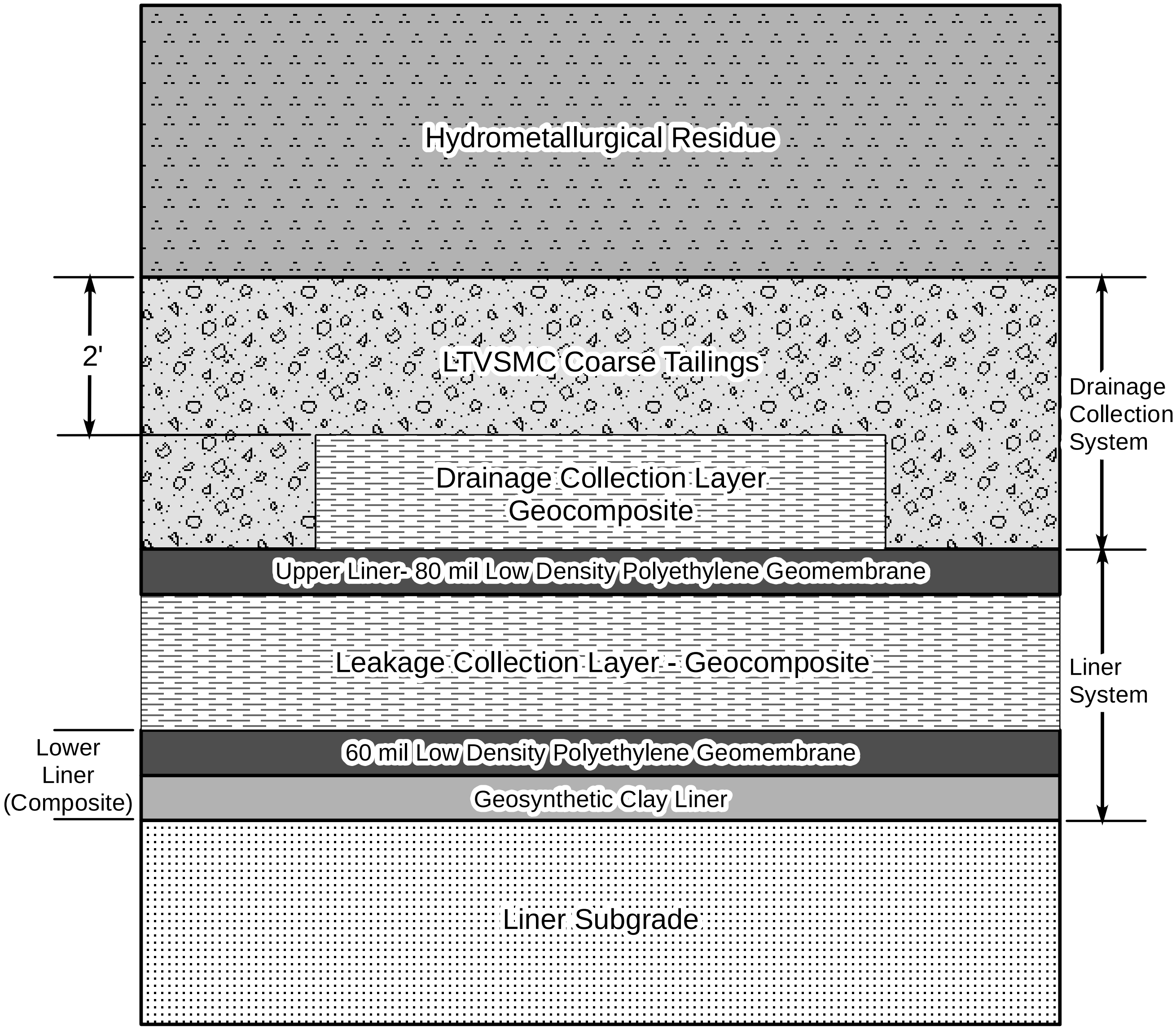
POLYMET MINING

FIGURE 10-8

HRF LOCATION RELATIVE
TO PLANT SITE FACILITIES
PERMIT TO MINE APPLICATION
HOYT LAKES, MINNESOTA

Scale: 0 500 1,000 Feet	Date: AUGUST 2016
Drafted by: DAT	Project No: 12P778

Path: X:\GB\IE\2012\12P778\GIS\mxd\PMA\Figure 10-8 HRF Location Plan.mxd Date: 9/12/2016



Notes
1. Drawing is not to scale.
2. Geocomposite and geomembrane type and thickness are preliminary.
3. Geocomposite consists of geonet and non-woven geotextile on top and bottom.
4. Source: Residue Management Plan V5, July 2016, included in Appendix 16 of the Application.

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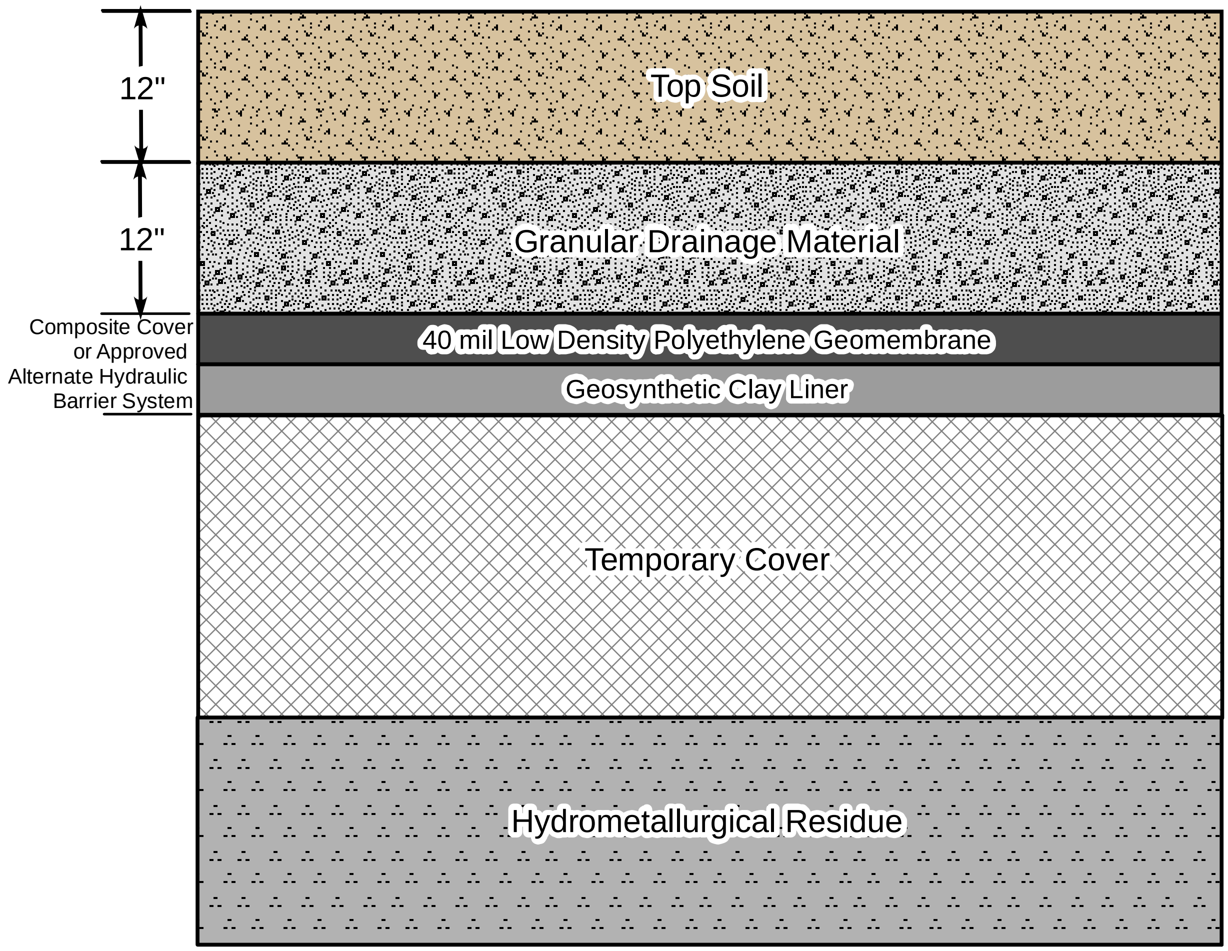
REVISED	DATE	BY	DESCRIPTION	FIGURE 10-9 HRF LINER AND DRAINAGE COLLECTION SYSTEM PERMIT TO MINE APPLICATION HOYT LAKES, MINNESOTA	
PREPARED BY: JSL			DATE: AUG. '16		
REVIEWED BY: RXW			DATE: AUG. '16	Scale: NOT TO SCALE	Date: AUGUST 2016
APPROVED BY: JOS1			DATE: AUG. '16	Drafted by: BJW1	Project No: 12P778

Path: X:\GB\IE\2012\12P778\GIS\mxd\PMA\Figure 10-9 HRF Liner.mxd Date: 9/2/2016



Notes
1. Drawing is not to scale.
2. Adapted from Residue Management Plan V5 included in Appendix 16 of the Application.

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PREPARED BY:	JSL	DATE: AUG. '16
REVIEWED BY:	RXW	DATE: AUG. '16
APPROVED BY:	JOS1	DATE: AUG. '16

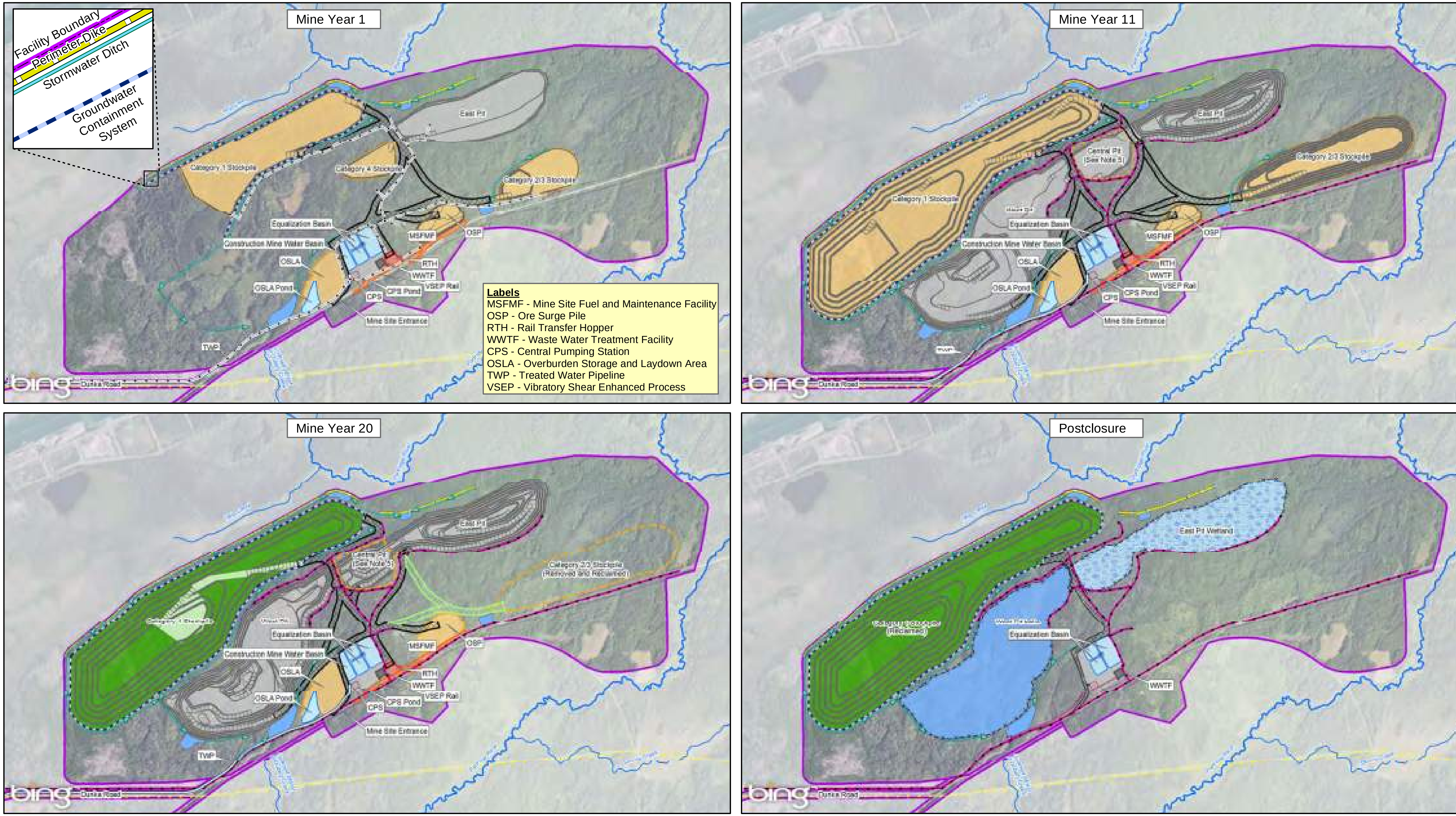
POLYMET MINING

FIGURE 10-10

HRF FINAL COVER SYSTEM
PERMIT TO MINE APPLICATION
HOYT LAKES, MINNESOTA

Scale:	NOT TO SCALE	Date:	AUGUST 2016
Drafted by:	BJW1	Project No:	12P778

Path: X:\GB\IE\2012\12P778\GIS\mxd\PMA\Figure 10-10 HRF Final Cover System Detail.mxd Date: 9/2/2016



Notes

1. Basemap from Esri and its data suppliers.
2. Project features from Barr Engineering Company.
3. Minnesota Power Substations and Power Lines supplied by the Minnesota Geospatial Information Office (MnGeo).
4. For clarity not all of the sumps, ditches, piping, and overflows are shown.
5. The Category 4 stockpile is removed, enabling the development of the Central Pit.
6. WWTF outfall pipeline installed during the postclosure maintenance phase.
7. Mine Water Ponds are lined with the exception of the OSLA Pond and Construction Mine Water Basin.

Legend

- Rivers and Streams
- Existing Electric Power Line[3]
- Proposed Transmission Lines (Mine Year 1)
- Proposed Transmission Lines (Post Mine Year 11)
- Treated Water Pipeline
- WWTF Outfall Pipeline[6]
- Stormwater Ditch
- Groundwater Containment System
- Perimeter Dike
- New Railroad Spur and Loadout
- Treated Mine Water Pond (Lined)
- Facility Footprint
- Mine Water Ponds[7]
- WWTF Buildings
- Haul Roads
- Active Stockpile
- Removed Stockpile
- Mine Pits
- Facility Boundary

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PREPARED BY:	JSL	DATE: SEP. '16
REVIEWED BY:	MJV2	DATE: SEP. '16
APPROVED BY:	JOS1	DATE: SEP. '16

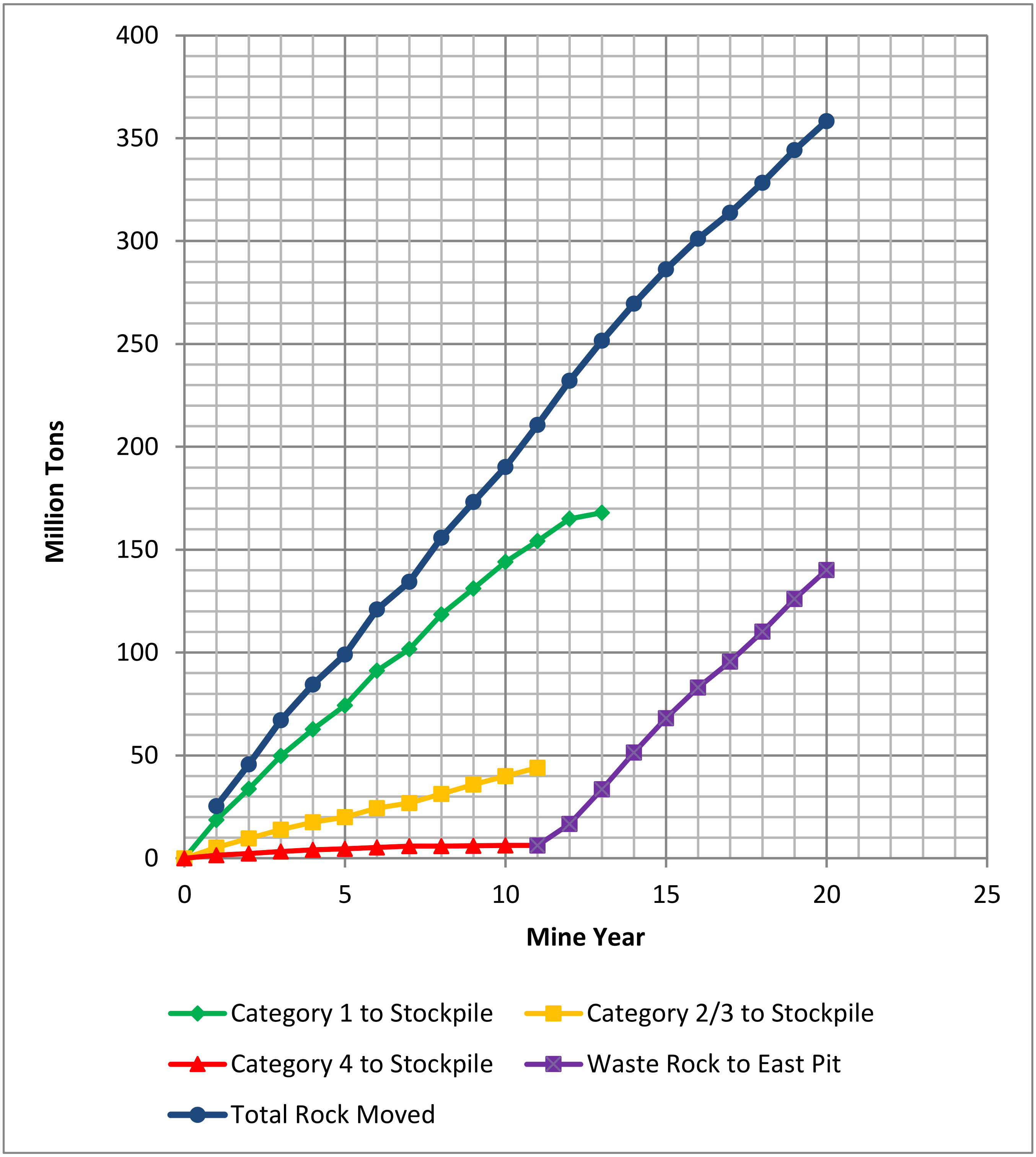
POLYMET MINING

FIGURE 10-11

MINE DEVELOPMENT AND LAYOUT SEQUENCE
MINE YEARS 1, 11, 20 AND POSTCLOSURE
PERMIT TO MINE APPLICATION
HOYT LAKES, MINNESOTA

Scale: 0 1,500 3,000 Feet	Date: SEPTEMBER 2016
Drafted by: DAT	Project No: 12P778

Path: X:\GB\IE\2012\12P778\GIS\mxd\PMA\Figure 10-11 Life of Mine Layout.mxd Date: 9/7/2016



Notes

1. The Total Rock Moved includes the movement of rock from the Catergory 2/3 and Category 4 stockpiles to the East Pit and continued mining from the West and Central Pits to the East Pit.
2. The Waste Rock to the East Pit includes the relocation of the material from the Category 2/3 and Category 4 stockpiles to the East Pit and continued mining from the West and Central Pits to the East Pit.

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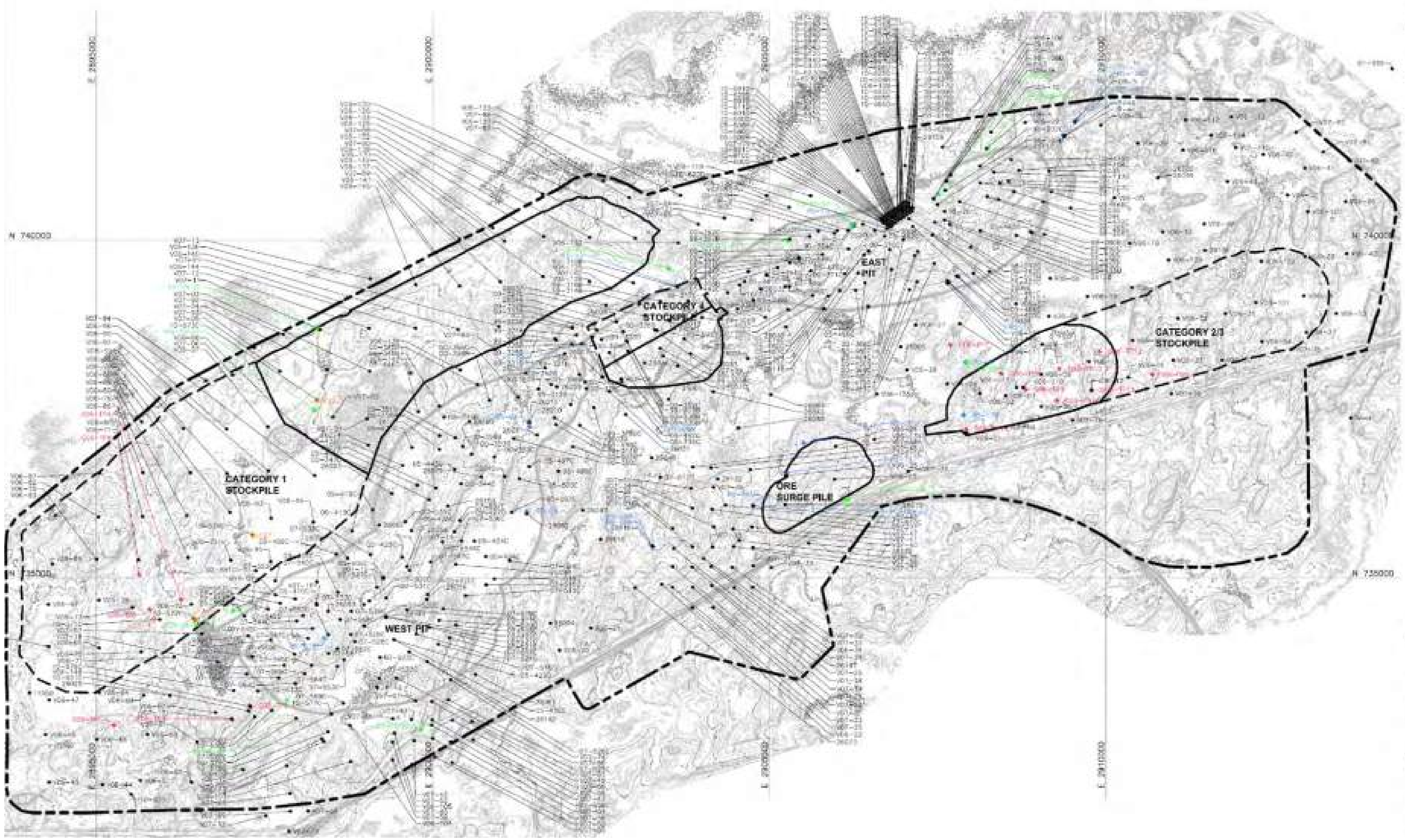
APPROVED BY: JOS1			DATE: AUG. '16

POLYMET MINING

FIGURE 10-12

WASTE ROCK PLACEMENT SCHEDULE
PERMIT TO MINE APPLICATION
HOYT LAKES, MINNESOTA

Scale: NOT TO SCALE	Date: AUGUST 2016
Drafted by: DAT	Project No: 12P778



LEGEND

- EXISTING GROUND TOPOGRAPHY
- MINE SITE BOUNDARY
- YEAR 11 PIT BOUNDARIES (SEE NOTE 1)
- YEAR 1 ORE, AND WASTE ROCK STOCKPILE OUTLINES (SEE NOTE 2)
- MAXIMUM ORE, AND WASTE ROCK STOCKPILE OUTLINES (SEE NOTE 2)
- GOLDER ASSOC. TEST PIT (2006)
- BARR ENGINEERING BOREHOLES (2005)
- BARR ENGINEERING BOREHOLES (2008)
- BORING OR GEOPHYSICAL SURVEY LOCATION
- AMERICAN ENGINEERING TESTING, INC. BOREHOLES (2010)

NOTES

1. OPEN PIT LAYOUTS PROVIDED BY BARR ENGINEERING IN OCTOBER 2011.
2. STOCKPILE LAYOUTS PROVIDED BY BARR ENGINEERING IN APRIL 2011 AND MODIFIED BY GOLDER.
3. SEE GENERAL NOTES AND LEGEND ON DRAWING 002.
4. SEE GEOTECHNICAL DATA PACKAGE VOLUME 3 FOR DETAILS ON TEST PITS, BOREHOLES AND GEOPHYSICAL SURVEYS.

REFERENCES

1. EXISTING GROUND TOPOGRAPHY PROVIDED BY BARR ENGINEERING, AUGUST 2011.
2. COORDINATE SYSTEM REFERENCE IS NAD83 MINNESOTA STATE PLANE NORTH
3. VERTICAL DATUM REFERENCE IS FEET ABOVE MEAN SEA LEVEL (AMSL).

NOTES
1. Source: Permit Support Drawings - Categories 1, 2/3 and 4 Stockpiles and Ore Surge Pile Design included in Appendix 4 of the Application.

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APPROVED BY:	JOS1			DATE: AUG.'16

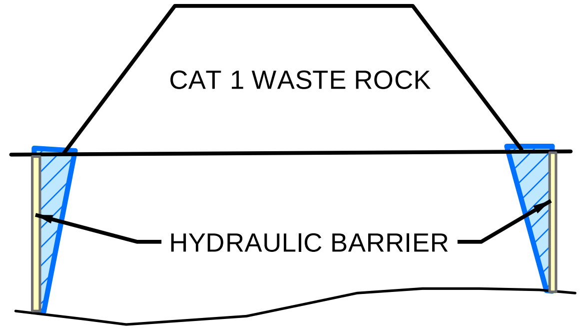
POLYMET MINING

FIGURE 10-13
MINE SITE GEOTECHNICAL INVESTIGATION LOCATIONS
PERMIT TO MINE APPLICATION
HOYT LAKES, MINNESOTA

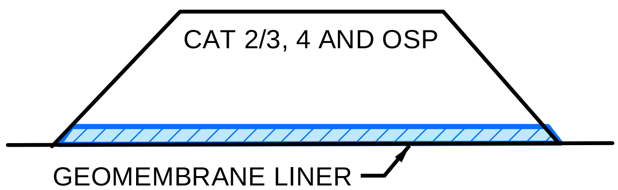
Scale: AS SHOWN	Date: AUGUST 2016
Drafted by: DAT	Project No: 12P778

Path: X:\GB\IE\2012\12P778\GIS\mxd\PMA\Figure 10-13 Mine Site Geotechnical Investigation Locations.mxd Date: 9/2/2016

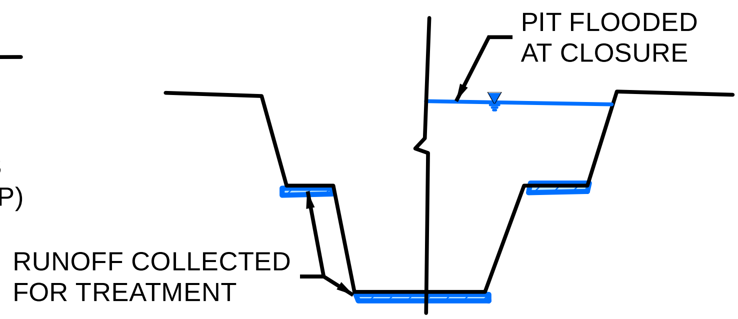
(1) STOCKPILE FOUNDATION MATERIAL
BELOW THE WATER TABLE



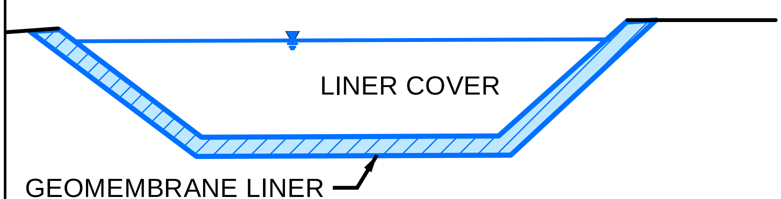
(2) CAT 1 WASTE ROCK STOCKPILE
GROUNDWATER CONTAINMENT SYSTEM



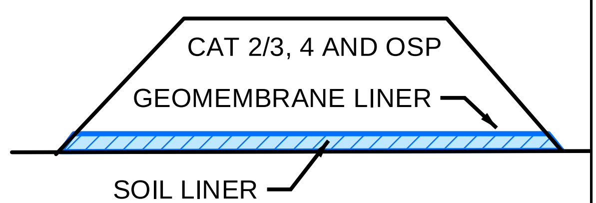
(3) TEMPORARY DRAINAGE LAYER ABOVE
THE GEOMEMBRANE LINER OF THE CAT 2/3
AND 4 STOCKPILE AND ORE SURGE PILE (OSP)



(4) IN-PIT HAUL ROAD TOP DRESSING



(5) MINE WATER POND
LINER COVER MATERIAL



(6) COMPACTED SOIL LINER BELOW A
TEMPORARY GEOMEMBRANE LINER

Legend

Saturated Overburden

Foth Infrastructure & Environment, LLC

REVISED	DATE	BY	DESCRIPTION

PREPARED BY: JSL	DATE: AUG. '16
REVIEWED BY: RXW	DATE: AUG. '16
APPROVED BY: JOS1	DATE: AUG. '16

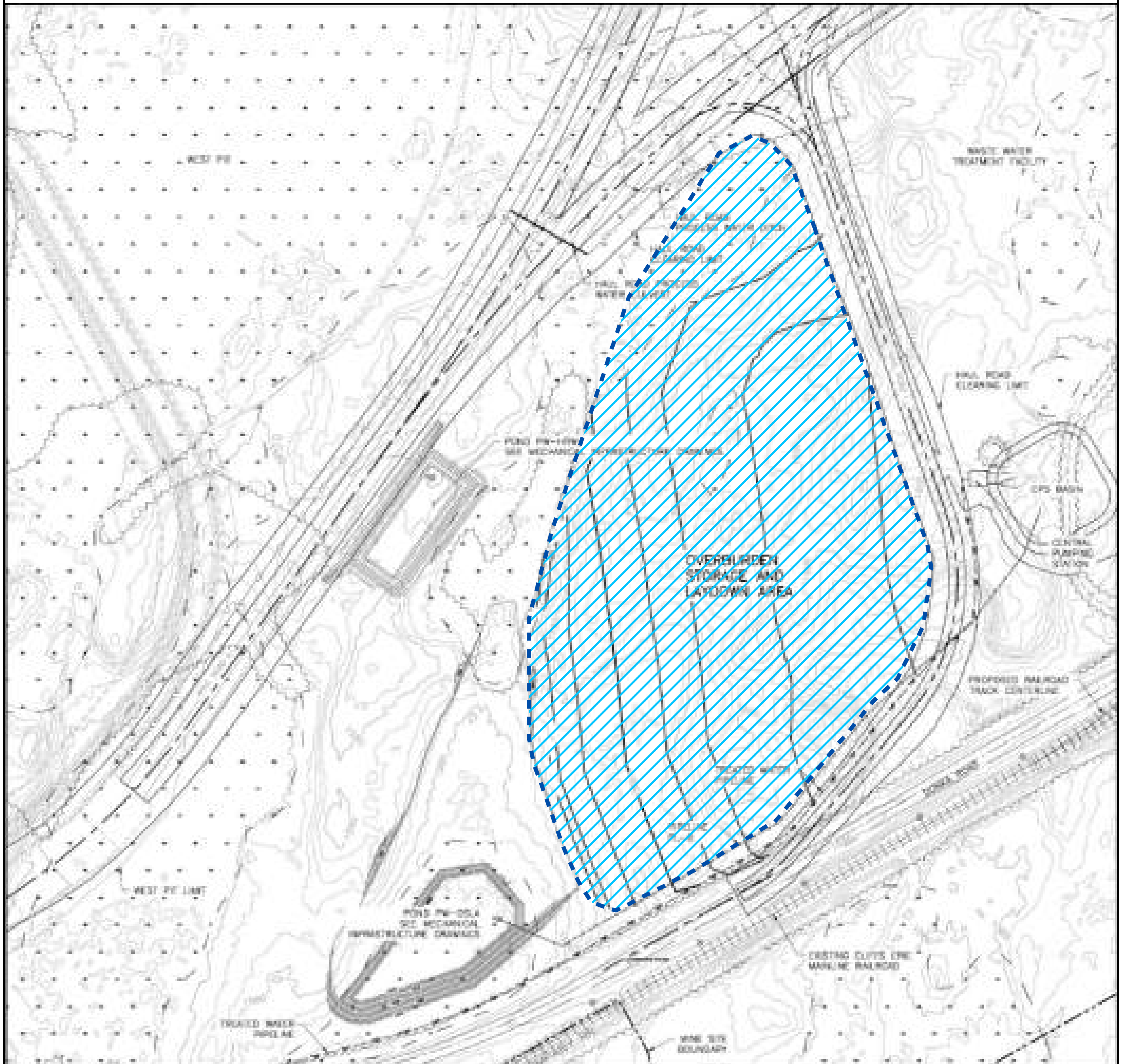
POLYMET MINING

FIGURE 10-14

POTENTIAL USES OF SATURATED
MINERAL OVERBURDEN
PERMIT TO MINE APPLICATION
HOYT LAKES, MINNESOTA

Scale: NOT TO SCALE	Date: AUGUST 2016
Drafted by: DAT	Project No: 12P778

Path: X:\GB\IE\2012\12P778\GIS\mxd\PMA\Figure 10-14 Potential Uses of Saturated Overburden.mxd Date: 8/26/2016



2 PLAN: OVERBURDEN STORAGE AND LAYDOWN AREA

0 150 300
SCALE IN FEET

Notes
1. Adapted from Permit Support Drawings - Mine Site and Dunka Road Earthwork included in Appendix 3 of the Application.

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REVIEWED BY: RXW DATE: AUG. '16
APPROVED BY: JOS1 DATE: AUG. '16

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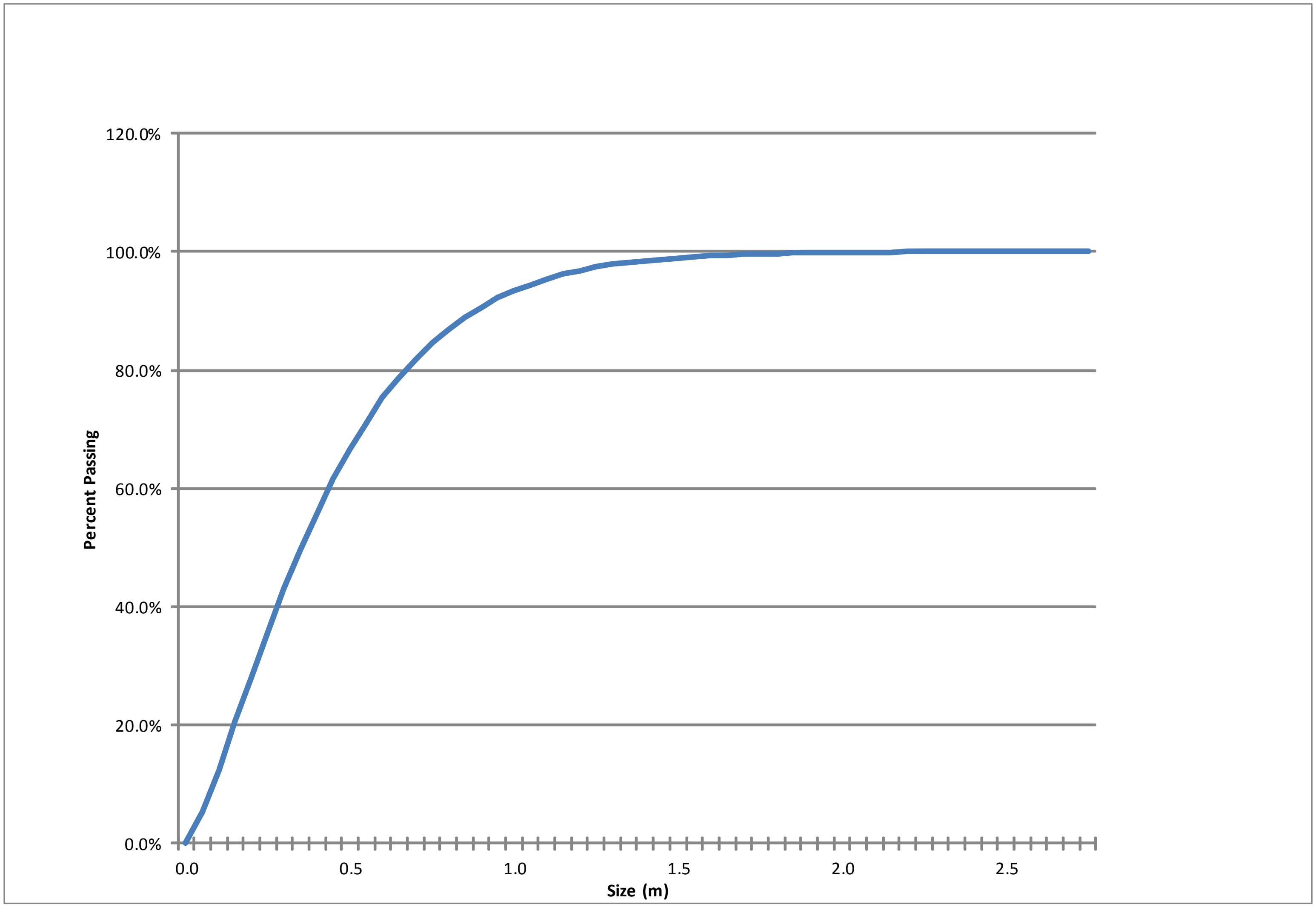
FIGURE 10-15
OVERBURDEN STORAGE AND LAYDOWN AREA GRADING PLAN
PERMIT TO MINE APPLICATION
HOYT LAKES, MINNESOTA

Scale: NOT TO SCALE
Date: AUGUST 2016
Drafted by: DAT
Project No: 12P778

Path: X:\GB\IE\2012\12P778\GIS\mxd\PMA\Figure 10-15 Overburden Storage and Laydown Grading Plan.mxd Date: 9/2/2016



Notes

1. The simulated blast curve predicts the particle size distribution of the blasted waste rock.
2. Source: Rock and Overburden Management Plan, V8, July 2016 in Appendix 16 of the Application.

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PREPARED BY: MJV2				DATE: AUG. '16
REVIEWED BY: JSL				DATE: AUG. '16
APPROVED BY: JOS1				DATE: AUG. '16

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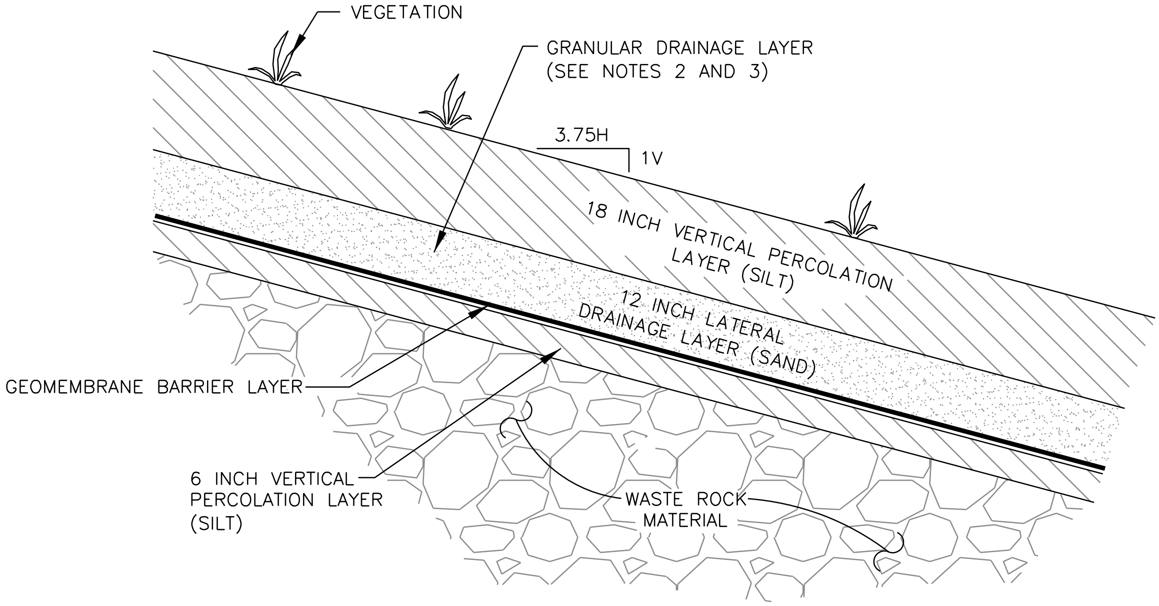
FIGURE 10-16

WASTE ROCK BLAST CURVE
PERMIT TO MINE APPLICATION
HOYT LAKES, MINNESOTA

Scale: NOT TO SCALE	Date: AUGUST 2016
Drafted by: DAT	Project No: 12P778

Path: X:\GB\IE\2012\12P778\GIS\mxd\PMA\Figure 10-16 Blast Curve Data.mxd Date: 9/2/2016



NOTES:

1. SOURCE: PERMIT SUPPORT DRAWINGS – CATEGORIES 1, 2/3 AND 4 STOCKPILES AND ORE SURGE PILE DESIGN INCLUDED IN APPENDIX 4 OF THE APPLICATION.

2. ON 1% SLOPE AREAS, PLACE 4 INCH DIAMETER PERFORATED CORRUGATED POLYETHYLENE PIPE (CPEP) WITH FILTER FABRIC SOCK AT 75 FOOT SPACING TO FACILITATE DRAINAGE OF GRANULAR DRAINAGE LAYER TO TOP SURFACE CHANNEL. PIPE LOCATION TO BE FIELD FIT.

3. AT BENCHES, PLACE 4 INCH PERFORATED CPEP DRAIN PIPE WITH FILTER FABRIC SOCK AT BASE OF COVER SYSTEM GRANULAR DRAINAGE LAYER AT SLOPE–BENCH INTERSECTION WITH OUTFLOW DIRECTED TO DOWNCHUTE CHANNELS.

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REVISED	DATE	BY	DESCRIPTION	FIGURE 10–17 TYPICAL CATEGORY 1 STOCKPILE RECLAMATION COVER DETAIL PERMIT TO MINE APPLICATION HOYT LAKES, MINNESOTA	
PREPARED BY: JSL			DATE: AUG. '16		
REVIEWED BY: MJV2			DATE: AUG. '16	Scale: NOT TO SCALE	Date: AUGUST 2016
APPROVED BY: JOS1			DATE: AUG. '16	Drafted By: JRB2	Project No: 12P778

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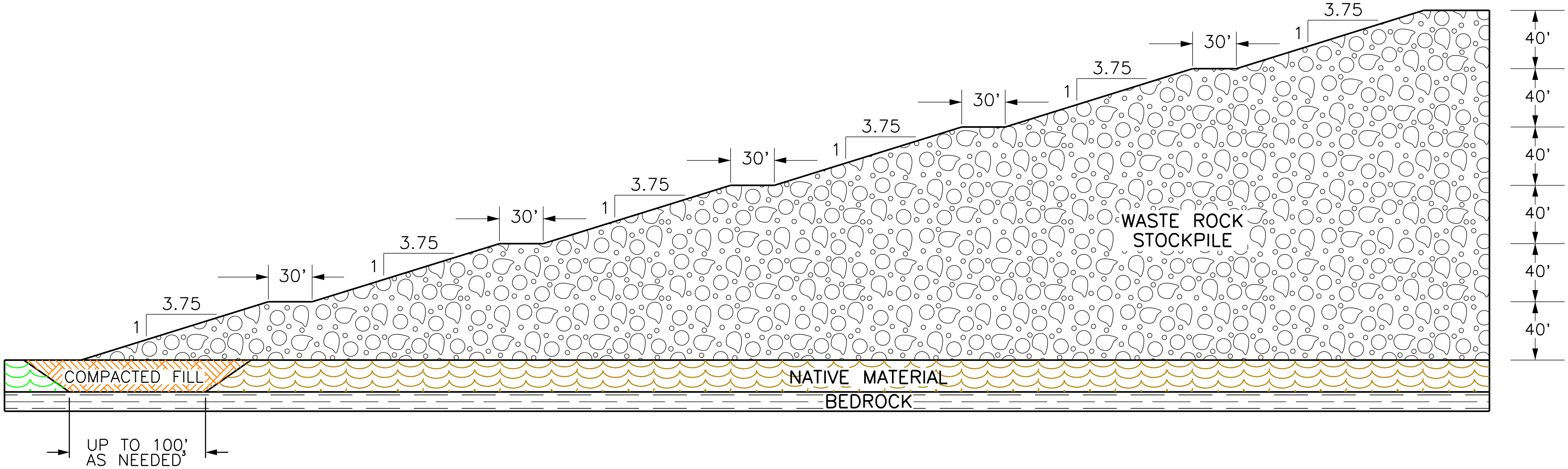
9/2/2016 8:45:58 AM jow



NOTES:

1. SOURCE: GEOTECHNICAL DATA PACKAGE, VOLUME 3 – MINE SITE STOCKPILES, V5, JULY 2016, INCLUDED IN APPENDIX 16 OF THE APPLICATION.

2. COMPACTED FILL WILL BE USED TO REPLACE UNSUITABLE SOILS THAT ARE PRESENT ALONG THE TOE OF STOCKPILE.

3. GROUNDWATER CONTAINMENT SYSTEM DESIGNED TO TIE INTO STOCKPILE TOE. SEE POLYMET CATEGORY 1 STOCKPILE GROUNDWATER CONTAINMENT SYSTEM, PERMIT APPLICATION SUPPORT DRAWINGS, INCLUDED IN APPENDIX 4 OF THE APPLICATION.

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REVIEWED BY: RXW/MJV2	DATE: AUG. '16	
APPROVED BY: JOS1	DATE: AUG. '16	

POLYMET MINING

FIGURE 10–18
CATEGORY 1 STOCKPILE
FINAL RECLAMATION CONFIGURATION
PERMIT TO MINE APPLICATION
HOYT LAKES, MINNESOTA

Scale: NOT TO SCALE	Date: AUGUST 2016
Drafted By: JRB2	Project No: 12P778

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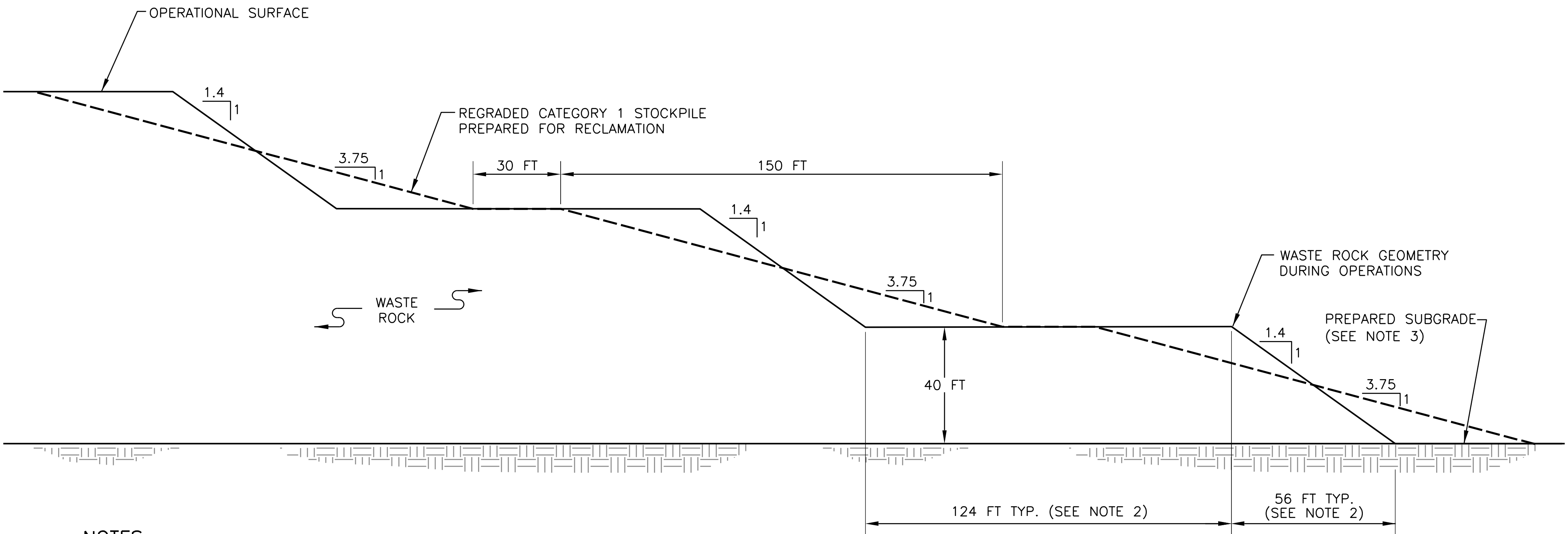
9/2/2016 8:32:33 AM jow



NOTES:

1. ADAPTED FROM PERMIT SUPPORT DRAWINGS – CATEGORIES 1, 2/3 AND 4 STOCKPILES AND ORE SURGE PILE DESIGN INCLUDED IN APPENDIX 4 OF THE APPLICATION.
2. STOCKPILE GEOMETRY DURING OPERATIONS BASED ON ASSUMED WASTE ROCK ANGLE OF REPOSE OF 35.5 DEGREES (1.4H:1V).
3. GEOTECHNICALLY UNSTABLE SOILS TO BE REMOVED AND REPLACED WITH COMPACTED STRUCTURAL FILL WITHIN 100 FT. OF CATEGORY 1 STOCKPILE PERIMETER LIMITS.
4. GROUNDWATER CONTAINMENT SYSTEM DESIGNED TO TIE INTO STOCKPILE TOE. SEE POLYMET CATEGORY 1 STOCKPILE GROUNDWATER CONTAINMENT SYSTEM, PERMIT APPLICATION SUPPORT DRAWINGS, INCLUDED IN APPENDIX 4 OF THE APPLICATION.

POLYMET MINING

Foth Infrastructure & Environment, LLC

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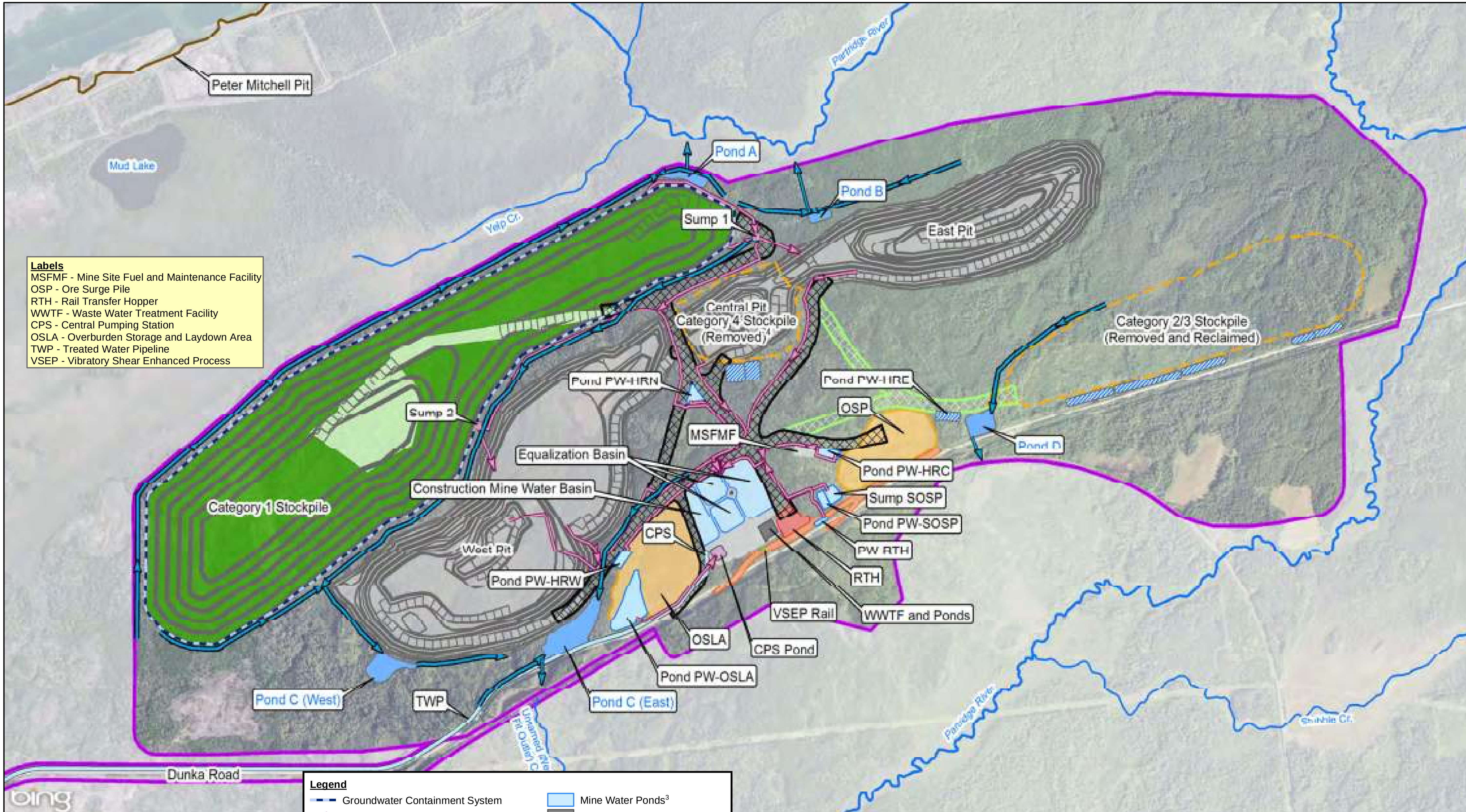
PREPARED BY: JSL	DATE: AUG. '16	
REVIEWED BY: MJV2	DATE: AUG. '16	
APPROVED BY: JOS1	DATE: AUG. '16	

POLYMET MINING

FIGURE 10-19
CATEGORY 1 STOCKPILE
TYPICAL GEOMETRY DURING OPERATIONS
AND REGRADED FOR RECLAMATION
PERMIT TO MINE APPLICATION

Scale: NOT TO SCALE	Date: AUGUST 2016
Drafted By: JRB2	Project No: 12P778

X:\GB\IE\2012\12P778\cad\figures\PMA\Figure 10-19 Cat-1_stockpile_geometry_regraded-reclaim.dgn
9/2/2016 8:41:44 AM jow



Notes

1. Basemap from Esri and its data suppliers.
2. Project features supplied by Barr Engineering Company.
3. Mine Water Ponds are lined with the exception of the OSLA Pond and Construction Mine Water Basin.
4. The Category 4 stockpile is removed, enabling the development of the Central Pit.
5. For clarity not all of the sumps, ditches, piping, and overflows are shown.

Legend

- Groundwater Containment System
- Mine Water Pipeline
- Stormwater Drainage/Flow Direction
- TWP
- Rivers and Streams
- New Railroad Spur and Loadout Footprint
- Rail Transfer Hopper
- Stormwater Ponds
- Treated Mine Water Pond (Lined)
- Reclaimed Ponds
- Mine Water Ponds[3]
- WWTF Buildings
- Haul Roads
- Reclaimed Stockpile
- Reclaimed Haul Roads
- Active Stockpile
- Mine Pits
- Category 1 - Open Stockpile
- Category 1 - Covered Stockpile
- Facility Boundary

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REVISED	DATE	BY	DESCRIPTION

PREPARED BY: JSL	DATE: AUG. '16	
REVIEWED BY: RXW	DATE: AUG. '16	Scale: 0 750 1,500 Feet
APPROVED BY: JOS1	DATE: AUG. '16	Drafted by: DAT

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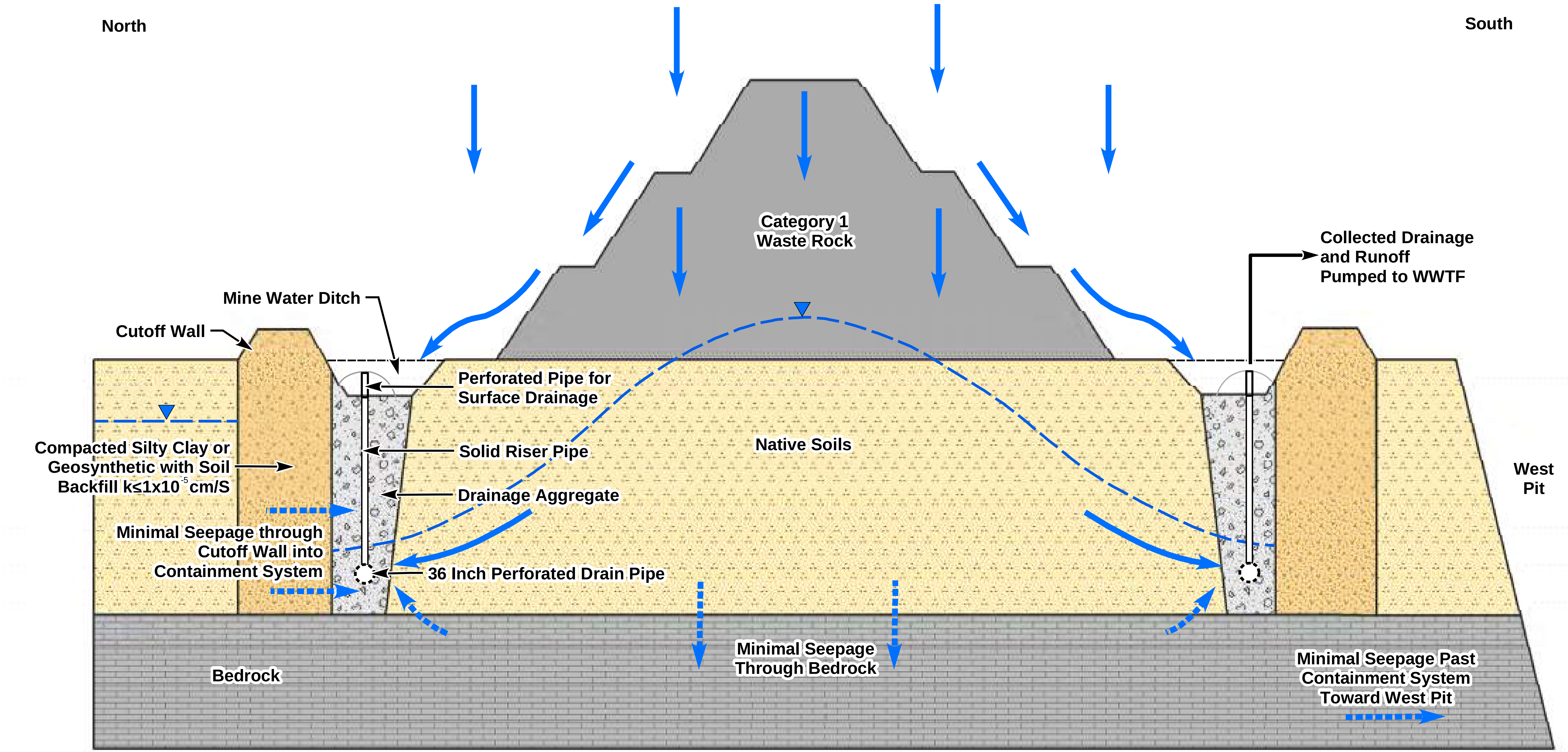
FIGURE 10-20
CATEGORY 1 STOCKPILE
GROUNDWATER CONTAINMENT SYSTEM
PERMIT TO MINE APPLICATION
HOYT LAKES, MINNESOTA

Date: AUGUST 2016
Project No: 12P778

Path: X:\GB\IE\2012\12P778\GIS\mxd\PMA\Figure 10-20 Cat 1 WR Groundwater Containment.mxd Date: 9/2/2016

Category 1 Stockpile and Groundwater Containment System During Operations

~13.6 Inches per Year (361 Gallons per Minute) Infiltration from Precipitation



Notes

1. k = hydraulic conductivity in centimeters per second
   GCS = Groundwater Containment System
2. Source: Rock and Overburden Management Plan V8, July 2016, included in Appendix 16 of the Application.

Legend

Water Table

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REVISED	DATE	BY	DESCRIPTION

PREPARED BY:	DRD	DATE:	AUG. '16
REVIEWED BY:	MJV2	DATE:	AUG. '16
APPROVED BY:	JOS1	DATE:	AUG. '16

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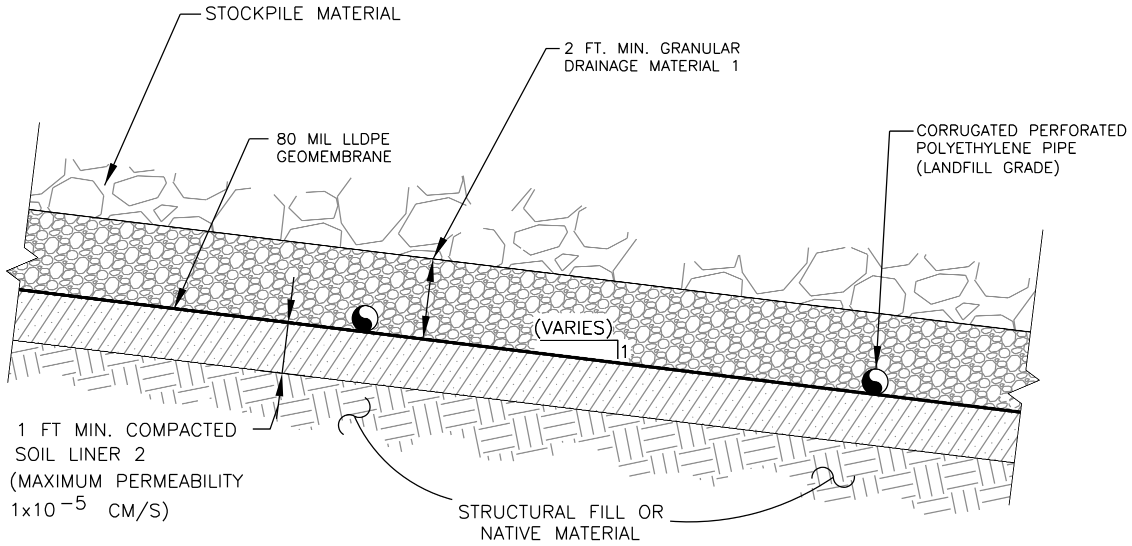
FIGURE 10-21
CATEGORY 1 STOCKPILE GROUNDWATER CONTAINMENT SYSTEM CROSS SECTION DURING OPERATIONS
PERMIT TO MINE APPLICATION
HOYT LAKES, MINNESOTA

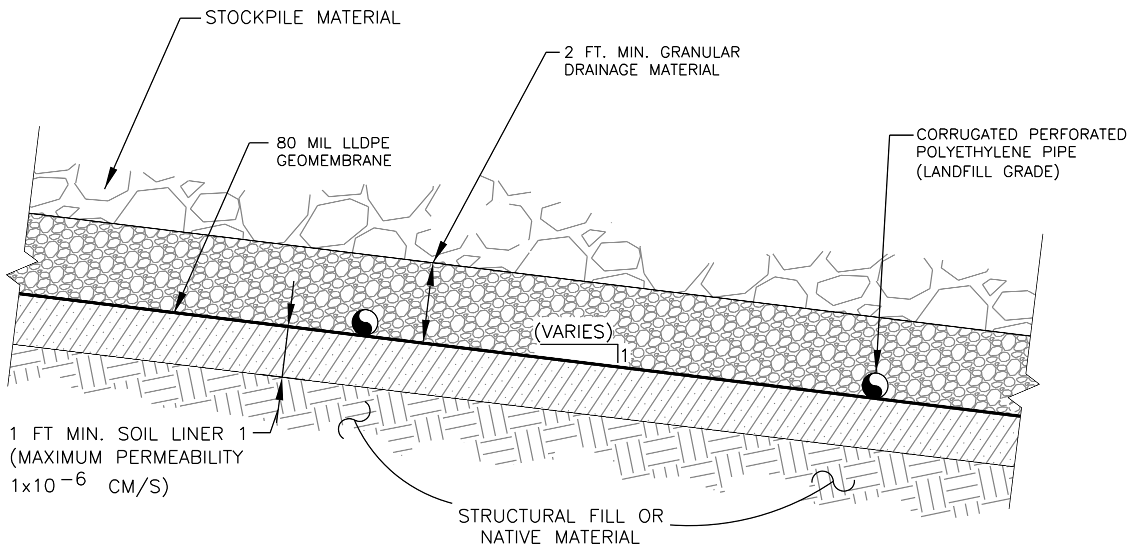
Scale:	NOT TO SCALE	Date:	AUGUST 2016
Drafted by:	BJW1	Project No:	12P778

Path: X:\GB\IE\2012\12P778\GIS\mxd\PMA\Figure 10-21 Cat 1 Stockpile GCS during Operations.mxd Date: 9/2/2016

CATEGORY 2/3 STOCKPILE LINER



CATEGORY 4 STOCKPILE AND ORE SURGE PILE LINER



NOTE:

1. SOURCE: PERMIT SUPPORT DRAWINGS – CATEGORIES 1, 2/3 AND 4 STOCKPILES AND ORE SURGE PILE DESIGN INCLUDED IN APPENDIX 4 OF THE APPLICATION.

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REVISED	DATE	BY	DESCRIPTION

PREPARED BY:	JSL	DATE: AUG. '16
REVIEWED BY:	MJV2	DATE: AUG. '16
APPROVED BY:	JOS1	DATE: AUG. '16

POLYMET MINING

FIGURE 10-22
CATEGORY 2/3 AND 4 WASTE ROCK STOCKPILE AND ORE SURGE PILE LINER SYSTEMS
PERMIT TO MINE APPLICATION
HOYT LAKES, MINNESOTA

Scale:	NOT TO SCALE	Date:	AUGUST 2016
Drafted By:	JRB2	Project No:	12P778

X:\GB\IE\2012\12P778\cad\figures\PMA\Figure 10-22 Cat_2-3-4_stockpile-ore_surge_pile_liner.dgn
9/2/2016 8:40:27 AM jow

11 Water Management

In accordance with Minnesota Rules, part 6132.0200, PolyMet designed the Project “to control possible adverse environmental effects of nonferrous metallic mineral mining, to preserve natural resources, and to encourage planning of future land utilization.” PolyMet will also conduct its operations "in a manner that will reduce impacts to the extent practicable, mitigate unavoidable impacts, and leave the Mining Area in a condition that protects natural resources and minimizes, to the extent practicable, the need for maintenance.” In addition, PolyMet designed and will construct and operate the Project to minimize hydrologic impacts associated with its facilities, including the FTB, HRF, and stockpiles.

The overall Project water management strategy includes capturing water at the Mine Site for use at the Plant Site, as well as capturing and reusing water within various Plant Site facilities to maximize water recycling and minimize discharges to the environment. The Project design includes systems for managing and monitoring water to comply with applicable surface water and groundwater quality standards at appropriate compliance points. PolyMet designed the water management systems to achieve compliance based on modeling of expected water quantity and quality. Additionally, PolyMet has created adaptive management and contingency mitigation procedures that it will utilize as necessary to maintain regulatory compliance.

PolyMet's water management strategy will require it to obtain permits in addition to the PTM, including one or more MPCA NPDES/SDS permits, MPCA Stormwater permits, one or more MDNR Dam Safety permits, and one or more MDNR Water Appropriation permits, along with a number of other non-water related permits and approvals. Once issued, these water-related permits will contain conditions and performance standards that, together with the Project design, will minimizes hydrologic impacts from the Project. Because these related permits will contain the detailed requirements relating to, among other things, water quality and appropriation, this section is not intended to address those independent statutory and regulatory requirements. Rather, this section provides a summary of the Project's water management, which will be presented in more detail in the related permits and associated applications, so as to demonstrate that the Project meets the water-related standards set forth in the nonferrous metallic mineral mining rules. While the information contained in this section is consistent with the material presented in the other permit applications, PolyMet recognizes the specific requirements associated with water management may evolve during permitting, and the final agency-approved permit conditions will take precedence over the information summarized in this section.

PolyMet proposes to manage water in 11 categories:

- mine water
- treated mine water
- process water
- sewage

- tailings basin water
- tailings basin seepage
- HRF water
- plant reservoir water
- industrial stormwater
- construction stormwater
- non-contact stormwater

Table 11-1 presents project-specific definitions for each category of water and its associated terminology.

The remainder of Section 11 is organized as follows. Section 11.1 provides an overall summary of construction-related water management, including a description of procedures and BMPs for managing construction stormwater at various Project locations. Section 11.2 describes the water balance for the Project once operations commence. Sections 11.3 and 11.4 focus on water management at the Mine Site and the Plant Site, respectively, during operations. Section 11.5 provides information on water management in the Transportation and Utility Corridors and Colby Lake Pipeline Corridor. Finally, Section 15 discusses water management after operations cease.

11.1 Construction Stormwater Management

Prior to start of construction, PolyMet will submit permit applications requesting authorization to discharge stormwater associated with pre-operation construction activities under the Minnesota NPDES/SDS Construction Stormwater General Permit (Permit No. MNR100001). For construction activities occurring during Project operations, the NorthMet Project NPDES/SDS Permit Application requested that Construction Stormwater General Permit coverage be incorporated into the Project’s individual NPDES/SDS Permit(s).

Stormwater associated with construction activities will be managed with controls and BMPs, including erosion and sediment control measures, construction water management control measures, dust control measures, and construction site restoration practices. Prior to the start of each phase of construction activities, these management measures will be incorporated into a Construction SWPPP based on detailed construction plans and in accordance with Construction Stormwater General Permit requirements.

11.2 Project Water Balance

Figure 11-1 through Figure 11-4 depict the Project water balance in Mine Years 10, 25, and 55. These figures provide conceptual diagrams showing various water inputs to and outputs from the Project, along with estimated flows for those years. The estimated values were compiled from water flow models developed for the Project. The general flow of water for the Project is summarized below.

Mine water at the Mine Site is comprised of water that has contacted surfaces disturbed by mining activities, such as drainage collected on stockpile liners; pit dewatering water; and runoff contacting ore, waste rock, and Mine Site haul road surfaces. PolyMet will manage runoff from construction dewatering of saturated mineral overburden as construction mine water. The Project will collect mine water across the Mine Site in sumps and ponds, and then pump the collected water to the WWTF for treatment (with the exception of runoff from the OSLA, which will be pumped directly to the CPS Pond). Construction mine water will be pumped to the construction mine water basin at the WWTF for settling. Treatment at the WWTF of mine water will include chemical precipitation and membrane filtration. The WWTF will discharge treated water to the CPS Pond, where it will mix with water from the OSLA Pond and the Construction Mine Water Basin; this combined water will be referred to as “treated mine water.” From the CPS Pond, PolyMet will pump the treated mine water through the TWP to the FTB.

The FTB will serve as the primary collection point for storage and recycling of water from the Mine Site and Plant Site. The FTB will receive process water from the Beneficiation Plant, treated mine water pumped from the Mine Site via the TWP, precipitation, and some of the water collected by the FTB seepage capture systems, along with other minor sources. Flotation Tailings will settle in the FTB Pond, and decanted tailings basin water will be recycled to the Beneficiation Plant. The Beneficiation Plant will also draw make-up water, as needed, from the Plant Reservoir, which will receive water from Colby Lake. Some of the water collected by the FTB seepage capture systems will be pumped to the WWTP for treatment and discharge. The WWTP will use membrane separation treatment technology. The WWTP will discharge treated effluent to three streams: Second Creek, Unnamed Creek, and Trimble Creek.

After the Hydrometallurgical Plant is commissioned, water will be pumped within a closed system between the HRF and the Hydrometallurgical Plant. The Hydrometallurgical Plant will discharge Residue and associated process water to the HRF, where it will mix in the HRF Pond with stormwater collected within the HRF and water collected by the leakage collection component of the HRF’s double liner system. Residue will settle in the HRF Pond, and decanted HRF water will be recycled to the Hydrometallurgical Plant. The Hydrometallurgical Plant will draw make-up water, as needed, from the Plant Reservoir, which will receive water from Colby Lake.

11.3 Mine Site Water Management and Infrastructure

Water management at the Mine Site will include collecting and managing mine water, stormwater, and sewage, and separating stormwater from mine water. The following sections describe the existing site conditions, and the water management systems related to mine water sewage, and stormwater during operations.

11.3.1 Existing Conditions

The Mine Site naturally drains toward the Partridge River, a tributary of the St. Louis River. Specifically, most of the Mine Site naturally drains to the south through culverts under Dunka Road and the adjacent Main Rail Line, then into the Partridge River downstream of the Dunka Road crossing. Runoff from the northernmost portion of the Mine Site generally drains north into the One Hundred Mile Swamp and Yelp Creek. These water bodies and associated wetlands form the headwaters of the Partridge River, which meanders around the eastern end of the Mine Site before turning southwest. The Mine Site is currently a mixture of forested upland and wetland areas, with the most common wetland types consisting of coniferous bog, shrub swamp, and coniferous swamp.

11.3.1.1 Surface Water

Tributaries to the Partridge River above Colby Lake and immediately downstream of the Mine Site include Yelp Creek and an Unnamed Creek downstream of the future West Pit overflow. Other tributaries located between the Mine Site and Colby Lake that will not be directly or indirectly affected by the Mine Site, from upstream to downstream, are Stubble Creek, the south branch of the Partridge River, Colvin Creek, Wetlegs Creek, Longnose Creek, three Unnamed Creeks, and Wyman Creek. Daily flow data are available for the Partridge River from the USGS gaging station 04015475 (Partridge River above Colby Lake at Hoyt Lakes) from years 1978 through 1987. During this period, hydrology was affected by the periodic and variable dewatering of the Peter Mitchell Pit by Northshore Mining Company, located at the headwaters of the Partridge River upstream of the Mine Site. Surface water gaging locations are shown on Figure 11-5.

Recent (2011-present) daily flow data near the Mine Site is available from MDNR gage H03155002, located on the Partridge River at the Dunka Road crossing (surface water monitoring location PM-3/SW003). This data is not directly comparable to the USGS gage 04015475 data due to the large difference in tributary watershed size and location. Based on its location, the MDNR gage H03155002 is more heavily influenced by Northshore Mining Company's dewatering of the Peter Mitchell Pit than the USGS gage 04015475 was when it was operational.

PolyMet has monitored surface water quality and quantity within the Partridge River watershed since 2004, and results through 2015 are summarized in PolyMet's NPDES/SDS Permit Application.

11.3.1.2 Groundwater

Groundwater at the Mine Site is located in both the surficial aquifer and bedrock units. Saturated conditions exist within the unconsolidated deposits (surficial aquifer), and the depth to groundwater is typically less than 10 feet with recharge occurring primarily via direct infiltration of precipitation. Groundwater flow in the surficial aquifer is generally southerly toward the

Partridge River and its tributaries. The thinness of the surficial aquifer, a bouldery till of the Rainy Lobe, ultimately controls the ability of the aquifer to transmit water. Due to the surficial aquifer being thin, groundwater flow paths are generally short. Shallow groundwater flow can also be interrupted by bedrock outcrops, which force local deviations in the flow field.

Groundwater in the upper portions of the bedrock is hydraulically connected, to some degree, with the overlying surficial aquifer. Groundwater in the upper bedrock also flows generally toward the south. Recharge to the bedrock is by infiltration of precipitation in outcrop areas and seepage from the overlying surficial aquifers. The bedrock units have low primary hydraulic conductivity.

PolyMet has been monitoring baseline groundwater quality through a network of monitoring wells in the unconsolidated surficial aquifer and bedrock since 2005, and results through 2015 are summarized in PolyMet's NPDES/SDS Permit Application.

11.3.2 Mine Water Management and Infrastructure

This section describes the design and operation of the infrastructure that PolyMet will use to manage mine water at the Mine Site in accordance with the provisions of the PTM Regulations and other applicable regulations, including those applicable under MPCA permitting requirements. Mine water is defined in Table 11-1. The Mine Site and associated mine water management infrastructure are shown on Figure 11-6. A conceptual overview of the mine water management system is shown on Figure 11-7.

The Project will capture mine water with a series of ditches, dikes, and stockpile foundation liners, along with the Category 1 Stockpile Groundwater Containment System, to keep this water separate from stormwater. PolyMet will manage the captured mine water through a system of lined sumps and ponds, and piping systems to send the water to the WWTF and CPS. Components of the mine water management system at the end of Mine Years 1, 2, and 11 are shown on Figure 11-8, Figure 11-9, and Figure 11-10, respectively.

PolyMet designed this water management system to route mine water by gravity flow to mine water sumps or ponds that are designed to contain water generated by design storms occurring within the various drainage areas. The design event used for each type of infrastructure is based on the expected water quality and overflow potential for the infrastructure. The following sections describe the design and operation of the major components of the mine water management system.

11.3.2.1 Pit Dewatering

PolyMet will dewater the Mine Pits during mining operations. Pit inflows will consist of groundwater and runoff from areas within the pits. PolyMet will direct this water to sumps within the pits where it will be collected and pumped to the WWTF.

PolyMet will utilize dewatering sumps as part of mine operations. The pit floors will be sloped toward water collection sumps which will be fitted with pumps and connections to the mine water pipelines. The mine water pipelines will convey the water to the WWTF.

PolyMet will adjust the size and location of the sumps, pumps, and pipes as the pits expand in size and depth, requiring periodic evaluation of the pumping system. PolyMet designed the Mine Pit pump capacities to remove within three days the water resulting from a peak annual snowmelt runoff event (approximately equivalent to the runoff volume expected during a 5-year, 24-hour storm event). In the event that a storm exceeds the sump and pump capacity, PolyMet will use the lowest level of the pit to store the excess water, with mining operations relocated to higher levels or delayed until water levels are pumped down. The Water Management Plan – Mine (Appendix 16.9) contains further discussion of pit dewatering, including estimated average annual and peak inflow rates, and pump and sump capacities.

11.3.2.2 Stockpile Drainage

PolyMet will store overburden, waste rock, and ore in stockpiles at the Mine Site. PolyMet will deploy engineered systems for stockpiles containing Category 1, 2, 3, and 4 waste rock, ore, and saturated mineral overburden to collect drainage. PolyMet will store the unsaturated mineral overburden and peat in stockpiles in the OSLA, or will use these materials for construction or reclamation.

All three temporary stockpiles (the Category 2/3 Waste Rock Stockpile, the Category 4 Waste Rock Stockpile, and the OSP) will be lined and will have engineered systems to collect drainage. The temporary stockpiles will be structurally sound, will have erosion controls on the stockpile surface, and will be designed to comply with Minnesota Rules, part 6132.2200 to provide for the collection of substantially all water, and Minnesota Rules, part 6132.2400 to minimize hydrologic impacts. PolyMet will utilize an engineered system for the stockpile liners comprised of, from the bottom up, a foundation; underdrain system with sumps, if required; an impermeable composite liner barrier; and an overliner drainage layer with sumps and overflow ponds. PolyMet will locate the overflow ponds adjacent to the sumps to provide storage for mine water that exceeds the sump design volumes. Each paired sump and pond will be surrounded by dikes and will have a combined capacity for the 100-year, 24-hour mine water yield plus a safety factor in the form of freeboard. PolyMet will pump the collected stockpile drainage to the WWTF.

If underdrains are required, PolyMet expects that water quality associated with the underdrain sumps will be the same as groundwater quality. Monitoring of these underdrains will be conducted as part of the NPDES/SDS Permit monitoring program.

The Project will collect drainage from the Category 1 Waste Rock Stockpile through a groundwater containment system, and then convey the collected water to the WWTF for treatment. PolyMet will develop the groundwater containment system in lieu of a liner system under the stockpile. The Water Management Plan – Mine (Appendix 16.9) includes further information on design of the Category 1 Stockpile Groundwater Containment System.

PolyMet will utilize the OSLA as a temporary storage area for unsaturated mineral overburden and peat that will be used in construction or reclamation. PolyMet will grade the OSLA to provide a relatively even, well drained site and direct surface runoff to the mine water pond at the southwestern corner of the area (the OSLA Pond). Mine water will be pumped from the OSLA Pond to the CPS Pond, then to the FTB.

11.3.2.3 Mine Water Ponds for Other Infrastructure

Lined mine water ponds will provide storage for gravity flow of mine water during heavy precipitation or short power outages. In addition to the temporary stockpile sumps and overflow ponds, PolyMet will construct other mine water ponds at the Mine Site for the following features:

- a series of haul road ponds to collect mine water from the haul roads
- an RTH Pond to collect mine water from the RTH
- an OSLA Pond to collect mine water from the OSLA

The design of the mine water ponds for the haul roads and RTH will be sufficient to contain runoff volumes from the 100-year, 24-hour storm, and the design of the OSLA Pond will allow it to handle the 25-year, 24-hour storm.

A pump and piping system will convey mine water from the haul road ponds and the RTH Pond to the WWTF. PolyMet will pump the mine water collected in the OSLA Pond to the CPS Pond. The Water Management Plan – Mine (Appendix 16.9) contains more detailed information on these ponds.

11.3.2.4 Waste Water Treatment Facility

PolyMet will construct the WWTF west of the RTH. The WWTF will treat mine water along with the WWTP reject concentrate. The treated effluent from the WWTF, along with construction mine water and runoff from the OSLA will then be pumped to the FTB for reuse in the beneficiation process (as shown on Figure 11-11). Reuse of the treated mine water at the Plant Site will eliminate the need to discharge WWTF effluent to surface waters at the Mine Site during operations and minimize the volume of water that will need to be appropriated from Colby Lake. The purpose of the WWTF is to maintain the overall water quality in the FTB Pond at or below water quality targets and to manage the water quality of the Tailings Basin seepage, which will be the influent to the WWTP.

The WWTF will consist of two types of water treatment: chemical precipitation and membrane filtration. Membrane separation is a mature technology that has been used for water treatment for over 40 years. It is not widely used to treat mine water because achievable effluent quality is much higher than is typically required for treated mine water discharge. Membrane separation is generally considered the best proven, commercially available technology for removing dissolved, inorganic constituents. Along with distillation, it is a method for treating water with high concentrations of dissolved salts.

A schematic illustration of the treatment train to be constructed at the WWTF is presented on Figure 11-11. The design of the WWTF can be adapted as needed, based on results of influent and effluent water quality monitoring. The details of the WWTF design are included in the NPDES/SDS Permit Application.

The Project will combine mine water streams at the Mine Site into three waste streams at the WWTF: construction mine water, mine water with low volume and relatively high concentrations of dissolved constituents, and mine water with high-volume and relatively low concentrations of dissolved constituents. PolyMet will store mine water containing relatively high concentrations of dissolved constituents (drainage from the temporary Category 2/3 and Category 4 Waste Rock Stockpile liners and the temporary OSP liner) in the West Equalization Basins and will route this water to the chemical precipitation treatment train. PolyMet will route mine water containing relatively low concentrations of dissolved constituents (runoff from haul roads and the RTH, pit dewatering water, and Category 1 Waste Rock Stockpile drainage, and construction mine water) to the East Equalization Basin and then route it to the membrane filtration treatment train. PolyMet will convey the WWTF effluent to the CPS Pond.

11.3.2.5 Central Pumping Station and Treated Water Pipeline

The Project will convey mine water treated by the WWTF, construction mine water treated in the Construction Mine Water Basin, and water collected in the OSLA Pond to the CPS Pond. From the CPS Pond, the combined treated mine water will be pumped through the TWP to the FTB (with the exception of water needed during East Pit flooding operations).

11.3.3 Sewage Management and Infrastructure

The Project will handle sewage collected from Mine Site sanitary facilities in holding tanks, and then will transport this water to the Plant Site for treatment by the Plant Site Sewage Treatment System.

11.3.4 Stormwater Management and Infrastructure for Mine Site Operations

This section describes stormwater management at the Mine Site during operations (Section 11.1 discusses stormwater management during initial construction). These controls include design features and BMPs for:

- Industrial stormwater, which consists of precipitation and runoff from the industrial areas at the Mine Site, where the discharge is composed entirely of stormwater and not combined with other water types.

- Construction stormwater during operations, which consists of precipitation, runoff, and dewatering water from construction areas with the exception of dewatering water from saturated mineral overburden, which is managed as mine water.
- Non-contact stormwater, which consists of precipitation and runoff that contacts natural, stabilized, or reclaimed surfaces and has not been exposed to mining activities, construction activities, or industrial activities. This includes runoff from on-site features constructed of overburden (unsaturated overburden or peat) once stabilized with permanent cover and the reclaimed Category 1 Waste Rock Stockpile.

The Project will separate stormwater from mine water through a system of ditches, dikes, and ponds. The Mine Site stormwater management infrastructure is shown on Figure 11-12.

PolyMet will manage stormwater to meet water quality standards either without treatment when possible, or if necessary, by removing total suspended solids (TSS) either through settling or through the use of flocculants, in on-site sedimentation ponds. PolyMet will control stormwater in and around the Mine Site in a manner that reduces potential impacts to mining activities, protects the environment, and maintains existing flow patterns off-site to the extent practicable.

Stormwater may come into contact with materials of regulatory significance (referred to as significant materials in the NPDES/SDS application) at the Mine Site, and PolyMet will manage this water through appropriate BMPs, including engineered controls and spill prevention and response procedures, to reduce or eliminate contact or exposure of pollutants to stormwater or remove pollutants from stormwater. PolyMet will develop and implement an Industrial SWPPP in accordance with Minnesota NPDES/SDS Industrial Stormwater General Permit (Permit No. MNR050000) requirements, which will describe these BMPs in further detail.

As described in the following subsections, PolyMet will control stormwater flowing on and off the Mine Site along natural watershed divides using a series of dikes and ditches constructed around the perimeter of the Mine Site, along the pit rims, and around the interior of the Mine Site. Sedimentation ponds along the perimeter of the Mine Site will allow for settling to reduce TSS from stormwater before it is discharged off-site. Receiving waterbodies for Mine Site stormwater includes the Partridge River and its tributaries.

PolyMet will design the Mine Site stormwater management systems to direct stormwater from up to the 100-year, 24-hour storm event away from mine water areas. The Project will base the overall system capacity on the Mine Site configuration, and will install specific system controls when needed during the LOM.

11.3.4.1 Exclusion Dikes

The Project will place exclusion dikes at strategic locations around the perimeter of the Mine Site and around the pit rims. PolyMet will construct perimeter dikes of silty sand or glacial till material excavated during construction of ditches and removal of overburden. The purpose of these dikes and ditches near the perimeter of the Mine Site will be to minimize the amount of surface water flowing on to the Mine Site, minimize dewatering of wetlands outside the perimeter of the Mine Site, eliminate mine water flowing uncontrolled off the Mine Site, and manage the rate and location of stormwater flowing off the Mine Site.

PolyMet will construct ditches along the interior of most of the perimeter dike system to convey stormwater adjacent to the dikes, prevent surface runoff from entering the Mine Pits, intercept stormwater prior to reaching mine water areas, and prevent water from pooling in areas where the dikes cut across low areas. The existing ground along some of the site perimeter is already relatively high, which will allow a ditch to capture the surface runoff without a dike. PolyMet will direct stormwater captured by the ditches to sedimentation ponds and then route the captured stormwater into a natural drainage system off the Mine Site.

PolyMet will construct pit rim dikes in areas where surface water might otherwise drain into the Mine Pits. The pit rim dikes will be temporary in nature, in place only as long as the rim of the Mine Pit is at a specific location. Reconstruction of the dikes will be necessary as the Mine Pit expands. PolyMet will construct dikes by pushing up a ridge of soil where needed around the rims of the pits during overburden stripping operations. The intention of the pit rim dikes is to intercept and direct surface runoff, not to impede movement of groundwater flow.

11.3.4.2 Stormwater Ditches

The Project will utilize stormwater ditches throughout the interior of the Mine Site to route stormwater away from areas of mining activity. The stormwater ditches will decrease the amount of mine water created on the Mine Site by conveying stormwater separately, which will help minimize the overall impacts on the Partridge River.

Interior ditches will convey collected stormwater to perimeter ditches and sedimentation ponds prior to controlled discharge. The layout of the proposed stormwater system will follow the existing drainage patterns at the Mine Site to the extent practical while meeting the objectives of the system.

11.3.4.3 Sedimentation Ponds and Outlets

The Project will utilize sedimentation ponds around the perimeter of the Mine Site to reduce TSS and to control stormwater discharge. Based on preliminary design, PolyMet proposes to construct up to five stormwater sedimentation ponds; the final number and configuration of stormwater ponds will be determined in final design, which will take into account construction stormwater needs and NPDES/SDS Permit requirements. PolyMet selected the current pond locations to match existing flow paths to the extent practical and to minimize the overall hydrologic impacts to the Partridge River:

- Pond A will be located at the northeastern corner of the Category 1 Waste Rock Stockpile and will direct stormwater off-site from the northern and western sides of the stockpile
- Pond B will be located between the East Pit and northern border of the property
- Pond C (West) is an interior stormwater pond located west of the West Pit and will be designed to provide additional flood storage upstream of Pond C (East)
- Pond C (East) will be located west of the OSLA
- Pond D will be located west of the Category 2/3 Waste Rock Stockpile, east of the OSP, on the northern side of Dunka Road

PolyMet will construct Ponds A, B, C (East), and D during Mine Year 1, and will construct the Pond C (West) during Mine Year 2. The sedimentation-pond design will reduce sediment in runoff from storms up to the 100-year, 24-hour storm event, and will achieve the industrial stormwater TSS benchmark value of 100 milligrams per liter (mg/L). PolyMet will inspect the sedimentation ponds annually to determine the depth of sedimentation within the pond, and will dredge the ponds if sediment accumulation reduces the available volume to below the required design storage capacity.

PolyMet will evaluate and design primary outlets and emergency outlets for each of the exterior stormwater sedimentation ponds on a site-specific basis. PolyMet will design primary outlets to provide flood attenuation capacity, and will design the emergency outlets to pass flows larger than the design values used to size the sedimentation pond. Stormwater sedimentation Ponds A and B will have their outlets fitted with controls to temporarily shut off discharge to or from the Mine Site during flooding conditions in the Partridge River.

The Water Management Plan – Mine (Appendix 16.9) contains more detailed information regarding sedimentation ponds and outlets.

11.4 Plant Site Water Management and Infrastructure

This section focuses on water management associated with Plant Site sewage treatment and stormwater. The following sections describe the existing site conditions, and the water management systems related to sewage and stormwater during operations, reclamation, closure, and postclosure maintenance.

11.4.1 Existing Conditions

The existing LTVSMC plant includes the Beneficiation Plant and other buildings, sewage treatment plant, the LTVSMC tailings basin, and the Emergency Basin (site of proposed HRF). The Beneficiation Plant, sewage treatment plant, other supporting infrastructure, and the southern portion of the LTVSMC tailings basin are located in the Second Creek watershed, a sub-watershed of the Partridge River watershed. Most of the LTVSMC tailings basin is located within the Embarrass River watershed. Additional detail on existing conditions at the Plant Site is presented in Section 11.4.2.1, Section 11.4.6.1, and Section 11.4.7.1.

11.4.2 Sewage Management and Infrastructure

This section describes the design and operation of the infrastructure that PolyMet will use to manage sewage at the Plant Site in accordance with applicable regulations. Project operations will generate sewage at various locations, including the Beneficiation Plant, Administration Building, Area 1 Shops, and Area 2 Shops. Sewage generated at the Mine Site will also be transported it to the Plant Site for treatment and disposal. The Plant Site Sewage Treatment System is shown on Figure 11-13.

PolyMet will upgrade and refurbish the existing sewage collection system and construct new stabilization ponds to replace the former LTVSMC sewage treatment plant. At the Area 1 and Area 2 Shops, PolyMet will evaluate and upgrade, if necessary, the existing septic systems. The septic tanks at the Area 1 and Area 2 Shops will be subject to a St. Louis County Subsurface Sewage Treatment System Permit, and are not discussed further in this Application.

11.4.2.1 Existing Sewage Treatment Infrastructure

The LTVSMC taconite processing facility utilized an on-site sewage treatment system to treat domestic wastes generated from restrooms, shower facilities, and a lunchroom area, as well as waste water from the Heating Plant and the potable water treatment plant. The LTVSMC sewage treatment system consisted of two parts: a collection system and a mechanical sewage treatment plant. As originally designed, this sewage system discharged treated effluent into a ditch that flowed to Second Creek. A pump station was later added to re-route the treated effluent to the northeast into the Emergency Basin. The existing sewage collection system consists primarily of original (1955) equipment, including sanitary sewer piping and manholes extending throughout the process plant area.

After the LTVSMC facility ceased taconite operations, Cliffs Erie decommissioned the mechanical sewage treatment plant. Sewage generated by the few employees at the Administration Building is currently routed to a septic system that was constructed in 2001.

11.4.2.2 Planned Sewage Collection System

PolyMet will refurbish the existing sewage collection system to meet current design standards to properly transport sewage to the stabilization ponds. The work will include repairing existing piping to minimize losses from and infiltration and inflow (I/I) to the treatment system. PolyMet also will add new piping and associated infrastructure to connect new Plant Site facilities to the sewer system. The Project also will discharge waste water from the Plant Site Potable Water Treatment Plant to the sewage collection system.

11.4.2.3 Stabilization Ponds

PolyMet will construct stabilization ponds, to be located west of the Concentrator, to treat Project sewage. The pond design will comply with the *MPCA Recommended Pond Design Criteria* (Reference (26)) and will include lined ponds and a controlled discharge. Design and operation of the facility will be in accordance with a permit to be issued by the State. The proposed stabilization ponds will consist of two primary ponds and one secondary pond with operating depths of four feet. The secondary pond will discharge to FTB Pond via an effluent pump station. The controlled discharge will occur in the spring and fall of each year. Each controlled discharge will typically last 10 to 14 days, depending on weather conditions. The design is described more fully in Appendix 9.

11.4.3 Potable Water System

Potable water is needed to supply drinking water to serve the Plant Site, including the Area 1 Shops, Area 2 Shops, and the Administration Building. In addition to drinking water, the primary potable water use at the Plant Site will be restrooms and showers within the existing buildings. Raw water supplied to the Potable Water Treatment Plant will be obtained from Colby Lake, via the existing Colby Lake pipeline which will be refurbished prior to operation. Before distribution, PolyMet will treat water from Colby Lake at the Potable Water Treatment Plant. The Potable Water Treatment Plant will meet requirements established by MDH and USEPA for a public, non-transient, non-community water supply system. Components of the Potable Water Treatment Plant are shown on Figure 11-14 and include clarification, flocculation, sedimentation, filtration, and disinfection. Distribution systems will be constructed or refurbished to comply with applicable plumbing codes.

11.4.4 Stormwater Management

This section describes stormwater management at the Plant Site (other than the Tailings Basin and Hydrometallurgical facilities) during operations. The following sections describe the existing site conditions and the stormwater management systems. Stormwater management at the Tailings Basin and Hydrometallurgical facilities is summarized in Sections 11.4.6 and 11.4.7, respectively.

11.4.4.1 Existing Stormwater Conditions

The Plant Site, other than the majority of the Tailings Basin, is located in the Partridge River watershed, south of the divide with the Embarrass River watershed. The Plant Site is split into two drainage areas (referred to as the East Plant and the West Plant) by a topographic divide running generally in north-south direction. Figure 11-15 identifies the East and West Plant areas.

Much of the East Plant drainage area is vegetated. There are currently two locations where stormwater leaves the East Plant via culverts. There are no existing stormwater ponds in the East Plant drainage area.

The West Plant drainage area includes the majority of the existing buildings, including the Beneficiation Plant and other infrastructure in the Plant Site. Historically, LTVSMC operations either collected water generated within many buildings and combined it with roof drainage for use in the production process or discharged water within buildings through floor drains to the stormwater system. Since LTVSMC operations ceased, water from building floor drains and roof drains has been routed to the Emergency Basin. Stormwater from the West Plant drainage area is routed through a series of ditches, culverts, manholes, catch basins, ponds, and pipes to a large stormwater ditch in the southwest corner of the Plant Site before being discharged off-site through a culvert.

Stormwater from the Area 1 Shops, Area 2 Shops, and ancillary areas either discharges as dispersed sheetflow or is routed through ditches and culverts.

11.4.4.2 Plant Site Stormwater

PolyMet will improve, repair, and replace the stormwater infrastructure at the Plant Site because most of the existing stormwater infrastructure, including the Beneficiation Plant's stormwater facilities, have been filled or partially filled with sediment or otherwise are in poor condition.

Additionally, with the planned changes to Project drainage patterns and routing of roof drains to stormwater, much of the existing stormwater infrastructure at the Plant Site is undersized and would not be able to handle the additional stormwater flow. PolyMet will inspect and cleanout the existing infrastructure that potentially will be reused. PolyMet expects that the majority of the infrastructure will likely be removed and replaced, and many existing ditches, if used, will need to be excavated deeper and/or wider than they currently are to restore or increase capacity. PolyMet will design the stormwater infrastructure for the Plant Site based on the 10-year, 24-hour storm event, with consideration and evaluation of flooding up to the 100-year, 24-hour storm.

Stormwater improvements in the East Plant drainage area will consist primarily of reinstalling site drainage features through repair or removal and mitigation, as necessary, and re-sizing stormwater infrastructure where required as a result of added roof drainage. The East Plant has no existing stormwater ponds, and PolyMet anticipates no future need for such ponds because stormwater will be managed through vegetated surfaces that will naturally treat for TSS. The East Plant currently has two culverts discharging stormwater via ditches tributary to Second Creek, and both of these locations will be maintained as stormwater outfalls.

Stormwater improvements in the West Plant drainage area will include reinstalling site drainage features and re-sizing stormwater infrastructure where necessary, and constructing stormwater ponds. Once the HRF construction begins, PolyMet will install a pipe through the railroad embankment to direct drainage from the HRF sub-drainage area to the south, where it will be collected and managed with the West Plant industrial stormwater.

As shown on Figure 11-16, PolyMet initially will construct three new stormwater ponds (the North, Central, and South Ponds), and later will develop a fourth stormwater pond east of the HRF, after construction commences for that facility. The Project will route stormwater from the West Plant drainage area in a generally north-to-south direction, through the ponds and a series of ditches, culverts, manholes, catch basins, and pipes. Stormwater from the North Pond and Central Pond will be routed to the South Pond, the largest and the last pond that stormwater from the West Plant will flow through before flowing off-site. The South Pond will be located in the southwestern corner of the Plant Site where there currently is a long, wide ditch. PolyMet will install a series of weirs or ditch blocks to create a pond in this location, and this ditch may be widened to the west if additional capacity is necessary. Water from the South Pond will flow off-site to the south through a culvert under the railroad grade. This culvert discharges to a system of ditches tributary to Second Creek.

Some of the existing building floor drains in the Beneficiation Plant currently discharge to the stormwater system. The state of Minnesota's NPDES/SDS Industrial Stormwater Multi-Sector General Permit (Permit No. MNR050000; herein referred to as the Industrial Stormwater General Permit) does not allow floor drains from process areas to be discharged as industrial stormwater. Therefore, PolyMet will permanently seal any existing floor drains that are currently being routed to the stormwater system or emergency basin, and will route this water to the Plant Site overflow collection system to be reused in the process or pumped to the FTB.

11.4.5 Beneficiation Plant

The largest user of water at the Plant Site is the Beneficiation Plant. PolyMet will use an annual average of approximately 13,800 gpm of process water in the Beneficiation Plant. PolyMet will recirculate water between the Beneficiation Plant and the FTB Pond, as described in the following section. PolyMet will pipe most of this water (99%) with the tailings to the FTB; less than 1% will be lost to evaporation or included with the concentrate.

The FTB Pond will supply most of the process water for the Beneficiation Plant. Other minor sources of process water will include water in the raw ore, reagents, gland seals of slurry pumps, and other processes. PolyMet will draw make-up water, as needed, from the Plant Reservoir, which will secure raw water pumped from Colby Lake under an MDNR Water Appropriation Permit. Make-up water demand will vary depending on factors such as precipitation and Project operations. The Beneficiation Plant average annual demand for make-up water from Colby Lake will be about 560 gpm and will vary from about 25 gpm to about 1,750 gpm depending on the Mine Year.

Section 11.4.6 provides additional information regarding the relationship between the Beneficiation Plant and FTB with respect to water management.

11.4.6 Tailings Basin Water Management and Infrastructure

This section focuses on water management at the Tailings Basin during operations. The following sections describe the existing site conditions; the systems for managing Flotation Tailings and associated water at the FTB; and the stormwater management systems associated with the Tailings Basin.

11.4.6.1 Existing Conditions

The history and development of the existing LTVSMC tailings basin is described in Section 10.2.1.2. LTVSMC discontinued the tailings basin operations in January 2001 and the facility has been inactive since that time. The exception to this is Cliffs Erie's ongoing reclamation and remediation activities pursuant to its MDNR-approved Closure Plan and MPCA-supervised Consent Decree. There is no water ponded in Cell 2W. Ponds of water remain in Cells 1E and 2E.

Seepage

LTVSMC managed surface seepage from the toes of the tailings basin dams through a system of ditches, pumps, and pipelines that captured seepage water and returned it to the pond. When LTVSMC shut down and discontinued tailings discharge to the cells, the toe-of-slope seepage flow reduced. Many of the seeps are no longer flowing, and the LTVSMC pumps are no longer active.

Currently, most tailings basin seepage enters the groundwater below the basin (groundwater seepage), and some emerges at surface seeps (surface seepage). Groundwater seepage currently follows the northwesterly gradient in the surficial aquifer and discharges to wetlands located north and west of the tailings basin. Surface seepage from seeps that remain active is collected and pumped back to the LTVSMC tailings basin through pump-back systems that were installed in 2011, under terms of the Consent Decree between MPCA and Cliffs Erie. Activities related to ongoing remediation activities for former operations are outside the scope of this Application.

Surface Water

The majority of the existing LTVSMC tailings basin is located in the Embarrass River watershed, upstream of the Embarrass River chain of lakes. A small portion of the existing tailings basin is located in the Second Creek watershed, a sub-watershed of the Partridge River watershed. Before Cliffs Erie installed the seepage collection system at SD026, tailings basin seepage was a major contributor to the headwaters of Second Creek.

The Project could potentially affect the following tributaries (east to west) to the Embarrass River located between the Tailings Basin and the Embarrass River: Unnamed (Mud Lake) Creek, Trimble Creek, and Unnamed Creek. The Project is not expected to affect other tributaries located between the Tailings Basin and the Embarrass River, which include (east to west) Spring Mine Creek, an unnamed creek, and Heikkilla Creek.

Daily flow data are available for the Embarrass River from the USGS gaging station 04017000 (at Embarrass, Minnesota) from 1942 to 1982. PolyMet has validated and adjusted this hydrology data for use on this Project. Daily flow data are also available for Second Creek from the USGS gaging station 04015500 (near Aurora, Minnesota) from 1955 to 1980; however, because flow at this location was heavily affected by Mine Pit dewatering, these data have not been used for this Project.

PolyMet and Cliffs Erie have monitored several locations within the Embarrass River watershed and the Second Creek watershed for surface water quality and quantity since 2004, and results through 2015 are summarized in PolyMet's NPDES/SDS Permit Application.

Groundwater

The surficial aquifer consists of a relatively thin mantle of glacial till and reworked glacial sediments. Depth to bedrock in the area surrounding the tailings basin is generally less than 50 feet. Although the thickness of the native sediments below the LTVSMC tailings is unknown, it is estimated that it is similar to the surrounding area. The underlying bedrock is the Giant’s Range granite batholith.

Groundwater elevations measured around the existing tailings basin indicate that groundwater flows to the north and northwest, toward the Embarrass River. As the LTVSMC tailings basin was built up over time, a groundwater mound formed beneath the basin due to seepage from the various ponds, which altered local flow directions and rates. Groundwater flow to the south and east is generally constricted by the bedrock outcrops and the underlying bedrock unit of the Giant’s Range granite batholith, which outcrops as a ridge and drainage divide and makes up the highest topography in the area. There is, however, a gap in the bedrock near the southern end of the tailings basin, which allows some water to flow south toward Cliffs Erie’s NPDES/SDS monitoring station SD026, forming the headwaters of Second Creek, a tributary to the lower Partridge River.

PolyMet continues to carry out baseline monitoring of groundwater quality and elevation at the existing tailings basin via a network of monitoring wells completed into the unconsolidated surficial aquifer. Results through 2015 are summarized in PolyMet's NPDES/SDS Permit Application.

11.4.6.2 Flotation Tailings and Associated Water Management

This section describes the design and operation of the infrastructure that will be used to manage Flotation Tailings and water at the Tailings Basin in accordance with applicable regulations. The Tailings Basin and associated water management infrastructure are shown on Figure 11-17. The FTB Pond will be the primary collection and distribution point for water used in the beneficiation process. The FTB Pond will receive process water from the Beneficiation Plant, treated mine water from the Mine Site via the TWP, precipitation, and Tailings Basin seepage collected by the FTB seepage capture systems (the FTB Seepage Containment System and the FTB South Seepage Management System), along with other minor sources. PolyMet will recycle water from the FTB Pond back to the Beneficiation Plant for uses as process water.

PolyMet designed the FTB as a closed system: during operations, no water from the FTB will be released through overflow or outlet structures and tailings basin seepage will be collected by the FTB seepage capture systems. The Water Management Plan – Plant (Appendix 16.10) and the Flotation Tailings Management Plan (Appendix 16.7) contain more information on Tailings Basin water management.

Flotation Tailings Basin

PolyMet designed the FTB to store Flotation Tailings generated over 20 years of operation. The pond design has sufficient freeboard to safely accommodate a PMP rainfall event. PolyMet will utilize three basic management techniques to minimize water quality impacts from the Flotation Tailings. First, it will process the ore using a bulk flotation process to minimize the amount of sulfide minerals in tailings reporting to the FTB. Second, it will deposit the Flotation Tailings as a bulk material, rather than allowing coarse and fine tailings to segregate; because bulk tailings exhibit lower release rates than segregated tailings. Third, the FTB design includes features to minimize oxidation of the tailings, because oxidation increases release rates from the tailings. Section 10 contains additional information on the characteristics of the Flotation Tailings.

PolyMet will manage inflows to the FTB Pond to keep the water level as high as possible without exceeding dam safety criteria. Setting the pond level as high as safely possible will minimize environmental impacts: smaller beaches minimize fugitive dust generation and reduce the potential for oxidation of exposed Flotation Tailings. The Flotation Tailings Management Plan (Appendix 16.7) contains additional information on the FTB pond management. In addition, Appendix 6 includes FTB permit application support drawings.

The Project will not discharge water from the FTB Pond during operations. PolyMet has designed the FTB to prevent surface overflow, and the FTB seepage capture systems will capture tailings basin seepage and either return it to the FTB Pond or route it to the WWTP for treatment prior to discharge off-site. PolyMet will manage the water level in the FTB Pond to maintain adequate freeboard by adjusting the relative amount of water routed back to the pond and sent to the WWTP. There will be an emergency overflow system, based on industry standard practices, for protection of dam integrity in the rare event that freeboard within the FTB is not sufficient to contain all stormwater from a PMP rainfall event. PMP rainfall events are by definition rare and such an event has a low likelihood of being experienced during the life of the basin. PolyMet will implement a geotechnical and dam safety monitoring program to support long-term performance of the FTB under the terms of its MDNR Dam Safety Permit.

Flotation Tailings Transport and Deposition

PolyMet will pump Flotation Tailings from the Beneficiation Plant to the FTB in slurry form through a system of pumps and pipes. For approximately the first seven years of operation, PolyMet will discharge the Flotation Tailings into Cell 2E. PolyMet will integrate the design of the tailings transport and deposition system with FTB dam design to define discharge locations and system head. The Tailings Transport and Return Water Pipelines are shown on Figure 11-17 and a conceptual overview of the process water management system is shown on Figure 11-18.

The Project will utilize movable pipelines to place tailings in the FTB. PolyMet will configure its system to discharge Flotation Tailings by gravity flow over beaches or subaqueously in the FTB Pond. Roughly, 30% of the tailings will be discharged on the beaches and 70% will be discharged subaqueously in the FTB Pond. Subaqueous deposition will spread slurry across the bottom of the FTB Pond without mixing with the pond water, and will minimize particle size segregation during deposition.

PolyMet will utilize a return water system to recycle Tailings Basin water from the FTB Pond for use in the Beneficiation Plant. As the dams are raised in the FTB, PolyMet will move the Return Water Pipeline to maintain the pipeline at or near the surface of the dam. The Flotation Tailings Management Plan (Appendix 16.7) contains additional information on the Flotation Tailings transport and deposition systems.

11.4.6.3 FTB Seepage Containment System and FTB South Seepage Management System

Seepage from the Tailings Basin will be collected by the FTB seepage capture systems, which are described in Section 10.2.3.4. Collected seepage will be either returned to the FTB Pond for reuse at the Beneficiation Plant or pumped to the WWTP for treatment, then discharged from permitted locations. The locations of the FTB seepage capture systems are shown on Figure 11-13.

The FTB Seepage Containment System along the northern and western sides of the Tailings Basin will be operational in Mine Year 1 before PolyMet places its first Flotation Tailings in the FTB. The segment along the eastern side of the Tailings Basin will be constructed before Cells 2E and 1E merge, which is anticipated in Mine Year 7. PolyMet does not anticipate Tailings Basin seepage along the eastern side of the Tailings Basin before that time.

11.4.6.4 Waste Water Treatment Plant and Stream Augmentation

PolyMet will construct a new WWTP, which will be located south of the FTB as shown on Figure 11-13. In accordance with Minnesota Rules, part 6132.0200, PolyMet has designed the WWTP "to control possible adverse environmental effects of nonferrous metallic mineral mining, to preserve natural resources, and to encourage planning of future land utilization."

PolyMet based the preliminary WWTP design on both the expected influent quantity and quality and on the desired effluent quantity and quality. Because the WWTP will discharge to tributaries of the Embarrass River during operations, PolyMet will obtain an NPDES/SDS Permit from MPCA that will include discharge limits and other relevant terms sufficient to meet the above criteria from the PTM Regulations.

Treatment train components to be included in the WWTP are illustrated on Figure 11-11. The WWTP will include a reverse osmosis unit or similar membrane separation technology designed to meet applicable effluent limitations and water quality standards, including requirements derived from Minnesota's sulfate standard for waters used for the production of wild rice. At the WWTP, PolyMet will utilize a pre-treatment basin and greensand filtration unit to remove soluble iron. Primary membrane filtration will remove metals and sulfate using a combination of reverse osmosis and nanofiltration membranes. PolyMet will treat primary membrane concentrate in a secondary membrane system. WWTP reject concentrate will be sent to the WWTF for treatment. Primary membrane permeate will be stabilized in a limestone contactor and discharged from permitted outfalls.

WWTP discharge will augment flow in streams downgradient of the FTB seepage capture systems. This discharge strategy, referred to as stream augmentation, is designed to avoid hydrologic impacts to downgradient streams due to operation of the FTB seepage capture systems which will significantly reduce the amount of tailings basin seepage currently flowing to Unnamed Creek, Trimble Creek, Unnamed (Mud Lake) Creek, and Second Creek. PolyMet will augment flow to Unnamed Creek, Trimble Creek, and Second Creek with treated water from the WWTP to offset potential hydrologic impacts to these creeks. PolyMet will augment flow to Unnamed (Mud Lake) Creek by constructing a drainage swale east of the LTVSMC tailings basin to re-route the non-contact stormwater currently flowing into the LTVSMC tailings basin. PolyMet will construct this drainage swale before the FTB Seepage Containment System is operational. In addition to augmenting streamflow in Unnamed (Mud Lake) Creek, the drainage swale will prevent water from ponding at the toe of the East Dam.

11.4.6.5 FTB Stormwater Management and Infrastructure

This section describes stormwater management at the FTB during Plant Site operations. These controls include design features and BMPs for industrial stormwater, which consists of precipitation and runoff that comes in contact with exterior slopes and access roads surrounding seepage capture systems during Project operations. The majority of the stormwater runoff from these areas will initially be construction stormwater. As the infrastructure is constructed, runoff will become industrial stormwater, and eventually, as these areas are reclaimed, runoff will be non-contact stormwater,

The areas associated with the FTB that will generate construction and industrial stormwater will be the access roads associated with the FTB seepage capture systems and the exterior slopes of the South Dam. PolyMet will incorporate management measures for runoff from these areas, including engineered controls and BMPs as necessary, into its Plant Site Industrial SWPPP. The drainage swale that will transport non-contact stormwater to augment Unnamed (Mud Lake) Creek is discussed above in connection with stream augmentation.

Stormwater may come into contact with materials of regulatory significance (referred to as significant materials in the NPDES/SDS application) at the Tailings Basin, mainly ferrous tailings, and PolyMet will manage this water through appropriate BMPs, including engineered controls and spill prevention and response procedures, to reduce or eliminate contact of pollutants to stormwater or remove pollutants from stormwater. This will include precipitation and runoff from the FTB South Dam exterior slopes and from the access roads surrounding the seepage capture systems, where not captured by these systems. PolyMet will develop and implement an Industrial (SWPPP in accordance with Minnesota NPDES/SDS Industrial Stormwater General Permit (Permit No. MNR050000) requirements, which will describe these BMPs in further detail.

11.4.7 Hydrometallurgical Plant and HRF Water Management and Infrastructure

This section focuses on water management associated with the Hydrometallurgical Plant and HRF during operations. The Hydrometallurgical Plant and HRF are a closed-loop system, where water is only lost to evaporation from the cell surface and entrapment within the Residue's pore space.

The HRF design includes structures and systems for managing water to prevent discharge from the facility. The HRF will retain precipitation, and has a double liner system to prevent leakage. Water management will include collection and management of process water and HRF water within the facility. PolyMet will utilize monitoring of downgradient flow paths to confirm that HRF system meets the zero-discharge design.

11.4.7.1 Existing Conditions

PolyMet will construct the HRF on top of the former LTVSMC Emergency Basin, which is near the southwestern corner of the existing tailings basin. Figure 11-13 shows the location of the proposed HRF, which will be constructed on the existing Emergency Basin. Similar to the Tailings Basin, the majority of the HRF will be in the Embarrass River watershed and a small portion will be in the Second Creek subwatershed. The Emergency Basin was designed to contain taconite tailings from the main LTVSMC tailings thickeners in the event of a power failure. Historical, accidental overflows, spillage, and floor drainage from the LTVSMC concentrator also reached the Emergency Basin.

The Emergency Basin drains to the northwest, between LTVSMC tailings basin Cell 2W and the railroad grade along the western perimeter. Water occasionally ponds in this area during periods of extended wet weather but there is no permanent pond in the Emergency Basin. There has been little consolidation of materials in the Emergency Basin, which will serve as the foundation or portions of the HRF, since LTVSMC operations ended in 2001. The absence of consolidation is due to the hydraulic placement of the material and hydrostatic pressures resulting from previously impounded water in the Emergency Basin. Before commencing HRF construction, PolyMet will compress the existing materials in the Emergency Basin by placement of a preload fill. The Emergency Basin and its history are further described in Section 3.0 of Geotechnical Data Package – Volume 2: HRF (Appendix 16.16). Appendix 7 provides the HRF permit application support drawings.

11.4.7.2 Hydrometallurgical Plant

PolyMet plans to construct the Hydrometallurgical Plant several years after mining starts. The timing for construction will depend on customer requirements and overall Project economics. The Hydrometallurgical Plant will require up to an annual average of approximately 443 gpm of process water. Of this amount, approximately 48 gpm is sent with the concentrate, and 267 gpm is lost to evaporation, out vents, with the product, or chemically consumed. The balance, approximately 223 gpm, will be piped with the Residue to the HRF. Figure 11-13 shows the Plant Site and the location of the HRF.

The process water sources will include recycled water from the HRF Pond (approximately 172 gpm) and make-up water from the Plant Reservoir that will be supplied with raw water pumped from Colby Lake. Make-up water demand will vary slightly, depending on factors such as precipitation and Project operations; however, the demand for make-up water from Colby Lake will be relatively constant at around 230 gpm with some other inflows contributing approximately 36 gpm to the Hydrometallurgical Plant.

11.4.7.3 HRF and Associated Water Management and Infrastructure

This subsection describes the design and operation of the infrastructure that will be used to manage the Residue and associated water at the HRF in accordance with applicable regulations.

Residue Transport and Deposition

PolyMet will pump Residue from the Hydrometallurgical Plant as slurry to the HRF, where it will settle out and be permanently stored. The HRF will function as a large-scale sedimentation basin. PolyMet will pump the slurry through a high density polyethylene pipe with multiple discharge ports into the HRF. PolyMet will maintain a pond within the HRF such that the solid fraction of the slurry will settle out, while the majority of the liquid fraction will be recovered by the return water system and pumped back to the Hydrometallurgical Plant for reuse. The levels of both the solids and liquid within the cell will increase incrementally over time. Each discharge port will have a valve to control the solids deposition in the HRF, and connections to change the discharge configuration as the water and Residue levels rise in the cell.

The return water system will consist of a floating pump system coupled to an adjustable pipe that can be shortened as the water level rises in the pond. PolyMet will automate the system to balance water return from the HRF with the water demand at the Hydrometallurgical Plant. PolyMet will accommodate a fluctuation in demand by temporary water level changes in the HRF and in the process water tank at the Hydrometallurgical Plant. PolyMet also will manage the water level in the HRF to facilitate Residue deposition at the desired locations within the HRF and to achieve the desired water clarity for process water at the Hydrometallurgical Plant.

Hydrometallurgical Residue Facility

PolyMet designed the HRF as a closed-loop system with the capacity to permanently store Residue that is generated during approximately 18 years of operation. PolyMet sized the cell to accommodate up to 3 feet of freeboard.

PolyMet will construct dams using downstream construction methods: the interior segments of the dam will be constructed first, then the dam will be raised upward and outward from the cell perimeter as additional capacity is needed. Southeastern and southwestern segments of the HRF dam will abut existing high ground. The northern HRF dam will abut Tailings Basin Cell 2W. PolyMet will construct dams using soil borrow and possibly quarried rock. PolyMet may also use LTVSMC coarse tailings to supplement the other borrow sources. PolyMet designed the HRF to meet all required factors of safety, and it will construct and operate the dams in accordance with Minnesota state dam safety regulations.

In addition to Residue from the Hydrometallurgical Plant, PolyMet may also place in the HRF gypsum from the Waste Water Treatment Plant and coal combustion residuals (coal ash) from an existing legacy Coal Ash Landfill near the Tailings Basin. These additional materials, if placed in the HRF, would represent up to approximately 5% to 6% of the solids stored in the HRF.

The HRF Pond will receive water from three sources: process water with the Residue slurry from the Hydrometallurgical Plant; stormwater run-on and direct precipitation; and water collected by the HRF Leakage Collection System. PolyMet will pump decanted water from the HRF Pond back to the Hydrometallurgical Plant for reuse in the process. The Residue Management Plan (Appendix 16.8) further describes operation of the facility.

Double Liner and Leakage Collection System

The HRF will include a double liner and a Leakage Collection System. Leakage is water that penetrates the upper layer of the liner system. The liner and Leakage Collection System incorporate two barrier layers separated by a leakage collection layer. The double liner and leakage collection system is designed to be virtually leak-free, as described below.

- Upper liner – The upper geomembrane liner will serve as the primary barrier to leakage from the HRF. PolyMet designed its thickness for durability and to resist ice impacts in the event of a temporary shutdown of the hydrometallurgical process in winter months. The upper liner will be subject to hydraulic head equal to the water level in the HRF.
- Leakage collection layer – The leakage collection layer will collect water that passes through the upper liner. The system will direct collected leakage to a sump and then pump it back to the HRF Pond. Together, the leakage collection layer and the associated

sump, pumps, and piping comprise the Leakage Collection System. The Leakage Collection System is designed to keep the hydraulic head on the lower liner system very low.

- Lower liner – The lower composite liner provides a virtually leak free barrier to prevent water passing through the upper liner from leaving the HRF. This performance is achieved because the hydraulic head on the lower liner will be so low that there will not be enough force to drive leakage through the lower liner system. Leakage through the upper liner will be retained above the lower liner and collected by the Leakage Collection System.

The HRF will also have a Drainage Collection System, which PolyMet will install during HRF construction, but will not activate it until after closure. Drainage, in this context, is water that flows through the Residue and is captured above the upper layer of the liner system. The Drainage Collection System will be used during reclamation to speed Residue dewatering.

11.4.7.4 Stormwater Management and Infrastructure

This subsection describes the management of stormwater at the HRF, including the design and operation of the infrastructure that will be used to manage stormwater in accordance with applicable regulations.

The Hydrometallurgical Plant and HRF will generate some industrial stormwater within the HRF as a result of precipitation or runoff in the tributary area internal to the HRF. PolyMet will collect this water in the HRF Pond and then manage it as HRF water in the closed loop system.

The tributary area reporting to the HRF is relatively small. It is limited by the system of HRF dams and by the high ground areas to the west and south. Potential surface water run-on into the HRF Pond will be limited to parts of the South Dam of Tailings Basin Cell 2W, the railroad embankment (Hinsdale Bridge Approach), and portions of the land area located to the northeast of the cell. PolyMet will install diversion swales in these areas to redirect surface water away from the HRF Pond, generally in a southern direction. During initial phases of the HRF development, a land-locked area may be created immediately east of the cell. PolyMet may allow surface water runoff in this area to discharge into the HRF Pond until elevations accommodate development of a surface water pond that will divert runoff from this area away from the HRF Pond through the railroad embankment to the Plant Site. Once directed south, PolyMet will manage runoff from the eastern exterior slopes of the HRF with Plant Site industrial stormwater, which is described above in Section 11.4.4.2.

PolyMet will manage industrial stormwater that comes into contact with materials of regulatory signficance at the HRF through appropriate BMPs, including engineering controls and spill response procedures, to reduce or eliminate contact of pollutants to stormwater. PolyMet will include these management measures in an Industrial SWPPP for the Plant Site.

11.5 Transportation and Utility Corridors Water Management and Infrastructure

This section focuses on water management associated with the Transportation and Utility Corridors. Water management includes stormwater and treated mine water. Mine water associated with the Transportation and Utility Corridors is limited to the treated mine water conveyed within the TWP from the Mine Site to the Plant Site.

11.5.1 Existing Conditions

The Transportation and Utility Corridors will connect the Mine Site and the Plant Site. These corridors include the existing Dunka Road and the Railroad Corridor. The Transportation and Utility Corridors drain toward the Partridge River, a tributary of the Upper St. Louis River, and water naturally drains to the south through culverts under Dunka Road and the Railroad Corridor. Specifically, the Transportation and Utility Corridors are located within the watersheds of the following Partridge River tributaries: Wetlegs Creek, Longnose Creek, and Wyman Creek. These tributaries have been monitored for water quality and quantity since 2004, and results through 2015 are summarized in PolyMet's NPDES/SDS Permit Application.

11.5.2 Stormwater Management and Infrastructure

This section describes the management of industrial stormwater along the Transportation and Utility Corridors, including the design and operation of the infrastructure that will be used to manage stormwater in accordance with applicable regulations. Industrial stormwater will include precipitation and runoff from Dunka Road and the Main Rail Line between the Mine Site and the Plant Site. PolyMet will manage stormwater along the Transportation and Utility Corridors to reduce potential impacts to the Project, minimize earthwork, protect the environment, and maintain existing flow patterns to the extent practical.

To maintain existing drainage patterns, PolyMet will utilize a series of ditches and culverts as part of this stormwater management. PolyMet will retain and extend existing ditches and culverts along the Dunka Road and the railroad lines, as necessary. PolyMet will install additional culverts in the Plant Spur, and through the TWP embankment. Industrial stormwater will discharge to natural watercourses, including to Wetlegs Creek, Longnose Creek, and Wyman Creek in the Partridge River watershed.

PolyMet will manage stormwater that comes into contact with materials of regulatory significance (referred to as significant materials in the NPDES/SDS application) in the Transportation and Utility Corridors through appropriate BMPs, including engineered controls and spill prevention and response procedures. This management will reduce or eliminate contact of pollutants to stormwater or remove pollutants from stormwater. PolyMet will develop and implement an Industrial SWPPP in accordance with Minnesota NPDES/SDS Industrial Stormwater General Permit (Permit No. MNR050000) requirements, which will describe these BMPs in further detail.

Table 11-1 Project Water Definitions

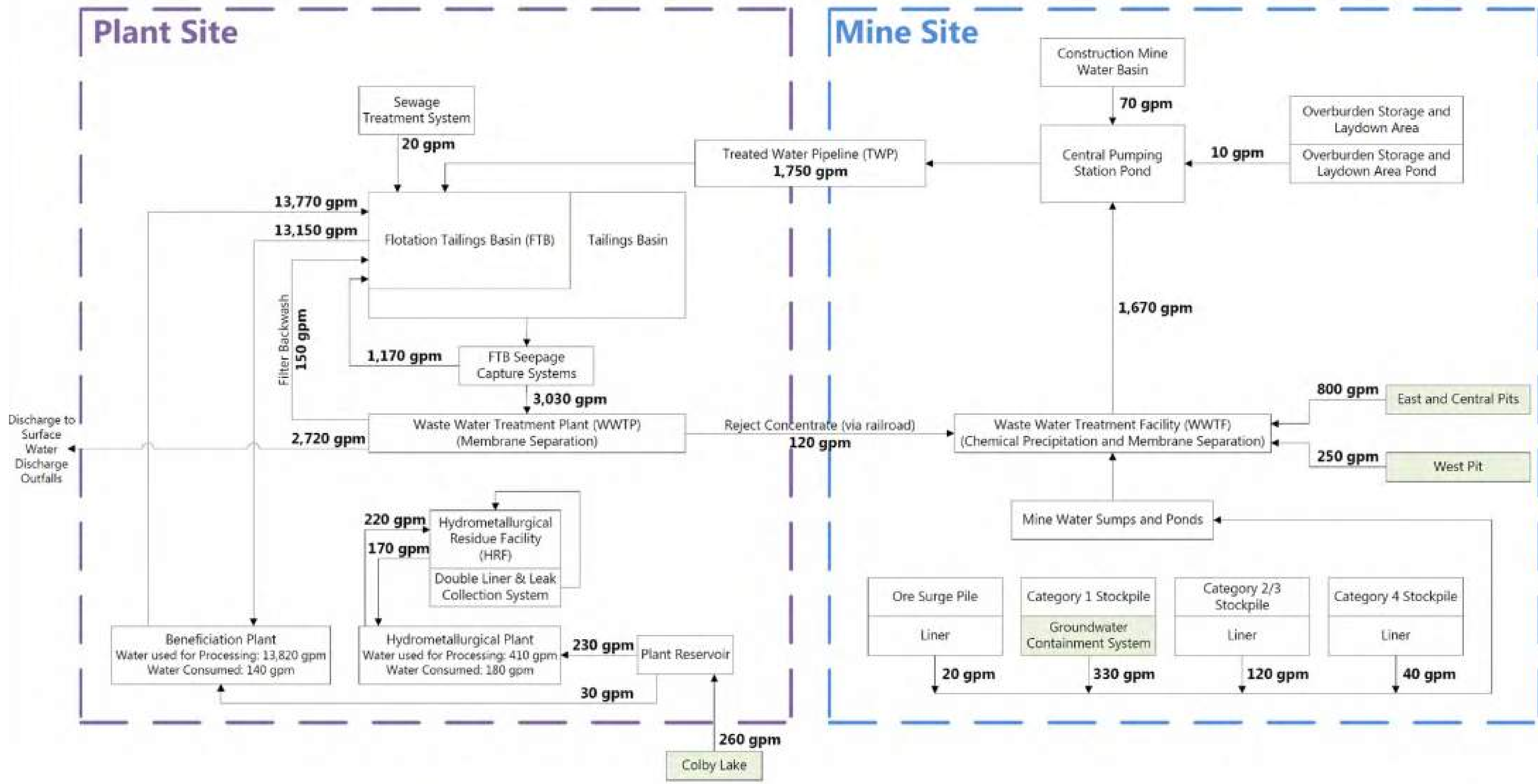
NorthMet-Specific Term	Project-Wide Definition[1]	Mine Site Specifics	WWTF/WWTP Specifics	Plant Site Specifics	Tailings Basin Specifics	HRF Specifics	Transportation and Utility Corridors Specifics
Mine Water	Water collected by the mine water management systems, including runoff, groundwater, and other water collected from areas of the Mine Site for treatment.	Water that has contacted surfaces disturbed by mining activities, such as drainage collected on stockpile liners, pit dewatering water, and runoff contacting ore, waste rock, and Mine Site haul road surfaces. This water is collected and treated at the WWTF. Runoff from the construction dewatering of saturated mineral overburden, which is collected in the Construction Mine Water Basin. Runoff from the OSLA, which is collected in the OSLA Pond.	The WWTF treats *mine water*. Construction *mine water* is generated by dewatering of saturated mineral overburden and is routed to the Construction Mine Water Basin from which it is routed to the Tailings Basin via the Treated Water Pipeline.	N/A	N/A	N/A	N/A
Treated Mine Water	Water routed from the Mine Site to the Tailings Basin via the Treated Water Pipeline.	Water combined in the CPS Pond from the WWTF, the Construction Mine Water Basin, and the OSLA Pond, which is routed from the Mine Site via the Treated Water Pipeline.	Water combined in the CPS Pond from the WWTF, the Construction Mine Water Basin, and the OSLA Pond, which is routed from the Mine Site to the Tailings Basin via the Treated Water Pipeline. Process	N/A	(no additions to Project-Wide Definition)	N/A	(no additions to Project-Wide Definition)
Process Water	Water that has been used in the beneficiation process or hydrometallurgical process.	N/A	*Process water* is an internal flow within the operation of the Beneficiation and Hydrometallurgical Plants and is not managed directly at either the WWTP or the WWTF.	(no additions to Project-Wide Definition)	Water that has been used in the beneficiation process.	Water that has been used in the hydrometallurgical process.	N/A
Sewage	Water collected from sanitary facilities and sedimentation tank and filter backwash waste collected from the Plant Site Potable Water Treatment Plant.	Water collected from Mine Site sanitary facilities, handled in holding tanks, periodically pumped out by a commercial vendor, and transported via truck to the Plant Site for treatment by the Sewage Treatment System.	N/A	Water collected from the Plant Site and Mine Site sanitary facilities and sedimentation tank and filter backwash waste collected from the Plant Site Potable Water Treatment Plant(2) for treatment by the Sewage Treatment System (STS). Also water collected by the Area 1 and Area 2 septic systems.	N/A	N/A	N/A
Tailings Basin Water	Water in the Tailings Basin Pond or in pores of the tailings, which includes the following sources:• *process water* resulting from the beneficiation process• *treated mine water* routed from the Mine Sit via the Treated Water Pipeline• *tailings basin seepage* collected by the FTB seepage capture systems and returned to the Pond• treated effluent from the Sewage Treatment System• precipitation and runoff from areas tributary to the FTB Pond	N/A	(no additions to Project-Wide Definition)	N/A	The primary water source for the Beneficiation Plant.	N/A	N/A

NorthMet-Specific Term	Project-Wide Definition[1]	Mine Site Specifics	WWTF/WWTP Specifics	Plant Site Specifics	Tailings Basin Specifics	HRF Specifics	Transportation and Utility Corridors Specifics
Tailings Basin Seepage	*Tailings basin water* that infiltrates through Flotation Tailings, LTVSMC tailings, or Tailings Basin dams and migrates through the base or the external dam faces of the Tailings Basin.	N/A	The WWTP treats *tailings basin seepage* collected by the FTB seepage capture systems.	N/A	(no additions to Project-Wide Definition)	N/A	N/A
HRF Water	Water collected and stored within the HRF, which includes the following: • *process water* resulting from the hydrometallurgical process and routed to the HRF as part of the residue slurry • precipitation and runoff from areas tributary to the HRF pond	N/A	N/A	N/A	N/A	The primary water source for the Hydrometallurgical Plant.	N/A
Plant Reservoir Water	Water collected and stored within the Plant Reservoir, which includes the following: • water pumped from Colby Lake • precipitation that falls on the Plant Reservoir	N/A	N/A	(no additions to Project-Wide Definition)	The make-up water source for the Beneficiation Plant.	The make-up water source for the Hydrometallurgical Plant.	N/A
Industrial Stormwater	Stormwater associated with *industrial activities.*[2]	Includes precipitation and runoff from the industrial areas at the Mine Site, where the discharge is composed entirely of *stormwater* and not combined with other water types. This definition does not include water defined as *mine water*.	N/A	Includes precipitation and runoff from the industrial areas at the Plant Site and, after construction of the HRF, runoff from portions of the southern exterior of the Tailings Basin dams (Cells 1E and 2W) and the eastern exterior of the HRF dams which will sheet flow onto the Plant Site.	Includes precipitation and runoff from the Tailings Basin dam exterior slopes and from the access roads surrounding the seepage capture systems, where not captured by the seepage capture systems.	Includes precipitation and runoff from the HRF dam exterior slopes.	Includes precipitation and runoff from Dunka Road and the railroad between the Mine Site and the Plant Site.
Construction Stormwater	Stormwater associated with *construction activities.*[2]	During operations, includes precipitation, runoff, and dewatering water from construction areas with the exception of dewatering water from saturated mineral overburden, which is managed as *mine water*.	N/A	(no additions to Project-Wide Definition)	(no additions to Project-Wide Definition)	(no additions to Project-Wide Definition)	(no additions to Project-Wide Definition)
Non-Contact Stormwater	Precipitation and runoff that contacts natural, stabilized, or reclaimed surfaces and has not been exposed to mining activities, *construction activities*, or *industrial activities*.[2]	Includes runoff from on-site features constructed of overburden (unsaturated overburden or peat) once stabilized with permanent cover and the reclaimed Category 1 Waste Rock Stockpile.	N/A	(no additions to Project-Wide Definition)	Does not include runoff from reclaimed Tailings Basin dam exterior slopes (refer to *industrial stormwater*).	Does not include runoff from reclaimed HRF dam exterior slopes (refer to *industrial stormwater*).	(no additions to Project-Wide Definition)

Notes:
1 If two types of waters mix, the mixture is handled as the more actively managed type of water (e.g., a mixture of non-contact stormwater and mine water is managed as mine water).
2 Stormwater associated with industrial activities are as defined in Minnesota Rules, part 7090.0080, subpart 6; stormwater associated with construction activities are as defined in Minnesota Rules, part 7090.0080, subpart 4.

Abbreviations:
CPS = Central Pumping Station
FTB = Flotation Tailings Basin
HRF = Hydrometallurgical Residue Facility
LTVSMC = LTV Steel Mining Company
N/A = not applicable
OSLA = Overburden Storage Laydown Area
WWTF = Waste Water Treatment Facility
WWTP = Waste Water Treatment Plant

Sources: Table 1-1 of Reference (27), Table 1-2 of Reference (28), Table 1-2 of Reference (29), Table 1-2 of Reference (30), Table 1-2 of Reference (23), Table 1-2 of Reference (24), and Table 1-2 of Reference (31)



Notes

1. Flow to the East Pit and from the Central Pit will begin in Mine Year 11.
2. Flow directions shown apply for Mine Year 1 to Mine Year 20.
3. See attached tables for annual average flows by year and Mine Year 10 annual average concentrations.
4. This figure is not a comprehensive water balance. For clarity, it shows flows that are key to the NorthMet Project's overall water use strategy, and omits flows such as inflows due to net precipitation and outflows due to potential liner leakage and other potential losses. Because not all flows are shown, and because flow rates are rounded, total flows may not equal the sum of their contributing parts.Water flows were obtained from the Water Modeling Data Package Volume 1: Mine Site, V14, February 2015, and the Water Modeling Data Package Volume 2: Plant Site V11, March 2015, included in Appendix 16 of the Application.

Legend

XX → = Approximate Water Flow in Gallons Per Minute (gpm)

= Water Appropriation Source

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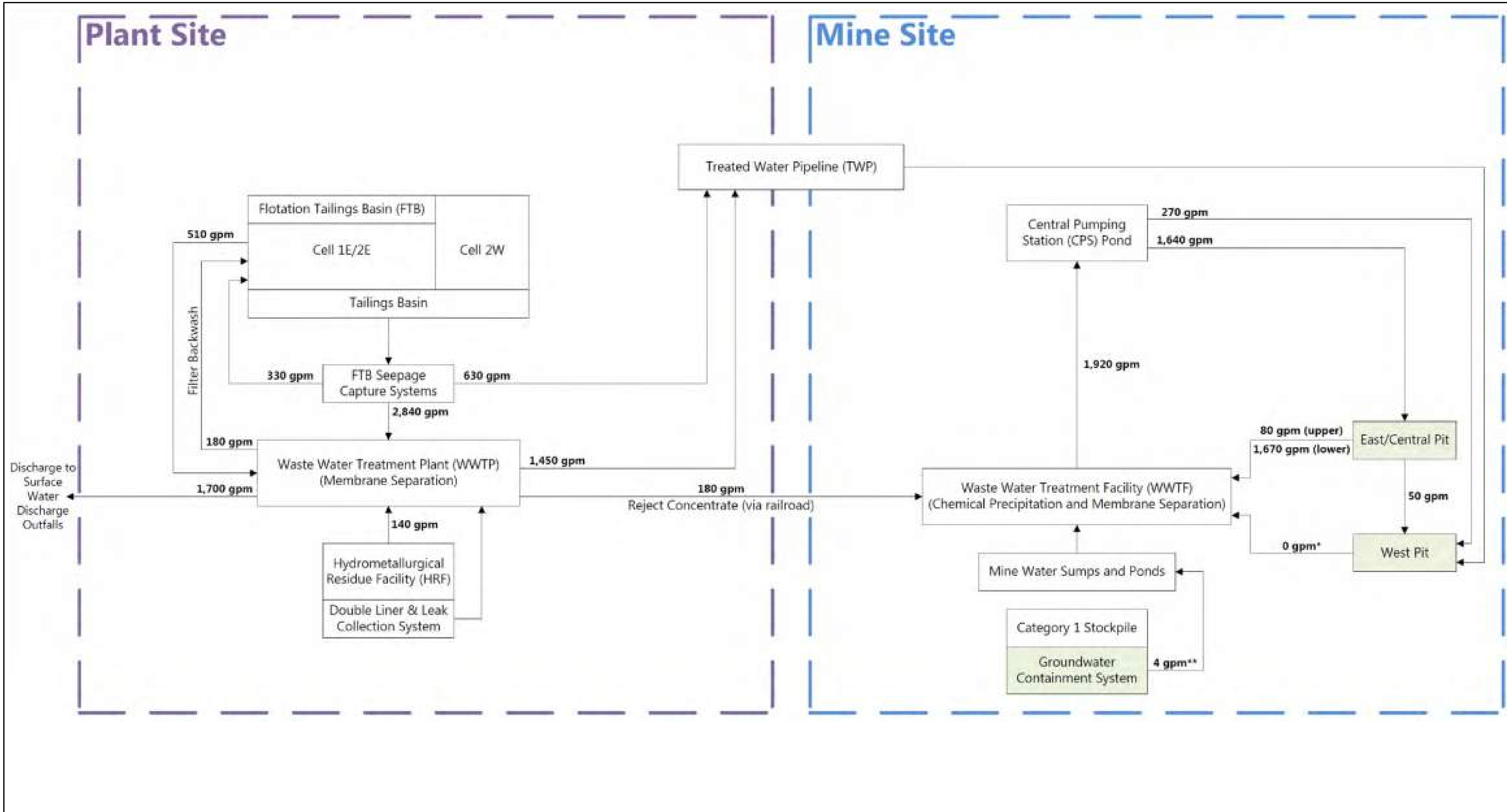
REVIEWED BY: DRD		DATE: AUG. '16
APPROVED BY: SVD1		DATE: AUG. '16

POLYMET MINING

FIGURE 11-1
PROJECT WATER BALANCE, MINE YEAR 10
PERMIT TO MINE APPLICATION
HOYT LAKES, MINNESOTA

Scale: NOT TO SCALE	Date: AUGUST 2016
Drafted by: DAT	Project No: 12P778

Path: X:\GB\IE\2012\12P778\GIS\mxd\PMA\Figure 11-1 Project Water Balance Mine Year 10.mxd Date: 9/2/2016



Notes

1. Flow from the West Pit does not occur during reclamation.
2. Flow from the GCS switches to the West Pit when East Pit treatment is complete.
3. Flow directions shown apply for Mine Year 21 to Mine Year 40.
4. See attached tables for annual average flows by year and Mine Year 25 annual average concentrations.
5. This figure is not a comprehensive water balance. For clarity, it shows flows that are key to PolyMet's overall water conservation and reuse strategy, and, except for the FTB, omits flows such as inflows due to Construction Mine Water, net precipitation, and outflows. Because not all flows are shown, and because flow rates are rounded, total flows may not equal the sum of their contributing parts.
6. Water flows were obtained from the Water Modeling Data Package Volume 1: Mine Site, V14, February 2015, and the Water Modeling Data Package Volume 2: Plant Site, V11, March 2015, included in Appendix 16 of the Application.

Legend

XX → = Approximate Water Flow in Gallons Per Minute (gpm)

= Water Appropriation Source

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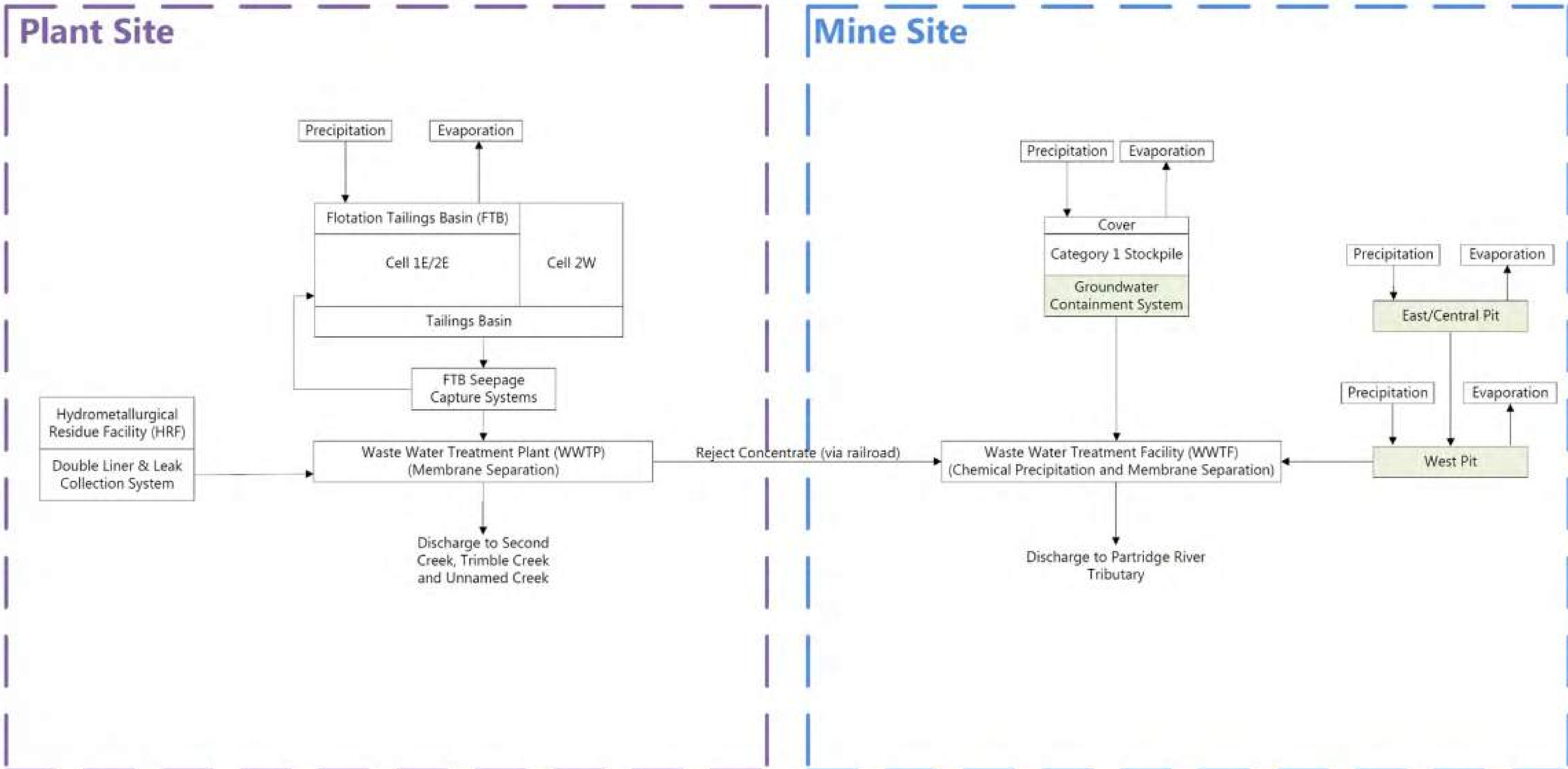
APPROVED BY: SVD1			DATE: AUG. '16

POLYMET MINING

FIGURE 11-2
PROJECT WATER BALANCE, MINE YEAR 25
PERMIT TO MINE APPLICATION
HOYT LAKES, MINNESOTA

Scale: NOT TO SCALE	Date: AUGUST 2016
Drafted by: DAT	Project No: 12P778

Path: X:\GB\IE\2012\12P778\GIS\mxd\PMA\Figure 11-2 Project Water Balance Mine Year 25.mxd Date: 9/2/2016



Legend

Water Flow Direction

= Water Appropriation Source

Notes:
1. Transition from Mechanical to Non-Mechanical Treatment could take place prior to or after Mine Year 55, depending on water quality and Agency approvals.

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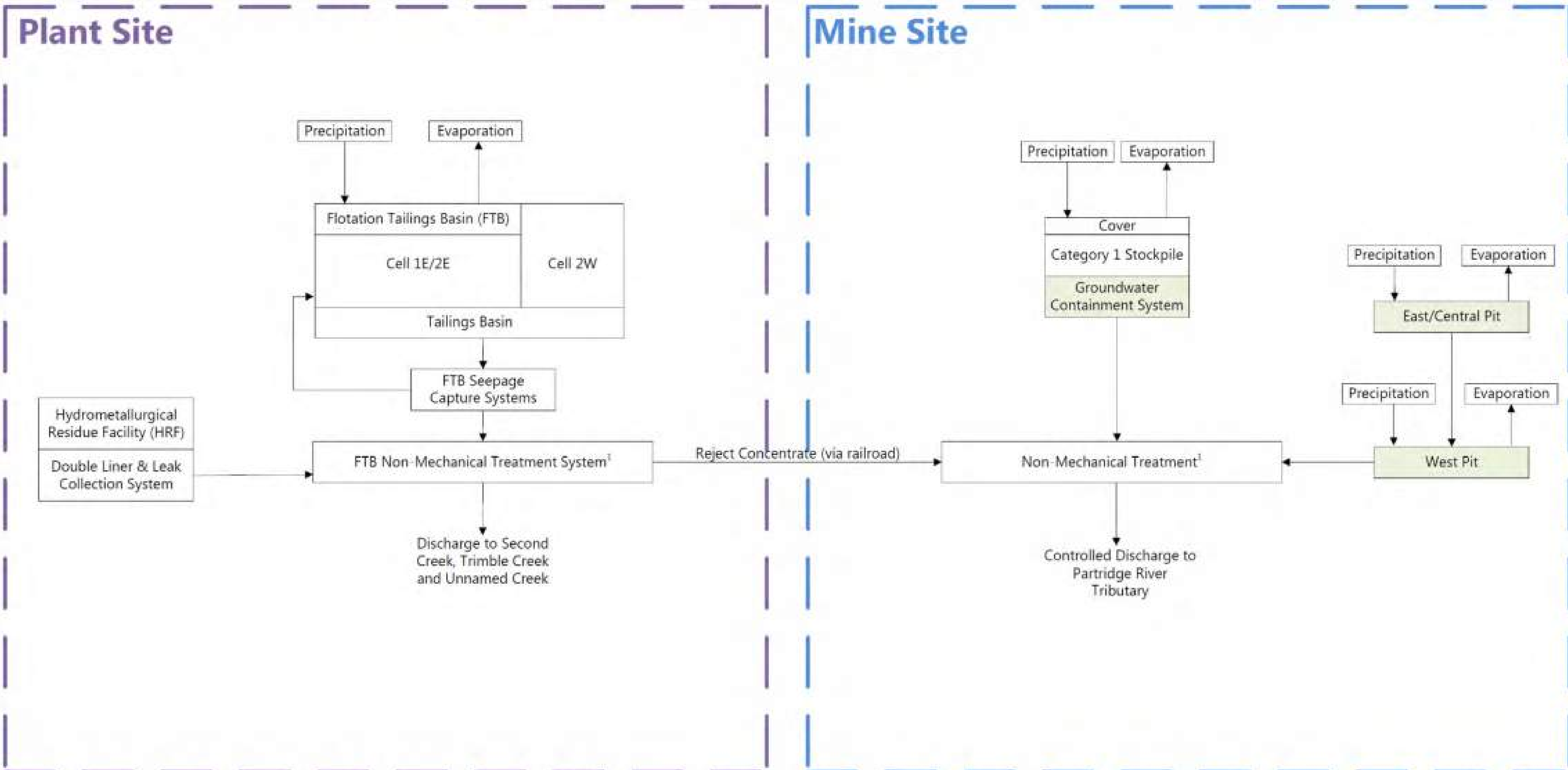
APPROVED BY: SVD1			DATE: AUG. '16

POLYMET MINING

FIGURE 11-3
PROJECT WATER FLOWS, MINE YEAR 55
MECHANICAL TREATMENT PHASE
PERMIT TO MINE APPLICATION
HOYT LAKES, MINNESOTA

Scale: NOT TO SCALE	Date: AUGUST 2016
Drafted by: DAT	Project No: 12P778

Path: X:\GB\IE\2012\12P778\GIS\mxd\PMA\Figure 11-3 Project Water Balance Mine Year 55 Mechanical Treatment Phase.mxd Date: 9/16/2016



Legend
Water Flow Direction
= Water Appropriation Source

Notes:
1. Transition from Mechanical to Non-Mechanical Treatment could take place prior to or after Mine Year 55, depending on water quality and Agency approvals.

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REVIEWED BY: DRD		DATE: AUG. '16	
APPROVED BY: SVD1		DATE: AUG. '16	

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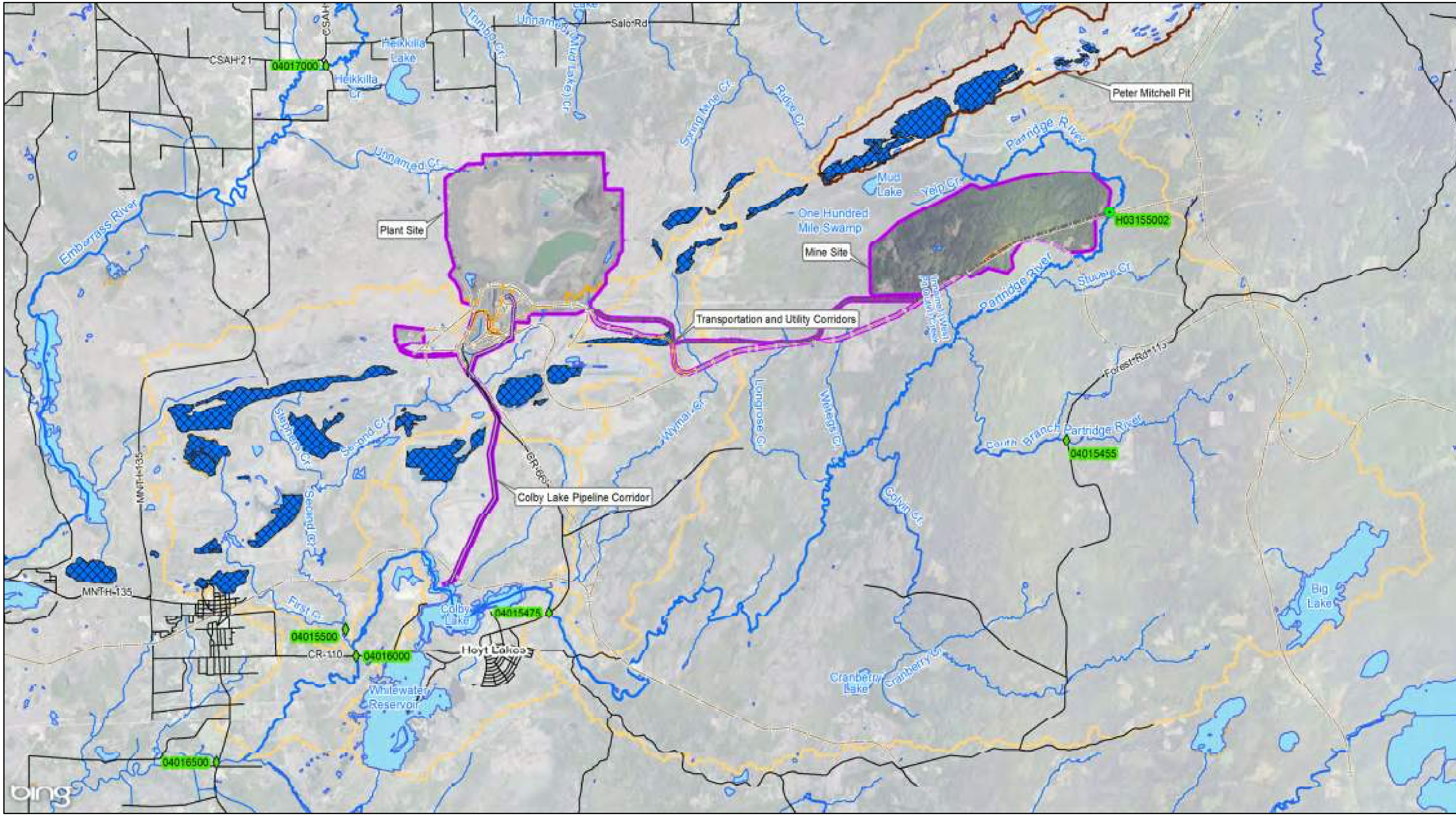
FIGURE 11-4
PROJECT WATER FLOWS, MINE YEAR 55
NON-MECHANICAL TREATMENT PHASE
PERMIT TO MINE APPLICATION
HOYT LAKES, MINNESOTA

Scale: NOT TO SCALE	Date: AUGUST 2016
Drafted by: DAT	Project No: 12P778

Path: X:\GB\IE\2012\12P778\GIS\mxd\PMA\Figure 11-4 Project Water Balance Mine Year 55 Non-Mechanical Treatment Phase.mxd Date: 9/16/2016



Notes

1. Basemap from Esri and its data suppliers.
2. Streams and Lakes supplied by Minnesota Data Deli.
3. NHD features are created from MDNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance, data sources may show watercourses that no longer exist.
4. USGS gaging stations supplied by United States Geological Survey.

Legend

- MDNR Gaging Station
- USGS Gaging Station
- Roads
- Dunka Road
- Proposed Railroad Track
- Existing Private Railroad
- Colby Lake Pipeline
- Rivers and Streams[3]
- Pit Lakes
- Natural Lakes
- Upper Partridge River Watershed
- Facility Boundary

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PREPARED BY:	DAT	DATE: AUG. '16
REVIEWED BY:	JSL	DATE: AUG. '16
APPROVED BY:	DRD	DATE: AUG. '16

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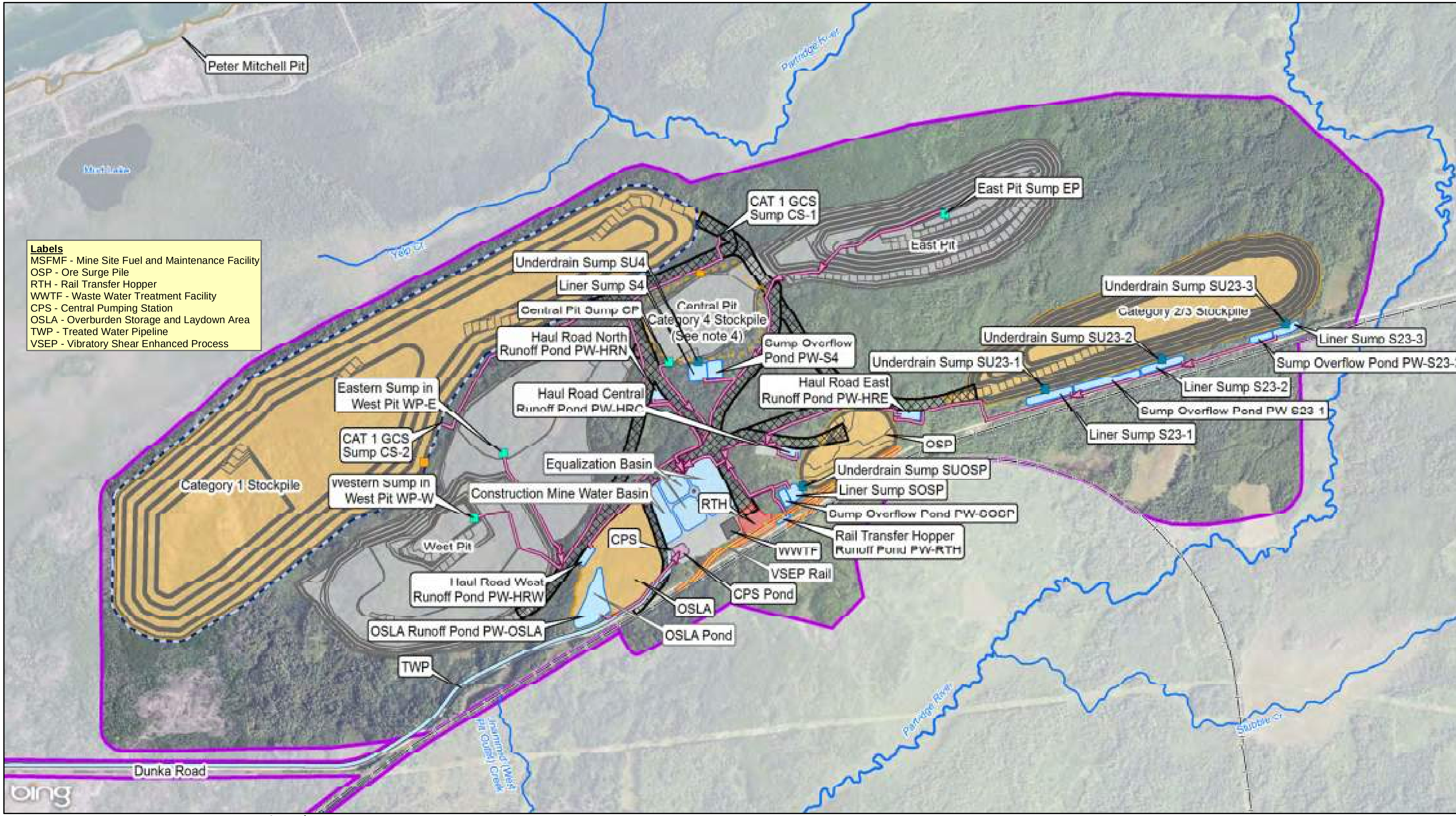
FIGURE 11-5
SURFACE WATER GAGING LOCATIONS
PARTRIDGE RIVER WATERSHED
PERMIT TO MINE APPLICATION
HOYT LAKES, MINNESOTA

Scale: 0 4,000 8,000 Feet	Date: AUGUST 2016
Drafted by: DAT	Project No: 12P778

Path: X:\GB\IE\2012\12P778\GIS\mxd\PMA\Figure 11-5 OCPC SW Gaging Locations.mxd Date: 9/2/2016



Notes

1. Basemap from Esri and its data suppliers.
2. Project Features supplied by Barr Engineering Company.
3. For clarity not all of the sumps, ditches, piping, and overflows are shown.
4. The Category 4 stockpile is removed, enabling the development of the Central Pit.
5. Mine Water Ponds are lined with the exception of the OSLA Pond and Construction Mine Water Basin.

Legend

- Cat 1 Sump Location
- Pit Sump Location
- Underdrain Sump Location
- Proposed Railroad Track
- Existing Private Railroad
- Groundwater Containment System
- Mine Water Pipeline
- Treated Water Pipeline
- Rivers and Streams
- Loadout Footprint
- Treated Mine Water Pond (Lined)
- Mine Water Ponds[5]
- WWTF Buildings
- Category 4 Stockpile (Removed)[4]
- Facility Footprint
- Haul Roads
- Active Stockpile
- Mine Pits
- Facility Boundary

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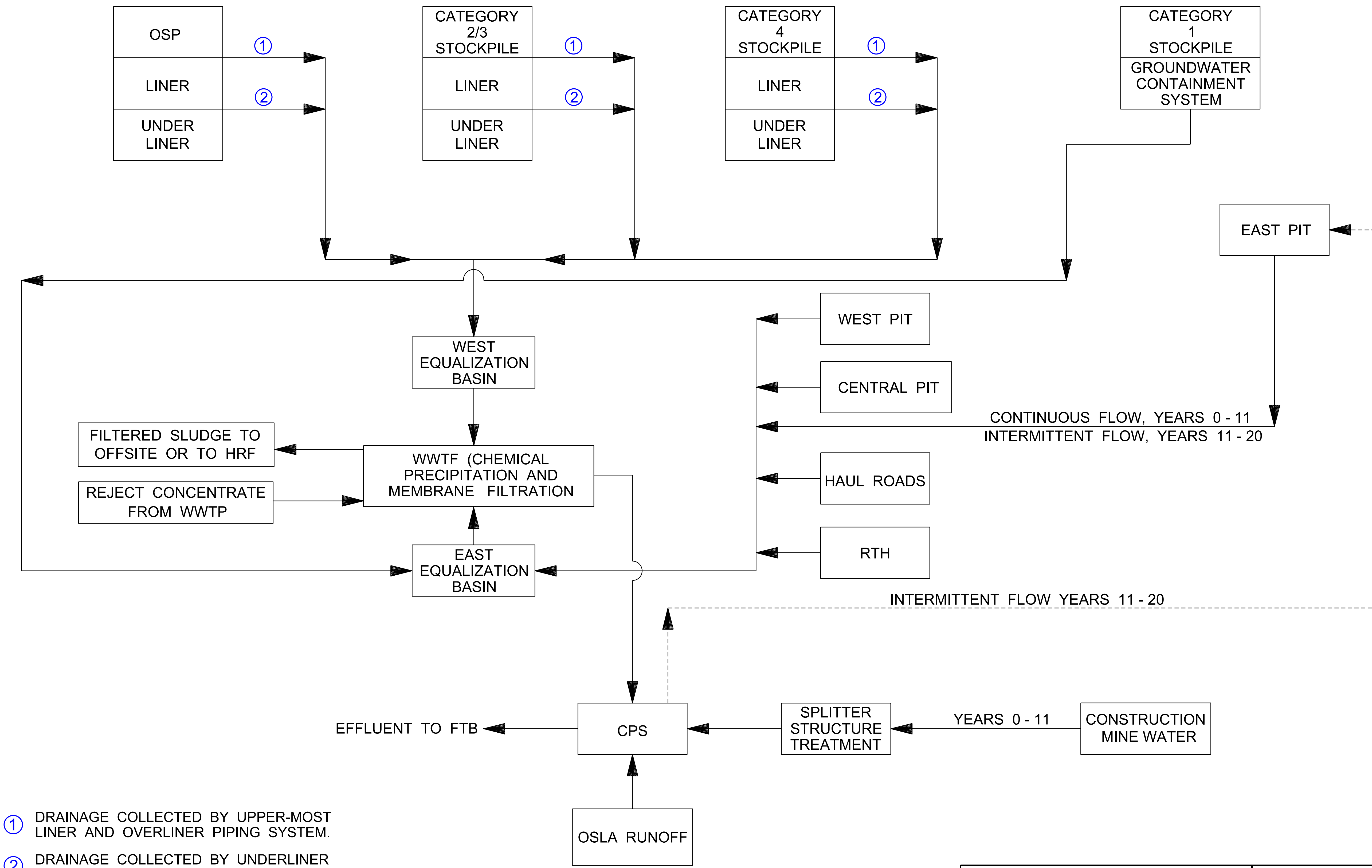
PREPARED BY: JSL		DATE: AUG. '16
REVIEWED BY: MJV2		DATE: AUG. '16
APPROVED BY: DRD		DATE: AUG. '16

POLYMET MINING

FIGURE 11-6
MINE WATER MANAGEMENT
PERMIT TO MINE APPLICATION
HOYT LAKES, MINNESOTA

Scale: 0 750 1,500 Feet	Date: AUGUST 2016
Drafted by: DAT	Project No: 12P778

Path: X:\GB\IE\2012\12P778\GIS\mxd\PMA\Figure 11-6 Mine Water Management.mxd Date: 8/26/2016



1 DRAINAGE COLLECTED BY UPPER-MOST LINER AND OVERLINER PIPING SYSTEM.

2 DRAINAGE COLLECTED BY UNDERLINER AND UNDERLINER PIPING SYSTEM

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PREPARED BY:	BJW1		DATE:	AUG. '16
REVIEWED BY:	JSL		DATE:	AUG. '16
APPROVED BY:	DRD		DATE:	AUG. '16

POLYMET MINING

FIGURE 11-7
MINE WATER FLOWS DURING OPERATION
PERMIT TO MINE APPLICATION
HOYT LAKES, MINNESOTA

Scale:	NOT TO SCALE	Date:	AUGUST 2016
Drafted By:	JOW	Project No:	12P778

X:\GB\IE\2012\12P778\cad\figures\PMA\Figure 11-7 Water Flows.dgn
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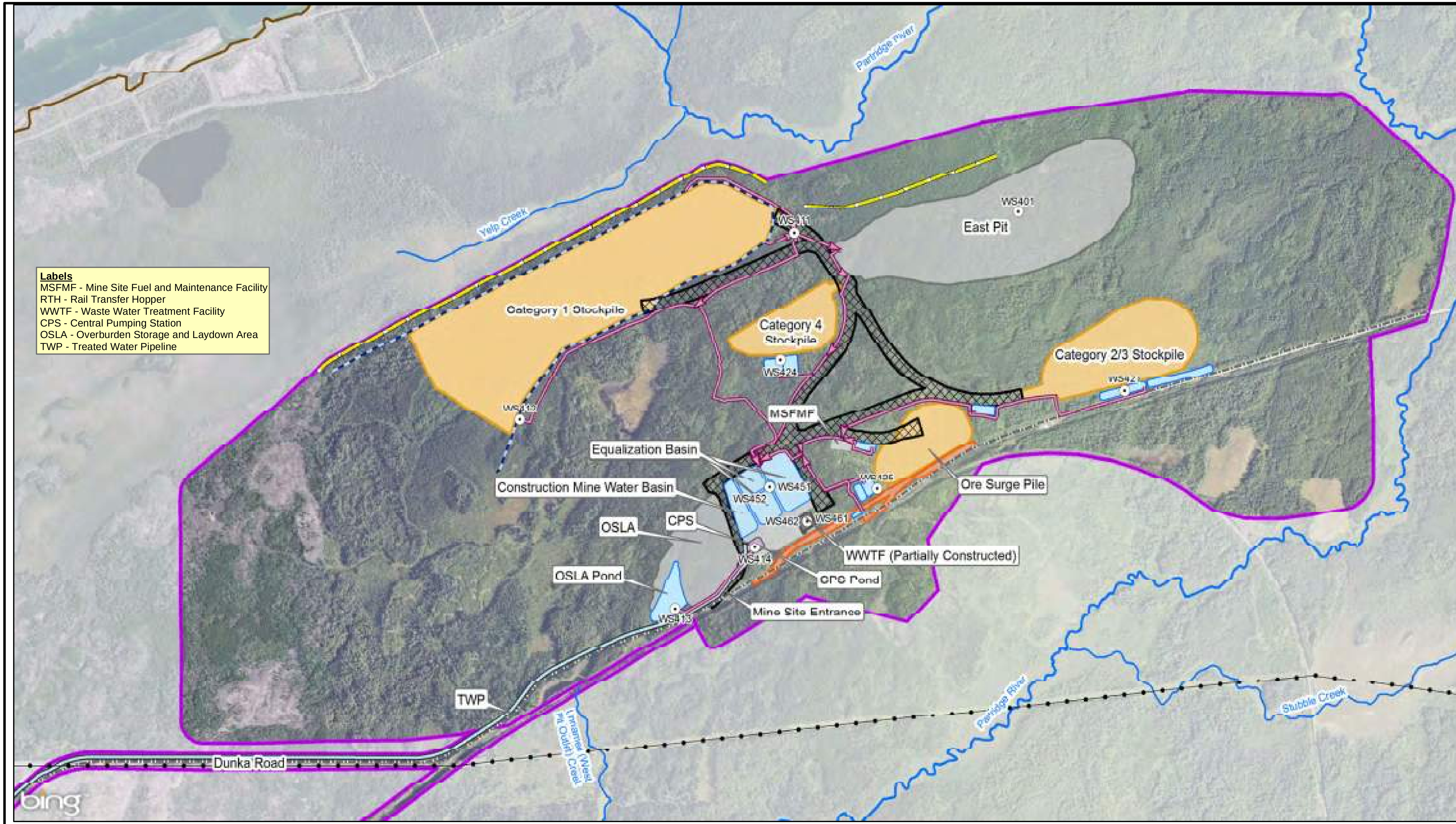

Notes

1. Basemap from Esri and its data suppliers.
2. Year 1 project features supplied by Barr Engineering Company.
3. NHD features are created from MnDNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance, data sources may show watercourses that no longer exist.
4. For clarity not all of the sumps, ditches, piping, and overflows are shown.
5. Mine Water Ponds are lined with the exception of the OSLA Pond and Construction Mine Water Basin.

Legend

- Internal Waste Stream Monitor Only
- Perimeter Dike
- Groundwater Containment System
- Existing Electric Power Line
- Rivers and Streams[3]
- Dunka Road
- Mine Water Piping
- Treated Water Pipeline
- Loadout Footprint
- Facility Footprint
- Haul Roads
- Active Stockpile
- Treated Mine Water Pond (Lined)
- Mine Water Ponds[5]
- WWTF Buildings
- Peter Mitchell Pit
- Mine Pits
- Facility Boundary

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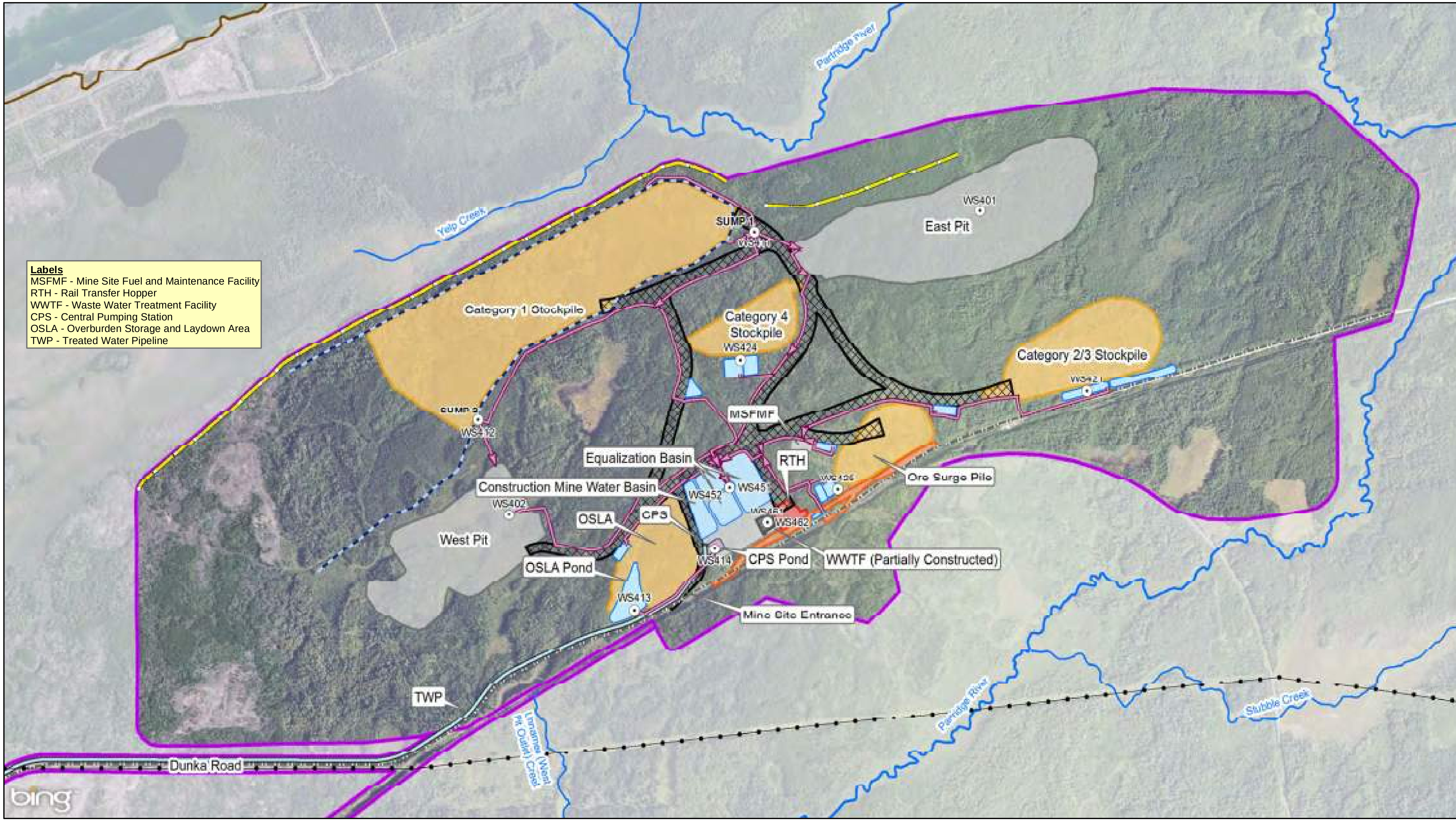
APPROVED BY: DRD	DATE: AUG. '16	Drafted by: DAT

POLYMET MINING

FIGURE 11-8
MINE WATER MANAGEMENT INFRASTRUCTURE: MINE YEAR 1
PERMIT TO MINE APPLICATION
HOYT LAKES, MINNESOTA

Date: AUGUST 2016
Project No: 12P778

Path: X:\GB\IE\2012\12P778\GIS\mxd\PMA\Figure 11-8 Mine Site Water Management Infrastructure Year 1.mxd Date: 8/26/2016



Notes

1. Basemap from Esri and its data suppliers.
2. Year 2 project features supplied by Barr Engineering Company.
3. NHD features are created from MnDNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance, data sources may show watercourses that no longer exist.
4. For clarity not all of the sumps, ditches, piping, and overflows are shown.
5. Mine Water Ponds are lined with the exception of the OSLA Pond and Construction Mine Water Basin.

Legend

- Internal Waste Stream Monitor Only
- Perimeter Dike
- Groundwater Containment System
- Existing Electric Power Line
- Rivers and Streams[3]
- Dunka Road
- Mine Water Piping
- Treated Water Pipeline
- Loadout Footprint
- Facility Footprint
- Haul Roads
- Rail Transfer Hopper
- Active Stockpile
- Treated Mine Water Pond (Lined)
- Mine Water Ponds[5]
- WWTF Buildings
- Peter Mitchell Pit
- Mine Pits
- Facility Boundary

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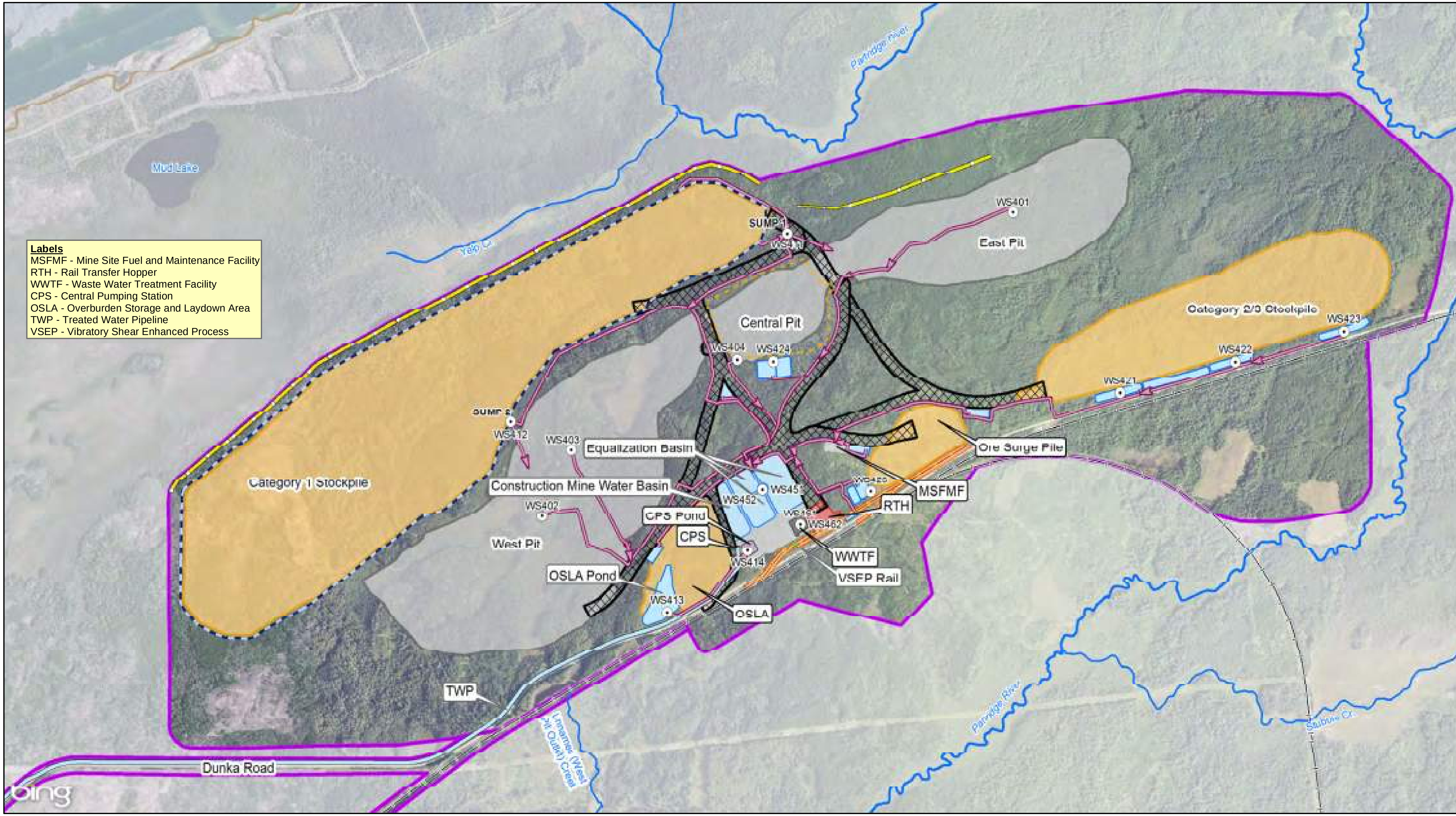
PREPARED BY: JSL			DATE: AUG. '16
REVIEWED BY: MJV2			DATE: AUG. '16
APPROVED BY: DRD			DATE: AUG. '16

POLYMET MINING

FIGURE 11-9
MINE WATER MANAGEMENT
INFRASTRUCTURE: MINE YEAR 2
PERMIT TO MINE APPLICATION
HOYT LAKES, MINNESOTA

Scale: 0 750 1,500 Feet | Date: AUGUST 2016
Drafted by: DAT | Project No: 12P778

Path: X:\GB\IE\2012\12P778\GIS\mxd\PMA\Figure 11-9 Mine Site Water Management Infrastructure Year 2.mxd Date: 8/26/2016



Notes
1. Basemap from Esri and its data suppliers.
2. Year 11 Project Features supplied by Barr Engineering Company.
3. For clarity not all of the sumps, ditches, piping, and overflows are shown.
4. The Category 4 stockpile is removed, enabling the development of the Central Pit.
5. Mine Water Ponds are lined with the exception of the OSLA Pond and Construction Mine Water Basin.

Legend
- Internal Waste Stream Monitor Only
- Perimeter Dike
- Groundwater Containment System
- Mine Water Pipe
- Proposed Railroad Track
- Existing Private Railroad
- Treated Water Pipeline
- Rivers and Streams
- Loadout Footprint
- Treated Mine Water Pond (Lined)
- Mine Water Ponds[5]
- WWTF Buildings
- Active Stockpile
- Category 4 Stockpile (Removed)
- Haul Roads
- Facility Footprint
- Mine Pits
- Facility Boundary

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REVISED	DATE	BY	DESCRIPTION

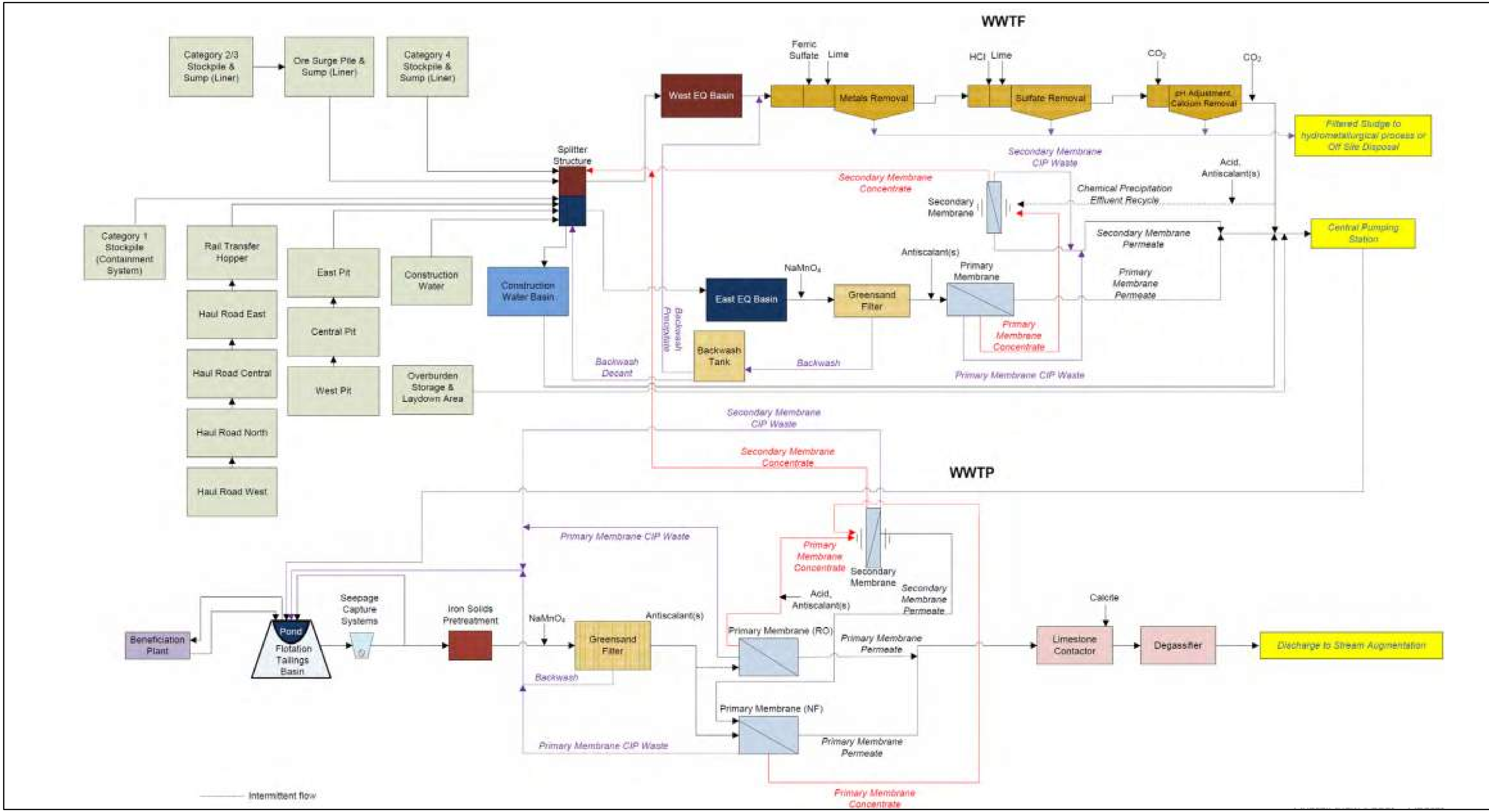
PREPARED BY:	JSL	DATE:	AUG. '16
REVIEWED BY:	MJV2	DATE:	AUG. '16
APPROVED BY:	DRD	DATE:	AUG. '16

POLYMET MINING

FIGURE 11-10
MINE WATER MANAGEMENT
INFRASTRUCTURE: MINE YEAR 11
PERMIT TO MINE APPLICATION
HOYT LAKES, MINNESOTA

Scale: 0 750 1,500 Feet
Date: AUGUST 2016
Drafted by: DAT
Project No: 12P778

Path: X:\GB\IE\2012\12P778\GIS\mxd\PMA\Figure 11-10 Mine Site Water Management Infrastructure Mine Year 11.mxd Date: 9/2/2016



NOTES

1. Figure based on Large Figure 4 from the NorthMet Project Waste Water Treatment System: Design and Operation Report (Barr Engineering Company, 2016).

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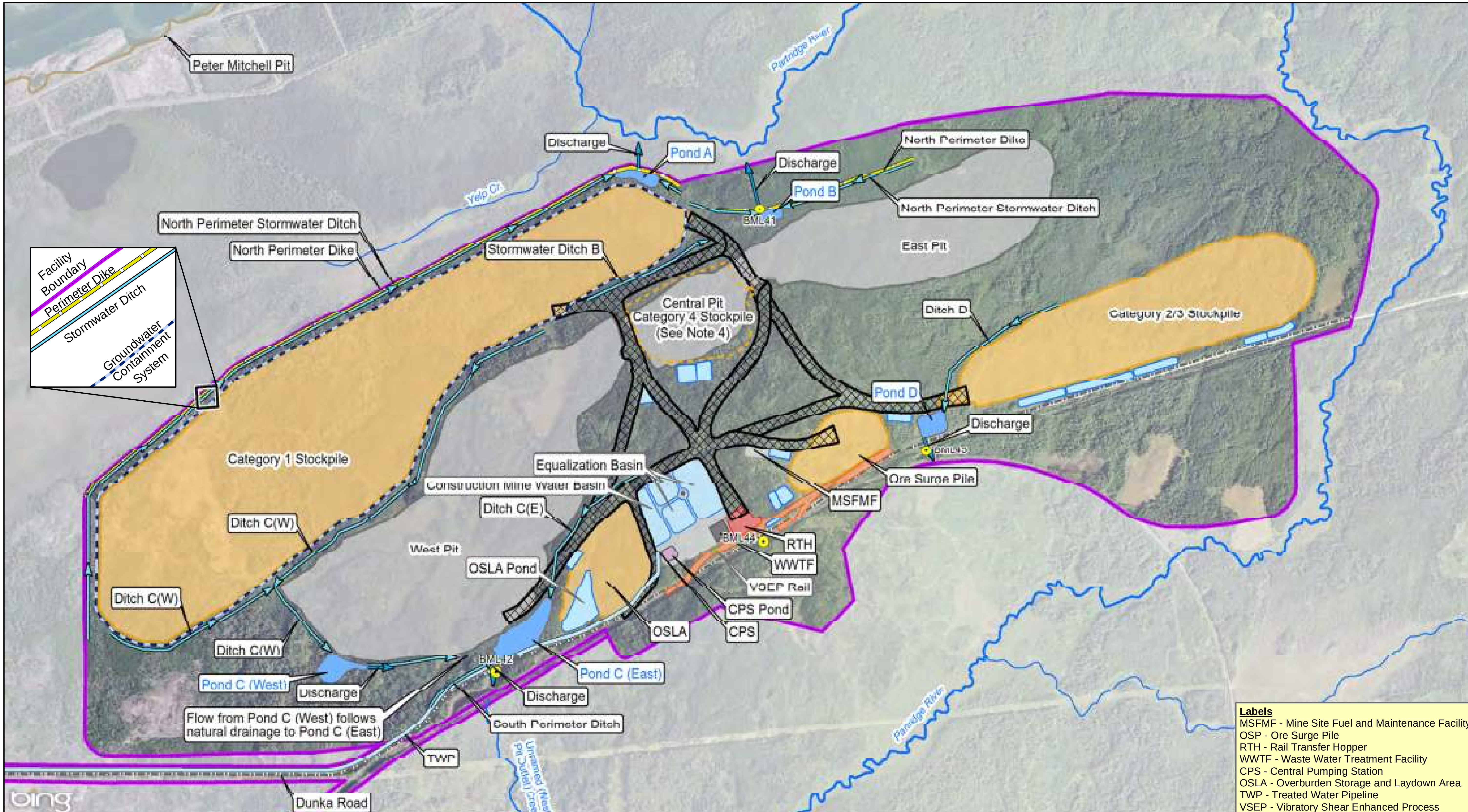
Foth Infrastructure & Environment, LLC				POLYMET MINING	
REVISED	DATE	BY	DESCRIPTION	**FIGURE 11-11** WATER TREATMENT OVERALL FLOW SHEET - OPERATIONS PERMIT TO MINE APPLICATION HOYT LAKES, MINNESOTA	
PREPARED BY:	DAT		DATE: AUG. '16		
REVIEWED BY:	JSL		DATE: AUG. '16	Scale: NOT TO SCALE	Date: AUGUST 2016
APPROVED BY:	DRD		DATE: AUG. '16	Drafted by: DAT	Project No: 12P778

Path: X:\GB\IE\2012\12P778\GIS\mxd\PMA\Figure 11-11 Water Treatment Train.mxd Date: 8/26/2016



Notes

1. Basemap from Esri and its data suppliers.
2. Project Features supplied by Barr Engineering Company.
3. For clarity not all of the sumps, ditches, piping, and overflows are shown.
4. The Category 4 stockpile is removed, enabling the development of the Central Pit.
5. Mine Water Ponds are lined with the exception of the OSLA Pond and Construction Mine Water Basin.

Legend

- Benchmark Stormwater Monitoring
- Stormwater Ditch
- Stormwater Discharge
- Perimeter Dike
- VSEP Rail
- Groundwater Containment System
- Treated Water Pipeline
- Dunka Road
- Rivers and Streams
- Category 4 Stockpile (Removed)
- Haul Roads
- Treated Mine Water Pond (Lined)
- Stormwater Ponds
- Loadout Footprint
- Mine Water Ponds[5]
- WWTF Buildings
- Active Stockpile
- Mine Pits
- Facility Boundary

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REVISED	DATE	BY	DESCRIPTION

PREPARED BY:	JSL	DATE:	AUG. '16
REVIEWED BY:	MJV2	DATE:	AUG. '16
APPROVED BY:	DRD	DATE:	AUG. '16

POLYMET MINING

FIGURE 11-12
MINE SITE STORMWATER MANAGEMENT
MINE YEAR 11
PERMIT TO MINE APPLICATION
HOYT LAKES, MINNESOTA

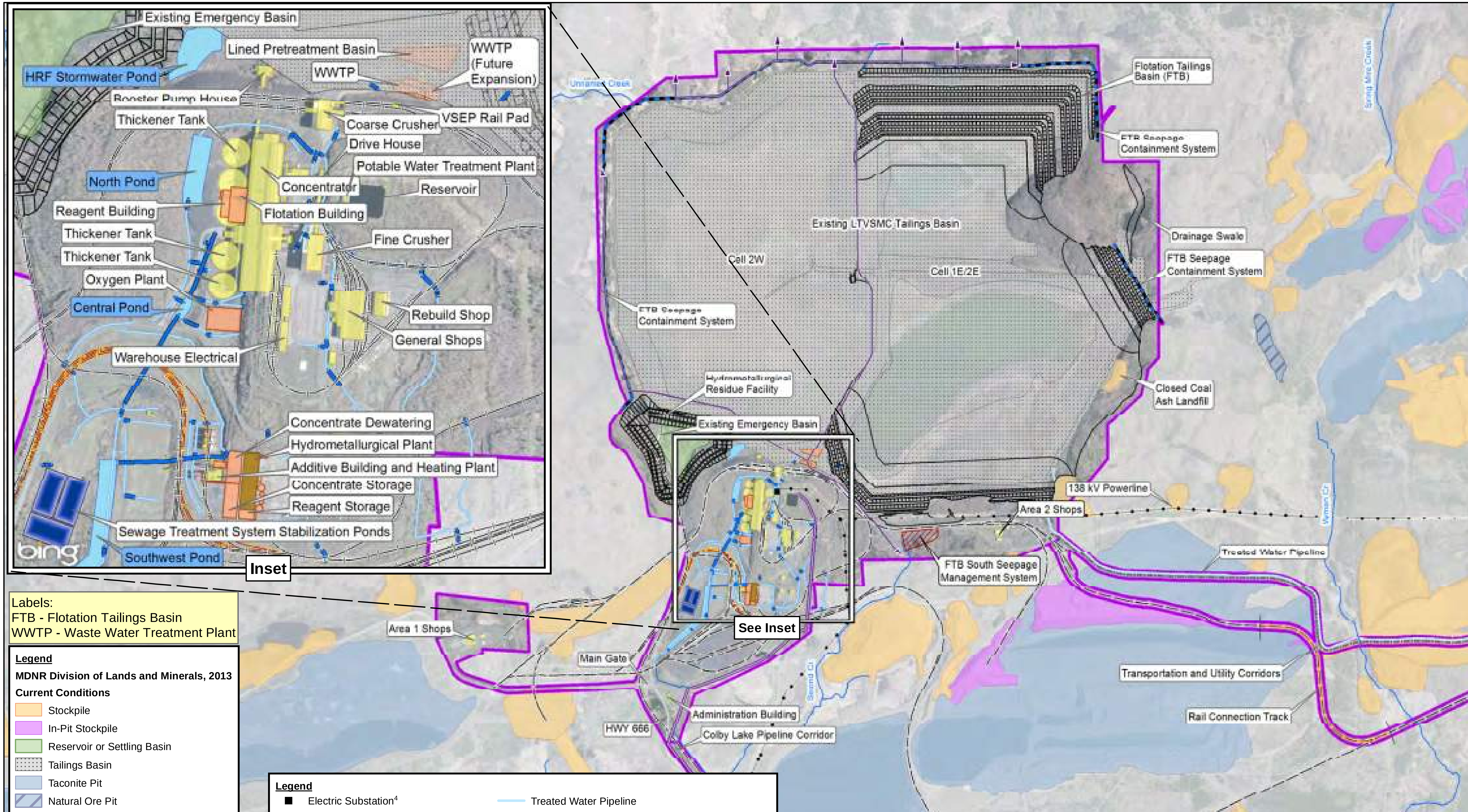
Scale: 0 750 1,500 Feet

Date: AUGUST 2016

Drafted by: DAT

Project No: 12P778

Path: X:\GB\IE\2012\12P778\GIS\mxd\PMA\Figure 11-12 Mine Site Stormwater Management.mxd Date: 9/2/2016



Labels:
FTB - Flotation Tailings Basin
WWTP - Waste Water Treatment Plant

Legend

MDNR Division of Lands and Minerals, 2013

Current Conditions

- Stockpile
- In-Pit Stockpile
- Reservoir or Settling Basin
- Tailings Basin
- Taconite Pit
- Natural Ore Pit

Legend

- Electric Substation[4]
- FTB Seepage Containment System
- Existing Electric Power Line[4]
- Dunka Road
- Proposed Railroad Track
- Existing Private Railroad
- Rivers, Streams and Ditches[3]
- Colby Lake Pipeline
- Culvert
- Ditch
- Treated Water Pipeline
- Treated Water Discharge Pipe
- Proposed Plant Site Buildings and Related Facilities
- Proposed Hydromet Plant
- Existing Buildings
- Sewage Treatment System Stabilization Ponds
- Hydromet Residue and Tailings Dam
- Proposed Stormwater Ponds
- Facility Boundary

Notes

1. Basemap from Esri and its data suppliers.
2. Project features, pipelines and details supplied by Barr Engineering Company.
3. NHD features are created from MDNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance, data sources may show watercourses that no longer exist.
4. Minnesota Power Substations and Power Lines supplied by the Minnesota Geospatial Information Office (MnGeo).

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REVIEWED BY: JSL			DATE: AUG. '16
APPROVED BY: DRD			DATE: AUG. '16

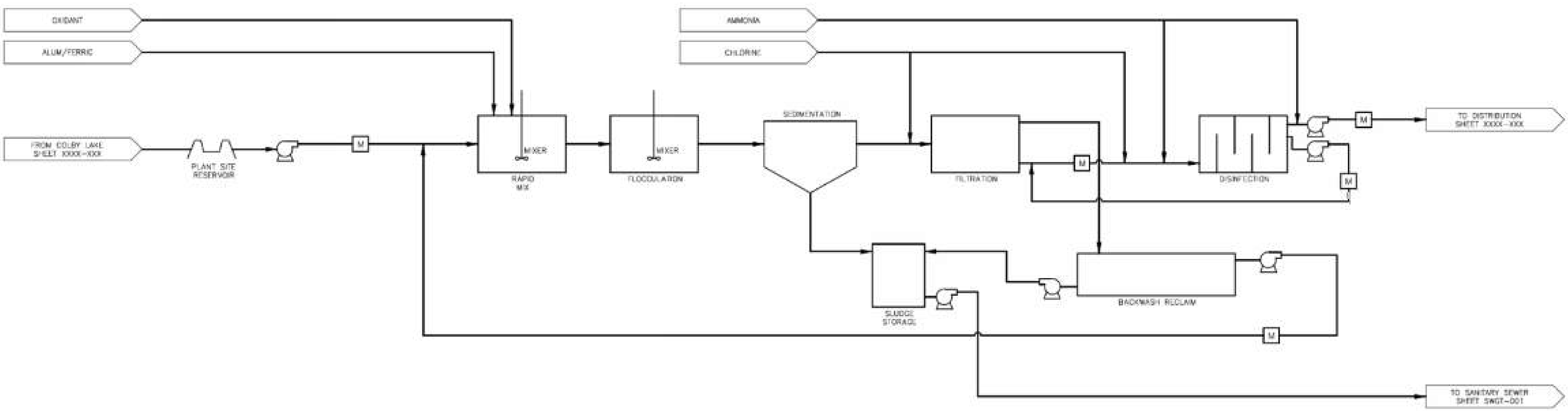
POLYMET MINING

FIGURE 11-13

PLANT SITE WATER MANAGEMENT ELEMENTS
PERMIT TO MINE APPLICATION
HOYT LAKES, MINNESOTA

Scale: 0 1,250 2,500 Feet	Date: AUGUST 2016
Drafted by: DAT	Project No: 12P778

Path: X:\GB\IE\2012\12P778\GIS\mxd\PMA\Figure 11-13 Plant Site Water Management Elements.mxd Date: 9/12/2016



Source:
1. PolyMet Potable Water System Design Basis, Barr Technical Memo 7/31/15

Foth Infrastructure & Environment, LLC

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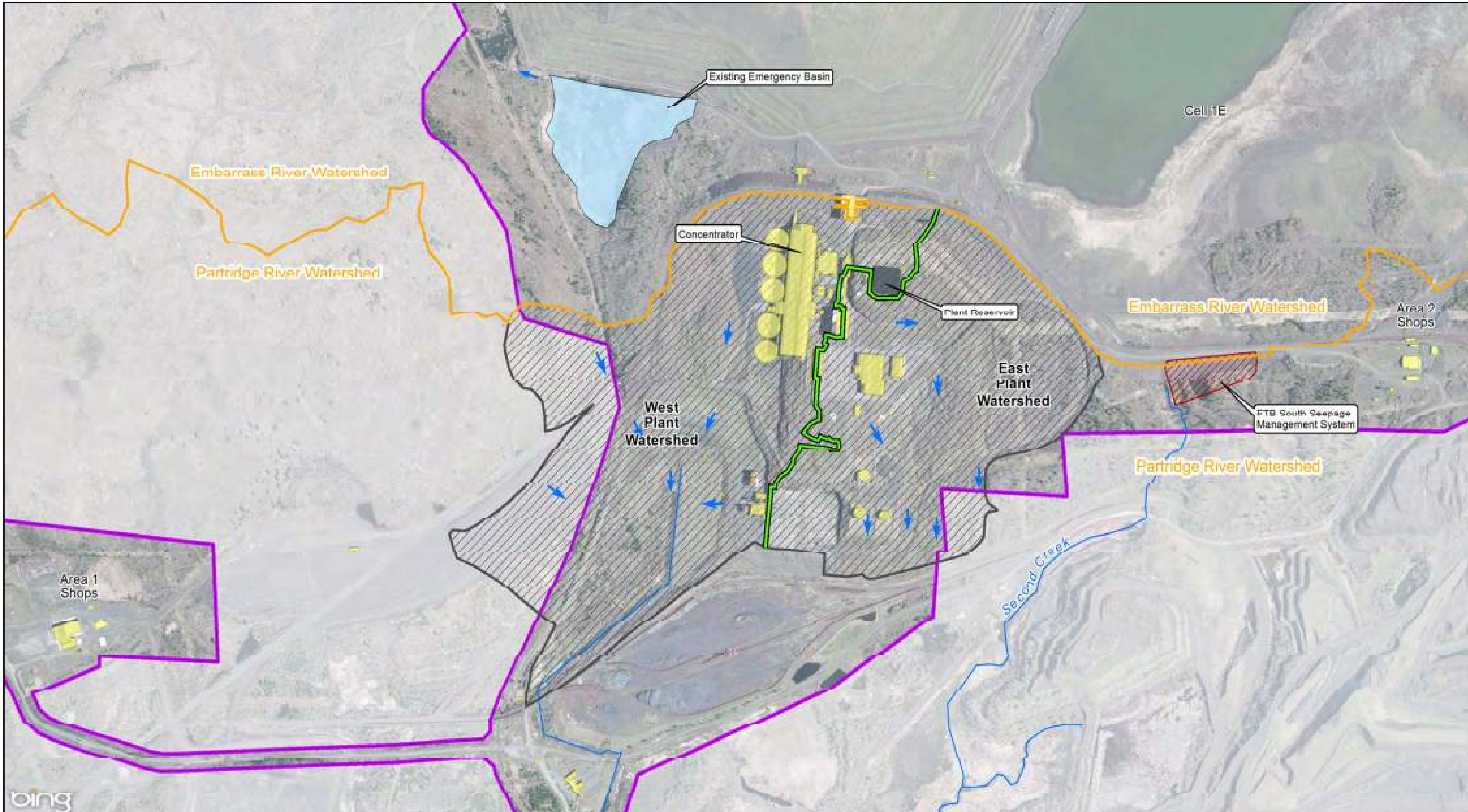
PREPARED BY:	DAT	DATE: AUG. '16
REVIEWED BY:	JSL	DATE: AUG. '16
APPROVED BY:	DRD	DATE: AUG. '16

POLYMET MINING

FIGURE 11-14
POTABLE WATER TREATMENT SYSTEM
PERMIT TO MINE APPLICATION
HOYT LAKES, MINNESOTA

Scale: NOT TO SCALE	Date: AUGUST 2016
Drafted by: DAT	Project No: 12P778

Path: X:\GB\IE\2012\12P778\GIS\mxd\PMA\Figure 11-14 Potable Water Treatment System.mxd Date: 8/23/2016



Notes
1. Basemap from Esri and its data suppliers.
2. Project features supplied by Barr Engineering Company.
3. NHD features are created from MDNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance, data sources may show watercourses that no longer exist.

Legend
- Existing Stormwater Drainage Direction
- Plant Drainage Divide
- Watershed Basin Boundary
- Stormwater Source Area
- Rivers and Streams[3]
- Existing Emergency Basin
- Existing Buildings
- Facility Boundary

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REVISED	DATE	BY	DESCRIPTION

PREPARED BY:	DAT	DATE:	SEP.'16
REVIEWED BY:	JSL	DATE:	SEP.'16
APPROVED BY:	DRD	DATE:	SEP.'16

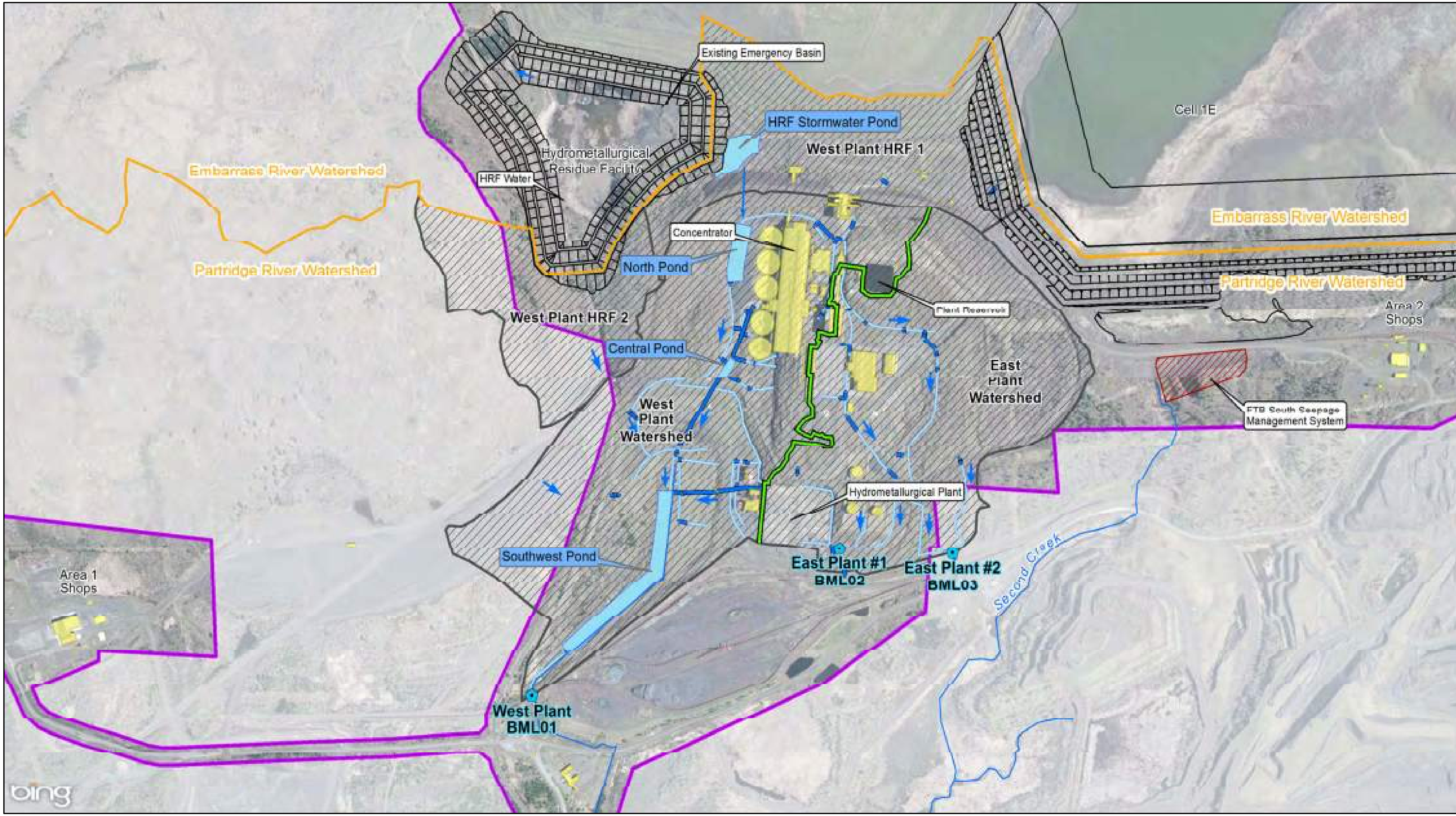
POLYMET MINING

FIGURE 11-15

EXISTING PLANT SITE STORMWATER MANAGEMENT
SOURCE AREA AND FLOW DIRECTIONS
PERMIT TO MINE APPLICATION
HOYT LAKES, MINNESOTA

Scale: 0 500 1,000 Feet	Date: SEPTEMBER 2016
Drafted by: DAT	Project No: 12P778

Path: X:\GB\IE\2012\12P778\GIS\mxd\PMA\Figure 11-15 Existing Stormwater at Plant Site.mxd Date: 9/7/2016



Notes
1. Basemap from Esri and its data suppliers.
2. Project features supplied by Barr Engineering Company.
3. NHD features are created from MDNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance, data sources may show watercourses that no longer exist.

Legend
- Plant Site Stormwater Discharge and Monitoring Location
- Existing Stormwater Drainage Direction
- Culvert
- Ditch
- Plant Drainage Divide
- Watershed Basin Boundary
- Rivers and Streams[3]
- Stormwater Source Area
- Existing Buildings
- Proposed Stormwater Ponds
- Hydromet Residue and Tailings Dam
- Facility Boundary

N

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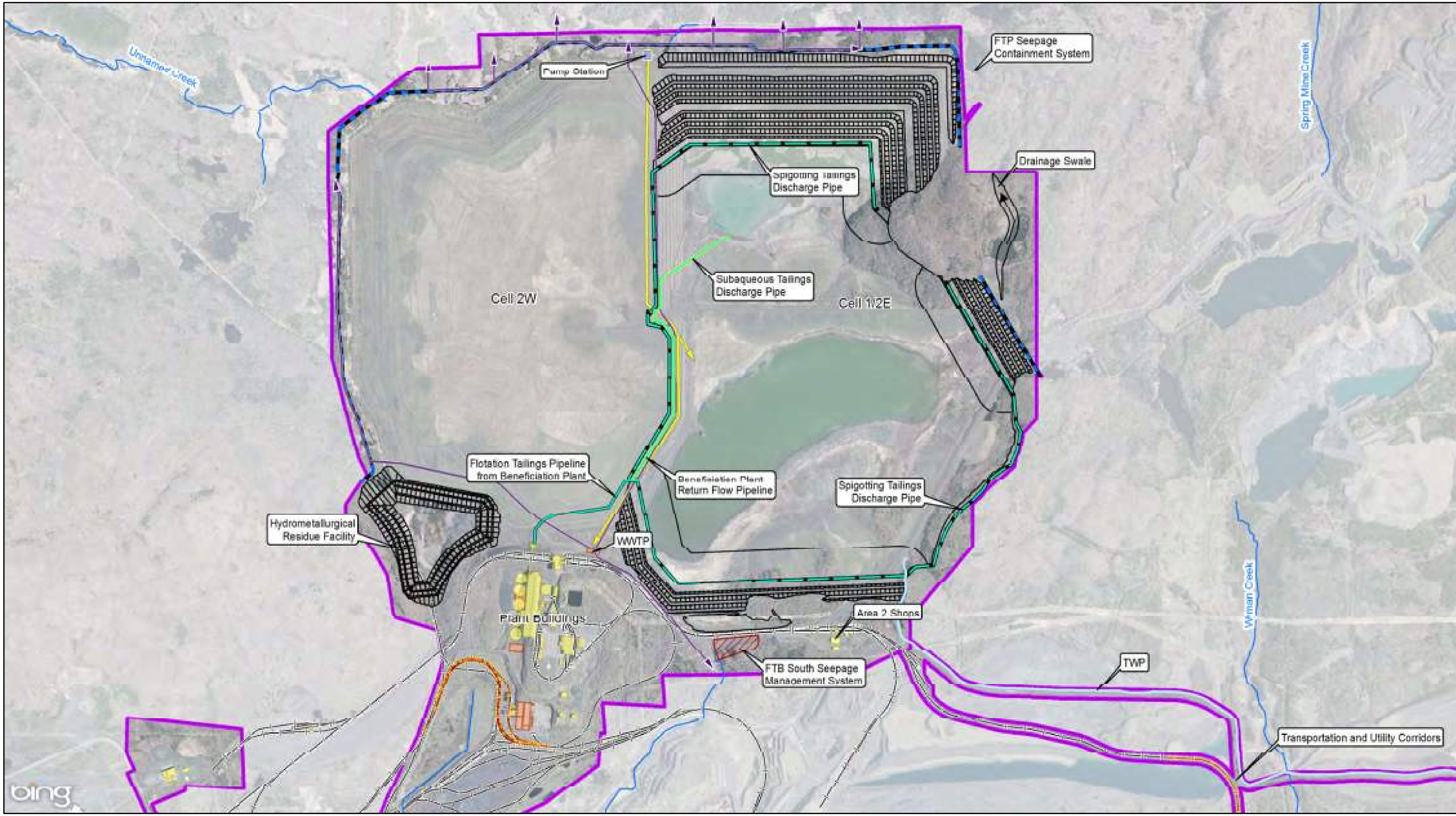
REVISED	DATE	BY	DESCRIPTION
PREPARED BY: DAT			DATE: AUG. '16
REVIEWED BY: JSL			DATE: AUG. '16
APPROVED BY: DRD			DATE: AUG. '16

POLYMET MINING

FIGURE 11-16
PROPOSED PLANT SITE STORMWATER MANAGEMENT SOURCE AREA AND PONDS
PERMIT TO MINE APPLICATION
HOYT LAKES, MINNESOTA

Scale: 0 500 1,000 Feet | Date: AUGUST 2016
Drafted by: DAT | Project No: 12P778

Path: X:\GB\IE\2012\12P778\GIS\mxd\PMA\Figure 11-16 Proposed Stormwater at Plant Site.mxd Date: 8/26/2016



Notes
1. Basemap by Esri and its data suppliers.
2. Project Features supplied by Barr Engineering Company.
3. NHD features are created from MDNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance, data sources may show watercourses that no longer exist.

Legend
- Beneficiation Plant Return Flow Pipeline
- Flotation Tailings Pipeline from Beneficiation Plant
- Spigotting Tailings Discharge Pipe
- Treated Water Discharge Pipe
- Seepage Water Pipe
- Treated Water Pipeline
- FTB Seepage Containment System
- Rivers and Streams[3]
- Proposed Railroad Track
- Existing Private Railroad
- Hydromet Residue and Tailings Dam
- Existing Buildings
- Proposed Plant Site Buildings
- Facility Boundary

POLYMET MINING

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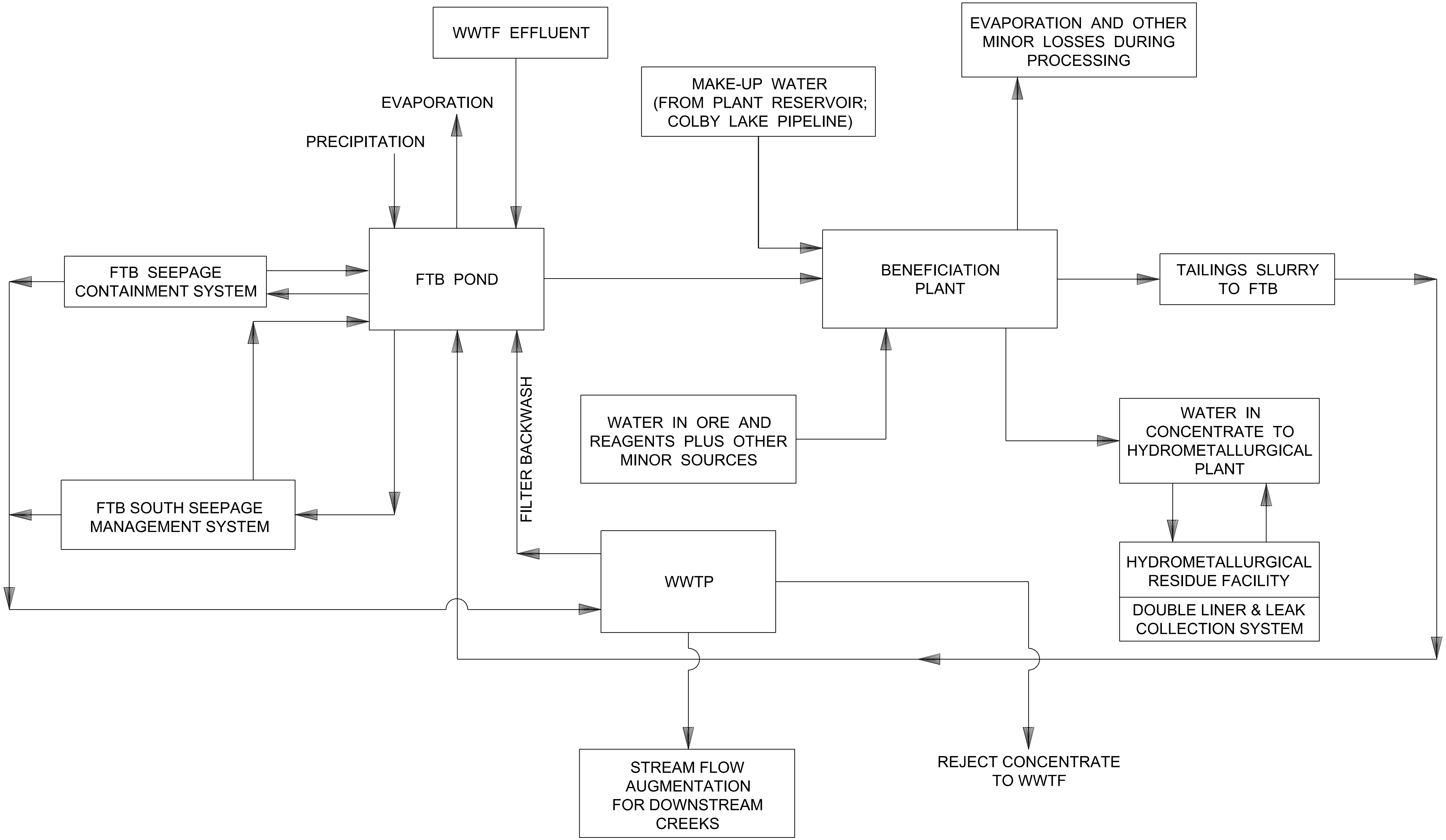
REVISED	DATE	BY	DESCRIPTION	
CHECKED BY:	DAT		DATE: AUG. '16	
APPROVED BY:	JSL		DATE: AUG. '16	
APPROVED BY:	DRD		DATE: AUG. '16	

POLYMET MINING

FIGURE 11-17
FLOTATION TAILINGS AND RETURN WATER PIPELINES
PERMIT TO MINE APPLICATION
HOYT LAKES, MINNESOTA

Scale: 0 1,000 2,000 Feet	Date: AUGUST 2016
Prepared by: DAT	Project No: 12P778

Path: X:\GB\IE\2012\12P778\GIS\mxd\PMA\Figure 11-17 FTB Tailings and Process Water.mxd Date: 9/2/2016



Foth Infrastructure & Environment, LLC

REVISED	DATE	BY	DESCRIPTION

PREPARED BY:	BJW1	DATE:	AUG. '16
REVIEWED BY:	JSL	DATE:	AUG. '16
APPROVED BY:	DRD	DATE:	AUG. '16

POLYMET MINING

FIGURE 11-18
PLANT SITE PROCESS WATER FLOWS
PERMIT TO MINE APPLICATION
HOYT LAKES, MINNESOTA

Scale:	NOT TO SCALE	Date:	AUGUST 2016
Drafted By:	JOW	Project No:	12P778

X:\GB\IE\2012\12P778\cad\figures\PMA\Figure 11-18 Process Water Flows.dgn
8/23/2016 2:56:40 PM bjw1

12 Wetland Assessment and Mitigation

12.1 Regulatory Overview

Wetland impacts associated with the Project are regulated under Section 404 of the federal CWA and WCA, including Minnesota Rules, chapter 8420. In conjunction with the Section 404 permitting process, PolyMet and the Co-Lead Agencies thoroughly evaluated wetland impacts in the FEIS, with input and review by the USEPA. In addition, the Section 404 authorization process requires certification under CWA Section 401 that the Project will meet applicable Minnesota water quality standards. As documented in detail in the FEIS (Appendix 16.1) and the Wetland Replacement Plan (Appendix 18.1), PolyMet designed the Project to meet CWA Section 401 and 404 requirements, Minnesota's water quality standards, and WCA requirements.

Section 404 of the CWA and WCA require that PolyMet avoid, minimize, and mitigate wetland impacts associated with the Project. If such impacts cannot be avoided, then PolyMet must replace impacted wetlands by creating or restoring other wetland areas under a mitigation plan that meets Section 404 and WCA requirements and that is approved by the USACE and MDNR, respectively. Similarly, Minnesota's PTM Regulations and the regulations implementing WCA both require that, before a company can conduct a mining activity that will result in the "draining or filling of wetlands," the company must replace such wetlands by "restoring or creating wetland areas under a wetland mitigation plan approved" by MDNR. Minnesota Rules, part 6132.5300; Minnesota Rules, part 8420.0330, subpart 1. As part of this Application, PolyMet is submitting three wetland mitigation plans that discuss the proposed wetland mitigation activities at each mitigation site (Appendix 18.1). PolyMet has also submitted mitigation plans to the USACE and the MPCA.

This section of the Application addresses the applicable wetland requirements by describing PolyMet's assessment of wetland impacts, documenting measures PolyMet took to avoid, minimize, and/or mitigate such impacts in its design of the Project, and summarizing PolyMet's plan to address unavoidable wetland impacts. The proposed wetland mitigation was designed to meet the St. Paul District USACE policy and WCA requirements.

12.2 Identification and Assessment of Wetlands

PolyMet conducted delineations and functional assessments of wetlands potentially impacted by the Project within the following Project Areas: Mine Site, Plant Site, and Transportation and Utility Corridors. PolyMet performed these delineations and functional assessments between 2004 and 2012.

PolyMet conducted the wetland delineations according to the Routine On-Site Determination Method specified in the USACE Wetland Delineation Manual (Reference (32)). PolyMet classified the wetlands using the Wetland Community Classification System (Reference (8)) and the USFWS Circular 39 Classification System (Reference (33)). More information on the wetland delineation can be found in Section 3.1 of the Wetland Data Package provided in Appendix 16.21. These wetlands are depicted and summarized on Figure 12-1 and Table 12-1, respectively.

This wetland delineation and assessment process identified 180 wetlands covering approximately 1,586 acres in the Project Areas. The percentage (based on acreage) of Eggers and Reed wetland community types identified include: coniferous bog (55%); shrub swamp (includes alder thicket and shrub-carr; 12%); shallow marsh (11%); coniferous swamp (9%); deep marsh (7%); sedge/wet meadow (3%); open bog (1%); hardwood swamp (1%); and open water (less than 1%) (Reference (8)).

The overall quality of these wetlands was evaluated using the Minnesota Rapid Assessment Method (MnRAM 3.0). Within the Mining Area, 105 of the 180 wetlands (58%) are rated as high quality, 13 wetlands (7%) rated as moderate quality, and 62 wetlands (35%) rated as low quality. Low quality wetlands are located at the Plant Site. Moderate quality wetlands are located at the Mine Site and Plant Site. High quality wetlands are located at the Mine Site and within the Transportation and Utility Corridor. See Section 11.0 of the Wetland Replacement Plan in Appendix 18.1 for more details on the types and quality of the wetlands delineated in each Project Area.

12.3 Consideration of Wetland Impact Avoidance and Impact Minimization/Mitigation

PolyMet prioritized avoiding, minimizing, and mitigating wetland impacts throughout the design and environmental review of the Project to prevent pollution, impairment, and destruction of the state’s natural resources and to support both the state and federal wetland permitting processes, as well as this Application. This effort included exploration of a range of alternative configurations of the Project that affect the magnitude of the Project’s direct wetland impacts. For a comprehensive analysis of the full range of alternatives explored and evaluated, see Section 3.2 of the FEIS (Appendix 16.1), and Sections 6.3, 6.4, 6.5, and 6.6 of the Wetland Replacement Plan (Appendix 18.1). This comprehensive alternatives analysis is briefly summarized below.

Although the Project is not a water-dependent Project, it is not possible to completely avoid wetland impacts. PolyMet’s alternatives analysis, however, resulted in changes to the Project design that avoided certain impacts and mitigated or minimized other impacts. Table 12-2 summarizes the direct wetland refinements based on the alternatives considered for the Project. These refinements reflect implementation of the strategy to avoid and minimize potential wetland impacts:

- minimize the footprint and optimize the placement of mining features, mainly at the Mine Site

- maintain a smaller disturbance footprint by re-using existing infrastructure, mainly at the Plant Site brownfield site
- utilize existing facilities and structures, to the extent practicable, to support ongoing activities, mainly at the Plant Site and the Transportation and Utility Corridors
- maintain future tailings disposal in a single location and within the existing watershed where the current facility is located
- expand the existing tailings disposal site upward, to the extent geotechnically practicable, thus disturbing less surface area while allowing more material to be placed in the same footprint
- divert runoff from operation areas away from undisturbed drainages
- install culverts to facilitate flow between wetland areas
- maintain Industrial SWPPPs, using BMPs, to prevent site erosion and subsequent downstream sedimentation
- collect and treat mine water and Tailings Basin seepage, and appropriately separate stormwater from mine water
- implement interim, concurrent (as practicable) and permanent reclamation at the site

12.4 Evaluation of Wetland Impacts

12.4.1 Methods

Where wetland impacts are unavoidable despite the comprehensive alternatives analysis and Project refinement process described above, PolyMet evaluated the nature and scope of these impacts. The Wetland Work Plan (Attachment A of Appendix 16.21) describes the methods used to identify both direct wetland impacts and potential indirect wetland impacts for the Project.

The FTB and the HRF are located within the LTVSMC Permit to Mine ‘Ultimate Tailings

Basin Limit’ boundary. State and federal wetland laws do not regulate lands within the LTVSMC Permit to Mine ‘Ultimate Tailings Basin Limit’ boundary, so they are not included in this analysis.

12.4.2 Direct Wetland Impacts

For the impact analysis, PolyMet defined direct impacts as mining-related activities that result in filling or excavation within the boundaries of a wetland. This analysis used accepted tools and protocols as defined in the Wetland Work Plan (Attachment A of Appendix 16.21). Wetland types within the Project footprint were identified using the wetland community classification system (Reference (8)).

The direct impacts associated with each wetland within the Mining Area are shown in Table 12-1, and summarized by wetland type in Table 12-3. Of the 166 wetlands in the Mining Area, 128 wetlands will be directly impacted, totaling 913.8 acres of direct wetland impact. The

Mine Site will contain the majority of direct wetland impacts (83%), followed by the FTB (15%), HRF (less than 1%), Dunka Road and Utility Corridor (less than 1%), and the Railroad Corridor (less than 0.1%).

These direct wetland impacts will occur in the following wetland types: coniferous bog (56%), shrub swamp (12%), coniferous swamp (9%), shallow marsh (8%), deep marsh (8%), sedge/wet meadow (5%), hardwood swamp (1%), and open bog (1%).

The Project will also result in 26.9 acres of fragmented wetlands. Fragmented wetlands are remnants of a directly impacted wetland. The determination of fragmentation is based on an analysis of wetland type, source of hydrology, size of remaining wetland, location in the current watershed, location in the future watershed, connectivity to other wetlands, and direction of flow in the area. As agreed upon with the Co-Lead Agencies during the EIS process, the fragmented wetlands will be included in the upfront compensatory mitigation for the Project.

There will be 913.8 acres of direct wetland impacts and 26.9 acres of fragmented wetlands, for a total of 940.7 acres of wetland impacts. The locations of direct wetland impacts across the Mining Area are shown on Figure 12-2 through Figure 12-8.

12.4.3 Potential Indirect Wetland Impacts

In addition to unavoidable direct wetland impacts that will be addressed in the wetland mitigation plan, described in Section 12.5, PolyMet analyzed the potential for indirect wetland impacts. A detailed description of the potential indirect assessment methodology and results is provided in Section 5.2 of the Wetland Data Package (Appendix 16.21). The purpose of this analysis was to identify wetlands to be monitored for potential indirect impacts as part of the monitoring plan (Appendix 18.2) to be implemented under the Section 404 and WCA permits for the Project.

12.5 Wetland Mitigation

Wetlands that are directly impacted and indirectly impacted by fragmentation will be replaced and mitigated by off-site wetland restoration projects (Appendix 18.1). Specifically, PolyMet plans to develop approximately 1,581 wetland mitigation credits at three off-site mitigation sites known as the Zim, Hinckley, and Aitkin sites. The majority of these credits will be from in-kind mitigation and over one-quarter of the credits will be from within the Project watershed. A brief description of the mitigation sites is provided in Table 12-4. The wetland mitigation credits for the Project are summarized in Table 12-5.

12.5.1 State WCA Wetland Mitigation Overview

Based on the WCA wetland mitigation standards (Minnesota Rules, part 8420.0522, subpart 4), the mitigation credits will qualify at a ratio of either one mitigation credit to one acre of wetland impact (1:1) or 1.5:1. The mitigation credits developed at the Zim site will qualify for the minimum mitigation ratio of 1:1, because they are located within the same major watershed and the majority of the mitigation credits are planned as in-kind credits. The credits from the Aitkin and Hinckley sites will qualify for a mitigation ratio of 1.5:1 because they are outside of the major watershed where the Project's wetland impacts occur. Table 12-6 for wetland mitigation utilizing WCA credits.

12.5.2 Federal CWA Wetland Mitigation Overview

PolyMet is working with the USACE St. Paul District to ascertain that wetland credits and mitigation sites will also satisfy federal requirements. Based on the St. Paul District policy for wetland mitigation, the base ratio for compensation of wetland impacts is 1.5:1. A draft guidance document from the St. Paul District USACE for the Project states that an increase in the base ratio to 2:1 may be required for certain wetland types (Reference (34)). The credits for wetland mitigation using the USACE ratios for the Project are summarized in Table 12-7.

12.5.3 Off-Site Wetland Mitigation Plan

The off-site wetland mitigation projects (Zim, Hinckley, and Aitkin sites) that will provide required mitigation for the Project's wetland impacts are summarized below. Site locations and watersheds are shown on Figure 12-9. Compensatory wetland mitigation site selection for the Project began in 2005 (see the detailed summary of the mitigation site selection process in Section 14.1 of the Wetland Replacement Plan in Appendix 18.1). PolyMet selected these three sites after considering the potential for each site to mitigate for impacted wetland community types. The bog and forested community types will be mitigated at a higher ratio based on the draft guidance document from the St. Paul District (Reference (34)).

12.5.3.1 Zim Wetland Mitigation Site

The Zim site was an active sod farm that has been drained by ditches and sub-surface drain tiles. This site is located in St. Louis County in the St. Louis River major watershed (#3) within the Lake Superior basin Bank Service Area (BSA) (#1). This site is located in two separate ownership units on approximately 532 acres of land located southwest of the city of Eveleth, Minnesota on the east side of County Road 7, as shown on Figure 12-10 and Figure 12-11.

Restoration methods on the site are designed to restore a coniferous bog community; however, developing a bog community is highly dependent on soil and groundwater parameters that are at times difficult to control. Therefore, a coniferous swamp community will be the contingent community if the soil and groundwater conditions are not adequate for bog regeneration.

Coniferous bogs or swamps are the target communities for the site, however, where trees do not successfully establish, the target community will be an open bog or sedge meadow. If the target community changes, the credit ratios will be recalculated (further details can be found in Section 12.5.3.4). A total of 504 acres of wetland restoration and 10 acres of upland buffer are proposed for the site. A total of 480 compensatory wetland mitigation credits are proposed from this site.

The credit calculations are shown in Table 12-7 and follow the St. Paul District USACE Policy and the draft guidance document from the St. Paul District USACE (Reference (34)). This site is located within the same watershed as the Project so the credits from the site qualify for the in-place incentive, a credit reduction of 0.25:1. Wetlands on this site will replace wetlands of the same type, so these credits will qualify for the in-kind incentive, a credit reduction of 0.25:1. Most of the credits from this site will be developed as bog and/or forested wetland communities and, therefore, will meet the minimum mitigation ratio of 1.5:1 for those communities.

Under WCA, the mitigation ratio will be 1:1 for credits at the Zim site because the impacted wetlands will be replaced within the same watershed and the majority will be replaced in-kind (Table 12-6). Mitigation credits from the Zim site are summarized in Table 12-5 based on actions eligible for credit in the WCA rules. Proposed actions eligible for credit include the following, with references to the subpart under Minnesota Rules, part 8420.0526:

- Restoration of drained wetlands are eligible for credit for 100% of the area restored (Minnesota Rules, part 8420.0526, subpart 3). This applies to the majority of the fields on the site that are drained by sub-surface drain tiles and will be restored to coniferous bog or coniferous swamp communities.
- Restoration of partially-drained wetlands are eligible for credit for 50% of the area restored (Minnesota Rules, part 8420.0526, subpart 4). This applies to the hydrologic restoration of partially-drained wooded wetlands and filled ditches.
- The upland areas restored and maintained in native vegetation are eligible for credit for 25% of the area (Minnesota Rules, part 8420.0526, subpart 2). The uplands at the Zim site occur in areas adjacent to ditches that will remain in place where the lateral effect of the ditches is expected to continue to eliminate wetland hydrology.

The majority of the wetland mitigation at the Zim site is proposed through the restoration of drained wetlands. Those areas were managed for sod production, with conditions ranging from open soil to a fully developed turf grass mat that is regularly mowed and herbicides are applied to control weeds. Sod production ceased at the end of 2012 with no other crop production or active land management since that time. The historic wetland hydrology has been removed from those areas by an extensive drain tile and ditch system. Therefore, the sod production areas of the site currently serve no natural wetland functions. The restoration of forested wetland communities within the site will restore wetland functions over the course of several to many years. Hydrologic and water quality functions such as water storage, hydrologic regime, and maintenance of water quality will be restored to a higher functioning level soon after the initial restoration activities are completed and to natural conditions within several years following initial restoration. Other wetland functions that rely on the reestablishment of natural wetland vegetation, such as vegetative diversity, wildlife habitat, and aesthetics/recreation will take longer to become fully restored. Substantial improvements in those functions will occur, however, during the first several years of restoration because permanent, native vegetation will begin to develop rapidly, the site will not be tilled, seeded, or regularly mowed, and human activity within the site will be minimal.

Hydrologic restoration of partially-drained wooded wetlands qualifies for 50% credit based on Minnesota Rules, part 8420.526, subpart 4. The 50% credit is based on the highest percentage available for restoration where qualifying agricultural activities were not conducted, despite the anticipated improvement of wetland functions to these communities. Benefits from this restoration will include an increase in the water storage capacity of the wetland, improved water quality, and increased soil saturation. The saturated soil is an important factor in maintaining a healthy bog plant community and associated wetland functions. Restoring the natural hydrology to the wooded communities at the Zim site is anticipated to facilitate the return of critical components of the bog community and halt peat subsidence.

Presently, the wooded communities subjected to partial drainage are degraded woodlands that lack healthy critical bog community vegetation components such as low-growing ericaceous shrubs, a continuous layer of *Sphagnum* moss, and abundant sedges (i.e., *Carex lasiocarpa*). Furthermore, exposed tree roots at the base of tree trunks are evidence that the soil in these areas is likely subsiding due to increased decomposition of the peat, likely caused by reduced surface saturation. Increasing soil saturation in this area will enable this community to re-establish critical components of a healthy bog ecosystem. Monitoring data will be collected after restoration to document the changes in the partially drained wooded communities. These data will be used to determine potential remedial actions and to document restored hydrology.

PolyMet expects to restore vegetation and hydrology to the site over a one-year period following wetland construction with up to 20 years of vegetation management.

Performance standards have been developed for the mitigation site to guide the restoration activities and to monitor whether vegetation and hydrology are meeting the design goals (see Zim Wetland Mitigation Site, Wetland Mitigation Plan, provided in Attachment C of Appendix 18.1). A declaration of restricted covenants will be prepared and recorded within one year after starting the restoration activities. The wetland restoration area will be monitored for up to 20 years beginning in the first full growing season after completing hydrologic restoration and ending upon certification by the USACE and MDNR that the wetlands have met performance standards.

12.5.3.2 Hinckley Wetland Mitigation Site

The Hinckley site was an active sod and row crop farm. The site currently has been drained by ditches and sub-surface drain tiles. The mitigation site is located in Pine County in the Snake River major watershed (#36) within BSA #6, adjacent to BSA #1 where the Project is located. This 417-acre site is located southwest of the city of Hinckley, Minnesota at the intersection of Sod Road and Highway 107 (Figure 12-12).

The proposed wetland mitigation area includes total of 348 acres of wetland restoration and 58 acres of upland buffer preservation (Table 12-5). Restoration methods on the site are designed to restore sedge meadow, shrub-carr, alder thicket, and hardwood swamp (Table 12-5). A total of 322 compensatory wetland mitigation credits are proposed from this site.

Under the WCA, the mitigation credits at the Hinckley site will replace Project impacts at 1.5:1 because the wetlands will be replaced outside of the Project watershed (Table 12-7). Mitigation credits from the Hinckley site are summarized in Table 12-5 based on actions eligible for credit in Minnesota Rules, chapter 8420.

Proposed actions eligible for credit include the following, with references to the subpart under Minnesota Rules, part 8420.0526:

- Restoration of drained wetlands are eligible for credit for 100% of the area restored (Minnesota Rules, part 8420.0526, subpart 3). This applies to all areas of the site in which hydrology monitoring has documented the removal of wetland hydrology.
- Restoration of partially-drained wetlands are eligible for credit for 50% of the area restored (Minnesota Rules, part 8420.0526, subpart 4). This applies to the hydrologic restoration of partially-drained wooded wetlands and filled ditches.
- Creation of wetlands are eligible for credit for 75% of the area created (Minnesota Rules, part 8420.0526 subpart 7). This applies to four areas on the Site that are planned for obtaining sufficient soils to fill existing ditches.
- The upland areas restored and maintained in native vegetation are eligible for credit for 25% of the area (Minnesota Rules, part 8420.0526, subpart 2). This applies to restoration of native vegetation in the uplands adjacent to the restored wetlands.

PolyMet expects to restore vegetation and hydrology to the site over a one-year period following wetland construction with up to 20 years of vegetation management.

Performance standards have been developed for the mitigation site to guide the restoration activities and to monitor whether vegetation and hydrology are meeting the design goals (see Hinckley Wetland Mitigation Site, Wetland Mitigation Plan provided in Appendix .3). A declaration of restricted covenants will be prepared and recorded within one year after starting the restoration activities. The wetland restoration area will be monitored for up to 20 years beginning in the first full growing season after completing hydrologic restoration and ending upon certification by the USACE and MDNR that the wetlands on this site have met the performance standards.

12.5.3.3 Aitkin Wetland Mitigation Site

The Aitkin site is currently an active farm producing sod and row crops that has been drained by ditches and sub-surface drain tiles. The site has been used for sod, wheat, soybeans, sunflowers, and wild rice production. The mitigation site is located in Aitkin County in the Elk-Nokasippi major watershed within BSA #5, adjacent to BSA #1 where the Project is located. The 1,020-acre site is located north of the city of Aitkin, Minnesota on either side of County Road 1, as shown on Figure 12-13.

The proposed wetland mitigation area includes 828 acres of wetland restoration and 65 acres of upland buffer preservation (Table 12-5). Restoration methods on the site are designed to restore shallow marsh, shrub-carr, hardwood swamp, and coniferous swamp. A total of 780 compensatory wetland mitigation credits are proposed from this site (Table 12-5).

Under the WCA, mitigation credits at the Aitkin site will replace Project impacts at 1.5:1, because the wetlands will be replaced outside of the Project watershed (Table 12-6). Mitigation credits from the Aitkin site are summarized in Table 12-6 based on actions eligible for credit in the WCA rules. Proposed actions eligible for credit include the following with references to the subpart under Minnesota Rules, part 8420.0526:

- Restoration of drained wetlands are eligible for credit for 100% of the area restored (Minnesota Rules, part 8420.0526, subpart 3). This applies to the areas of the site where hydrology monitoring has documented the removal of wetland hydrology.
- Restoration of partially-drained wetlands are eligible for credit for 50% of the area restored (Minnesota Rules, part 8420.0526, subpart 4). This applies to the hydrologic restoration of partially-drained filled ditches.
- The upland areas restored and maintained in native vegetation are eligible for credit for 25% of the area (Minnesota Rules, part 8420.0526, subpart 3). This applies to restoration of native vegetation in the uplands adjacent to the restored wetlands.

PolyMet expects to restore vegetation and hydrology to the site over a one-year period following wetland construction with up to 20 years of vegetation management.

Performance standards have been developed for the mitigation site to guide the restoration activities and to monitor whether vegetation and hydrology are meeting the design goals (Aitkin Wetland Mitigation Site, Wetland Mitigation Plan, provided in Appendix .3). A declaration of restricted covenants will be prepared and recorded within one year after starting the restoration activities. The wetland restoration area will be monitored for up to 20 years beginning in the first full growing season after completing hydrologic restoration and ending upon certification by the USACE and MDNR that the wetlands have met performance standards.

12.5.3.4 Contingencies for Unsuccessful Mitigation

If the restored wetland communities at the mitigation sites do not meet performance standards, as described in each site’s mitigation plan (Appendix .3), remedial or corrective actions and possibly additional mitigation credits may be required. Site conditions relative to the performance standards will be discussed in each annual monitoring report. If the performance standards are not met, PolyMet will propose remedial actions to meet the performance standard. If performance standards within the planned community types are not met for three consecutive years, PolyMet will analyze the effects on the approved wetland mitigation credits and propose a change to the wetland mitigation plan, which may include a modification of wetland community type, changes to the proposed credit ratios, or additional wetland mitigation.

Similarly, if a wetland community is not developing as planned and defined in the performance standards after the fifth full growing season after restoration, PolyMet will work with the USACE and MDNR to develop appropriate, alternative wetland mitigation plans, including alternative mitigation or revisions to the overall mitigation ratio based on changes to wetland community types. PolyMet will submit all plan revisions to the USACE and MDNR for review and approval before implementation.

Should additional wetland mitigation be required, after utilizing the excess credits presented in Table 12-5 through Table 12-7, PolyMet will first identify and pursue wetland mitigation opportunities, including wetland preservation options, within the Project watershed. PolyMet will utilize information available at that time regarding potential wetland mitigation opportunities available through the Board of Water and Soil Resources (BWSR) or other relevant entities. PolyMet will submit information on the wetland mitigation opportunities identified and pursued to the USACE and MDNR for review and approval before making final decisions on additional mitigation.

12.6 Monitoring

This section describes monitoring proposed to demonstrate 1) performance of wetland mitigation at the Zim, Hinckley, and Aitkin sites; and 2) to assess potential indirect wetland impacts at the Mine Site and Plant Site.

12.6.1 Wetland Mitigation Site Monitoring

12.6.1.1 Zim Site

Shallow water table monitoring wells have been monitored on the Zim site and a reference wetland since May 2012 to characterize the pre-restoration hydrology and will continue until the initiation of restoration. After restoration, the monitoring design may be altered to better characterize restored conditions. Hydrology monitoring will continue for up to 20 years beginning in the first full growing season after completing hydrologic restoration. Additional details are provided in the Zim Wetland Mitigation Site, Wetland Mitigation Plan, provided in Attachment C of Appendix 18.1.

Monitoring reports will be prepared and submitted in Mine Years 1, 2, 3, 5, 8, 12, and 20 following construction. Monitoring results will be included in the reports to assess whether or not the restored wetland are in conformance with performance standards and to determine whether continued monitoring is required. The monitoring reports will describe the status of the wetland mitigation, summarize the results of the vegetative and hydrologic monitoring, discuss management activities and corrective actions conducted during the previous period, and discuss activities planned for the following period. The report will be submitted to the USACE and MDNR by one month after the end of each year.

12.6.1.2 Hinckley Site

Shallow water table monitoring wells have been monitored on the Hinckley site and reference wetlands since May 2014 to characterize the pre-restoration hydrology and will continue until the initiation of restoration. After restoration, the monitoring design may be altered to better characterize restored conditions. Hydrology monitoring will continue for up to 8 years beginning in the first full growing season after completing hydrologic restoration. Additional details are provided in the Hinckley Wetland Mitigation Site, Wetland Mitigation Plan, provided in Attachment D of Appendix 18.1.

Monitoring reports will be prepared and submitted in Mine Years 1, 2, 3, 4, and 5 for all wetland types and also in Mine Year 8 for shrub communities following construction. Monitoring results will be included in the reports to assess whether or not the restored wetland are in conformance with performance standards and to determine whether continued monitoring is required. The monitoring reports will describe the status of the wetland mitigation, summarize the results of the vegetative and hydrologic monitoring, discuss management activities and corrective actions conducted during the previous period, and discuss activities planned for the following period. The report will be submitted to the USACE and MDNR by one month after the end of each year.

12.6.1.3 Aitkin Site

Shallow water table monitoring wells have been monitoring on the Aitkin site and a reference wetland since May 2012 to characterize the pre-restoration hydrology and will continue until the initiation of restoration. After restoration, the monitoring design may be altered to better characterize restored conditions. Hydrology monitoring will continue for up to 8 years beginning in the first full growing season after completing hydrologic restoration. Additional details are provided in the Aitkin Wetland Mitigation Site, Wetland Mitigation Plan, provided in Attachment 3 of Appendix 18.1.

Monitoring reports will be prepared and submitted in Mine Years 1, 2, 3, 4, and 5 for all wetland types and also in Mine Year 8 for shrub communities following construction. Monitoring results will be included in the reports to assess whether or not the restored wetland are in conformance with performance standards and to determine whether continued monitoring is required. The monitoring reports will describe the status of the wetland mitigation, summarize the results of the vegetative and hydrologic monitoring, discuss management activities and corrective actions conducted during the previous period, and discuss activities planned for the following period. The report will be submitted to the USACE and MDNR by one month after the end of each year.

12.6.2 Wetland Monitoring Plan for Potential Indirect Wetland Impacts

Wetland monitoring is being conducted at the Project Site to provide baseline data to use in identifying potential indirect impacts to wetlands caused by mining activities. Monitoring is currently being conducted within all wetlands containing a potential indirect wetland impact factor rating of 3-5 and a sampling of those wetlands with factor ratings of 1-2 (see Wetland Data Package provided in Appendix 16.21). To determine if indirect impacts occur, hydrology, vegetation, and wetland boundaries will be monitored, documented, and compared with baseline monitoring and reference wetlands. A total of 56 monitoring wells and five reference wells have been installed to collect baseline hydrology data and to document potential indirect wetland impacts. The monitoring protocol is provided in the Monitoring Plan for Potential Indirect Wetland Impact provided in Appendix 18.2. This monitoring will continue for the life of the Project, though portions of the monitoring design may be altered to improve the design or to eliminate unnecessary data collection.

Pre-Project hydrology monitoring of wetlands and groundwater within and surrounding the proposed mine has been conducted since 2005 at well locations approved by the USACE and MDNR. Hydrology data collected from 2005-2009 are presented in reports submitted to the USACE and the MDNR. During 2008 through 2011, there were 21 locations monitored for hydrology. During 2012-2016, there were 61 locations monitored for hydrology (see Large Figures 16, 17, and 18 in Appendix 18.1). Baseline vegetation pre-project monitoring was completed in 2015 in the wetlands that are current monitored for hydrology. The hydrology monitoring and vegetation monitoring protocols are described in Appendix 18.2. Pre-Project monitoring did not include collection wetland boundaries other than what was completed in the wetland delineation and baseline wetland type evaluation for the Project.

Pre-project monitoring locations include five reference wetlands approved by the USACE and MDNR to document the natural hydrologic fluctuations in wetlands that will not be affected by the Project. The reference wetland data will be used to facilitate interpretation of the Project hydrologic data. Within the Mine Site, hydrology monitoring wells were installed in 2008 and 2014 in reference wetlands (Large Figures 16 and 18 in Appendix 18.1). Within the FTB area, hydrology monitoring wells were installed in 2010 and 2014 in reference wetlands (Large Figure 17 in Appendix 18.1).

Hydrologic monitoring will continue at the monitoring locations and at reference wetland locations every year throughout the growing season for the life of the mine operation. If it is determined that certain wells are not providing useful information, the monitoring may be modified with the concurrence of the USACE and MDNR.

Monitoring data will be submitted to the USACE and MDNR annually for the life of the mine. Hydrology data will be presented every year to show monitoring locations, hydrographs, and analysis of wetland hydrologic conditions in the context of precipitation conditions. Vegetation and wetland boundary data will be presented every five years and will be used to determine the acreage of impacts and potential indirect impacts that are not evident based on hydrologic data. Indirect impacts will be assessed in the annual reports to the extent possible. Acreage of indirect impacts will be determined, if any, and will be used to determine the requirements for wetland mitigation credits, if such credits are needed. If compensatory mitigation is necessary, credits will be proposed in the annual report as described in Section 12.5.3.4.

Table 12-1 Summary of Wetlands in Project Areas

Project Area	Wetland ID	Dominant Circular 39 Community	Total Wetland Area within the Project Area (acres)	Direct Wetland Impacts (acres)	Fragmentation Impacts (acres)	Remaining Wetland Area (acres)	Dominant Eggers and Reed Wetland Community	Wetland Quality	Type of Impact[1]
Mine Site	1	3	0.42	0	0	0.42	Shallow marsh	Moderate	
Mine Site	3	3	0.35	0	0	0.35	Shallow marsh	Moderate	
Mine Site	5	2	0.61	0.61	0	0	Wet meadow	High	F
Mine Site	6	3	0.62	0	0	0.62	Shallow marsh	Moderate	
Mine Site	7	2	0.07	0	0	0.07	Wet meadow	Moderate	
Mine Site	8	2	6.8	6.8	0	0	Sedge meadow	Moderate	F,E
Mine Site	9	3	1.8	0.07	0	1.73	Shallow marsh	High	F
Mine Site	10	2	1.17	0	0	1.17	Sedge meadow	High	
Mine Site	11	8	8.88	0	0	8.88	Coniferous bog	High	
Mine Site	12	6	0.13	0	0	0.13	Alder thicket	High	
Mine Site	13	4	5.03	0.09	0	4.94	Deep marsh	High	F
Mine Site	14	2	0.33	0.33	0	0	Wet meadow	High	F
Mine Site	16	3	0.31	0	0	0.31	Shallow marsh	High	
Mine Site	18	3	18.9	18.9	0	0	Shallow marsh	High	E
Mine Site	19	3	1.68	0.05	0	1.63	Shallow marsh	High	E
Mine Site	20	2	17.06	16.96	0.1	0	Sedge meadow	High	E, Fr
Mine Site	22	3	1.43	0	0	1.43	Shallow marsh	High	
Mine Site	22A	7	0.89	0	0	0.89	Coniferous swamp	High	
Mine Site	24	6	0.8	0.39	0	0.41	Alder thicket	High	E
Mine Site	25	8	1.95	0	0	1.95	Coniferous bog	High	
Mine Site	27	8	1.07	1.07	0	0	Coniferous swamp	Moderate	E
Mine Site	29	3	12.02	0	0	12.02	Shallow marsh	High	
Mine Site	32	8	73.36	70.99	2.37	0	Coniferous bog	High	F,E, Fr
Mine Site	33A	6	18.46	5.77	0	12.69	Alder thicket	High	E
Mine Site	33B	7	4.56	0	0	4.56	Coniferous swamp	High	
Mine Site	37	6	2.39	2.39	0	0	Shrub-carr	High	F
Mine Site	43	6	8.29	7.26	0	1.03	Alder thicket	High	F
Mine Site	44	6	3.27	1.99	0	1.28	Alder thicket	High	E
Mine Site	45	6	37.55	28.83	3.58	5.14	Alder thicket	High	F,E, Fr
Mine Site	47	8	0.54	0.54	0	0	Open bog	High	F
Mine Site	48	8	89.16	27.8	1.86	59.5	Coniferous bog	High	F,E, Fr
Mine Site	48A	7	2.65	2.21	0	0.44	Coniferous swamp	High	F
Mine Site	51	6	7.47	7.45	0.02	0	Alder thicket	High	F, Fr
Mine Site	52	6	3.88	3.88	<0.01	0	Alder thicket	High	F,E, Fr
Mine Site	53	6	18.59	0	0	18.59	Alder thicket	High	
Mine Site	53A	7	2.35	0	0	2.35	Coniferous swamp	High	

Project Area	Wetland ID	Dominant Circular 39 Community	Total Wetland Area within the Project Area (acres)	Direct Wetland Impacts (acres)	Fragmentation Impacts (acres)	Remaining Wetland Area (acres)	Dominant Eggers and Reed Wetland Community	Wetland Quality	Type of Impact[1]
Mine Site	53B	7	0.43	0	0	0.43	Coniferous swamp	High	
Mine Site	53C	7	2.88	0	0	2.88	Coniferous swamp	High	
Mine Site	54	7	4.11	0	0	4.11	Coniferous swamp	High	
Mine Site	54C	6	0.74	0	0	0.74	Alder thicket	High	
Mine Site	55	6	3.91	3.85	0.06	0	Alder thicket	High	F,E, Fr
Mine Site	56	8	2.79	2.79	0	0	Open bog	High	E
Mine Site	57	7	78.06	50.49	1.41	26.16	Coniferous swamp	High	F,E, Fr
Mine Site	58	6	34.58	0	0	34.58	Alder thicket	High	
Mine Site	60	6	6.71	6.71	0	0	Alder thicket	High	F
Mine Site	61	7	0.45	0	0	0.45	Coniferous swamp	High	
Mine Site	62	8	12.13	0	0	12.13	Coniferous bog	High	
Mine Site	64	7	0.31	0	0	0.31	Hardwood swamp	High	
Mine Site	68	7	23.81	10.89	0.09	12.83	Coniferous swamp	High	F,E, Fr
Mine Site	72	7	1.39	0	0	1.39	Coniferous swamp	High	
Mine Site	74	7	6.12	6.12	0	0	Hardwood swamp	High	E
Mine Site	76	8	3.92	2.21	0	1.71	Coniferous bog	High	E
Mine Site	77	8	13.01	0.92	<0.01	12.09	Coniferous bog	High	F,E, Fr
Mine Site	78	8	1.75	1.75	0	0	Coniferous bog	High	F
Mine Site	79	8	2.39	0	0	2.39	Coniferous bog	High	
Mine Site	80	8	0.29	0.22	0.08	0	Coniferous bog	High	F, Fr
Mine Site	81	7	1.68	1.44	0.24	0	Coniferous swamp	High	F,E, Fr
Mine Site	82	8	62.4	60.77	1.63	0	Coniferous bog	High	F,E, Fr
Mine Site	83	8	3.99	0	0	3.99	Open bog	High	
Mine Site	84	8	1.33	0	0	1.33	Coniferous bog	High	
Mine Site	85	8	1.41	1.41	0	0	Coniferous bog	High	E
Mine Site	86	8	2.47	2.46	0.01	0	Coniferous bog	High	F, Fr
Mine Site	88	8	5.58	5.02	0	0.56	Coniferous bog	High	F
Mine Site	90	8	176.08	34.22	0	141.86	Coniferous bog	High	F,E
Mine Site	90A	8	7.91	1.2	0	6.71	Open bog	High	F
Mine Site	95	8	2.54	2.54	0	0	Coniferous swamp	High	E
Mine Site	96	8	17.3	13.14	0	4.16	Coniferous bog	High	F,E
Mine Site	97	8	4.46	2.57	1.89	0	Coniferous bog	High	F,E, Fr
Mine Site	98	8	15.5	15.07	0.42	0	Coniferous bog	High	F,E, Fr
Mine Site	99	8	1.4	0.49	0	0.91	Coniferous bog	High	F,E
Mine Site	100	8	176.19	102.96	3.44	69.79	Coniferous bog	High	F,E, Fr
Mine Site	100A	6	1.66	1.66	0	0	Alder thicket	High	F
Mine Site	101	8	14.21	11.73	0.08	2.4	Coniferous bog	High	F,E, Fr
Mine Site	103	8	118.84	109.97	8.86	0	Coniferous bog	High	F,E, Fr

Project Area	Wetland ID	Dominant Circular 39 Community	Total Wetland Area within the Project Area (acres)	Direct Wetland Impacts (acres)	Fragmentation Impacts (acres)	Remaining Wetland Area (acres)	Dominant Eggers and Reed Wetland Community	Wetland Quality	Type of Impact[1]
Mine Site	104	8	3.57	3.47	0.1	0	Coniferous bog	High	F, Fr
Mine Site	105	8	15.48	0	0	15.48	Coniferous bog	High	
Mine Site	107	8	40.92	31.63	0.1	9.19	Coniferous bog	High	F,E, Fr
Mine Site	107A	7	1.74	1.69	0.05	0	Coniferous swamp	High	F,E, Fr
Mine Site	107B	3	4.51	2.89	0	1.62	Shallow marsh	High	F,E
Mine Site	107C	6	27.6	27.6	0	0	Alder thicket	High	E
Mine Site	114	8	0.73	0.73	0	0	Coniferous bog	High	F
Mine Site	120	3	0.58	0.12	0	0.46	Shallow marsh	Moderate	E
Mine Site	200	7	6.36	6.36	0	0	Hardwood swamp	High	F
Mine Site	201	2	13.49	13.49	0	0	Wet meadow	High	F
Mine Site	202	8	3.11	3.11	0	0	Open bog	High	F
Mine Site	552	8	8.72	8.72	0	0	Coniferous bog	High	F
Mine Site	567	3	1.4	1.4	0	0	Shallow marsh	High	F
MINE SITE SUBTOTAL	87		1297.78	758.19	26.39	513.19		80/87 High 7/87 Moderate	
Railroad Connection Corridor	1038	7	0.07	0.07	0	0	Coniferous swamp	High	F
Railroad Connection Corridor	R-3	6	0.1	0.1	0	0	Shrub-carr	High	F
Railroad Connection Corridor	R-4	6	0.2	0.2	0	0	Alder thicket	High	F
Railroad Connection Corridor	R-5	3	0.07	0.07	0	0	Shallow marsh	High	F
RAILROAD CONNECTION CORRIDOR SUBTOTAL	4		0.44	0.44	0	0		4/4 High	
Dunka Road and Utility Corridor	22B	3	0.34	0.34	0	0	Shallow marsh	High	F
Dunka Road and Utility Corridor	22C	6	0.38	0.38	0	0	Alder thicket	High	F
Dunka Road and Utility Corridor	54A	7	0.6	0.6	0	0	Coniferous swamp	High	F
Dunka Road and Utility Corridor	54B	6	0.13	0.13	0	0	Alder thicket	High	F
Dunka Road and Utility Corridor	54D	7	0.09	0.09	0	0	Coniferous swamp	High	F
Dunka Road and Utility Corridor	390	6	0.41	0.41	0	0	Alder thicket	High	F
Dunka Road and Utility Corridor	392	6	0.14	0.14	0	0	Alder thicket	High	F
Dunka Road and Utility Corridor	394	7	0.64	0.64	0	0	Coniferous swamp	High	F
Dunka Road and Utility Corridor	395	7	0.01	0.01	0	0	Coniferous swamp	High	F
Dunka Road and Utility Corridor	396	6	0.65	0.65	0	0	Alder thicket	High	F
Dunka Road and Utility Corridor	400	8	0.14	0.14	0	0	Coniferous bog	High	F
Dunka Road and Utility Corridor	553	7	0.09	0.09	0	0	Coniferous swamp	High	F
Dunka Road and Utility Corridor	554	7	0.11	0.11	0	0	Coniferous swamp	High	F
Dunka Road and Utility Corridor	569	6	0.68	0.68	0	0	Alder thicket	High	F
Dunka Road and Utility Corridor	716	6	0.02	0.02	0	0	Alder thicket	High	F
Dunka Road and Utility Corridor	814	8	0.75	0.75	0	0	Coniferous bog	High	F
Dunka Road and Utility Corridor	862	6	0.78	0.78	0	0	Alder thicket	High	F

Project Area	Wetland ID	Dominant Circular 39 Community	Total Wetland Area within the Project Area (acres)	Direct Wetland Impacts (acres)	Fragmentation Impacts (acres)	Remaining Wetland Area (acres)	Dominant Eggers and Reed Wetland Community	Wetland Quality	Type of Impact[1]
Dunka Road and Utility Corridor	1034	6	0.02	0.02	0	0	Alder thicket	High	F
Dunka Road and Utility Corridor	1035	6	0.16	0.16	0	0	Alder thicket	High	F
Dunka Road and Utility Corridor	1124	6	0.44	0.44	0	0	Alder thicket	High	F
Dunka Road and Utility Corridor	R-7	3	0.18	0.18	0	0	Shallow marsh	High	F
DUNKA ROAD AND UTILITY CORRIDOR SUBTOTAL	21		6.76	6.76	0	0		21/21 High	
FTB	251	6	1.43	1.43	0	0	Alder thicket	Moderate	C
FTB	272	4	1.11	1.1	0.01	0	Deep marsh	Low	C, Fr
FTB	278	6	1.04	0.23	0	0.81	Alder thicket	Low	C
FTB	279	6	4.84	3.33	<0.01	1.51	Alder thicket	Low	C, Fr
FTB	282	3	14.25	7.42	0	6.83	Shallow marsh	Moderate	C
FTB	284	6	2.92	2.51	0	0.41	Alder thicket	Low	C
FTB	290	7	0.48	0.22	0.02	0.24	Coniferous swamp	Moderate	F,E, Fr
FTB	292	4	1.71	1.29	0	0.42	Deep marsh	Low	C
FTB	307	3	0.78	0.77	<0.01	0	Shallow marsh	Low	C, Fr
FTB	308	4	7.17	1.95	0	5.22	Deep marsh	Low	C
FTB	309	2	0.02	0.02	0	0	Wet meadow	Low	C
FTB	312	6	1.98	1.33	0	0.65	Shrub-carr	Low	C
FTB	314	3	24.87	5.7	0	19.17	Shallow marsh	Low	C
FTB	573	3	0.12	0	0	0.12	Shallow marsh	Low	
FTB	582	4	27.49	8.11	0	19.38	Deep marsh	Low	C
FTB	585	6	1.58	0	0	1.58	Alder thicket	Low	
FTB	586	4	1.89	1.53	0	0.36	Deep marsh	Low	C
FTB	587	3	0.97	0.17	0	0.8	Shallow marsh	Low	C
FTB	590	3	5.43	5.38	0	0.05	Shallow marsh	Low	C
FTB	591	4	2.71	0.7	0	2.01	Deep marsh	Low	C
FTB	593	4	9.8	8.47	0.15	1.18	Deep marsh	Low	C, Fr
FTB	594	4	0.06	0	0	0.06	Deep marsh	Low	
FTB	595	4	2.14	1.09	0.01	1.04	Deep marsh	Low	F, Fr
FTB	811	7	0.2	0.2	0	0	Coniferous swamp	Low	C
FTB	968	7	13.76	10.27	0	3.49	Coniferous swamp	Low	C
FTB	1027	6	0.2	0	0	0.2	Alder thicket	Moderate	
FTB	1125	2	0.07	0.07	0	0	Sedge meadow	Low	
FTB	1126	7	0.69	0.69	0	0	Hardwood swamp	Low	
FTB	1134	3	14.45	8.71	0.04	5.7	Shallow marsh	Low	C, Fr
FTB	1135	4	0.51	0	0	0.51	Deep marsh	Low	
FTB	1139	3	20.25	2.54	0	17.71	Shallow marsh	Low	C
FTB	1155	3	0.55	0.41	0.15	0	Shallow marsh	Low	C, Fr

Project Area	Wetland ID	Dominant Circular 39 Community	Total Wetland Area within the Project Area (acres)	Direct Wetland Impacts (acres)	Fragmentation Impacts (acres)	Remaining Wetland Area (acres)	Dominant Eggers and Reed Wetland Community	Wetland Quality	Type of Impact[1]
FTB	1156	3	15.07	11.08	0.06	3.35	Shallow marsh	Low	C, Fr
FTB	1159	3	0.05	0	0.05	0	Shallow marsh	Low	Fr
FTB	1160	5	0.85	0	0	0.85	Deep water	Low	
FTB	1176	7	0.34	0	0	0.34	Hardwood Swamp	Moderate	
FTB	P10	6	0.34	0	0	0.34	Alder thicket	Low	
FTB	T1	4	1.93	0.11	0	1.82	Deep marsh	Low	F
FTB	T2	4	0.9	0.9	0	0	Deep marsh	Low	F
FTB	T3	2	0.09	0.09	0	0	Wet meadow	Low	F
FTB	T4	2	1.02	1.02	0	0	Wet meadow	Low	F
FTB	T5	2	0.24	0.24	0	0	Wet meadow	Low	F
FTB	T6	6	0.07	0.07	0	0	Shrub-carr	Low	F
FTB	T7	3	0.92	0.92	0	0	Shallow marsh	Low	F
FTB	T8	2	0.03	0.01	0	0.02	Wet meadow	Low	F
FTB	T10	4	1.48	1.48	0	0	Deep marsh	Low	F
FTB	T11	4	0.95	0.95	0	0	Deep marsh	Low	F
FTB	T12	3	0.39	0.39	0	0	Shallow marsh	Low	F
FTB	T13	4	1.05	0.97	0	0.08	Deep marsh	Low	F
FTB	T13A	4	0.16	0.16	0	0	Deep marsh	Low	F
FTB	T14	4	45.2	45.2	0	0	Deep marsh	Low	E
FTB	T15	3	1.7	1.7	0	0	Shallow marsh	Low	F
FTB SUBTOTAL	52		238.25	140.93	0.49	96.25		5/52 Moderate 47/52 Low	
HRF	1155	3	35.45	6.89	0.00	28.56	Shallow marsh	Low	F
HRF	1159	3	0.62	0.62	0.00	0.00	Shallow marsh	Low	F
HRF SUBTOTAL	2		36.07	7.51	0	28.56		2/2 Low	
Colby Lake Water Pipeline Corridor	P1	4	0.23	0	0	0.23	Deep marsh	Low	
Colby Lake Water Pipeline Corridor	P2	6	0.03	0	0	0.03	Shrub-carr	Low	
Colby Lake Water Pipeline Corridor	P3	3	0.25	0	0	0.25	Shallow marsh	Low	
Colby Lake Water Pipeline Corridor	P4	6	1.28	0	0	1.28	Shrub-carr	Low	
Colby Lake Water Pipeline Corridor	P5-1	4	0.77	0	0	0.77	Deep marsh	Low	
Colby Lake Water Pipeline Corridor	P5-2	3	0.14	0	0	0.14	Shallow marsh	Low	
Colby Lake Water Pipeline Corridor	P6	3	0.18	0	0	0.18	Shallow marsh	Low	
Colby Lake Water Pipeline Corridor	P7-1	3	0.11	0	0	0.11	Shallow marsh	Low	
Colby Lake Water Pipeline Corridor	P7-2	3	1.9	0	0	1.9	Shallow marsh	Low	
Colby Lake Water Pipeline Corridor	P8	2	0.07	0	0	0.07	Wet meadow	Low	
Colby Lake Water Pipeline Corridor	P9	2	1.28	0	0	1.28	Wet meadow	Low	
Colby Lake Water Pipeline Corridor	P10	6	0.41	0	0	0.41	Alder thicket	Low	
Colby Lake Water Pipeline Corridor	P11	6	0.03	0	0	0.03	Shrub-carr	Low	

Project Area	Wetland ID	Dominant Circular 39 Community	Total Wetland Area within the Project Area (acres)	Direct Wetland Impacts (acres)	Fragmentation Impacts (acres)	Remaining Wetland Area (acres)	Dominant Eggers and Reed Wetland Community	Wetland Quality	Type of Impact[1]
Colby Lake Water Pipeline Corridor	P12	6	0.31	0	0	0.31	Shrub-carr	Moderate	
COLBY LAKE WATER PIPELINE SUBTOTAL	14		6.99	0	0	6.99		1/14 Moderate 13/14 Low	
PROJECT TOTAL	180		1,586.29	913.84	26.88	644.99		105/180 High 13/180 Moderate 62/180 Low	

Notes:

[1] The types of wetland impact are excavation (E), fill (F), fragmentation (Fr), and containment system (C).

Abbreviations:

FTB = Flotation Tailings Basin

HRF = Hydrometallurgical Residue Facility

Source: Adapted from Appendix 18.1

Table 12-2 Summary of Reduced Aquatic Ecosystem Impacts Based on Draft Alternative Development

Refinement made from Alternatives Evaluation	Project Aspects Changed	Environmental Impact Reduced
Mine Site Alternative in Draft EIS adopted as part of Proposed Project and refined based on additional drilling and engineering with Category 1 Stockpile Groundwater Containment System	Only Category 1 Stockpile is permanent – all other stockpiles relocated to the East Pit	Three permanent stockpiles eliminated and any associated impacts will therefore be temporary. Also, highest sulfur rock backfilled to East Pit and stored subaqueously.
	Move Temporary Category 4 Stockpile to be above Central Pit and Central Pit rescheduled so that floor of pit above East Pit backfill during operations	Reduce wetland impacts
	Eliminate Category 3 waste rock stockpile by combining Category 2/3 waste rock and lean ore stockpiles at the location of the Category 4 and Category 3 waste rock stockpiles.	Reduce wetland impacts
	Revise haul roads to reduce wetland fragmentation	Reduce wetland impacts
	All Category 1 waste rock in East Pit or Category 1 Stockpile	Category 1 stockpile can be closed and cover system construction begin in Year 14 - less water flow through the pile once cover is constructed
	Replace Category 1 liner with Groundwater Containment System and pump collected water to WWTF	Capture and treat virtually all water from stockpile
	Maximize use of Category 1 rock and overburden for construction in above liner or below the water table applications	Any water that contacts these materials will be captured and treated, or used in an application where the redox conditions will not change
	Minor changes in pit and stockpile footprints due to updated drilling	Reduce wetland impacts
Category 1 Stockpile Cover System	ET cover system replaced with membrane cover system	Minimize long term water flow through the stockpile
Waste Water Treatment Facility (WWTF)	Plan for sulfate treatment during operations and upgrade to Reverse Osmosis (RO) for long term	Project discharge meets wild rice standard
New Concentrate Shipping Building near the Additive Plant with dewatering by filter instead of dryer	New dewatering equipment and required concentrate storage will not fit in existing building; alternate location evaluated	New building on disturbed ground = no wetland impacts
Relocate Hydrometallurgical Residue Facility	Move Hydrometallurgical Residue Facility from south end of Cell 2W to the Emergency Basin	Eliminate concerns about liner failure on location that is still settling and provide a virtually zero leakage liner system
FTB Seepage Containment System	Vertical wells on north side of FTB replaced by trench/barrier system on north and west sides	Capture and treat virtually all groundwater and surface seepage from FTB
Enhanced FTB Pond Cover (liner)	Additional bentonite amendment to further reduce seepage - results in routine overflow in closure	Further reduce seepage
Waste Water Treatment Plant (WWTP)	Pumping of excess water to Partridge River replaced by RO treatment of excess water also cleans up pond to allow overflow in closure	Project discharge meets wild rice standard
Adaptive Water Management Plan (AWMP)	Formal plan to adaptively manage water in operations, reclamation, and long-term closure via financially assured fixed and adaptive engineering controls that relies on mechanical treatment but has the ultimate objective of non-mechanical treatment in the long term	Provides a high degree of certainty in achieving water quality objectives based on proactive management; lessens impacts in the long term with low maintenance non-mechanical treatment

Abbreviations:
AWMP = Adaptive Water Management Plan
FTB = Flotation Tailings Basin
RO = reverse osmosis
WWTF = Waste Water Treatment Facility
WWTP = Waste Water Treatment Plan

Source: Adapted from Large Table 3 of Appendix 18.1

Table 12-3 Summary of Direct Wetland Impacts

Project Area	Circular 39 Wetland Classification	1	2	2	3	4	5	6	6	7	7	8	8		Wetland Total
	Eggers and Reed Wetland Community	Seasonally Flooded	Fresh (Wet) Meadow	Sedge Meadow	Shallow Marsh	Deep Marsh	Shallow, Open Water	Shrub-Carr	Alder Thicket	Hardwood Swamp	Coniferous Swamp	Open Bog	Coniferous Bog	Deepwater	
Mine Site	Direct Impact (acres)	0	14.43	23.76	23.43	0.09	0	2.39	95.39	12.48	70.33	7.64	508.25	0	758.2
	Fragmentation Impacts (acres)	0	0	0.1	0	0	0	0	3.66	0	1.79	0	20.84	0	26.39
	# of directly impacted wetlands	0	3	2	6	1	0	1	11	2	7	4	22	0	59
Railroad Connection Corridor	Direct Impact (acres)	0	0	0	0.07	0	0	0.1	0.2	0	0.07	0	0	0	0.44
	# of directly impacted wetlands	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	# of directly impacted wetlands	0	0	0	1	0	0	1	1	0	1	0	0	0	4
Dunka Road and Utility Corridor	Direct Impact (acres)	0	0	0	0.52	0	0	0	3.81	0	1.54	0	0.89	0	6.76
	# of directly impacted wetlands	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	# of directly impacted wetlands	0	0	0	2	0	0	0	11	0	6	0	2	0	21
FTB	Direct Impact (acres)	0	1.38	0.07	45.19	74.01	0	1.4	7.5	0.69	10.69	0	0	0	140.93
	# of directly impacted wetlands	0	0	0	0.3	0.17	0	0	<0.01	0	0.02	0	0	0	0.49
	# of directly impacted wetlands	0	5	1	12	15	0	2	4	0	3	0	0	0	43
HRF	Direct Impact (acres)	0	0	0	7.51	0	0	0	0	0	0	0	0	0	7.51
	# of directly impacted wetlands	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	# of directly impacted wetlands	0	0	0	2	0	0	0	0	0	0	0	0	0	2
Total	(acres)	0	15.81	23.93	77.02	74.27	0	3.89	110.56	13.17	84.44	7.64	529.99	0	940.72

Abbreviations:
FTB = Flotation Tailings Basin
HRF = Hydrometallurgical Residue Facility

Source: Adapted from Appendix 18.1

Table 12-4 Description of Mitigation Sites

Wetland Replacement Site	Watershed Name, Bank Service Area (BSA)	County	Township (T), Range (R), Section (S)	Restored (R), Preserved (P) or Created (C)?
On-site	St. Louis River #3, BSA #1	St. Louis	T59, R13, S1,2,3,9,10, and 11	C
Zim Site	St. Louis River #3, BSA #1	St. Louis	T55, R18, S2,3,10,11,26,27, and 34	R
Hinckley Site	Snake River #36, BSA #6	Pine	T39, R22, S5	R
Aitkin Site	Elk-Nokasippi #10, BSA #5	Aitkin	T47, R27, S1; T47, R26, S6	R

Note:
Zim Site includes both Zim North Unit and Zim South Unit.
Abbreviations:
BSA = Bank Service Area

Source: Adapted from Appendix 18.1

Table 12-5 Mitigation Credit Summary

Community/Credit Type	Within Project Watershed: Zim Wetland Mitigation (acres)	Within Project Watershed: Credit Percent	Within Project Watershed: Zim Wetland Mitigation Credits	Outside Project Watershed[1]: Aitkin Wetland Mitigation (acres)	Outside Project Watershed[1]: Aitkin Wetland Mitigation Credits	Outside Project Watershed[1]: Hinckley Wetland Mitigation (acres)	Outside Project Watershed[1]: Hinckley Wetland Mitigation Credits	Outside Project Watershed[1]: Credit Percent	Outside Project Watershed[1]: Aitkin and Hinckley Wetland Mitigation Credits	Total Wetland Mitigation[1] (acres)	Credit Percent	Total Wetland Mitigation Credits[1]
Off-Site Restoration of drained wetland2												
Type 2 Fresh (Wet) Meadow	0		0	0	0	0	0		0	0		0
Type 2 Sedge Meadow	0		0	0	0	56.17	56.17		56.17	56.17		56.17
Type 3 Shallow Marsh	0		0	21.22	21.22	0	0		21.22	21.22		21.22
Type 4 Deep Marsh	0		0	0	0	0	0		0	0		0
Type 5 Shallow, Open Water	0		0	0	0	0	0		0	0		0
Type 6 Shrub-Carr	0	100%	0	0	0	98.43	98.43	100%	98.43	98.43	100%	98.43
Type 6 Alder Thicket	0		0	0	0	98.44	98.44		98.44	98.44		98.44
Type 7 Hardwood Swamp	0		0	147.95	147.95	7.40	7.40		155.35	155.35		155.35
Type 7 Coniferous Swamp	0		0	544.94	544.94	0	0		544.94	544.94		544.94
Type 8 Open Bog	7.54		7.54	0	0	0	0		0	7.54		7.54
Type 8 Coniferous Bog	443.09		443.09	0	0	0	0		0	443.09		443.09
Off-Site Restoration of partially-drained wetland[3]												
Type 2 Sedge Meadow	0		0	0	0	13.16	6.58		6.58	13.16		6.58
Type 3 Shallow Marsh	0		0	0.30	0.15	0	0		0.15	0.30		0.15
Type 7 Coniferous Swamp	0		0	25.15	12.58	0	0		12.58	25.15		12.58
Type 8 Open Bog	2.83	50%	1.42	0	0	0	0	50%	0	2.83	50%	1.42
Type 6 Shrub-Carr	0		0	0	0	62.46	31.23		31.23	62.46		31.23
Type 7 Hardwood Swamp	0		0	73.49	36.75	0.17	0.09		36.83	73.66		36.83
Type 8 Coniferous Bog	50.45		25.23	0	0	0	0		0	50.45		25.23
Off-Site Wetland Creation[4]												
Type 2 Sedge Meadow	0		0	0	0	7.14	5.36		5.36	7.14		5.36
Type 6 Shrub-Carr	0	75%	0	0	0	2.52	1.89	75%	1.89	2.52	75%	1.89
Type 6 Alder Thicket	0		0	0	0	2.52	1.89		1.89	2.52		1.89

Community/Credit Type	Within Project Watershed: Zim Wetland Mitigation (acres)	Within Project Watershed: Credit Percent	Within Project Watershed: Zim Wetland Mitigation Credits	Outside Project Watershed[1]: Aitkin Wetland Mitigation (acres)	Outside Project Watershed[1]: Aitkin Wetland Mitigation Credits	Outside Project Watershed[1]: Hinckley Wetland Mitigation (acres)	Outside Project Watershed[1]: Hinckley Wetland Mitigation Credits	Outside Project Watershed[1]: Credit Percent	Outside Project Watershed[1]: Aitkin and Hinckley Wetland Mitigation Credits	Total Wetland Mitigation[1] (acres)	Credit Percent	Total Wetland Mitigation Credits[1]
Off-Site Wetland Restoration that will not receive credit5												
Type 2 Sedge Meadow	0	---	0	14.02	0	0	0	---	0	14.02	---	0
Type 3 Shallow Marsh	0	---	0	0.02	0	0	0	---	0	0.02	---	0
Type 7 Coniferous Swamp	0	---	0	0.86	0	0	0	---	0	0.86	---	0
Off-Site Upland Buffer[6]	9.78	25%	2.45	64.26	16.07	57.31	14.33	25%	30.39	131.35	25%	32.84
Impact[7]	0.03	---	-0.03	0.51	-0.51	0.32	-0.32	---	0.86	0.86	---	-0.86
No Credit[8]	18.12	---	---	127.60	---	10.68	---	---	---	156.40	---	---
Upland Buffer Total	9.78	---	2.45	64.26	16.07	57.31	14.33	---	30.39	131.35	---	32.84
Wetland Total	503.91	---	477.24	827.95	763.04	348.41	307.15	---	1,070.22	1,680.27	---	1,547.46
Total	531.84	---	479.69	1,020.32	779.14	416.72	321.48	---	1,100.61	1,968.88	---	1,581.16

Notes:

1 Totals may not add exactly due to rounding.

2 Credits for restoration of completely drained wetlands are worth 100% of the acreage restored based on USACE St. Paul District Policy (Restoration via re-establishment) and the Minnesota WCA Chap. 8420.0526 Subp. 3

3 Credits for restoration of partially-drained wetlands are worth 50% of the acreage restored based on USACE St. Paul District Policy (Restoration via rehabilitation) and the Minnesota WCA Chap. 8420.0526 Subp. 4

4 Credits for wetland creation are worth 75% of the acreage created based on USACE St. Paul District Policy (Wetland Creation) and the Minnesota WCA Chap. 8420.0526 Subp. 7 (per Minnesota Statute 103G.2251 modified August 1, 2011.)

5 Wetlands will be restored within areas that will not receive credit (e.g., Diversion Channel easement).

6 Credits for upland buffers are worth 25% of the acreage of native, noninvasive vegetation established or maintained adjacent to the wetland based on USACE St. Paul District Policy (Preservation) and the Minnesota WCA Chap. 8420.0526 Subp. 1

7 Negative credits for ditches (wetlands) that are filled within upland buffer.

8 Areas within a Site without construction including homesteads, building areas, easements, etc.

Source: Adapted from Appendix 18.1

Table 12-6 Wetland Mitigation Credits Using WCA Mitigation Ratios

Wetland or Credit Type	Mitigation Credits				NorthMet Project Proposed Direct Wetland Impacts (acres)[1,2]	Credits Applied for 1:1 Replacement	Additional Mitigation Required[3] +0.5:1	Total Mitigation Credits Applied	Total Mitigation Ratio
	Zim	Aitkin	Hinckley	Total					
Type 2 Fresh (Wet) Meadow	0	0	0	0	15.81	15.81	7.91	23.72	1.5:1
Type 2 Sedge Meadow	0	0	68.11	68.11	23.92	23.92	11.96	35.88	1.5:1
Type 3 Shallow Marsh	0	20.86	0	20.86	77.03	77.03	38.52	115.55	1.5:1
Type 4 Deep Marsh	0	0	0	0	74.29	74.29	37.15	111.44	1.5:1
Type 5 Shallow, Open Water	0	0	0	0	0	0	0	0	1.5:1
Type 6 Shrub-Carr	0	0	131.23	131.23	3.89	3.89	1.95	5.84	1.5:1
Type 6 Alder Thicket	0	0	100.33	100.33	110.59	110.59	55.30	165.89	1.5:1
Type 7 Hardwood Swamp	0	184.70	7.49	192.18	13.16	13.16	6.58	19.74	1.5:1
Type 7 Coniferous Swamp	0	557.52	0	557.52	84.43	84.43	42.22	126.65	1.5:1
Type 8 Open Bog	8.96	0	0	8.96	7.64	7.64	3.82	11.46	1.5:1
Type 8 Coniferous Bog	468.29	0	0	468.32	529.98	529.98	30.83	560.81	1:1[4]
Wetland Total	477.24	763.07	307.47	1,547.46	940.74	940.74	236.23	1,176.97	---
Upland Buffer	2.45	16.07	14.01	32.84	---	---	---	---	---
Total	479.69	779.14	321.48	1,580.30	940.74	940.74	236.23	1,176.97	1.25:1[5]
Total Surplus Wetland Mitigation Credits for Project (Total credits minus 1:1 credits minus additional mitigation required)						403.33			
Total Wetland Mitigation Credits Used for Project						1,176.97			

Notes:
[1]Totals may not add exactly due to rounding.
[2]The total includes fragmentation of wetlands (26.9 acres).
[3]Additional required for mitigation out of the watershed at Aitkin and Hinckley sites.
[4]Assumes 1:1 replacement for 473.3 acres compensated in-kind and in the watershed and 1.5:1 for the remaining 56.7 acres replaced out of the watershed.
[5]The ratio of applied credits to project impacts (not including the total surplus credits).
Abbreviations:
WCA = Wetland Conservation Act

Source: Adapted from Appendix 18.1

Table 12-7 Wetland Mitigation Credits Using USACE Mitigation Ratios

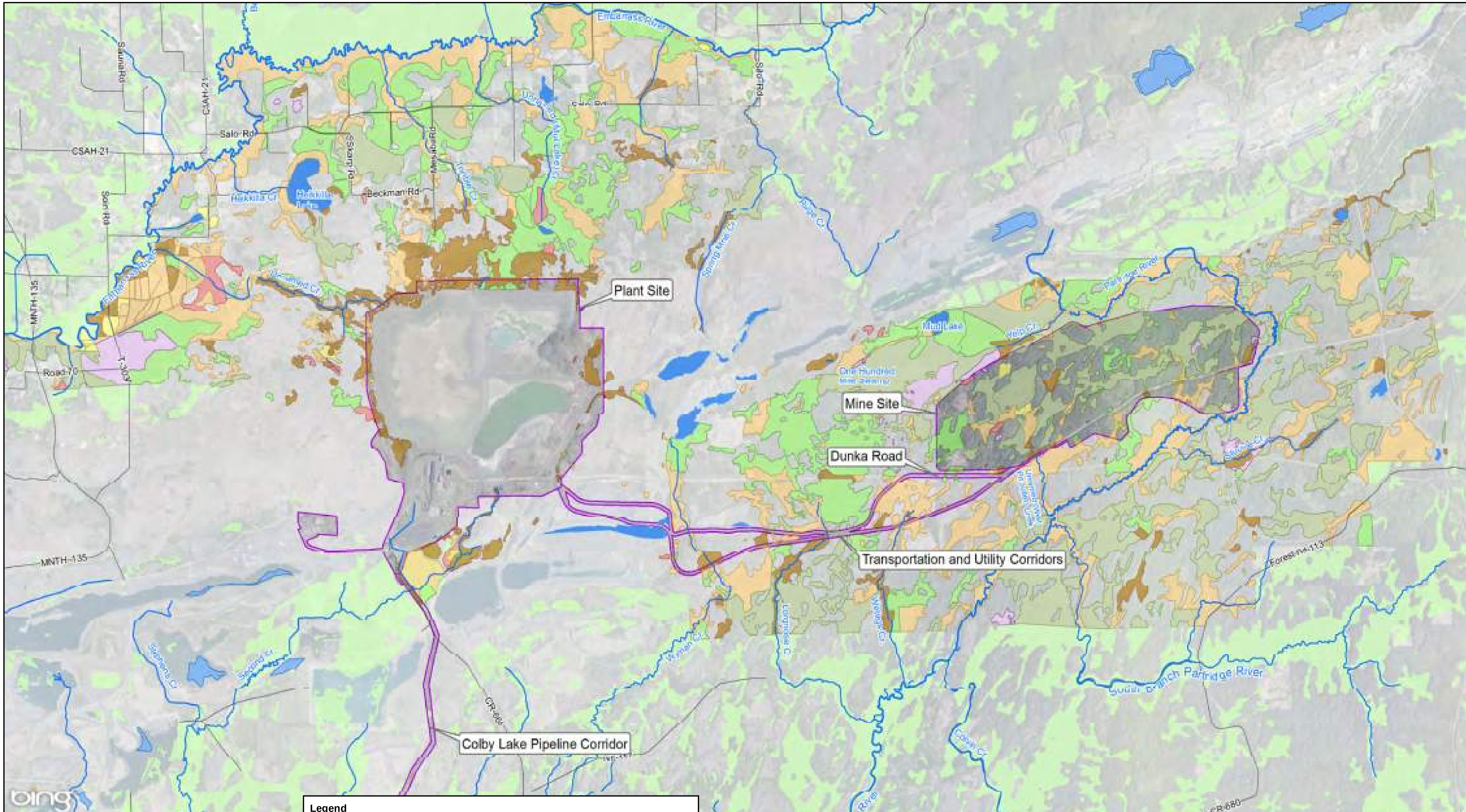
Wetland or Credit Type	Mitigation Credits Available				NorthMet Project Proposed Direct Wetland Impacts in Acres[1,2]			Total Credits Required for Mitigation at Base Ratio	No More Than 2 Apply			Total Applied Mitigation Credits[6,7]	Applied Mitigation Ratio[8]
	Zim	Aitkin	Hinckley	Total	Non-forested, Non-bog, and Low or Medium Quality (Base Ratio 1.5:1)[3]	Bogs, Forested, and High Quality (Base Ratio 2:1)[4]	Total Impact Acres		Incentive for in kind -0.25:1	Incentive for credits in-place -0.25:1	Incentive for credits in-advance[5] -0.25:1		
Type 2 Fresh (Wet) Meadow	0	0	0	0	1.38	14.43	15.81	30.93	---	---	---	30.93	1.96
Type 2 Sedge Meadow	0	0	68.11	68.11	6.87	17.05	23.92	44.41	(5.98)	---	---	38.43	1.61
Type 3 Shallow Marsh	0	20.86	0	20.86	53.13	23.90	77.03	127.50	(5.22)	---	(5.22)	117.07	1.52
Type 4 Deep Marsh	0	0	0	0	74.20	0.09	74.29	111.48	---	---	---	111.48	1.50
Type 5 Shallow, Open Water	0	0	0	0.0	0	0	0.0	0.0	---	---	---	0	---
Type 6 Shrub-Carr	0	0	131.23	131.23	1.40	2.49	3.89	7.08	(0.97)	---	---	6.11	1.57
Type 6 Alder Thicket	0	0	100.33	100.33	7.50	103.09	110.59	217.43	---	---	---	217.43	1.97
Type 7 Hardwood Swamp	0	184.70	7.49	192.18	0.69	12.47	13.16	25.98	(3.29)	---	---	22.69	1.72
Type 7 Coniferous Swamp	0	557.52	0	557.52	0	84.43	84.43	168.86	(21.11)	---	---	147.75	1.75
Type 8 Open Bog	8.96	0	0	8.96	0	7.64	7.64	15.28	---	---	---	15.28	2.00
Type 8 Coniferous Bog	468.29	0	0	468.29	0	529.98	529.98	1059.96	(117.07)	(117.07)	---	825.82	1.56
Wetland Total	477.24	763.07	307.47	1,547.46	145.17	795.57	940.74	1808.90	---	---	---	1,532.97	1.63
Upland Buffer	2.45	16.07	14.01	32.84	---	---	---	---	---	---	---	---[9]	---
Total	479.69	779.14	321.48	1,580.30	940.74			1,808.90	(153.64)	(117.07)	(5.22)	1,532.97	1.63
									(275.92)				
Total Surplus Wetland Mitigation Credits for Project (Total credits minus 1:1 credits minus additional mitigation required))				47.33									

Notes:

[1] Totals may not add exactly due to rounding.
[2] The total includes fragmentation of wetlands (26.9 acres).
[3] Base ratio 1.5:1 per USACE St. Paul District Policy for wetlands that are not considered High quality or Difficult-to-Replace, which includes forested wetland and bog communities.
[4] Base ratio 2:1 per Reference (34) for wetlands that are High quality or Difficult-to-Replace, which includes forested wetland and bog communities.
[5] Based on Reference (34) guidance for in-advance qualification.
[6] Total Applied Mitigation Credits = Total Credits Required for Mitigation at Base Ratio minus Incentive Credits.
[7] Credits applied may include surplus credits from different wetland types.
[8] The ratio of applied credits to project impacts (not including the surplus credits).
[9] Includes 0.5 credit of upland buffer, applied from totals listed above.

Abbreviations:
USACE = United States Army Corps of Engineers

Source: Adapted from Appendix 18.1



Notes

1. Basemap from Esri and its data suppliers.
2. NHD features are created from MDNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance, data sources may show watercourses that no longer exist.
3. Source: Wetland Data Package, V11, April 2015, in Appendix 16 of the Application.

Legend

- Roads
- Rivers and Streams[2]
- Facility Boundary

National Wetlands Inventory

- Undifferentiated Wetlands
- Lakes

Eggers & Reed Wetland Types

- Shrub Swamp (Alder thicket & Shrub-carr)
- Coniferous bog
- Coniferous swamp
- Deep marsh; Shallow marsh
- Hardwood swamp
- Open water (Shallow, open water & lakes)
- Open bog
- Sedge meadow; Wet meadow

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POLYMET MINING

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APPROVED BY: DRD			DATE: AUG. '16

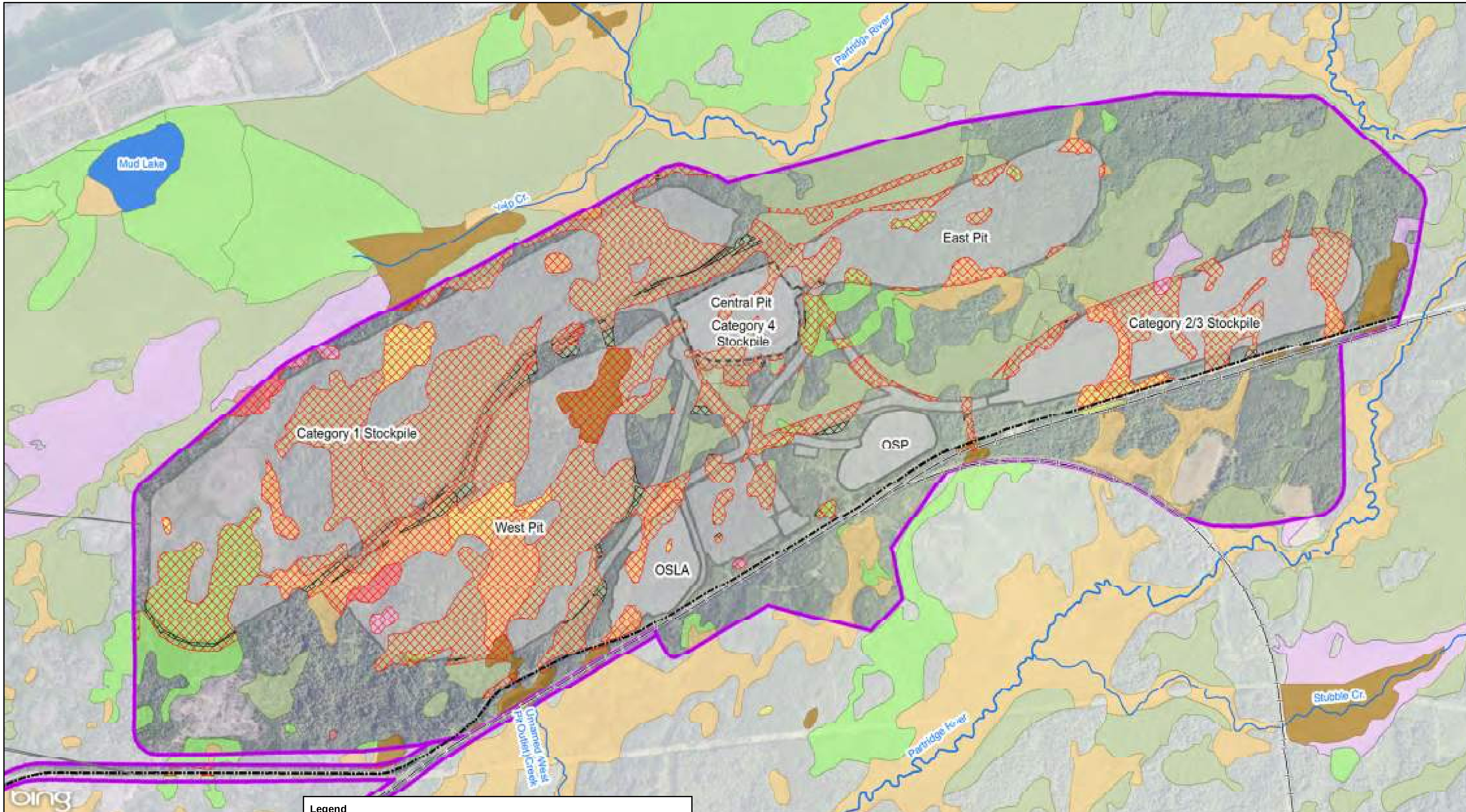
POLYMET MINING

FIGURE 12-1

WETLAND DELINEATION
PERMIT TO MINE APPLICATION
HOYT LAKES, MINNESOTA

Scale: 0 3,000 6,000 Feet	Date: AUGUST 2016
Drafted by: DAT	Project No: 12P778

Path: X:\GB\IE\2012\12P778\GIS\mxd\PMA\Figure 12-1 Wetland Delineation.mxd Date: 9/9/2016



Notes

1. Basemap from Esri and its data suppliers.
2. NHD features are created from MDNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance, data sources may show watercourses that no longer exist.
3. Source: Wetland Data Package, V11, April 2015, in Appendix 16 of the Application.

Legend

- Existing Private Railroad
- Rivers and Streams[2]
- Category 4 Stockpile
- Mine Site Features
- Direct Wetland Impacts
- Fragmented Wetlands
- Facility Boundary

Eggers & Reed Wetland Types

- Shrub Swamp (Alder thicket & Shrub-carr)
- Coniferous bog
- Coniferous swamp
- Deep marsh; Shallow marsh
- Hardwood swamp
- Open water (Shallow, open water & lakes)
- Open bog
- Sedge meadow; Wet meadow

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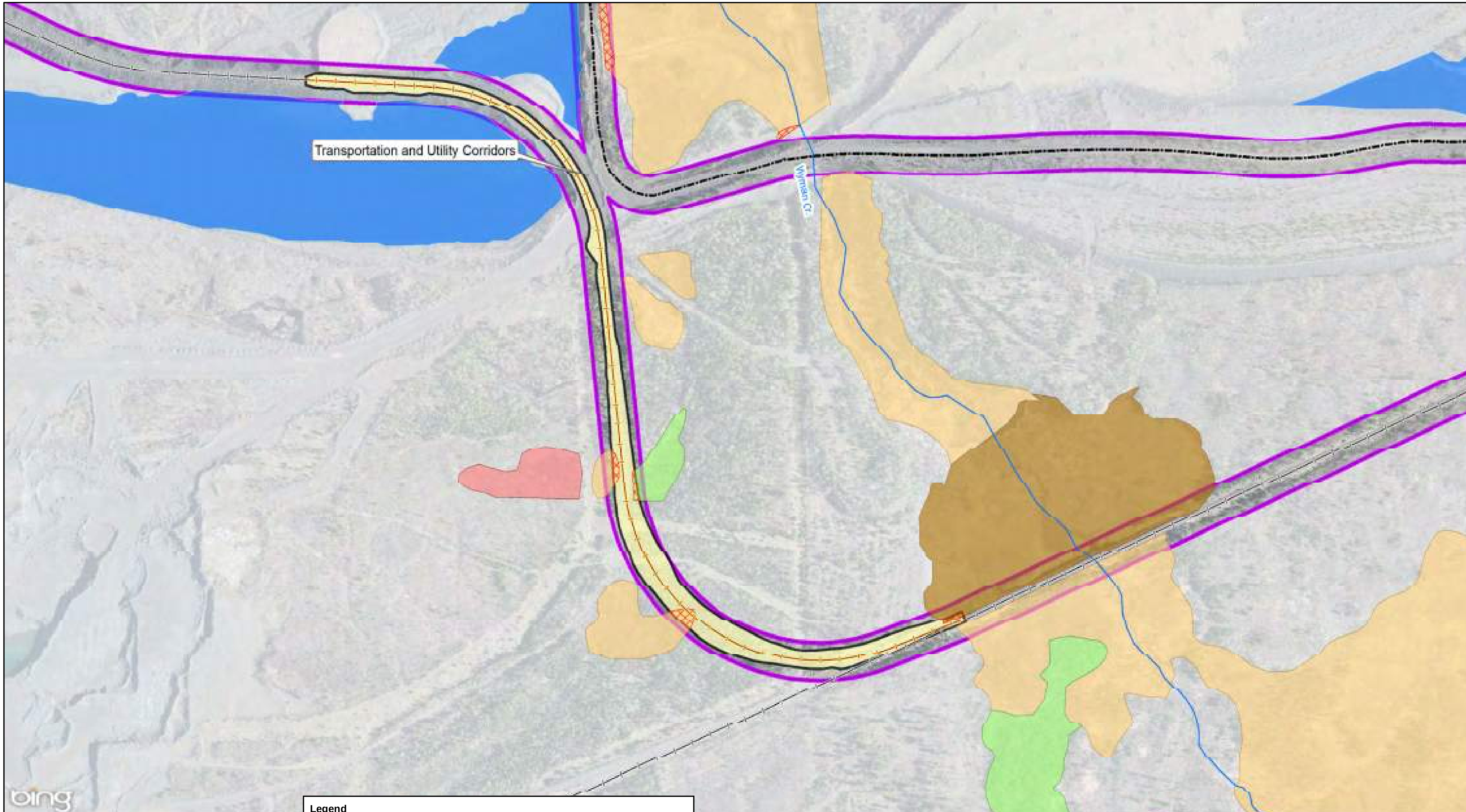
REVIEWED BY: JSL			DATE: AUG. '16
APPROVED BY: DRD			DATE: AUG. '16

POLYMET MINING

FIGURE 12-2
MINE SITE AREA WETLANDS
SHOWING DIRECT WETLAND IMPACTS
PERMIT TO MINE APPLICATION
HOYT LAKES, MINNESOTA

Scale: 0 750 1,500 Feet	Date: AUGUST 2016
Drafted by: DAT	Project No: 12P778

Path: X:\GB\IE\2012\12P778\GIS\mxd\PMA\Figure 12-2 Mine Site Area Wetlands.mxd Date: 9/9/2016



Legend

- Proposed Railroad Track
- Existing Private Railroad
- Rivers and Streams[2]
- Plant Spur
- Direct Wetland Impacts
- Facility Boundary

Eggers & Reed Wetland Types

- Shrub Swamp (Alder thicket & Shrub-carr)
- Coniferous bog
- Coniferous swamp
- Deep marsh; Shallow marsh
- Hardwood swamp
- Open water (Shallow, open water & lakes)
- Open bog
- Sedge meadow; Wet meadow

Notes

1. Basemap from Esri and its data suppliers.
2. NHD features are created from MDNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance, data sources may show watercourses that no longer exist.
3. Source: Wetland Data Package, V11, April 2015, in Appendix 16 of the Application.

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APPROVED BY:	DRD	DATE:	AUG. '16

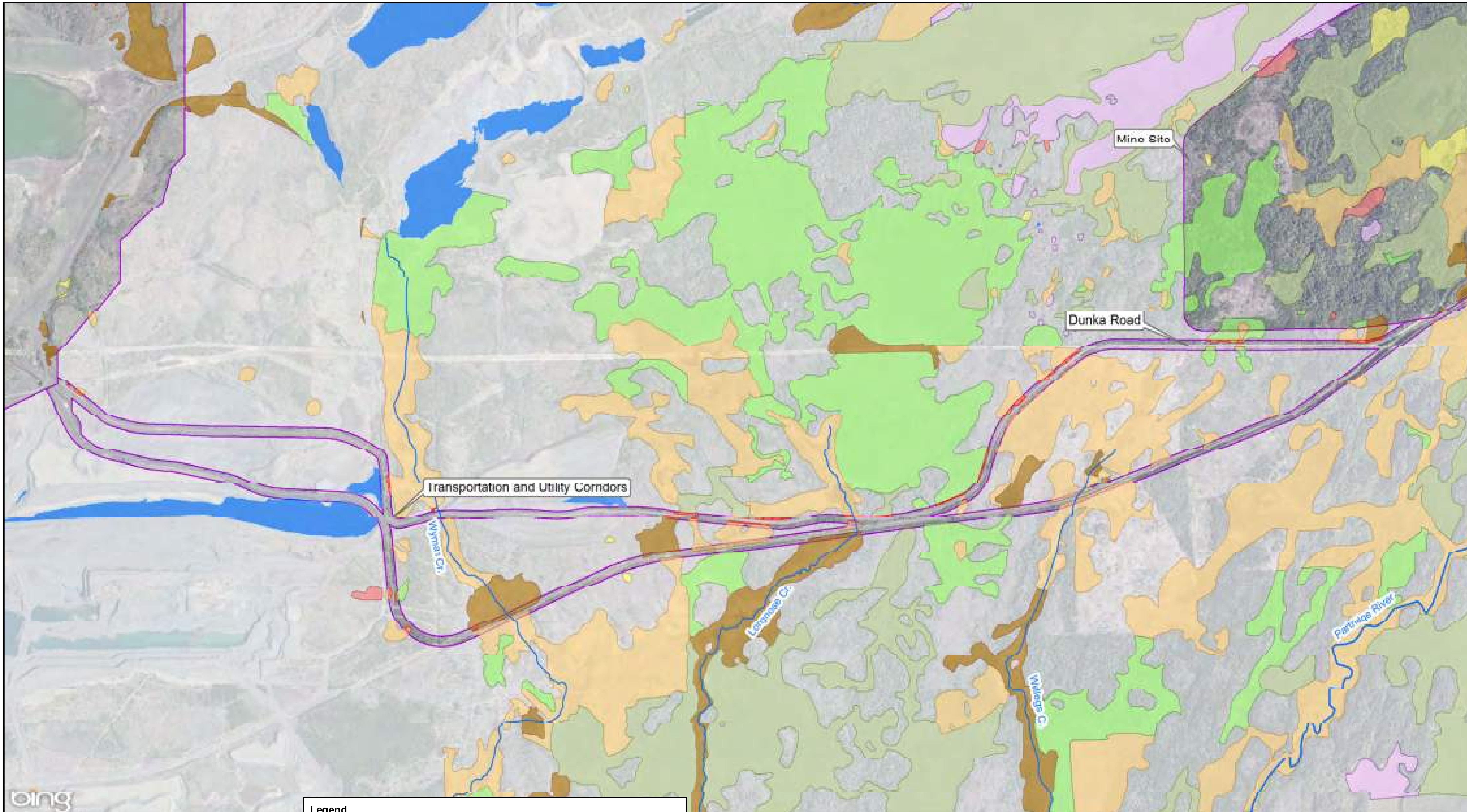
POLYMET MINING

FIGURE 12-3

PLANT SPUR WETLANDS
SHOWING DIRECT WETLAND IMPACTS
PERMIT TO MINE APPLICATION
HOYT LAKES, MINNESOTA

Scale: 0 250 500 Feet		Date:	AUGUST 2016
Drafted by:	DAT	Project No:	12P778

Path: X:\GB\IE\2012\12P778\GIS\mxd\PMA\Figure 12-3 Railroad Connection Corridor Wetlands.mxd Date: 9/12/2016



Notes
1. Basemap from Esri and its data suppliers.
2. NHD features are created from MDNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance, data sources may show watercourses that no longer exist.
3. Source: Wetland Data Package, V11, April 2015, in Appendix 16 of the Application.

Legend
- Rivers and Streams[2]
- Direct Wetland Impacts
- Facility Boundary

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

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POLYMET MINING

FIGURE 12-4
TRANSPORTATION AND UTILITY CORRIDORS WETLANDS
SHOWING DIRECT WETLAND IMPACTS
PERMIT TO MINE APPLICATION
HOYT LAKES, MINNESOTA

Scale: 0 1,000 2,000 Feet		Date:	AUGUST 2016
Drafted by:	DAT	Project No:	12P778

Path: X:\GB\IE\2012\12P778\GIS\mxd\PMA\Figure 12-4 Transportation and Utility Corridor Wetlands.mxd Date: 9/9/2016

Notes

1. Basemap from Esri and its data suppliers.
2. NHD features are created from MDNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance, data sources may show watercourses that no longer exist.
3. Source: Wetland Data Package, V11, April 2015, in Appendix 16 of the Application.

Legend

- Roads
- Existing Private Railroad
- Rivers and Streams[2]
- Direct Wetland Impacts
- Facility Boundary

Eggers & Reed Wetland Types

- Shrub Swamp (Alder thicket & Shrub-carr)
- Coniferous bog
- Coniferous swamp
- Deep marsh; Shallow marsh
- Hardwood swamp
- Open water (Shallow, open water & lakes)
- Open bog
- Sedge meadow; Wet meadow

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POLYMET MINING

FIGURE 12-5
PLANT SITE WETLANDS
SHOWING DIRECT WETLAND IMPACTS
PERMIT TO MINE APPLICATION
HOYT LAKES, MINNESOTA

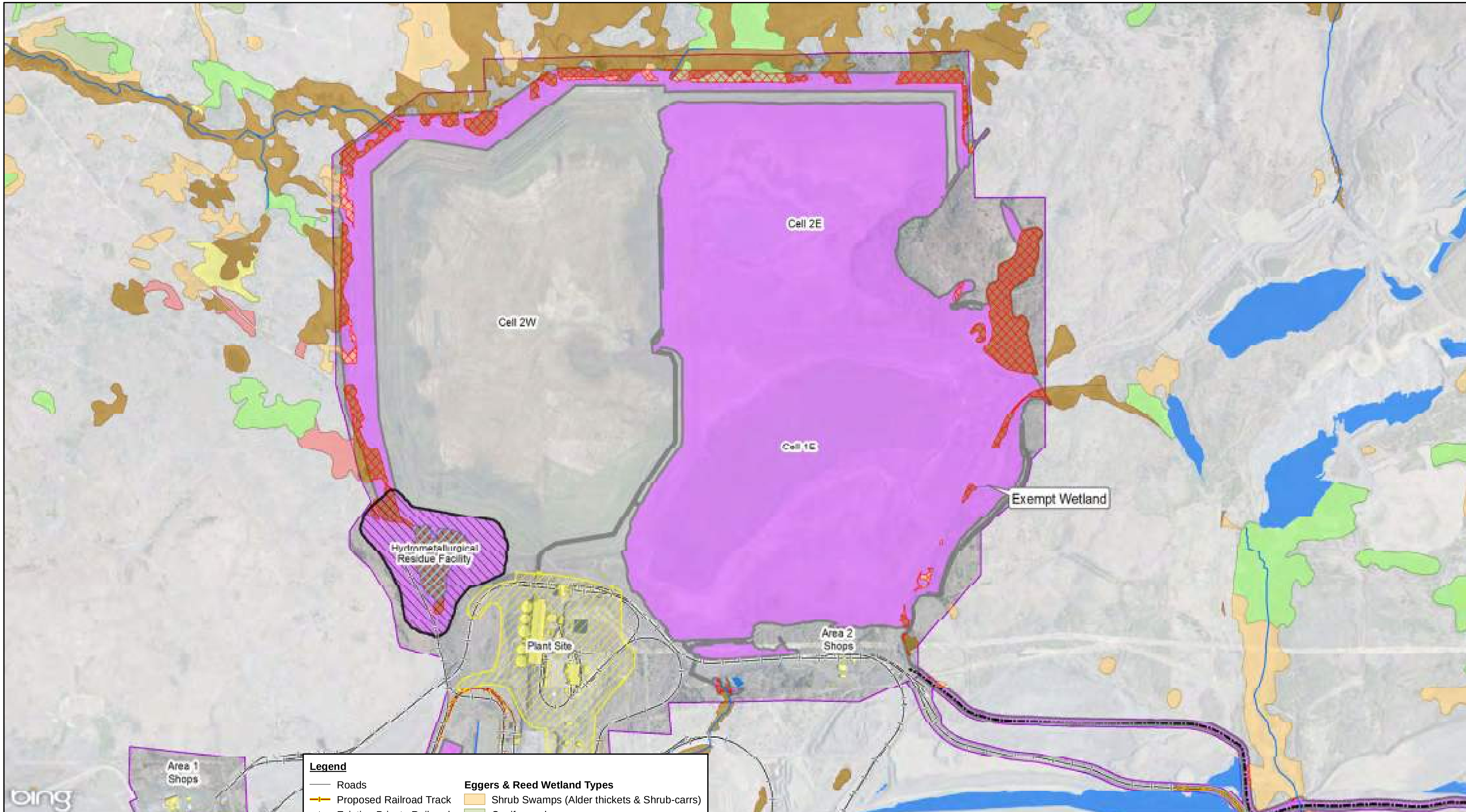
Scale: 0 600 1,200 Feet

Date: AUGUST 2016

Drafted by: DAT

Project No: 12P778

Path: X:\GB\IE\2012\12P778\GIS\mxd\PMA\Figure 12-5 Plant Site and Second Creek Wetlands.mxd Date: 9/9/2016



Notes

1. Basemap from Esri and its data suppliers.
2. NHD features are created from MDNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance, data sources may show watercourses that no longer exist.
3. Source: Wetland Data Package, V11, April 2015, in Appendix 16 of the Application.

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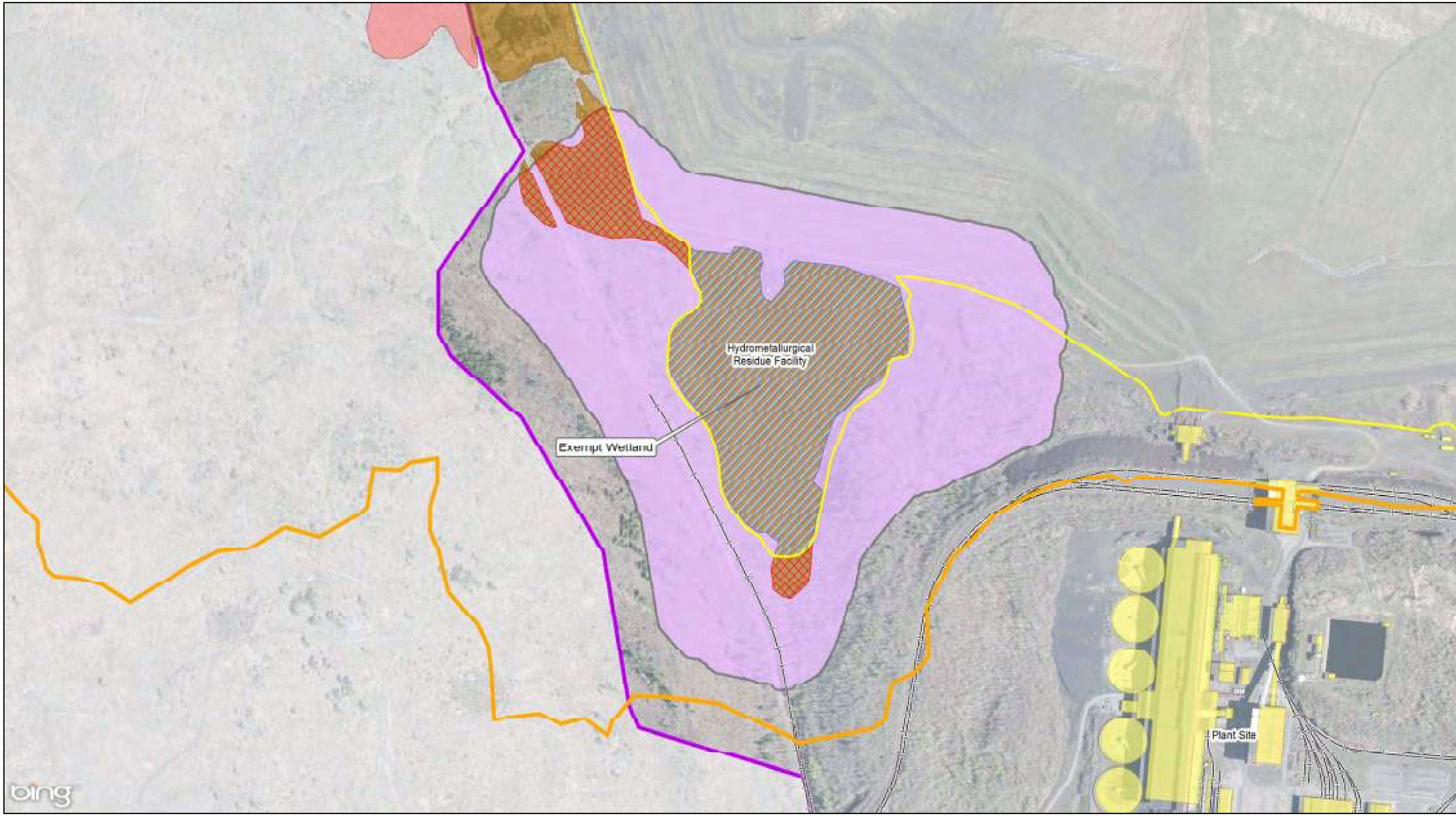
APPROVED BY: DRD			DATE: AUG. '16

POLYMET MINING

FIGURE 12-6
FLOTATION TAILINGS BASIN AREA WETLANDS SHOWING DIRECT WETLAND IMPACTS
PERMIT TO MINE APPLICATION
HOYT LAKES, MINNESOTA

Scale: 0 750 1,500 Feet	Date: AUGUST 2016
Drafted by: DAT	Project No: 12P778

Path: X:\GB\IE\2012\12P778\GIS\mxd\PMA\Figure 12-6 Flotation Tailings Basin Area Wetlands.mxd Date: 9/9/2016



Notes

1. Basemap from Esri and its data suppliers.
2. NHD features are created from MDNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance, data sources may show watercourses that no longer exist.
3. Source: Wetland Data Package, V11, April 2015, in Appendix 16 of the Application.

Legend

- Existing Private Railroad
- Rivers and Streams[2]
- Hydrometallurgical Residue Facility
- Exempt Wetland
- Existing Buildings
- Cliffs Erie, LLC Permit to Mine Ultimate Tailings Basin Limit
- Watershed Basin Boundary
- Direct Wetland Impacts

Eggers & Reed Wetland Types

- Deep marsh; Shallow marsh
- Hardwood swamp
- Facility Boundary

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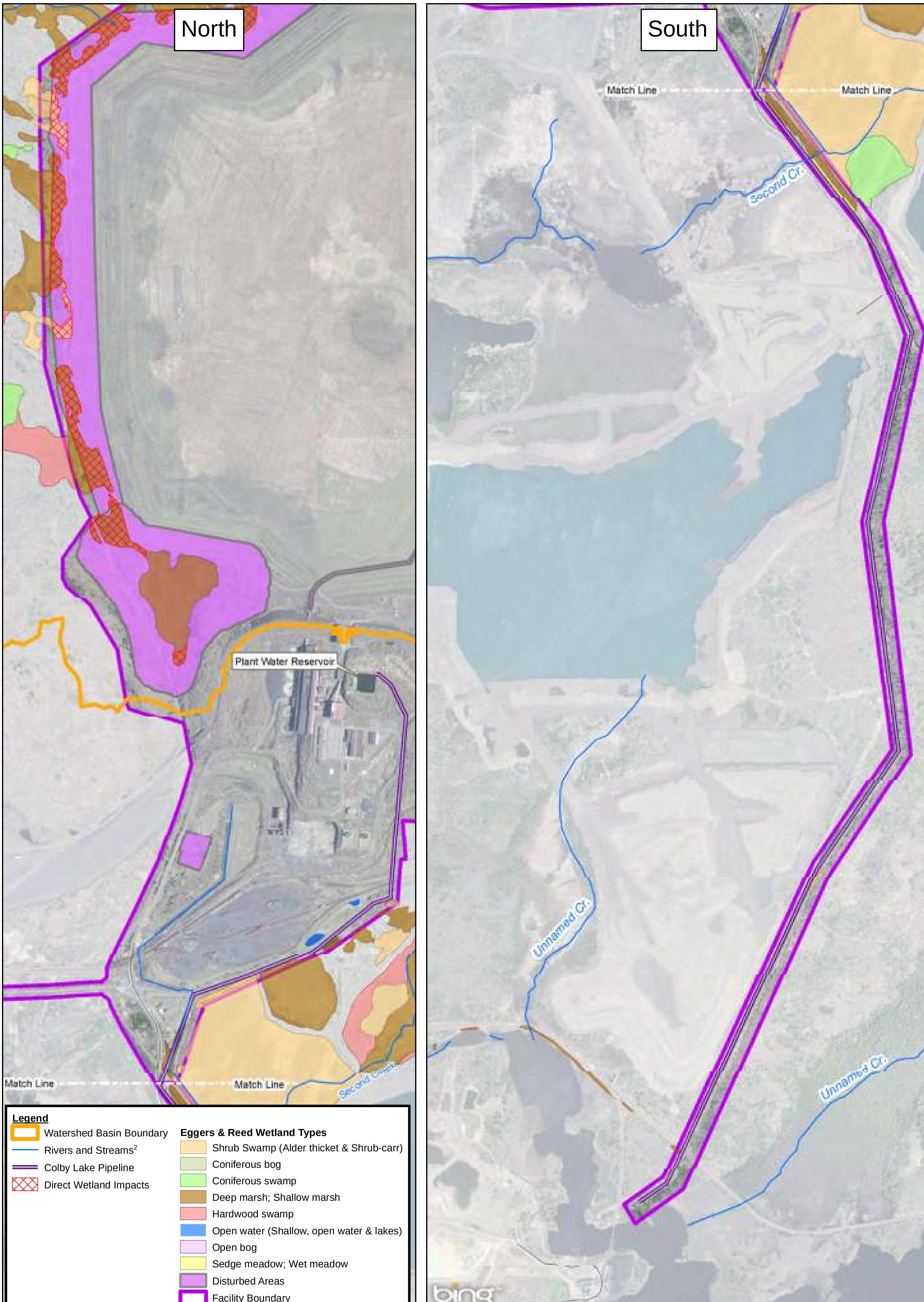
POLYMET MINING

FIGURE 12-7
HYDROMETALLURGICAL RESIDUE FACILITY
WETLANDS SHOWING DIRECT WETLAND IMPACTS
PERMIT TO MINE APPLICATION
HOYT LAKES, MINNESOTA

Scale: 0 250 500 Feet	Date: AUGUST 2016
Drafted by: DAT	Project No: 12P778

Path: X:\GB\IE\2012\12P778\GIS\mxd\PMA\Figure 12-7 Hydrometallurgical Residue Facility Wetlands.mxd Date: 9/9/2016



Notes

1. Basemap from Esri and its data suppliers.
2. NHD features are created from MDNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance, data sources may show watercourses that no longer exist.
3. Source: Wetland Data Package, V11, April 2015, in Appendix 16 of the Application.

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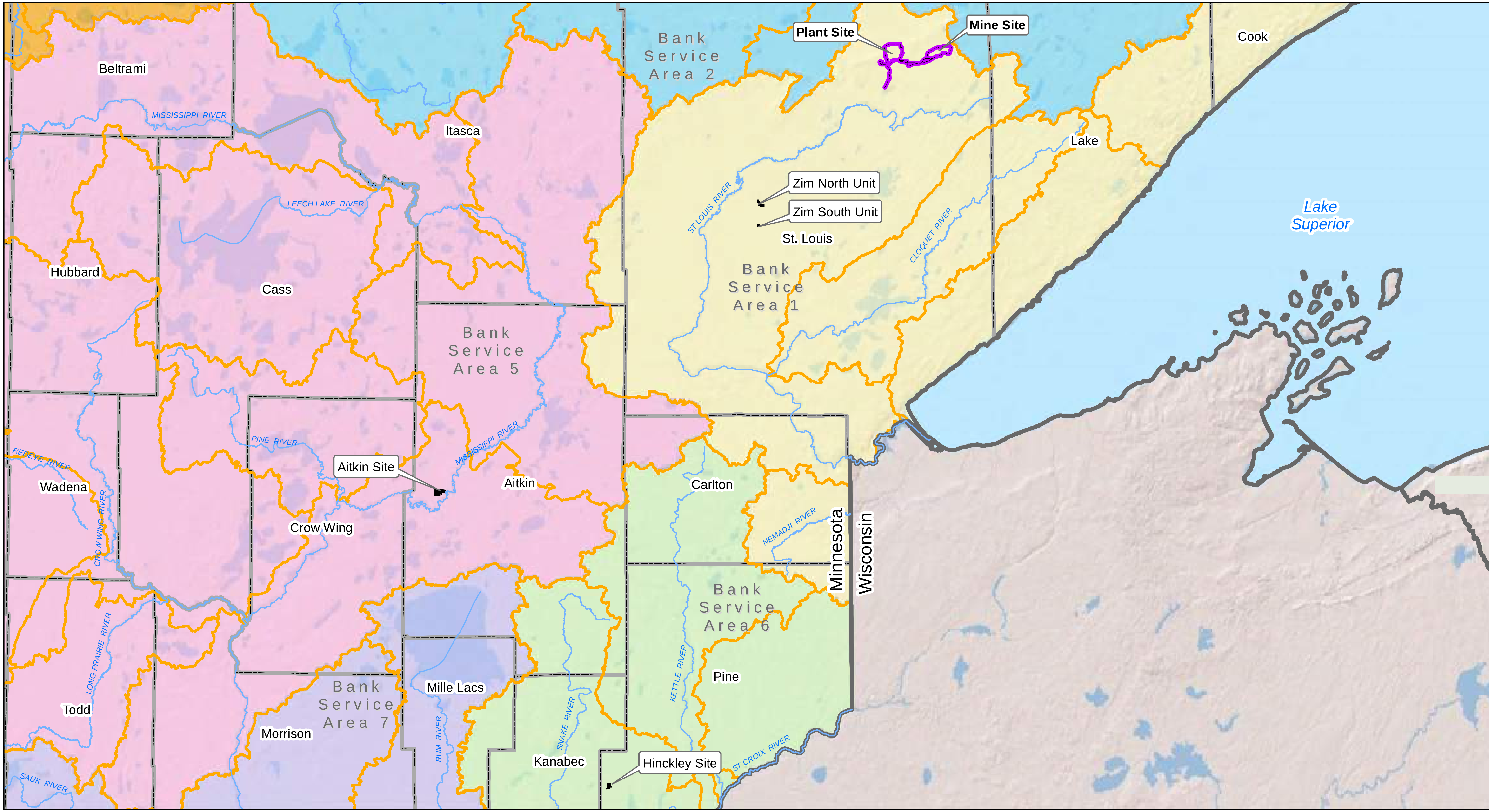
APPROVED BY:	DRD			DATE: AUG. '16

POLYMET MINING

FIGURE 12-8
COLBY LAKE PIPELINE CORRIDOR WETLANDS SHOWING DIRECT WETLAND IMPACTS
PERMIT TO MINE APPLICATION
HOYT LAKES, MINNESOTA

Scale: 0 750 1,500 Feet	Date: AUGUST 2016
Drafted by: DAT	Project No: 12P778

Path: X:\GB\IE\2012\12P778\GIS\mxd\PMA\Figure 12-8 Colby Lake Water Pipeline Wetlands.mxd Date: 9/9/2016



Notes

1. Shaded Relief supplied by Esri and its data suppliers.
2. Bank Service Areas and Wetland Mitigation Sites and Wetlands supplied by Barr Engineering Company.
3. Basemap features downloaded from Minnesota Geospatial Information Office (MnGeo)

Legend

- Facility Boundary
- Wetland Mitigation Sites
- Major Rivers
- Major Watersheds
- County Counties
- State Boundaries

Bank Service Areas

- 1
- 2
- 3
- 5
- 6
- 7

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POLYMET MINING

FIGURE 12-9
WETLAND MITIGATION SITE LOCATIONS
PERMIT TO MINE APPLICATION
HOYT LAKES, MINNESOTA

Scale: 0 7.5 15 Miles
Date: AUGUST 2016
Drafted by: DAT
Project No: 12P778

Path: X:\GB\IE\2012\12P778\GIS\mxd\PMA\Figure 12-9 Wetland Mitigation Site Locations.mxd Date: 9/2/2016

Notes

1. Aerial suplied by Esri and its data suppliers.
2. Hydrology Monitoring Locations, Unit Boundaries, Ditches, Drain Tiles and Wetland Restoration Methods supplied by Barr Engineering Company.

Legend

- Hydrology Monitoring Location
- Roads
- County Ditches
- Ditches
- Estimated Drain Tiles
- North Unit Boundary

Restoration Method

- Restore Drained Fields
- Excavated Ponds
- Filled Ditches
- Restore Partial Drainage
- Upland Buffer/Ditch Lateral Effect
- Preservation
- Open Ditches
- Roads

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REVISED	DATE	BY	DESCRIPTION

PREPARED BY:	DAT	DATE:	AUG. '16
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APPROVED BY:	DRD	DATE:	AUG. '16

POLYMET MINING

FIGURE 12-10
ZIM WETLAND MITIGATION SITE
NORTH UNIT
PERMIT TO MINE APPLICATION
HOYT LAKES, MINNESOTA

Scale: 0 400 800 Feet		Date:	AUGUST 2016
Drafted by:	DAT	Project No:	12P778

Path: X:\GB\IE\2012\12P778\GIS\mxd\PMA\Figure 12-10 Zim Wetland Mitigation Site North Unit.mxd Date: 8/26/2016

Notes
1. Aerial suplied by Esri and its data suppliers.
2. Hydrology Monitoring Locations, Unit Boundaries, Ditches, Drain Tiles and Wetland Restoration Methods supplied by Barr Engineering Company.

Legend

- Hydrology Monitoring Location
- Roads
- County Ditches
- Ditches
- Estimated Drain Tiles
- South Unit Boundary

Restoration Method

- Restore Drained Fields
- Excavated Ponds
- Filled Ditches
- Restore Partial Drainage
- Upland Buffer/Ditch Lateral Effect
- Preservation
- Open Ditches
- Roads

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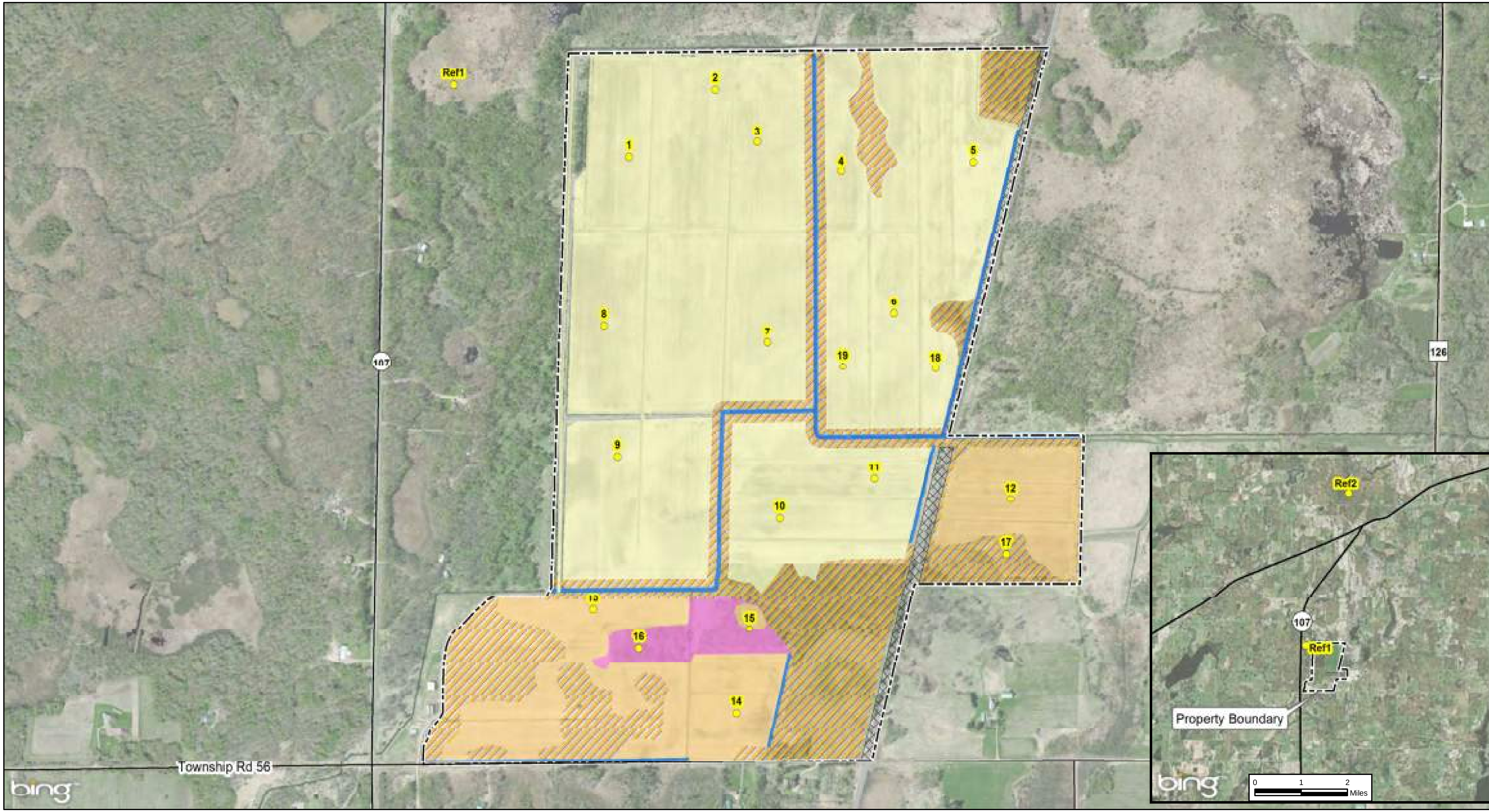
REVIEWED BY:	JSL	DATE:	AUG. '16
APPROVED BY:	DRD	DATE:	AUG. '16

POLYMET MINING

FIGURE 12-11
ZIM WETLAND MITIGATION SITE
SOUTH UNIT
PERMIT TO MINE APPLICATION
HOYT LAKES, MINNESOTA

Scale: 0 200 400 Feet		Date:	AUGUST 2016
Drafted by:	DAT	Project No:	12P778

Path: X:\GB\IE\2012\12P778\GIS\mxd\PMA\Figure 12-11 Zim Wetland Mitigation Site South Unit.mxd Date: 8/26/2016



Notes

1. Aerial suplied by Esri and its data suppliers.
2. Hydrology Monitoring Locations, Property Boundary, Wetland Restoration Types supplied by Barr Engineering Company.

Legend

- Hydrology Monitoring Location
- Roads
- Property Boundary

Wetland Restoration Type

- Hardwood Swamp
- Shrub-carr/Alder thicket
- Sedge/Wet Meadow
- Upland Buffer, Upland
- Ditch; None, Ditch
- None, Exclusion

Foth Infrastructure & Environment, LLC

REVISED	DATE	BY	DESCRIPTION

PREPARED BY:	DAT	DATE:	AUG. '16
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POLYMET MINING

FIGURE 12-12

HINCKLEY WETLAND MITIGATION SITE
PERMIT TO MINE APPLICATION
HOYT LAKES, MINNESOTA

Scale: 0 350 700 Feet	Date: AUGUST 2016
Drafted by: DAT	Project No: 12P778

Path: X:\GB\IE\2012\12P778\GIS\mxd\PMA\Figure 12-12 Hinckley Wetland Mitigation Site.mxd Date: 8/23/2016

Notes

1. Aerial suplied by Esri and its data suppliers.
2. Hydrology Monitoring Locations, Property Boundary, Wetland Restoration Methods supplied by Barr Engineering Company.

Legend

- Hydrology Monitoring Location
- Roads
- Property Boundary

Wetland Restoration Type

- Conifer Swamp
- Hardwood Swamp
- Shallow Marsh
- Shrub carr
- Upland Buffer
- Ditch
- None

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REVISED	DATE	BY	DESCRIPTION

PREPARED BY:	DAT	DATE:	AUG. '16
REVIEWED BY:	JSL	DATE:	AUG. '16
APPROVED BY:	DRD	DATE:	AUG. '16

POLYMET MINING

FIGURE 12-13
AITKIN WETLAND MITIGATION SITE
PERMIT TO MINE APPLICATION
HOYT LAKES, MINNESOTA

Scale: 0 500 1,000 Feet		Date:	AUGUST 2016
Drafted by:	DAT	Project No:	12P778

Path: X:\GB\IE\2012\12P778\GIS\mxd\PMA\Figure 12-13 Aitkin Wetland Mitigation Site.mxd Date: 8/23/2016

13 Air Quality Management

13.1 Overview

The Project includes both mining and associated ore processing facilities. PolyMet will utilize conventional air pollution control techniques common to mining and other industrial operations. These control techniques include fabric filters, venturi and packed-bed scrubbers, and fugitive dust control procedures at various facilities, locations, and stages within the Project to provide levels of emission control that will protect human health and the environment. These control techniques are considered to be state-of-the-art with respect to air pollution control.

The MPCA, pursuant to its authority under state law and under the federal CAA as delegated by the USEPA, will be responsible for the air permitting for the Project.

13.1.1 Regulatory Requirements

The FEIS determined that “the NorthMet Project Proposed Action has been shown to not cause or contribute to significant air quality effects.” Furthermore, while not required by law, the FEIS process evaluated the potential local and regional effects, up to 180 miles from the Project, to ensure that its operation would not produce adverse impacts to sensitive resources such as the Boundary Waters Canoe Area Wilderness (BWCAW) and Voyageurs National Park.

The Project design includes mitigation measures to control fugitive dust emissions. It also incorporates control technologies similar to the Best Available Control Technologies (termed BACT-like) established by USEPA to minimize potential air pollutant emissions. In particular, various facilities include BACT-like controls to reduce mercury emissions to levels that will not impede the state of Minnesota's mercury emissions reduction goals, and BACT-like emission controls for fine particulates to address control of any potential amphibole fibers in the ore.

With respect to the MDNR's PTM Regulations, PolyMet designed its planned construction, operational, and reclamation activities to minimize potential adverse impacts to natural resources and the public, and to comply will applicable requirements relating to protection of air quality and related air-pollution control and mitigation requirements. In particular, the Project will meet the siting requirements of the MDNR regulations that may affect air quality issues, including setback, separation, and buffer requirements. In addition, PolyMet located and designed Project facilities, structures, and infrastructure to minimize, and to facilitate control of air emissions from sources of dust and other fugitives. In this regard, PolyMet will implement BMPs such as using dust-suppression techniques and planting vegetation to minimize erosion in compliance with Minnesota Rules, parts 6132.2700 and 6132.2800.

13.1.2 Air Emissions Inventory and Emissions Estimate

PolyMet has already submitted an application for an air permit to MPCA. In connection with this permitting process, PolyMet analyzed the total estimated emissions of air pollutants from the

Project's operation, including both point and fugitive source emissions. While not required as part of the MPCA permitting, PolyMet also performed air dispersion modeling for compliance with pertinent Class I and Class II air quality criteria and Air Emission Risk Analyses (AERA). This modeling demonstrates that the Project's estimated air emissions will comply with applicable federal and state air quality and emissions standards, and will not cause or contribute to any adverse effects on nearby sensitive areas, including the BWCAW, Voyageurs National Park, Rainbow Lake Wilderness Area, and Isle Royale National Park. The AERA demonstrated that all chemicals evaluated were at or below MPCA risk guideline values.

The air permit application contains further detail regarding PolyMet's estimated potential and controlled air emissions from the Project, including PolyMet's inventory of air emission sources. PolyMet developed its emissions inventory based on extensive sources of relevant information, including PolyMet's pilot-test data, site-specific overburden sampling, drill core analysis for waste rock and ore zones, as well as other sampling work in the region. In addition, PolyMet used information from equipment vendors, test data from similar facilities, or when necessary, USEPA emission factors.

PolyMet prepared estimated Project point source emissions from these data to develop its Air Permit Application. The Controlled Potential to Emit (CPTE) for the Project is below New Source Review (NSR) thresholds. Therefore, by accepting federally enforceable permit conditions requiring the operation of the pollution control equipment, the Project facilities do not trigger PSD requirements. The CPTE (i.e., accounting for proposed federally enforceable requirements to install and operate pollution control equipment) for the Project is above Title V (Part 70) permitting requirements, so the Project will be permitted as a synthetic minor source for PSD purposes, but will require a Title V permit.

The following sections provide a further overview of anticipated emissions of criteria pollutants and hazardous air pollutants (HAP), as classified by the federal CAA and Minnesota law, in each area of the Project, and of PolyMet's plans for controlling those emissions to comply with applicable federal and state air quality standards and emission control requirements. The criteria pollutants relevant to the Project are particulate matter (PM), particulate matter with an aerodynamic diameter of less than 10 microns (PM_{10}), particulate matter with an aerodynamic diameter of less than 2.5 microns ($PM_{2.5}$) carbon monoxide (CO), sulfur dioxide (SO_2), oxides of nitrogen (NO_X), volatile organic compounds (VOC), and lead (Pb). The Project’s potential HAP emissions are as listed in or identified pursuant to CAA section 112(b). Potential HAP emissions will be below major source thresholds for Part 70/Title V air permitting.

13.2 Emissions within the Mine Site and Transportation and Utility Corridors

The emission sources at the Mine Site and Transportation and Utility Corridors will be mostly fugitive in nature, meaning the emissions will occur outdoors and will not be routed to a stack or vent for control. The only point source at the Mine Site will be the WWTF, which includes space heating for the facility building, an emergency diesel-powered generator, and a lime silo with associated mixing equipment. PolyMet will control emissions from the WWTF through the use of a fabric filter on the silo vent and low emitting fuels (natural gas for heaters and diesel fuel for generators). Details on air emissions and controls are provided in the Project's air permit application.

13.2.1 Sources of Fugitive Emissions

The planned open-pit mining operation and related transportation logistics will be the primary source of the fugitive emissions at the Mine Site and Transportation and Utility Corridors. Those emission sources include the following:

- Unpaved roads
  - Unpaved mine roads will generate dust from moving ore, waste rock, and overburden, as well as other materials, around the Mine Site in haul trucks and other vehicles
  - Dunka Road will generate dust from PolyMet traffic transporting personnel, equipment, and materials through areas controlled by PolyMet, both at the Mine Site and in the Transportation and Utility Corridors
- Material handling will produce fugitive emissions from the loading and unloading of haul trucks with overburden, waste rock, and ore and the loading of railcars with ore
- Crushing and screening will generate dust from the processing of overburden and other approved rock for use in the construction of roads, dams, berms, etc., and as railroad ballast
- Blasthole drilling will create fugitive emissions, both from drilling holes and the associated blasting
- Rail traffic moving ore to the Plant Site is not expected to generate dust in the Transportation and Utility Corridors; because of the size of the ore being transported, dust will not be generated

PolyMet will minimize emissions from fugitive dust through the development and adoption of a Fugitive Emission Control (FEC) Plan. The Plan targets a control efficiency of 90% for Mine Site haul roads and an 80% efficiency for the Dunka Road. The Plan includes control procedures for each source.

The air permit application contains further detail on the FEC plan which will be updated throughout the permitting process. PolyMet has also agreed to conduct special purpose ambient monitoring at the Mine Site to demonstrate the performance of the FEC Plan. Figure 13-1 provides a view of the Mine Site, and shows the location of point source emissions.

13.2.2 Evaluation of Priority Pollutant and HAP Emissions

PolyMet evaluated both potential criteria pollutant and HAP emissions at the Mine Site and Transportation and Utility Corridors. The expected HAP emissions are primarily due to metals that make up part of the mineral matrix of the mined rock and ore, overburden, and road surface material.

Because both the criteria pollutant and HAP emissions will be a component of the fugitive dust generated by the mining operations, PolyMet will control those emissions through implementation of the FEC Plan procedures. PolyMet's modeling of estimated Project emissions included dust and other potential fugitive emissions. This modeling demonstrates that with the mitigation measures included in the FEC Plan, PolyMet's activities at the Mine Site and Transportation and Utility Corridors will comply with applicable air quality and emission standards and MPCA air permitting requirements.

13.3 Emissions at the Plant Site

The majority of emission sources at the Plant Site will be point sources. Some fugitive emissions will occur at the Plant Site, however, including those associated with activities at the FTB and HRF. Both the point source and fugitive emissions at the Plant Site are summarized below.

13.3.1 Point Source Emission

The primary Plant Site point source air pollutant emissions will include:

- The Beneficiation Plant will generate emissions from the crushing and grinding of ore, along with the flotation steps and other elements of the concentration process. This includes the Beneficiation Plant operation from the ore railcar dumping to the flotation process where the minerals of interest are concentrated. Equipment for the storage and shipping of flotation concentrate will also be installed.
- The Hydrometallurgical Plant, including the autoclave, which includes tanks, equipment and processes used to leach valuable metals from the nickel concentrate and then separate and recover the valuable metals from the autoclave leach solution, will generate various emissions.
- Process Consumables Handling Sources will create emissions in connection with handling, transferring and storing additives used in the Beneficiation Plant, autoclave, and Hydrometallurgical Plant.
- Combustion Sources and Fuel Tanks, which include boilers, heaters, emergency diesel engines and fuel oil and gasoline tanks, will also generate emissions.

The following subsections provide additional detail concerning the control of these various emissions at the Plant Site.

13.3.2 Criteria Pollutant Emissions

The expected criteria pollutant emissions from the Plant Site are described below.

13.3.2.1 Crusher/Concentrator

PolyMet plans to utilize the first two crushing stages of the former LTVSMC Beneficiation Plant along with the Plant's connected conveying and storage equipment. Figure 13-2 identifies the location of the Beneficiation Plant and related equipment. PolyMet will install a new SAG mill and ball mill at the Beneficiation Plant. Because these mills will utilize wet processes, they will not generate particulate emissions and the overall emissions will be reduced from the previous LTVSMC grinding circuit. PolyMet is also including three fine crushing lines and related equipment in the Air Permit Application to provide operating flexibility.

PolyMet will install state-of-the art fabric filter technology, utilizing baghouses or cartridge type filters, as the pollution control equipment on all crushing lines. Where practical, the exhaust gas from the dust collectors will be recirculated to reduce heating demand and combustion pollutant emissions. Dust collector exhaust will be passed through a High Efficiency Particulate Arrestor (HEPA) filter before being released into the indoor environment for additional protection for the workers in the buildings. PolyMet will also equip the HEPA filters with an audible alarm to notify operators if the pressure drop is outside of the specified range, so that corrective action can be taken, or if necessary, the exhaust can be routed through the stack or the associated equipment shutdown. The air permit application contains further information regarding the pollution control plans and equipment.

PolyMet's flotation process for copper and nickel concentration is also a wet system, but additives will be used which may cause emissions of VOCs. This flotation process will be performed in equipment located in the Beneficiation Plant. PolyMet intends to produce copper concentrate as a salable product throughout operations. PolyMet will also sell nickel concentrate as a finished product. Once the Hydrometallurgical Plant is constructed, however, the nickel concentrate may be delivered to this facility for further processing to produce higher value nickel and Au/PGM products.

PolyMet does not anticipate that handling and storing of flotation concentrate within the Beneficiation Plan will produce dust because this material is a damp filter cake. PolyMet plans to install direct ventilation and if necessary dust collectors to capture emissions associated with flotation concentrate air streams.

13.3.2.2 Autoclave

When PolyMet constructs the Hydrometallurgical Plant, it will include installation of an autoclave and associated flash vessel to further process the nickel flotation concentrate. Potential emissions from the autoclave and flash vessel will include PM, PM_{10}, $PM_{2.5}$, SO_2, sulfuric acid mist, NO_X, CO, VOC, and fluorides. PolyMet performed extensive sampling on the pilot-scale autoclave and flash vessel. The concentrations in both the air and condenser underflow streams were measured to quantify controlled and uncontrolled emissions. The test results of the observed pollutants were scaled up and used to estimate commercial plant scale emissions.

PolyMet will control emissions from the autoclave and flash vent with a venturi scrubber and packed bed scrubber in series. This means that the packed bed scrubber will follow the venturi scrubber to provide additional particulate matter control.

The air permit application contains further information regarding sampling, test results, and pollution control plans for the autoclave and flash vessel.

13.3.2.3 Hydrometallurgical Plant Process Tanks

Processing in the Hydrometallurgical Plant will include various steps, tanks, and equipment designed to extract residual copper from the concentrate to produce a gold/platinum group metals concentrate and to precipitate nickel and cobalt as a hydroxide precipitate. Some of these tanks have the potential to emit sulfuric acid mist and sulfur dioxide. PolyMet will capture emissions, and then vent the emissions to a scrubbing system. PolyMet utilized the data from the pilot-study to calculate sulfuric acid and sulfur dioxide emissions to design the scrubber system.

The air permit application includes further discussion of the sampling, test results, and pollution control equipment for the Hydrometallurgical Plant.

13.3.2.4 Process Consumables

Process consumables (e.g., flocculants, lime, limestone, frothers, etc.) can generate emissions during activities associated with storing, processing, and other handling of these materials. PolyMet will utilize fabric filters on process consumable equipment where appropriate, including silo vents and crushers. The air permit application contains information relating to these emission control techniques.

13.3.2.5 Combustion Related Sources

The Project does not include significant combustion sources. PolyMet will utilize natural gas space heaters with low-NO_X designs in most buildings at the Plant Site to provide heating. PolyMet will use two diesel-powered backup generators to provide backup in case of a power failure and will install a new diesel generator at the WWTP. Two diesel-powered fire pumps will be used to pump water in case of a fire. While an autoclave startup boiler will be located in the autoclave area, the oxidation reaction in the autoclave will produce sufficient heat to maintain the reaction once it has started, and heat exchangers will be used to avoid the need for external heat sources on a continuous basis. There will be minor emissions from miscellaneous sources, such as the cooling tower and a heater for the oxygen plant, and fuel tanks for the generators, fire pumps, and motor vehicles. A propane-fired boiler will heat office areas at the Administration Building and the Area 1 and 2 shops.

All new stationary internal combustion engines will be certified to meet the applicable USEPA emission standards. Internal combustion engines used for back-up power and fire pumps will include certifications from the manufacturer indicating they meet the most recently applicable performance standards.

13.3.3 Fugitive Emission Sources

There will be several sources of fugitive emissions at the Plant Site. These emissions are similar to those located at the Mine Site, and PolyMet utilized the same emissions calculation procedures to determine the extent of the emissions. The fugitive emission sources at the Plant Site will be limited to the following:

- Limestone handling – there will be four fugitive sources associated with limestone handling:
    - Transfers from the limestone conveyor coming from the railcar unloading building to the stacker conveyor
    - Transfers from the stacker conveyor to the stockpile
    - Transfers via a front end loader to the reclaim pocket for conveyance to the limestone crusher in the additive plant
    - Transfers from the reclaim feeder to the tunnel conveyor running to the limestone crusher
- FTB activities – there will be three tailings-related fugitive sources:
    - Emissions from the construction of FTB dams and the HRF.
    - Light truck traffic on unpaved roads.
    - Wind erosion off the portions of the FTB dams and beaches above the water line (which will be limited to the exposed beaches where the deposited tailings are not saturated with water and have not been stabilized with vegetation or other means). Management of the water line will be such that exposed beaches will be kept to a minimum. To the extent practicable, erosion will also be controlled through use of vegetation in non-active portions of the FTB through progressive reclamation.
- Hydrometallurgical Plant – sulfur dioxide will be delivered and stored as a pressurized liquid; some fugitive emissions will occur when the tank is filled. Fugitive emissions from the HRF will be minimized through management of Residue in a pond that substantially reduces the potential for fugitive dust. To the extent practicable, erosion will be controlled through use of vegetation in non-active portions of the HRF as part of progressive reclamation.
- General vehicle traffic – Light truck traffic on Plant Site roads.

- Miscellaneous storage stockpiles – Wind erosion from various small stockpiles that may be stored on-site.

PolyMet will minimize Plant Site fugitive emissions through the development and implementation of a FEC Plan. Consistent with modeling conducted for the Project air emissions permit and MPCA guidance, Level III-A controls are proposed for the Plant Site roads to achieve 80% control of fugitive dust emissions. The FEC Plan includes control procedures for each source discussed above.

The air permit application contains the FEC Plan for the Plant Site. The FEC Plan may be updated during the permitting process.

13.3.4 HAP Emissions

PolyMet will principally control HAP emissions at the Plant Site by controlling particulate emissions through implementation of its FEC Plan. These control measures will address metals, such as nickel, that are a part of the mineral matrix of particulate emissions from the Beneficiation Plant, flotation concentrate handling sources, and Hydrometallurgical Plant. In addition, scrubbers will reduce emissions of acid gasses that are also HAPs.

13.4 Methodology and Evaluation Criteria for Air Permitting

The following subsections summarize the air quality standards that apply to the Project. They also describe the modeling methodologies and specific modeling assessments that PolyMet evaluated to verify that operation of the Project will comply with these standards.

13.4.1 Regulatory Setting

13.4.1.1 Air Quality Standards – Regulatory Setting

Under the federal CAA, USEPA has developed National Ambient Air Quality Standards (NAAQS) for the seven criteria air pollutants (NO_2, SO_2, CO, O_3, PM_{10}, $PM_{2.5}$, and lead) that are relevant to the Project. Under the applicable federal and state regulations, the primary standards are set to protect the public health; secondary standards are intended to protect public welfare, including protection from damage to animals, crops, vegetation, visibility, and buildings. USEPA has delegated authority for implementing these NAAQS requirements to MPCA, which has done so by promulgating ambient air standards for the state of Minnesota that are known as the Minnesota Ambient Air Quality Standards (MAAQS). In addition to the criteria pollutants established by USEPA, the MAAQS contain standards for total suspended particulate (TSP) and hydrogen sulfide (H_2S).

13.4.1.2 Federal and State Regulation – Attainment Status

Under the federal CAA, the USEPA has defined all areas within the United States as one of two classifications: attainment or non-attainment. Attainment areas are those areas for which ambient air quality data has been collected to demonstrate that they are in compliance, or for which there is insufficient data to demonstrate non-compliance with the NAAQS. The latter are known as unclassified areas. As discussed below, there are various permitting programs, air quality standards, and emissions limits in place to limit adverse air impacts within attainment areas.

An area that does not meet NAAQS requirements for a particular pollutant is classified as a non-attainment area for that pollutant, and the USEPA requires the state to develop state implementation plans to control existing and future emissions in order to bring the area into compliance with the NAAQS. MPCA and USEPA have designated the Mining Area as attainment or unclassified for all relevant air quality pollutants; accordingly, the non-attainment requirements are not applicable.

13.4.1.3 Prevention of Significant Deterioration Review

Under the CAA, the federal PSD requirements provide for a pre-construction review and permit process for the construction and operation of a new or modified major stationary source of emissions in attainment areas. The PSD program is intended to prevent degradation of air quality within attainment areas. The PSD program is not triggered by minor emission sources.

There are two primary regulatory classifications under the PSD program, Class I areas (which include national parks, national monuments, and wilderness) are areas where air quality should be given special protection, and Class II areas, which includes most other locations. For attainment areas, the USEPA has promulgated PSD increments (essentially allowable increases in emissions above certain baselines) for four pollutants (NO_2, SO_2, PM_{10}, and $PM_{2.5}$) for both Class I and Class II regions.

The Project is located within a Class II attainment area, as designated by the USEPA and MPCA. The CAA defines an emissions source as a major stationary source in an attainment area if it will have any criteria pollutant emissions above 250 tons per year (tpy) or any greenhouse gas emissions above 100,000 tpy. Because PolyMet will limit its actual emissions below these major source thresholds for the PSD program, and these limitations will be incorporated into PolyMet's forthcoming air permit (i.e., the Project will be permitted as a "synthetic minor"), the Project is not subject to PSD review and restrictions.

Moreover, because of this "synthetic minor" limitation, the Project is not required to conduct a Class I potential impact analysis as part of its MPCA air permitting process. Nonetheless, as discussed later in this section, PolyMet conducted Class I modeling in connection with the EIS process and is updating that analysis as part of the air permitting effort.

13.4.1.4 Technology-Based Performance Standards and Other Requirements

Federal and state New Source Performance Standards are technology-based performance standards that are applicable to new or modified stationary sources of regulated emissions. Various state and federal ambient air quality standards and emissions limits are in place to minimize degradation of air quality in attainment areas. These ambient air quality standards are defined by the applicable NAAQS and the MAAQS requirements. PolyMet's modeling of estimated air emissions demonstrates that the Project as designed will meet all applicable NAAQS and MAAQS standards.

MPCA, as part of its air permitting process, will impose conditions on PolyMet to assure that the Project will comply with all applicable federal and state New Source Performance Standards, ambient air quality standards, and other emissions limits. The PTM Regulations, administered by MDNR, also require the control of fugitive emissions from areas disturbed by mining, processing, transportation, construction, operations, and reclamation activities. PolyMet's FEC Plans are intended to verify compliance with the PTM Regulations' requirements for dust suppression.

13.4.2 Federal Hazardous Air Pollutants

Through use of controls, potential emissions of federal HAPs will be below the major source thresholds of 10 tons per year for an individual HAP and 25 tons per year for total HAPs. The Project will therefore qualify as a synthetic minor source of HAPs and will not be subject to Maximum Achievable Control Technology (MACT) regulations specified for major sources of HAP emissions. The standards that apply to non-major or area sources of HAPs, however, may apply and will be specified as necessary in the air permit application for the Project.

13.4.3 Predictive Modeling Approach

PolyMet conducted air dispersion modeling to evaluate compliance with NAAQS and MAAQS requirements, to support PSD increment analysis, and to identify potential effects on Class I and Class II areas. Although the Project is not classified as a major stationary source for PSD considerations because of the operating limits (i.e., "synthetic minor" conditions) accepted by PolyMet as permit conditions, PolyMet conducted PSD increment modeling analysis in connection with the EIS process and is updating that analysis as part of the air permitting effort.

PolyMet performed an air quality modeling analysis to estimate the potential effects of the Project on Class I areas within 180 miles of Project facilities. The Class I modeling analyzed potential PSD increment impacts associated with SO_2, PM_{10}, NO_2, sulfur and nitrogen deposition, as well as visibility impairment.

PolyMet's Class II air quality modeling addressed individual point sources of emissions from the Project, as well as sources of fugitive particulate matter. PolyMet conducted this Class II modeling for PM10, PM2.5, NO2, and SO2 with respect to applicable averaging times at the Mine Site, Plant Site, and Transportation and Utilities Corridors.

13.5 Class I Modeling Results

As discussed above, the Project, because it will not be a major emissions source under federal and state air quality regulations, is below the applicable CAA threshold for Class I modeling. PolyMet nevertheless performed such modeling in connection with the EIS process. The modeling assessed four Class I areas for potential impacts from Project emissions: the BWCAW, Isle Royale National Park, Rainbow Lake Wilderness, and Voyageurs National Park.

The Class I modeling results demonstrate that the Project will not cause deterioration of air quality and will not have adverse effects on flora and fauna or terrestrial or aquatic ecosystems in these four areas. In addition, the modeling demonstrates that any impacts from Project air emissions to visibility at these wilderness and park areas will be below perceptible levels.

13.6 Class II Modeling Results

PolyMet also conducted Class II air dispersion modeling analysis as part of the EIS process and in preparation for permitting. The Class II modeling included analysis for all of the potential criteria pollutants and HAP emissions associated with the Project. Because of the Project's design, the emissions of particular relevance were PM_{10}, $PM_{2.5}$ at both the Plant and Mine Site, and SO_2 and NO_2 at the Plant Site. The modeling evaluated the Project's estimated compliance with NAAQS and MAAQS air quality standards and with PSD increment requirements.

All modeling analyses conducted for an air permit application in Minnesota must follow MPCA's analytical procedures, which require MPCA's approval of both a dispersion modeling protocol and dispersion modeling report. PolyMet's modeling analysis adheres to the MPCA-approved dispersion modeling protocol and dispersion modeling report requirements.

13.6.1 Receptor Grid and Ambient Air Boundary

In compliance with MPCA requirements, PolyMet based its proposed ambient air boundaries for the Project on land that PolyMet expects to control at the commencement of operations. The ambient air boundaries establish the receptor grid boundaries for measuring compliance with applicable air quality standards. Different receptor grids were used at the Mine and Plant Sites. Due to the specific requirements of MPCA's air permitting regulations, these air boundaries differ in some aspects from the Mining Area boundary required for the Permit to Mine under the MDNR's PTM Regulations. More detailed information on receptor boundaries and the Class II modeling process can be found in the air permit application for the Project.

13.6.2 Model Results

The sections below present the emissions modeling results for the Mine Site and Plant Site.

13.6.2.1 Mine Site Emissions

At the Mine Site, the $PM_{2.5}$ and PM_{10} modeling indicates that the Project will be in compliance with the applicable NAAQS and MAAQS requirements at the ambient air boundaries. The PM_{10}

increment modeling results also show that anticipated concentration increases from the Project are below any PSD threshold. The air permit application contains these Mine Site modeling results.

13.6.2.2 Plant Site Emissions

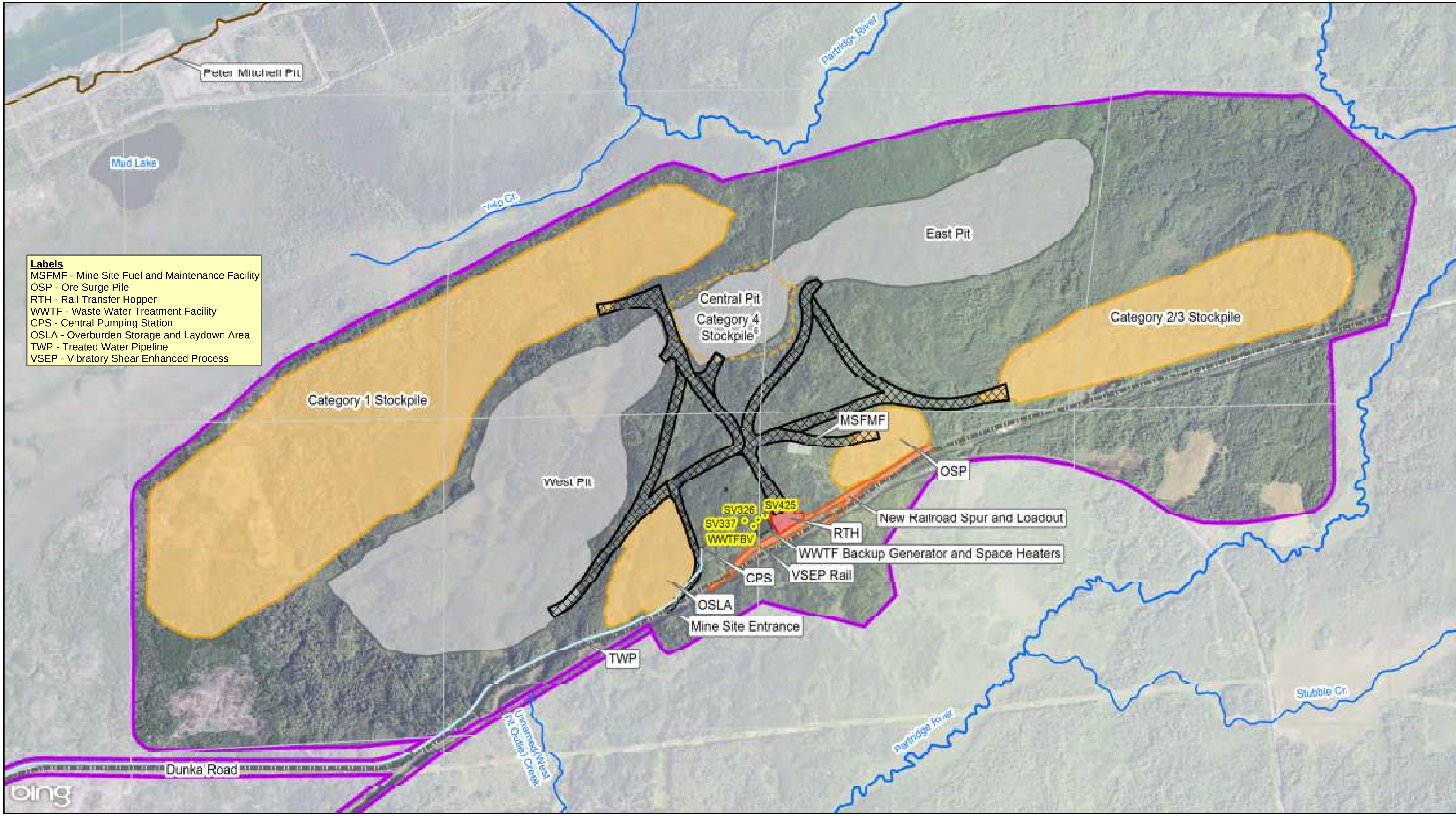
At the Plant Site, the $PM_{2.5}$ and PM_{10} modeling estimates that the Project will meet the applicable NAAQS and MAAQS requirements at the ambient air boundaries. The cumulative modeling results (i.e., the Project plus other nearby sources) for the one hour SO_2 and NO_2 threshold indicated an exceedance of applicable standards, but the Project emissions alone are not projected to cause or contribute to those exceedances. The SO_2 and NO_2 modeling - based solely on Project emissions at the ambient air boundaries - confirms that the Project will meet the NAAQS and MAAQS requirements. The PM_{10} increment modeling results show that anticipated concentration increases from the Project are below any PSD threshold. The air permit application contains these Plant Site modeling results.

13.7 AERA

MPCA guidance indicates that for facilities that are required to complete environmental review under MEPA rules, an AERA is needed if, after the use of control equipment, the facility will emit more than 250 tons per year of a single criteria air pollutant from point sources. The Project will not have more than 250 tons per year of emissions of any criteria pollutant from point sources, and therefore, an AERA was not triggered by this requirement. MPCA may also request an AERA based on other considerations, such as the facility's location or the presence of unique off-site receptors. The MPCA requested that PolyMet conduct an AERA as part of the Project's environmental review, and PolyMet agreed to conduct this additional analysis.

Minor changes have been incorporated into the Plant and Mine Site emission inventories and a few parameters in the MPCA's AERA process have changed since the 2013 Supplemental Plant Site and Mine Site AERA's were submitted. Due to these changes, the MPCA requested additional analysis of the potential incremental health risks associated with the Plant and Mine Site operations using the most current information prior to issuing an air permit. The 2016 Plant and Mine Site AERA's assess any changes in potential health risks based on the most current information available. More detailed information on the Plant and Mine Site AERA work plans can be found in the Project air permit application.

When the estimated risks are compared to guideline values, and accounting for conservatism in the risk analysis methodology, adverse impacts to human health are not expected to be associated with the potential air emissions from the Plant and Mine Site operations. The air permit application contains the Plant Site and Mine Site AERA results.



Notes
1. Basemap from Esri and its data suppliers.
2. Project features from map packages received from Barr Engineering Company.
3. Point sources data is from Air Quality Management Plan - Mine V4, December 2014 in Appendix 16 of the Application.
4. Facility boundary is not the same as the ambient air boundary.
5. For clarity not all of the sumps, ditches, piping, and overflows are shown.
6. The Category 4 stockpile is removed, enabling the development of the Central Pit.

Legend
- Point Emission Sources
- Rivers and Streams
- Treated Water Pipeline
- VSEP Rail
- Section Lines
- WWTF Buildings
- Facility Boundary

Potential Fugitive Emission Sources
- Rail Transfer Hopper
- New Railroad Spur and Loadout
- Mine Site Roads
- Category 4 Stockpile (Removed)[6]
- Dunka Road
- MSFMF Footprint

- Active Stockpile
- Mine Pits

POLYMET MINING

Foth

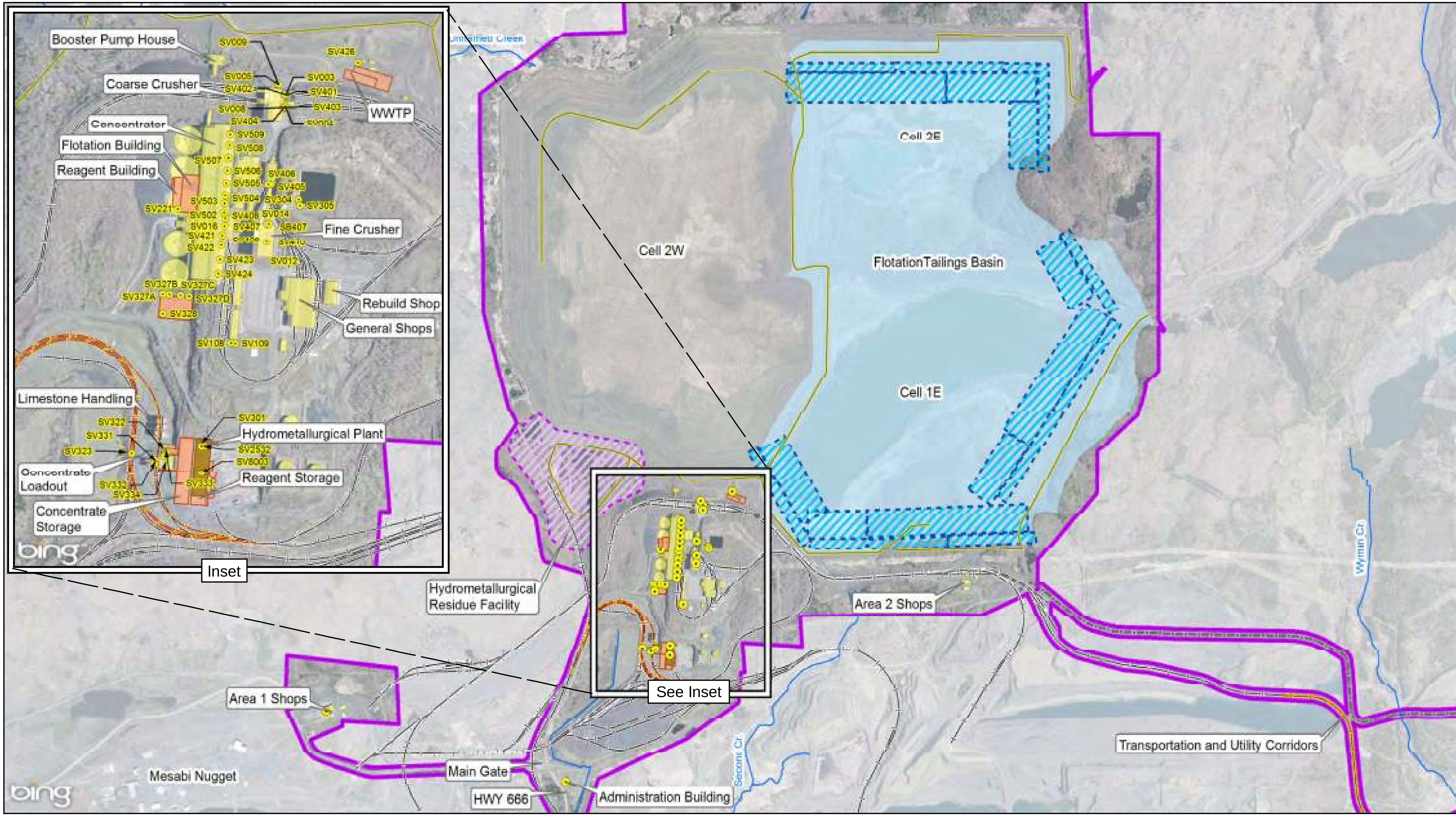
Foth Infrastructure & Environment, LLC			
REVISED	DATE	BY	DESCRIPTION
PREPARED BY: DAT			DATE: AUG. '16
REVIEWED BY: JSL			DATE: AUG. '16
APPROVED BY: CED1			DATE: AUG. '16

POLYMET MINING

FIGURE 13-1
MINE SITE - FUGITIVE AND POINT SOURCES OF AIR EMISSIONS
PERMIT TO MINE APPLICATION
HOYT LAKES, MINNESOTA

Scale: 0 750 1,500 Feet | Date: AUGUST 2016
Drafted by: DAT | Project No: 12P778

Path: X:\GB\IE\2012\12P778\GIS\mxd\PMA\Figure 13-1 Fugitive and Point Sources of Air Emissions Mine Site.mxd Date: 9/2/2016



Notes

1. Basemap from Esri and its data suppliers.
2. Project features supplied by Barr Engineering Company.
3. NHD features are created from MDNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance, data sources may show watercourses that no longer exist.
4. Point sources data is from Air Quality Management Plan - Plant V7, December 2014, in Appendix 16 of the Application.
5. Facility boundary is not the same as the ambient air boundary.

Legend

- Point Emission Sources
- Proposed Railroad Track
- Existing Private Railroad
- Rivers and Streams[3]
- Flotation Tailings Basin
- Proposed Plant Site Buildings
- Proposed Hydromet Plant
- Existing Buildings

Potential Fugitive Emission Sources

- Dunka Road
- Plant Site Access Roads
- HRF Dams and Beaches
- FTB Dams and Beaches
- Facility Boundary

POLYMET MINING

Foth

Foth Infrastructure & Environment, LLC

REVISED	DATE	BY	DESCRIPTION

PREPARED BY: DAT DATE: AUG. '16
REVIEWED BY: JSL DATE: AUG. '16
APPROVED BY: CED1 DATE: AUG. '16

POLYMET MINING

FIGURE 13-2
PLANT SITE - FUGITIVE AND POINT SOURCES OF AIR EMISSIONS
PERMIT TO MINE APPLICATION
HOYT LAKES, MINNESOTA

Scale: 0 1,000 2,000 Feet
Date: AUGUST 2016
Drafted by: DAT
Project No: 12P778

Path: X:\GB\IE\2012\12P778\GIS\mxd\PMA\Figure 13-2 Fugitive and Point Sources of Air Emissions Plant Site.mxd Date: 9/12/2016

14 Project Monitoring Programs

This section summarizes PolyMet's monitoring plans for the Project. The following information is summarized in this section:

- Section 14.1 provides an overview of the Project monitoring
- Section 14.2 summarizes monitoring that will be completed per requirements of the PTM Regulations
- Section 14.3 summarizes monitoring that will be done per the requirements of other media-specific permits including:
    - NPDES/SDS Permits (Section 14.3.1)
    - Construction Stormwater Permits (Section 14.3.2)
    - Wetland Permits (Section 14.3.3)
    - Air Permit (Section 14.3.4)
    - Water Appropriations Permits (Section 14.3.5)
    - Dam Safety Permits (Section 14.3.6)

14.1 Project Monitoring Overview

PolyMet will comprehensively monitor the Mine Site, Plant Site, and Transportation and Utility Corridors during construction, operations, reclamation, closure, and postclosure maintenance phases of the Project. Monitoring will occur at multiple levels that cover both operational and environmental aspects of the Project. PolyMet developed the monitoring programs to meet several goals summarized below:

- Continuously assess the Project relative to the MDNR's PTM Regulations
- Include indicator monitoring as an early detection tool
- Determine compliance with media-specific permitting and compliance criteria
- Monitor performance of engineering infrastructure and pollution control facilities and equipment
- Enable detection and assessment of any impacts related to the Project
- Verify the long-term integrity and performance of reclamation and closure
- Support and inform adaptive management

14.2 Permit to Mine Monitoring

The PTM Regulations, Minnesota Rules, chapter 6132, outline certain monitoring requirements. Most of these requirements are discussed in the reclamation standards in Minnesota Rules, parts 6132.2000 through 6132.3200. Monitoring programs to satisfy the PTM Regulations' requirements are listed below and described in the following subsections:

- Mine Pit monitoring

- Stockpile monitoring
- Transportation and Utility Corridors monitoring
- FTB and HRF monitoring
- Wetland mitigation monitoring

14.2.1 Mine Pit Monitoring

Monitoring will occur at the Mine Site to cover the following aspects of the Project:

- assessment of rock stability in the mine pit and slopes
- management of blasting in the pit
- monitoring of groundwater inflows into the pit

Mine Pit Stability Monitoring

PolyMet will conduct stability monitoring to verify the safety and stability of the mine pit walls, facilitate effective segregation of rock, and manage groundwater inflow to the mine. Monitoring will include the following:

- Collection of additional geological data – Data will be collected throughout the LOM to continually assess and revise, if necessary, the interpretation of stratigraphy and stability.
- Geologic mapping of mine pit walls – Routine geotechnical observations will be an important part of slope management. Observations will result in monthly mapping of certain features during operations. This will also include monitoring for new rock types or formations encountered during mining that have not been previously characterized, as required under Minnesota Rules, part 6132.1300, subpart 2, item E.
- Slope stability monitoring – This monitoring will include weekly surveys of pit slopes, survey monuments, inclinometers and daily visual inspections of pit walls and other features.
- Slope pore water pressure assessment – If necessary, PolyMet will monitor pore water pressure.
- Mine sequencing and development – This monitoring will include daily reporting of the types, amounts, sequence, and schedule of mining of the ore body, including the distinction among ore, lean ore, and waste rock, as required under Minnesota Rules, part 6132.1300, subpart 2, item A.

The above information will be developed and/or reviewed by on-site personnel and tracked in the Project files. This monitoring will be described in further detail in the Waste Rock and Ore Management and Monitoring Plan and the Overburden Management and Monitoring Plan outlined in Appendix 11.

Blast Monitoring

PolyMet will conduct certain monitoring of blasting activities to meet overpressure and ground vibration requirements of Minnesota Rules, part 6132.2900, to limit the distance fly rock travels within the blast radius, and to maintain pit wall stability during blasting. Monitoring will include the following aspects:

- Pre-blast warning, assessment of atmospheric conditions and timing;
- Control of blast area and explosives;
- Seismograph monitoring;
- Keeping and maintaining a blasters' log; and
- Conduct vibration monitoring and air overpressure monitoring

The above information will be developed and/or reviewed by on-site personnel and tracked in the Project files. This monitoring will be described in further detail in the Waste Rock and Ore Management and Monitoring Plan outlined in Appendix 11.

Mine Pit Inflow Monitoring

During operations, Mine Pit inflow will be monitored to minimize indirect impacts to wetlands, maintain pit wall stability, and minimize the need for enhanced management and mitigation of pit inflows. Monitoring will include the following:

- Groundwater monitoring – Water levels in specified groundwater monitoring wells surrounding the pit will be monitored monthly during the non-frozen portions of the year and mine pit dewatering rates will be monitored continuously. The groundwater monitoring wells specified will be in accordance with the Water Appropriation Permit requirements, for which this groundwater monitoring will be completed.
- Field inspections – These will be performed to assess erosion of pit slope surficial soils, open fractures in mine pit walls, and wetland areas in the vicinity of the Mine Pits.
- Data review – Monitoring data and field observations will be compiled and reviewed to establish and monitor mitigation triggers.

The above information will be developed and/or reviewed by on-site personnel and tracked in Project files. This monitoring will be described in further detail in the Mine Site Water Management and Monitoring plan outlined in Appendix 11.

14.2.2 Stockpile Monitoring

Stockpiles at the Mine Site will include several categories of waste rock (Categories 1, 2/3, and 4) and the OSP. In general, the monitoring program for each type of stockpile will include the following monitoring aspects:

- Placement verification monitoring – This type of monitoring will be performed daily primarily for waste rock to verify proper placement and amounts of material into the appropriate stockpile.
- Survey monitoring – This type of monitoring will verify that the stockpile is built to the lines, grades, and slope as designed.
- Stability monitoring – PolyMet will use a combination of visual inspection and surveying to monitor the stockpiles for any irregular or unusual movements.
- Drainage monitoring – Surfaces will be regularly checked for water seeps and erosion; pipes and sumps will be checked for blockage; and outslopes will be checked for presence of seeps and material displacement.

The above information will be developed and/or reviewed by on-site personnel and tracked in Project files. This monitoring will be described in further detail in the Waste Rock and Ore Management and Monitoring Plan and the Overburden Management and Monitoring Plan outlined in Appendix 11.

14.2.3 Transportation and Utility Corridors Monitoring

Monitoring will be performed along the Transportation and Utility Corridors to verify the integrity of ore rail car equipment, confirm pipeline integrity, and assess water quality along rail track areas. Monitoring will include the following aspects:

- Ore car inspections – Ore cars will be inspected to verify they meet certain specifications for transport of ore from the Mine Site to the Plant Site.
- Quarterly track inspections – Trained individuals will perform inspections of track sections within the Transportation and Utility Corridors for ore spillage and track integrity.
- Surface water monitoring to assess water quality

The above information will be developed and/or reviewed by on-site personnel and tracked in Project files. This monitoring will be described in further detail in the Transportation and Utility Corridors Management and Monitoring Plan outlined in Appendix 11.

14.2.4 FTB and HRF Monitoring

At the Plant Site, monitoring will take place at both the FTB and HRF to maintain safety and stability of the structures and minimize impacts to water resources. Following are the general types of monitoring that will be performed at both facilities:

- Material characteristics verification – Monitoring will take place to verify materials used in construction meet specifications for strength and stability. Ongoing tests on construction materials will continue throughout operations as new sources are used.

- Stability Monitoring – Section 14.3.6 discusses the stability monitoring proposed under the Dam Safety Permits for the FTB and HRF.

Information from the monitoring program will be developed and/or reviewed by on-site personnel and tracked in Project files. This monitoring will be described in further detail in the FTB Management and Monitoring Plan and the HRF Management and Monitoring Plan outlined in Appendix 12.

14.2.5 Wetland Mitigation and Monitoring

The PTM Regulations expressly incorporate the requirements of WCA and require that the Mining and Reclamation Plan incorporate a MDNR-approved wetland mitigation plan. To meet the requirements of WCA and the PTM Regulations, PolyMet has included specifications for its mitigation plan in Appendix 18.3. Additionally, specific monitoring requirements for wetlands will be outlined in the CWA Section 404 and WCA permits for the Project. A summary of monitoring requirements for wetlands is discussed below in Section 14.3.3.

14.3 Other Media-Specific Monitoring

Media-specific permits issued for the Project will provide detailed environmental monitoring requirements to meet conditions of each permit. The purpose of this subsection is to provide an overall summary of the monitoring proposed in the relevant permit applications. Actual monitoring requirements may change as permitting progresses on each specific permit. Media-specific permits that set forth environmental monitoring requirements will include the following:

- NPDES/SDS
- Construction Stormwater
- Wetland
- Air Quality
- Water Appropriations
- Dam Safety

14.3.1 NPDES/SDS Permit Monitoring

The Project’s NPDES/SDS Permit Application includes proposed monitoring relating to water quality. The NPDES/SDS Permit will cover monitoring for groundwater, surface water, surface water discharge from the WWTP, and industrial stormwater. Construction stormwater will be covered in one or more separate permits issued by MPCA. Monitoring stations are divided between the Mine Site and the Plant Site. In the proposed monitoring plan included in the Project’s NPDES/SDS Permit application, the WWTF and Transportation and Utility Corridors are grouped with the Mine Site, whereas the WWTP, Beneficiation Plant, Tailings Basin, and HRF are grouped with the Plant Site. Monitoring for the Project is specified by monitoring type. The categories of monitoring are briefly described below. The Project NPDES/SDS Permit Application contains further information on the number of monitoring locations for each category, the parameters to be monitored, the frequency of monitoring, and the method of reporting. Upon NPDES/SDS permit issuance, details of required monitoring will be incorporated into the Mine Site Water Management and Monitoring Plan outlined in Appendix 11 and the Plant Site Water Management and Monitoring Plan outlined in Appendix 12.

Groundwater Monitoring

Groundwater monitor wells will be established at the Mine Site and Plant Site. Following are the types of monitoring that are proposed:

- Compliance monitoring – This will be performed at locations where the Project will need to demonstrate compliance with applicable permit limits. Locations are downgradient of potential Project impacts, typically be at or near property boundaries.
- Indicator monitoring – This type of monitoring will occur between Project features and the property boundary to allow for early detection of potential Project impacts.
- Performance monitoring – This type of monitoring will be performed to assess the performance of engineering infrastructure (i.e., liner systems, containment systems, etc.). Performance monitoring stations will include monitoring wells, paired monitoring wells, paired piezometers, and stockpile underdrains.
- Background monitoring – This type of monitoring will be performed to document groundwater quality upgradient of the Project.
- Monitor-only – At these types of stations, no limits or standards will apply; however, there may be triggers that will initiate further investigation. These will be located downgradient of potential Project impacts.

Surface Water Monitoring

Surface water monitoring will consist of sampling at upstream and downstream locations off-site to assess potential surface water quality impacts from the Project. Following are the types of monitoring that are proposed:

- Background monitoring – Background water quality will be conducted to document surface water quality upstream of potential Project impacts.
- Monitor-only – At these types of stations, no limits or standards will apply; however, there may be triggers that will initiate further investigation. These will be located downstream of potential Project impacts.

Surface Water Discharge Monitoring

Surface water discharge monitoring will measure the quality and quantity of treated effluent discharged from the WWTP. The Project will need to demonstrate compliance with the NPDES/SDS Permit limits at these locations.

Industrial Stormwater Monitoring

Industrial stormwater monitoring will include benchmark stormwater monitoring. This type of monitoring will be performed at benchmark stormwater monitoring locations to evaluate the potential impact of industrial activities on stormwater runoff. Results will be compared against applicable benchmark values to determine whether additional stormwater control measures may be necessary.

Internal Waste Stream Monitoring

Certain internal waste streams will be monitored to evaluate resultant water quality as compared to estimated quality. Internal waste stream monitoring stations are proposed as monitor-only; therefore, no numerical limits would apply, but there may be triggers that will initiate further investigation or analysis.

14.3.2 Construction Stormwater Monitoring

Separate permit applications will be submitted requesting authorization to discharge stormwater associated with Project construction activities occurring prior to Mine Year 1. Under this request, the Project would receive coverage under the Construction Stormwater General Permit. PolyMet would develop and submit a series of SWPPPs for activities during construction, which would be included in this permit application request. The SWPPPs will specify the inspection and maintenance requirements.

14.3.3 Wetland Monitoring

As described above in Section 14.2.5, wetland mitigation plans have been included in Appendix 18.3 to fulfill requirements of CWA Section 404 and WCA as incorporated by reference in the PTM Regulations. Specific requirements for wetland monitoring will be outlined in the CWA Section 404 and WCA wetland permits. For the Project, two types of wetland monitoring will occur:

Wetland Mitigation Site Monitoring

This type of monitoring is designed to monitor the functionality of the three established off-site mitigation sites described in Section 12.5 above. The mitigation plans are intended to facilitate restoration of impaired wetland functions at each of the sites. Monitoring includes assessment of pre-restoration hydrology conditions and continued monitoring post-restoration to evaluate the progress and condition of the restored wetlands. PolyMet will use the results of the monitoring to assess whether restored wetland areas conform to requirements of WCA performance standards and to determine whether continued monitoring is required. The monitoring plans for the mitigation sites are included in the wetland mitigation plans in Appendix 18.3.

Wetland Monitoring at the Project

Wetland monitoring is designed to monitor direct and potential indirect impacts to wetlands at the Mine Site, Plant Site, and Transportation and Utility Corridors. Monitoring will include assessing pre-project conditions, establishing hydrology monitoring locations in wetlands, conducting vegetation monitoring, conducting wetland boundary assessments, and establishing impact criteria. Monitoring will assess whether facility activities have directly or indirectly impacted wetland areas. If monitoring identifies additional wetland impacts, provisions will be made to provide additional mitigation. More details on proposed monitoring requirements are outlined in the Wetland Replacement Plan in Appendix 18.1.

14.3.4 Air Quality Monitoring

Specific air quality monitoring requirements will be set forth in the Air Permit that will be issued for the Project. Monitoring will include measurements associated with federal and state regulations and specific measures to control fugitive dust as described in the Mine Site and Plant Site FEC Plans. Below is a summary of the general types of air quality monitoring that typically occur. Upon issuance of the Project Air Permit, details of required monitoring will be incorporated into the Mine Site Air Quality Management and Monitoring Plan outlined in Appendix 11 and the Plant Site Air Quality Management and Monitoring Plan outlined in Appendix 12.

Mine Site

Most of the air emissions from this location will be in the form of fugitive emissions from unpaved roads, material handling, crushing and screening of aggregate materials, and blasthole drilling. Monitoring will include visual observations of sources of fugitive dust emissions in accordance with the Mine Site FEC Plan. The general types of monitoring that will be tracked will include the following:

- Materials produced – Quantities of ore, waste rock, and overburden will be tracked annually to estimate fugitive emissions.
- Mobile equipment mileage – Vehicle miles traveled will be tracked for haul trucks used to remove process materials from the mine pit to estimate annual fugitive particulate emissions.
- Application rates of water or other dust suppressants – In accordance with the Mine Site FEC Plan, the rates of application of water and other dust suppressants to on-site roadways will be tracked.

Point sources of stack emissions will include emissions from the WWTF, which includes a fabric filter control device associated with a lime silo, space heating and diesel generator combustion emissions. Monitoring for the fabric filter control device will require recording of the pressure drop across the filter control device and comparing the results against the acceptable range set forth by the manufacturer of the equipment. It is not anticipated that stack testing will be required.

PolyMet will also install ambient air quality monitors at specified locations near the ambient air boundary for the Mine Site. Monitors will be located at opposite ends of the Mine Site such that contributions from the Project can be isolated from impacts from off-site sources. The frequency for monitoring will be specified in the Air Permit.

Plant Site

The Plant Site will include a combination of fugitive and point sources of air emissions that will be monitored in accordance with requirements of the Air Permit that will be issued for the Project. Fugitive emissions monitoring will include:

- Tracking of quantities of materials used to construct the FTB and HRF – This information will be used to calculate annual fugitive emissions from these activities.
- Mobile equipment – Vehicle miles traveled will be tracked to estimate annual fugitive particulate emissions.
- Application rates of water or other dust suppressants – In accordance with the Plant Site FEC Plan, the rates of application of water and other dust suppressants to on-site roadways will be tracked.

Point sources will also be subject to certain monitoring requirements. Generally, fabric filter control devices or liquid scrubbers will be used for particulate matter control. Many of the particulate emission control equipment will be subject to federal New Source Performance Standards (NSPS), which will require certain monitoring. Typical types of monitoring include:

- Fuel usage tracking for combustion sources;
- Performance stack tests for sources covered under NSPS requirements;
- Continuous pressure drop measurements for fabric filter control devices;
- Pressure drop and liquid flow rates for liquid scrubber control devices;
- Visual opacity measurements for certain point sources of particulate emissions;

More details on air quality monitoring at both the Mine Site and Plant Site will be specified in the Air Permit that will be issued for the Project.

14.3.5 Water Appropriations Permit Monitoring

Monitoring in connection with water appropriations permits will measure flow rates and water levels to document appropriation rates and monitor potential effects of permitted dewatering. A proposed monitoring plan for water appropriations, included in the Project’s Water Appropriations Permit applications, outlines the proposed monitoring strategy, including station locations and numbers, frequency of water level monitoring, and flow data collection.

In addition to stations that will monitor the potential effects of permitted withdrawals, the water appropriations monitoring plan also includes stations that will monitor the stream augmentation program to evaluate potential hydrologic or ecological effects associated with changes in the surface water flow in creeks downstream of the FTB seepage capture systems. The Water Appropriations Permit Application proposed four types of monitoring:

- Groundwater monitoring – The purpose of groundwater monitoring is to identify the effects of permitted groundwater withdrawals on groundwater levels.
- Surface water monitoring – This type of monitoring will identify the effects of permitted groundwater withdrawals on surface water flow downstream of the Mine Site and Plant Site.
- Internal appropriations source monitoring – This monitoring will document the volume of water withdrawn during operations by Project infrastructure (such as the Mine Pits and the Category 1 Stockpile Groundwater Containment System).
- Stream augmentation monitoring – This monitoring will document the collected seepage flows, the augmentation flows, the stream flow, and ecologic conditions in identified creeks.

Upon Project Water Appropriations Permit issuance, details of required monitoring will be incorporated into the Mine Site Water Management and Monitoring Plan outlined in Appendix 11 and the Plant Site Water Management and Monitoring Plan outlined in Appendix 12.

14.3.6 Dam Safety Permit Monitoring

14.3.6.1 Geotechnical Monitoring

PolyMet will employ geotechnical monitoring and construction quality assurance (QA) and quality control (QC) practices to maintain the stability of the FTB and HRF dams throughout construction and operations. QA/QC activities will comply with the requirements of Minnesota Rules, part 6132,2200, subpart 2, item C(1) and part 6132.2500, subpart 2, item B(2). Construction quality control will be the responsibility of the contractor constructing the facility. A Construction Quality Control Plan will be provided before construction for both the FTB and HRF.

14.3.6.2 Instrumentation

PolyMet also will employ stability monitoring throughout operations, reclamation, and initial portions of the closure to verify that the FTB and HRF dam design specifications are met. Stability monitoring will include installation of piezometers to monitor the piezometric surface in the dams, and installation of inclinometers and survey points to monitor dam movements to comply with Minnesota Rules, part 6132.2200, subpart 2, item C(2) and 6132.2500, subpart 2, item B(3). Appendix 16.7 includes an FTB Instrumentation and Monitoring Plan, and Appendix 16.8 includes an HRF Instrumentation and Monitoring Plan.

Piezometers

Existing and proposed piezometers will monitor the phreatic surface within the dams. The location of the phreatic surface can have an impact on slope stability. PolyMet will periodically compare piezometer measurements to phreatic surface location estimated by slope stability and seepage modeling to confirm that the location of the phreatic surface is within acceptable limits.

Inclinometers

PolyMet will install inclinometers to monitor the internal movement of the FTB dams. Actual movement, as monitored by the inclinometers, will be compared with movements estimated by deformation modeling of the FTB dams and with movements observed in similar tailings basins.

Survey Monitoring Hubs

PolyMet will establish survey monitoring hubs to facilitate the monitoring of horizontal and vertical surface deformation of the FTB and HRF dams.

Geotechnical monitoring (further described in Section14.2.4, Appendix 16.7, and Appendix 16.8) to fulfill the Dam Safety Permit requirements is anticipated to fulfill the PTM stability monitoring requirements. Geotechnical stability monitoring will provide data for dam safety analysis and inspection, and contribute to the overall understanding of the plant site water balance. Several methods will be used to meet these objectives. Piezometers will be used to monitor the phreatic surface within the dams, inclinometers will be placed at specified locations to monitor the movement of the dams, and monitoring hubs will be established to allow monitoring of horizontal and vertical deformation of the dams. In addition, certain periodic inspections will be performed to obtain visual data that will be used to fulfill Permit to Mine and dam safety permit requirements.

As part of dam safety permit compliance, PolyMet will submit an annual report that will include the following information for both the FTB and HRF, where applicable:

- summary and analysis of geotechnical monitoring
- summary of construction completed and associated costs
- photographic record of dam conditions
- summary of annual dam safety inspections and dam safety reviews
- summary of routine inspections for the previous year
- summary of unusual events/observations for the previous year
- summary of the deposition for the previous year
- identification of planned changes in operations that could impact dam stability

More information on monitoring and inspection requirements will be presented in the Dam Safety Permits that will be issued for the Project, then incorporated into the FTB Management and Monitoring Plan and the HRF Management and Monitoring Plan outlined in Appendix 12.

15 Reclamation, Closure, and Postclosure Maintenance

PolyMet has developed, and presents in this Application, a Mining and Reclamation Plan for the Project consistent with the requirements of Minnesota Rules, part 6132.1000 and 6132.1100, subparts 6 and 7. Section 3 provides an overview of the Mining and Reclamation Plan, including references to the sections in this Application where the various components of the Plan are presented in detail. Each of those Application sections, as summarized in Section 3, identifies the applicable permitting goals for the elements of the Project discussed in that section, and then describes how the Project meets the applicable regulatory requirements so as to achieve these permitting goals.

This Section 15, which is part of the Mining and Reclamation Plan, summarizes how PolyMet will comply with the requirements of the PTM Regulations with respect to progressive reclamation during the mine operations and the additional requirements that apply after mine operations end. In particular, this addresses the reclamation standards and requirements of Minnesota Rules, parts 6032.1000 - .3200 that are applicable in the various periods following the LOM, which the PTM Regulations define as the "reclamation," "closure," and "postclosure maintenance periods." These MDNR definitions, which are provided in Minnesota Rules, part 6032.0200, are incorporated into this Section 15, as further discussed below.

15.1 Reclamation Time Periods

PolyMet will undertake progressive reclamation of various facilities and conditions, as appropriate, during mining operations beginning in Mine Year 1 and continuing through Mine Year 20. When areas are closed and no longer necessary for mining operations, PolyMet will undertake progressive reclamation of those areas in accordance with Minnesota Rules, chapter 6132. PolyMet's Annual Report to MDNR under the PTM Regulations will include the following information with respect to progressive reclamation:

- the anticipated reclamation activities in the upcoming year, including methods, schedule, and research
- notification of intent to close any portions of the Mining Area in the upcoming year; and a description of the reclamation activities completed in the previous year

Final reclamation will commence after complete cessation of Project operations, which PolyMet currently anticipates will occur at the end of Mine Year 20. The expected timeframe for reclamation, closure, and postclosure maintenance is described in Section 3.2. Figure 3-4 presents the overall anticipated schedule for the reclamation, closure, and postclosure periods. This figure also contains a summary of activities within each of these three periods. Figure 15-1 and Figure 15-2 show the Mine Site and Plant Site conditions, respectively after final reclamation actions (including closure and postclosure maintenance) are complete.

15.2 Objective

The overall objective of the Reclamation, Closure and Postclosure Maintenance Plan (Appendix 14) is, consistent with the requirements of PTM Regulations and good mining practices, for the Mining Area to meet various criteria when it (or any portion of it) is closed and no renewed use or activity will occur. These criteria include the following:

- the closed Mining Area or portion is safe, secure, and free of hazards
- it is in an environmentally stable condition
- it minimizes hydrologic conditions and the release of hazardous substances that adversely affect natural resources; and it is maintenance free

In addition to meeting the foregoing criteria, PolyMet's planned reclamation, closure, and postclosure maintenance work is intended to allow restoration of the Mining Area so as to encourage planning of future land utilization and to facilitate implementation of such future plans as contemplated by the PTM Regulations.

In general, under the Reclamation, Closure and Postclosure Maintenance Plan, PolyMet will reclaim areas as soon as practical while the Project is in operation. In addition to such progressive reclamation, PolyMet will evaluate conditions within the Mining Area at the end of operations. Thereafter, PolyMet will implement the Reclamation, Closure, and Postclosure Maintenance Plan with respect to areas not previously reclaimed, including demolishing buildings and structures, reclaiming and vegetating the sites on which such facilities were located, remediating any environmental hazards in compliance with applicable statutes and regulations, and implementing other necessary reclamation, closure, and postclosure maintenance practices to satisfy the standards and requirements of Minnesota law, including the pertinent reclamation standards set forth in Minnesota Rules, parts 6132.0200 - .3200.

15.3 Mine Site Reclamation, Closure, and Postclosure Maintenance

This subsection discusses progressive reclamation, final reclamation, closure, and postclosure maintenance at the Mine Site.

15.3.1 Progressive Reclamation

At the Mine Site, PolyMet will begin progressive reclamation activities as soon as practical throughout operations. Progressive reclamation will include backfilling the Categories 2/3 and 4 Waste Rock Stockpiles into the East Pit, East Pit flooding, and incremental installation of the Category 1 Waste Rock Stockpile Cover System.

Reclamation of the East Pit and the Categories 2/3 and 4 Waste Rock Stockpiles will begin in approximately Mine Year 11 and extend through approximately Mine Year 20. Waste rock from the temporary Category 2/3 and 4 Waste Rock Stockpiles, along with waste rock from on-going mining in the West Pit, will be permanently disposed in the East Pit, once mining ceases in that pit in Mine Year 11. PolyMet will completely remove the Category 4 Waste Rock Stockpile in Mine Year 11. Reclamation will include removal of piping, pump systems, and liner systems, or, covering these systems with soil, associated with the stockpile foundation and the stockpile sumps and ponds. Reclamation of the Categories 2/3 and 4 Waste Rock Stockpiles is detailed in Appendix 14

Table 10-19 shows the sequence of East Pit backfilling. Backfilling the East Pit will involve hauling approximately 140 million tons of waste rock, including material from the Categories 2/3 and 4 Waste Rock Stockpiles, to the East Pit between Mine Years 11 and 20. PolyMet will flood the backfilled East Pit as quickly as possible in order to submerge the waste rock, while maintaining a safe working surface above the water elevation to facilitate continued backfill.

Progressive reclamation of the permanent Category 1 Waste Rock Stockpile will start in Mine Year 14, and the stockpile is expected to be fully reclaimed by the end of Mine Year 21. An engineered stockpile cover system will be installed incrementally, to minimize exposure of the waste rock and the amount of mine water generated from the stockpile. Progressive reclamation of the Category 1 Waste Rock Stockpile will also enable PolyMet to minimize erosion of the outer slopes, promote closure land use, and minimize the need for active site care and maintenance during the closure period. Before constructing the cover system, PolyMet will grade the stockpile surfaces to promote long-term stability, to enhance vegetation growth and erosion control, and to develop a surface drainage network over the stockpile. Progressive reclamation of the Category 1 Waste Rock Stockpile is detailed in Appendix 16.13.

15.3.2 Reclamation

During the reclamation phase at the Mine Site, PolyMet will demolish structures, establish fencing around the perimeters of the Mining Area, implement necessary site management and security measures, reclaim and vegetate the temporary stockpile footprints, manage water levels and water quality in the East and West Pits, and remove selected water management infrastructure.

15.3.2.1 Temporary Stockpiles and Haul Roads

Reclamation will include removal of piping, pump systems, and liner systems, or, covering these systems with soil, associated with the temporary stockpile foundations and the stockpile sumps and ponds. PolyMet will reclaim the stockpile, sump, and pond footprints to establish a mixture of upland and wetland areas, depending on the ultimate elevation of the remaining materials. Once reclamation in these areas is complete, PolyMet will scarify and seed the haul roads to these areas to minimize surface runoff while maintaining continued access by small vehicles for long-term monitoring and maintenance. Reclamation of the temporary stockpiles and haul roads is detailed in Appendix 14.

15.3.2.2 Mine Pit Reclamation and Water Management

Mine Pit reclamation and water management are a key aspect of the reclamation phase. PolyMet will establish final slopes and seed the overburden portion of the pit walls. East Pit flooding will continue and PolyMet will begin cycling East Pit water through the WWTF to remove the flushing load of constituents added as waste rock was backfilled to the pit and the pit walls were inundated. During reclamation, PolyMet will also construct the outlet structure between the East Pit and the West Pit.

After pit dewatering systems are removed in the West Pit, the pit will begin to flood naturally with water from groundwater inflows, precipitation, and stormwater runoff from the tributary watershed. Flooding will also be accelerated with water pumped from the Plant Site.

While the West Pit is flooding, the WWTF will continue to treat water from the Category 1 Stockpile Groundwater Containment System, the WWTP reject concentrate, and some water from the East Pit. PolyMet will pump WWTF effluent to the West Pit to augment pit flooding, and to the East Pit to promote flushing. Appendix 14 provides additional information on mine pit reclamation, and Appendix 16.13 describes the operation of the Project waste water treatment system during reclamation.

15.3.2.3 Water Management Infrastructure

Selected water management infrastructure will be removed during reclamation.

Perimeter and Interior Dikes

PolyMet will maintain the perimeter dike located north of the Central and East Pits to minimize mixing of Partridge River flows with the East Pit water. PolyMet also will maintain perimeter dikes located on the north side of the Category 1 Waste Rock Stockpile and along the west boundary of the Mine Site to provide access to groundwater monitoring locations. Most pit rim dikes will be removed. During reclamation, PolyMet will route stormwater runoff within the Mine Site to the Mine Pits using a combination of existing and new ditches. Some portions of the pit rim dikes will remain in place during reclamation if they are needed to prevent an uncontrolled discharge into the pits and potential erosion (headcutting) of the pits walls. PolyMet will conduct additional evaluation of this requirement prior to Mine Year 20. PolyMet expects to remove material from the main body of the dikes and to use it for restoration of disturbed surfaces prior to reclamation. To minimize disturbance of subsurface soils during restoration, the subsurface seepage control component of the dikes will remain in place. PolyMet will scarify and revegetate surfaces to be reclaimed.

Ditch Filling and Rerouting

For reclamation, PolyMet will maximize the use of ditches that already exist in Mine Year 20, however, a few new ditches may need to be constructed to direct stormwater runoff into the East or West Pits during reclamation. PolyMet will design new ditches using the same criteria as other stormwater ditches at the Mine Site. Reclamation of ditches will include installing ditch blocks or filling, and revegetating the restored surface.

Stormwater and Mine Water Pond Restoration

At closure, PolyMet will reclaim the stormwater sedimentation ponds, the mine water ponds, and the remaining stockpile sumps and overflow ponds by developing wetlands or by filling and revegetating the areas. Outlet control structures from Ponds A and B will remain in-place to prevent Partridge River floodwater from entering the Mine Site. Outlet control structures from Ponds C (East) and D will remain in-place to direct water under Dunka Road and Main Rail Line to the Partridge River along natural drainage paths. PolyMet will modify the overflow weir in Pond C (West) to create a more natural transition to the remaining stormwater ditch. The mine water sumps and ponds may require cleanout and removal of the geomembrane liner in closure. PolyMet will dispose of material removed from the ponds in the Mine Pits or an approved landfill.

Pipe and Pump Removal

During reclamation, PolyMet will either abandon in place or remove and recycle mine water pipes and process water pipes and pumps except those used for the flooding of the West Pit or recycling of the East or West Pit water.

Central Pumping Station and Treated Water Pipeline Removal

PolyMet will remove the CPS building when it is no longer needed, and will reclaim and revegetate the area. PolyMet will reclaim the CPS Pond as a wetland, or fill and revegetate the area. PolyMet will abandon in place or remove and recycle the TWP, and will reclaim and revegetate the disturbed areas.

15.3.3 Closure

During closure, PolyMet will continue flushing the East Pit water through the WWTF and will continue flooding the West Pit with water from the Plant Site. This water management plan will remain in place at the Mine Site throughout the closure phase as depicted on Figure 3-7. Monitoring, reporting, and water treatment will continue until MDNR releases PolyMet from its obligations under the PTM requirements. If site inspections or water monitoring data show that additional reclamation work is needed, PolyMet will develop and implement a plan for the work.

During the closure and postclosure maintenance periods, PolyMet will maintain the water level in the West Pit below the natural overflow elevation by pumping water from the West Pit to the WWTF for treatment. PolyMet plans to use reverse osmosis or similar membrane separation treatment technology as the primary treatment process for water that will be discharged to the Partridge River.

15.3.4 Postclosure Maintenance

Postclosure maintenance activities at the Mine Site will include the transition to postclosure treatment at the WWTF and discharge to the Partridge River via Unnamed (West Pit Outlet) Creek. At the beginning of postclosure maintenance, PolyMet expects to use mechanical treatment at the WWTF to treat water from the flooded East Pit and West Pit and water captured by the Category 1 Stockpile Groundwater Containment System as depicted on Figure 3-8. Mechanical treatment technologies will remain in place until it is determined that non-mechanical treatment can be utilized as depicted on Figure 3-9. PolyMet will test and assess the suitability of non-mechanical treatment technologies and the timing for implementing such technologies. Water quality monitoring will continue in the postclosure maintenance phase as long as is necessary under terms of applicable permits.

PolyMet's closure and postclosure maintenance activities will continue until standards of Minnesota Rules, part 6132.3200 have been met, including requirements that the closed Mining Area is stable, and free of hazards, and that hydrologic impacts and any releases of substances that adversely impact other natural resources have been minimized. Postclosure maintenance will continue until the reclamation is stable and self-sustaining and no further maintenance is required, at which time MDNR may issue release of the permittee once the requirements Minnesota Rules, parts 6132.1400 and 6132.4800 have been met.

15.4 Plant Site Reclamation, Closure, and Postclosure Maintenance

This subsection discusses progressive reclamation, final reclamation, closure, and postclosure maintenance at the Plant Site.

15.4.1 Progressive Reclamation

At the Plant Site, PolyMet's progressive reclamation will include incremental dam-slope restoration at the FTB and the HRF. As dams are constructed, exterior slopes will be stabilized and vegetated. The exterior dam faces will be permanently vegetated by a qualified reclamation contractor according to Minnesota Rules, part 6132.2700. See Figure 15-3 for Vegetative References.

During construction of FTB dams, the exterior face of the dams will be amended with a bentonite layer to limit oxygen infiltration into the Flotation Tailings. The bentonite amendment will entail addition of granulated bentonite (approximately 3% by dry weight) to an 18-inch thick layer of the dam construction material, overlain by an additional 30-inch layer of dam construction material.

15.4.2 Reclamation

During the reclamation phase at the Plant Site, PolyMet will demolish structures, establish fencing around the perimeters of the Mining Area, implement necessary site management and security measures, reclaim the FTB and the HRF, and continue to manage water quality.

15.4.2.1 Infrastructure Removal

PolyMet will decommission the majority of the Plant Site during the reclamation phase. PolyMet will remove the tailings pipeline and associated pumping systems and will also demolish and reclaim the Beneficiation Plant, Hydrometallurgical Plant, and associated facilities.

15.4.2.2 FTB Reclamation

Upon completion of ore processing operations the FTB will be closed in accordance with Minnesota Rules, part 6132.3200. Reclamation of the FTB will include measures to control fugitive dust, reduce infiltration of oxygen and water, and manage water flows. For final reclamation, PolyMet will vegetate upland areas and grade interior portions of the FTB dams to provide a gently sloping surface that effectively will route stormwater runoff to the interior of the FTB, accommodate future differential settlement of the underlying Flotation Tailings, and maximize ponding of water in the reclaimed FTB Pond. The pond bottom and beaches will be amended with bentonite to reduce percolation from the FTB Pond and beaches, thereby maintaining a permanent pond that will provide an oxygen barrier above the Flotation Tailings. This will reduce oxidation and resultant production of constituents of concern and reduce the amount of water collected by the FTB seepage capture systems. Appendix 14 provides additional information about FTB reclamation.

15.4.2.3 HRF Reclamation

In reclamation, PolyMet will temporarily cover and dewater the HRF. PolyMet will later install a permanent multi-layer cover system that will be virtually maintenance free. Dewatering will activate the HRF Drainage Collection System to collect the water stored in the Residue pore spaces, with this water and water remaining in the HRF Pond pumped to the WWTP. Overall, dewatering will create a stable surface for reclamation and minimize the hydraulic head on the liner system, limiting the potential for leakage.

The multilayer HRF cover system will include a composite cover, composed of a GCL overlain by a 40-mil low density polyethylene or similar MPCA-approved geomembrane barrier layer. The final grading in the reclamation period will create a gently sloping closure surface that readily sheds surface water runoff, accommodates future differential settlement of the underlying Residue, and minimizes ponding of water on the closed HRF surface. Drainage pipes will be installed within a layer of granular material above the GCL, to collect and direct runoff away from the HRF cell. These actions will prevent water from collecting inside the cell resulting in a so-called “bathtub” effect. Figure 10-10 and the permit application support drawings contained in Appendix 7 include detailed information regarding the cover system. PolyMet estimates that HRF reclamation activities will be completed approximately 10 years after the end of operations. Appendix 14 provides additional information about HRF reclamation.

Once reclamation and closure activities are complete, PolyMet will continue to keep the Leakage Collection System in service during the closure and postclosure maintenance periods, and water that is collected will be pumped to the WWTP (or subsequently to non-mechanical treatment).

15.4.2.4 Water Quality Management and Stream Augmentation

During reclamation, the WWTP will continue to treat Tailings Basin seepage collected by the FTB seepage capture systems. PolyMet will prevent FTB overflow by pumping excess pond water to the WWTP. The long-term objective is to replace the WWTP with non-mechanical water treatment systems; however, PolyMet will continue to operate the WWTP through closure and postclosure until non-mechanical systems are demonstrated and approved. During the closure or postclosure maintenance periods, if PolyMet demonstrates that water in the FTB complies with applicable water quality standards, PolyMet may seek approval to allow the pond to discharge directly. Stream augmentation will continue as needed during reclamation and closure.

15.4.3 Closure

During closure, PolyMet will continue to operate the FTB seepage capture systems and the WWTP, and continue to send water to the West Pit to aid in flooding. Closure activities may include modification of the WWTP in preparation for postclosure treatment. Monitoring will continue to assess compliance with applicable water quality standards, as discussed in Section 14. Figure 3-12 depicts the water management plan for the Plant Site during closure.

Dam stability will be periodically evaluated after closure by a qualified geotechnical engineer at a frequency and for the duration required by the NorthMet Dam Safety Permit. It is anticipated that the frequency and intensity of these evaluations will decrease over time as vegetation becomes fully established and as it is confirmed that areas prone to erosion have been restored and permanently stabilized.

15.4.4 Postclosure Maintenance

Postclosure maintenance activities at the Plant Site will include continued management of water, continued operations of the FTB seepage capture systems, and water treatment for discharge. Mechanical water treatment technologies will remain in place until it is determined that non-mechanical forms of treatment can be utilized. Water quality monitoring will continue in the postclosure maintenance phase as long as is necessary under terms of applicable permits.

PolyMet's postclosure maintenance activities will continue until standards of Minnesota Rules, part 6132.3200 have been met, including requirements that the closed Mining Area is stable, and free of hazards, and that hydrologic impacts and any releases of substances that adversely impact other natural resources have been minimized. Postclosure maintenance will continue until the reclamation is stable and self-sustaining and no further maintenance is required, at which time

MDNR may issue release of the permittee once the requirements Minnesota Rules, parts 6132.1400 and 6132.4800 have been met.

15.5 Transportation and Utility Corridors Reclamation, Closure, and Postclosure Activities

Transportation and Utility Corridors infrastructure that is not being utilized for reclamation activities will be reclaimed and vegetated during the reclamation phase. Reclamation will include:

- removal of road segments that are not required for closure and postclosure
- removal of rail line components
- removal of power lines and other utilities not required for closure and postclosure
- site grading and revegetation

Maintenance of the portions of Transportation and Utility Corridors that remain in use will continue through the closure and postclosure periods.

15.6 Colby Lake Pipeline Corridor Reclamation, Closure, and Postclosure Activities

Colby Lake Pipeline will be decommissioned and reclaimed once no longer necessary. The disturbed area will be reclaimed to meet the approved reclamation standards. This area will be monitored during closure and postclosure to assess and maintain the reclamation standards.

15.7 Acceptable Reclamation Research

The PTM Regulations allow alternative activities to be implemented in certain circumstances, including after operations cease, based upon acceptable research and findings. Minnesota Rules, part 6132.0100, subpart 2 defines "acceptable research" as “research approved by the commissioner that is site-related and is reasonably designed for the purpose of demonstrating that reclamation can be achieved by alternative methods.” PolyMet intends to undertake several test projects during operations to evaluate alternative methods for reclamation. Test projects have previously been proposed for the FTB Pond Bottom Cover System, the Category 1 Waste Rock Stockpile Cover System, and Non-Mechanical Treatment Systems. Assuming this research is acceptable and successful, PolyMet may seek to incorporate alternative methods of reclamation into its Reclamation, Closure and Postclosure Maintenance Plan.

15.8 Plans to Transition from Mechanical to Non-Mechanical Water Treatment

An important objective of the Project is to provide water treatment for as long as necessary to meet applicable regulatory standards at groundwater and surface water compliance points. The Project includes long-term mechanical treatment (reverse osmosis or equivalently performing technology) at both the Mine Site and Plant Site with a goal of transitioning to a non-mechanical treatment technology requiring less maintenance over the long term. This goal is consistent with the closure and postclosure maintenance requirements of the PTM Regulations, including the regulatory goals of minimizing and eventually eliminating the need for maintenance.

This section provides PolyMet's conceptual plan for transitioning from mechanical water treatment to non-mechanical treatment technologies after the 20-year mine life. PolyMet plans to transition from mechanical to non-mechanical water treatment as soon as PolyMet can demonstrate that non-mechanical water treatment technologies will effectively treat water to meet the applicable water quality standards. PolyMet anticipates conducting evaluations, including data collection and pilot-studies, during the mine operations and after operations cease to demonstrate the ability to transition to non-mechanical water treatment while maintaining compliance with applicable water quality standards. PolyMet anticipates that its evaluation of non-mechanical treatment systems will include several components of the Project, including the Category 1 Stockpile Groundwater Containment System, West Pit overflow, Tailings Basin, Tailings Basin Pond overflow (post mechanical treatment options).

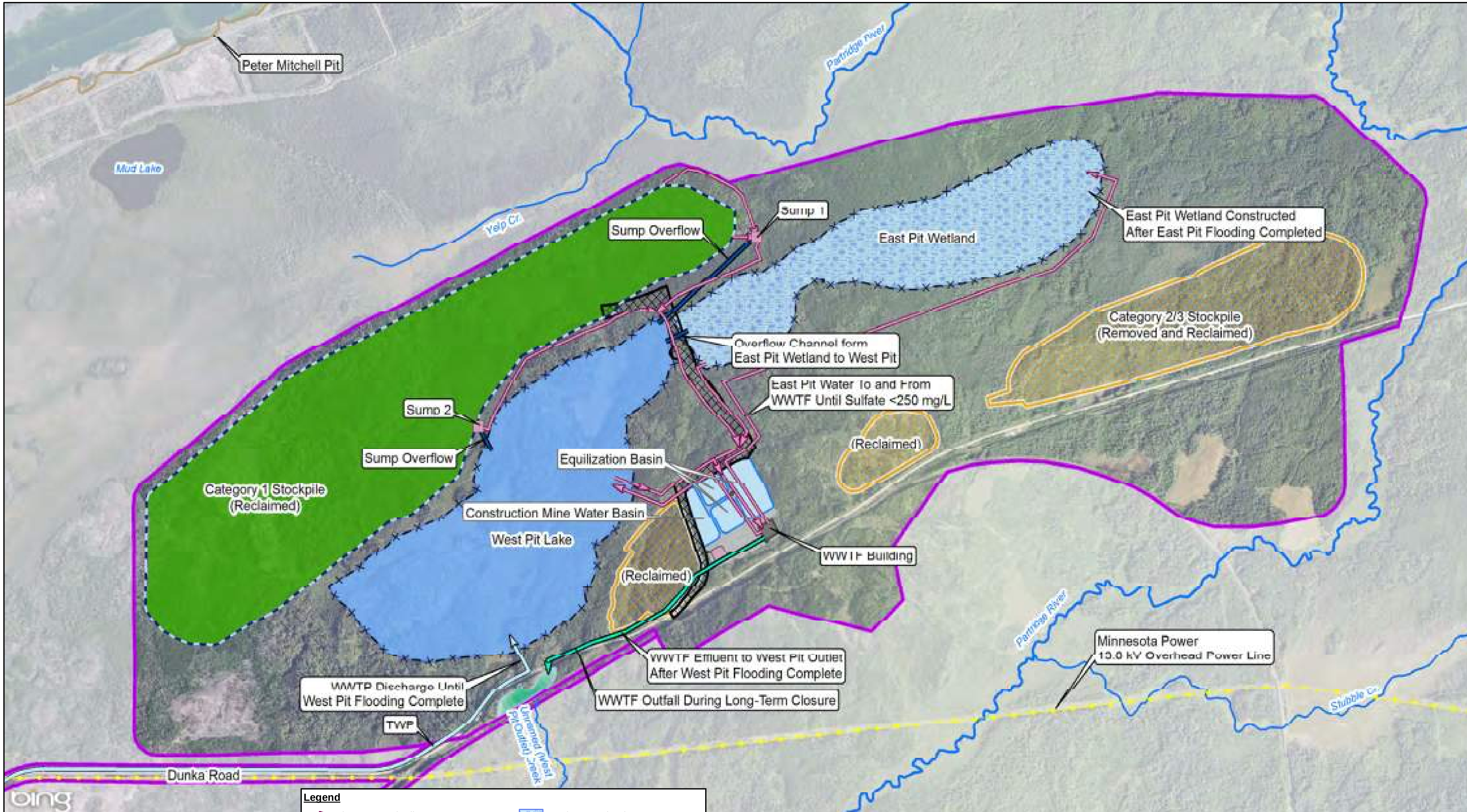
Non-mechanical water treatment technologies are proven methods of water treatment, but they need to be tailored to site-specific conditions, principally those relating to water quality. Non-mechanical water treatment technologies can be thoroughly evaluated in four steps: (1) collecting site-specific information (e.g., hydrology and influent water quality), (2) laboratory testing, (3) pilot-scale testing, and (4) designing a system for full scale implementation.

PolyMet to date has collected and analyzed a substantial quantity of water quality and related data with respect the Project and the historic and existing condition of the Mining Area. It also has conducted extensive modeling with respect to the anticipated performance of the Project's pollution control systems, including the Tailings Basin and the associated seepage capture systems, the WWTP and WWTF, and various liners and covers to prevent groundwater infiltration and surface water runoff of parameters of concern. PolyMet will undertake a number of additional data collection and analyses during operations, such as those summarized below.

At the Tailings Basin, additional site-specific hydrologic information can be collected when the Groundwater Containment System is constructed and throughout operations. Also, the quality of the water expected at the Tailings Basin in the long term due to PolyMet's operation could start to be realized at the toe of the basin during operations. Thus, the four steps for evaluating non-mechanical water treatment at the Tailings Basin will be implemented during Project operations, potentially allowing the non-mechanical water treatment system at the Tailings Basin to be put in place shortly after operations are complete and the FTB pond cover is installed. If the transition to non-mechanical treatment is undertaken prior to the completion of West Pit flooding, Colby Lake water possibly could be used to aid in the flooding of the West Pit (with or without treatment at the WWTP). Alternatively, West Pit flooding could be extended, depending on water quality results and other considerations.

At the Mine Site, the four steps for evaluating non-mechanical treatment technologies could be finalized in less than the time estimated for completion of the West Pit flooding (e.g., approximately 35 years after the end of operations). Additional time is included in PolyMet's current plan, however, because the water quality in the pit may take some time to reach equilibrium after the West Pit has flooded. Therefore, PolyMet anticipates implementing the four evaluation steps during the reclamation period (approximately Mine Year 25 – Mine Year 28). As a result, nonmechanical water treatment technology could be implemented at the Mine Site a few years after the West Pit has been flooded at the end of the closure period, currently projected for Mine Year 55.

The water models used to support permitting for the Project were not designed to estimate when treatment for compliance with water quality standards can be ended, nor are they intended to estimate when treatment can transition from mechanical to non-mechanical systems. Rather, PolyMet will assess actual treatment requirements on a recurring basis through operations and the post-operations periods based on the actual results of monitoring discharges, performance of engineering controls, and water resources. This process will rely on monitoring results (supported by additional analysis through modeling) to continuously protect groundwater and surface water in compliance with water quality standards.



Notes

1. Basemap from Esri and its data suppliers.
2. Project features supplied by Barr Engineering Company.
3. Minnesota Power Substations and Power Lines supplied by the Minnesota Geospatial Information Office (MnGeo).
4. For clarity not all of the sumps, ditches, piping, and overflows are shown.
5. Mine Water Ponds are lined with the exception of the OSLA Pond and the Construction Mine Water Basin.

Legend

- Mine Water Pipeline
- WWTF Outfall Pipeline
- Overflow Piping
- Treated Water Pipeline
- Groundwater Containment System
- Rivers and Streams
- Electric Power Line[3]
- Aeration Pond
- Haul Roads
- Fence
- Surface Wetland
- Pit Lake
- Treated Mine Water Pond (Lined)
- Mine Water Ponds[5]
- WWTF Buildings
- Facility Footprint
- Reclaimed Areas
- Category 1 - Covered Stockpile
- Facility Boundary

N

POLYMET MINING

Foth

Foth Infrastructure & Environment, LLC

REVISED	DATE	BY	DESCRIPTION

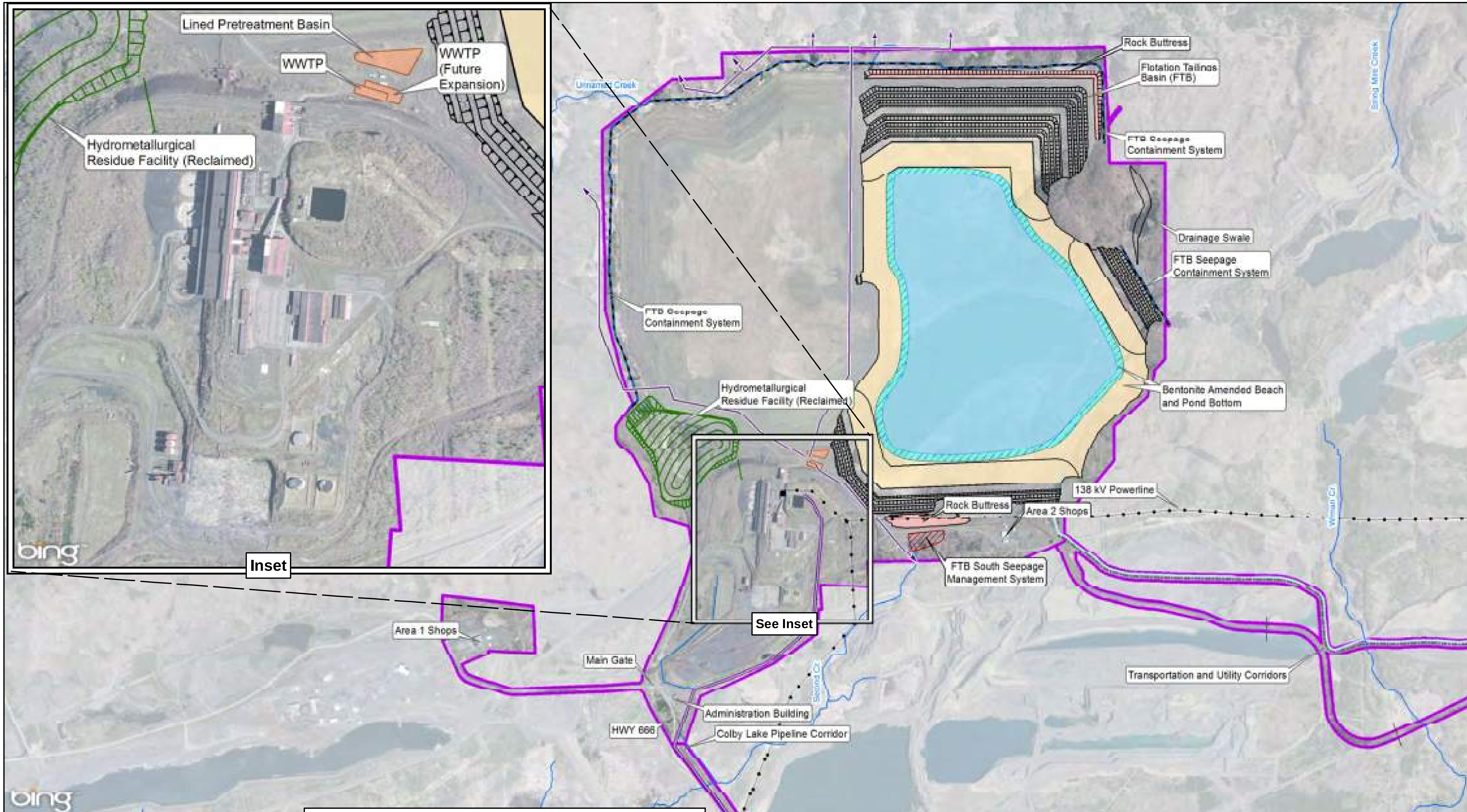
PREPARED BY:	DAT	DATE:	AUG. '16
REVIEWED BY:	JSL	DATE:	AUG. '16
APPROVED BY:	JOS1	DATE:	AUG. '16

POLYMET MINING

FIGURE 15-1
MINE SITE FEATURES TO REMAIN AFTER CLOSURE
PERMIT TO MINE APPLICATION
HOYT LAKES, MINNESOTA

Scale: 0 750 1,500 Feet | Date: AUGUST 2016
Drafted by: DAT | Project No: 12P778

Path: X:\GB\IE\2012\12P778\GIS\mxd\PMA\Figure 15-1 Mine Site Features to Remain After Closure.mxd Date: 9/2/2016



Notes

1. Basemap from Esri and its data suppliers.
2. Project features, pipelines and details supplied by Barr Engineering Company.
3. NHD features are created from MDNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance, data sources may show watercourses that no longer exist.
4. Minnesota Power Substations and Power Lines supplied by the Minnesota Geospatial Information Office (MnGeo).

Legend

- Electric Substation[4]
- Approximate Pond Area
- Approximate Upland Area
- Approximate Wetland Area
- Rock Buttress
- Existing Electric Power Line[4]
- Dunka Road
- Rivers, Streams and Ditches[3]
- Colby Lake Pipeline
- FTB Seepage Containment System
- Treated Water Pipeline
- Treated Water Discharge Pipe
- WWTP
- Facility Boundary
- FTB_Closure

POLYMET MINING

Foth

Foth Infrastructure & Environment, LLC

REVISED	DATE	BY	DESCRIPTION

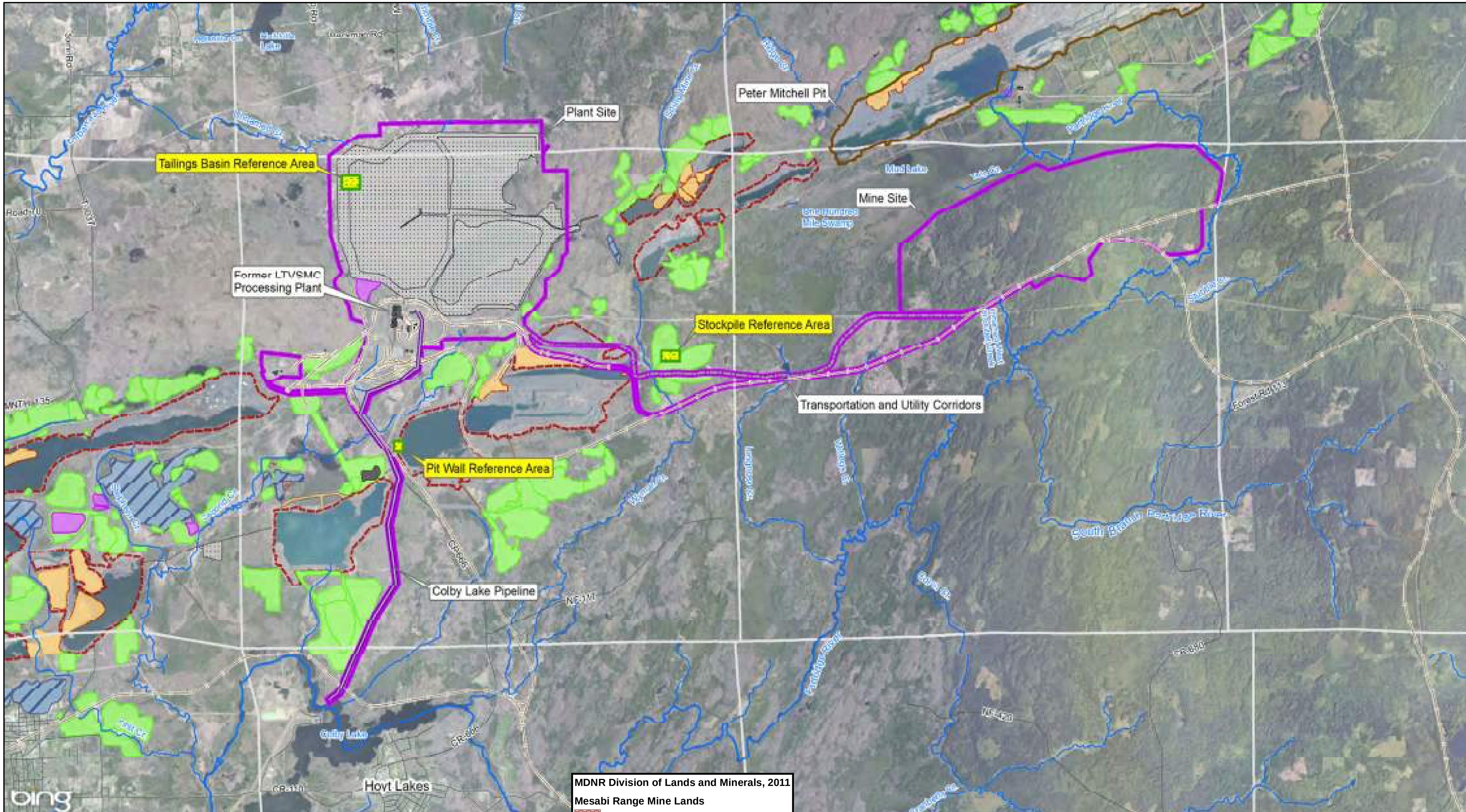
PREPARED BY: DAT DATE: AUG. '16
REVIEWED BY: JSL DATE: AUG. '16
APPROVED BY: JOS1 DATE: AUG. '16

POLYMET MINING

FIGURE 15-2
PLANT SITE FEATURES TO REMAIN AFTER CLOSURE
PERMIT TO MINE APPLICATION
HOYT LAKES, MINNESOTA

Scale: 0 1,250 2,500 Feet
Date: AUGUST 2016
Drafted by: DAT
Project No: 12P778

Path: X:\GB\IE\2012\12P778\GIS\mxd\PMA\Figure 15-2 Plant Site Features to Remain After Closure.mxd Date: 9/9/2016



Notes

1. Basemap from Esri and its data suppliers.
2. Project features supplied by Barr Engineering.
3. NHD features are created from MnDNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance, data sources may show watercourses that no longer exist.
4. MDNR Division of Lands and Minerals, 2011 dataset supplied by Barr Engineering Company.

Legend

- Vegetative Reference Sites
- Dunka Road
- Roads
- Existing Private Railroad
- Colby Lake Pipeline
- Rivers and Streams[3]
- Townships
- Facility Boundary

MDNR Division of Lands and Minerals, 2011

Mesabi Range Mine Lands

- Caved Area
- Haul Road
- Stockpile
- In-Pit Stockpile
- Plant or Shop Area
- Reservoir or Settling Basin
- Tailings Basin
- Taconite Pit
- Natural Ore Pit

POLYMET MINING

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N

Foth Infrastructure & Environment, LLC

REVISED	DATE	BY	DESCRIPTION

PREPARED BY:	BJW1	DATE:	AUG. '16
REVIEWED BY:	JSL	DATE:	AUG. '16
APPROVED BY:	JOS1	DATE:	AUG. '16

POLYMET MINING

FIGURE 15-3
VEGETATIVE REFERENCE AREAS
PERMIT TO MINE APPLICATION
HOYT LAKES, MINNESOTA

Scale: 0 3,000 6,000 Feet	Date: AUGUST 2016
Drafted by: DAT	Project No: 12P778

Path: X:\GB\IE\2012\12P778\GIS\mxd\PMA\Figure 15-3 Vegetative Reference Areas.mxd Date: 9/2/2016

16 Financial Assurance

Under the nonferrous PTM rules (Minnesota Rules, part 6132.1200), a permittee must provide "financial assurance" to ensure that MDNR can act if the permittee's operations cease, reclamation is required, and the circumstances for permittee forfeiture of its financial assurance funding are present. Financial assurance for the estimated cost of "corrective actions" is also outlined in the rules. The permittee must annually identify the reclamation, closure, and postclosure maintenance activities that would be necessary if operations cease within the upcoming calendar year and detail them in a contingency reclamation plan. The permittee then provides MDNR with financial assurance in an amount equal to the cost of the contingency reclamation plan. Annual updates of the contingency mitigation plan are accompanied by adjustments (upward or downward) in the resulting financial assurance, as various environmental, economic, regulatory, or other circumstances dictate.

This Section 16 explains how PolyMet has estimated the costs of its contingency reclamation plan for Construction Year 1. For context, PolyMet is also providing information on the projected costs of reclamation for Construction Year 2 and Mine Year 1. PolyMet's mining and mineral processing will begin in Mine Year 1. Existing Plant Site facilities, including the former LTVSMC Tailings Basin and associated infrastructure, are currently permitted under DNR's ferrous regulations that are applicable to the prior taconite mining activities at the site (the "Existing PTM"). PolyMet over time will incorporate all needed existing facilities into the Project.

The Mine Year 1 projections in this Section 16 include cost estimates for both reclamation of new activities, structures, and conditions added by the Project, and reclamation of existing ferrous conditions as they relate to the Project (primarily relating to the former LTVSMC Tailings Basin) that are currently subject to the Existing PTM. The transition of financial assurance for these ferrous-related reclamation costs from the existing MDNR and MPCA permits to the Project will be addressed in the NorthMet permitting process, and will be completed by the start of active processing in Mine Year 1.

PolyMet proposes to use a mix of financial assurance instruments in order to provide the commissioner with access to funds as contemplated in the Minnesota Rules in a manner that is conducive to project development. PolyMet contemplates that the mix of instruments will be modified over time through construction, operations, reclamation, closure, and postclosure maintenance. The core of PolyMet's proposed financial assurance will comprise a combination of surety bonding, irrevocable letters of credit, and a trust fund, supplemented by environmental insurance.

16.1 Overview

Minnesota Rules, part 6132.1200 establish the requirements for financial assurance, including the reclamation activities that are subject to financial assurance, the assurance amount, and the criteria and procedures for forfeiture of the financial assurance to the State. A variety of financial assurance instruments can be used to meet financial assurance under the PTM rules.

Minnesota Rules, part 6132.1200, subpart 5 outlines the criteria for financial assurance to be included in a Permit to Mine application, as well as the financial assurance instruments that can be used. The financial assurance being proposed by PolyMet will be managed as described in Minnesota Rules, part 6132.1200, subpart 4.

Under the PTM rules, the financial assurance amount for a new mining project must equal the Contingency Reclamation Estimate (CRE). The CRE represents the cost estimate for implementing a contingency reclamation plan. Minnesota Rules, part 6132.1300, subpart 4 describes the requirements for a contingency reclamation plan. The CRE reflects the cost for the agency to reclaim the site if activities cease within the upcoming calendar year. Within the first calendar year of receiving its Permit to Mine, PolyMet will be constructing the Project and preparing for future mining activities. Therefore, the CRE described in Section 16.2 is for Construction Year 1, and does not include any mining activities.

Additional projections for possible reclamation costs for Construction Year 2 and Mine Year 1 are provided in Section 16.3 and Section 16.4, respectively. These cost projections are for informational purposes only. They facilitate an understanding of how the cost estimates for reclamation will change over the first few years of the Project. Because they are based on a variety of assumptions that are subject to change, those cost projections likely will be adjusted as circumstances dictate. As stated in Minnesota Rules, part 6132.1200, subpart 2, item A, permittees are expected to make annual adjustments to their CRE and financial assurance. Thus, in future Annual Reports, PolyMet will adjust the CRE for Construction Year 2 and Mine Year 1 (shown as cost projections in Section 16.3 and Section 16.4), as required by the nonferrous PTM rules.

PolyMet's approach to addressing financial assurance is described below. Section 16.2 describes the CRE for Construction Year 1. Sections 16.3 and Section 16.3.1 evaluate possible future reclamation costs and financial assurance, including Construction Year 2 (Section 16.3) and Mine Year 1 (Section 16.3.1). Section 16.4 describes the general trends for reclamation costs over the life of the mine and beyond, and represents graphically the various timeframes when substantial increases or decreases are expected to occur. Section 16.6 discusses anticipated adjustments to reclamation costs and financial assurance over time.

16.2 Financial Assurance for Construction Year 1

This section provides the information necessary to support the amount and form of financial assurance PolyMet must submit before obtaining a Permit to Mine, in accordance with Minnesota Rules, part 6132.1300, subpart 2. The CRE described in this section is for Construction Year 1.

16.2.1 Annual Report for Construction Year 1

The Annual Report, located in Appendix 13, describes the activities that will take place during Construction Year 1, which is the first year activities authorized by the Permit to Mine will occur at the site. Figure 16-1 and Figure 16-2 show the development that will occur at the Mine Site and Plant Site during Construction Year 1.

16.2.2 Contingency Reclamation Plan for Construction Year 1

As outlined above, under the nonferrous PTM rules, the CRE provides the core building block to calculate financial assurance for reclamation of a mine and its various facilities. The CRE must be adjusted annually to account for changing conditions at the site, and accordingly, for a new project like NorthMet, the CRE for the first year is effectively addressing a premature closure scenario where only limited construction activities would have taken place. Specifically, the CRE and resulting financial assurance must be sufficient to cover reclamation of those facilities built and disturbances created in the initial construction year in the event of premature Project closure.

For the Project, during Construction Year 1, there will be no Duluth Complex or Virginia Formation rock disturbed at the Mine Site, which means no ore or waste rock will be excavated and no pits and no stockpiles will be developed. As a result, there will be no need for water treatment at the Mine Site if the Project were to cease during this timeframe. During Construction Year 1, no processing will occur at the Plant Site so no nonferrous tailings will be deposited in the FTB. The construction activities at the FTB, such as installation of the FTB Seepage Containment System, will result in little, if any, additional costs under a premature closure.

The contingency reclamation plan for Construction Year 1 is contained in Appendix 15.1.

Minnesota Rules, part 6132.1200, subpart 3 also discusses financial assurance for the estimated cost of “corrective actions.” Corrective actions are defined as those actions to be conducted by the permittee in the event of a discovered condition of noncompliance. This includes notifications, investigations, and mitigations required to bring the facility back into compliance. Because the Project is not yet under construction, there are no corrective actions for which financial assurance would be required in Construction Year 1. If, after the Project is underway, the commissioner was to determine there were noncompliance events requiring a corrective action plan under Minnesota Rules, part 6132.1300, subpart 3, item B, then PolyMet will prepare and submit a cost estimate for such action. This information, if needed, will be incorporated into the Annual Report required under Minnesota Rules, part 6132.1300, subpart 4 with associated financial assurance.

16.2.3 Contingency Reclamation Estimate (CRE) and Basis for Estimate for Construction Year 1

The CRE for Construction Year 1 is based on the reclamation that would be needed for those items that PolyMet will build for the Project during Construction Year 1. These reclamation activities would include direct costs for the following items:

- Demolition of structures (buildings, railroads, power lines, pipelines, roads and parking lots) built during Construction Year 1 at the Plant Site and Mine Site
    - removal of those structures to grade
    - off-site disposal of demolition material
    - covering with soil and revegetating of structure footprint
    - remediation of existing Areas of Concern (AoCs) that are disturbed by activities during Construction Year 1
- Tailings Basin
    - Reshaping and reseeding of first lift of the FTB dams
    - Provisions, if needed, for construction activities at the FTB (i.e., FTB Seepage Containment System)
- Mine Site
    - Replacement of topsoil stripped off of Mine Site feature footprints (Categories 1, 2/3, and 4 Waste Rock Stockpiles, OSP, East Pit footprint, OSLA) and revegetation of those areas
    - Piping and liners installed will be left in place rather than removed (covered and revegetated)
- Water monitoring
- Personnel

Indirect costs that account for contingency, adaptive management, and engineering redesign are also included in the CRE. It is standard procedure in the mining industry to include funds for these types of costs as a percentage of all or part of the direct costs. For the Construction Year 1 CRE, indirect costs have been calculated as 5% of the direct costs.

Costs for closure and postclosure maintenance in the CRE are discounted in the financial assurance estimate to their present value using an 8% rate of return. This rate of return is based on the State of Minnesota's actuarial discount rate for the state pension plan, set through June 30, 2017 (Minnesota Statutes, section 356.215). A 1.1% rate of inflation is also used in this estimate. This inflation rate is based on the Consumer Price Index (CPI) inflation rate for the last 12 months ending in August 2016. Taking into account the rate of return and rate of inflation, the net discount rate is 6.9%.

The CRE was prepared using the Standardized Reclamation Cost Estimator (SRCE) model version 1.4.16 (Reference (35)). The SRCE model was originally developed for the State of Nevada to provide a standardized approach to calculating bond costs for closure.

The SRCE provides a systematic approach to the development of a closure cost with modules included for the most common closure elements encountered at mining operations, no matter their location. The SRCE does not include closure tasks that are not commonly found at mining operations and provides blank worksheets for the development of custom calculations which can be linked into the model.

The model inputs required are the physical dimensions of the various facilities and calculations are based upon first principles. These calculations and assumptions are demonstrated on each worksheet with diagrams and examples of the calculations performed by the model.

See Appendix 15.2 for the SRCE model of the CRE and the technical details of the basis for the CRE and SRCE model.

16.2.4 Form and Amount of Financial Assurance to Be Submitted Prior to Permit Issuance

Table 16-1 shows the CRE total costs for reclamation activities for Construction Year 1.

Table 16-1 Construction Year 1 Contingency Reclamation Estimate

CRE	TOTAL
Construction Year 1	$ 12,441,852

As provided in Minnesota Rules 6132.1200, subparts 2 and 4.B(1), PolyMet will submit financial assurance in an amount equal to the CRE for Construction Year 1 for approval prior to Permit to Mine issuance. The financial assurance instrument will likely be some combination of surety bond(s) and irrevocable letters of credit. The financial assurance package will also include commercial general liability, pollution liability, and property insurance. Insurance coverage will provide security against unknown, unanticipated, and catastrophic conditions resulting in claims against the property, should they occur.

16.3 Reclamation Costs for Construction Year 2

This section sets forth PolyMet's projection for reclamation costs that may require financial assurance for Construction Year 2 based on currently anticipated construction activities and potential reclamation relating to those activities. This analysis of possible reclamation costs for Construction Year 2 is based on various assumptions regarding Project activities, site conditions, statutes and regulations, reclamation costs, timing considerations, and other matters. These assumptions are subject to change, and PolyMet's actual CRE submission for Construction Year 2 will reflect those changes.

During Construction Year 2, no processing will occur at the Plant Site so no nonferrous tailings will be deposited in the FTB. While this absence of nonferrous tailings is identical to Construction Year 1, PolyMet's projected reclamation costs for Construction Year 2 incorporate additional closure costs for the existing facilities, primarily relating to PolyMet's renovation of additional LTVSMC buildings and infrastructure at the Plant Site.

If any corrective actions were identified by MDNR as necessary in Construction Year 1, a corrective action plan, with applicable cost estimates, would need to be included in the Annual Report for Construction Year 2 pursuant to Minnesota Rules, part 6132.1300, subpart 3. The analysis in Section 16.3.1 assumes no corrective action plan will be necessary.

16.3.1 Basis for Reclamation Costs for Construction Year 2

The projected reclamation costs for Construction Year 2 were prepared using the SRCE model and includes direct costs for:

- Demolition of structures (buildings, railroads, power lines, pipelines, roads and parking lots) at Plant Site and Mine Site built in construction or modified for the Project
  - removal of structure to grade
  - off-site disposal of demolition material
  - covering with soil and revegetating of structure footprint
  - remediation of existing Areas of Concern (AoCs) that are disturbed by activities during Construction Year 2
- Tailings Basin
  - Reshaping and reseeding of first lift of the FTB dams
  - Provisions, if needed, for construction activities at the FTB (i.e., FTB Seepage Containment System)
- Mine Site

- Replacement of topsoil and overburden stripped off of Mine Site feature footprints (Categories 1, 2/3, and 4 Waste Rock Stockpiles, OSP, East Pit footprint, OSLA) and revegetation of those areas
- Piping and liners installed will be left in place rather than removed (covered and revegetated)

- Water monitoring
- Well abandonment
- Personnel

Data and information used in building the SRCE model for this Construction Year 2 scenario, and the assumptions that serve as the basis of the reclamation cost projections, are provided in Appendix 15.3. These assumptions are subject to change as discussed above.

In addition to the direct costs referenced above, indirect costs that account for contingency, adaptive management, and engineering redesign are also included in the projection for Construction Year 2. Indirect costs have been calculated as 5% of the direct costs.

Costs for closure and post closure maintenance are discounted to their present value using an 8% rate of return. This rate of return is based on the State of Minnesota's actuarial discount rate for the state pension plan, set through June 30, 2017 (Minnesota Statutes, section 356.215). A 1.1% rate of inflation also is used in this calculation. This inflation rate is based on the CPI inflation rate for the last 12 months ending in August 2016. Taking into account the rate of return and rate of inflation, the net discount rate is 6.9%.

16.3.2 Projected Form and Amount of Financial Assurance to Be Submitted Before Construction Year 2

The projection outlined in this section of the permit application is for informational purposes only. The Construction Year 2 information will be updated approximately one year prior to commencement of Construction Year 2, and a CRE for Construction Year 2 will be prepared and submitted to the MDNR for approval.

Table 16-2 shows the projected total costs for reclamation activities for Construction Year 2.

Table 16-2 Construction Year 2 Reclamation Cost Projection

Reclamation Cost Projection	TOTAL
Construction Year 2	$ 43,730,954

The details of the CRE for Construction Year 2 will be contained in the NorthMet Annual Report and Reclamation Plan. The amounts will be updated and adjusted based on activities undertaken during Construction Year 1, regulatory changes, and other factors. The then-existing financial assurance instrument(s) for Construction Year 1 (surety bond or an irrevocable letter of credit) will be updated to include the Construction Year 2 financial assurance.

The remainder of the financial assurance package will include commercial general liability, pollution liability, and property insurance. Insurance coverage will provide security against unknown, unanticipated, and catastrophic conditions resulting in claims against the property, should they occur.

16.4 Reclamation Costs for Mine Year 1

This section sets forth PolyMet's evaluation of reclamation costs that could be subject to financial assurance before the company commences Mine Year 1 based on various assumptions regarding activities, site conditions, statutes and regulations, costs, and other matters. Mine Year 1 is assumed to begin when mining and processing operations commence and PolyMet’s water treatment plant at the Plant Site is operational. These assumptions are subject to change, and PolyMet's actual CRE submission for Mine Year 1 will reflect those changes.

For purposes of the analysis provided in this section, PolyMet has identified all reclamation cost items that are associated with the facilities and conditions anticipated to be present in Mine Year 1. Accordingly, the cost estimates included both reclamation of new activities, structures, and conditions created at the Mine Site and Plant Site by the Project, and reclamation of existing ferrous-related facilities and conditions as they relate to the Project (primarily relating to the former LTVSMC Tailings Basin) at the Plant Site. The transition of financial assurance for these ferrous-related reclamation costs from the existing permits presently in place to the Project Permit to Mine will be addressed in the NorthMet permitting process, and will be completed by the start of Mine Year 1.

16.4.1 Basis for Reclamation Costs for Mine Year 1

Cost estimates for Mine Year 1 were prepared using the SRCE model and various assumptions as referenced above, and include direct costs for:

- Demolition of structures (including buildings, railroads, power lines, pipelines, roads and parking lots) at Plant Site and Mine Site
    - removing structure to grade
    - off-site disposal of demolition material
    - covering with soil and revegetating structure footprint
    - removing selected water management infrastructure
    - remediation of existing Areas of Concern (AoCs)

- Tailings Basin
  - vegetating upland areas and grading interior portions of the FTB dams
  - routing stormwater runoff to the interior of the FTB
  - amending the pond bottom and beaches with bentonite to reduce percolation from the FTB Pond and beaches, thereby maintaining a permanent pond that will provide an oxygen barrier above the Flotation Tailings
- Mine Site
  - relocating material in the Categories 2/3, and 4 Waste Rock Stockpiles and OSP to the East Pit
  - piping and liners installed will be left in place rather than removed (covered and revegetated)
  - constructing the cover system on the Category 1 Waste Rock Stockpile and extending the containment system to completely encircle the stockpile
  - reclaiming and revegetating the East Pit mine wall
  - reclaiming and revegetating the Overburden Storage and Laydown Area
  - managing water levels and water quality in the East Pit
  - installing perimeter fence
- Water Treatment
  - operating the WWTF at the Mine Site to remove flushing load in the East Pit during reclamation
  - operating mechanical treatment (WWTP) for as long as necessary to meet water quality standards
  - modifying and replacing water treatment equipment
  - maintaining and replacing associated water management components
  - developing non-mechanical water treatment systems
- Water and stability monitoring
- Well abandonment
- Personnel

The SRCE model results for Mine Year 1 incorporating the scenario summarized above, and the relevant assumptions, are contained in Appendix 15.4. As noted above, these assumptions are subject to change.

In addition to the direct costs, the calculations in Appendix 15.4 include indirect costs that account for contingency, adaptive management, and engineering redesign. Indirect costs have been calculated as 5% of the direct costs.

Costs for closure and post closure maintenance are discounted to their present value using an 8% rate of return. This rate of return is based on the State of Minnesota’s actuarial discount rate for the state pension plan, set through June 30, 2017 (Minnesota Statutes, section 356.215). A 1.1% rate of inflation is used in this estimate. This inflation rate is based on the CPI inflation rate for the last 12 months ending in August 2016. Taking into account the rate of return and rate of inflation, the net discount rate is 6.9%.

16.4.2 Projected Form and Amount of Financial Assurance

The estimate outlined in this section of the Application is for informational purposes only. The Mine Year 1 financial assurance information will be updated approximately one year prior to commencement of Mine Year 1, and a CRE for Mine Year 1 will be prepared and submitted to the MDNR for approval.

Table 16-3 shows the projected total costs for Mine Year 1.

Table 16-3 Mine Year 1 Reclamation and Water Treatment Cost Projection

Reclamation and Water Treatment Cost Projection	TOTAL
Mine Year 1	$ 197,390,336

The existing financial assurance instruments (some combination of surety bonds, insurance, and irrevocable letters of credit, as commercially available) will be updated to include the Mine Year 1 financial assurance prior to the commencement of mining. A trust fund for the benefit of the State for the projected postclosure maintenance costs will also become part of the financial assurance package. Although the trust fund instrument will not be part of the financial assurance package for the Project until Mine Year 1, PolyMet expects to begin the process of establishing the trust by a combination of property and publicly beneficial plant and equipment, or cash, during Construction Years 1 and 2. For each year during the life of the mine, the total combined value of bonds, irrevocable letters of credit, and cash or assets in the trust will be at least equal to the estimated CRE for the year in which operations occur. Therefore, until fully funded, the trust will be supported by a bond or irrevocable letter of credit.

Once operations begin, PolyMet will contribute to the trust fund on an annual basis. The minimum annual amount to be contributed will be dependent on conditions in the Permit to Mine. Favorable metal market conditions (prices of copper and nickel) could enable larger annual contributions to the trust fund. PolyMet’s goal is to fully fund the trust using annual contributions no later than Mine Year 15.

Performance of the trust fund will be evaluated annually, and adjusted accordingly, to generate sufficient funds over the long term.

16.5 Long-Term Projection

This section provides additional information on how reclamation activities and costs are projected to change over time for the Project. Consistent with the analysis in Section 16.3 and Section 16.3.1, this information (presented in Figure 16-3 and Figure 16-4) is based on various assumptions regarding activities, site conditions, statutes and regulations, costs, timing considerations, and other matters. These assumptions are subject to change, and PolyMet's actual financial assurance will reflect those changes.

Figure 16-3 provides a graphical representation of the cost drivers that will significantly change (increase or decrease) reclamation estimates over time, as well as the financial assurance instruments that can be used, alone or in various combinations. Figure 16-4 depicts the water treatment component of the reclamation estimates during operations, closure, and postclosure maintenance, as well as the financial assurance instruments.

Figure 16-3 shows that during the first 11 years, the footprint of the Project will be increasing, and therefore the costs for reclamation will steadily increase. During this timeframe, reclamation costs will increase notably when the Hydrometallurgical Plant and HRF become part of the Project. Reclamation costs will peak at Mine Year 11, the year when the maximum footprint for the mine will occur. From Mine Year 11 through Mine Year 20, progressive reclamation will occur, and from Year 21 to 24, final reclamation will occur. These reclamation activities will steadily lower the financial assurance costs after Mine Year 11. Other than costs for water treatment (discussed below), financial assurance costs for closure and postclosure maintenance will mainly be associated with maintenance and monitoring activities, and the frequency of these maintenance and monitoring activities will generally decrease with time.

Figure 16-4 graphically represents how the water treatment component of the closure costs change over time. The figure also shows that if the State were to desire to add funds to the trust as a result of PolyMet’s inability to meet requirements, the surety bond or irrevocable letter of credit could provide funding for that purpose. PolyMet’s goal is to fully fund the trust using annual contributions no later than Mine Year 15. Prior to the commencement of mining (Mine Year 1), bonds and/or irrevocable letters of credit will be in place for the financial assurance, and a trust fund will be started. For example, if PolyMet were to stop operating in Mine Year 5, Figure 16-4 shows that the trust fund will cover 50% of the financial assurance, and the other 50% would be covered by a bond or irrevocable letter of credit. The actual mix of financial assurance instruments will depend on the specific reclamation costs and other actual circumstances addressed in the assumptions included in this analysis.

Figure 16-5 combines the information shown on Figure 16-3 and Figure 16-4, and incorporates the relative timing of these components to permitting activities, construction activities and operational activities.

16.6 Potential Future Adjustments to Financial Assurance

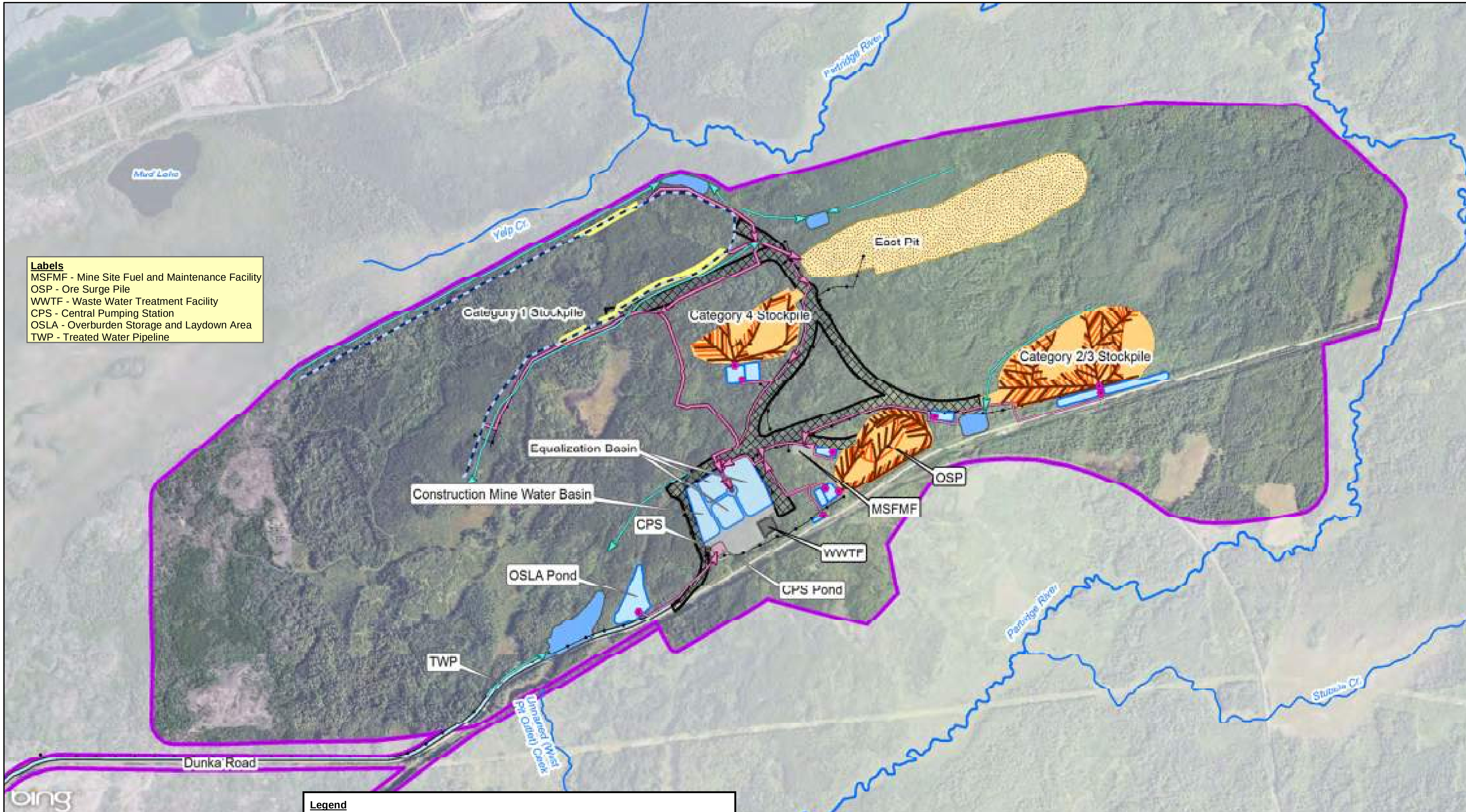
16.6.1 Regulatory Changes

PolyMet's projected reclamation costs and financial assurance analysis are based on current statutory and regulatory standards. As noted above, the nonferrous PTM rules require PolyMet to reevaluate its CRE and resulting financial assurance annually. If circumstances warrant an adjustment of these amounts, the rules require such adjustments to be made.

16.6.2 Transition to Non-Mechanical Treatment

As indicated above, the largest component of the projected reclamation costs is mechanical water treatment with reverse osmosis or equivalent technology. The initial reclamation cost projections summarized above assume that such mechanical treatment will continue through the entire reclamation timeframe. During its periodic reevaluation of reclamation costs, however, PolyMet anticipates that it will propose a transition to non-mechanical water treatment technologies that will result in an adjustment to reclamation cost calculations once this technology is successfully demonstrated under site-specific conditions.

PolyMet is submitting a work plan to the MPCA and DNR for approval to pilot test non-mechanical water treatment at the Tailings Basin that would start in the spring of 2017. The details and objectives of this proposal are described in Appendix 17.4. PolyMet will provide the results of these tests to MPCA and MDNR in quarterly reports. When it is demonstrated that non-mechanical treatment can meet applicable regulatory standards, PolyMet will put forward adjustments to its financial assurance obligations, if appropriate.



Notes
1. Basemap from Esri and its data suppliers.
2. Project features supplied by Barr Engineering Company.
3. Minnesota Power Substations and Power Lines supplied by the Minnesota Geospatial Information Office (MnGeo).
4. Mine Water Ponds are lined with the exception of the OSLA Pond and Construction Mine Water Basin.

Legend
- Rivers and Streams
- Proposed Transmission Lines
- Stockpile Overliner Collection Piping
- Stockpile Underliner Collection Piping
- Treated Water Pipeline
- Stormwater Ditches
- Stormwater Ponds
- Stockpile Liner Footprints
- Category 1 Stockpile Excavation
- Haul Roads
- Mine Water Pumps
- Groundwater Containment System
- Mine Water Piping
- Treated Mine Water Pond (Lined)
- Mine Water Ponds[4]
- WWTF Buildings
- WWTF Graded Footprint
- East Pit Stripping
- Facility Boundary

POLYMET MINING

Foth

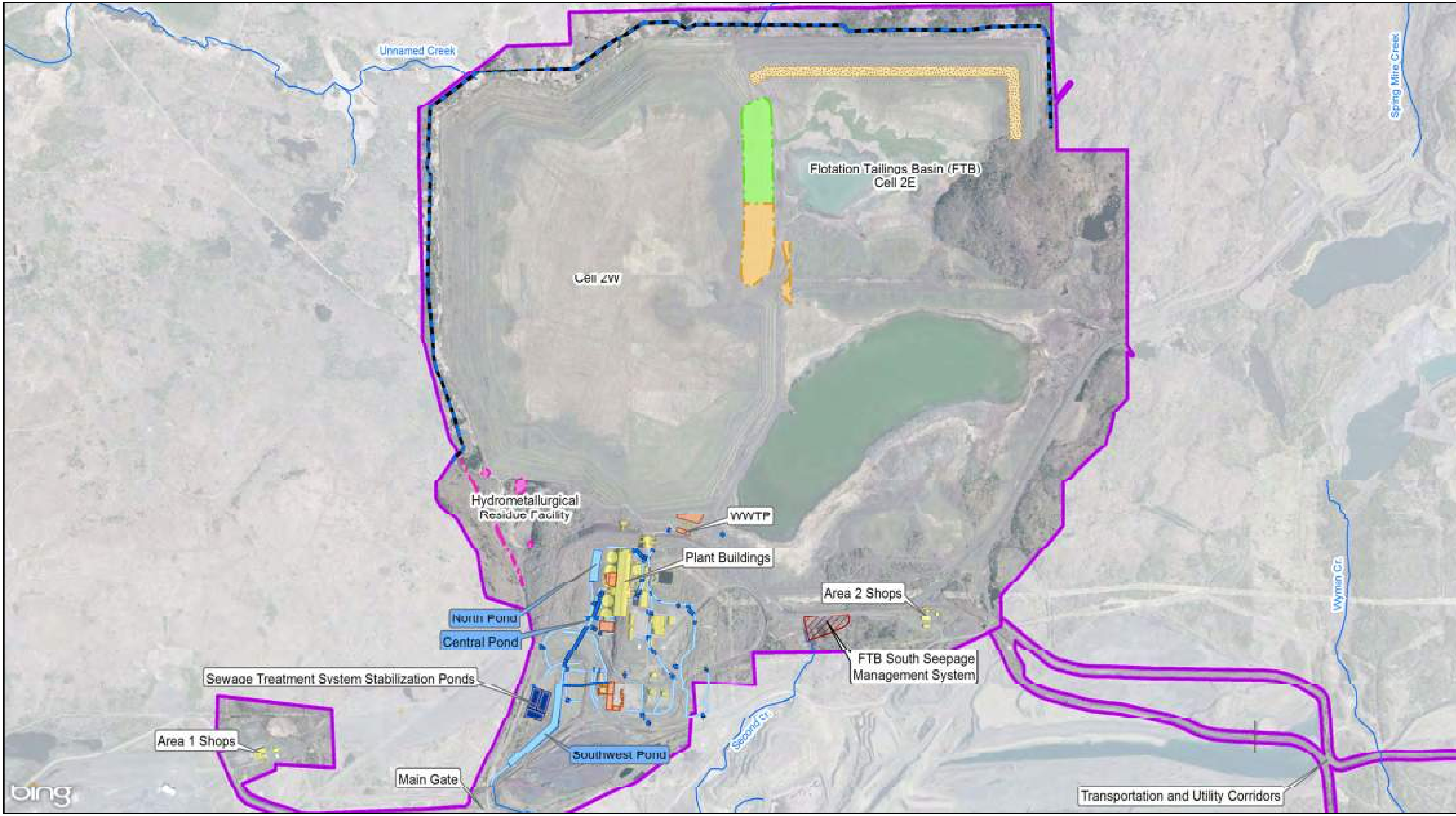
Foth Infrastructure & Environment, LLC			
REVISED	DATE	BY	DESCRIPTION
PREPARED BY: DAT			DATE: SEP. '16
REVIEWED BY: JSL			DATE: SEP. '16
APPROVED BY: JOS1			DATE: SEP. '16

POLYMET MINING

FIGURE 16-1
CONSTRUCTION YEAR 1:
MINE SITE DEVELOPMENT
PERMIT TO MINE APPLICATION
HOYT LAKES, MINNESOTA

Scale: 0 750 1,500 Feet	Date: SEPTEMBER 2016
Drafted by: DAT	Project No: 12P778

Path: X:\GB\IE\2012\12P778\GIS\mxd\PMA\Figure 16-1 Construction Year 1 Mine Site Development.mxd Date: 9/8/2016



Notes
1. Basemap from Esri and its data suppliers.
2. Project features supplied by Barr Engineering Company.

Legend
- Rivers, Streams and Ditches
- FTB Seepage Containment System
- Stormwater Culvert
- Stormwater Ditch
- Facility Boundary
- Hydrometallurgical Residue Facility Pre-Load Areas
- Stage 1 Borrow Areas
- Stage 2 Borrow Areas
- FTB Dam Footprint
- Existing Buildings
- Proposed Plant Site Buildings and Related Facilities
- Proposed Industrial Stormwater Ponds
- Sewage Treatment System Stabilization Ponds

POLYMET MINING

Foth

Foth Infrastructure & Environment, LLC

REVISED	DATE	BY	DESCRIPTION

PREPARED BY:	DAT	DATE:	SEP. '16
REVIEWED BY:	JSL	DATE:	SEP. '16
APPROVED BY:	JOS1	DATE:	SEP. '16

POLYMET MINING

FIGURE 16-2
CONSTRUCTION YEAR 1:
PLANT SITE DEVELOPMENT
PERMIT TO MINE APPLICATION
HOYT LAKES, MINNESOTA

Scale: 0 1,000 2,000 Feet
Date: SEPTEMBER 2016
Drafted by: DAT
Project No: 12P778

Path: X:\GB\IE\2012\12P778\GIS\mxd\PMA\Figure 16-2 Construction Year 1 Plant Site Development.mxd Date: 9/8/2016

Figure 16-3

RECLAMATION COST PROJECTION AND INSTRUMENTS

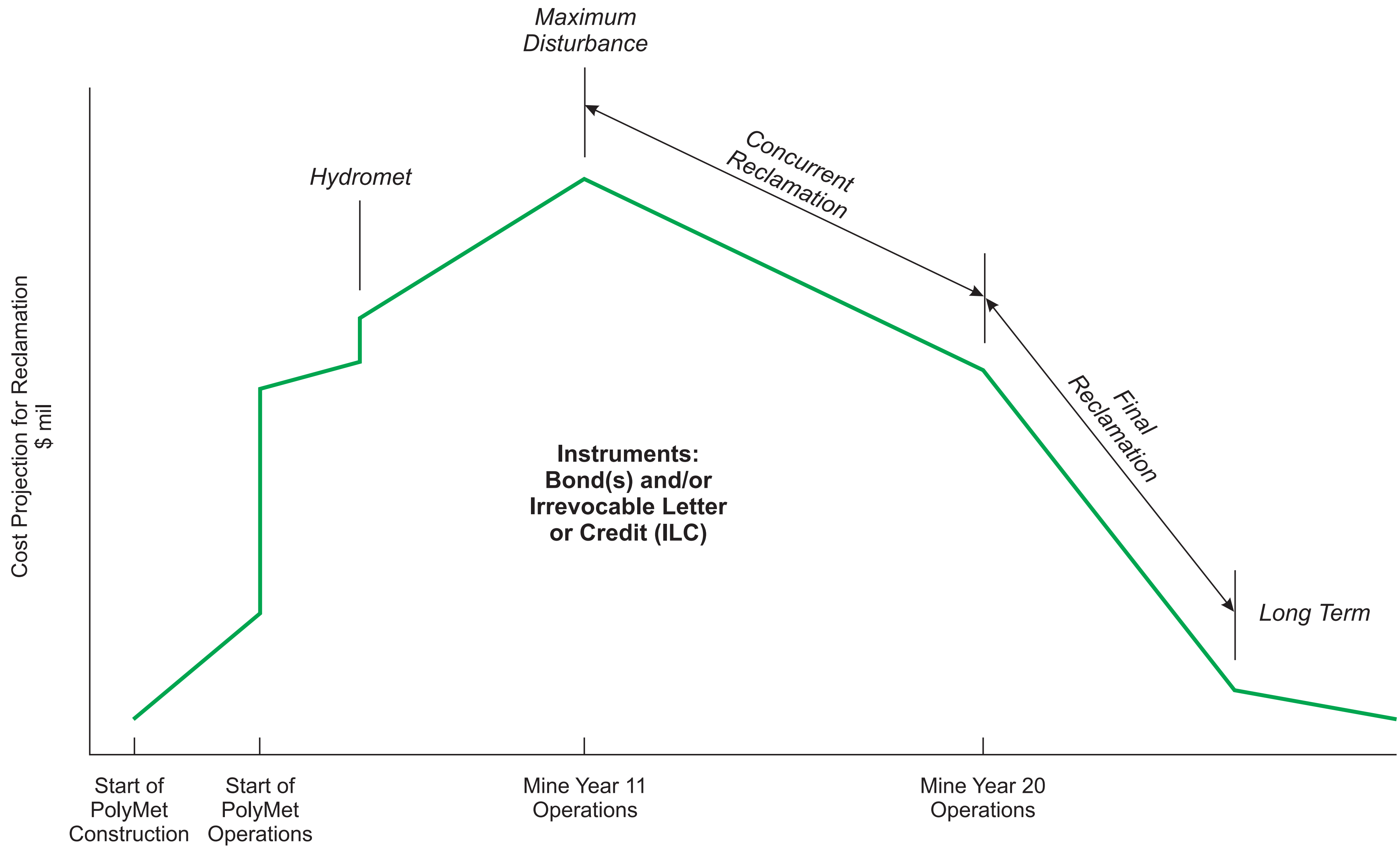


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Figure 16-4

WATER TREATMENT COST PROJECTION AND INSTRUMENTS

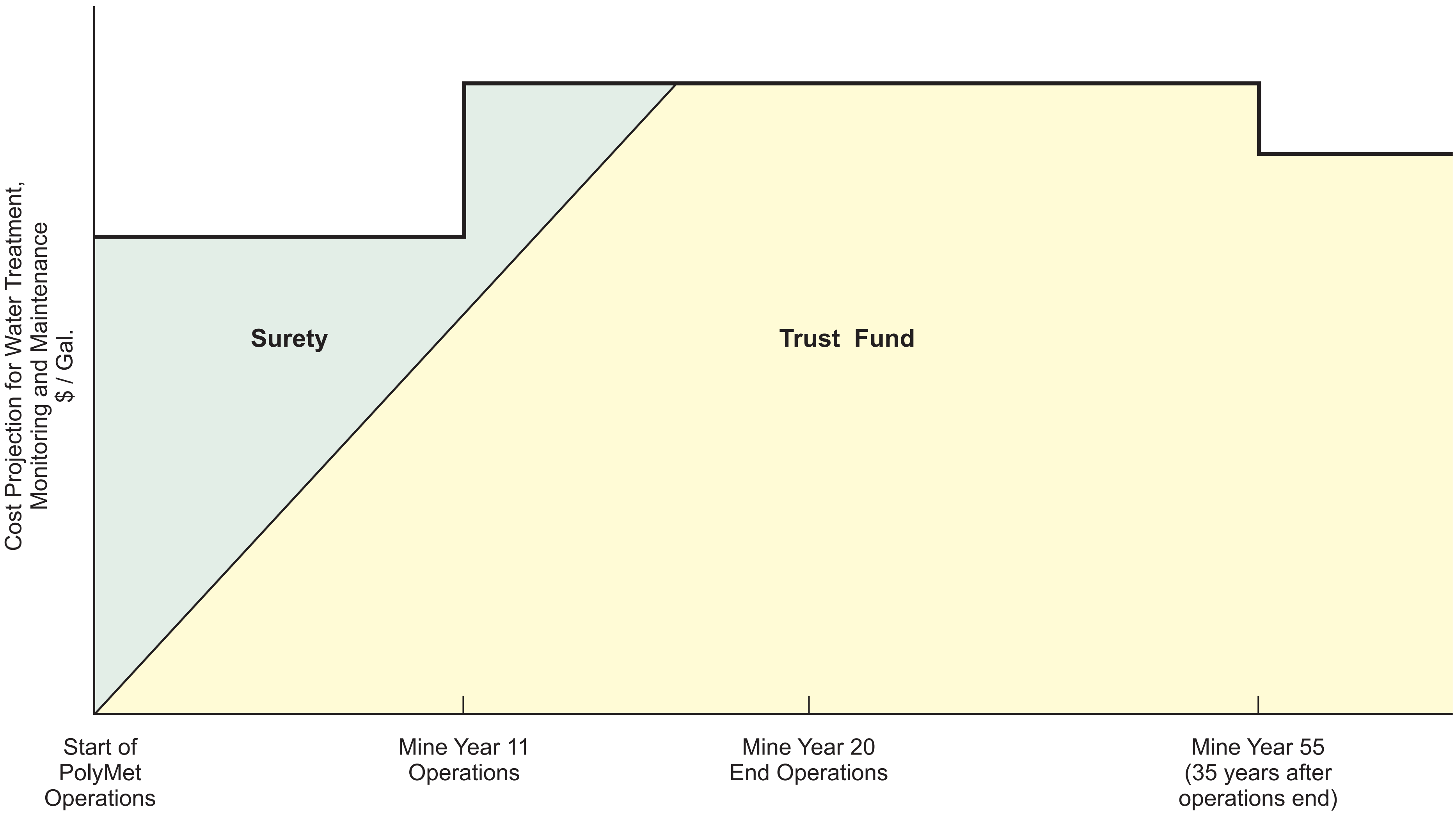

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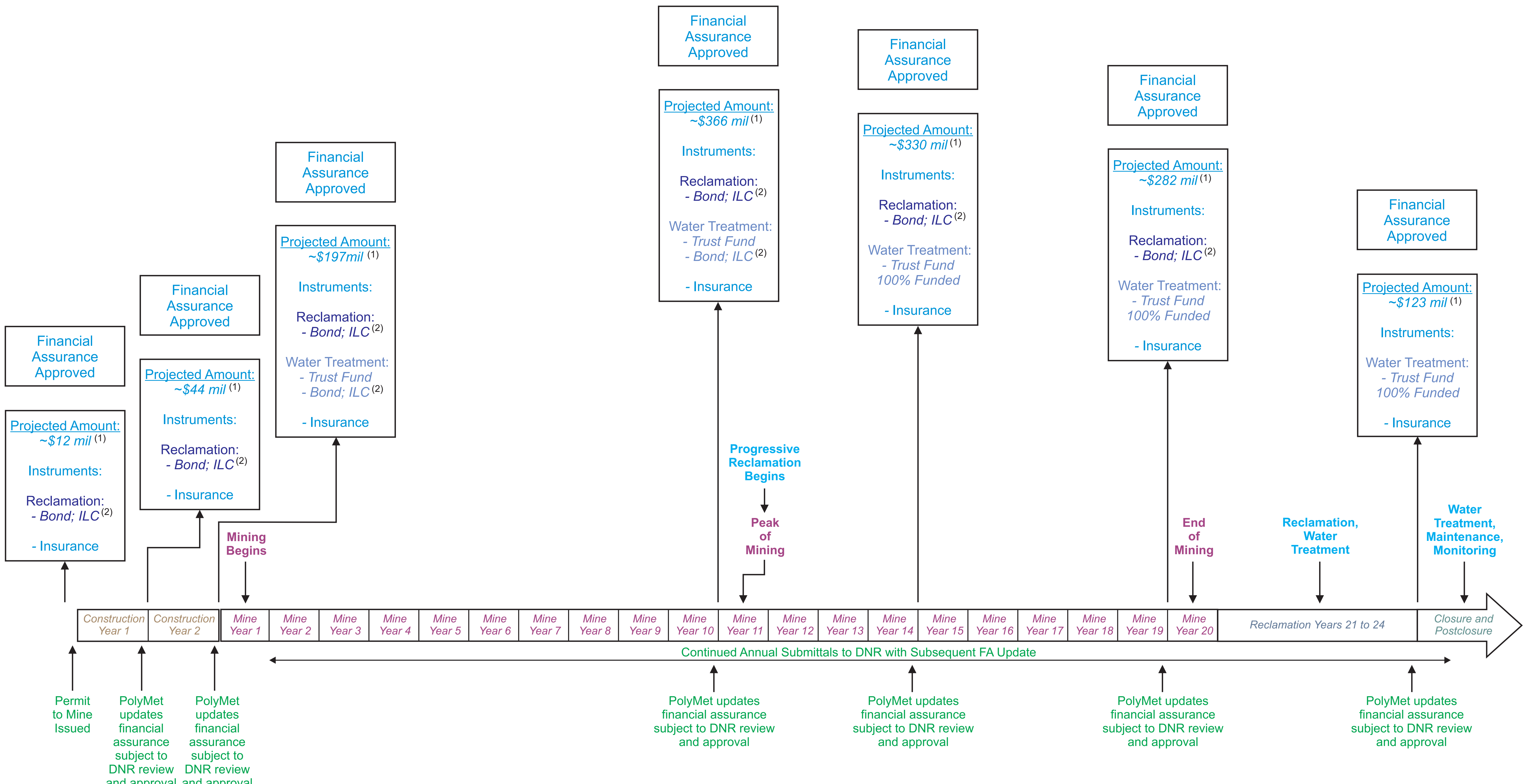
Figure 16-5

FINANCIAL ASSURANCE AND PROJECT TIMELINE

All financial projections are subject to DNR review and approval and are not final numbers.
The DNR also reviews and approves the amount and type of financial instruments on an annual basis.
Figure shows this annual process for select years during the project timeline.



(1) Amounts are subject to change based on a variety of factors, including future technological and regulatory developments. Methodology for estimating projected amounts for Mine Years 11, 15, 20 and 25 is described in Appendix 15.4.
(2) Irrevocable Letter of Credit

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