

NorthMet Dam Safety Permit Application

Flotation Tailings Basin

Prepared for
Poly Met Mining, Inc.



July 2016



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Certifications

I hereby certify that this plan, specification, or report was prepared by me or under my direct supervision and that I am a duly Licensed Professional Engineer under the laws of the state of Minnesota.

Thomas J. Radue

Thomas J. Radue

PE #: 20951

7/11/2016

Date

1.0 Introduction

This document constitutes an application for a Dam Safety Permit in the state of Minnesota for the NorthMet Project Flotation Tailings Basin (FTB). It provides the information required by Minnesota Rules, part 6115.0410 and the Minnesota Permitting and Reporting System (MPARS).

1.1 Project Description

Poly Met Mining, Inc. (PolyMet) is proposing to develop the NorthMet Project (Project) copper-nickel-platinum group elements mine and associated processing facilities. The Project is described in Section 1.1 of the NorthMet Mining Project and Land Exchange Final Environmental Impact Statement (FEIS) (Reference (1)). The Project is located south of the city of Babbitt and north of the city of Hoyt Lakes in St. Louis County, Minnesota, as shown on Large Figure 1. Existing infrastructure in the vicinity of the FTB is shown on Large Figure 2.

The Project will generate approximately 11.27 million short tons (approximately 10,000,000 in-place cubic yards) of Flotation Tailings annually throughout 20 years of ore processing. The Flotation Tailings will be a slurry of fine sand, silt, and clay size particles, with approximately 60% of particles smaller than 0.075 mm. The slurry will be pumped from the Beneficiation Plant to the FTB.

The FTB will be constructed on Cells 1E and 2E of the existing former LTV Steel Mining Company (LTVSMC) tailings basin. The Flotation Tailings will settle out within the FTB and decanted water will be pumped back to the Beneficiation Plant for reuse as process water. The slurry discharge will be configured such that the discharge point can periodically be adjusted (vertically and horizontally) to distribute tailings uniformly. Seepage will be collected by the FTB seepage capture systems. The FTB will be constructed in increments (stages) over the 20 years of facility operation. This permit application covers all planned increments of FTB construction. For further description of FTB staging, see Section 2.2.2 of the Flotation Tailings Management Plan (Reference (2)).

The Minnesota Department of Natural Resources (MDNR) has classified the proposed Flotation Tailings Basin as a Class II dam. The FTB dams have been designed to achieve necessary factors of safety (Geotechnical Data Package – Volume 1, [Reference (3)]). A dam break analysis was completed to understand the potential consequences in the unlikely event of a failure of the FTB dam (Attachment H of Reference (2)). Results are incorporated in the Contingency Action Plan (Attachment F of Reference (2)) so emergency responders can plan for a worst-case scenario and be prepared to take necessary actions should a dam break ever occur.

1.2 Definitions and Terms

In this document, the Flotation Tailings Basin (FTB) refers to the proposed NorthMet Flotation Tailings impoundment placed atop Cells 1E and 2E of the former LTVSMC tailings basin, and the Tailings Basin is the existing LTVSMC tailings basin as well as the combined LTVSMC tailings basin and the FTB. Coarse tailings are LTVSMC coarse tailings, and Flotation Tailings are the NorthMet bulk flotation tailings.

1.3 Dam Safety Permit Application Structure

The content requirements for this FTB Dam Safety Permit Application are summarized in Large Table 1, which is described further in Section 2.0. The majority of the required FTB Dam Safety Permit Application documentation and information was prepared to support the Project EIS process, has undergone extensive MDNR review and peer review, and is therefore already in the MDNR files and the public record. So as not to re-produce existing information, the approach for this application is to communicate where required application information can be found; requirements that are already met in other documentation are referenced in Large Table 1, as further described in Section 2.0. Any components not previously developed are presented in the subsequent sections of this application, as referenced in Large Table 1.

2.0 Permit Application Requirements

The requirements for Dam Safety Permit applications in Minnesota are laid out in Minnesota Rules, part 6115.0410 and the Minnesota Permitting and Reporting System (MPARS) application. Large Table 1 summarizes each requirement, provides the regulatory citation, and identifies the document which contains the information. Table 2-1 describes the configuration of Large Table 1.

Table 2-1 Dam Safety Permit Application Correlation Table (Large Table 1) Format Summary

Section	Citation	Requirement	Document	Section and Page Number
Large Table 1 is divided into the 5 primary permit application content sections required by Minnesota Rules, part 6115.0410: <ul style="list-style-type: none">• General Permit Application• Preliminary Design Report• Final Design Report• Plans and Specifications• Permit Standards	Provides the citation for the Minnesota Rules in which the permit application content requirement is stated.	Provides a synopsis of required permit application content.	Identifies the document currently on file with the MDNR and in the public record in which the required permit application content is presented.	Identifies the section and page number of the document in which the required permit application content is presented.

Note: This FTB Dam Safety Permit Application consists of the content provided within this written document, and in the sections and on the pages of the documents referenced in Large Table 1.

The MPARS application has previously been submitted as part of the Wetland Permit Application (Reference (4)) and to avoid duplication the MPARS application is not repeated herein.

3.0 Permit Application Supporting Content

The sections and pages of the documents referenced in Large Table 1 in aggregate constitute the majority of the FTB Dam Safety Permit Application. Additional application content not previously submitted to the MDNR is presented in the following subsections.

3.1 General Permit Application

The items required under the General Permit Application have been previously submitted to the MDNR and are referenced in Large Table 1.

3.2 Preliminary Design Report

Most items required under the Preliminary Design Report have been previously submitted to the MDNR and are referenced in Large Table 1. The following subsections present additional application information not previously submitted to the MDNR.

3.2.1 Preliminary Cost Estimate

Per Minnesota Rules, part 6115.0520, MDNR Dam Inspection Fees paid by PolyMet will be based on estimated costs of dam construction. At the end of each stage of construction, and in any case at intervals not exceeding five years in duration, PolyMet will file an affidavit of actual costs for each stage of construction. In cases where actual construction costs exceed estimates, PolyMet will pay the associated Inspection Fee difference. The initial Inspection Fee shall be based on the estimated initial year cost of dam construction, provided as Large Table 2.

Portions of the FTB construction costs unrelated to tailings containment and dam stability are anticipated to be excluded from the computation of Dam Inspection Fees and are noted as such on Large Table 2 and/or excluded from Large Table 2 in their entirety (e.g., FTB Seepage Containment and Stream Augmentation Systems).

3.2.2 Ancillary Features

Some features that will be co-located with the Tailings Basin do not serve a tailings containment function and therefore are ancillary to overall dam safety permitting. Ancillary features and their general function and location are summarized in Table 3-1. Ancillary features are shown on the Permit Application Support Drawings incorporated as Attachment A of this permit application. In addition, Attachment B provides information on the FTB Seepage Containment and Stream Augmentation Systems. The FTB Seepage Containment and Stream Augmentation Systems are co-located with the Tailings Basin and therefore the corresponding Permit Application Support Drawings are provided for MDNR reference. However, these systems serve a water quality management function rather than a tailings containment function and therefore are ancillary to overall dam safety permitting.

Table 3-1 Flotation Tailings Basin Ancillary Features

Item	Location	Function
Emergency Overflow Channel	Interface of Cell 2E North Dam with East Slope – All Stages of Dam Construction	Provide Emergency Overflow Capability During Operations-Phase Development of Flotation Tailings Basin
Drainage Swale	Cell 2E East Dam	Eliminate Ponding of Surface Water at Toe of Slope at Cell 2E East Dam
Closure Overflow Channel	North End of Cell 2E North Dam	Provide Emergency Overflow Capability After Flotation Tailings Basin Closure
Access Roads	East Side of Cell 1E	Provide Vehicle Access on East Perimeter of Tailings Basin Cell 1E and 2E
Tailings Discharge Pipeline	Location is Variable – Typically Perimeter of Cells 1E and 2E	Transport of Flotation Tailings to Discharge on Perimeter of Cells 1E and 2E and for Tailings Transport to Diffuser Raft
Diffuser Raft	Cells 1E and 2E	For Discharge of Flotation Tailings in Central Area of Cells 1E and 2E
Transfer Pump Raft and Pipeline	Cell 2E	Transfer of Pond Water from Cell 2E into Cell 1E
Return Water Raft and Pipeline	Cell 1E	Transfer of Pond Water from Cell 1E to Concentrator
FTB Seepage Containment and Stream Augmentation Systems	Cell 1E, Cell 2E, Cell 2W	FTB Seepage Containment and Stream Augmentation

Note: Items noted in the table are shown in the Permit Application Support Drawings provided in Attachment A or Attachment B to this Permit Application.

3.3 Final Design Report

Most items required under the Final Design Report have been previously submitted to the MDNR and are referenced in Large Table 1. The following subsections present additional application information not previously submitted to the MDNR.

3.3.1 Borrow and Aggregate Locations and Volumes

The borrow materials and aggregates required for FTB construction and closure are listed in Table 3-2, including estimated quantities and planned borrow locations.

Table 3-2 Borrow and Aggregate Locations and Volumes

Borrow Type and Use	Estimated Quantity	When Used	Planned Borrow Locations
LTVSMC Coarse Tailings – Flotation Tailings Basin Dams	16,550,000 Cubic Yards	FTB Construction	Tailings Basin Cell 2E and Cell 2W Dam Crests
Import Borrow – Flotation Tailings Basin Dams	2,500,000 Cubic Yards	FTB Construction	Area 5 Stockpiles and PolyMet Discretion
Rock – Flotation Tailings Basin Buttresses	1,630,000 Cubic Yards	FTB Construction	Area 5 Stockpiles, Drainage Swale, and PolyMet Discretion
Bentonite – Flotation Tailings Basin Cover	135,000 Tons	FTB Closure	Import by Rail
Riprap – Erosion Control Features	209,000 Tons	FTB Construction and Closure	Area 5 Stockpiles and PolyMet Discretion
Granular Filter Material – Erosion Control Features	70,000 Cubic Yards	FTB Construction and Closure	PolyMet Discretion
Cement – Cement Deep Soil Mix Columns	50,000 Tons	FTB Construction	PolyMet Discretion
1" Minus Rock – Roadway Surfacing	2,600 Cubic Yards	FTB Construction	PolyMet Discretion

Note: Material quantities listed above are approximate based on designs presented in the Permit Application Support Drawings provided in Attachment A to this Permit Application. Planned borrow locations are for cost estimate purposes; borrow locations will be refined based on additional data collected prior to construction.

3.3.2 Detailed Cost Estimate

A detailed cost estimate for the initial year of FTB construction (called the Construction Phase in PolyMet's planning schedule) is provided as Large Table 2. The cost estimate provides:

- a listing of each of the construction materials required for the initial year of FTB construction
- the unit of measure and quantity for each construction material
- an estimate of unit price for each construction material, based on evaluation of unit pricing provided by independent construction contractors
- the cost estimate extension
- comments providing additional context for the cost estimates

The detailed estimate shall serve as the basis for Mine Year 1 Inspection Fees due from PolyMet to the MDNR. Estimates will subsequently be replaced by actual costs incurred at the time of construction. Some material types are included in Large Table 2 with quantities of zero for the initial year of construction because they will be used in future years of FTB construction. Quantities for these materials will be added at the time of the applicable cost estimate update. The FTB Seepage Containment and Stream Augmentation Systems shown in the Permit Application Support Drawings (Attachment B) are ancillary features for water quality control; they are not a part of the containment of the Flotation Tailings, and the costs of these features are therefore excluded from the cost estimates provided herein.

3.4 Plans and Specifications

As previously noted, FTB Permit Application Support Drawings are provided in Attachment A. Attachment C provides construction specifications for FTB construction. The construction specifications have been prepared absent a final decision by PolyMet on project implementation approach (e.g., Design-Bid-Build, Engineer-Procure-Construct). Construction specifications will be updated as deemed appropriate by PolyMet once project permits are received and a project implementation approach selected.

3.5 Dam Break Analysis

The FTB dams have been designed to achieve necessary factors of safety (Geotechnical Data Package – Volume 1, (Reference (3)), so a dam break is unlikely. A dam break analysis was completed to understand the potential extent of flood inundation between the FTB and the Embarrass River in the unlikely event of a failure at the dam. Results are presented in Attachment H of Reference (2), and incorporated in the Contingency Action Plan (Appendix F of Reference (2)). The Contingency Action plan defines responsibilities, specifies procedures for identifying and responding to unexpected and potentially hazardous conditions threatening the integrity and performance of the FTB, and provides information for emergency responders to plan for a worst-case scenario and be prepared to take necessary actions should a dam break ever occur.

3.6 Permit Standards

The items required under Permit Standards have been previously submitted to the MDNR and are referenced in Large Table 1.

3.7 Material Test Results Supplement to Geotechnical Data Package – Volume 1

For the bentonite-amended LTVSMC coarse tailings to be utilized in the FTB cover system, slope stability analyses presented in Geotechnical Data Package – Volume 1 (Reference (3)) utilize an assumed value of 38.5° friction angle and zero cohesion for drained (ESSA) and undrained (USSA) shear strength. Shear strength testing of bentonite-amended LTVSMC Coarse Tailings has since been performed to confirm this assumption. Results, provided in Attachment D, show drained shear strength friction angles above 38.5°, and undrained shear strength friction angles below 38.5° but with substantial cohesion resulting from the bentonite addition. The result is a substantive increase in undrained shear strength above the assumed value when friction angle and cohesion are considered. Therefore, validity of the shear strength assumptions presented in Geotechnical Data Package – Volume 1 (Reference (3)) for the bentonite-amended LTVSMC coarse tailings has been confirmed and the stability analysis results remain valid.

4.0 References

1. **Minnesota Department of Natural Resources, U.S. Army Corps of Engineers and United States Forest Service.** Final Environmental Impact Statement: NorthMet Mining Project and Land Exchange. November 2015.
2. **Poly Met Mining Inc.** NorthMet Project Flotation Tailings Management Plan (v6). July 2016.
3. —. NorthMet Project Geotechnical Data Package Vol 1 - Flotation Tailings Basin (v7). July 2016.
4. —. NorthMet Project Wetland Permit Application (v2). August 19, 2013.
5. —. NorthMet Project Project Description (v9). February 2015.
6. **Barr Engineering Co.** NPDES/SDS Permit Application Volume V – Tailings Basin and Beneficiation Plant for Poly Met Mining Inc. estimated submittal July 2016.
7. **Poly Met Mining Inc.** NorthMet Project Wetland Data Package (v11). April 2015.
8. —. NorthMet Project Water Management Plan - Plant (v5). July 2016.
9. —. NorthMet Project Water Modeling Data Package Volume 2 - Plant Site (v11). March 2015.
10. —. NorthMet Project Waste Characterization Data Package (v12). February 2015.
11. —. NorthMet Project Air Quality Management Plan - Plant (v7). December 2014.
12. **U.S. Army Corps of Engineers; U.S. Forest Service; Minnesota Department of Natural Resources.** NorthMet Environmental Impact Statement Co-lead Agencies' Consideration of a West Pit Backfill Alternative Interagency Memorandum (for Poly Met Mining Inc.). April 11, 2013.
13. **Foth Infrastructure and Environmental, LLC.** Permit to Mine Application. Prepared for Poly Met Mining Inc. NorthMet Project. estimated submittal August 2016.

Large Tables

Large Table 1 Flotation Tailings Basin Dam Safety Permit Requirements: Correlation Table

Subsection of Minnesota Rules, Part 6115.0410 ⁽¹⁾	Rule Citation ⁽²⁾	Rule Requirement ⁽³⁾	Document ⁽⁴⁾	Section and Page Number ⁽⁵⁾
General Permit Application	6115.0410 (2)(B)	Purpose of proposed dam construction.	Flotation Tailings Management Plan (Reference (2))	Section 1.0, pages 3-4
	MPARS Application	Project purpose and need.	Final Environmental Impact Statement (Reference (1))	Section 1.3, pages 11-12 of Section 1
	6115.0410 (2)(C)	Location, type, size, and height of the dam.	Flotation Tailings Management Plan (Reference (2))	Section 2.2, pages 6-10
	6115.0410 (2)(D)	Storage capacity of impoundment.	Flotation Tailings Management Plan (Reference (2))	Large Table 1, pages 45-46
	MPARS Application	Project description, including a description of all project elements that effect aquatic resources (wetlands, streams, etc.).	NorthMet Project Description (Reference (5))	Sections 4.3.6, 4.3.8.3, and 4.4.3.1, pages 60-62, 64-65, and 73-74
		Plans and cross-section or profile drawings showing the location, character, and dimensions of all proposed activities and aquatic resource impacts.	NPDES Permit Application Volume V – Tailings Basin and Beneficiation Plant Support Drawings (Reference (6))	Appendix A
			Wetland Data Package (Reference (7))	Large Figure 9 and Large Figure 25
		Description of direct or indirect impacts to aquatic resources.	Water Management Plan - Plant (Reference (8))	Section 2.5, page 22
			Wetland Data Package (Reference (7))	Sections 5.1.5 and 5.2.2, pages 21, and 48-56
Preliminary Design Report	6115.0410 (3)(A)	A general statement setting forth the effect on the environment.	Final Environmental Impact Statement (Reference (1))	Section 4.0, page 1 of Section 4
	6115.0410 (3)(B)	Maps showing the location of county, township, and section lines; the outline of the impoundments; the location of state, county, and township roads; the locations of utilities, e.g., pipelines, transmission, telegraph, and telephone lines; the topography; and other structure or facilities including dwellings affected by the proposed dam.	Dam Safety Permit Application	Large Figure 1, Large Figure 2
	6115.0410 (3)(C)	A report of surface conditions, i.e., geology, topography.	Flotation Tailings Management Plan (Reference (2))	Attachment H (Dam Break Analysis), pages 7-8, 11-13 of Attachment H
	6115.0410 (3)(D)	Typical cross-sections of the dam accurately showing elevations, proposed impoundment levels, and top width.	Water Modeling Data Package; Plant Site (Reference (9))	Section 4.3, pages 14-16
	6115.0410 (3)(E)	Logs of borings in the foundation and in the borrow areas.	Dam Safety Permit Application – FTB Permit Application Support Drawings	Attachment A
		Results of seismic and resistivity subsurface investigations, when they are readily available.	Geotechnical Data Package Volume 1 (Reference (3))	Attachments D, H, and J; Exhibits A, D and G of Attachment F
	6115.0410 (3)(F)	Preliminary design assumptions, operational aspects, tentative conclusions, and references. The design assumptions shall pertain to such hydrologic features as drainage area, rainfall data, runoff, inflow, area-capacity-elevation data, and flood routing, in addition to structural, geologic, and geotechnical assumptions.	Reports are not readily available, therefore this requirement is not applicable	
			Water Modeling Data Package Volume 2 (Reference (9))	Section 4.0
			Geotechnical Data Package Volume 1 (Reference (3))	Sections 6.0 through 8.0
	6115.0410 (3)(G)	A preliminary cost estimate.	Flotation Tailings Management Plan (Reference (2))	Section 2.5 and Attachment C and Attachment H
	6115.0410 (3)(H)	Future plans on ultimate project size including dams and impoundments.	Dam Safety Permit Application	Large Table 2
	6115.0410 (3)(I)	A general description of all other activities and elements related to and part of the total dam project, such as operational plans and details of smaller dams, dikes, diversions, reclaim water facilities, and other facility and utility lines including pipelines, roads, and railroads. The report shall identify each element or activity of the total dam project which would require a permit under the provisions of parts 6115.0150 to 6115.0260.	Flotation Tailings Management Plan (Reference (2))	Large Table 1, pages 45-46
			Dam Safety Permit Application	Table 3-1

Subsection of Minnesota Rules, Part 6115.0410⁽¹⁾	Rule Citation⁽²⁾	Rule Requirement⁽³⁾	Document⁽⁴⁾	Section and Page Number⁽⁵⁾
Final Design Report	6115.0410 (6)(A)	General description of the project, such as its service life, production rates, required storage and area(s).	Flotation Tailings Management Plan (Reference (2))	Section 1.0, pages 2-4
		Geological considerations such as physiography, topography, geology, seismicity, and groundwater conditions.	Geotechnical Data Package Volume 1 (Reference (3)) Water Modeling Data Package; Plant Site (Reference (9))	Section 3.3 (seismicity), pages 9-10 Section 4.3 (other requirements), pages 14-29
		Hydrologic Studies such as:		
		physical features, climatology	Water Modeling Data Package; Plant Site (Reference (9))	Sections 4.1 and 4.2, pages 13-14
		design storm and design flood characteristics, flood routing	Flotation Tailings Management Plan (Reference (2))	Section 3.3, pages 20, and pages 1-8 of Attachment H
		water-material balance	Water Modeling Data Package; Plant Site (Reference (9))	Section 6.1.5, pages 141-145
		free-board requirements	Flotation Tailings Management Plan (Reference (2))	Section 4.2, pages 22-24
		dam-break flood	Flotation Tailings Management Plan (Reference (2))	Attachment H (Dam Break Analysis), pages 1-8 of Attachment H
		geotechnical information, such as rock-soil sampling and logging, geophysical investigations, field and lab testing, instrumentation data	Geotechnical Data Package Volume 1 (Reference (3))	Attachment D (Historical Geotechnical Reports), Attachment E (2007 Geotechnical Investigation Laboratory Test Results), Attachment F (2014 Geotechnical Investigation Report), Attachment H (2007 Geotechnical Investigation CPTu Sounding Logs and Dissipation Test Results), Attachment I (2007 Geotechnical Investigations Dilatometer Test Results), Attachment J (2007 Geotechnical Investigation SPT Boring Logs)
		considerations of construction materials and their properties, such as quantities required, borrow and aggregate locations and volumes, field and lab work and investigations, concrete, waste materials generation and placement techniques	Flotation Tailings Management Plan (Reference (2))	Large Table 1 (Dam material volumes), pages 45-46 Section 2.2.4 (Construction materials description), pages 7-10
			Dam Safety Permit Application	Table 3-2 (Borrow and Aggregate Locations and Volumes), and Attachment C (Construction Specifications)
			Geotechnical Data Package Volume 1 (Reference (3))	Section 5, pages 30-64; and Attachments B-F, M, and N (Construction material properties)
		investigation of the stored waste materials such as generation, transportation, mechanical/chemical/special testing, disposal practice	Flotation Tailings Management Plan (Reference (2))	Section 2.3, page 11-12; Section 4.0 page 21-25; Section 5.0 page 27-28
			Waste Characterization Data Package (Reference (10))	Section 5, pages 31-41
	6115.0410 (6)(B)	Seepage analysis	Geotechnical Data Package Volume 1 (Reference (3))	Section 7.2, pages 100-106
		Stability, deformation, and settlement analysis.	Geotechnical Data Package Volume 1 (Reference (3))	Section 7.3, pages 107-119, Section 7.3.5, page 115
			Dam Safety Permit Application	Section 3.7 and Attachment D
		Design details of facilities, such as dam, foundation, impoundment, abutments, spillways or decant facilities, diversions, outlet works, and instrumentation.	Dam Safety Permit Application – FTB Permit Application Support Drawings	Attachment A
			Flotation Tailings Management Plan (Reference (2))	Section 5.0 (Instrumentation), pages 26-27
		Operational aspects, such as impoundment operating criteria, initial filling criteria, responsibility and coordination, emergency procedures, and warning systems.	Flotation Tailings Management Plan (Reference (2))	Section 4 (Operational Plan), pages 21-25
			Flotation Tailings Management Plan (Reference (2))	Attachment F (Contingency Action Plan), pages 1-9 of Attachment F
	6115.0410 (6)(B) 6115.0410 (6)(B)	Air, water, and solid pollution controls, sedimentation, and erosion controls.	Air Quality Management Plan – Plant (Reference (11))	Attachment A (Fugitive Emissions Control Plan)
			Flotation Tailings Management Plan (Reference (2))	Sections 5 and 7 (Erosion), pages 28-31, and 37-39
			NPDES Permit Application (Reference (6))	Application Volume V Sections 2.4 and 3 (Water and Sedimentation), pages 26-30, and 31-38
		Operational and post-operational maintenance and abandonment considerations.	Flotation Tailings Management Plan (Reference (2))	Sections 4.3 and 7, pages 24-25, and 36-40
		Surveillance and inspection programs.	Flotation Tailings Management Plan (Reference (2))	Section 5, pages 26-30
	6115.0410 (6)(C)	Detailed cost estimate.	Dam Safety Permit Application	Large Table 2

Subsection of Minnesota Rules, Part 6115.0410⁽¹⁾	Rule Citation⁽²⁾	Rule Requirement⁽³⁾	Document⁽⁴⁾	Section and Page Number⁽⁵⁾
Plans and Specifications	6115.0410 (7)(A-C)	Plans	Dam Safety Permit Application – FTB Permit Application Support Drawings	Attachment B
		General Provisions	Dam Safety Permit Application – Construction Specifications	Attachment C
		Technical Specifications	Dam Safety Permit Application – Construction Specifications	Attachment C
Permit Standards	6115.0410 (8)(B)	Lack of other suitable feasible and practical alternative sites and that the dam will benefit the population or socioeconomic base of the area involved.	Final Environmental Impact Statement (Reference (1)) NorthMet Environmental Impact Statement Co-lead Agencies' Consideration of a West Pit Backfill Alternative Interagency Memorandum (Reference (12))	Section 3.2.3, pages 139-155
	6115.0410 (8)(C)	The need in terms of quantifiable benefits.	Final Environmental Impact Statement (Reference (1))	Section 1.3.2.1, page 11
	6115.0410 (8)(D)	The stability of the dam, foundation, abutments, and impoundment under all conditions of construction and operation, including consideration of liquefaction, shear, or seepage failure, overturning, sliding, overstressing and excessive deformation, under all loading conditions including earthquake. This determination must be based on current, prudent engineering practice, and the degree of conservatism employed must depend on hazards.	Geotechnical Data Package Volume 1 (Reference (3))	Section 7.3, pages 107-119
	6115.0410 (8)(E)	Discharge and/or storage capacity capable of handling the design flood based on current, prudent engineering practice and the hazard classification.	Flotation Tailings Management Plan (Reference (2))	Section 3.3, page 20 of Attachment H
	None. Information requested by MDNR on 10/31/13	Financial assurance.	Permit to Mine Application (Reference (13))	Sections 15

(1) Section – Denotes the primary sub-sections of Minnesota Rules, part 6115.0410 for Dam Safety Permitting.

(2) Rule Citation – Denotes the sub-section of the Rule that the Permit Application content addresses.

(3) Rule Requirement – Provides a summary statement of the content requirement of each sub-section of the Rule.

(4) Document – Lists the document containing the content/information required by the cited Rule.

(5) Section and Page Number – Lists the document's section and page number on which the content/information required by the Rule is located.

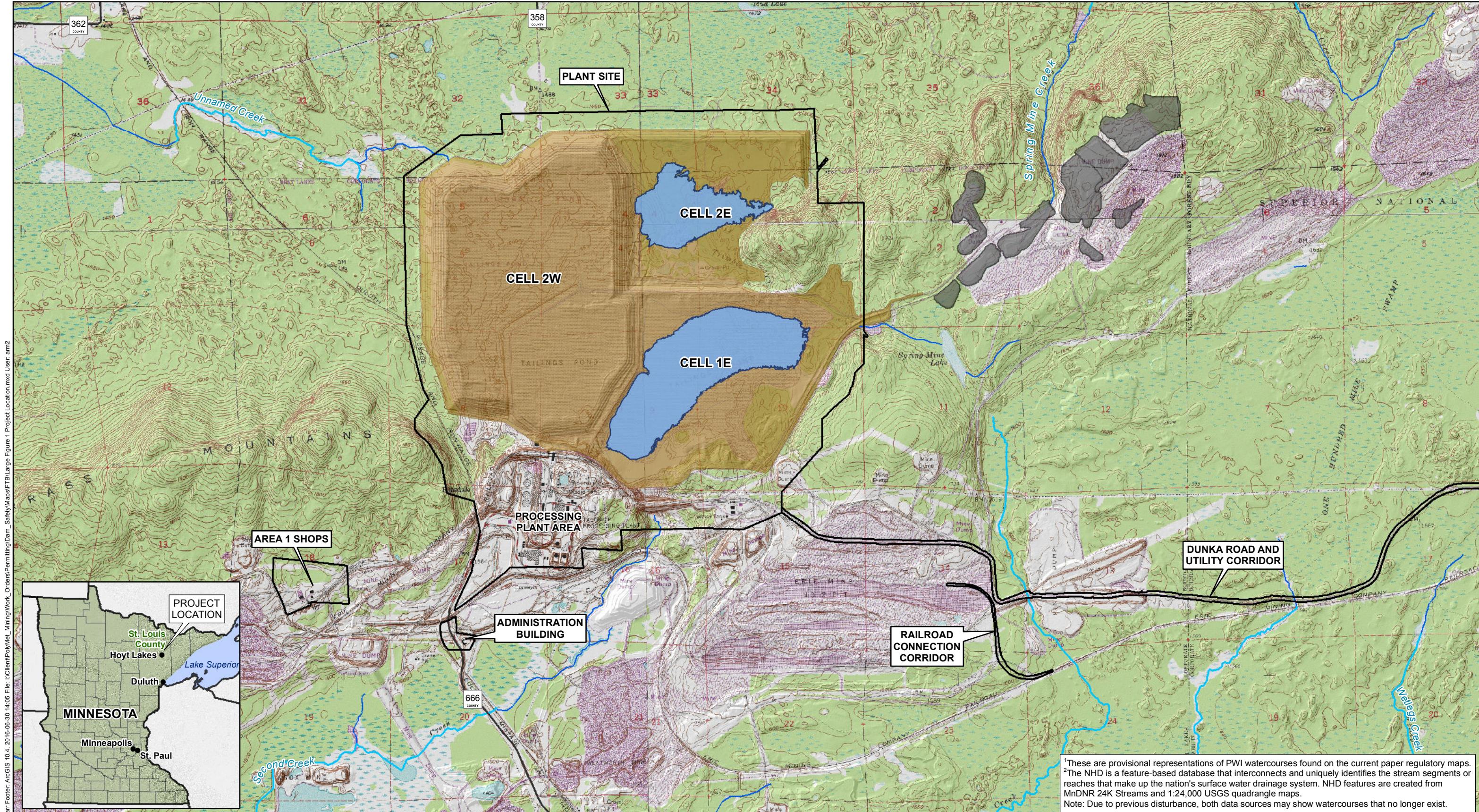
Large Table 2 Construction Phase - Construction Cost Estimate

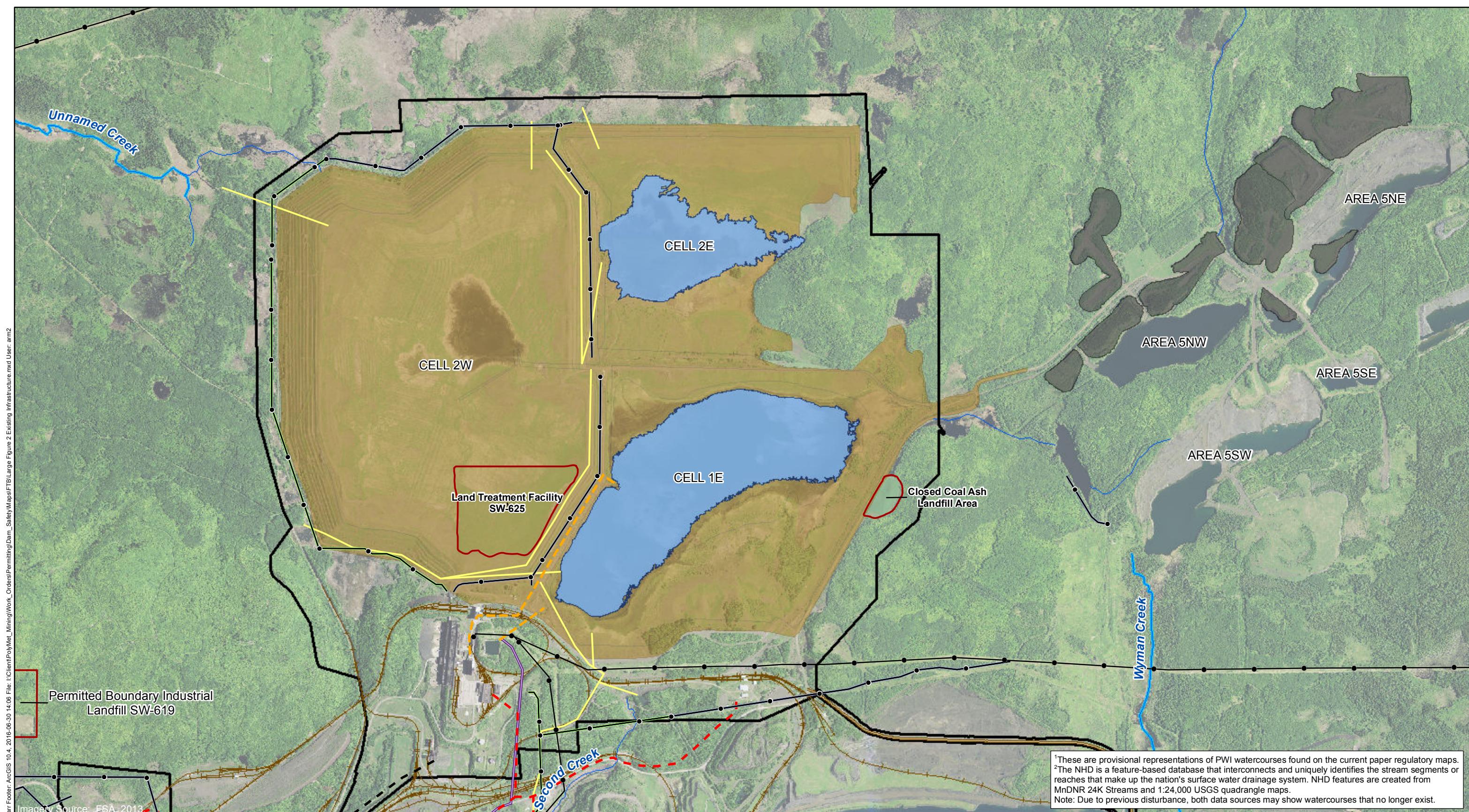
Item	Description	Unit	Construction Phase Quantity	Contractor Estimate	Cost Extension ⁽²⁾	Comments
1	Mobilization and Demobilization	LS	1	\$700,000.00	\$700,000	Project Setup, Equipment Mob. and Demob., Routine Project Admin., Health and Safety, Etc.
2	Preliminary Activities ⁽¹⁾				\$0	See Below
2.a.	Environmental Protection Measures ⁽¹⁾	LS	1	\$70,400.00	\$70,000	None
2.b.	Temporary Dewatering and Pumping ⁽¹⁾	LS	1	\$80,000.00	\$80,000	None
3	Clearing and Grubbing	Acre	0	\$2,000.00	\$0	None
4	Subgrade Improvement	Acre	70	\$600.00	\$42,000	Rough grade and compact existing tailings dam surface. Include removal of surface vegetation.
5	Peat Removal	CY	0	\$2.60	\$0	Excavate and dispose of peat for buttress construction. Dewatering incidental to excavation.
6	Rock Excavation (Drainage Swale)	CY	0	\$9.60	\$0	Excavate and dispose of soil and rock for drainage swale east of Cell 1E. Volume includes soil overburden.
7	LTVSMC Coarse Tailings Common Excavation and Stockpile	CY	0	\$2.40	\$0	Excavation, transport and stockpile LTVSMC Coarse Tailings from dam between Cells 1E and 2E to NE corner of Cell 2W.
8	LTVSMC Coarse Tailings Borrow	CY	2,475,900	\$2.60	\$6,437,000	Excavation, transport, placement, and compaction.
9	Import Borrow	CY	0	\$6.40	\$0	Procurement, transport, placement, and compaction.
10	Buttress Construction	CY	0	\$3.20	\$0	Transport, placement, and compaction – from Area 5 Waste Rock Stockpile to buttress (30" minus rock).
11	Cement Deep Soil Mix (CDSM) Zone Construction				\$0	See Below
11.a.	CDSM Construction Pad Installation	Acre	8.6	\$44,290	\$381,000	Geogrid or Non-Woven Geotextile Reinforcing (\$2.75/SY) and 2' Coarse Aggregate Import (\$9.60/CY).
11.b.	CDSM Construction	SF	375,000	\$29.15	\$10,931,000	Cost based on square feet treated using 3' dia. columns, 10' wall spacing, and 50' column length.
12	Slope Erosion Control - Topsoil, Seed, Mulch and Fertilizer	Acre	37	\$1,280.00	\$47,000	Shallow rooted grasses, one application fertilizer, and spray applied mulch. Include 4" topsoil.
13	Exterior Dike Bentonite Augmentation	Acre	37	\$28,800.00	\$1,066,000	Remove 30" tailings cover layer, mix 18" layer of soil with bentonite, compact augmented layer, replace 30" tailings cover layer and compact. Use 3% bentonite by weight for mixture.
14	Construct Dike Access Road ⁽¹⁾	LF	0	\$7.20	\$0	None
15	Relocate Coal Ash Landfill ⁽¹⁾	CY	0		\$0	Move to area specified by PolyMet.
16	Pumping and Piping				\$0	See Below
16.a.	Furnish and Install Floating Pump Station ⁽¹⁾	LS	1	\$880,000.00	\$880,000	Including pumps, raft, floating walkway access and all necessary fittings up to and including flexible hose.
16.b.	Furnish and Install 6-inch Dia. DR17 HDPE Pipe ⁽¹⁾	LF	3,000	\$22.40	\$67,000	Pipe from pump on floating pump station to discharge point in Cell 1E pond.
16.c.	Furnish and Install 16-inch Dia. Rubber Lined Pipe ⁽¹⁾	LF	4,500	\$41.60	\$187,000	Pipe for tailings discharge from pond edge to discharge barge/raft incl. pipe support pontoon and pipe.
16.d.	Furnish Tailings Discharge Pipe Barge/Raft and Diffuser ⁽¹⁾	LS	0		\$0	Procurement by Contractor. Installation will be completed by PolyMet.
17	Random Riprap	CY	1,000	\$17.60	\$18,000	Area 5 rock crushed to MnDOT Class II riprap specs. Include geotextile fabric.
18	Furnish and Install Concrete Precast Channel	LF	1,600	\$340.00	\$544,000	EOF Channel installation. Include grading and access road with 8 inches of 1" minus rock as road surface.
19	Remove and Reinstall Precast Channel	LF	0	\$40.00	\$0	EOF Channel installation. Include grading and access road with 8 inches of 1" minus rock as road surface.
20	Site Restoration	AC	196	\$1,600.00	\$314,000	Seed, fertilize, and mulch disturbed areas including stockpiles.
21	Granular Filter Material	CY	400	\$14.40	\$6,000	MnDOT 3601-2 granular filter material.
22	Allowance for Haul Road Construction - Area 5 to Basin ⁽¹⁾	LS	1	\$520,000.00	\$520,000	None
Cost Estimate Total – Flotation Tailings Basin: Project Construction Phase					\$22,290,000	
Portion of Cost Estimate Total Subject to MDNR Dam Inspection Fees – Flotation Tailings Basin: Project Construction Phase					\$20,486,000	

(1) Items anticipated to be excluded from computation of MDNR Dam Inspection Fees and therefore excluded from Construction Cost Estimate Total subject to MDNR Dam Inspection Fees.

(2) Cost Extensions rounded to nearest \$1,000.

Large Figures





EIS Project Areas	Colby Lake Pipeline
Existing Tailings Basin	Existing Pipelines
Tailings Ponds	Tailings Water Management (Surface)
Area 5 Stockpile Footprints	Tailings Water Management (Underground)
Solid Waste Facilities - Approximate Boundaries	Inter-Pit Pipeline for Shop
	Water Supply (Underground)
Existing Private Railroad	Power Lines In Use
	Power Lines Not In Use
	Public Waters Inventory (PWI) Watercourses ¹
	National Hydrography Dataset (NHD) Rivers & Streams ²
	Natural Gas Line (Underground)

0 1,000 2,000 4,000
Feet



TAILINGS BASIN AREA
EXISTING INFRASTRUCTURE
NorthMet Project
Poly Met Mining Inc.

Large Figure 2
Dam Safety Permit Application

Attachments

Attachment A

Permit Application Support Drawings – Flotation Tailings Basin

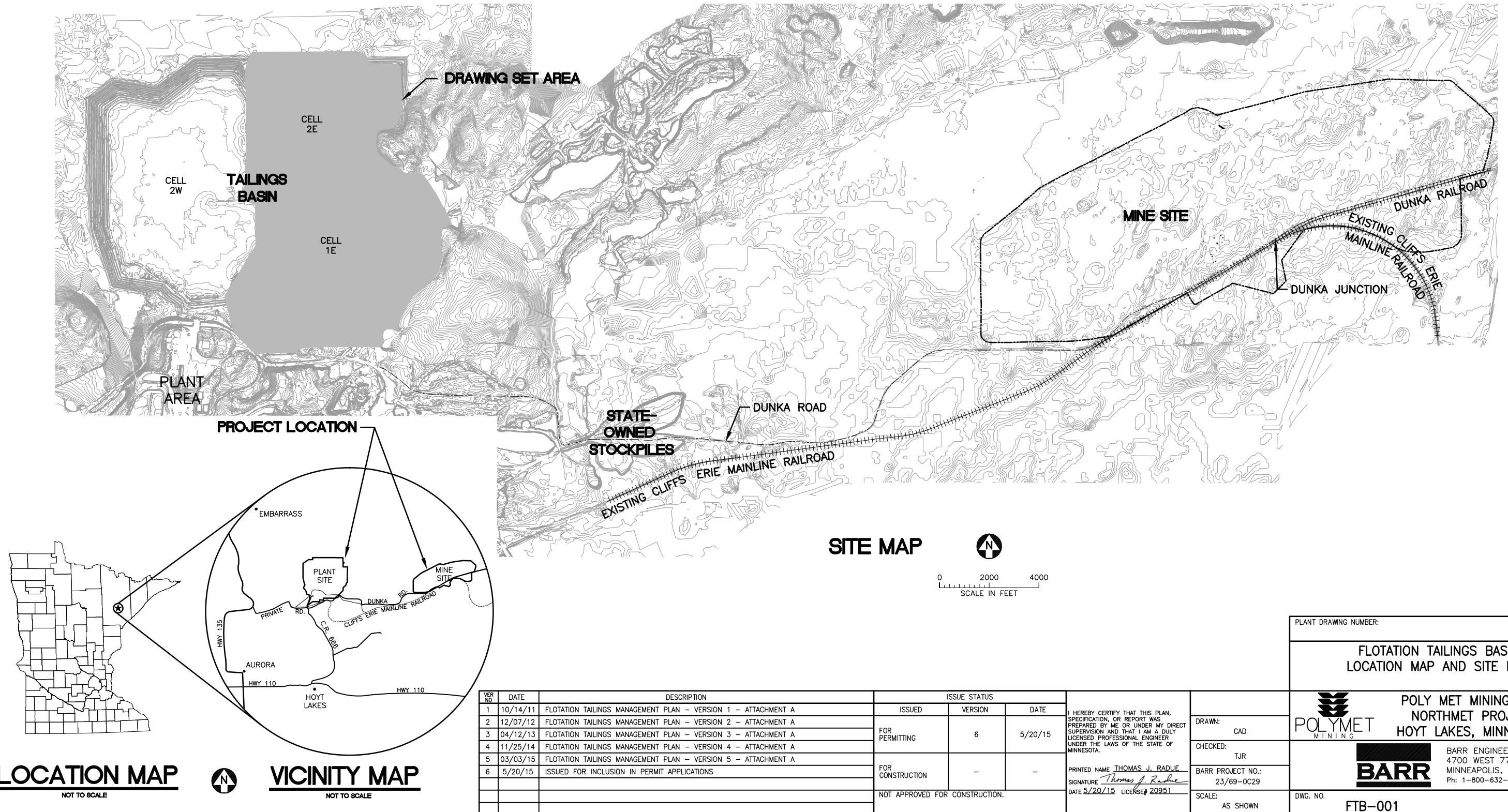
POLY MET MINING, INC. NORTHMET PROJECT

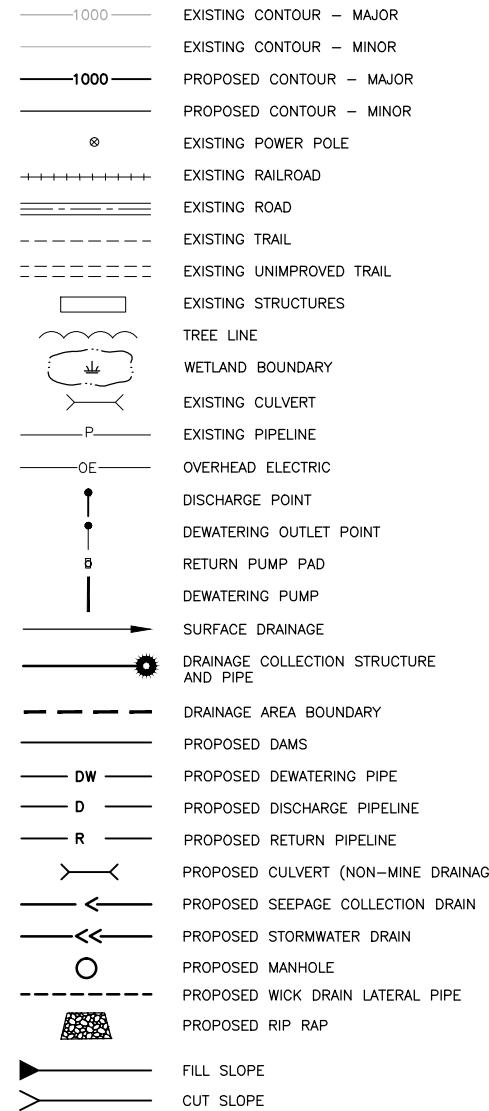
PERMIT SUPPORT DRAWINGS

FLOTATION TAILINGS BASIN

HOYT LAKES, MINNESOTA

CADD USER: AdaptUser FILE: \\PWEDENA\EDINA\PW\IN\18635E06-BFF8-4AD0-A31A-2092BF3D0E7C\23E2B6BF-424F-48B5-B4E7-6143B7B81CA8\PERMIT_NMMT-02-CS-001.DWG PLOT DATE: 6/8/2015 4:09 PM



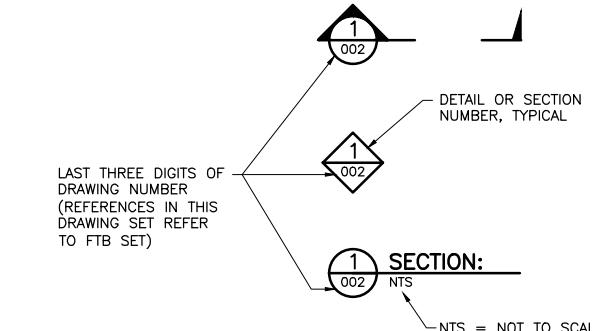
GENERAL LEGENDABBREVIATIONS

APPROX.	- APPROXIMATE
CDSM	- CEMENT DEEP SOIL MIX
CMP	- CORRUGATED METAL PIPE
CPEP	- CORRUGATED POLYETHYLENE PIPE
CY	- CUBIC YARD
DR	- DIMENSION RATIO
DWG	- DRAWING
EL.	- ELEVATION
F	- DIAMETER
FTB	- FLOTATION TAILINGS BASIN
GCL	- GEOSYNTHETIC CLAY LINER
HDPE	- HIGH DENSITY POLYETHYLENE
HRF	- HYDROMETALLURGICAL RESIDUE FACILITY
LDPE	- LOW DENSITY POLYETHYLENE
LF	- LINER FEET
LTVSMC	- LTV STEEL MINING COMPANY
MCY	- MILLION CUBIC YARDS
mil	- one thousandth of an inch
MIN	- MINIMUM
MSL	- MEAN SEA LEVEL
NTS	- NOT TO SCALE
SCH.	- SCHEDULE
DR	- DIMENSION RATIO
TYP.	- TYPICAL

SHEET INDEXSHEET NO. TITLE

GENERAL DRAWINGS

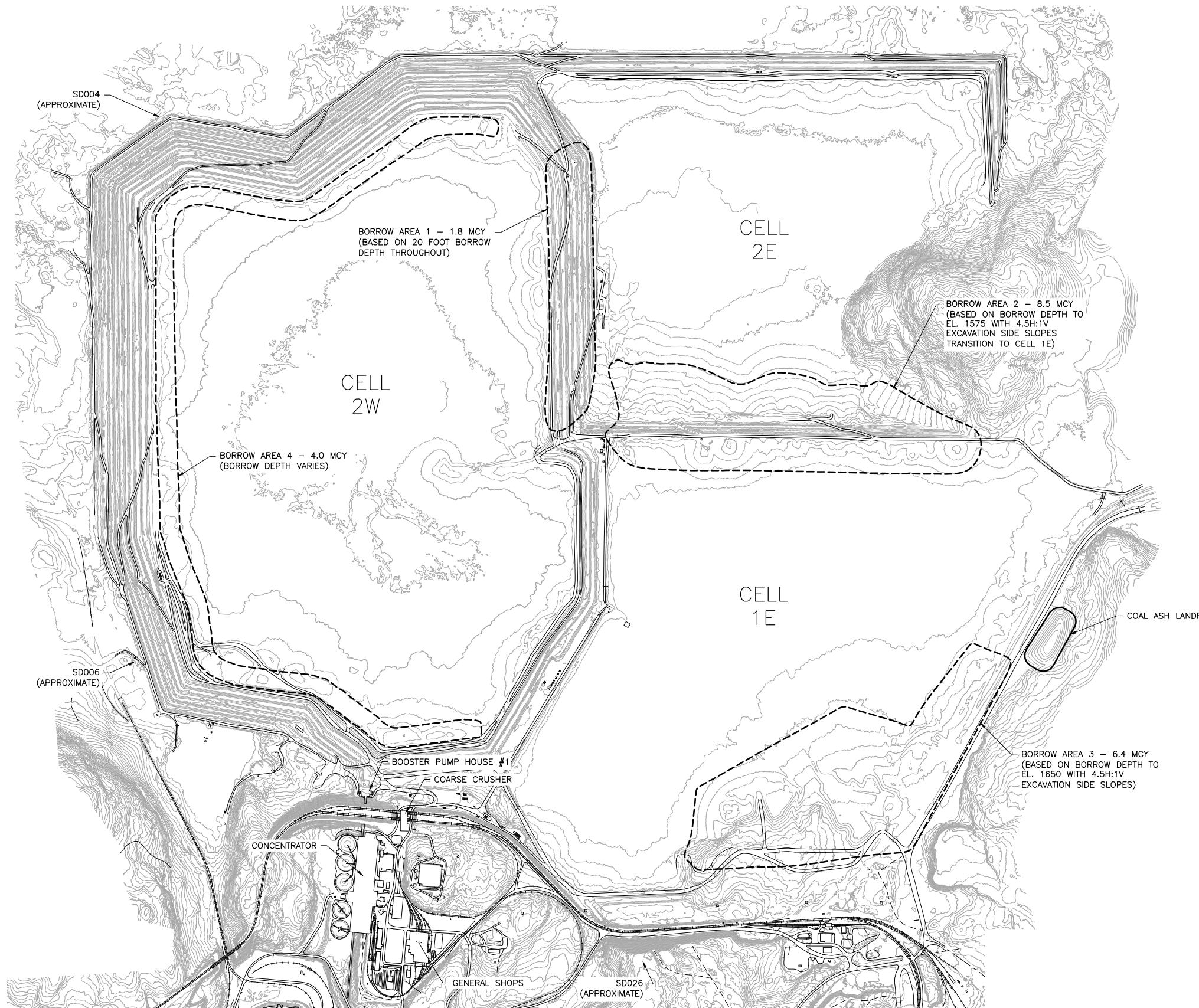
FTB-001	LOCATION MAP AND SITE MAP
FTB-002	LEGEND AND SHEET INDEX
FTB-003	EXISTING CONDITIONS
FTB-004	LAYOUT MINE YEAR 20
FTB-005	LAYOUT MINE YEAR 1
FTB-006	LAYOUT MINE YEAR 5
FTB-007	LAYOUT MINE YEAR 7
FTB-008	NORTH DAM - MINE YEAR 20 LAYOUT
FTB-009	NORTH DAM - TYPICAL CROSS SECTION
FTB-010	NORTH DAM - STAGED CONSTRUCTION
FTB-011	EAST AND WEST DAMS - MINE YEAR 20 LAYOUT
FTB-012	EAST AND WEST DAMS - TYPICAL CROSS SECTIONS AND DRAINAGE SWALE
FTB-013	SOUTH DAM - MINE YEAR 20 LAYOUT
FTB-014	SOUTH DAM - TYPICAL CROSS SECTION
FTB-015	EMERGENCY OVERFLOW CHANNEL - LAYOUT
FTB-016	EMERGENCY OVERFLOW CHANNEL - SECTIONS
FTB-017	EMERGENCY OVERFLOW CHANNEL - DETAILS
FTB-018	EMERGENCY OVERFLOW CHANNEL - SEQUENCING
FTB-019	PIPING LAYOUT CELL 2E
FTB-020	PIPING LAYOUT CELL 1/2E
FTB-021	DETAILS
FTB-022	TRANSFER PUMP RAFT
FTB-023	TAILINGS DISPOSAL DIFFUSER RAFT
FTB-024	CLOSURE PLAN

DRAWING NUMBERINGNOTES

- COORDINATE SYSTEM IS MINNESOTA STATE PLANE NORTH ZONE, NAD83.
- ELEVATIONS ARE MEAN SEA LEVEL (MSL), NAVD88.
- EXISTING TOPOGRAPHIC INFORMATION SHOWN ON THE DRAWINGS WAS PREPARED BY AEROMETRIC, INC. FROM LIDAR DATA COLLECTED ON MARCH 17, 2010.
- EXISTING TOPOGRAPHIC INFORMATION WAS UPDATED FOR AREAS SOUTH EAST OF COAL ASH LANDFILL AND EAST OF OUTCROP BETWEEN CELLS 1E AND 2E USING CONTOURS FROM DATA COLLECTED IN 1999.
- FLOTATION TAILINGS BASIN DESIGN WAS BASED ON CONTOURS FROM DATA COLLECTED IN 1999. PROPOSED DAM LAYOUTS MAY NOT EXACTLY MATCH THE TOPOGRAPHY FROM 2010 LIDAR.

PLANT DRAWING NUMBER:		FLOTATION TAILINGS BASIN LEGEND AND SHEET INDEX	
POLY MET MINING, INC. NORTHMET PROJECT HOYT LAKES, MINNESOTA		BARR ENGINEERING COMPANY 4700 WEST 77TH STREET MINNEAPOLIS, MN. Ph: 1-800-632-2277	
POLYMET MINING		BARR	
VER NO	DATE	DESCRIPTION	ISSUE STATUS
1	10/14/11	FLOTATION TAILINGS MANAGEMENT PLAN - VERSION 1 - ATTACHMENT A	ISSUED
2	12/07/12	FLOTATION TAILINGS MANAGEMENT PLAN - VERSION 2 - ATTACHMENT A	FOR PERMITTING
3	04/12/13	FLOTATION TAILINGS MANAGEMENT PLAN - VERSION 3 - ATTACHMENT A	6
4	11/25/14	FLOTATION TAILINGS MANAGEMENT PLAN - VERSION 4 - ATTACHMENT A	5/20/15
5	03/03/15	FLOTATION TAILINGS MANAGEMENT PLAN - VERSION 5 - ATTACHMENT A	
6	5/20/15	ISSUED FOR INCLUSION IN PERMIT APPLICATIONS	FOR CONSTRUCTION
			NOT APPROVED FOR CONSTRUCTION
			REV
			FTB-002

VER NO	DATE	DESCRIPTION	ISSUE STATUS	REMARKS
1	10/14/11	FLOTATION TAILINGS MANAGEMENT PLAN - VERSION 1 - ATTACHMENT A	ISSUED	
2	12/07/12	FLOTATION TAILINGS MANAGEMENT PLAN - VERSION 2 - ATTACHMENT A	FOR PERMITTING	
3	04/12/13	FLOTATION TAILINGS MANAGEMENT PLAN - VERSION 3 - ATTACHMENT A	6	
4	11/25/14	FLOTATION TAILINGS MANAGEMENT PLAN - VERSION 4 - ATTACHMENT A	5/20/15	
5	03/03/15	FLOTATION TAILINGS MANAGEMENT PLAN - VERSION 5 - ATTACHMENT A		
6	5/20/15	ISSUED FOR INCLUSION IN PERMIT APPLICATIONS	FOR CONSTRUCTION	
			NOT APPROVED FOR CONSTRUCTION	

**NOTES:**

1. CONTOURS DO NOT REFLECT BORROW REMOVAL.
2. BORROW LTVSMC COARSE TAILINGS IN THE NUMERICAL SEQUENCE SHOWN.
3. COAL ASH LANDFILL TO BE RELOCATED TO HYDROMET RESIDUE FACILITY OR ALTERNATE PERMITTED FACILITY PRIOR TO TAILINGS DEPOSITION IN CELL 1E.

PLANT DRAWING NUMBER:	
FTB-003	
FLOTATION TAILINGS BASIN EXISTING CONDITIONS	
POLY MET MINING, INC. NORTHMET PROJECT HOYT LAKES, MINNESOTA	
 POLYMET MINING	
BARR ENGINEERING COMPANY 4700 WEST 77TH STREET MINNEAPOLIS, MN. Ph: 1-800-632-2277	

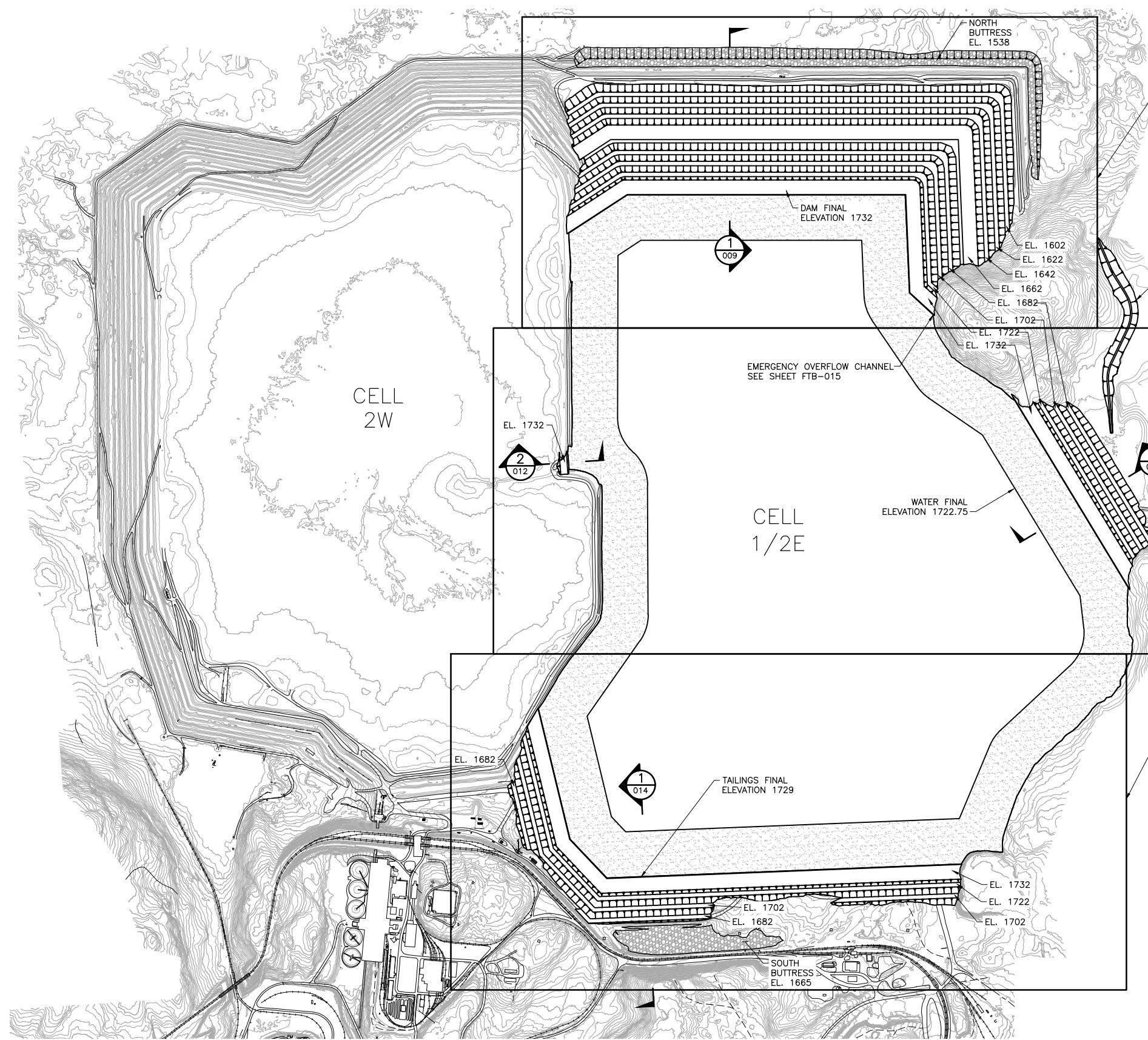
1 PLAN: EXISTING CONDITIONS

0 800 1600

SCALE IN FEET



VER NO	DATE	DESCRIPTION	ISSUED	VERSION	DATE	HEREBY CERTIFY THAT THIS PLAN, SHEET NO. OF WHICH THIS IS, WAS PREPARED BY ME OR UNDER MY DIRECT SUPERVISION AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MINNESOTA.
1	10/14/11	FLOTATION TAILINGS MANAGEMENT PLAN - VERSION 1 - ATTACHMENT A	FOR PERMITTING	6	5/20/15	
2	12/07/12	FLOTATION TAILINGS MANAGEMENT PLAN - VERSION 2 - ATTACHMENT A				DRAWN: CAD
3	04/12/13	FLOTATION TAILINGS MANAGEMENT PLAN - VERSION 3 - ATTACHMENT A				CHECKED: TJR
4	11/25/14	FLOTATION TAILINGS MANAGEMENT PLAN - VERSION 4 - ATTACHMENT A				BARR PROJECT NO.: 23/69-OC29
5	03/03/15	FLOTATION TAILINGS MANAGEMENT PLAN - VERSION 5 - ATTACHMENT A	FOR CONSTRUCTION	-	-	SCALE: AS SHOWN
6	5/20/15	ISSUED FOR INCLUSION IN PERMIT APPLICATIONS				DWG. NO. FTB-003
			NOT APPROVED FOR CONSTRUCTION			REV



- NOTE:**
- CEMENT DEEP SOIL MIX (CDSM) ZONE NOT SHOWN. SEE SHEETS FTB-003 AND FTB-009.
 - LOCATION AND DIMENSIONS OF CDSM SHEAR WALL MAY CHANGE AS DESIGNS ARE FINALIZED.

PLANT DRAWING NUMBER:
FLOTATION TAILINGS BASIN LAYOUT MINE YEAR 20

1 PLAN: TAILINGS BASIN LAYOUT MINE YEAR 20

0 800 1600
SCALE IN FEET

VER NO	DATE	DESCRIPTION	ISSUE STATUS
1	10/14/11	FLOTATION TAILINGS MANAGEMENT PLAN - VERSION 1 - ATTACHMENT A	ISSUED
2	12/07/12	FLOTATION TAILINGS MANAGEMENT PLAN - VERSION 2 - ATTACHMENT A	FOR PERMITTING
3	04/12/13	FLOTATION TAILINGS MANAGEMENT PLAN - VERSION 3 - ATTACHMENT A	6
4	11/25/14	FLOTATION TAILINGS MANAGEMENT PLAN - VERSION 4 - ATTACHMENT A	5/20/15
5	03/03/15	FLOTATION TAILINGS MANAGEMENT PLAN - VERSION 5 - ATTACHMENT A	
6	5/20/15	ISSUED FOR INCLUSION IN PERMIT APPLICATIONS	FOR CONSTRUCTION
			NOT APPROVED FOR CONSTRUCTION

HEREBY CERTIFY THAT THIS PLAN, SHEET NO. 004 OF 008, WAS PREPARED BY ME OR UNDER MY DIRECT SUPERVISION AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MINNESOTA.
DRAWN: CAD
CHECKED: TJR
BARR PROJECT NO.: 23/69-OC29
PRINTED NAME THOMAS J. RADUE SIGNATURE DATE 5/20/15 LICENSE # 20951

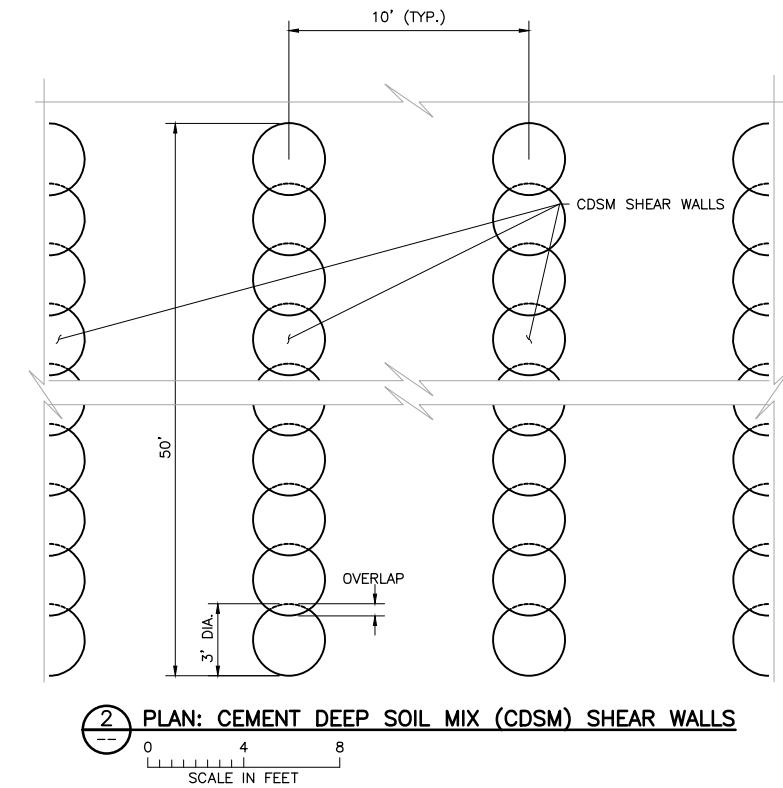
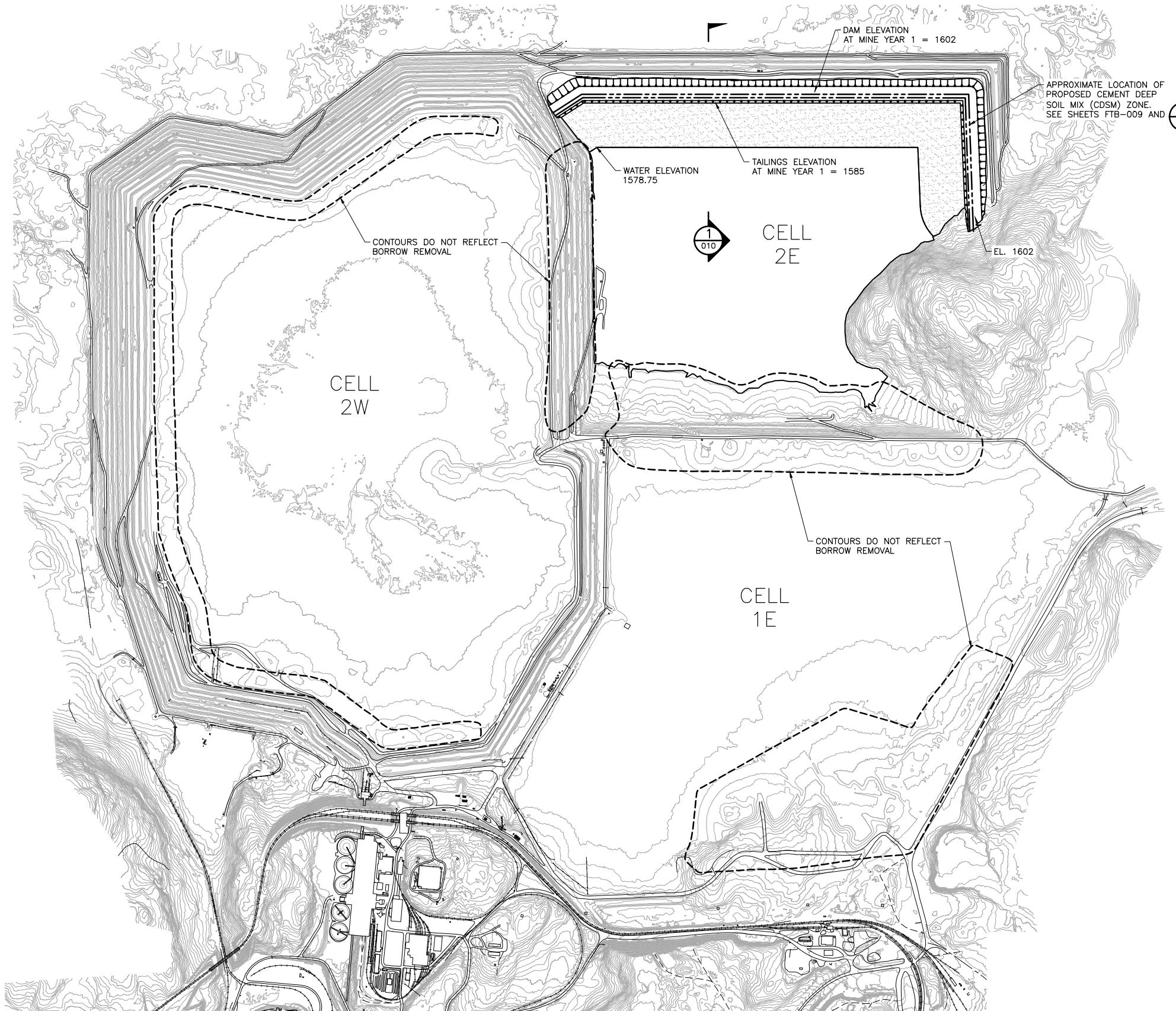
POLY MET MINING, INC.
NORTHMET PROJECT
HOYT LAKES, MINNESOTA

BARR ENGINEERING COMPANY
4700 WEST 77TH STREET
MINNEAPOLIS, MN.
Ph: 1-800-632-2277

REV

INCHES

DWG. NO. **FTB-004**



- NOTES:**
- SEE SHEET FTB-015 FOR OPERATIONS-PHASE EMERGENCY OVERFLOW CHANNEL.
 - CDSM TO BE CONSTRUCTED PRIOR TO TAILINGS PLACEMENT.

PLANT DRAWING NUMBER:
FLOTATION TAILINGS BASIN
LAYOUT MINE YEAR 1

1 PLAN: TAILINGS BASIN LAYOUT MINE YEAR 1
0 800 1600
SCALE IN FEET

INCHES

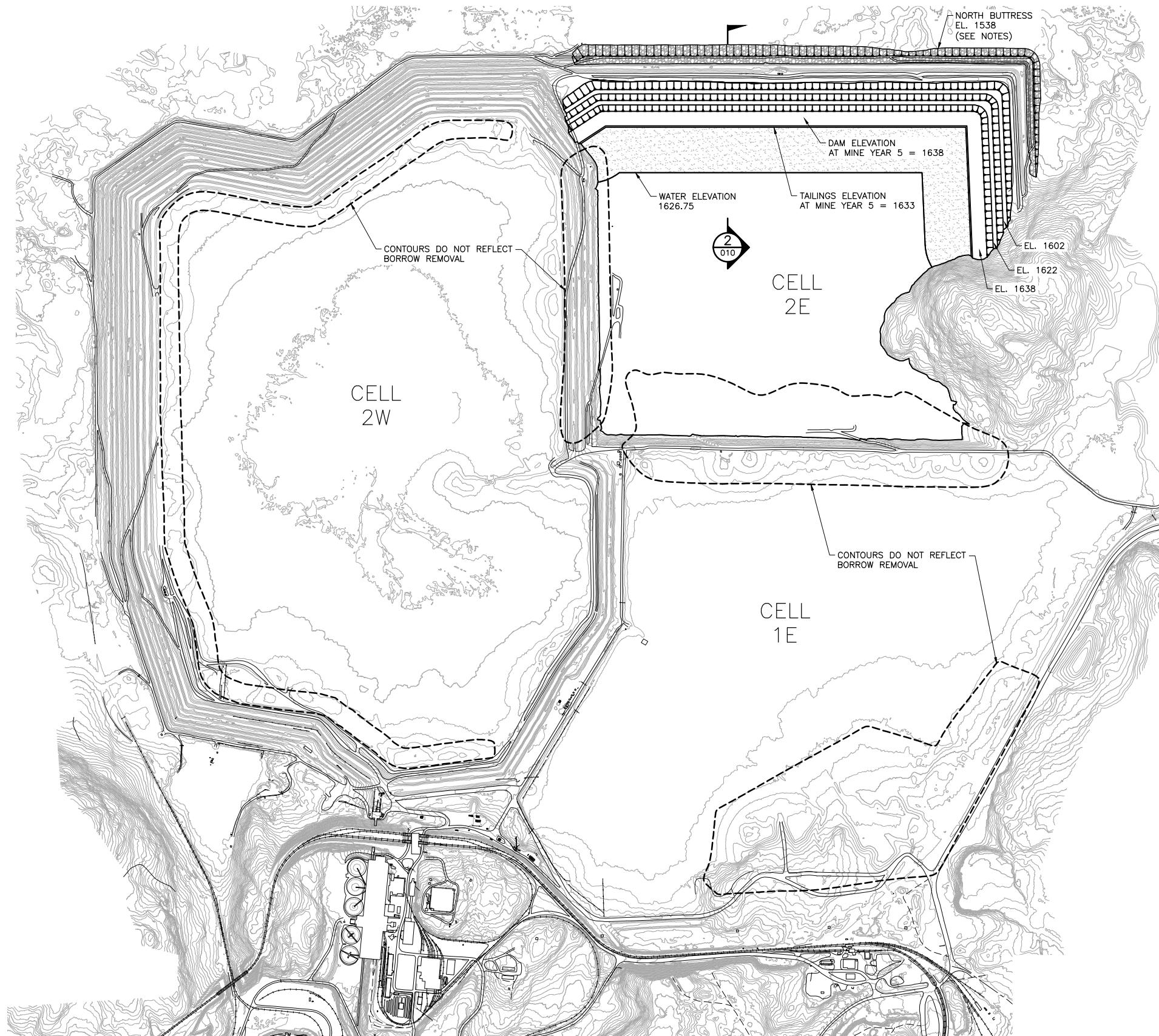
VER NO	DATE	DESCRIPTION	ISSUE STATUS	REMARKS
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2	12/07/12	FLOTATION TAILINGS MANAGEMENT PLAN - VERSION 2 - ATTACHMENT A	VERSION	6
3	04/12/13	FLOTATION TAILINGS MANAGEMENT PLAN - VERSION 3 - ATTACHMENT A	DATE	5/20/15
4	11/25/14	FLOTATION TAILINGS MANAGEMENT PLAN - VERSION 4 - ATTACHMENT A		
5	03/03/15	FLOTATION TAILINGS MANAGEMENT PLAN - VERSION 5 - ATTACHMENT A		
6	5/20/15	ISSUED FOR INCLUSION IN PERMIT APPLICATIONS	FOR CONSTRUCTION	PRINTED NAME THOMAS J. RADUE SIGNATURE Thomas J. Radue DATE 5/20/15 LICENSE # 20951
				NOT APPROVED FOR CONSTRUCTION

POLY MET MINING, INC.
NORTHMET PROJECT
HOYT LAKES, MINNESOTA
POLYMET
MINING

BARR ENGINEERING COMPANY
4700 WEST 77TH STREET
MINNEAPOLIS, MN.
Ph: 1-800-632-2277

BARR

DWG. NO. FTB-005 REV



NOTES:

1. SEE SHEET FTB-015 FOR OPERATIONS-PHASE EMERGENCY OVERFLOW CHANNEL.
2. CDSM ZONE NOT SHOWN. SEE SHEETS FTB-003 AND FTB-009.

PLANT DRAWING NUMBER:	
FLOTATION TAILINGS BASIN LAYOUT MINE YEAR 5	

POLY MET MINING, INC.
NORTHMET PROJECT
HOYT LAKES, MINNESOTA

BARR ENGINEERING COMPANY
4700 WEST 77TH STREET
MINNEAPOLIS, MN.
Ph: 1-800-632-2277

BARR

1 PLAN: TAILINGS BASIN LAYOUT MINE YEAR 5

0 800 1600
SCALE IN FEET

N

VER NO	DATE	DESCRIPTION	ISSUE STATUS	
1	10/14/11	FLOTATION TAILINGS MANAGEMENT PLAN - VERSION 1 - ATTACHMENT A	ISSUED	
2	12/07/12	FLOTATION TAILINGS MANAGEMENT PLAN - VERSION 2 - ATTACHMENT A	FOR PERMITTING	6 5/20/15
3	04/12/13	FLOTATION TAILINGS MANAGEMENT PLAN - VERSION 3 - ATTACHMENT A		
4	11/25/14	FLOTATION TAILINGS MANAGEMENT PLAN - VERSION 4 - ATTACHMENT A		
5	03/03/15	FLOTATION TAILINGS MANAGEMENT PLAN - VERSION 5 - ATTACHMENT A	FOR CONSTRUCTION	-
6	5/20/15	ISSUED FOR INCLUSION IN PERMIT APPLICATIONS		
			NOT APPROVED FOR CONSTRUCTION	

HEREBY CERTIFY THAT THIS PLAN,
SHEET FLOTATION TAILINGS BASIN
PREPARED BY ME OR UNDER MY DIRECT
SUPERVISION AND THAT I AM A DULY
LICENSED PROFESSIONAL ENGINEER
UNDER THE LAWS OF THE STATE OF
MINNESOTA.

PRINTED NAME THOMAS J. RADUE
SIGNATURE Thomas J. Radue
DATE 5/20/15 LICENSE # 20951

DRAWN:
CAD

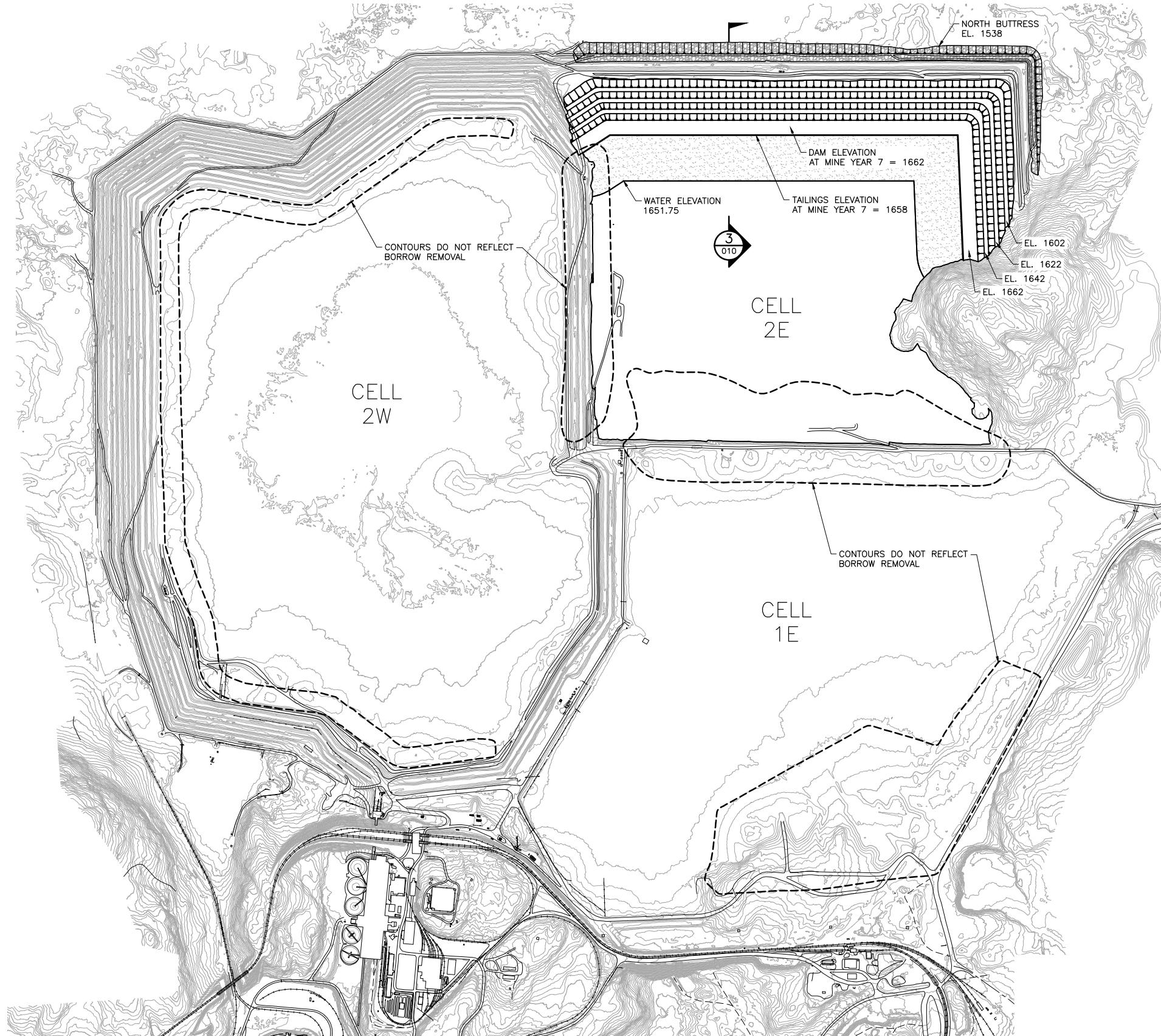
CHECKED:
TJR

BARR PROJECT NO.:
23/69-OC29

SCALE:
AS SHOWN

FTB-006

REV



1 PLAN: TAILINGS BASIN LAYOUT MINE YEAR 7

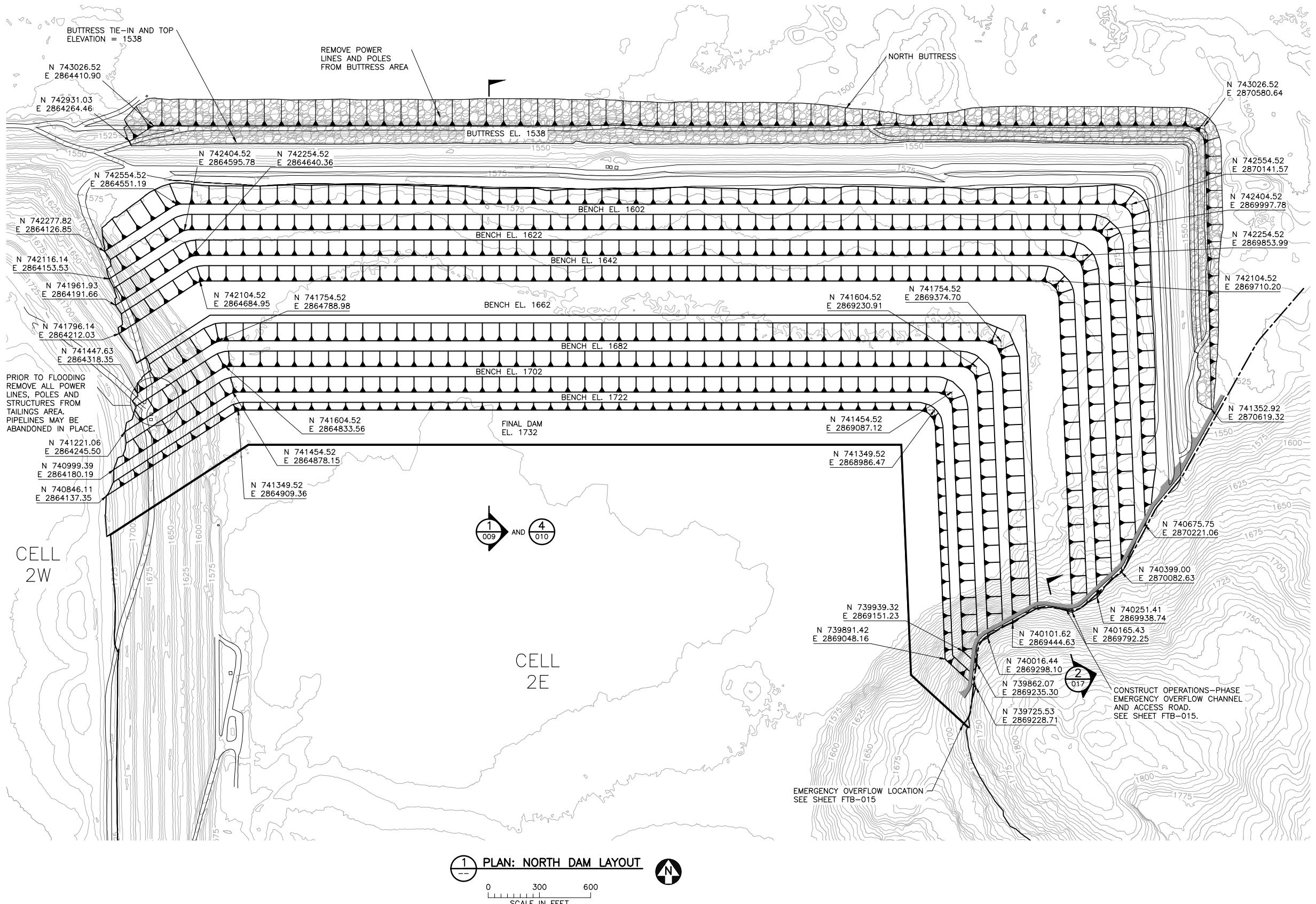
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3	04/12/13	FLOTATION TAILINGS MANAGEMENT PLAN – VERSION 3 – ATTACHMENT A	FOR PERMITTING	6
4	11/25/14	FLOTATION TAILINGS MANAGEMENT PLAN – VERSION 4 – ATTACHMENT A		
5	03/03/15	FLOTATION TAILINGS MANAGEMENT PLAN – VERSION 5 – ATTACHMENT A		
6	5/20/15	ISSUED FOR INCLUSION IN PERMIT APPLICATIONS	FOR CONSTRUCTION	–
			NOT APPROVED FOR CONSTRUCTION	

S	DATE	I HEREBY CERTIFY THAT THIS PLAN, SPECIFICATION, OR REPORT WAS PREPARED BY ME OR UNDER MY DIREC- TION AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MINNESOTA.
	5/20/15	

PRINTED NAME THOMAS J. RADU
SIGNATURE *Thomas J. Radu*
DATE 5/20/15 LICENSE# 20951

tion

PLANT DRAWING NUMBER:	
FLOTATION TAILINGS BASIN LAYOUT MINE YEAR 7	
 POLYMET <small>MINING</small>	POLY MET MINING, INC. NORTHMET PROJECT HOYT LAKES, MINNESOTA
	 BARR
BARR ENGINEERING COMPANY 4700 WEST 77TH STREET MINNEAPOLIS, MN. Ph: 1-800-632-2277	
DWG. NO.	REV
FTB-007	



VER NO	DATE	
1	10/14/11	FLOTATION TAILING
2	12/07/12	FLOTATION TAILING
3	04/12/13	FLOTATION TAILING
4	11/25/14	FLOTATION TAILING
5	03/03/15	FLOTATION TAILING
6	5/20/15	ISSUED FOR INC

EMERGENCY OVERFLOW LO
SEE SHEET FTB-015

NOTES:

1. DAM ACCESS ROAD LOCATION IS APPROXIMATE. FIELD LOCATE TO PROVIDE PREFERRED SLOPE AND DRAINAGE.
2. EXTEND ACCESS ROAD TO AREA 5 STOCKPILES AND TO PLANT (NOT SHOWN).
3. CDSM ZONE NOT SHOWN. SEE SHEETS FTR-003 AND FTR-009

NT DRAWING NUMBER:

FLOTATION TAILINGS BASIN
NORTH DAM
MINE YEAR 20 LAYOUT

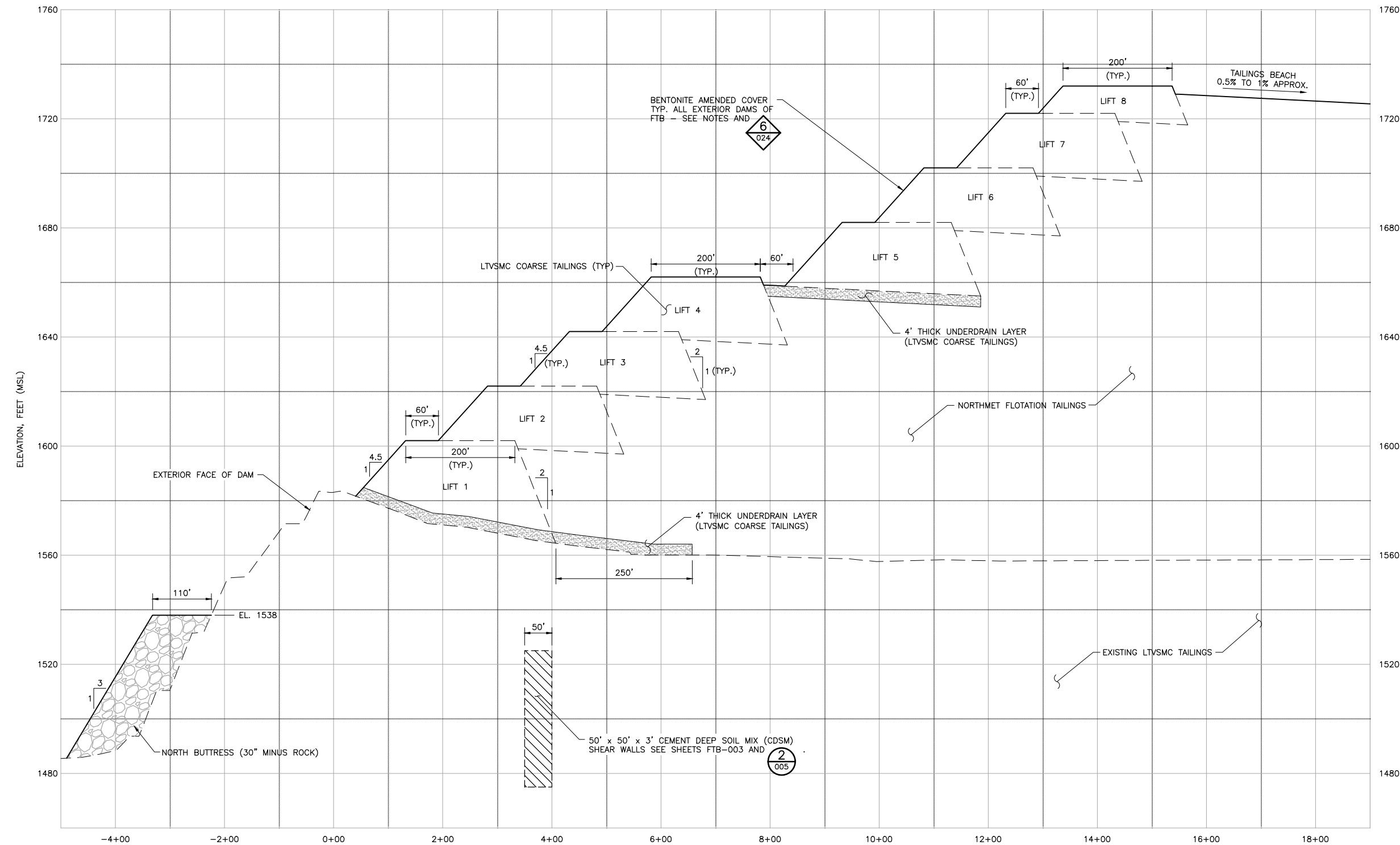
 POLYMET
MINING

POLY MET MINING, INC.
NORTHMET PROJECT
HOYT LAKES, MINNESOTA

 BARR

BARR ENGINEERING COMPANY
4700 WEST 77TH STREET
MINNEAPOLIS, MN.
Ph: 1-800-632-2277

NO. FTB-008 REV



ELEVATION: NORTH DAM TYPICAL CROSS SECTION

NOTES:

- DAMS AND BUTTRESS DIMENSIONS MAY CHANGE WITH EVALUATION OF FUTURE DAM STABILITY PERFORMANCE DATA.
- LOCATION AND DIMENSIONS OF CDSM SHEAR WALLS MAY CHANGE AS DESIGNS ARE FINALIZED.

PLANT DRAWING NUMBER:

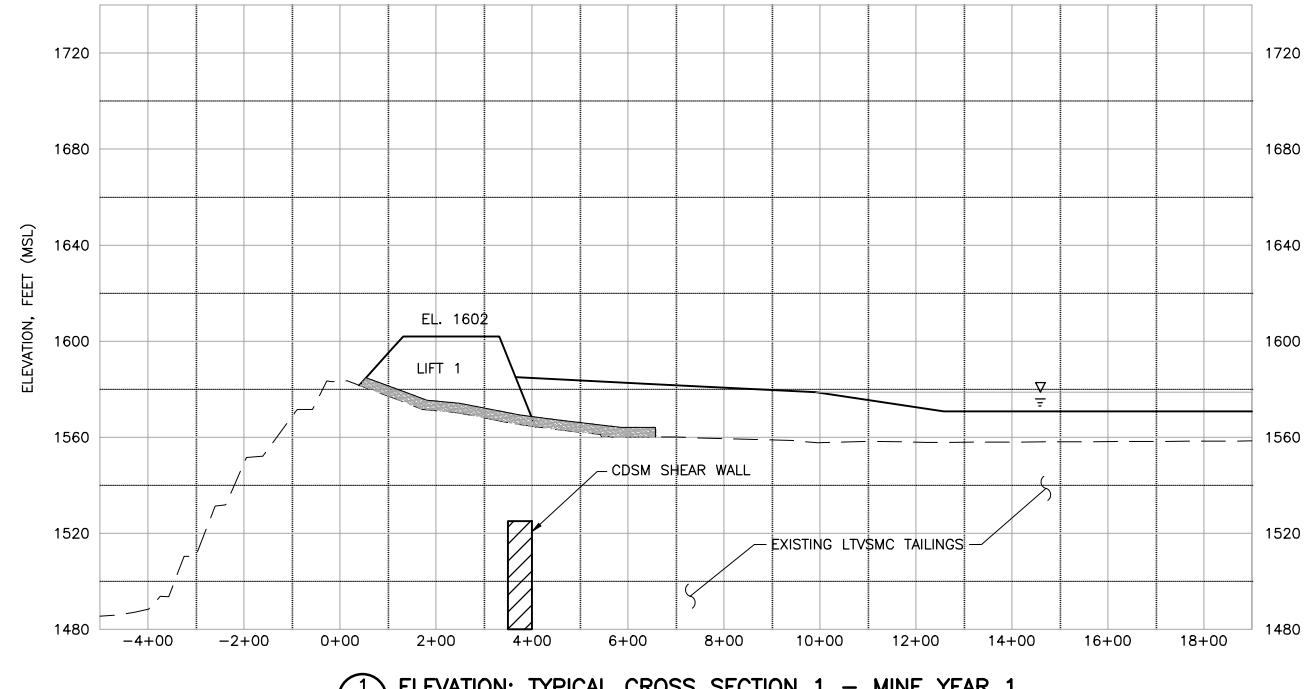
FLOTATION TAILINGS BASIN
NORTH DAM
TYPICAL CROSS SECTION

POLY MET MINING, INC.
NORTHMET PROJECT
HOYT LAKES, MINNESOTA

BARR ENGINEERING COMPANY
4700 WEST 77TH STREET
MINNEAPOLIS, MN.
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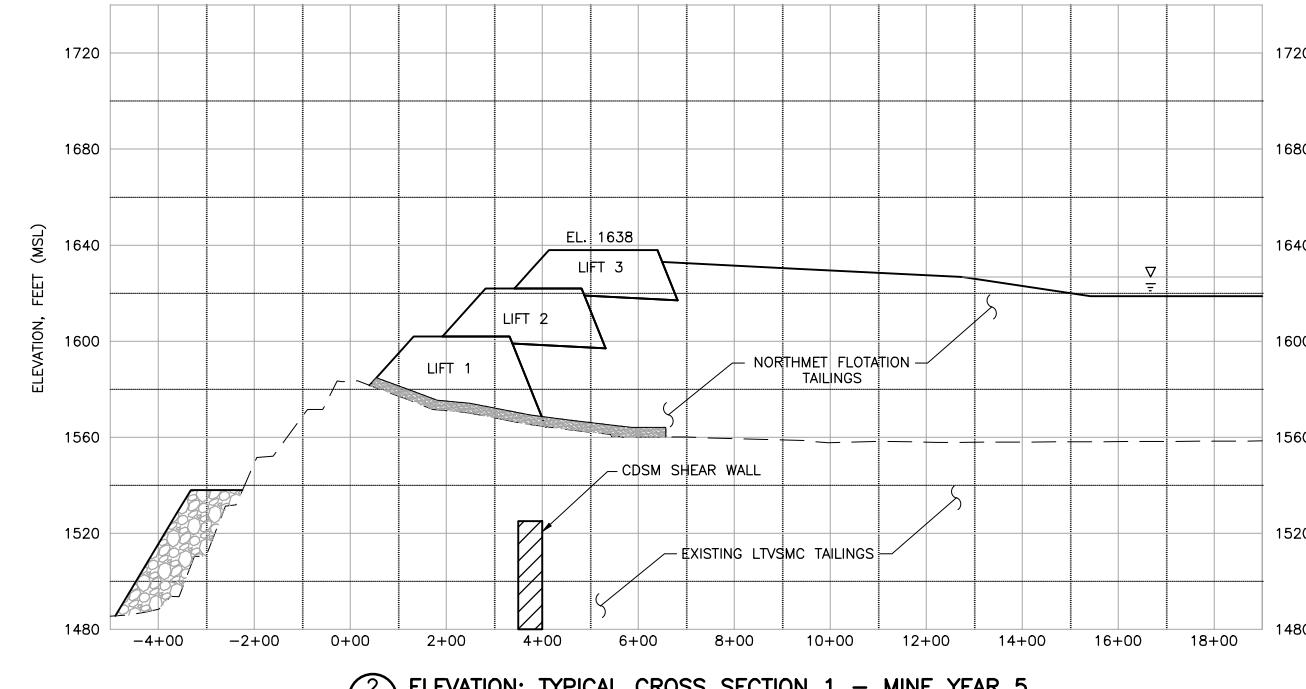
BARR

VER NO	DATE	DESCRIPTION	ISSUE STATUS	PRINTED NAME	SIGNATURE	DATE
1	10/14/11	FLOTATION TAILINGS MANAGEMENT PLAN - VERSION 1 - ATTACHMENT A	ISSUED	THOMAS J. RADUE	Thomas J. Radue	
2	12/07/12	FLOTATION TAILINGS MANAGEMENT PLAN - VERSION 2 - ATTACHMENT A	FOR PERMITTING			5/20/15
3	04/12/13	FLOTATION TAILINGS MANAGEMENT PLAN - VERSION 3 - ATTACHMENT A				
4	11/25/14	FLOTATION TAILINGS MANAGEMENT PLAN - VERSION 4 - ATTACHMENT A				
5	03/03/15	FLOTATION TAILINGS MANAGEMENT PLAN - VERSION 5 - ATTACHMENT A	FOR CONSTRUCTION			
6	5/20/15	ISSUED FOR INCLUSION IN PERMIT APPLICATIONS				
			NOT APPROVED FOR CONSTRUCTION			



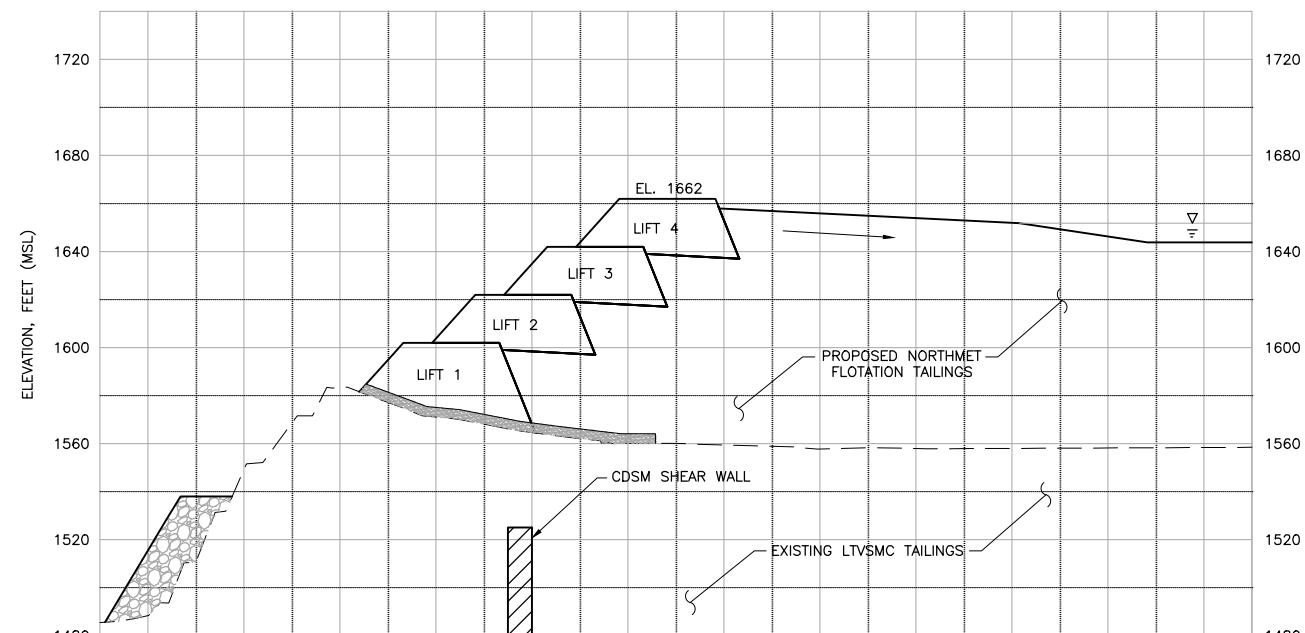
1 ELEVATION: TYPICAL CROSS SECTION 1 - MINE YEAR 1

0 200 400
HORZ. SCALE IN FEET



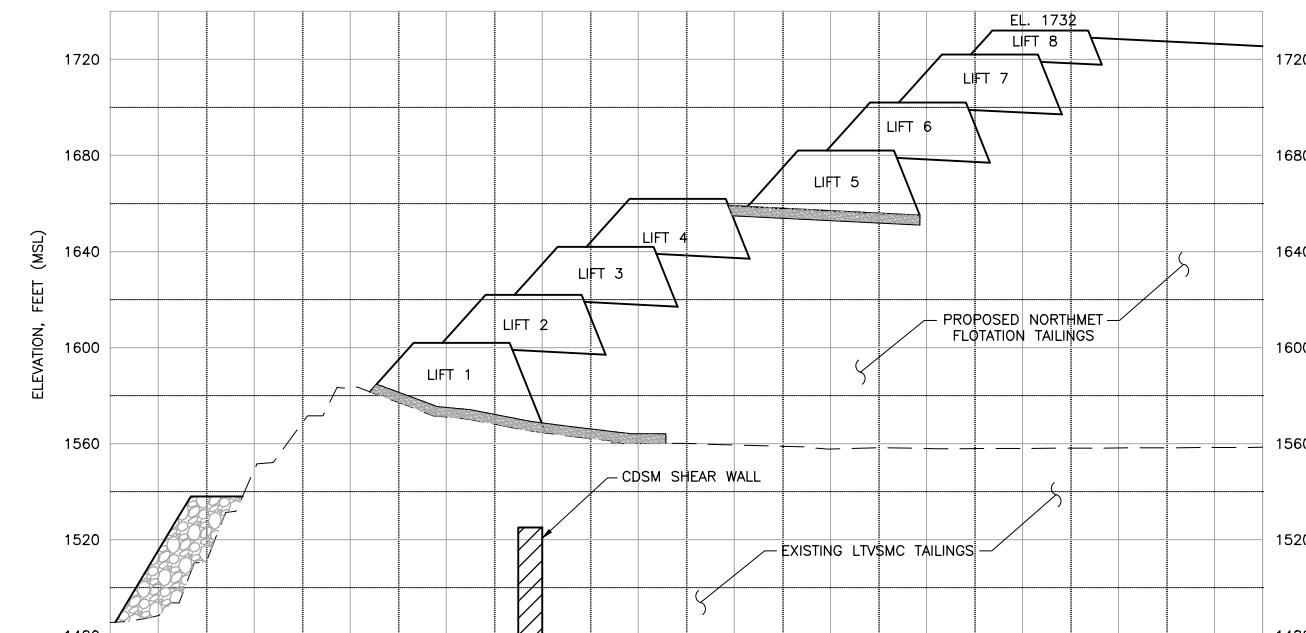
2 ELEVATION: TYPICAL CROSS SECTION 1 - MINE YEAR 5

0 200 400
HORZ. SCALE IN FEET



3 ELEVATION: TYPICAL CROSS SECTION 1 - MINE YEAR 7

0 200 400
HORZ. SCALE IN FEET



4 ELEVATION: TYPICAL CROSS SECTION 1 - MINE YEAR 20

0 200 400
HORZ. SCALE IN FEET

NOTE:

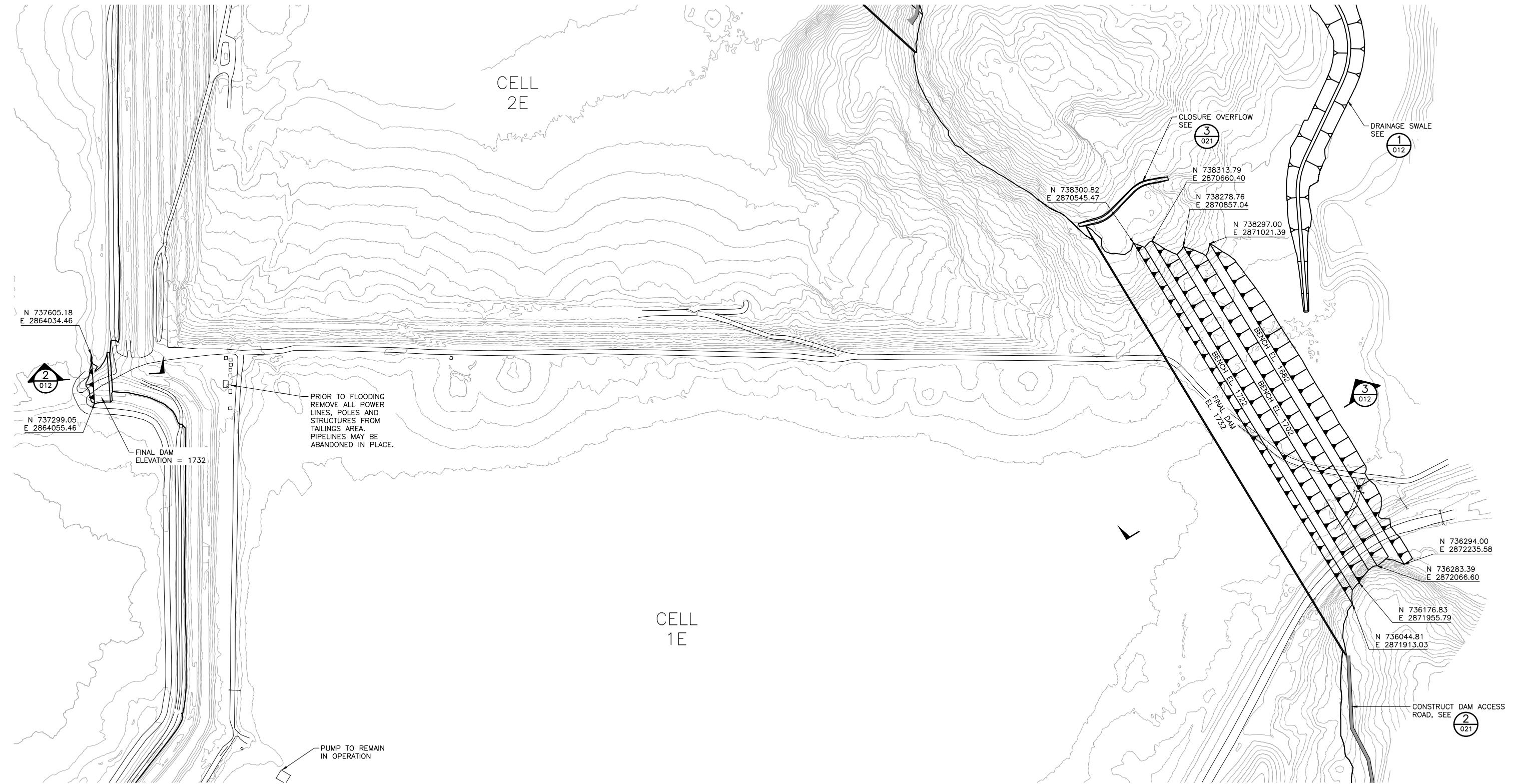
- DAM AND BUTTRESS DIMENSIONS MAY CHANGE WITH EVALUATION OF FUTURE DAM STABILITY PERFORMANCE DATA.
- PLACE BENTONITE AMENDED SOIL COVER ON OUTSIDE FACE OF NEW DAMS.

VER NO	DATE	DESCRIPTION	ISSUE STATUS
1	10/14/11	FLOTATION TAILINGS MANAGEMENT PLAN - VERSION 1 - ATTACHMENT A	ISSUED
2	12/07/12	FLOTATION TAILINGS MANAGEMENT PLAN - VERSION 2 - ATTACHMENT A	FOR PERMITTING
3	04/12/13	FLOTATION TAILINGS MANAGEMENT PLAN - VERSION 3 - ATTACHMENT A	6
4	11/25/14	FLOTATION TAILINGS MANAGEMENT PLAN - VERSION 4 - ATTACHMENT A	5/20/15
5	03/03/15	FLOTATION TAILINGS MANAGEMENT PLAN - VERSION 5 - ATTACHMENT A	FOR CONSTRUCTION
6	5/20/15	ISSUED FOR INCLUSION IN PERMIT APPLICATIONS	-
			NOT APPROVED FOR CONSTRUCTION
			Thomas J. Radue Signature: Thomas J. Radue Date 5/20/15 License # 20951

HEREBY CERTIFY THAT THIS PLAN, SPECIFICATIONS, OR DRAWINGS, PREPARED BY ME OR UNDER MY DIRECT SUPERVISION AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MINNESOTA.
DRAWN: CAD
CHECKED: TJR
BARR PROJECT NO.: 23/69-OC29
SCALE: AS SHOWN

PRINTED NAME THOMAS J. RADUE
SIGNATURE: Thomas J. Radue
DATE 5/20/15 LICENSE # 20951

PLANT DRAWING NUMBER:		
FLOTATION TAILINGS BASIN NORTH DAM STAGED CONSTRUCTION		
 POLY MET MINING, INC. NORTHMET PROJECT HOYT LAKES, MINNESOTA		
 BARR BARR ENGINEERING COMPANY 4700 WEST 77TH STREET MINNEAPOLIS, MN. Ph: 1-800-632-2277		
DWG. NO.	FTB-010	REV



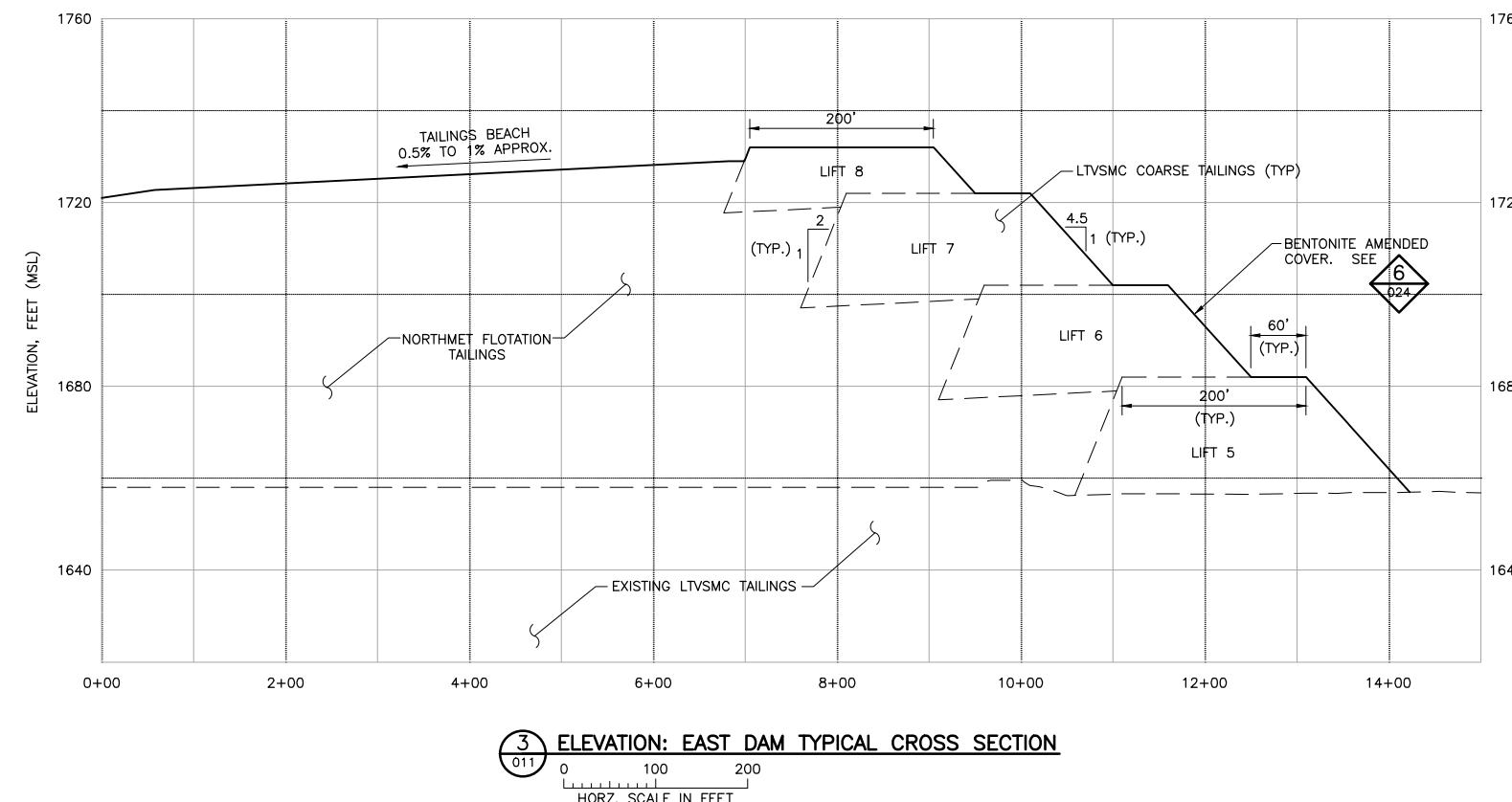
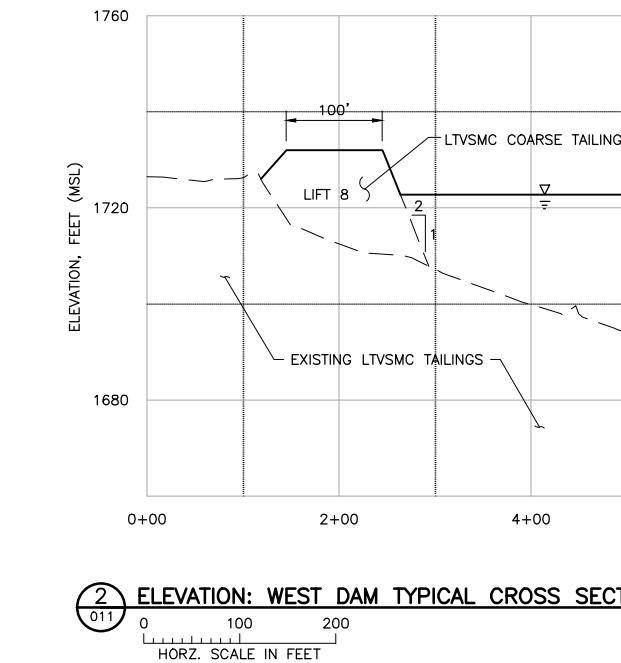
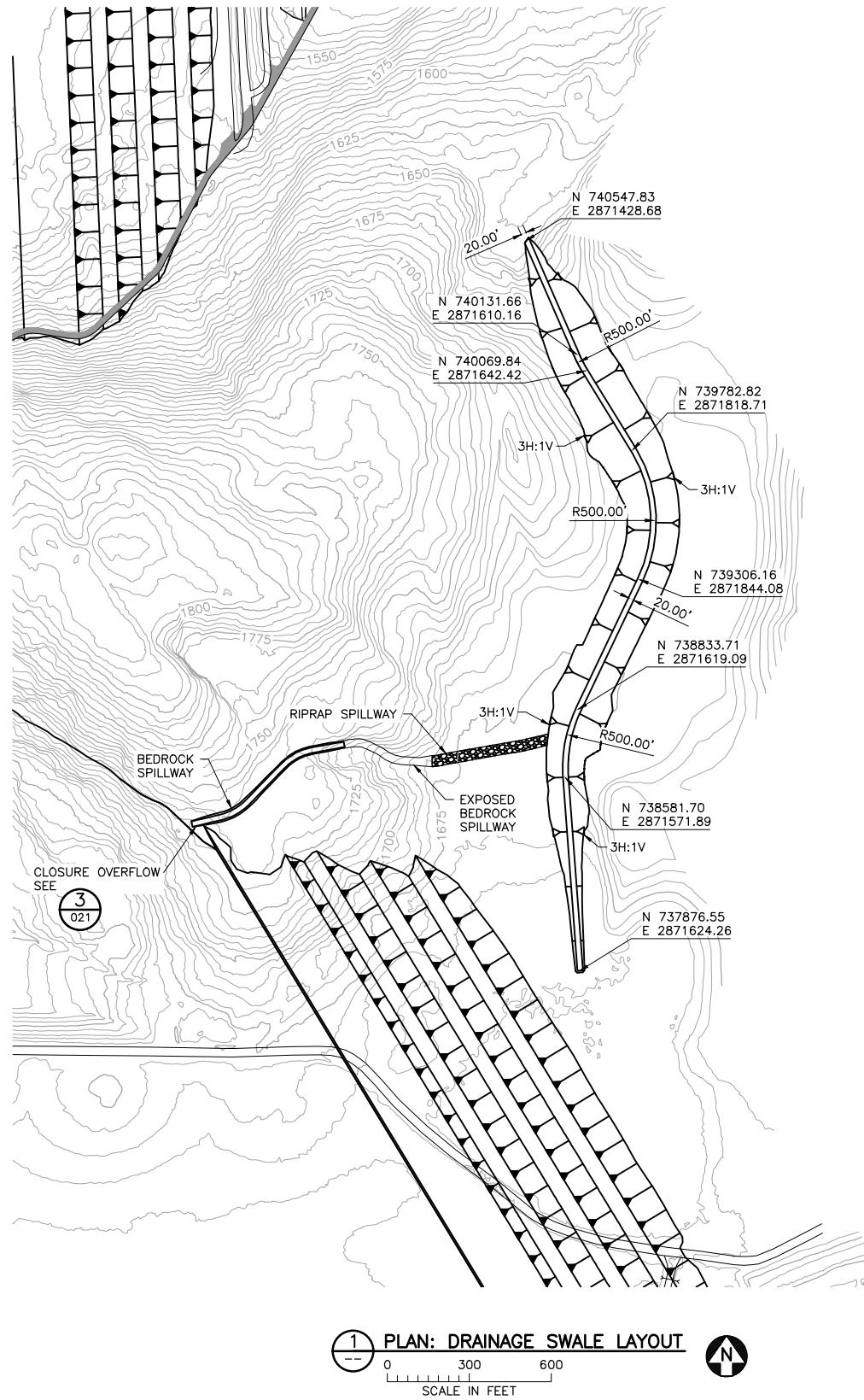
PLAN: EAST AND WEST DAM LAYOUT

VER NO	DATE	DESCRIPTION
1	10/14/11	FLOTATION TAILINGS MANAGEMENT PLAN – VERSION 1 – AT
2	12/07/12	FLOTATION TAILINGS MANAGEMENT PLAN – VERSION 2 – AT
3	04/12/13	FLOTATION TAILINGS MANAGEMENT PLAN – VERSION 3 – AT
4	11/25/14	FLOTATION TAILINGS MANAGEMENT PLAN – VERSION 4 – AT
5	03/03/15	FLOTATION TAILINGS MANAGEMENT PLAN – VERSION 5 – AT
6	5/20/15	ISSUED FOR INCLUSION IN PERMIT APPLICATIONS

	ISSUE STATUS		
MENT A	ISSUED	VERSION	DA
MENT A			
MENT A	FOR PERMITTING	6	5/20,
MENT A			
MENT A			
MENT A	FOR CONSTRUCTION	-	-
	NOT APPROVED FOR CONSTRUCTION		

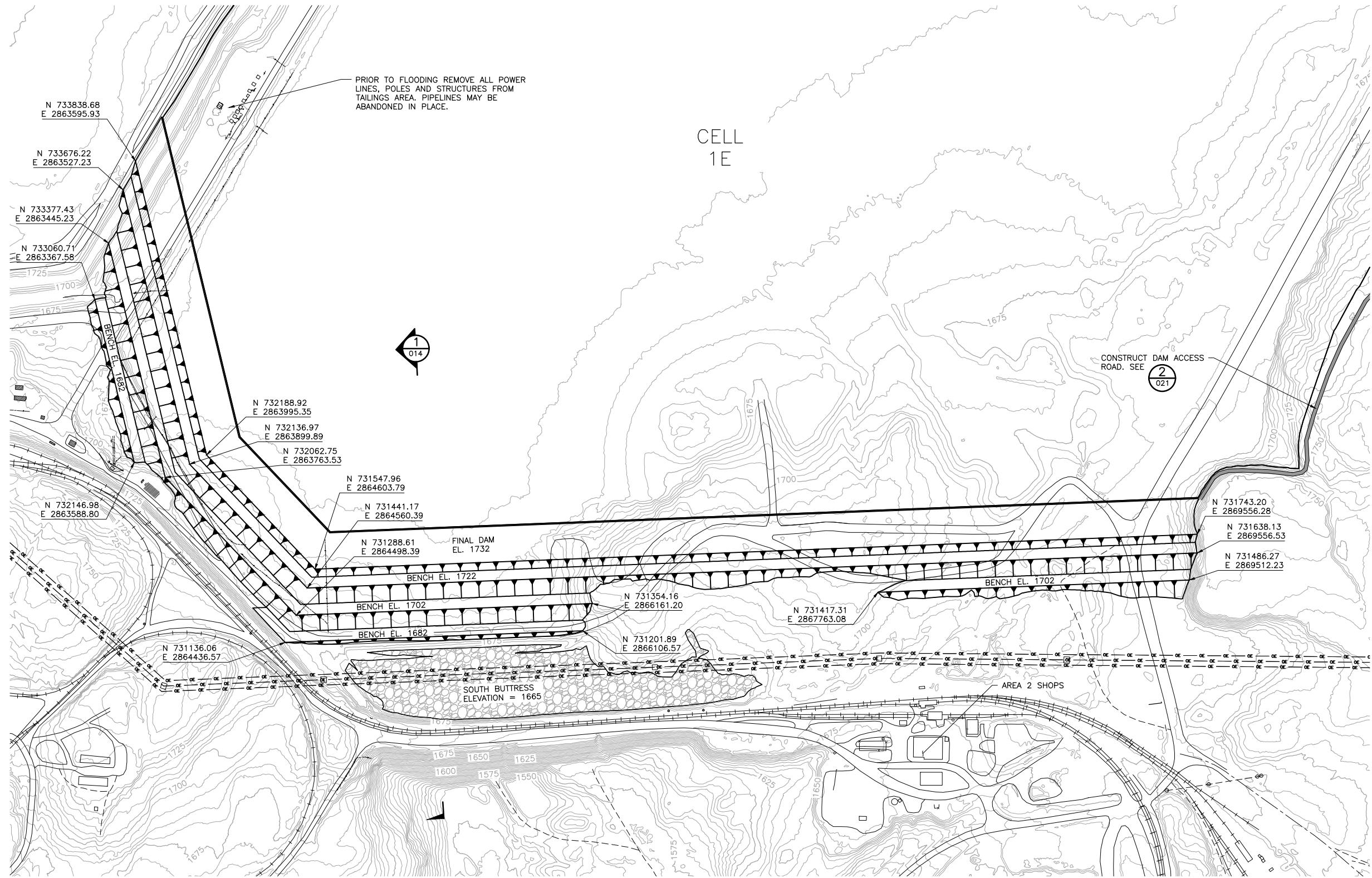
TE	I HEREBY CERTIFY THAT THIS PLAN, SPECIFICATION, OR REPORT WAS PREPARED BY ME OR UNDER MY DIREC- TION AND SUPERVISION AND THAT I AM A DUL- TURE LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MINNESOTA.
/15	PRINTED NAME THOMAS J. RADL
	SIGNATURE <i>Thomas J. Radl</i>
	DATE 5/20/15 LICENSE# 20951

PLANT DRAWING NUMBER:	
<p style="text-align: center;">FLOTATION TAILINGS BASIN EAST AND WEST DAMS MINE YEAR 20 LAYOUT</p>	
 POLYMET <small>MINING</small>	<p style="text-align: center;">POLY MET MINING, INC. NORTHMET PROJECT HOYT LAKES, MINNESOTA</p>
	 <p style="text-align: center;">BARR</p>
DWG. NO.	REV
FTB-011	
BARR ENGINEERING COMPANY 4700 WEST 77TH STREET MINNEAPOLIS, MN. Ph: 1-800-632-2277	



PLANT DRAWING NUMBER:		
FLOTATION TAILINGS BASIN EAST AND WEST DAMS TYPICAL CROSS SECTIONS AND DRAINAGE SWALE		
 POLY MET MINING, INC. NORTHMET PROJECT HOYT LAKES, MINNESOTA		
DRAWN:	BARR ENGINEERING COMPANY 4700 WEST 77TH STREET MINNEAPOLIS, MN. Ph: 1-800-632-2277	
CHECKED:	BARR	
BARR PROJECT NO.:	23/69-OC29	
SCALE:	AS SHOWN	
DWG. NO.	FTB-012	
REV		

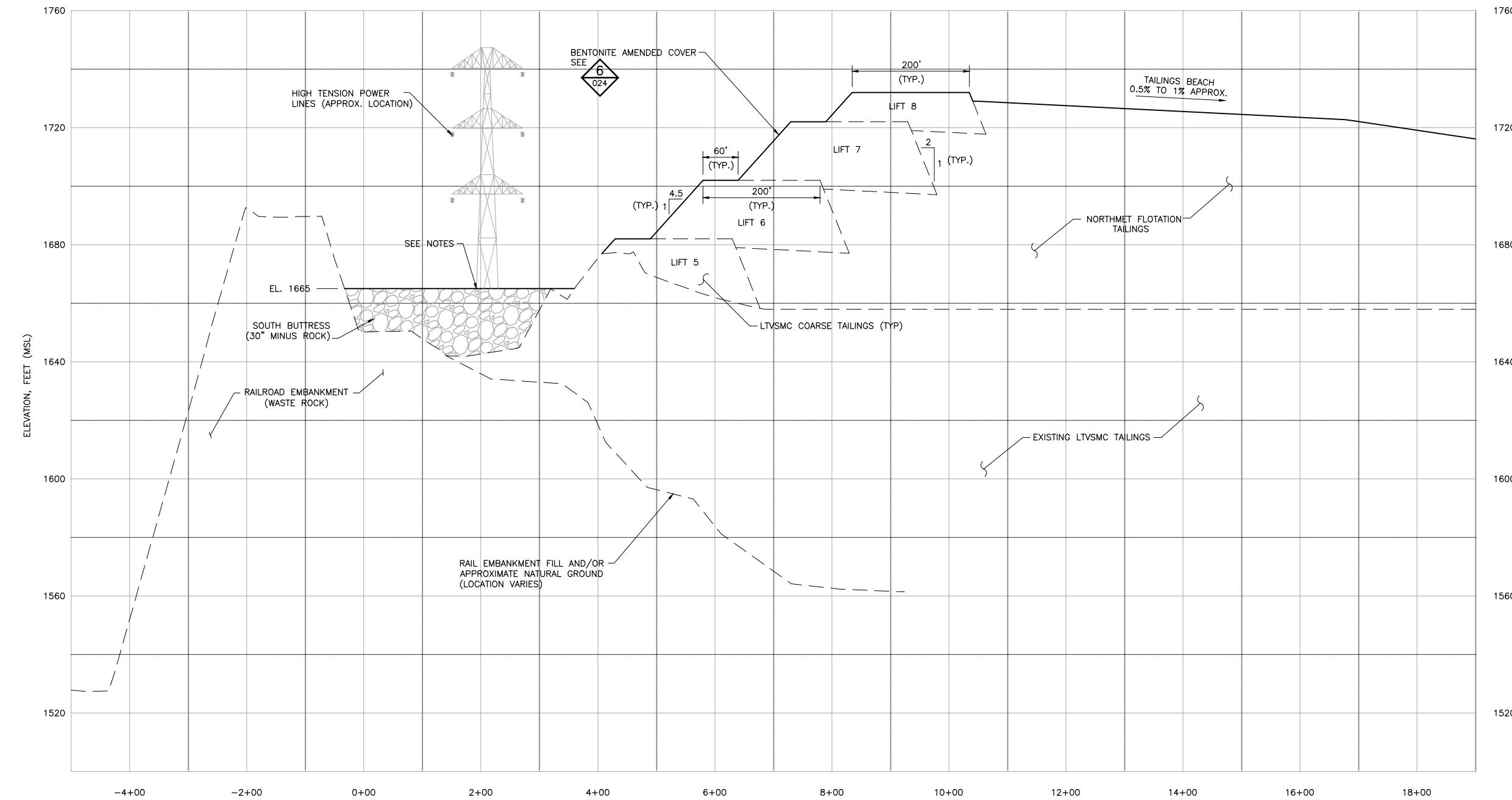
VER NO	DATE	DESCRIPTION	ISSUE STATUS	REMARKS
1	10/14/11	FLOTATION TAILINGS MANAGEMENT PLAN - VERSION 1 - ATTACHMENT A	ISSUED	FOR PERMITTING
2	12/07/12	FLOTATION TAILINGS MANAGEMENT PLAN - VERSION 2 - ATTACHMENT A	VERSION	6
3	04/12/13	FLOTATION TAILINGS MANAGEMENT PLAN - VERSION 3 - ATTACHMENT A	DATE	5/20/15
4	11/25/14	FLOTATION TAILINGS MANAGEMENT PLAN - VERSION 4 - ATTACHMENT A		
5	03/03/15	FLOTATION TAILINGS MANAGEMENT PLAN - VERSION 5 - ATTACHMENT A		
6	5/20/15	ISSUED FOR INCLUSION IN PERMIT APPLICATIONS	FOR CONSTRUCTION	PRINTED NAME THOMAS J. RADUE SIGNATURE Thomas J. Radue DATE 5/20/15 LICENSE # 20951
				NOT APPROVED FOR CONSTRUCTION



1 PLAN: SOUTH DAM LAYOUT
-- 0 300 600
SCALE IN FEET

VER NO	DATE	DESCRIPTION	ISSUE STATUS
1	10/14/11	FLOTATION TAILINGS MANAGEMENT PLAN - VERSION 1 - ATTACHMENT A	ISSUED
2	12/07/12	FLOTATION TAILINGS MANAGEMENT PLAN - VERSION 2 - ATTACHMENT A	FOR PERMITTING
3	04/12/13	FLOTATION TAILINGS MANAGEMENT PLAN - VERSION 3 - ATTACHMENT A	6
4	11/25/14	FLOTATION TAILINGS MANAGEMENT PLAN - VERSION 4 - ATTACHMENT A	5/20/15
5	03/03/15	FLOTATION TAILINGS MANAGEMENT PLAN - VERSION 5 - ATTACHMENT A	
6	5/20/15	ISSUED FOR INCLUSION IN PERMIT APPLICATIONS	FOR CONSTRUCTION
			NOT APPROVED FOR CONSTRUCTION

PLANT DRAWING NUMBER:			
FLOTATION TAILINGS BASIN SOUTH DAM YEAR 20 LAYOUT			
DRAWN: CAD			POLY MET MINING, INC.
CHECKED: TJR			NORTHMET PROJECT
BARR PROJECT NO.: 23/69-OC29			HOYT LAKES, MINNESOTA
SCALE: AS SHOWN			BARR
DWG. NO. FTB-013			REV



1 ELEVATION: SOUTH DAM TYPICAL CROSS SECTION
0 100 200
HORZ. SCALE IN FEET

NOTES:

1. DAM DIMENSIONS MAY CHANGE WITH EVALUATION OF FUTURE PERFORMANCE DATA.

2. HIGH TENSION POWER LINES SHOWN FOR REFERENCE. TOWER FOUNDATIONS ARE LOCATED OUTSIDE OF THE AREA COVERED BY THE BUTTRESS.

PLANT DRAWING NUMBER:

FLOTATION TAILINGS BASIN
SOUTH DAM
TYPICAL CROSS SECTIONS

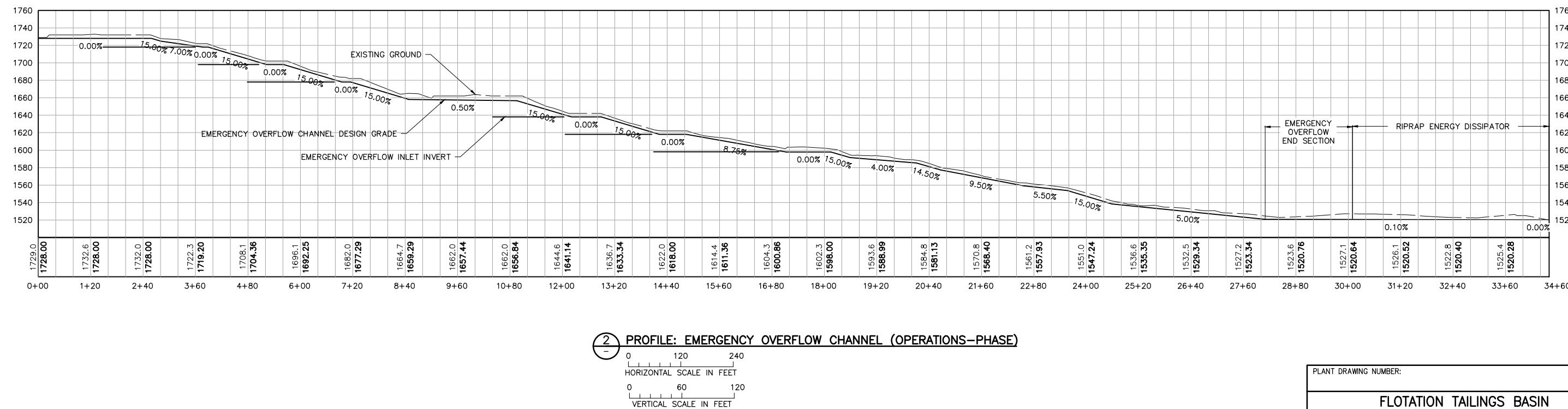
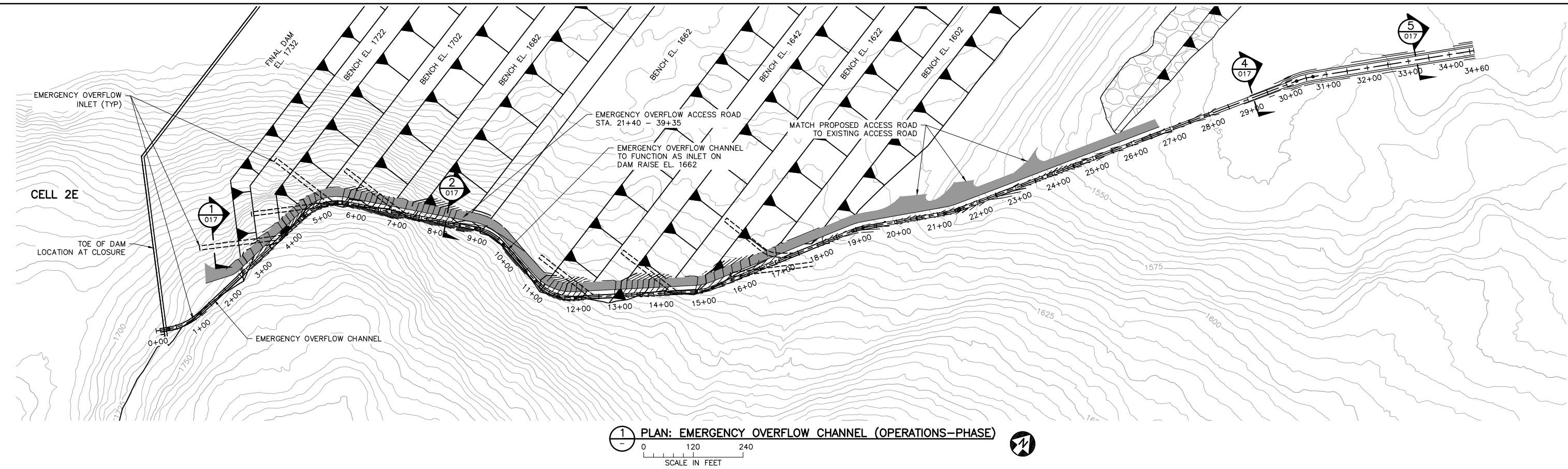
VER NO	DATE	DESCRIPTION	ISSUE STATUS			HEREBY CERTIFY THAT THIS PLAN, SPECIFICATIONS, OR DRAWINGS, PREPARED BY ME OR UNDER MY DIRECT SUPERVISION AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MINNESOTA.	PRINTED NAME THOMAS J. RADUE SIGNATURE Thomas J. Radue DATE 5/20/15 LICENSE # 20951	DRAWN: CAD CHECKED: TJR BARR PROJECT NO.: 23/69-OC29 SCALE: AS SHOWN	POLY MET MINING, INC. NORTHMET PROJECT HOYT LAKES, MINNESOTA		
			ISSUED	VERSION	DATE						
			FOR PERMITTING	6	5/20/15						
			FOR CONSTRUCTION	-	-						
			NOT APPROVED FOR CONSTRUCTION								

BARR ENGINEERING COMPANY
4700 WEST 77TH STREET
MINNEAPOLIS, MN.
Ph: 1-800-632-2277



FTB-014

REV



PLANT DRAWING NUMBER:
FLOTATION TAILINGS BASIN
EMERGENCY OVERFLOW CHANNEL
LAYOUT

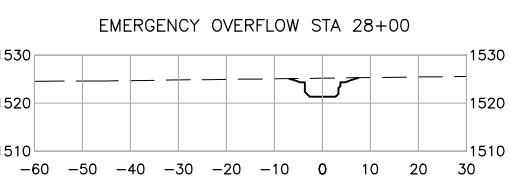
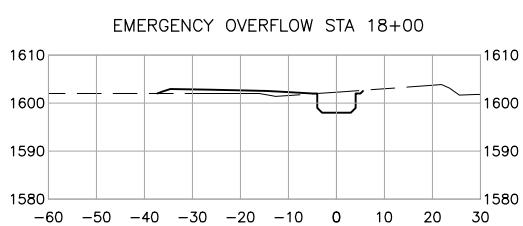
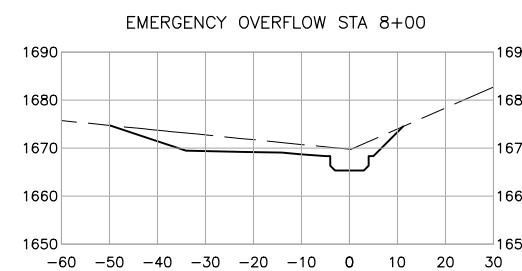
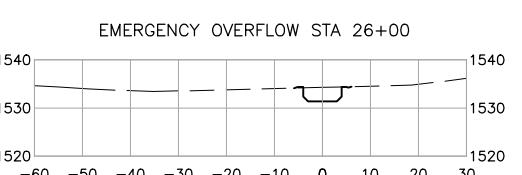
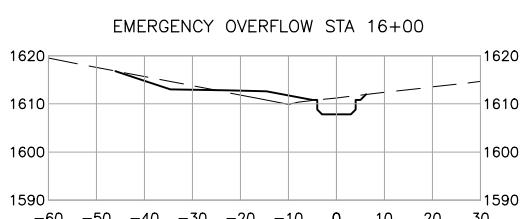
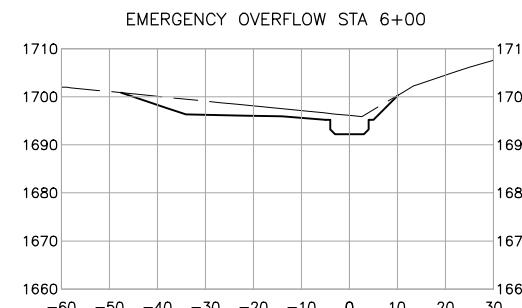
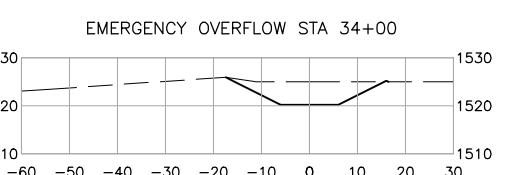
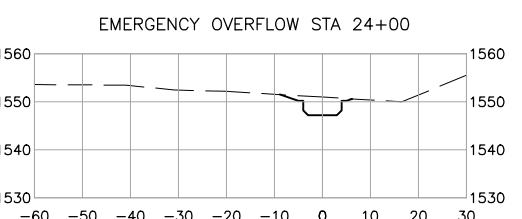
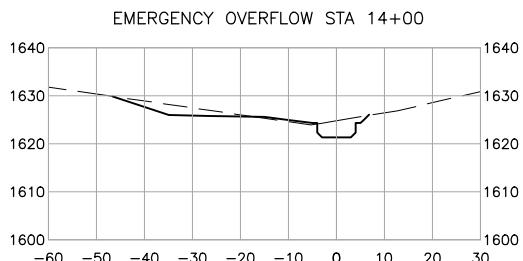
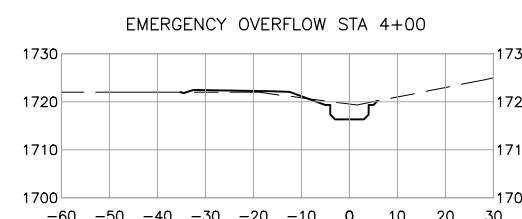
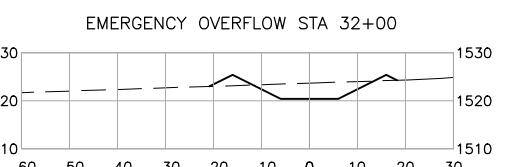
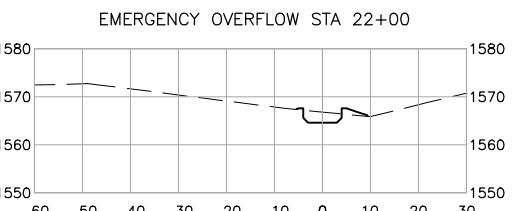
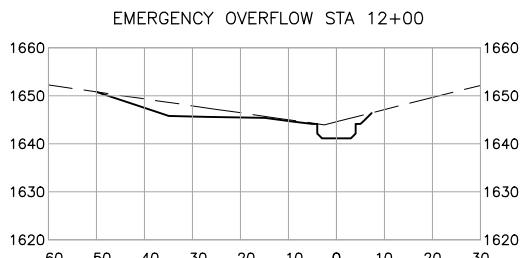
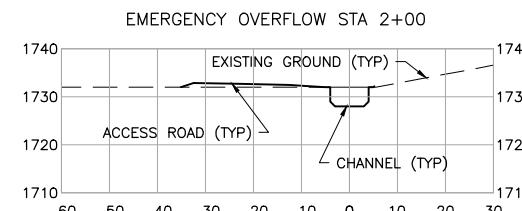
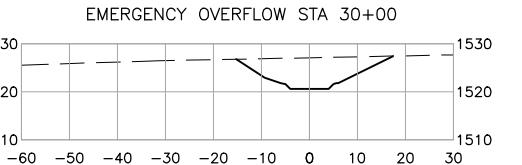
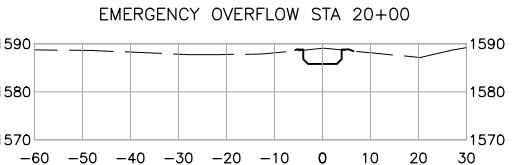
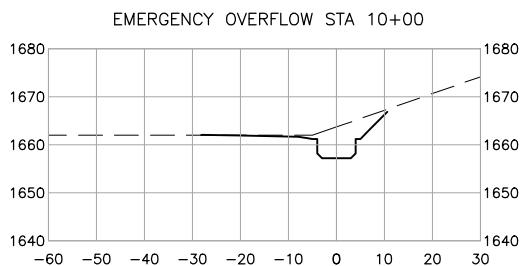
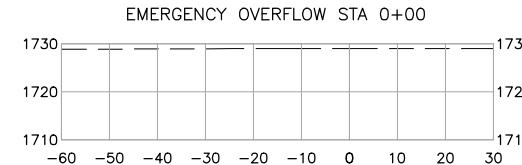
POLY MET MINING, INC.
NORTHMET PROJECT
HOYT LAKES, MINNESOTA

BARR ENGINEERING COMPANY
4700 WEST 77TH STREET
MINNEAPOLIS, MN.
Ph: 1-800-632-2277

BARR

DRAWN: CAD
CHECKED: TJR
BARR PROJECT NO.: 23/69-OC29
SCALE: AS SHOWN
DWG. NO. FTB-015
REV

VER NO	DATE	DESCRIPTION	ISSUE STATUS	PRINTED NAME	SIGNATURE
1	10/14/11	FLOTATION TAILINGS MANAGEMENT PLAN - VERSION 1 - ATTACHMENT A	ISSUED	THOMAS J. RADUE	
2	12/07/12	FLOTATION TAILINGS MANAGEMENT PLAN - VERSION 2 - ATTACHMENT A	FOR PERMITTING	6	5/20/15
3	04/12/13	FLOTATION TAILINGS MANAGEMENT PLAN - VERSION 3 - ATTACHMENT A			
4	11/25/14	FLOTATION TAILINGS MANAGEMENT PLAN - VERSION 4 - ATTACHMENT A			
5	03/03/15	FLOTATION TAILINGS MANAGEMENT PLAN - VERSION 5 - ATTACHMENT A	FOR CONSTRUCTION	-	-
6	5/20/15	ISSUED FOR INCLUSION IN PERMIT APPLICATIONS	NOT APPROVED FOR CONSTRUCTION		Thomas J. Radue 5/20/15



1 SECTION: EMERGENCY OVERFLOW CHANNEL
0 20 40
SCALE IN FEET

VER NO	DATE	DESCRIPTION	ISSUE STATUS
1	10/14/11	FLOTATION TAILINGS MANAGEMENT PLAN – VERSION 1 – ATTACHMENT A	ISSUED
2	12/07/12	FLOTATION TAILINGS MANAGEMENT PLAN – VERSION 2 – ATTACHMENT A	FOR PERMITTING
3	04/12/13	FLOTATION TAILINGS MANAGEMENT PLAN – VERSION 3 – ATTACHMENT A	6
4	11/25/14	FLOTATION TAILINGS MANAGEMENT PLAN – VERSION 4 – ATTACHMENT A	5/20/15
5	03/03/15	FLOTATION TAILINGS MANAGEMENT PLAN – VERSION 5 – ATTACHMENT A	
6	5/20/15	ISSUED FOR INCLUSION IN PERMIT APPLICATIONS	FOR CONSTRUCTION
			NOT APPROVED FOR CONSTRUCTION

HEREBY CERTIFY THAT THIS PLAN,
SPECIFICATIONS AND DRAWINGS
WERE PREPARED BY ME OR UNDER MY DIRECT
SUPERVISION AND THAT I AM A DULY
LICENSED PROFESSIONAL ENGINEER
UNDER THE LAWS OF THE STATE OF
MINNESOTA.

PRINTED NAME THOMAS J. RADUE
SIGNATURE Thomas J. Radue
DATE 5/20/15 LICENSE# 20951

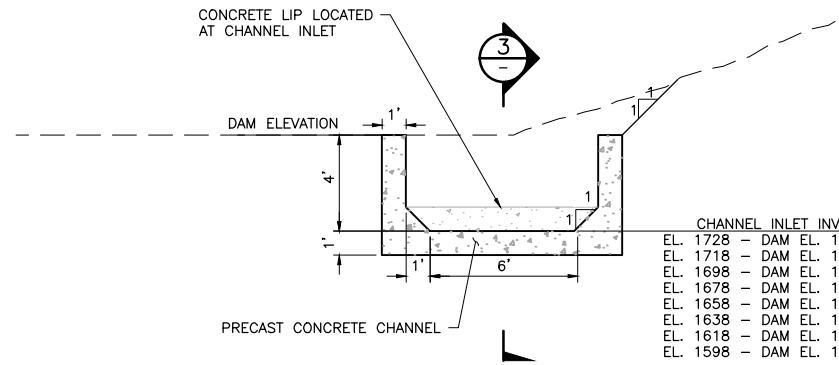
PLANT DRAWING NUMBER:
**FLOTATION TAILINGS BASIN
EMERGENCY OVERFLOW CHANNEL
SECTIONS**

**POLY MET MINING, INC.
NORTHMET PROJECT
HOYT LAKES, MINNESOTA**

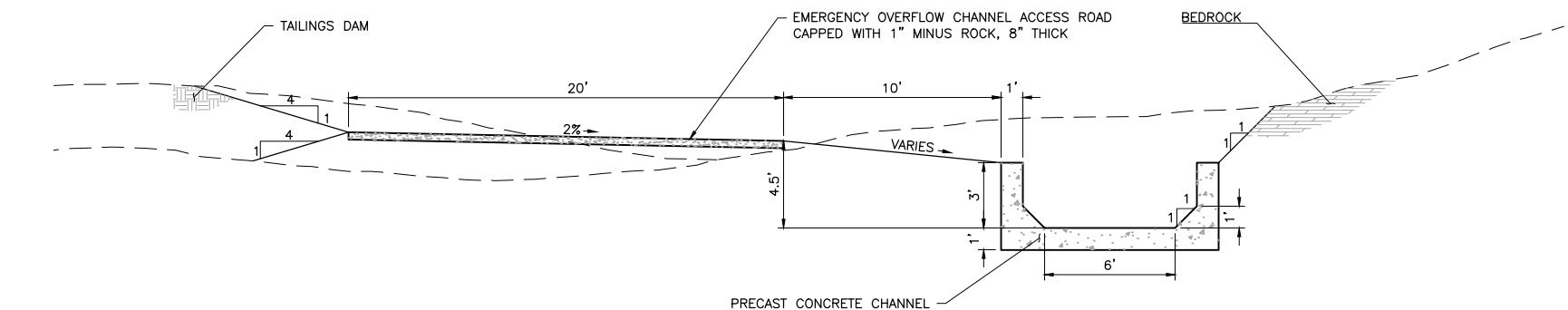
BARR ENGINEERING COMPANY
4700 WEST 77TH STREET
MINNEAPOLIS, MN.
Ph: 1-800-632-2277

BARR

REV
DWG. NO. FTB-016

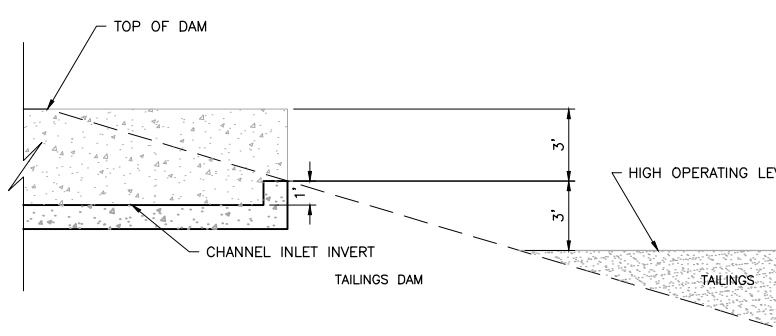


SECTION: TYPICAL EMERGENCY OVERFLOW CHANNEL INLET

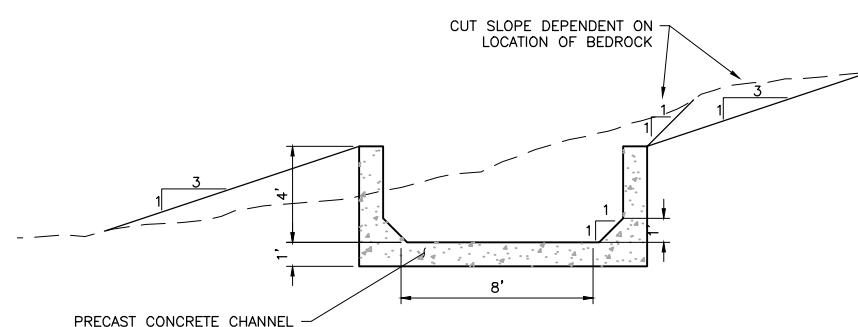


SECTION: EMERGENCY OVERFLOW CHANNEL

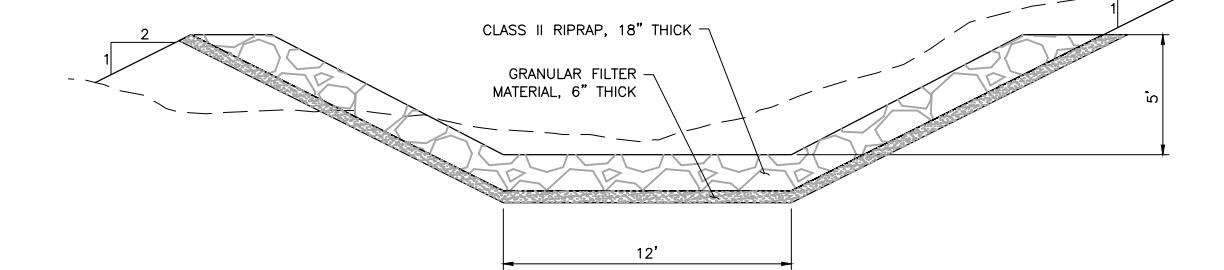
NOTE:
INCREASE EMERGENCY OVERFLOW CHANNEL DEPTH TO 4' WHEN CHANNEL SLOPE IS 0%



DETAIL: EMERGENCY OVERFLOW CHANNEL INLET



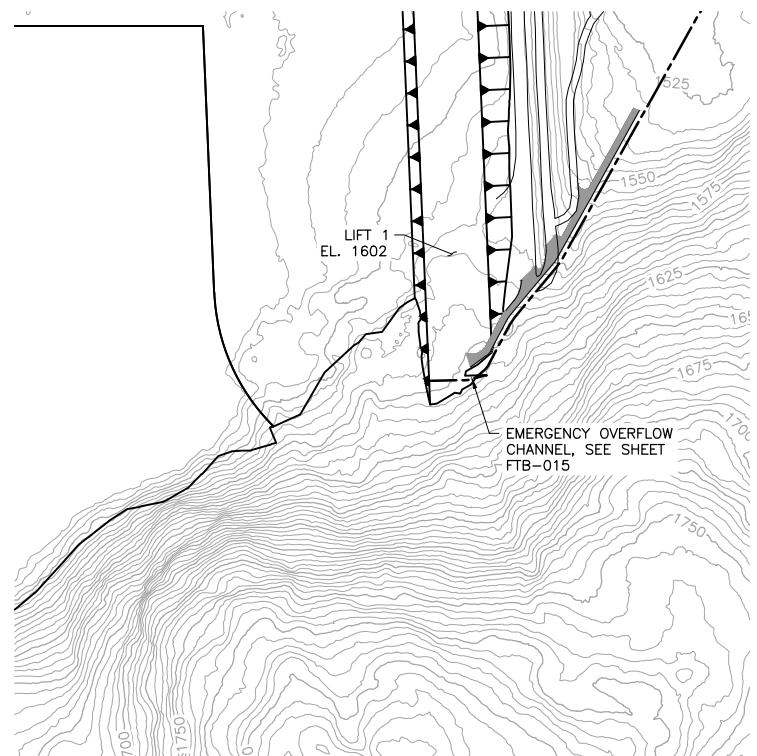
SECTION: EMERGENCY OVERFLOW CHANNEL END SECTION – STA. 28+10 – 30+10



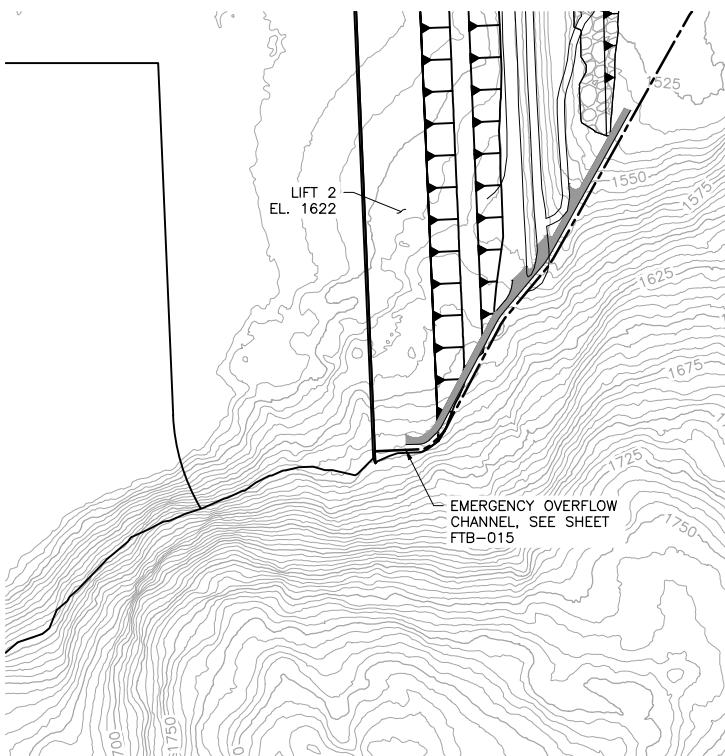
SECTION: RIPRAP OVERFLOW CHANNEL ENERGY DISSIPATOR – STA. 30+10 – 34+60

PLANT DRAWING NUMBER:		
FLOTATION TAILINGS BASIN EMERGENCY OVERFLOW CHANNEL DETAILS		
DRAWN:	POLYMET MINING	POLY MET MINING, INC. NORTHMET PROJECT HOYT LAKES, MINNESOTA
CHECKED:	TJR	BARR ENGINEERING COMPANY 4700 WEST 77TH STREET MINNEAPOLIS, MN. Ph: 1-800-632-2277
BARR PROJECT NO.:	23/69-OC29	
SCALE:	AS SHOWN	DWG. NO. FTB-017
REV:		

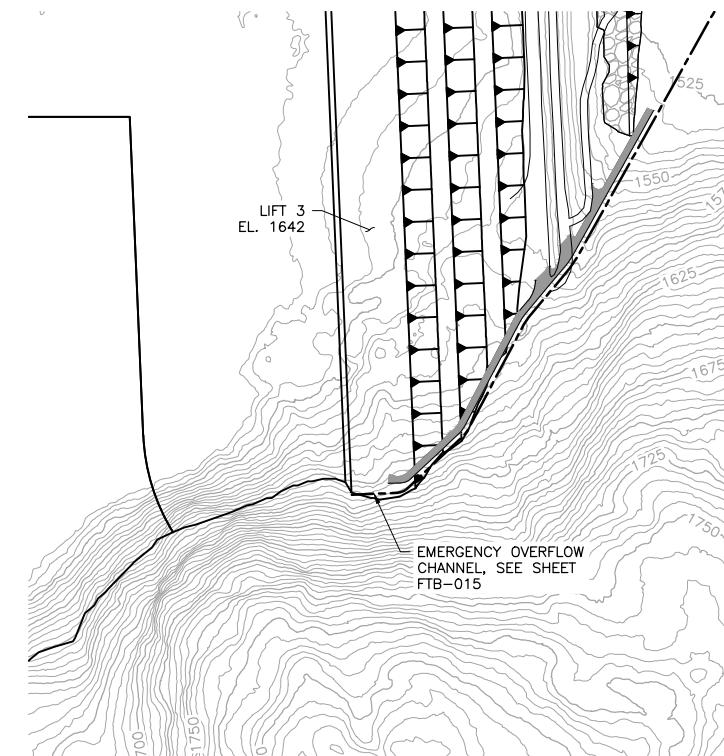
VER NO	DATE	DESCRIPTION	ISSUE STATUS	REMARKS
1	10/14/11	FLOTATION TAILINGS MANAGEMENT PLAN – VERSION 1 – ATTACHMENT A	ISSUED	FOR PERMITTING
2	12/07/12	FLOTATION TAILINGS MANAGEMENT PLAN – VERSION 2 – ATTACHMENT A	VERSION	6
3	04/12/13	FLOTATION TAILINGS MANAGEMENT PLAN – VERSION 3 – ATTACHMENT A	DATE	5/20/15
4	11/25/14	FLOTATION TAILINGS MANAGEMENT PLAN – VERSION 4 – ATTACHMENT A		
5	03/03/15	FLOTATION TAILINGS MANAGEMENT PLAN – VERSION 5 – ATTACHMENT A		
6	5/20/15	ISSUED FOR INCLUSION IN PERMIT APPLICATIONS	FOR CONSTRUCTION	PRINTED NAME THOMAS J. RADUE SIGNATURE Thomas J. Radue DATE 5/20/15 LICENSE# 20951
				NOT APPROVED FOR CONSTRUCTION



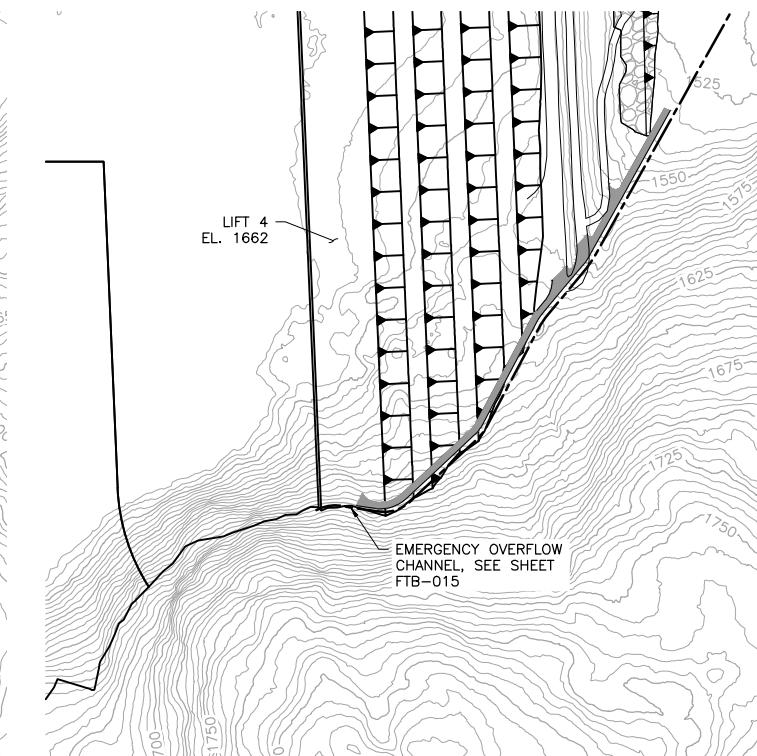
1 PLAN: EMERGENCY OVERFLOW CHANNEL – LIFT 1



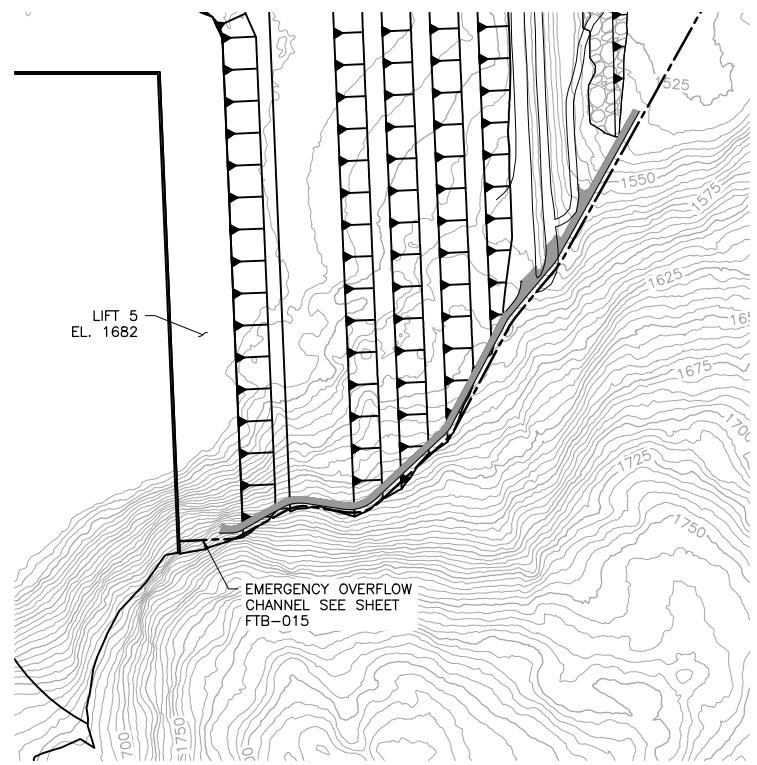
2 PLAN: EMERGENCY OVERFLOW CHANNEL – LIFT 2



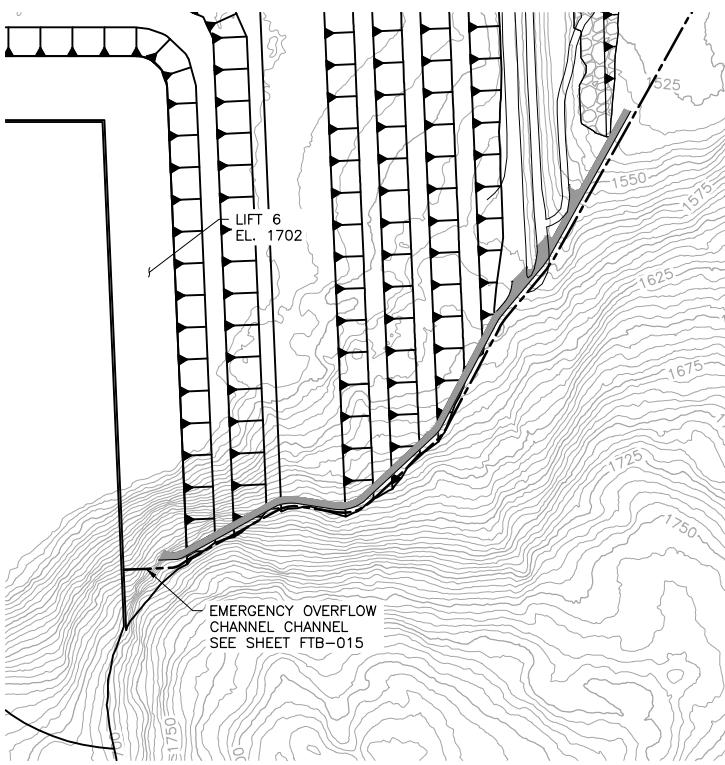
3 PLAN: EMERGENCY OVERFLOW CHANNEL – LIFT 3



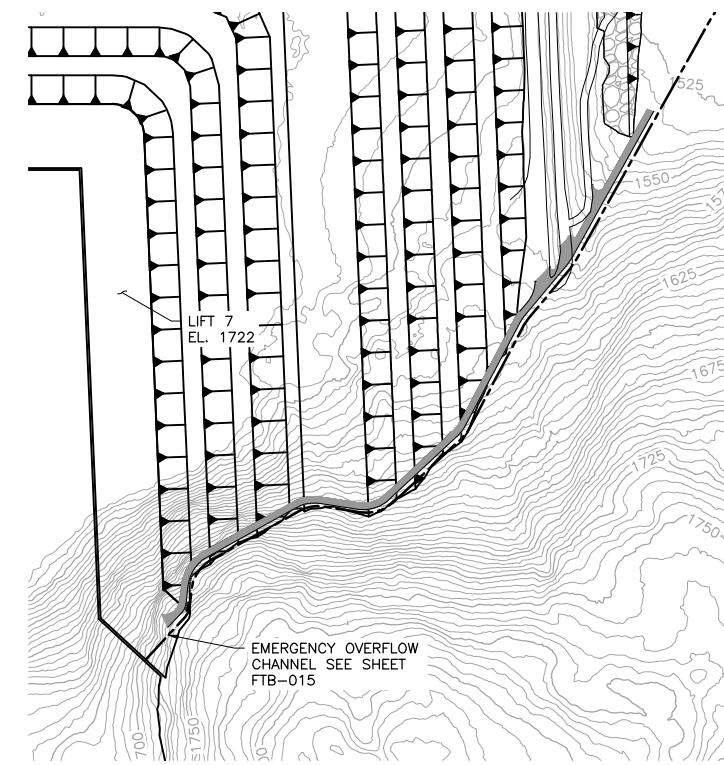
4 PLAN: EMERGENCY OVERFLOW CHANNEL – LIFT 4



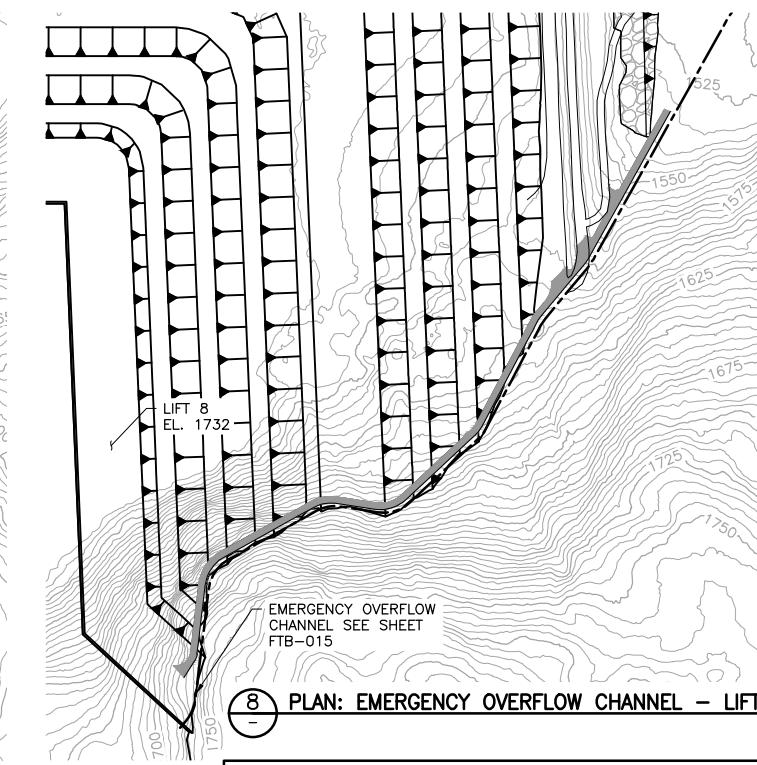
5 PLAN: EMERGENCY OVERFLOW CHANNEL – LIFT 5



6 PLAN: EMERGENCY OVERFLOW CHANNEL – LIFT 6

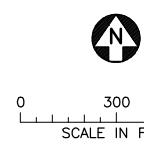


7 PLAN: EMERGENCY OVERFLOW CHANNEL – LIFT 7



8 PLAN: EMERGENCY OVERFLOW CHANNEL – LIFT 8

PLANT DRAWING NUMBER:		
FLOTATION TAILINGS BASIN EMERGENCY OVERFLOW CHANNEL SEQUENCING		
 POLY MET MINING, INC. NORTHMET PROJECT HOYT LAKES, MINNESOTA		
BARR ENGINEERING COMPANY 4700 WEST 77TH STREET MINNEAPOLIS, MN. Ph: 1-800-632-2277		
 BARR PROJECT NO.: 23/69-OC29		
SCALE: AS SHOWN		
DWG. NO. FTB-018		
REV		

0 300 600
SCALE IN FEET

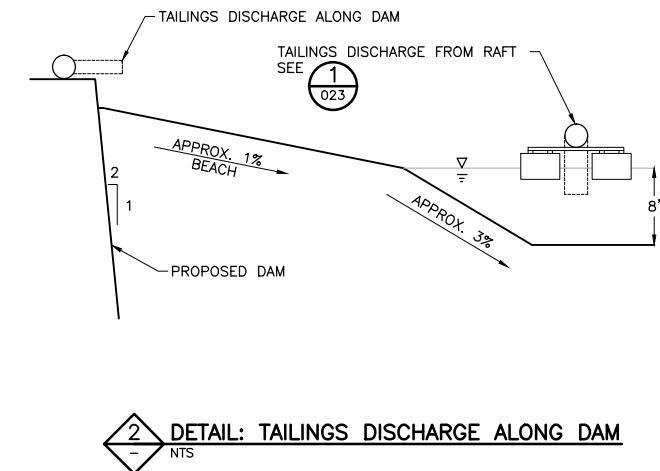
NOTES:

1. EMERGENCY OVERFLOW CHANNEL PLAN VIEW
NOT SHOWN, SEE SHEET FTB-015 FOR
REFERENCE.

VER NO	DATE	DESCRIPTION	ISSUED	VERSION	DATE
1	10/14/11	FLOTATION TAILINGS MANAGEMENT PLAN – VERSION 1 – ATTACHMENT A			
2	12/07/12	FLOTATION TAILINGS MANAGEMENT PLAN – VERSION 2 – ATTACHMENT A	FOR PERMITTING	6	5/20/15
3	04/12/13	FLOTATION TAILINGS MANAGEMENT PLAN – VERSION 3 – ATTACHMENT A			
4	11/25/14	FLOTATION TAILINGS MANAGEMENT PLAN – VERSION 4 – ATTACHMENT A			
5	03/03/15	FLOTATION TAILINGS MANAGEMENT PLAN – VERSION 5 – ATTACHMENT A	FOR CONSTRUCTION	-	-
6	5/20/15	ISSUED FOR INCLUSION IN PERMIT APPLICATIONS			
			NOT APPROVED FOR CONSTRUCTION		
			SIGNATURE <i>Thomas J. Radue</i>		
			DATE 5/20/15	LICENSE #	20951

I HEREBY CERTIFY THAT THIS PLAN, SHEET NO. CS-018, IS THE PROPERTY OF PREPARED BY ME OR UNDER MY DIRECT SUPERVISION AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MINNESOTA.		
DRAWN:	CAD	
CHECKED:	TJR	
BARR PROJECT NO.:	23/69-OC29	
SCALE:	AS SHOWN	DWG. NO.

PRINTED NAME <i>Thomas J. Radue</i>
SIGNATURE <i>Thomas J. Radue</i>
DATE 5/20/15

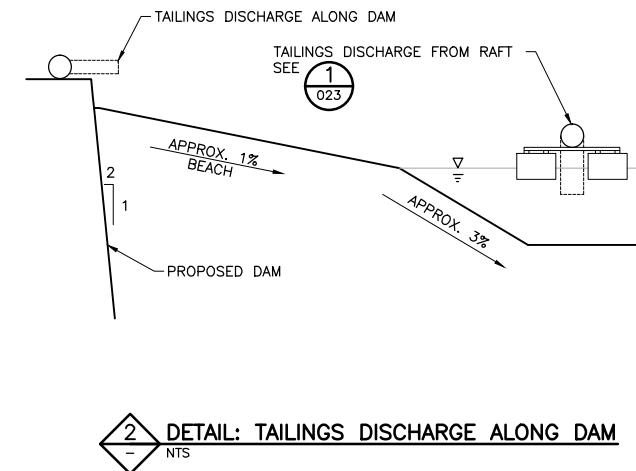
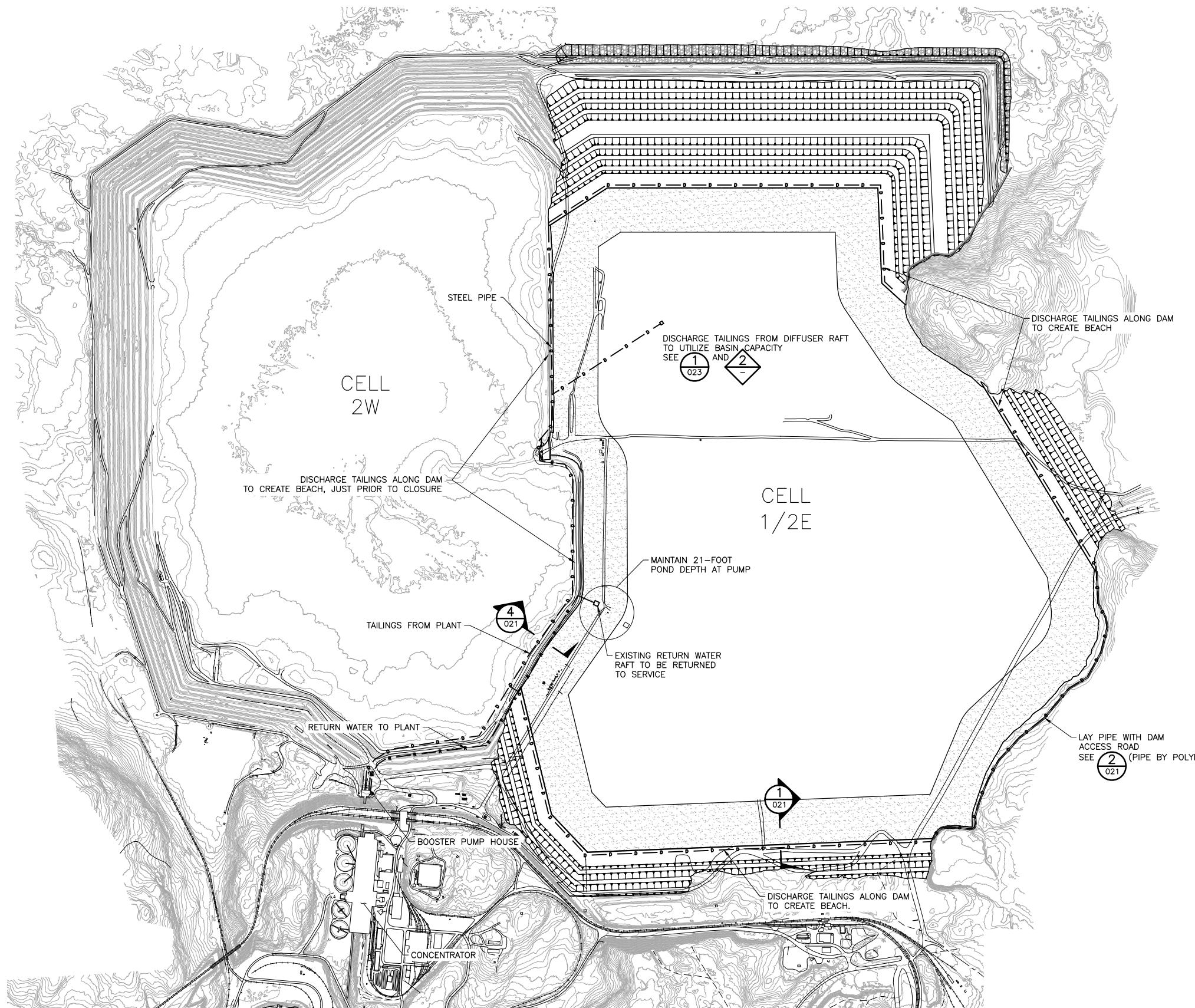


PLANT DRAWING NUMBER:				
FLOTATION TAILINGS BASIN PIPING LAYOUT CELL 2E				
PLANT DRAWING NUMBER:				
FLOTATION TAILINGS BASIN PIPING LAYOUT CELL 2E				
POLY MET MINING, INC. NORTHMET PROJECT HOYT LAKES, MINNESOTA				
BARR ENGINEERING COMPANY 4700 WEST 77TH STREET MINNEAPOLIS, MN. Ph: 1-800-632-2277				
DWG. NO. FTB-019				
REV				

1 PLAN: PIPING LAYOUT CELL 2E
0 800 1600
SCALE IN FEET



VER NO	DATE	DESCRIPTION	ISSUED	VERSION	DATE	NOTES
1	10/14/11	FLOTATION TAILINGS MANAGEMENT PLAN - VERSION 1 - ATTACHMENT A				HEREBY CERTIFY THAT THIS PLAN, SHEET NO. OF 100, WAS PREPARED BY ME OR UNDER MY DIRECT SUPERVISION AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MINNESOTA.
2	12/07/12	FLOTATION TAILINGS MANAGEMENT PLAN - VERSION 2 - ATTACHMENT A	FOR PERMITTING	6	5/20/15	DRAWN: CAD CHECKED: TJR BARR PROJECT NO.: 23/69-OC29
3	04/12/13	FLOTATION TAILINGS MANAGEMENT PLAN - VERSION 3 - ATTACHMENT A				
4	11/25/14	FLOTATION TAILINGS MANAGEMENT PLAN - VERSION 4 - ATTACHMENT A				
5	03/03/15	FLOTATION TAILINGS MANAGEMENT PLAN - VERSION 5 - ATTACHMENT A	FOR CONSTRUCTION	-	-	PRINTED NAME THOMAS J. RADUE SIGNATURE Thomas J. Radue DATE 5/20/15 LICENSE # 20951
6	5/20/15	ISSUED FOR INCLUSION IN PERMIT APPLICATIONS				
			NOT APPROVED FOR CONSTRUCTION			SCALE: AS SHOWN



NOTES:

- Pipeline locations are preliminary.

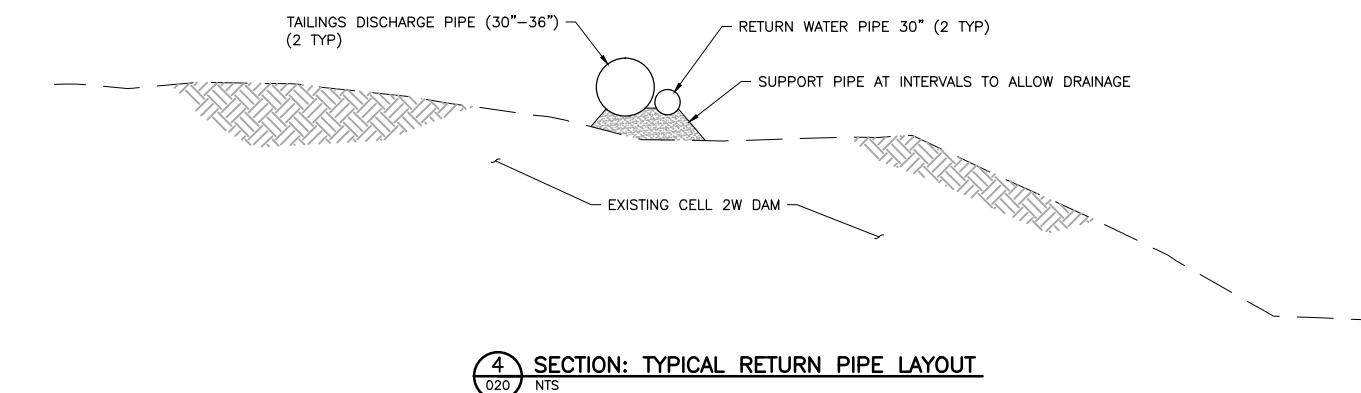
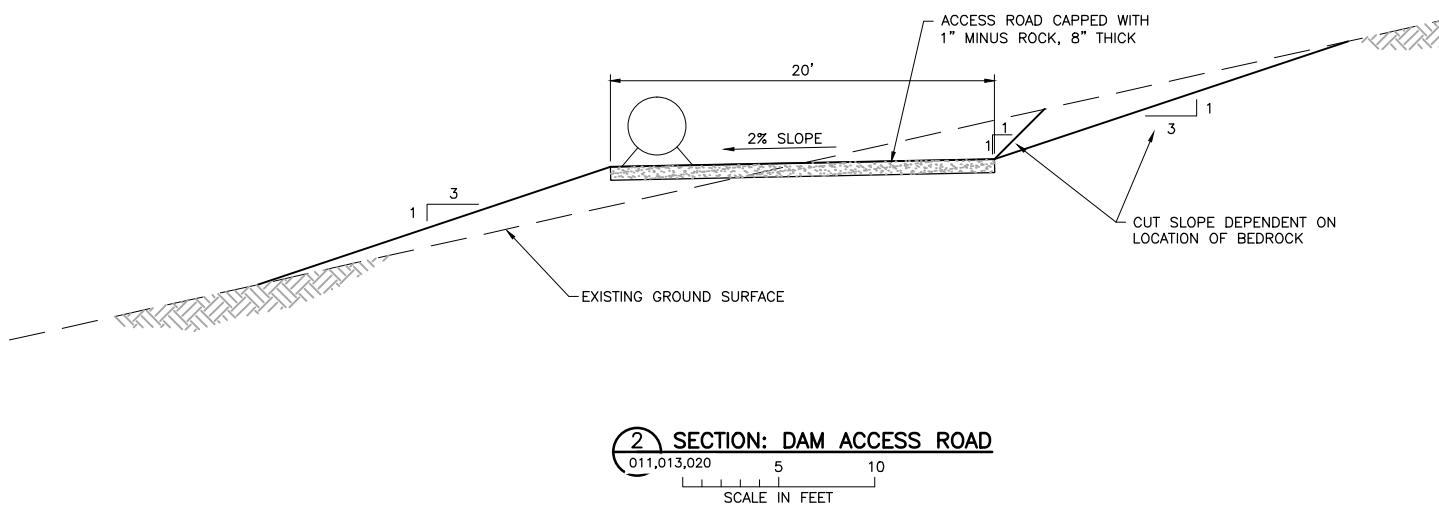
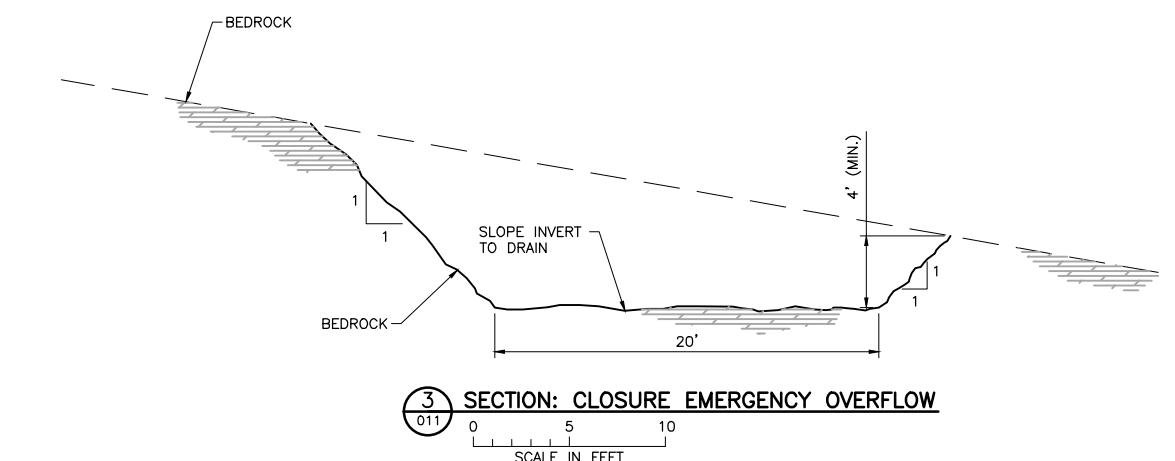
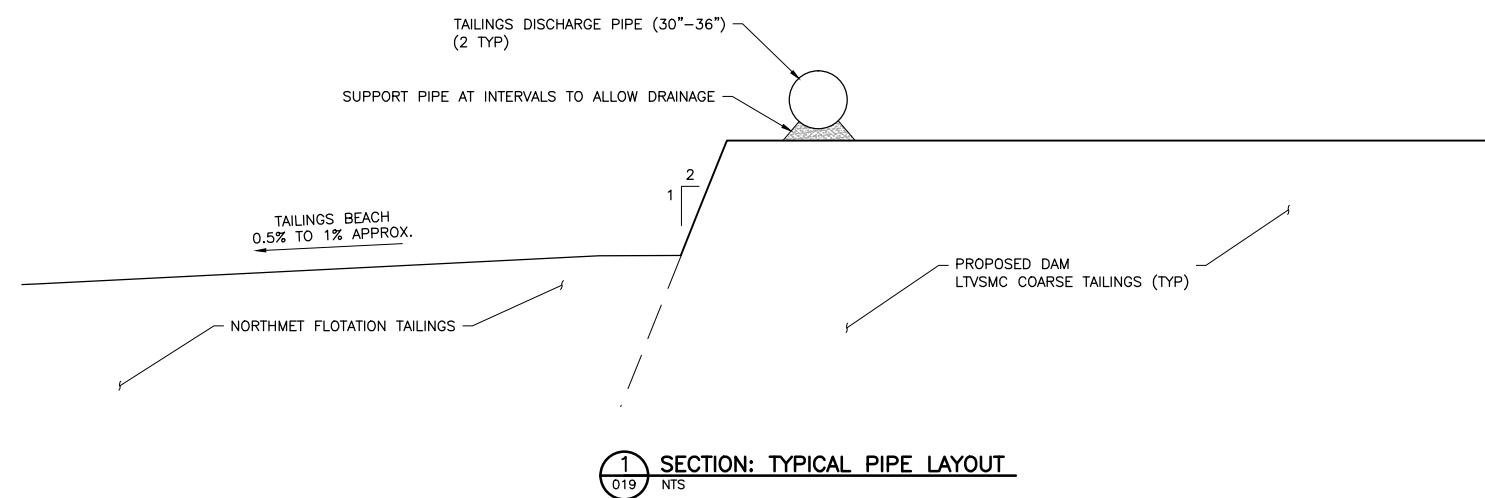
PLANT DRAWING NUMBER:
FLOTATION TAILINGS BASIN
PIPING LAYOUT CELL 1/2E

1 PLAN: PIPING LAYOUT CELL 1/2E
0 800 1600
SCALE IN FEET

VER NO	DATE	DESCRIPTION	ISSUE STATUS	
1	10/14/11	FLOTATION TAILINGS MANAGEMENT PLAN - VERSION 1 - ATTACHMENT A	ISSUED	
2	12/07/12	FLOTATION TAILINGS MANAGEMENT PLAN - VERSION 2 - ATTACHMENT A	FOR PERMITTING	6 5/20/15
3	04/12/13	FLOTATION TAILINGS MANAGEMENT PLAN - VERSION 3 - ATTACHMENT A		
4	11/25/14	FLOTATION TAILINGS MANAGEMENT PLAN - VERSION 4 - ATTACHMENT A		
5	03/03/15	FLOTATION TAILINGS MANAGEMENT PLAN - VERSION 5 - ATTACHMENT A		
6	5/20/15	ISSUED FOR INCLUSION IN PERMIT APPLICATIONS	FOR CONSTRUCTION	-
				NOT APPROVED FOR CONSTRUCTION
				REV

HEREBY CERTIFY THAT THIS PLAN,
SHEET NO. 1 OF 100, WAS
PREPARED BY ME OR UNDER MY DIRECT
SUPERVISION AND THAT I AM A DULY
LICENSED PROFESSIONAL ENGINEER
UNDER THE LAWS OF THE STATE OF
MINNESOTA.
PRINTED NAME THOMAS J. RADUE
SIGNATURE Thomas J. Radue
DATE 5/20/15 LICENSE # 20951

POLY MET MINING, INC.
NORTHMET PROJECT
HOYT LAKES, MINNESOTA
POLYMET
MINING
BARR ENGINEERING COMPANY
4700 WEST 77TH STREET
MINNEAPOLIS, MN.
Ph: 1-800-632-2277
BARR
DWG. NO. FTB-020
REV

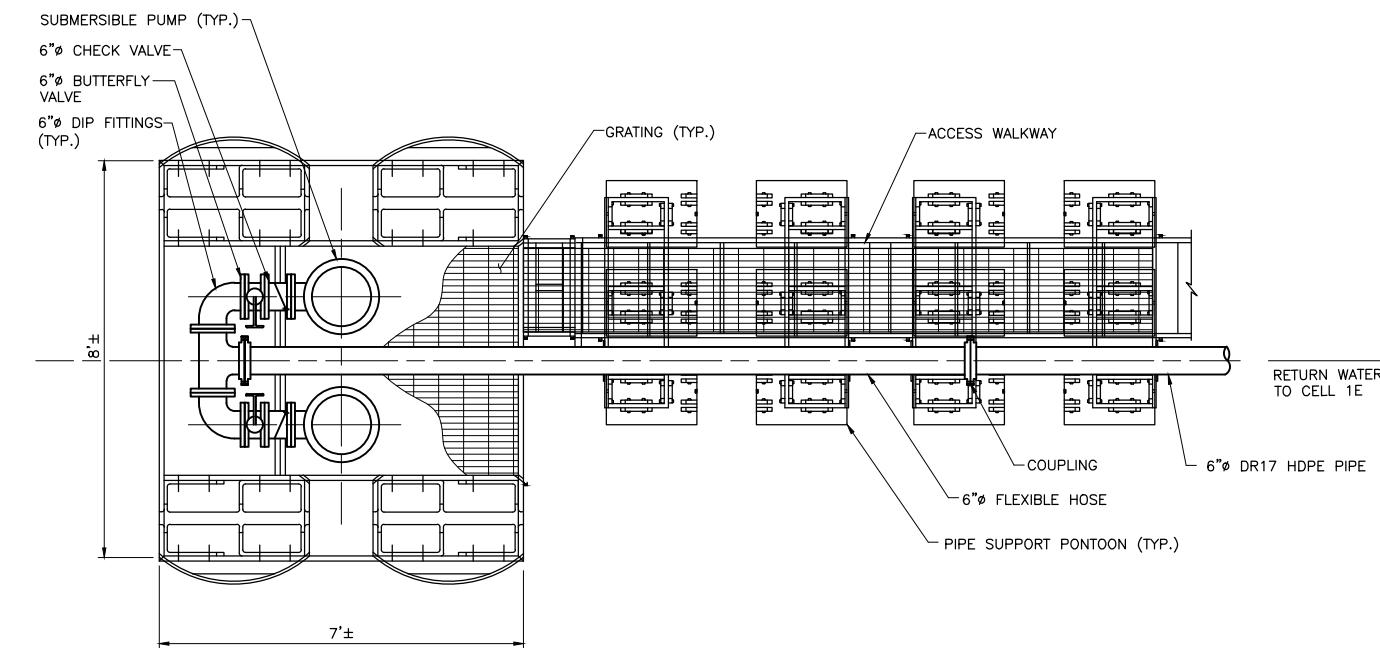
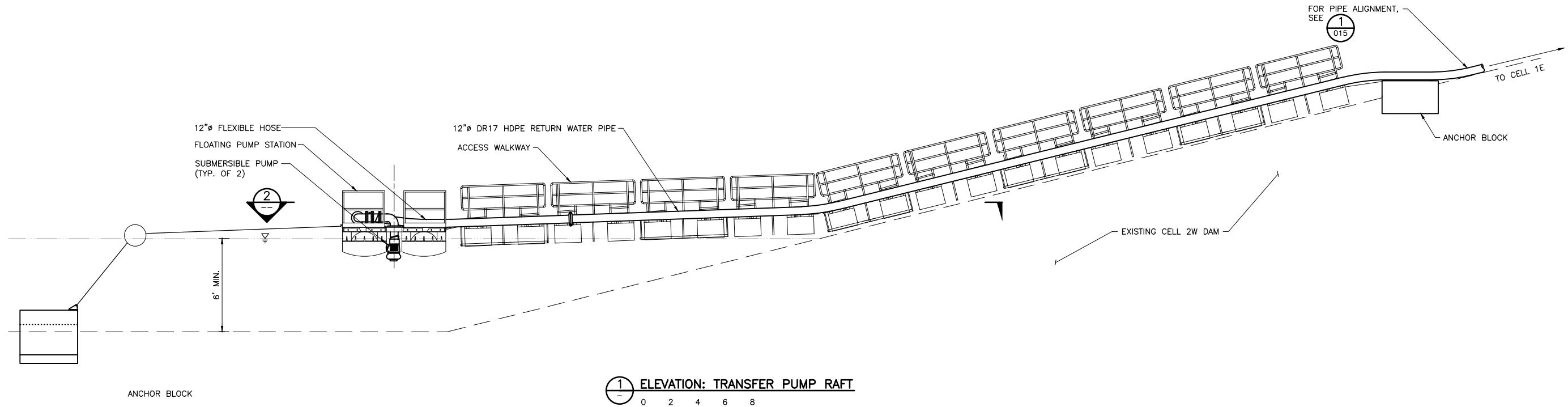
**NOTES:**

1. EMERGENCY OVERFLOW SIZING AND CONFIGURATION IS PRELIMINARY.
2. PIPELINE INFORMATION IS PRELIMINARY.
3. CONSTRUCT CLOSURE EMERGENCY OVERFLOW AT CLOSURE. OPERATIONS-PHASE EMERGENCY OVERFLOW TO BE MAINTAINED OR REMOVED AT OWNER'S DETERMINATION.
4. ALL PIPE SIZES SHOWN ARE PRELIMINARY.

VER NO	DATE	DESCRIPTION	ISSUE STATUS	
1	10/14/11	FLOTATION TAILINGS MANAGEMENT PLAN - VERSION 1 - ATTACHMENT A	ISSUED	
2	12/07/12	FLOTATION TAILINGS MANAGEMENT PLAN - VERSION 2 - ATTACHMENT A	FOR PERMITTING	6 5/20/15
3	04/12/13	FLOTATION TAILINGS MANAGEMENT PLAN - VERSION 3 - ATTACHMENT A		
4	11/25/14	FLOTATION TAILINGS MANAGEMENT PLAN - VERSION 4 - ATTACHMENT A		
5	03/03/15	FLOTATION TAILINGS MANAGEMENT PLAN - VERSION 5 - ATTACHMENT A	FOR CONSTRUCTION	-
6	5/20/15	ISSUED FOR INCLUSION IN PERMIT APPLICATIONS		
			NOT APPROVED FOR CONSTRUCTION	

I HEREBY CERTIFY THAT THIS PLAN, SHEET NUMBER CS-021, WAS PREPARED BY ME OR UNDER MY DIRECT SUPERVISION AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MINNESOTA.		
DRAWN:	CAD	
CHECKED:	TJR	
BARR PROJECT NO.:	23/69-OC29	
SCALE:	AS SHOWN	DWG. NO.

PLANT DRAWING NUMBER:		
FLOTATION TAILINGS BASIN DETAILS		
POLY MET MINING, INC. NORTHMET PROJECT HOYT LAKES, MINNESOTA		
BARR ENGINEERING COMPANY 4700 WEST 77TH STREET MINNEAPOLIS, MN. Ph: 1-800-632-2277		
REV	FTB-021	

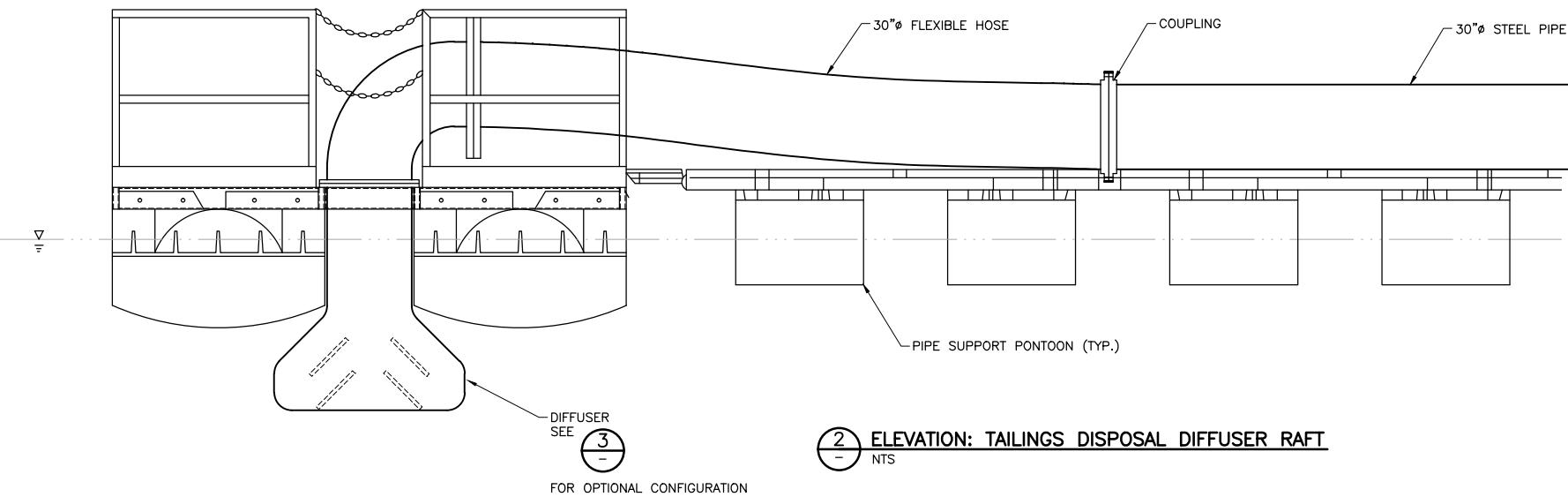
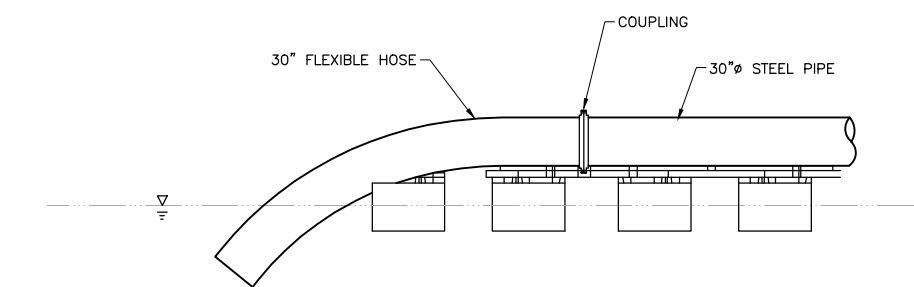
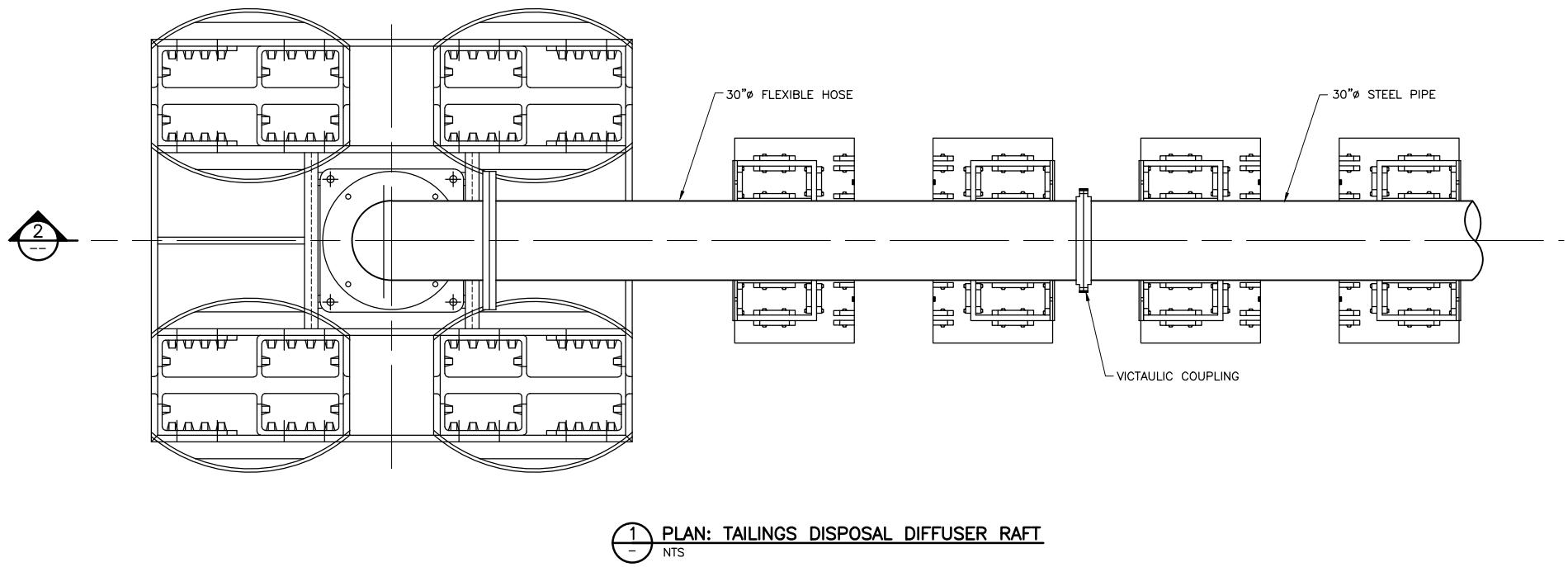


NOTES:

1. ALL PIPE SIZES SHOWN ARE PRELIMINARY.

PLANT DRAWING NUMBER:		
FLOTATION TAILINGS BASIN TRANSFER PUMP VENT		
POLY MET MINING, INC. NORTHMET PROJECT HOYT LAKES, MINNESOTA		
BARR ENGINEERING COMPANY 4700 WEST 77TH STREET MINNEAPOLIS, MN. Ph: 1-800-632-2277		
BARR		
DWG. NO.	FTB-022	
REV		

VER NO	DATE	DESCRIPTION	ISSUE STATUS	REMARKS
1	10/14/11	FLOTATION TAILINGS MANAGEMENT PLAN - VERSION 1 - ATTACHMENT A	ISSUED	
2	12/07/12	FLOTATION TAILINGS MANAGEMENT PLAN - VERSION 2 - ATTACHMENT A	FOR PERMITTING	6 5/20/15 I HEREBY CERTIFY THAT THIS PLAN, SPECIFICATIONS, OR DRAWINGS, PREPARED BY ME OR UNDER MY DIRECT SUPERVISION AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MINNESOTA.
3	04/12/13	FLOTATION TAILINGS MANAGEMENT PLAN - VERSION 3 - ATTACHMENT A		
4	11/25/14	FLOTATION TAILINGS MANAGEMENT PLAN - VERSION 4 - ATTACHMENT A		
5	03/03/15	FLOTATION TAILINGS MANAGEMENT PLAN - VERSION 5 - ATTACHMENT A	FOR CONSTRUCTION	PRINTED NAME THOMAS J. RADUE SIGNATURE Thomas J. Radue DATE 5/20/15 LICENSE # 20951
6	5/20/15	ISSUED FOR INCLUSION IN PERMIT APPLICATIONS	NOT APPROVED FOR CONSTRUCTION	

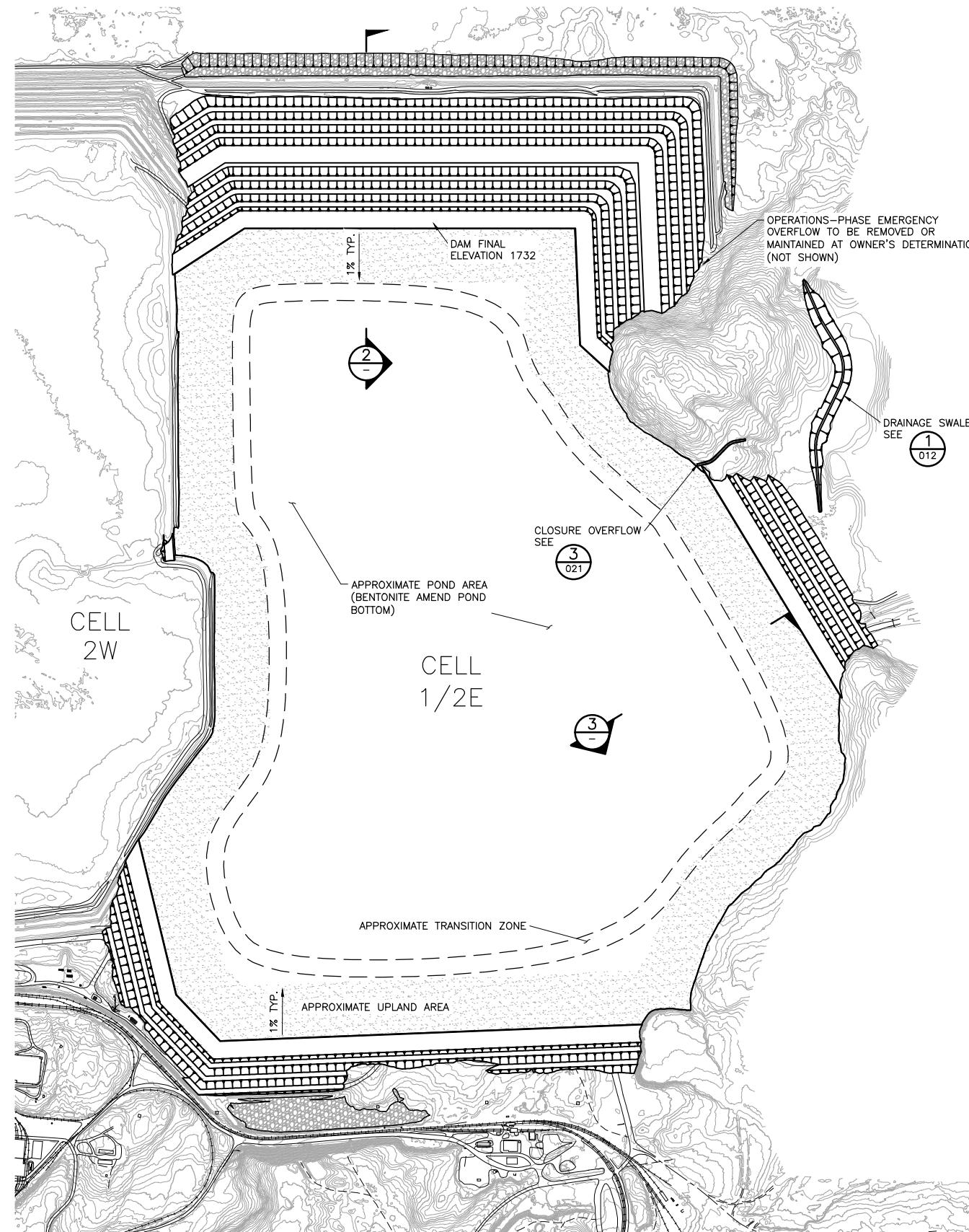


NOTES:

- ALL PIPE SIZES SHOWN ARE PRELIMINARY.

PLANT DRAWING NUMBER:	
FLOTATION TAILINGS BASIN TAILINGS DISPOSAL DIFFUSER RAFT	
POLY MET MINING, INC. NORTHMET PROJECT HOYT LAKES, MINNESOTA	
 POLYMET MINING	
BARR ENGINEERING COMPANY 4700 WEST 77TH STREET MINNEAPOLIS, MN. Ph: 1-800-632-2277	
DRAWN:	CAD
CHECKED:	TJR
BARR PROJECT NO.:	23/69-OC29
SCALE:	AS SHOWN
DWG. NO.	FTB-023
REV	

VER NO	DATE	DESCRIPTION	ISSUE STATUS	REMARKS
1	10/14/11	FLOTATION TAILINGS MANAGEMENT PLAN – VERSION 1 – ATTACHMENT A	ISSUED	
2	12/07/12	FLOTATION TAILINGS MANAGEMENT PLAN – VERSION 2 – ATTACHMENT A	FOR PERMITTING	6 5/20/15
3	04/12/13	FLOTATION TAILINGS MANAGEMENT PLAN – VERSION 3 – ATTACHMENT A		
4	11/25/14	FLOTATION TAILINGS MANAGEMENT PLAN – VERSION 4 – ATTACHMENT A		
5	03/03/15	FLOTATION TAILINGS MANAGEMENT PLAN – VERSION 5 – ATTACHMENT A	FOR CONSTRUCTION	-
6	5/20/15	ISSUED FOR INCLUSION IN PERMIT APPLICATIONS		
			NOT APPROVED FOR CONSTRUCTION	
			SIGNATURE <i>Thomas J. Radue</i>	
			DATE 5/20/15 LICENSE# 20951	

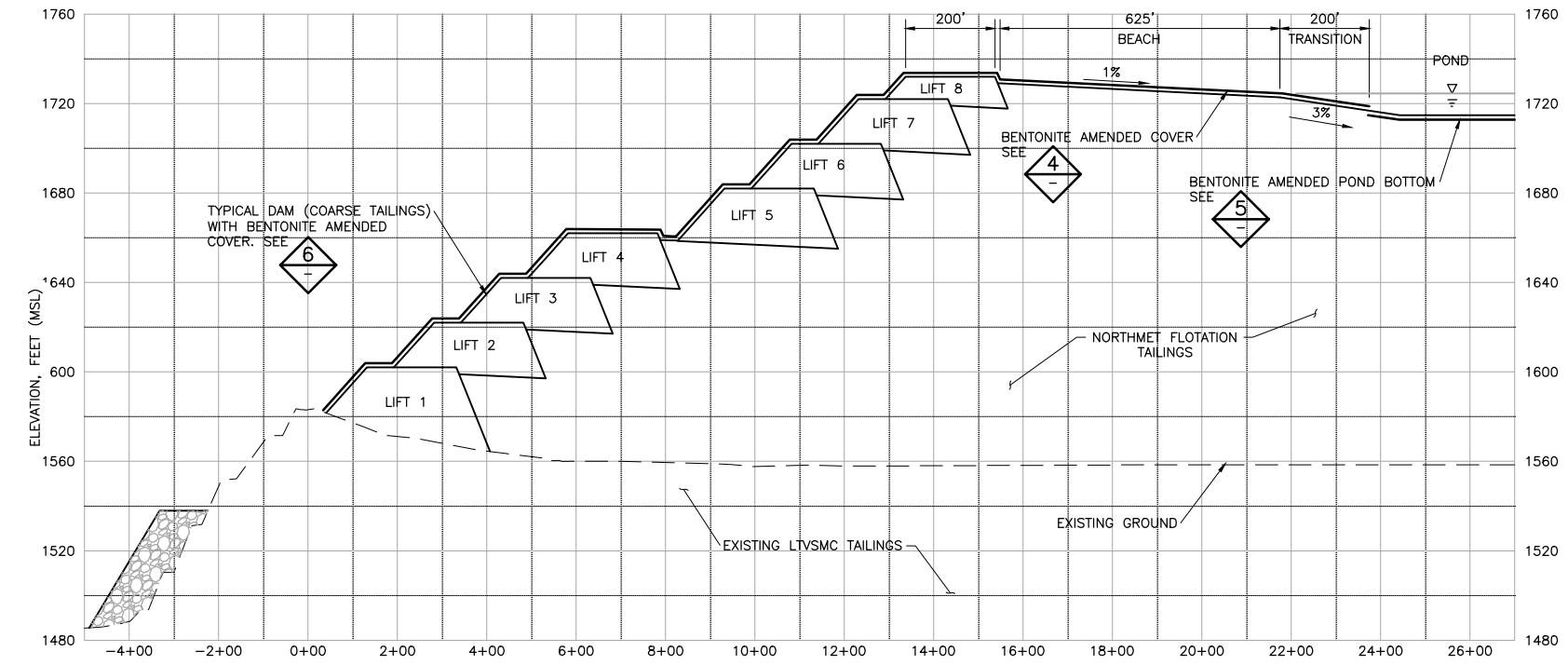


1 PLAN: PROPOSED CLOSURE PLAN

0 800 1600
SCALE IN FEET

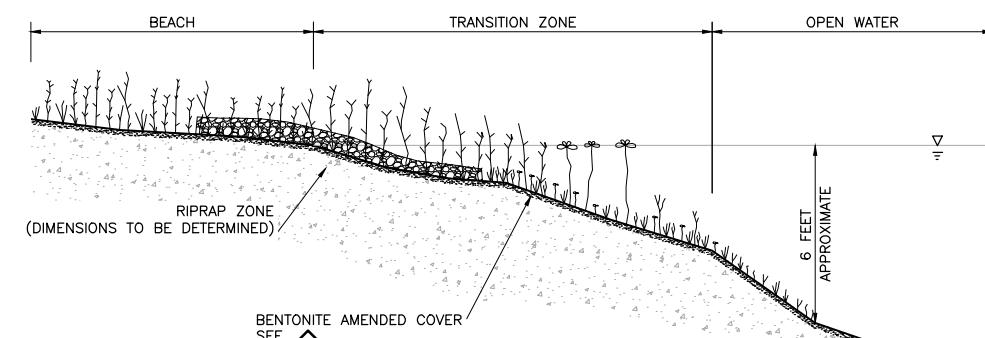


VER NO	DATE	DESCRIPTION	ISSUE STATUS			HEREBY CERTIFY THAT THIS PLAN, SPECIFICATIONS, AND DRAWINGS, PREPARED BY ME OR UNDER MY DIRECT SUPERVISION AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MINNESOTA.	DRAWN:
			ISSUED	VERSION	DATE		
1	10/14/11	FLOTATION TAILINGS MANAGEMENT PLAN - VERSION 1 - ATTACHMENT A					
2	12/07/12	FLOTATION TAILINGS MANAGEMENT PLAN - VERSION 2 - ATTACHMENT A	FOR PERMITTING	6	5/20/15		
3	04/12/13	FLOTATION TAILINGS MANAGEMENT PLAN - VERSION 3 - ATTACHMENT A					
4	11/25/14	FLOTATION TAILINGS MANAGEMENT PLAN - VERSION 4 - ATTACHMENT A					
5	03/03/15	FLOTATION TAILINGS MANAGEMENT PLAN - VERSION 5 - ATTACHMENT A	FOR CONSTRUCTION	-	-	PRINTED NAME THOMAS J. RADUE SIGNATURE Thomas J. Radue DATE 5/20/15 LICENSE # 20951	CAD
6	5/20/15	ISSUED FOR INCLUSION IN PERMIT APPLICATIONS				NOT APPROVED FOR CONSTRUCTION	

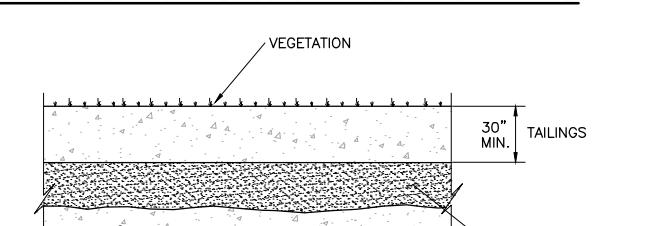


2 SECTION: CELL 2E TAILINGS BASIN CLOSURE TYPICAL SECTION

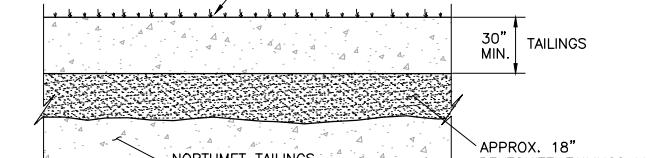
0 200 400
HORIZONTAL SCALE IN FEET



3 SECTION: SCHEMATIC TAILINGS BASIN CLOSURE SURFACE



4 DETAIL: BENTONITE AMENDED COVER



PLANT DRAWING NUMBER:
FLOTATION TAILINGS BASIN CLOSURE PLAN

POLY MET MINING, INC.
NORTHMET PROJECT
HOYT LAKES, MINNESOTA

BARR ENGINEERING COMPANY
4700 WEST 77TH STREET
MINNEAPOLIS, MN.
Ph: 1-800-632-2277

BARR

FTB-024

REV

Attachment B

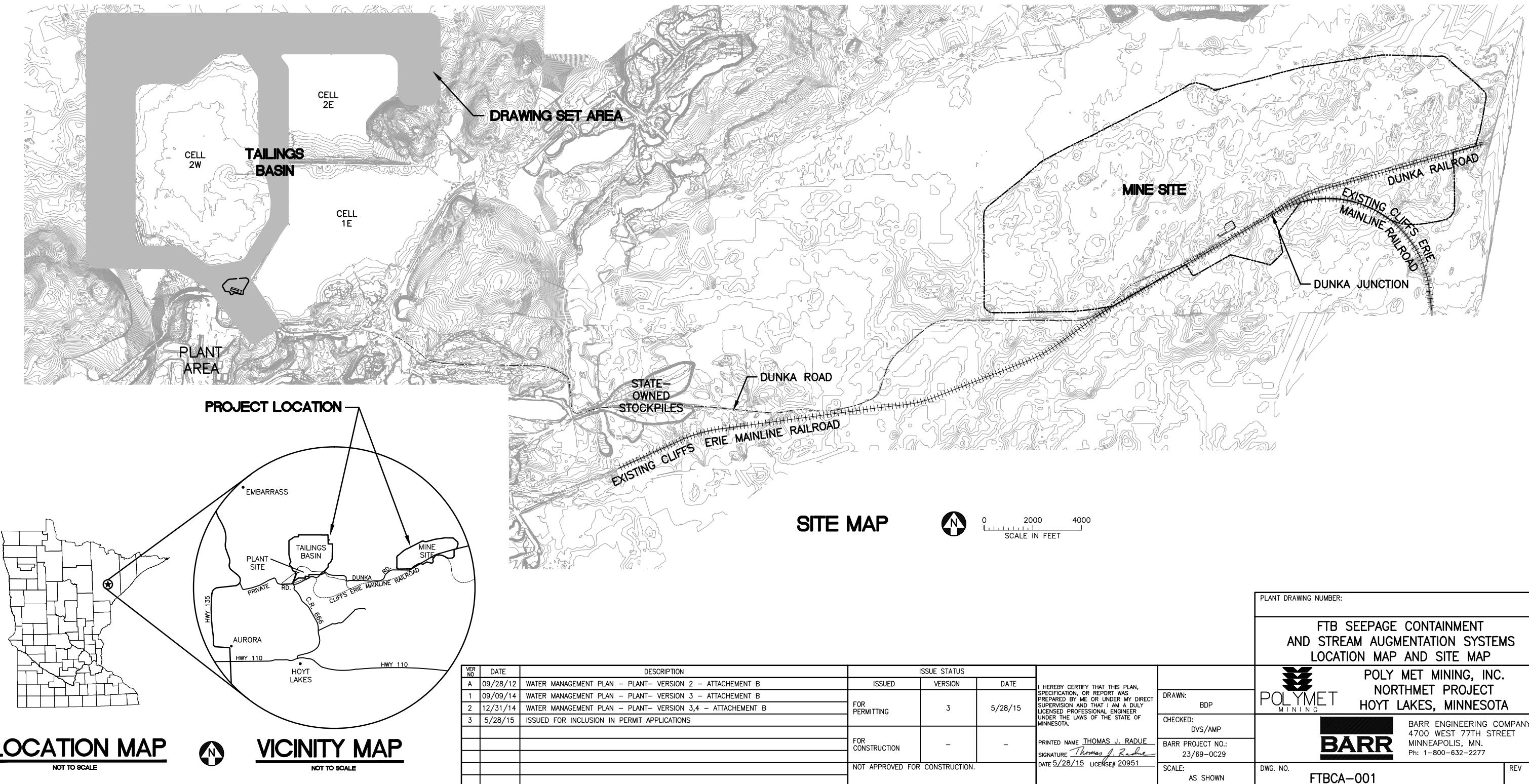
Permit Application Support Drawings – Flotation Tailings Basin Seepage Containment and Stream Augmentation Systems

POLY MET MINING, INC. NORTHMET PROJECT

FTB SEEPAGE CONTAINMENT AND STREAM AUGMENTATION SYSTEMS

HOYT LAKES, MINNESOTA

CADD USER: Terri J. Toms FILE: K:\DESIGN\23690C29.10\PERMIT_NMT-10-CU-001.DWG PLOT DATE: 6/9/2015 10:50 AM



GENERAL LEGEND

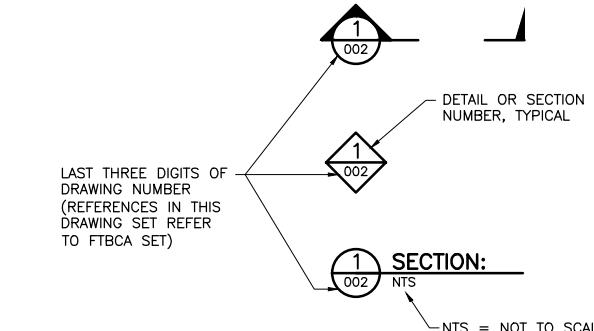
— 1000 —	EXISTING CONTOUR - MAJOR
— — —	EXISTING CONTOUR - MINOR
— 1000 —	PROPOSED CONTOUR - MAJOR
— — —	PROPOSED CONTOUR - MINOR
◎	EXISTING POWER POLE
+++++	EXISTING RAILROAD
=====	EXISTING ROAD
— — — —	EXISTING TRAIL
====	EXISTING UNIMPROVED TRAIL
	EXISTING STRUCTURES
	TREE LINE
	WETLAND BOUNDARY
	EXISTING CULVERT
P	EXISTING PIPELINE
+ - +	CUTOFF WALL ALIGNMENT
— — —	OVERHEAD ELECTRIC
— — — →	SURFACE DRAINAGE
— — —	PROPOSED DEWATERING PIPE
— — —	PROPOSED DISCHARGE PIPELINE
— — —	PROPOSED RETURN PIPELINE
	PROPOSED CULVERT (NON-MINE DRAINAGE)
— — —	PROPOSED SEEPAGE COLLECTION DRAIN
— — —	PROPOSED STORMWATER DRAIN
O	PROPOSED MANHOLE
	PROPOSED RIP RAP
	ROTASONIC BORING
	ROTASONIC BORING WITH PIEZOMETER
	SPT BORING
	SPT BORING WITH PACKER
	FLOW METER

ABBREVIATIONS

APPROX.	- APPROXIMATE
CDSM	- CEMENT DEEP SOIL MIX
CMP	- CORRUGATED METAL PIPE
CPEP	- CORRUGATED POLYETHYLENE PIPE
CY	- CUBIC YARD
DR	- DIMENSION RATIO
DWG	- DRAWING
EL.	- ELEVATION
Ø	- DIAMETER
FTB	- FLOTATION TAILINGS BASIN
GCL	- GEOSYNTHETIC CLAY LINER
HDPE	- HIGH DENSITY POLYETHYLENE
HRF	- HYDROMETALLURGICAL RESIDUE FACILITY
LDPE	- LOW DENSITY POLYETHYLENE
LF	- LINER FEET
LTVSMC	- LTV STEEL MINING COMPANY
MCY	- MILLION CUBIC YARDS
mil	- one thousandth of an inch
MIN	- MINIMUM
MSL	- MEAN SEA LEVEL
NTS	- NOT TO SCALE
SCH.	- SCHEDULE
DR	- DIMENSION RATIO
TYP	- TYPICAL
N-MH-XX	- NORTH SECTION MANHOLE
NW-MH-XX	- NORTHWEST SECTION MANHOLE
W-MH-XX	- WEST SECTION MANHOLE
N-MH/PS-XX	- NORTH SECTION MANHOLE/PUMP STATION
NW-MH/PS-XX	- NORTHWEST SECTION MANHOLE
W-MH/PS-XX	- WEST SECTION MANHOLE/PUMP STATION

SHEET INDEXSHEET NO. TITLEGENERAL DRAWINGS

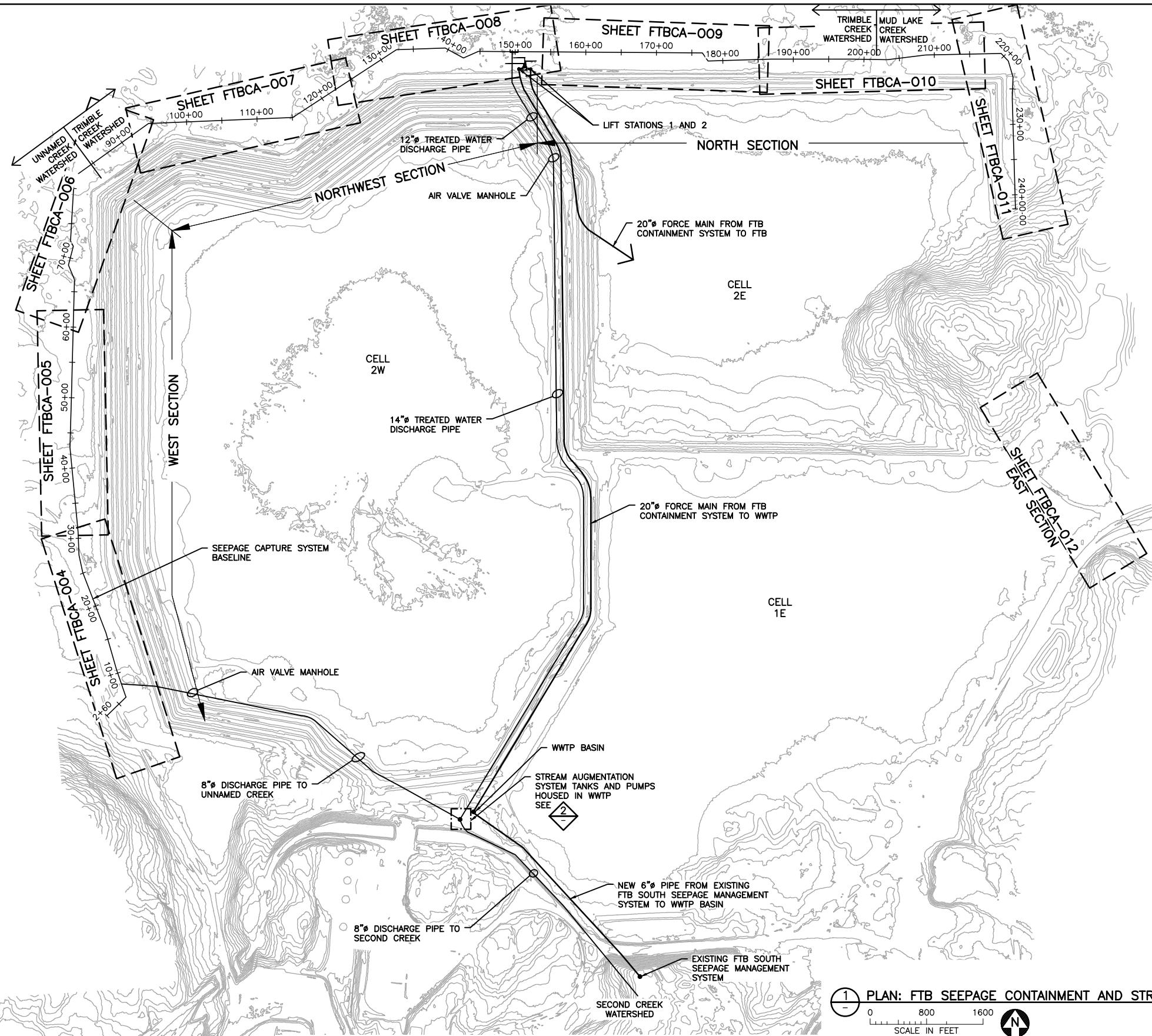
FTBCA-001	LOCATION MAP AND SITE MAP
FTBCA-002	LEGEND AND SHEET INDEX
FTBCA-003	PLAN SHEET LAYOUT
FTBCA-004	PLAN AND PROFILE- STATION 0+00 TO STATION 30+94
FTBCA-005	PLAN AND PROFILE- STATION 30+94 TO STATION 61+88
FTBCA-006	PLAN AND PROFILE- STATION 61+88 TO STATION 92+82
FTBCA-007	PLAN AND PROFILE- STATION 92+82 TO STATION 123+76
FTBCA-008	PLAN AND PROFILE- STATION 123+76 TO STATION 154+70
FTBCA-009	PLAN AND PROFILE- STATION 154+70 TO STATION 185+64
FTBCA-010	PLAN AND PROFILE- STATION 185+64 TO STATION 216+58
FTBCA-011	PLAN AND PROFILE- STATION 216+58 TO STATION 240+17
FTBCA-012	EAST SECTION PLAN & PROFILE STATION 0+00 TO STATION 25+43
FTBCA-013	DETAILS
FTBCA-014	DETAILS
FTBCA-015	DETAILS

DRAWING NUMBERINGNOTES

- COORDINATE SYSTEM IS MINNESOTA STATE PLANE NORTH ZONE, NAD83.
- ELEVATIONS ARE MEAN SEA LEVEL (MSL), NAVD88.
- EXISTING TOPOGRAPHIC INFORMATION SHOWN ON THE DRAWINGS WAS PREPARED BY AEROMETRIC, INC. FROM LIDAR DATA COLLECTED ON MARCH 17, 2010.
- EXISTING TOPOGRAPHIC INFORMATION WAS UPDATED FOR AREAS SOUTH EAST OF COAL ASH LANDFILL AND EAST OF OUTCROP BETWEEN CELLS 1E AND 2E USING CONTOURS FROM DATA COLLECTED IN 1999.

PLANT DRAWING NUMBER:	FTB SEEPAGE CONTAINMENT AND STREAM AUGMENTATION SYSTEMS LEGEND AND SHEET INDEX		
POLY MET MINING, INC. NORTHMET PROJECT HOYT LAKES, MINNESOTA			
DRAWN:	BARR ENGINEERING COMPANY 4700 WEST 77TH STREET MINNEAPOLIS, MN. Ph: 1-800-632-2277		
CHECKED:	BARR PROJECT NO.: 23/69-OC29		
SCALE:	DWG. NO. FTBCA-002 REV		

VER NO	DATE	DESCRIPTION	ISSUE STATUS			HEREBY CERTIFY THAT THIS PLAN, SPECIFICATIONS AND DRAWINGS WERE PREPARED BY ME OR UNDER MY DIRECT SUPERVISION AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MINNESOTA.
			ISSUED	VERSION	DATE	
A	09/28/12	WATER MANAGEMENT PLAN - PLANT- VERSION 2 - ATTACHEMENT B				
1	09/09/14	WATER MANAGEMENT PLAN - PLANT- VERSION 3 - ATTACHEMENT B				
2	12/31/14	WATER MANAGEMENT PLAN - PLANT- VERSION 3,4 - ATTACHEMENT B	FOR PERMITTING	3	5/28/15	
3	5/28/15	ISSUED FOR INCLUSION IN PERMIT APPLICATIONS	FOR CONSTRUCTION	-	-	PRINTED NAME THOMAS J. RADUE SIGNATURE DATE 5/28/15 LICENSE # 20951
						NOT APPROVED FOR CONSTRUCTION.



① PLAN: FTB SEEPAGE CONTAINMENT AND STREAM AUGMENTATION LAYOUT

SCALE IN FEET

VER NO	DATE	DESCRIPTION	ISSUE STATUS			I HEREBY CERTIFY THAT THIS PLAN, SPECIFICATION, OR REPORT WAS PREPARED BY ME OR UNDER MY DIRECT SUPERVISION AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MINNESOTA.
			ISSUED	VERSION	DATE	
A	09/28/12	WATER MANAGEMENT PLAN – PLANT- VERSION 2 – ATTACHEMENT B				
1	09/09/14	WATER MANAGEMENT PLAN – PLANT- VERSION 3 – ATTACHEMENT B				
2	12/31/14	WATER MANAGEMENT PLAN – PLANT- VERSION 3,4 – ATTACHEMENT B	FOR PERMITTING	3	5/28/15	
3	5/28/15	ISSUED FOR INCLUSION IN PERMIT APPLICATIONS				
			FOR CONSTRUCTION	–	–	PRINTED NAME THOMAS J. RADUE SIGNATURE  DATE 5/28/15 LICENSE# 20951
			NOT APPROVED FOR CONSTRUCTION.			

LAYOUT

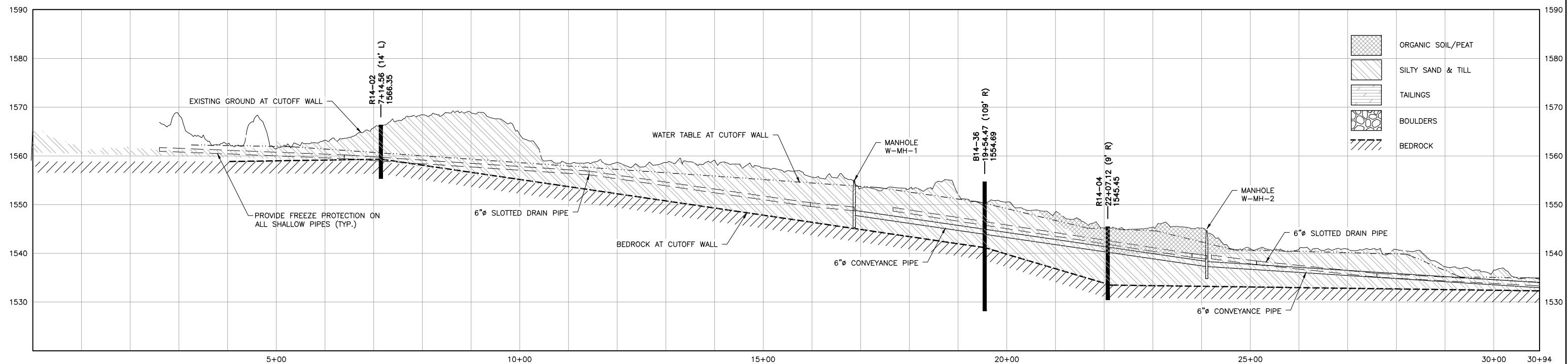
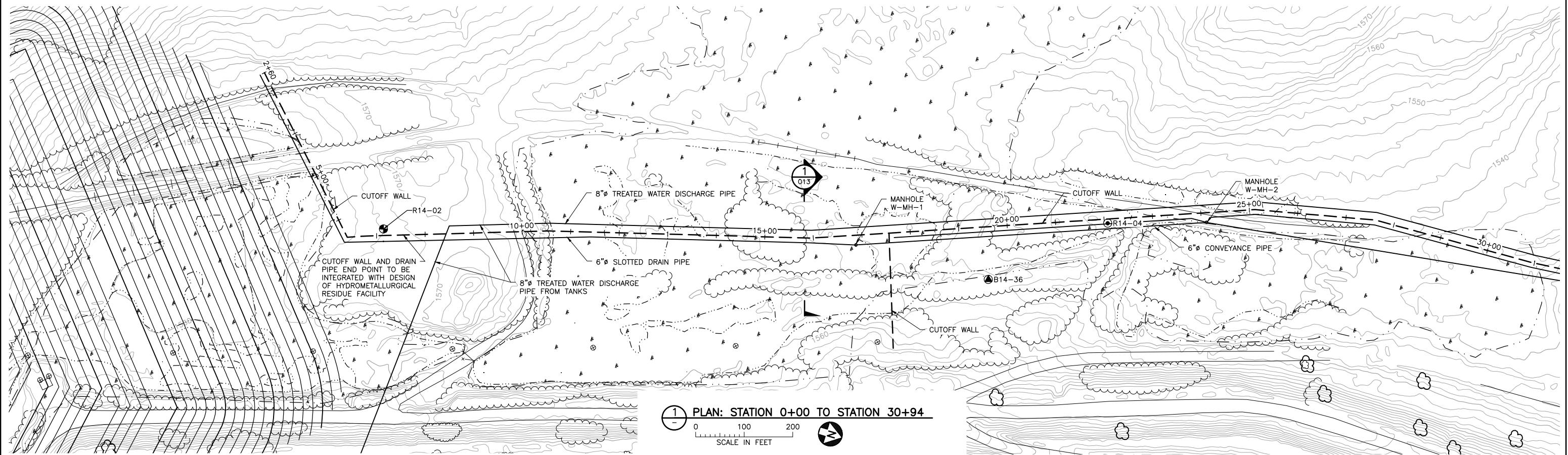
PLANT DRAWING NUMBER:

**FTB SEEPAGE CONTAINMENT
AND STREAM AUGMENTATION SYSTEMS
PLAN SHEET LAYOUT**

 POLY MET MINING, INC.
NORTHMET PROJECT
HOYT LAKES, MINNESOTA

BARR ENGINEERING COMPANY
4700 WEST 77TH STREET
MINNEAPOLIS, MN.
Ph: 1-800-632-2277

FTBCA-003 REV



NOTES:

- HORIZONTAL LOCATION OF FORCE MAIN, SEEPAGE CONVEYANCE PIPES AND STREAM AUGMENTATION PIPES/DISCHARGE POINTS ON THIS SHEET AND SUBSEQUENT SHEETS SHOWN FOR CLARITY. ACTUAL LOCATION TO BE DETERMINED DURING FINAL DESIGN.
- MANHOLE LOCATIONS ON THIS SHEET AND SUBSEQUENT SHEETS ARE PRELIMINARY.
- ACCESS ROAD NOT SHOWN ON THIS SHEET AND SUBSEQUENT SHEETS.

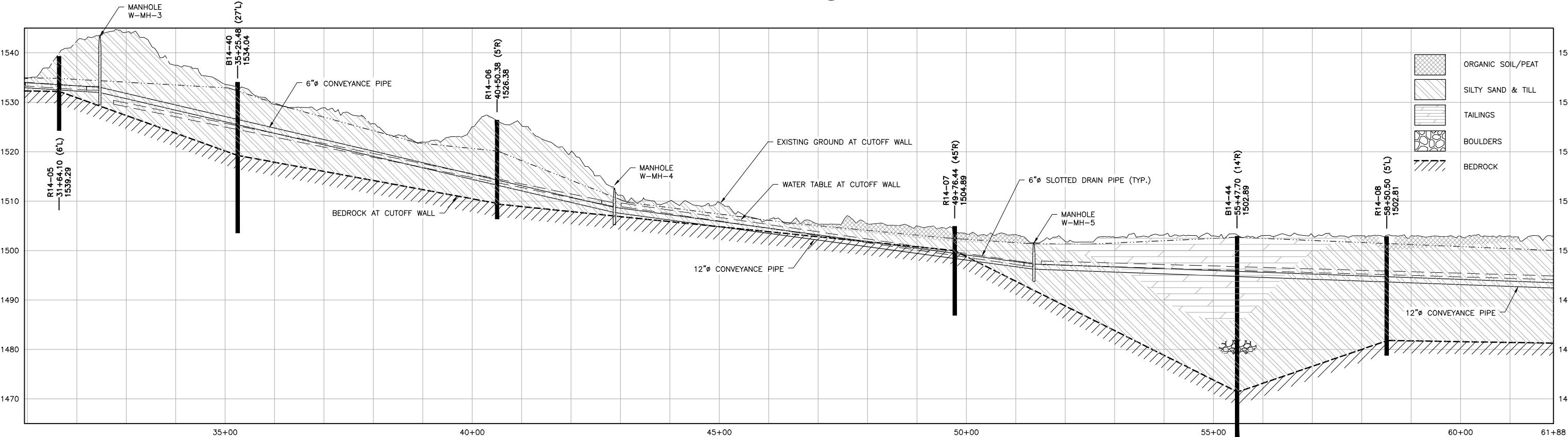
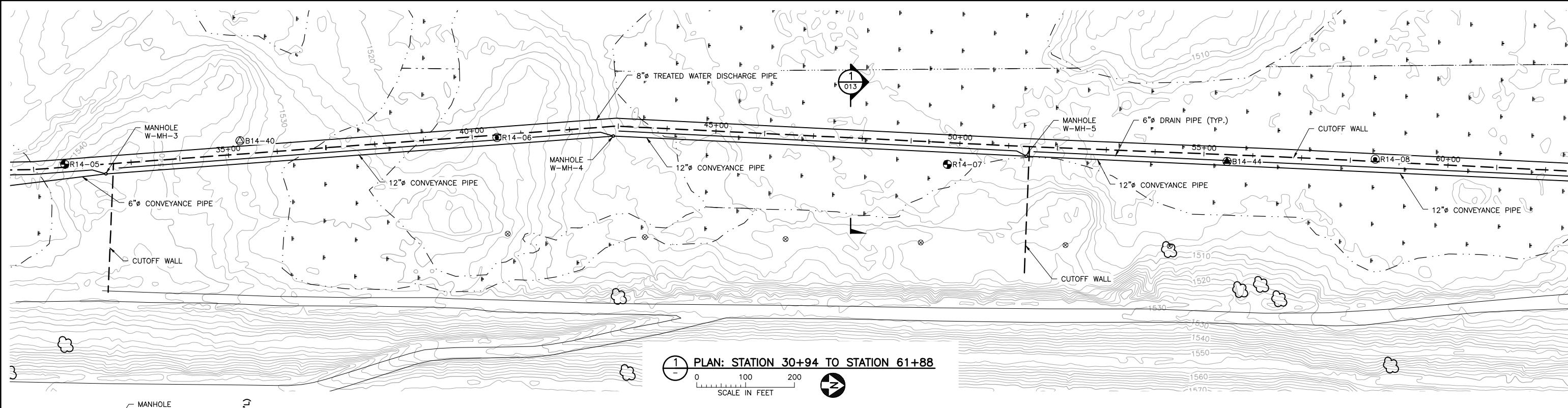
- TREATED WATER DISCHARGE PIPES NOT SHOWN IN PROFILE ON THIS SHEET AND SUBSEQUENT SHEETS.
- WATER TABLE ELEVATIONS ARE ESTIMATED BASED ON PIEZOMETERS, BORING LOGS, SOIL TYPES AND AERIAL PHOTOGRAPHY.
- GROUND SURFACE ELEVATIONS ARE BASED ON 2010 LIDAR DATA (NAVD88). BORING ELEVATIONS SHOWN ARE BASED ON 2010 LIDAR DATA (NAVC88) ADJUSTED AFTER GEOTECHNICAL EXPLORATION (03-11-2014 THRU 05-20-2014). STRATIGRAPHY AND WATER TABLES ARE BASED ON THE 2014 FIELD INVESTIGATION LOGS.
- BORING LOCATION OFFSETS FROM PROPOSED CUTOFF WALL ALIGNMENT ARE SHOWN. SUBSURFACE CONDITIONS ON WALL ALIGNMENT WILL DIFFER FROM THOSE SHOWN.
- AREAS OF COBBLES AND BOULDERS BETWEEN BORING LOCATIONS AND ADJACENT BORING LOCATIONS SHOULD BE ASSUMED TO EXIST.

VER NO	DATE	DESCRIPTION	ISSUED	VERSION	DATE	HEREBY CERTIFY THAT THIS PLAN, SPECIFICATION OR REPORT WAS PREPARED BY ME OR UNDER MY DIRECT SUPERVISION AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MINNESOTA.	DRAWN:
A	09/28/12	WATER MANAGEMENT PLAN - PLANT- VERSION 2 - ATTACHEMENT B					BJH
1	09/09/14	WATER MANAGEMENT PLAN - PLANT- VERSION 3 - ATTACHEMENT B					
2	12/31/14	WATER MANAGEMENT PLAN - PLANT- VERSION 3,4 - ATTACHEMENT B	FOR PERMITTING	3	5/28/15		
3	5/28/15	ISSUED FOR INCLUSION IN PERMIT APPLICATIONS					
			FOR CONSTRUCTION	-	-	PRINTED NAME THOMAS J. RADUE SIGNATURE Thomas J. Radue DATE 5/28/15 LICENSE# 20951	CHECKED: DVS/AMP
							BARR PROJECT NO.: 23/69-0C29
			NOT APPROVED FOR CONSTRUCTION.				SCALE: AS SHOWN
							DWG. NO. FTBCA-004
							REV

POLY MET MINING, INC.
NORTHMET PROJECT
HOYT LAKES, MINNESOTA

BARR ENGINEERING COMPANY
4700 WEST 77TH STREET
MINNEAPOLIS, MN.
Ph: 1-800-632-2277

BARR



PLANT DRAWING NUMBER: FTBCA-005

POLY MET MINING, INC.
NORTHMET PROJECT
HOYT LAKES, MINNESOTA

**FTB SEEPAGE CONTAINMENT
AND STREAM AUGMENTATION SYSTEMS
PLAN & PROFILE STATION 30+94 TO 61+88**

DRAWN: BJH

CHECKED: DVS/AMP

BARR PROJECT NO.: 23/69-OC29
Ph: 1-800-632-2277

BARR ENGINEERING COMPANY
4700 WEST 77TH STREET
MINNEAPOLIS, MN.

BARR

INCHES

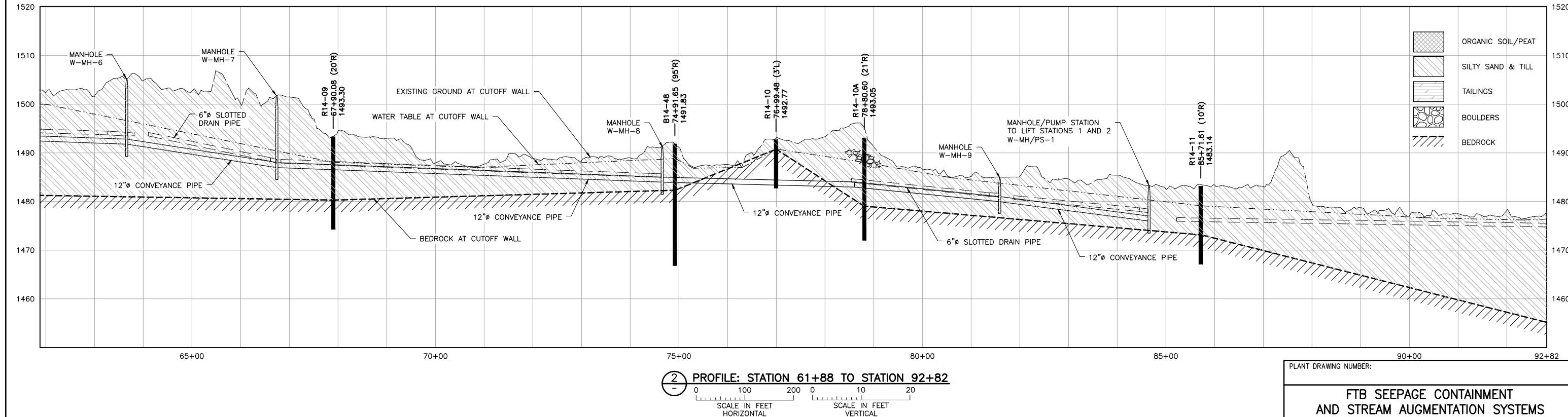
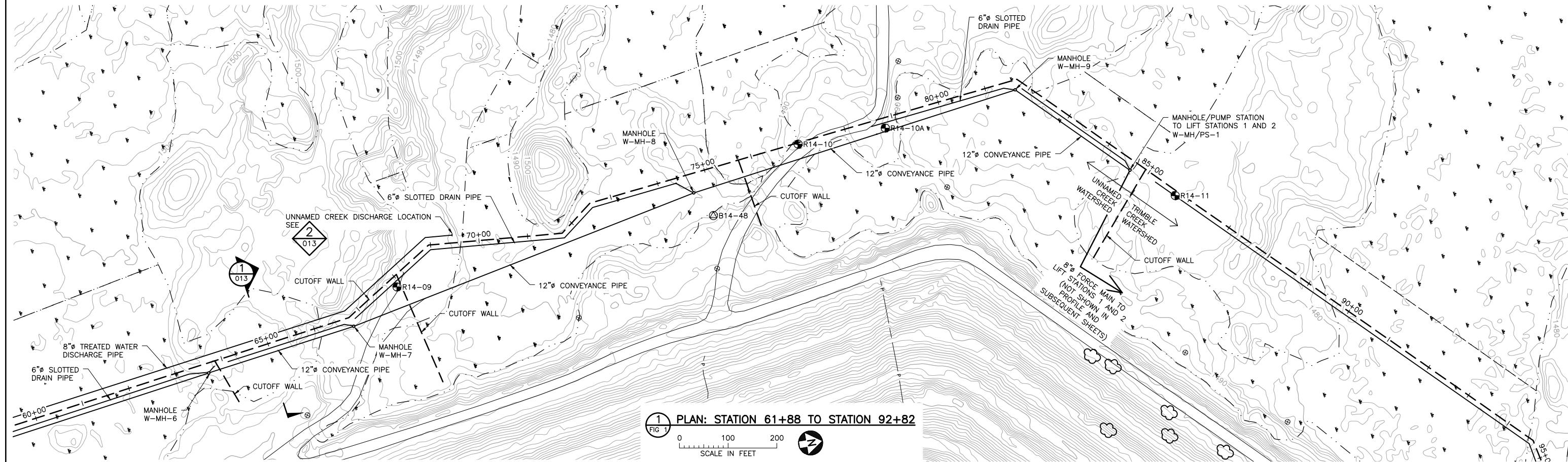
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VER NO. DATE DESCRIPTION ISSUE STATUS DRAWN: POLYMET MINING

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1	09/09/14	WATER MANAGEMENT PLAN - PLANT- VERSION 3 - ATTACHEMENT B				PRINTED NAME THOMAS J. RADUE
2	12/31/14	WATER MANAGEMENT PLAN - PLANT- VERSION 3,4 - ATTACHEMENT B				SIGNATURE <i>Thomas J. Radue</i>
3	5/28/15	ISSUED FOR INCLUSION IN PERMIT APPLICATIONS				DATE 5/28/15 LICENSE # 20951
			FOR CONSTRUCTION	-	-	
						SCALE: AS SHOWN
			NOT APPROVED FOR CONSTRUCTION.			DWG. NO. FTBCA-005



VER NO	DATE	DESCRIPTION	ISSUED	VERSION	DATE
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2	12/31/14	WATER MANAGEMENT PLAN - PLANT- VERSION 3,4 - ATTACHEMENT B			
3	5/28/15	ISSUED FOR INCLUSION IN PERMIT APPLICATIONS	FOR CONSTRUCTION	-	-
					NOT APPROVED FOR CONSTRUCTION.

I HEREBY CERTIFY THAT THIS PLAN, SPECIFICATION, OR REPORT WAS PREPARED BY ME OR UNDER MY DIRECT SUPERVISION AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MINNESOTA.

DRAWN: BJH

CHECKED: DVS/AMP

BARR PROJECT NO.: 23-69-0C29

SIGNATURE Thomas J. Radue
DATE 5/28/15 LICENSE # 20951

SCALE: AS SHOWN

POLY MET MINING, INC.
NORTHMET PROJECT
HOYT LAKES, MINNESOTA

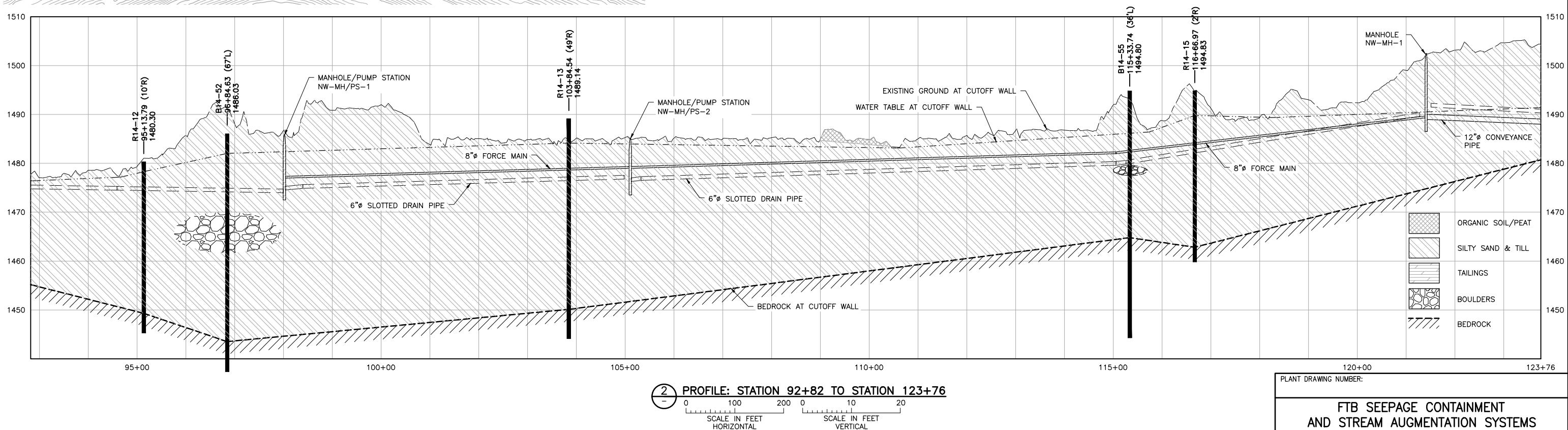
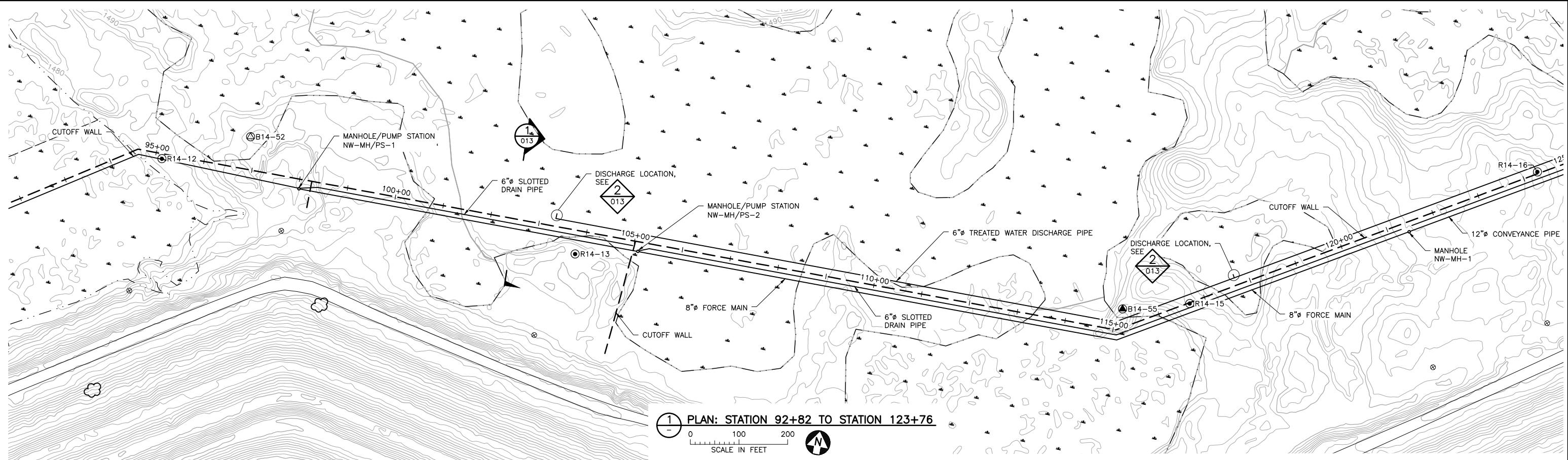
POLYMET
MINING

BARR ENGINEERING COMPANY
4700 WEST 77TH STREET
MINNEAPOLIS, MN.
Ph: 1-800-632-2277

BARR

FTBCA-006

REV



ITEM	ISSUED	VERSION	DATE	REMARKS
ENT B				I HEREBY CERTIFY THAT THIS PLAN, SPECIFICATION, OR REPORT WAS PREPARED BY ME OR UNDER MY DIRECT SUPERVISION AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MINNESOTA.
ENT B				
MENT B	FOR PERMITTING	3	5/28/15	

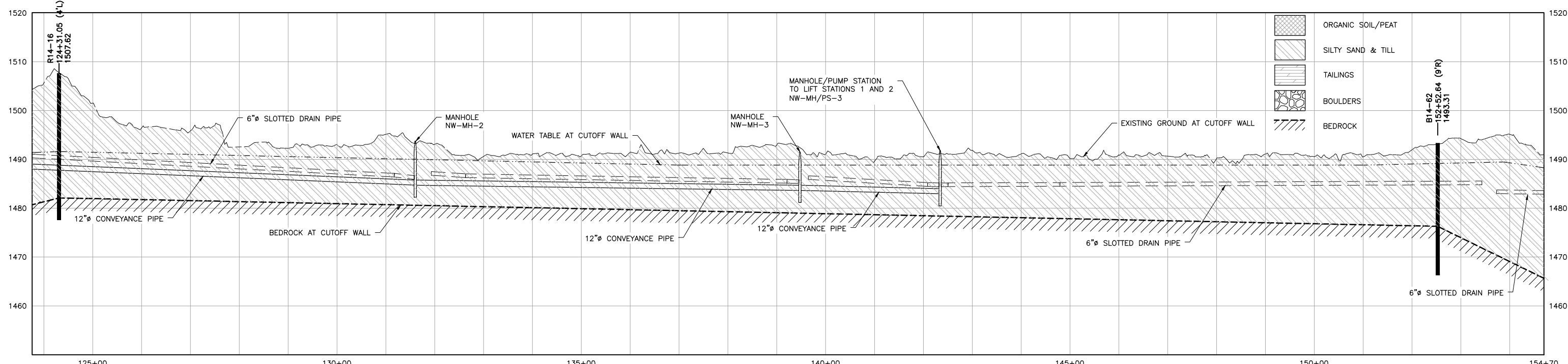
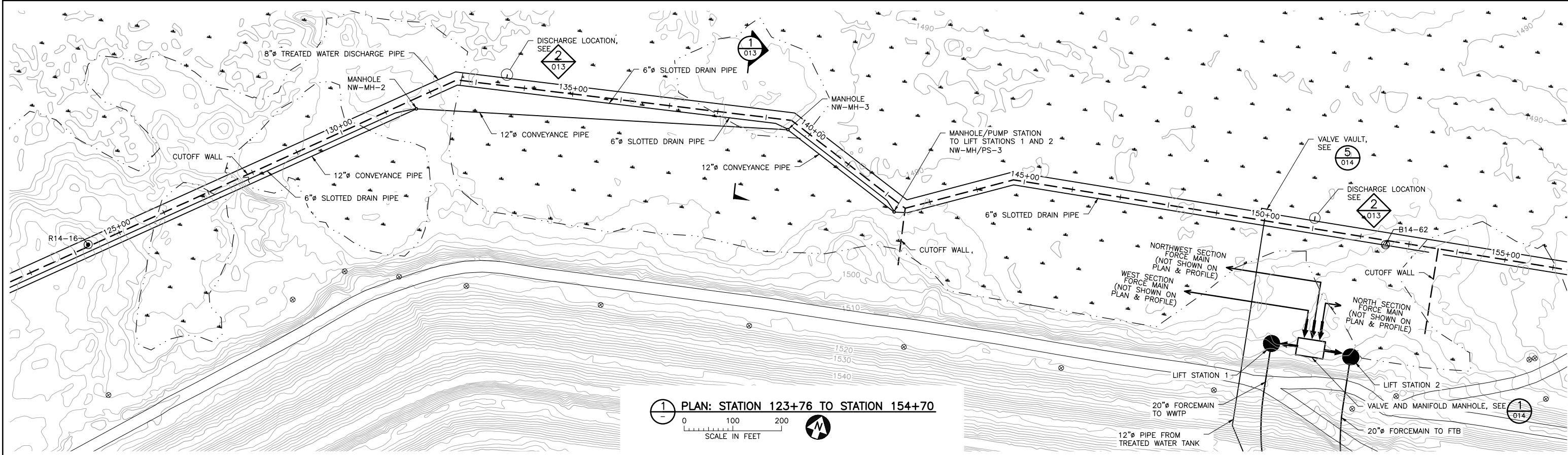
	FOR CONSTRUCTION	-	-	MINNESOTA.
	NOT APPROVED FOR CONSTRUCTION.			PRINTED NAME THOMAS J. RADUE SIGNATURE <i>Thomas J. Radue</i> DATE 5/28/15 LICENSE# 20951

120+00	123+76
PLANT DRAWING NUMBER:	
FTB SEEPAGE CONTAINMENT AND STREAM AUGMENTATION SYSTEMS PLAN & PROFILE STATION 92+82 TO 123+76	

POLY MET MINING, INC.
NORTHMET PROJECT
HOYT LAKES, MINNESOTA

BARR ENGINEERING COMPANY
4700 WEST 77TH STREET
MINNEAPOLIS, MN.
Ph: 1-800-632-2277

TBCA-007



ADD USER: Adapter User FILE: \\PWEINAD\EDNA.FW\EDNA.FW IN\1863E06-BFFF-44D-D31A-2092BF3D0E7C\ef560f5a-207D-41DB-93B4-821D469668\PERMIT--NMTU-10-CU-008.DWG PLOT SCALE: 1:2 PLOT DATE: 6/8/2015 5:06 PM

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1	09/09/14	WATER MANAGEMENT PLAN – PLANT – VERSION 3 – ATTACHED
2	12/31/14	WATER MANAGEMENT PLAN – PLANT – VERSION 3,4 – ATTACHED
3	5/28/15	ISSUED FOR INCLUSION IN PERMIT APPLICATIONS

		ISSUE STATUS	
ITEM	DESCRIPTION	ISSUED	VERSION
ITEM B	FOR PERMITTING		3
	FOR CONSTRUCTION		-
		NOT APPROVED FOR CONSTRUCTION	

DATE	I HEREBY CERTIFY THAT THIS PLAN, SPECIFICATION, OR REPORT WAS PREPARED BY ME OR UNDER MY DIRECT SUPERVISION AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER IN ACCORDANCE WITH THE LAWS OF THE STATE OF MINNESOTA.
5/28/15	
—	PRINTED NAME <u>THOMAS J. RADUE</u> SIGNATURE <u>Thomas J. Radue</u> DATE <u>5/28/15</u> LICENSE # <u>20951</u>

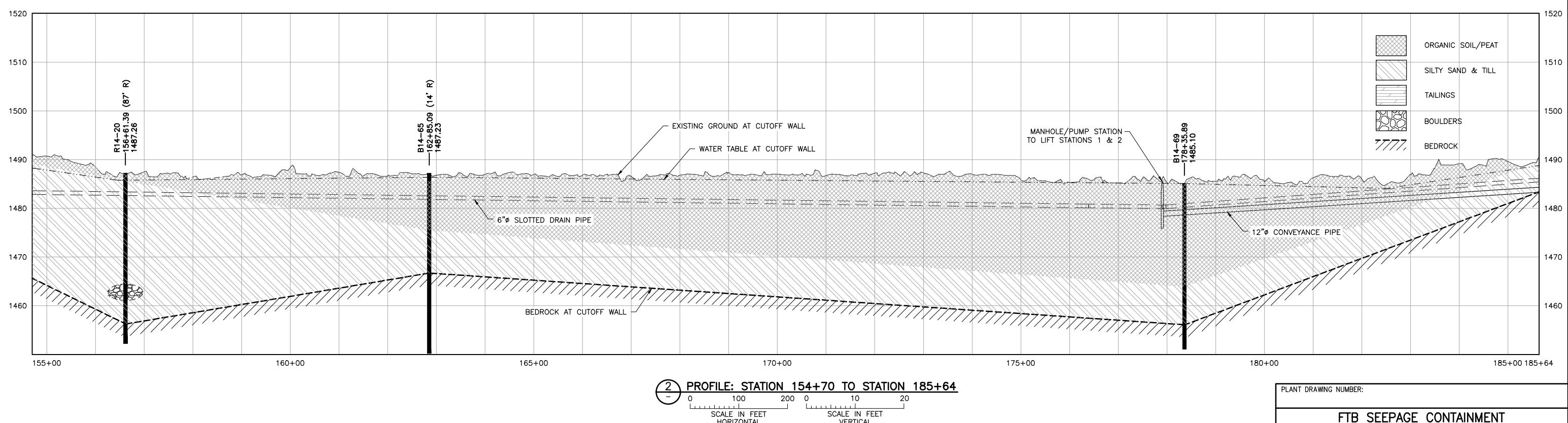
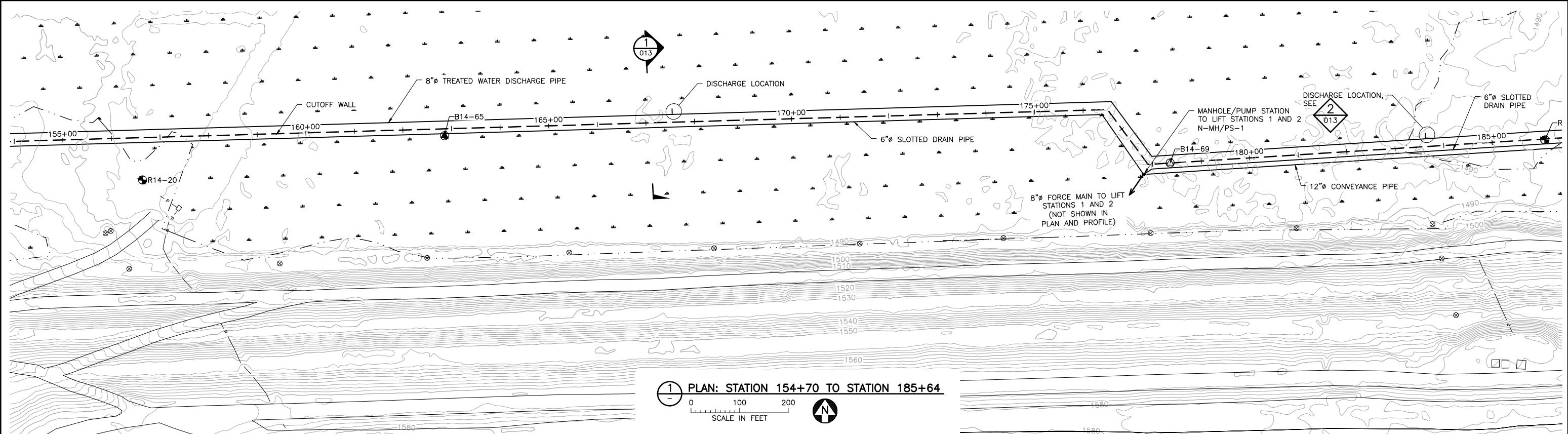
	 POLYMER MINING
DRAWN:	BJH
CHECKED:	DVS/AMP
BARR PROJECT NO.:	23/69-0C29
SCALE:	DWG. NO.

POLY MET MINING, INC.
NORTHMET PROJECT
HOYT LAKES, MINNESOTA

BARR

BARR ENGINEERING COMPANY
4700 WEST 77TH STREET
MINNEAPOLIS, MN.
Ph: 1-800-632-2277

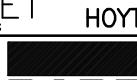
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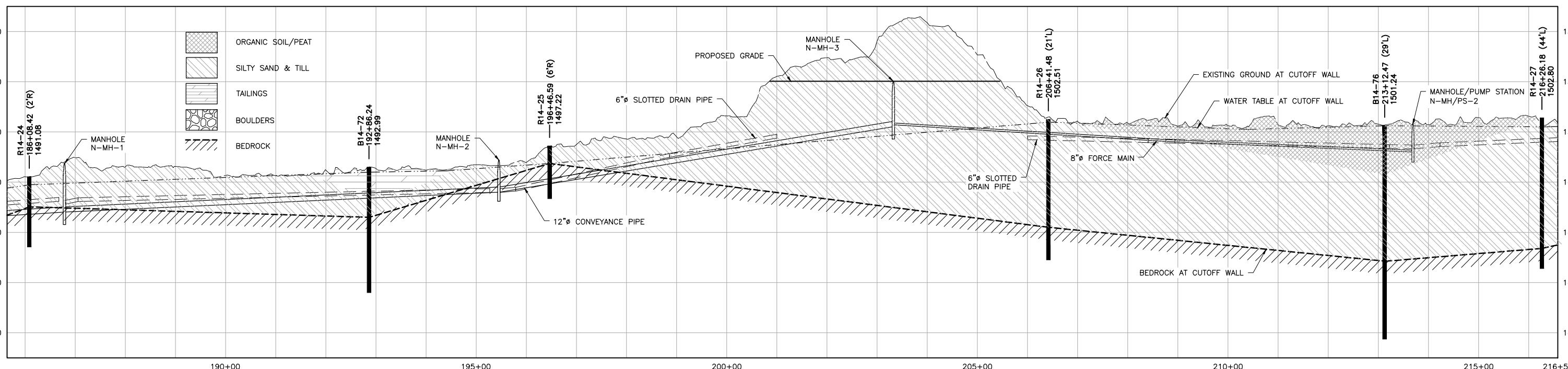
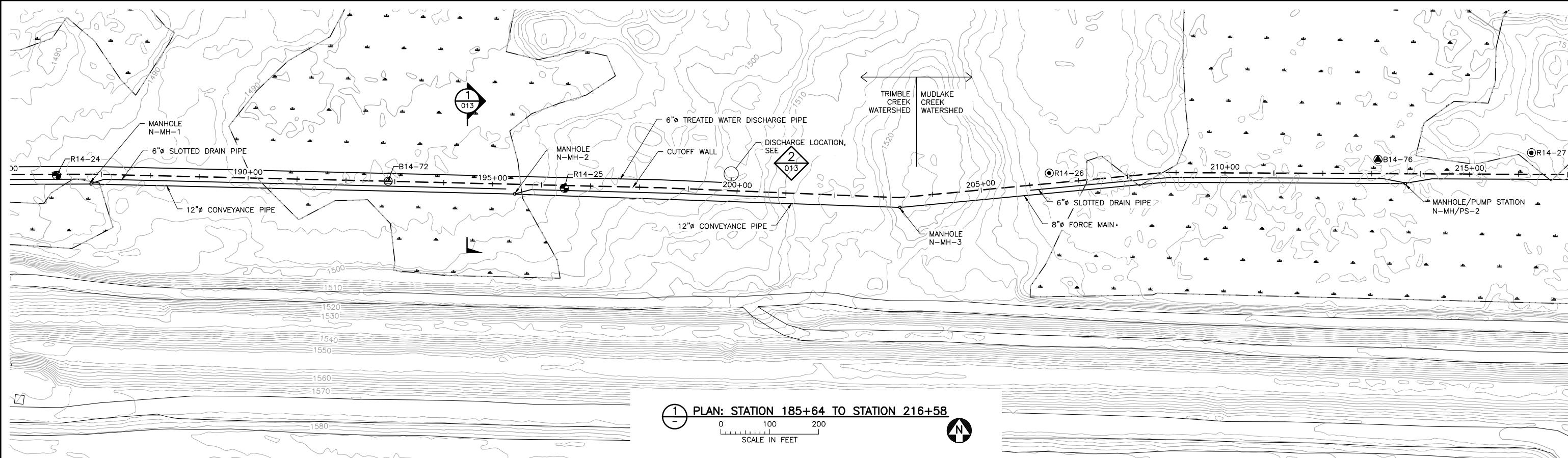


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3	5/28/15	ISSUED FOR INCLUSION IN PERMIT APPLICATIONS

ENT B	ISSUED	VERSION	DATE	I HEREBY CERTIFY THAT THIS PLAN, SPECIFICATION, OR REPORT WAS PREPARED BY ME OR UNDER MY DIRECT SUPERVISION AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF WASHINGTON.
ENT B				
MENT B	FOR PERMITTING	3	5/28/15	

	FOR CONSTRUCTION	-	-	MINNESOTA PRINTED NAME THOMAS J. RADUE SIGNATURE <i>Thomas J. Radue</i> DATE 5/28/15 LICENSE # 20951
NOT APPROVED FOR CONSTRUCTION.				

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 POLYMET <small>M I N I N G</small>	<p style="text-align: center;">POLY MET MINING, INC. NORTHMET PROJECT HOYT LAKES, MINNESOTA</p>
	 BARR
DWG. NO.	REV
FTB-CA-009	



PLANT DRAWING NUMBER:	FTB SEEPAGE CONTAINMENT AND STREAM AUGMENTATION SYSTEMS PLAN & PROFILE STATION 185+64 TO 216+58		
DRAWN:	POLY MET MINING, INC. NORTHMET PROJECT HOYT LAKES, MINNESOTA		
CHECKED:	POLYMET MINING		
BARR PROJECT NO.:	BARR ENGINEERING COMPANY 4700 WEST 77TH STREET MINNEAPOLIS, MN. Ph: 1-800-632-2277		
SCALE:	REV DWG. NO. FTBCA-010		

VER NO	DATE	DESCRIPTION	ISSUED	VERSION	DATE
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2	12/31/14	WATER MANAGEMENT PLAN - PLANT- VERSION 3,4 - ATTACHEMENT B			
3	5/28/15	ISSUED FOR INCLUSION IN PERMIT APPLICATIONS	FOR CONSTRUCTION	-	-
			NOT APPROVED FOR CONSTRUCTION.		

I HEREBY CERTIFY THAT THIS PLAN, SPECIFICATION, OR REPORT WAS PREPARED BY ME OR UNDER MY DIRECT SUPERVISION AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MINNESOTA.

PRINTED NAME THOMAS J. RADUE
SIGNATURE *Thomas J. Radue*
DATE 5/28/15 LICENSE # 20951

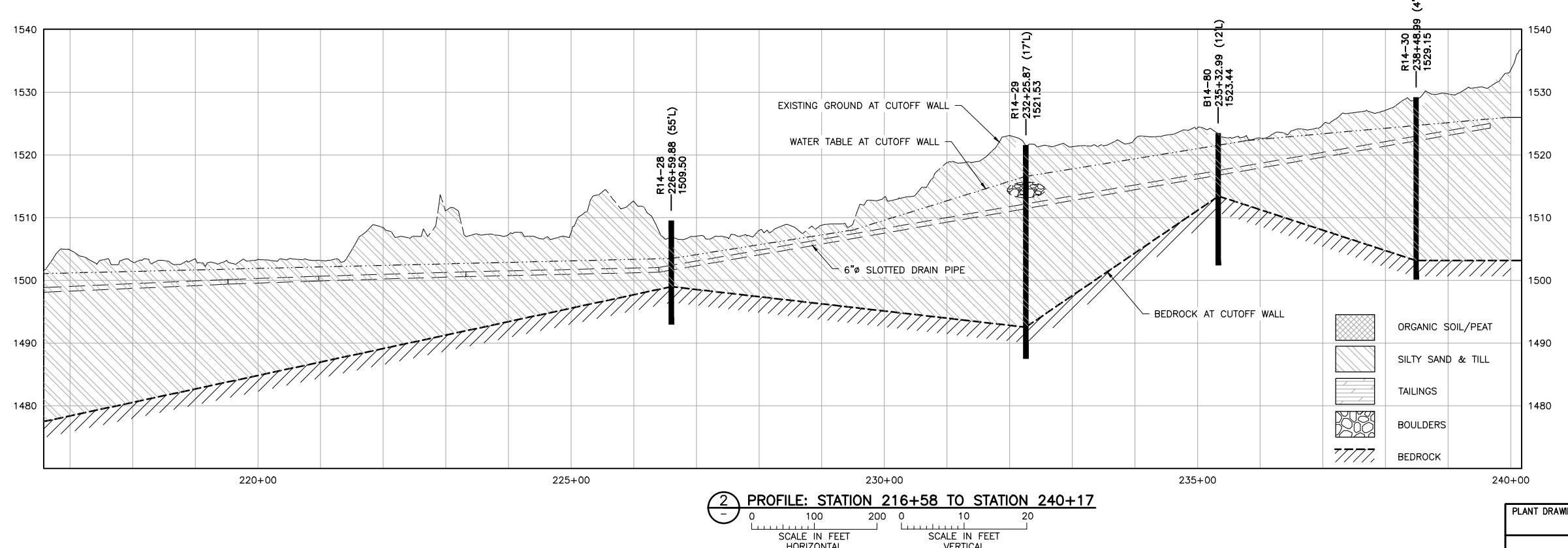
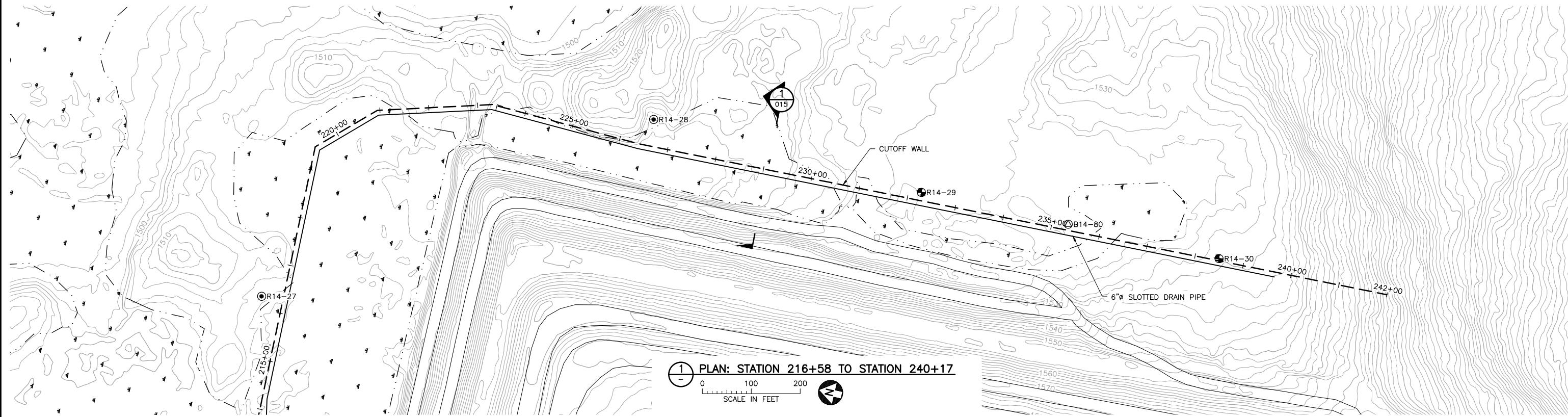
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BJH

CHECKED:
DVS/AMP

BARR PROJECT NO.:
23/69-OC29

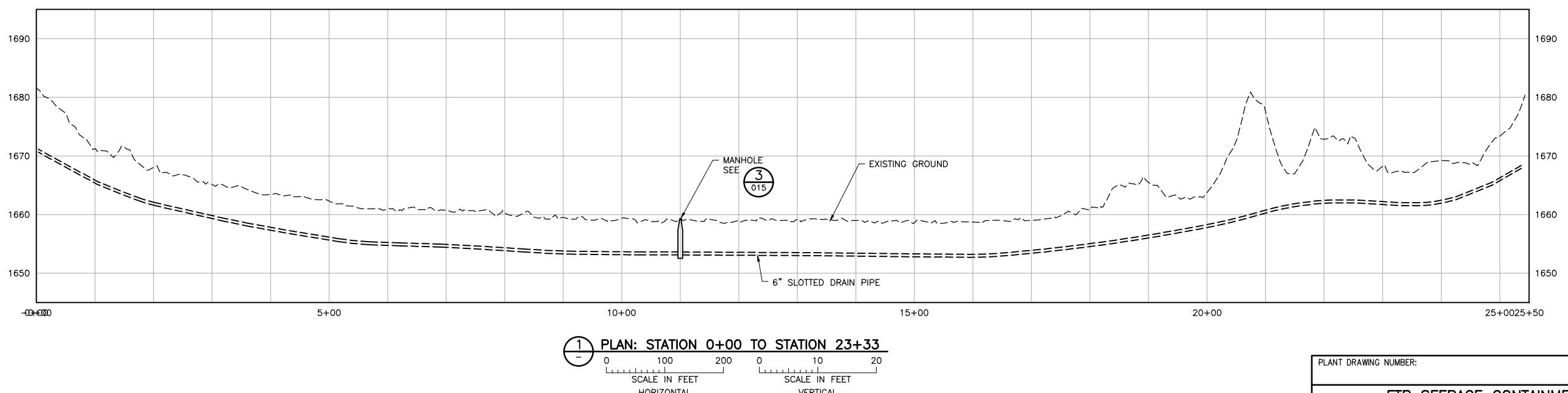
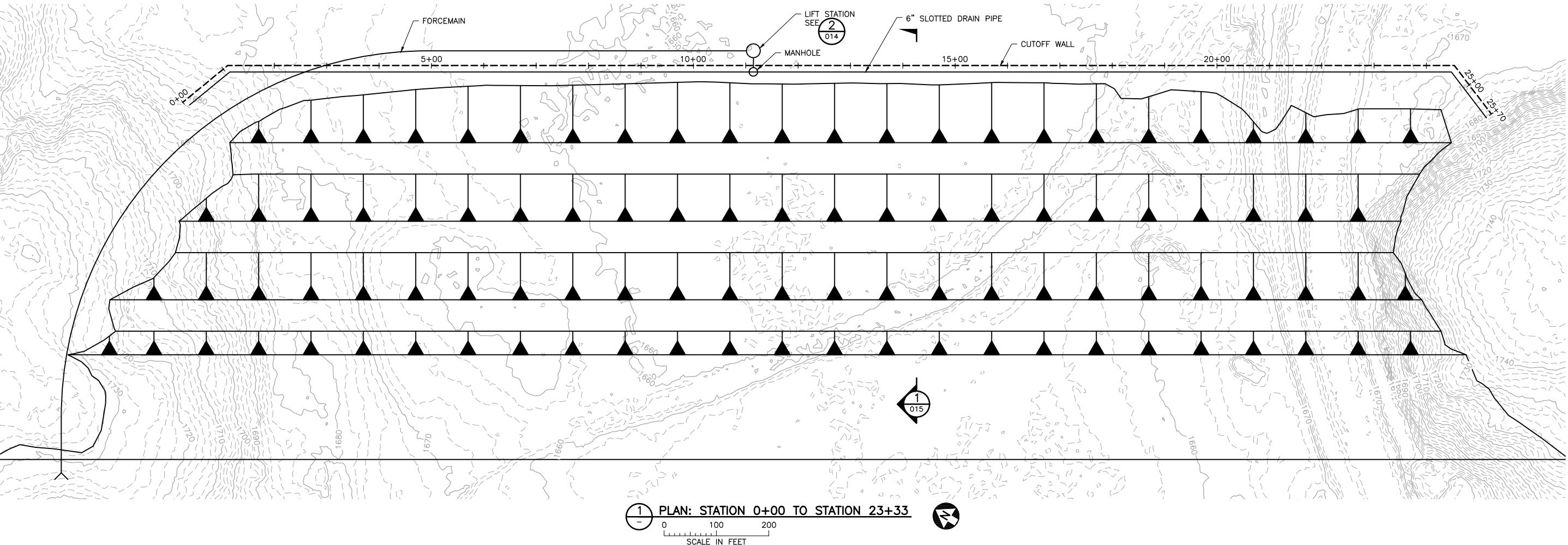
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AS SHOWN

DWG. NO.
FTBCA-010



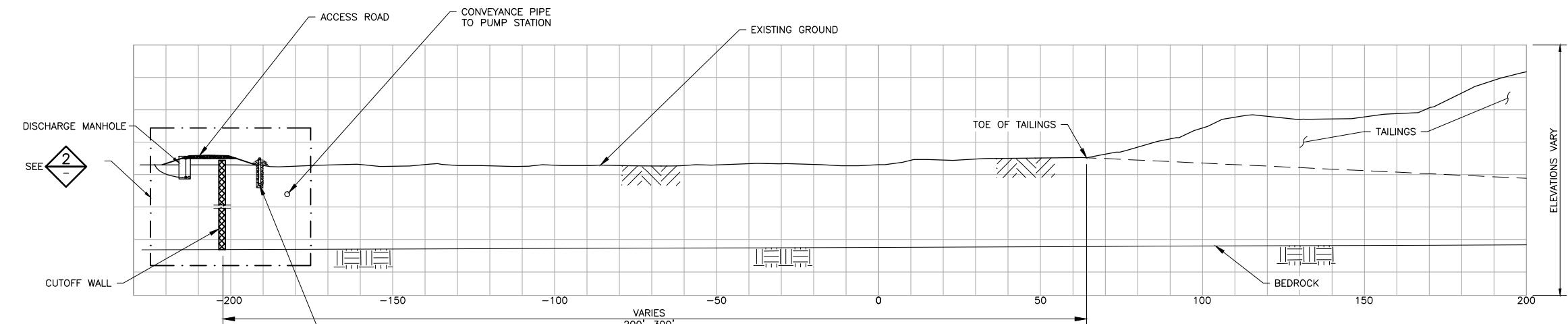
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POLY MET MINING, INC.	NORTHMET PROJECT	
POLYMET MINING	HOYT LAKES, MINNESOTA	
BARR ENGINEERING COMPANY	4700 WEST 77TH STREET	
	MINNEAPOLIS, MN.	
	Ph: 1-800-632-2277	
BARR		
INCHES	DWG. NO. FTBCA-011	
2	REV	
1		

VER NO	DATE	DESCRIPTION	ISSUED	VERSION	DATE	NOT APPROVED FOR CONSTRUCTION.	PRINTED NAME	SIGNATURE	DATE
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1	09/09/14	WATER MANAGEMENT PLAN - PLANT- VERSION 3 - ATTACHEMENT B	FOR PERMITTING	3	5/28/15		DRAWN:	BJH	
2	12/31/14	WATER MANAGEMENT PLAN - PLANT- VERSION 3,4 - ATTACHEMENT B					CHECKED:	DVS/AMP	
3	5/28/15	ISSUED FOR INCLUSION IN PERMIT APPLICATIONS	FOR CONSTRUCTION	-	-		BARR PROJECT NO.:	23/69-OC29	
							DATE	5/28/15	LICENSE # 20951
							SCALE:	AS SHOWN	
							DWG. NO.	FTBCA-011	

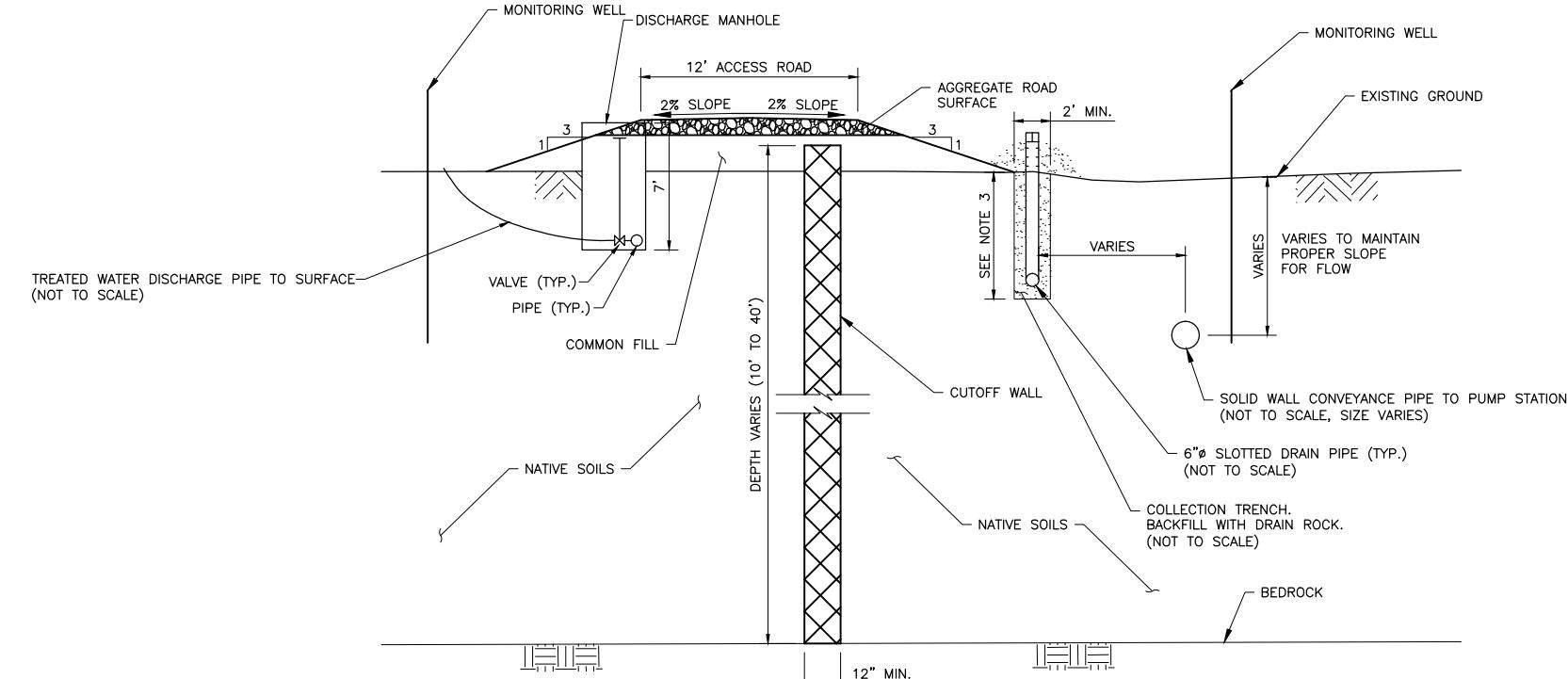


ENT B	ISSUED	VERSION	DATE	I HEREBY CERTIFY THAT THIS PLAN, SPECIFICATION, OR REPORT WAS PREPARED BY ME OR UNDER MY DIRECTION, AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MINNESOTA.
ENT B	FOR PERMITTING	3	5/28/15	
ENT B	FOR CONSTRUCTION			PRINTED NAME THOMAS J. RADUE SIGNATURE <i>Thomas J. Radue</i> DATE 5/28/15 LICENSE# 20951
	NOT APPROVED FOR CONSTRUCTION.			

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 POLYMET <small>MINING</small>	POLY MET MINING, INC. NORTHMET PROJECT HOYT LAKES, MINNESOTA
	BARR <small>Engineering</small> <small>Environmental</small> <small>Geotechnical</small> <small>Structural</small> <small>Water Resources</small>
DWG. NO. FTBCA-012	REV



1 TYPICAL SECTION
SCALE IN FEET



2 TYPICAL DETAIL
SCALE IN FEET

NOTES:

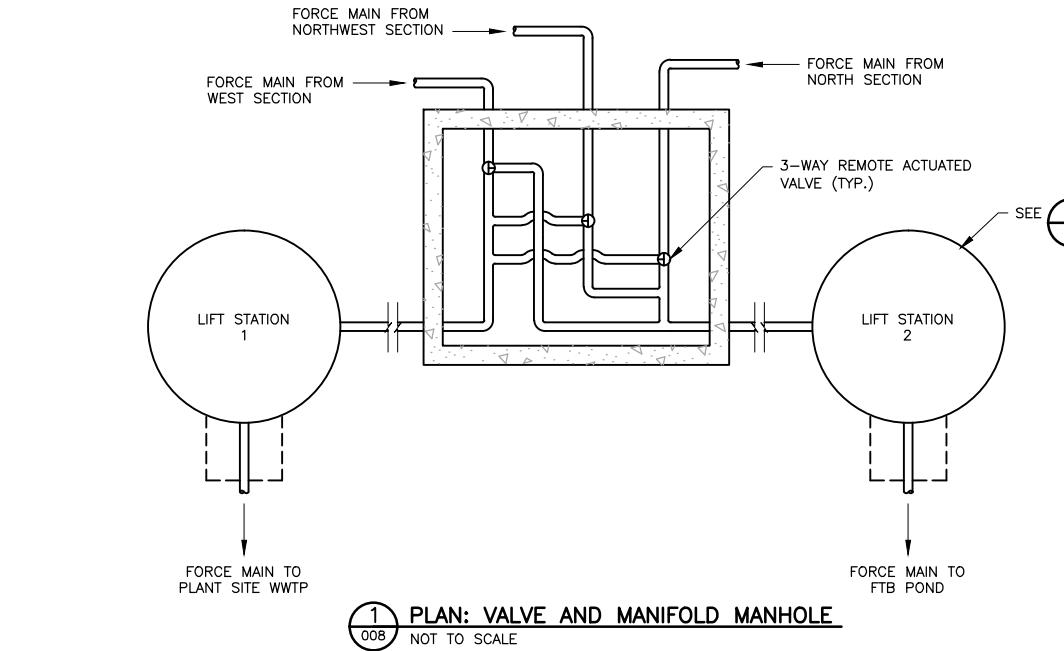
1. DIFFUSER TO BE INSTALLED ON DISCHARGE PIPES AS REQUIRED TO PREVENT EROSION.
2. CUTOFF WALL MAXIMUM DESIGN HYDRAULIC CONDUCTIVITY = 1×10^{-6} CM/SEC
3. 7' TYPICAL BUT MAY BE LESS IN AREAS WITH SHALLOW BEDROCK

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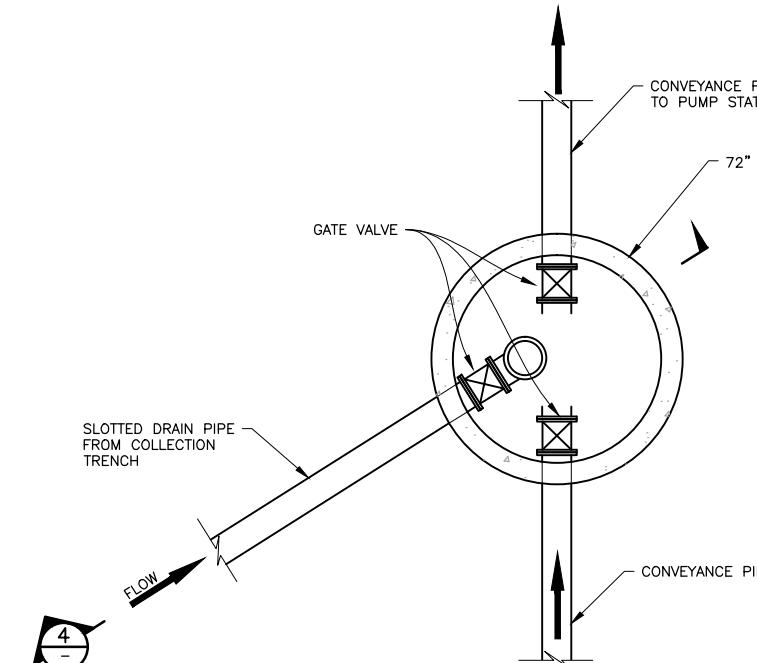
FTB SEEPAGE CONTAINMENT
AND STREAM AUGMENTATION SYSTEMS
DETAILS

POLY MET MINING, INC. NORTHMET PROJECT HOYT LAKES, MINNESOTA	BARR ENGINEERING COMPANY 4700 WEST 77TH STREET MINNEAPOLIS, MN. Ph: 1-800-632-2277
DRAWN: BDP	
CHECKED: DVS/AMP	
BARR PROJECT NO.: 23/69-OC29	
SCALE: AS SHOWN	DWG. NO. FTBCA-013
REV	

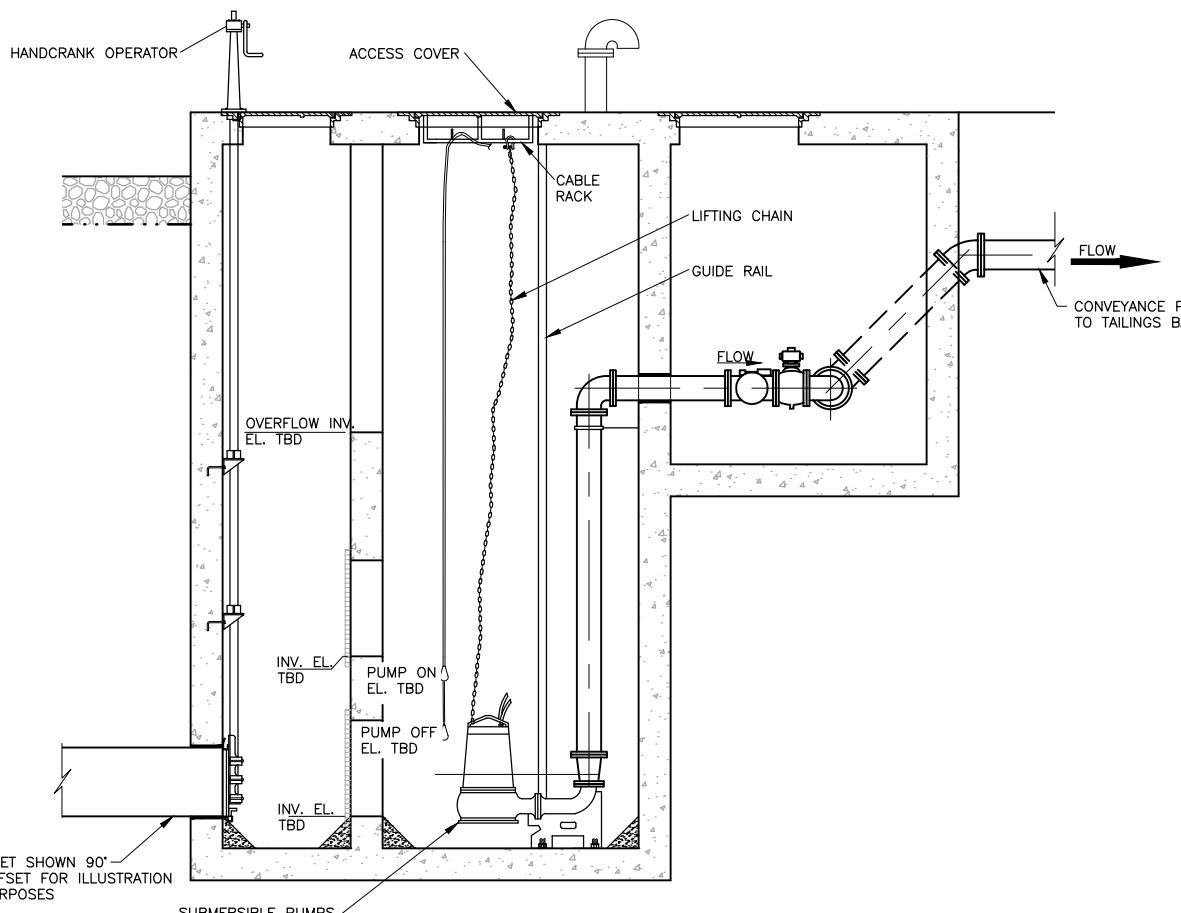
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2	12/31/14	WATER MANAGEMENT PLAN - PLANT- VERSION 3,4 - ATTACHEMENT B	3
3	5/28/15	ISSUED FOR INCLUSION IN PERMIT APPLICATIONS	5/28/15
			PRINTED NAME THOMAS J. RADUE SIGNATURE Thomas J. Radue DATE 5/28/15 LICENSE# 20951
			NOT APPROVED FOR CONSTRUCTION.



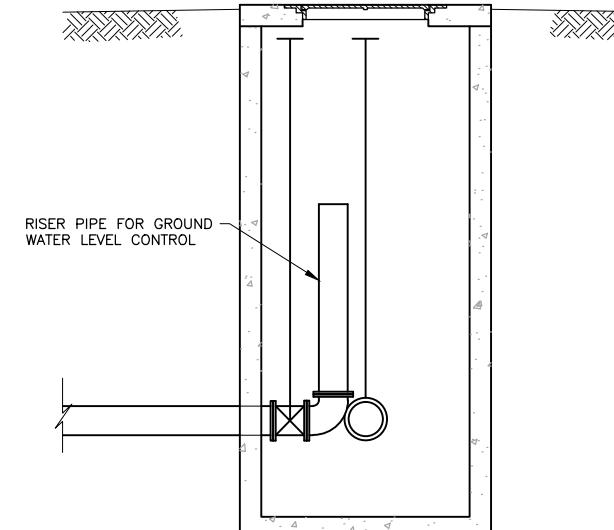
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008 NOT TO SCALE



5 PLAN: VALVE VAULT
008 NOT TO SCALE



SECTION: LIFT STATION (TYP.)



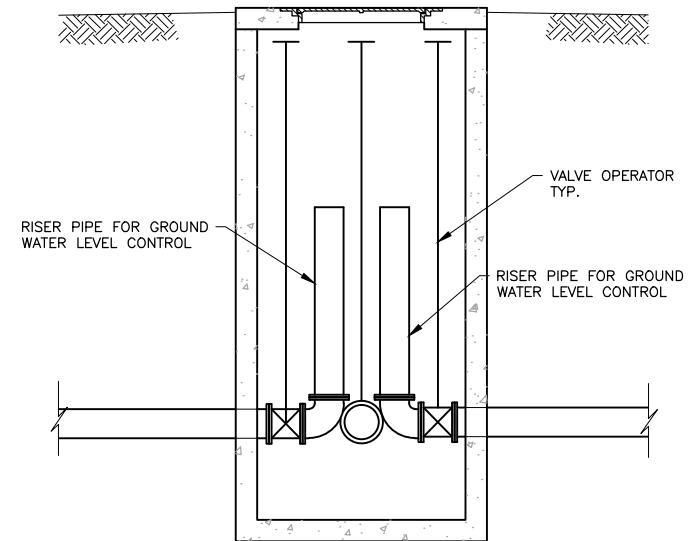
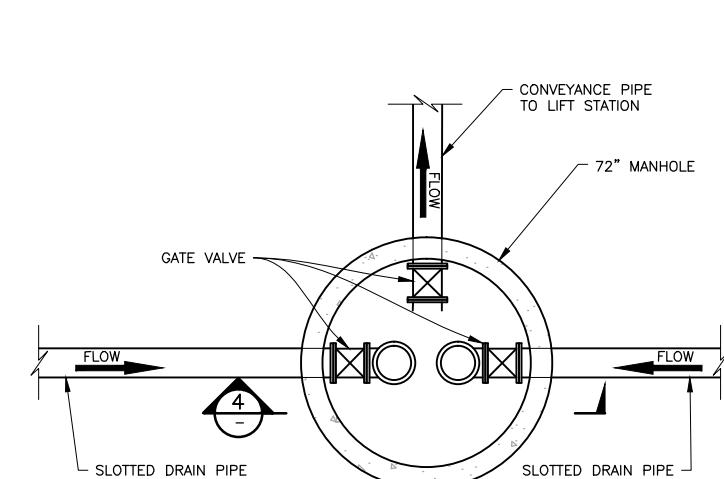
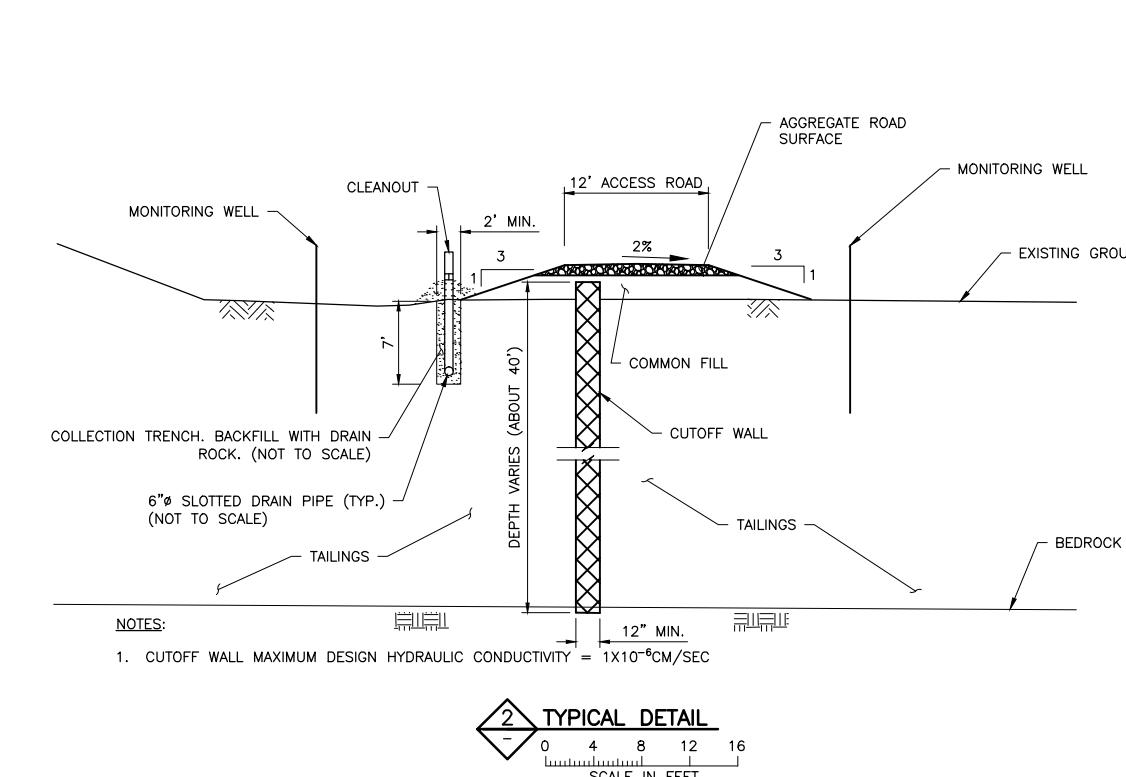
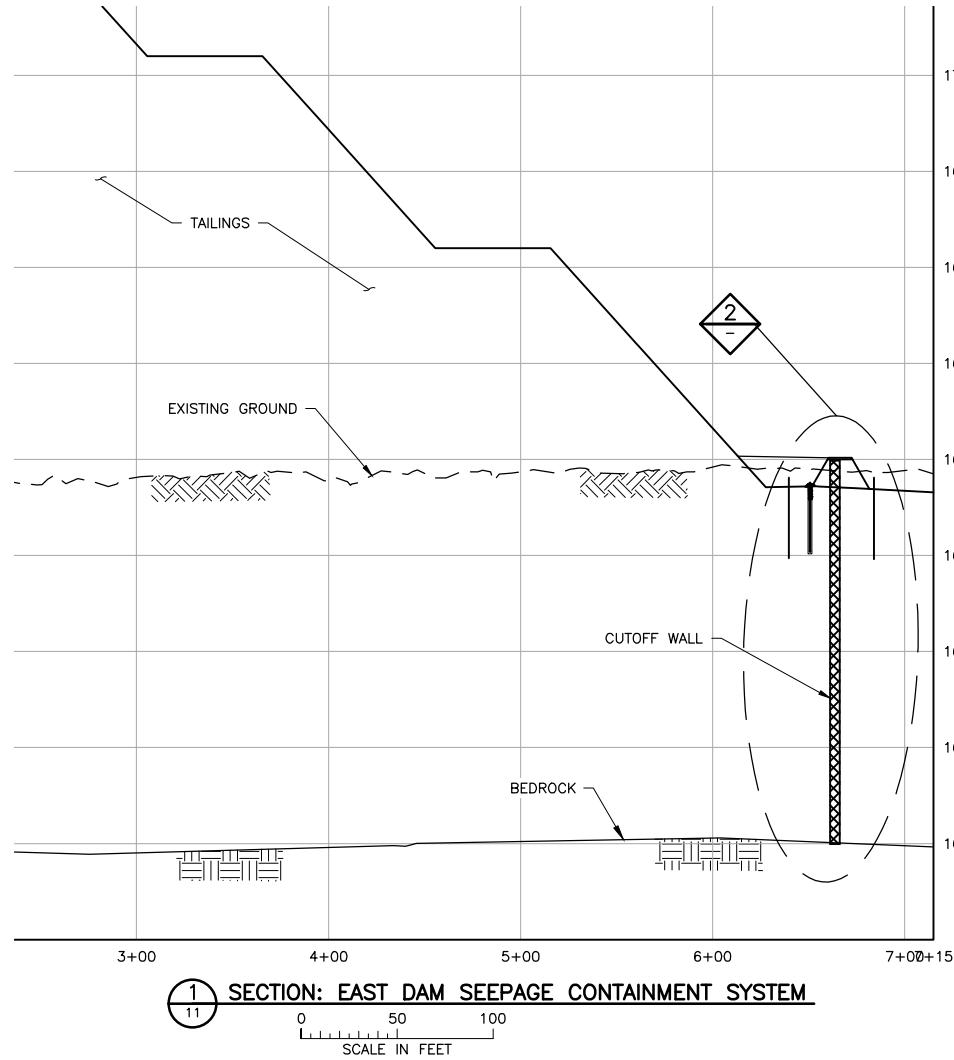
SECTION: MANHOLE (T)
NOT TO SCALE

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2	12/31/14	WATER MANAGEMENT PLAN – PLANT- VERSION 3,4 – ATTACHEMENT B	FOR PERMITTING	3
3	5/28/15	ISSUED FOR INCLUSION IN PERMIT APPLICATIONS		
			FOR CONSTRUCTION	
				NOT APPROVED FOR CONSTRUCTION.

NOTES:

1. LIFT STATION, MANHOLE AND VAULT CONFIGURATIONS SHOWN ON THIS SHEET ARE INTENDED TO BE REPRESENTATIVE OF TYPICAL FACILITIES NEEDED FOR OPERATION OF THE SEEPAGE CONTAINMENT AND STREAM AUGMENTATION SYSTEMS. THE ACTUAL DESIGN FOR EACH LIFT STATION, PUMP STATION, MANHOLE, AND VAULT WILL BE DEVELOPED DURING DETAILED DESIGN TO REFLECT THE SPECIFIC EQUIPMENT REQUIREMENTS FOR EACH LOCATION.
2. PUMP STATIONS WILL BE SIMILAR TO MANHOLE SHOWN IN  WITH SMALL SUBMERSIBLE PUMP,
3. FLOW METERS WILL BE PROVIDED FOR DISCHARGE FROM ALL LIFT AND PUMP STATIONS AND AT OTHER LOCATIONS AS REQUIRED FOR OPERATIONS.

PLANT DRAWING NUMBER:		
<p style="text-align: center;">FTB SEEPAGE CONTAINMENT AND STREAM AUGMENTATION SYSTEMS DETAILS</p>		
 POLYMET <small>MINING</small>	<p style="text-align: center;">POLY MET MINING, INC.</p> <p style="text-align: center;">NORTHMET PROJECT</p> <p style="text-align: center;">HOYT LAKES, MINNESOTA</p>	
		
		<p>BARR ENGINEERING COMPANY 4700 WEST 77TH STREET MINNEAPOLIS, MN. Ph: 1-800-632-2277</p>
DWG. NO.	FTBCA-014	
	REV	



PLANT DRAWING NUMBER:				
FTB SEEPAGE CONTAINMENT AND STREAM AUGMENTATION SYSTEMS DETAILS				
POLY MET MINING, INC. NORTHMET PROJECT HOYT LAKES, MINNESOTA				
DRAWN:	BDP			
CHECKED:	DVS/AMP			
BARR PROJECT NO.:	23/69-OC29			
SCALE:	AS SHOWN	DWG. NO.		
		FTBCA-015		
REV				

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2	12/31/14	WATER MANAGEMENT PLAN - PLANT- VERSION 3,4 - ATTACHEMENT B		DATE 5/28/15
3	5/28/15	ISSUED FOR INCLUSION IN PERMIT APPLICATIONS	FOR CONSTRUCTION	
			NOT APPROVED FOR CONSTRUCTION.	

Attachment C

Construction Specifications – Flotation Tailings Basin

Technical Specifications for Permitting

NorthMet Flotation Tailings Basin

PolyMet Mining Corporation
NorthMet
Hoyt Lakes, MN

Table of Contents

Division 1 General Requirements

Section	01010	Summary of Work
	01200	Meetings
	01300	Submittals
	01400	Quality Control
	01510	Temporary Utilities
	01560	Stormwater Erosion Prevention Sediment and Dust Control

Division 2 Site Work

Section	02220	Excavating, Backfilling, and Compacting
	02240	Dewatering and Diversion
	02271	Riprap
	02610	Pipes and Fittings
	03100	Bentonite-Amended Tailings
	313200	Cement Deep Soil Mixing



SECTION 01010

SUMMARY OF WORK

PART 1 GENERAL

1.01 SPECIFICATIONS

- A. The format of these Specifications is based upon the CSI MASTERFORMAT; however differences in format and subject matter location do exist. These Specifications are written in imperative and streamlined form. This imperative language is directed to the Contractor, unless specifically noted otherwise. It is solely the Contractor's responsibility to thoroughly read and understand these Specifications and request written clarification of those portions which are unclear.
- B. Division of the Work as made in these Specifications is for the purpose of specifying and describing work which is to be completed. There has been no attempt to make a classification according to trade or agreements which may exist between Contractor, Subcontractors, or trade unions or other organizations. Such division and classification of the Work shall be solely the Contractor's responsibility.

1.02 EXISTING SITE CONDITIONS AND USES

- A. The Project Site is located at Poly Met Mining Inc.'s NorthMet Project near Hoyt Lakes, Minnesota.
- B. The Flotation Tailings Basin (FTB) is located northeast of the processing plant area and immediately east of, and adjacent to, Cell 2W.

1.03 WORK COVERED BY SPECIFICATIONS

- A. The overall scope of the Work which is more fully described in these Specifications includes, but is not necessarily limited to, furnishing all labor, tools, equipment, and materials necessary to:
 1. Mobilize and demobilize labor, equipment, materials, and temporary facilities.
 2. Obtain any necessary permits prior to performing the Work to the extent that such permits have not previously and/or are not planned to be obtained by Owner.
 3. Site preparation of all dam construction areas and borrow areas (including surface preparation and stripping topsoil).
 4. Protect all existing instrumentation and Project Site features, which include but are not limited to existing above ground pipelines, underground pipelines, pipeline discharge locations, electric utilities, inclinometers, piezometers, monitoring wells, and survey benchmarks.
 5. Excavate LTVSMC Coarse Tailings from areas shown on the Drawings, then place and compact LTVSMC Coarse Tailings to create proposed dams and access roads.
 6. Excavate, transport and place off-site borrow materials required for dam construction.
 7. Construct Cement Deep Soil Mix (CDSM) zone as shown on the drawings.
 8. Place Bentonite amended cover on exterior of all proposed dams and final beaches within the Flotation Tailings Basin.
 9. Construct North and South Buttresses as shown on the Drawings.
 10. Construct Tailings Discharge and Return Water Pipelines as shown on the Drawings.
 11. Construct Emergency Overflow as shown on the Drawings.



12. Construct Drainage Swale as shown on the Drawings.
 13. Fabricate and Install Diffuser Raft and Transfer Pump Raft.
 14. Refurbish and return Return Water Barge to service.
 15. Perform permanent site restoration of all areas disturbed by the Work.
 16. Submit construction documentation as specified.
- B. It is the intent of these Specifications to cover all aspects of the Project except items that may specifically be excluded as described herein. Should there be some item or items not shown on the Drawings or not described in these Specifications which are required for the Work, those items and the furnishing of all labor, materials, and equipment shall be considered incidental to the Work and no additional compensation will be provided.
- C. The Work includes the furnishing of all labor, equipment, tools, machinery, materials, and other items required for the construction of a complete Project as specified and shown on the Drawings. Equipment furnished shall be in safe operating condition and of adequate size, capacity, and condition for the performance of the Work. Contractor shall obtain all measurements necessary for the Work and shall be responsible for establishing all dimensions, levels, and layout of the Work.
- D. Contractor shall be solely responsible for the coordination of its activities with regard to the Project and the Owner, and for the coordination and its Subcontractor's activities with regard to the Project and the Owner.
- E. Contractor shall utilize material sources designated by Owner and shall develop necessary access roads to transport material sources to the Project Site.
- F. Contractor shall provide soil testing as required in Section 02220.

1.04 WORK BY OWNER OR OTHERS

- A. Owner will provide bench-mark and site coordinate information necessary for construction of the Work. Once provided, it is Contractor's responsibility to protect the bench-marks. Contractor shall request benchmark and site coordinate information from Owner a minimum of five days prior to the time when such information is needed.
- B. Owner will provide electrical service (voltage phase and KVA TBD) and connection to the Contractor's trailer.
- C. Others will construct the FTB Seepage Containment and Stream Augmentation Systems. Such systems are separate from/not integral to FTB construction and operations and their construction is excluded from this Scope of Work. It shall be the Contractor's responsibility to integrate their Work and activities with that of others working on or adjacent to the FTB.

1.05 OWNER FURNISHED PRODUCTS

- A. Owner will provide borrow sources for the construction of dams.

1.06 CONTRACTOR USE OF PREMISES

- A. Definition of Project Site: The Project Site is defined as the area within the construction limits shown on Drawings to be provided to Contractor by Owner prior construction, plus a nearby material and equipment storage and staging area, the location of which will be designated by Owner. Contractor shall limit operations, including material and equipment storage, to within

those boundaries. Any disturbance outside the construction limits shall be fully restored at Contractor's expense in accordance with Laws and Regulations. Contractor shall obtain pre-approval of Owner at all locations where Contractor uses land not included in the construction limits.

- B. Hours of Operation: Working hours shall be set by Contractor, subject to approval by Owner.
- C. Protection and Repair of Existing Facilities and Utilities: Contractor shall perform operations carefully and in such a manner as to protect existing facilities and utilities. Obstructions not shown on the Drawings may exist and shall be exposed by Contractor without damage. Contractor shall be responsible for damage to existing facilities and utilities resulting from Contractor's operations, and shall repair or replace damaged items to Owner's satisfaction. Groundwater monitoring wells shall be protected during construction unless directed otherwise by Owner.
- D. Unfavorable Construction Conditions: When unfavorable weather, soil, drainage, or other unsuitable construction conditions exist, Contractor shall confine operations to work which will not be adversely affected by such conditions. No portion of the Work shall be constructed under conditions which would adversely affect the quality of the Work or the safety of workers, unless special means or precautions are taken to perform the Work in a proper, safe and satisfactory manner.
- E. Survey Markers: Contractor shall conduct operations so as to preserve bench-marks, survey reference points, and stakes existing or established by Owner for the construction. Contractor will be charged the expense of repairing or replacing survey markers and shall be responsible for mistakes or lost time resulting from damage or destruction of survey markers due to Contractor's operations.
- F. Environmental Protection: Contractor shall conduct operations so as to fully comply with all state required and project-specific environmental protection requirements including but not limited to surface water runoff control and water quality protection, fugitive dust emissions control and air quality protection, groundwater quality protection, and noise abatement.

PART 2 PRODUCTS [NOT USED]

PART 3 EXECUTION [NOT USED]

END OF SECTION 01010



SECTION 01200

MEETINGS

PART 1 GENERAL

1.01 PRECONSTRUCTION CONFERENCE

- A. After Owner and Contractor have executed the Agreement, Owner will schedule a preconstruction conference at Project Site that shall be attended by Owner, Contractor, Engineer, Owner's On-site Representative, and others as appropriate. The meeting will be scheduled within twenty-eight (28) calendar days following formal agreement to Contract. The purpose of the meeting will be to ensure that all parties understand their responsibilities and the procedures that will be used to assure efficient completion of the Work.
- B. Agenda items may include:
 - 1. Distribution of Plans and Specifications.
 - 2. Designation of responsible personnel for all parties, lines of communication, and lines of authority.
 - 3. Scope of work and the anticipated schedule of operations.
 - 4. Critical work sequencing.
 - 5. Submittal and field test reporting procedures.
 - 6. Record documents and reporting.
 - 7. Project Site safety and security procedures.
 - 8. List of major subcontractors.
 - 9. Procedures for processing change orders.
 - 10. Use of premises including equipment and material storage.
 - 11. Major equipment deliveries.
 - 12. Housekeeping procedures.
 - 13. Other items for consideration during construction activities.

1.02 PROGRESS MEETINGS

- A. Weekly progress meetings will be scheduled by the Owner's On-Site Representative at a regular time mutually agreeable to by the Owner, Contractor, and Owner's On-Site Representative. The Contractor shall attend these meetings and shall coordinate and require the attendance of subcontractors whose work may be in progress at the time or whose presence may be required for any purpose. Scheduling of required attendees shall meet with the approval of the Owner's On-Site Representative.
- B. Following each meeting, the Owner's On-Site Representative will prepare and distribute to Owner and Contractor copies of the minutes of the meeting. These will include a brief summary of the progress of the Work since the previous meeting.
- C. The weekly meeting agenda will include at least the following:
 - 1. Administrative/Purchasing issues.
 - 2. Technical/Construction issues.
 - 3. Design issues.
 - 4. Schedule/Progress issues.
 - 5. Project Site safety issues.
 - 6. Status review of required submittals.



1.03 UNSCHEDULED MEETINGS

- A. The Contractor shall attend other unscheduled meetings which may be reasonably requested by Owner's On-Site Representative or Owner to discuss unanticipated changes in the Work or conditions at the Project Site and which must be resolved before progression of work.

1.04 BASIS FOR COMPENSATION

- A. The Contractor's cost for work under this Section shall be included in the Bid Price and no additional compensation will be provided.

PART 2 PRODUCTS [NOT USED]

PART 3 EXECUTION [NOT USED]

END OF SECTION 01200

PERMITTING

SECTION 01300

SUBMITTALS

PART 1 GENERAL

1.01 GENERAL PROCEDURES

- A. This Section stipulates the requirements for transmission of submittals from Contractor to Owner's On-Site Representative and actions taken by Owner's On-Site Representative regarding submittals.
- B. Submittals shall be identified with the project name, name of submittal, and Specification Section for which the submittal is required.
- C. Owner's On-Site Representative will accept submittals only from Contractor. Submittals from subcontractors, vendors, suppliers, or others will be returned without review or action.
- D. Owner's On-Site Representative will accept only those submittals required by the Specifications. Unsolicited submittals will be returned without review or action.
- E. All engineering data, regardless of origin, shall be stamped with the approval of the Contractor. The Contractor's stamp of approval will be a representation to the Owner and Owner's On-Site Representative that the Contractor has assumed full responsibility for determining and verifying all quantities, dimensions, field construction criteria, materials, catalog numbers, and similar data, and that he has reviewed or coordinated each submittal with the requirements of the Specifications.
- F. All engineering data shall be identified by use of the nomenclature established by the Plans and Specifications. Equipment drawings shall have the equipment name and number clearly displayed. Material drawings shall have the structure name and structure number (when applicable) clearly displayed.

1.02 CORRESPONDENCE

- A. Correspondence forwarding engineering data shall be addressed to the Owner and Owner's On-Site Representative as follows.

To the Owner:

Poly Met Mining Inc.
NorthMet Project
P.O. Box 475; County Road 666
Hoyt Lakes, MN 55750-0475
Attention: **Mr. Jim Tieberg**

To the Owner's On-site Representative:

c/o _____
Poly Met Mining Inc.
NorthMet Project
P.O. Box 475; County Road 666
Hoyt Lakes, MN 55750-0475

Copies to the Owner:

Poly Met Mining Inc.
Attention: **TBD** _____

Copies to the Project Engineer:

TBD

- B. A letter of transmittal shall accompany all submittals of engineering data and shall include a list of the data included in the transmittal. Lists shall include manufacturer's drawing numbers



identified with the corresponding project equipment or structure nomenclature as applicable. The letter shall be identified by the project name.

1.03 PROGRESS SCHEDULE

- A. Submit an estimated progress schedule and a finalized progress schedule in accordance with the requirements of the General Conditions.
- B. Update the schedule on a weekly basis for presentation, discussion, and distribution at the weekly progress meeting.

1.04 SCHEDULE OF VALUES AND PROGRESS PAYMENT SCHEDULE

- A. Submit a schedule of values for the Work. The schedule shall be broken out as follows for each Bid Price item and each Unit Adjustment Price item on the Bid Form:
 1. Item description.
 2. Unit of measure upon which the item is based.
 3. Contractor's estimated quantity (number of units upon which the total price for the item is based: for Unit Adjustment Price items, enter 0 for quantity).
 4. Total unit price, including materials, equipment, labor, overhead, and profit (for Unit Adjustment Prices, shall be same unit price as on the Bid Form).
 5. Extension (total price for the item, calculated by multiplying the number of units by the total unit price).
- B. Submit a schedule of anticipated progress payment requests with the schedule of values. The proposed progress payment schedule shall be based on monthly or target-percentage invoicing for Work completed, and shall be closely coordinated with the schedule of values. Resubmit a revised schedule of anticipated progress payment requests whenever the progress schedule is updated or revised. Update the payment schedule each time an actual payment request varies more than 10 percent from the schedule. The progress payment schedule shall take into consideration retainage if applicable.
- C. The schedule of values and anticipated progress payment schedule shall be subject to review and approval by Owner. If, in the opinion of Owner, the schedules do not contain sufficient detail or appear to be unbalanced, the Owner may require Contractor to revise and resubmit the schedules and/or provide documentation to justify Contractor's distribution. Contractor shall correct such deficiencies and resubmit the schedules.

1.05 REVIEW OF SUBMITTALS

- A. The Owner's On-Site Representative's review of engineering data will cover only general conformity of the data to the Specifications, external connections, and interfaces with equipment and materials furnished under separate specifications. The Owner's On-Site Representative's review does not indicate a thorough review of all dimensions, quantities, and details of the equipment, material, device, or item indicated or the accuracy of the information or documentation submitted; nor shall review or approval by the Owner's On-Site Representative be construed as relieving the Contractor from any and all responsibility for errors or deviations from the requirements of drawings and specifications.

1.06 SUBMITTAL FOR INFORMATION OR DOCUMENTATION

- A. Submit 2 copies to Owner's On-Site Representative and 2 copies to Owner.

- B. Unless otherwise specified, submittal shall be made at least 1 day before the subject of the submittal is to be incorporated into the Work.
- C. Submittal is for the purpose of formal verification that the subject of the submittal conforms to the requirements of the Specifications, for formal documentation of the Work, or both.
- D. No action is required by Owner or Owner's On-Site Representative. Owner's On-Site Representative will generally notify Contractor if deficiencies are identified; however Contractor is solely responsible for ensuring that the subject of the submittal conforms to the requirements of the Specifications.

1.07 SUBMITTAL FOR REVIEW

- A. Submit 2 copies to the Owner's On-Site Representative.
- B. Unless otherwise specified, submittal shall be made at least 10 days before the subject of the submittal is to be incorporated into the Work. Owner's On-Site Representative will respond within 5 days from receipt of submittal.
- C. Submittal is for the purpose of providing opportunity to Owner's On-Site Representative for review and comment on the subject of the submittal.
- D. Owner's On-Site Representative will respond to the submittal either with a list of comments or indicating no comments.
- E. If Owner's On-Site Representative's comments indicate a deficiency with respect to the requirement of the Specifications, Contractor shall amend the submittal and resubmit. Owner's On-Site Representative will again respond to the resubmittal.
- F. If Owner's On-Site Representative's comments are in regards to an issue which is based on Contractor's discretion, Contractor shall furnish additional information, provide justification, and otherwise cooperate in addressing and resolving Owner's On-Site Representative's comments.
- G. Contractor shall remain solely responsible for ensuring that the subject of the submittal conforms to the requirements of the Specifications.

1.08 RECORD DOCUMENTS

- A. Submit record documents prior to Substantial Completion.
- B. Record documents shall accurately reflect the as-constructed condition.

1.09 WARRANTY AND GUARANTEE CERTIFICATES

- A. Submit warranty and guarantee certificates prior to Substantial Completion.
- B. Warrantee and guarantee certificates shall be signed by Contractor, Installer, Manufacturer, and others as required by the Specifications.

1.10 BASIS FOR COMPENSATION

- A. The Contractor's cost for work under this Section shall be included in the Bid Price and no additional compensation will be provided.

PART 2 PRODUCTS [NOT USED]

PART 3 EXECUTION [NOT USED]

END OF SECTION 01300

PERMITTING

SECTION 01400

QUALITY CONTROL

PART 1 GENERAL

1.01 FIELD QUALITY CONTROL

- A. Complete construction quality control for the Work as described in these Specifications, unless specified as the responsibility of the Owner.
- B. Retain an independent registered land surveyor licensed in the State of Minnesota for performing quality control on line and grade of the Work. The quality control survey data shall be available for review at all times by Owner and Owner's On-Site Representative.
- C. Retain an independent soil and material testing firm(s) for performing the quality control testing. The quality control data shall be available for review at all times by Owner and Owner's On-Site Representative.
- D. All quality control test results will be used by Owner to demonstrate compliance with Project permit requirements. Tests shall be performed and samples shall be collected at random locations such that the test results may be considered representative. Testing shall be performed or samples collected at specific locations determined by Owner's On-Site Representative, if requested.
- E. Owner's On-Site Representative shall have full authority to direct testing activities of Contractor-retained independent soil and material testing firm (s) including, but not limited to: selecting locations and materials for testing, reviewing all raw and final test data, and conducting audits of testing company field and in-laboratory testing procedures and equipment. In cases where testing firm personnel violate Project Site safety procedures or otherwise appear to lack the competence required to fully perform the required testing, Owner's On-Site Representative with concurrence of Owner shall also have the authority to dismiss testing firm personnel from the Project Site.

1.02 SUBMITTALS

- A. Submit for approval name(s) and qualifications of Contractor's independent registered land surveyor and Contractor's independent soil and material testing firm(s).
- B. Submit for information on a daily basis, the following information:
 - 1. Survey data for each day that survey work is performed.
 - 2. Soil compaction data for each day that soil compaction data is collected.
 - 3. Other soil and material test data daily as it is available.
- C. Submit for documentation a tabulation of all results of survey work performed. This submittal shall be made prior to substantial completion. The tabulation shall be signed by the registered land surveyor. The tabulation shall contain the following information for each survey location:
 - 1. A unique identification number.
 - 2. Coordinates.

3. Elevation of the finished surface of each material (e.g. top of LTVSMC Coarse Tailings for dam and access road construction; top of bentonite amended cover on exterior of dams and interior beaches; top of Tailings Discharge and Return Water Pipelines; existing surface and finished surface for stockpiled construction materials; other as needed).
- D. Submit for documentation the results of all soil compaction and other material testing performed. Test results shall be compiled in a report-format and submitted prior to substantial completion of Work.
- E. Submit for approval supplier information for bentonite to be used for bentonite augmentation of tailings. Submittal shall include:
1. Supplier's business name and address.
 2. Source location of bentonite.
 3. Bentonite packaging and delivery methods.
 4. Bentonite handling and storage methods upon receipt on site.

1.03 SURVEY VERIFICATION REQUIREMENTS

- A. Contractor's independent registered land surveyor shall verify that elevations, grades, slopes, and material thickness constructed by Contractor are within the tolerances specified in Section 02220. Material thickness shall be determined from the elevation difference between shots taken at the same coordinate location. On slopes, the surveyed vertical thickness shall be adjusted by calculating the thickness perpendicular to the slope for presentation in the submittals. The surveying work shall include determining elevations at specific locations on a matrix of survey points as described below.
1. Dams: For elevation, grade, and material thickness verification, survey shots shall be taken on the top of LTVSMC Coarse Tailings and top of Bentonite Amended Cover. The toe, midpoint, and top of each dam shall be surveyed at 100-foot intervals along the dam alignment.
 2. Bentonite Amended Cover: For elevation, grade, and material thickness verification, survey shots shall be taken on the top of each layer (i.e. top of LTVSMC/Flotation Tailings, top of bentonite-tailings mix layer, and top of cover layer) of the Bentonite Amended Cover at 100' grid spacing.
 3. Buttresses: For elevation and grade verification, survey shots shall be taken of the final grade of each buttress. The toe, midpoint, and top of each buttress shall be surveyed at 100-foot intervals along the buttress alignment.
 4. Tailings Discharge and Return Water Pipelines: For elevation and grade verification, survey shots shall be taken on the top-of-pipe elevations at a maximum of 50-foot intervals (lineal) in the areas where pipe has little or no significant change in elevation, and at changes in grade. Coordinate the location of these shots with Owner or Owner's On-Site Representative.

1.04 CONTRACTOR TESTING RESPONSIBILITIES

- A. Retain an independent testing laboratory(s).
- B. Perform all the testing requirements described in these Technical Specifications unless noted as the responsibility of the Owner.

1.05 OWNER TESTING RESPONSIBILITIES

- A. Contractor shall provide material samples, and/or coordinate with and provide access to work areas for Owner's On-Site Representative and Owner's independent testing firms for sampling and/or testing.
- B. Work failing to meet Specifications shall be repaired at Contractor's expense. Owner will perform additional testing after repairs are completed. The expense of retesting may be charged to Contractor. Contractor may ask to review results of Owner's testing during construction.

1.06 PRESENTATION OF DATA

- A. All survey and compaction test data shall be summarized and submitted to Owner or Owner's On-Site Representative on a daily basis. Failure to submit data on a daily basis shall be cause for Owner to suspend Contractor's operations until submittals are made current. Contractor shall not be entitled to additional compensation for any suspension of operations ordered by Owner due to Contractor's failure to submit data on a daily basis.
- B. Survey data shall be summarized in a tabular format listing each survey point by unique identification number, coordinate, elevation, difference from previous elevation (material thickness), and required material thickness as appropriate. Required material thickness is measured perpendicular to the slope. Material thickness based upon survey shots at the same coordinate location shall be corrected to the perpendicular-to-slope thickness.
- C. Compaction test data shall be summarized in a tabular format listing each compaction test by unique identification number, horizontal coordinate, elevation (within 0.5 foot vertical of actual location), reference proctor, in-place moisture content, dry density, percent compaction, and compaction specification requirement.

1.07 BASIS FOR COMPENSATION

- A. The Contractor's cost for work under this Section shall be included in the Bid Price and no additional compensation will be provided.

PART 2 PRODUCTS [NOT USED]

PART 3 EXECUTION [NOT USED]

END OF SECTION 01400

SECTION 01510

TEMPORARY UTILITIES

PART 1 GENERAL

1.01 TEMPORARY UTILITIES

- A. Water: Potable water is not available at the Project Site. Make all arrangements necessary to provide water for potable consumption. Water used for construction purposes need not be potable but must meet all applicable surface water quality criteria. Non-potable water will be available from an on-site location designated by Owner. The costs of furnishing potable and other water and water usage shall be included in the Bid Price and no additional compensation will be provided.
- B. Sanitary Facilities: Contractor shall provide sanitary facilities for use by Contractor's employees, subcontractors, suppliers, Owner's On-Site Representative, Owner and all other persons to be working on the Project Site. Sanitary facilities shall, as a minimum, comply with the requirements of applicable Laws and Regulations for temporary sanitary facilities and shall be emptied and sanitized at the frequency needed to be maintained in a clean and useable condition. Sanitary facilities shall be maintained until Substantial Completion unless earlier removal is approved by Owner or Owner's On-Site Representative. The cost of sanitary facilities shall be included in the Bid Price and no additional compensation will be provided.
- C. Electricity: Furnish portable electric power generators necessary for construction of the Work. Should Contractor need electric power service for Contractor's purposes, it shall be the Contractor's responsibility to arrange for and pay for such service. The cost shall be included in the Bid Price and no additional compensation will be provided. Owner will provide access to electric service connection at the location of the Contractor's office location, and provide electric service to the Office Trailer furnished for Owner's On-Site Representative's use.
- D. Telephone and Fax: Phone service is not readily available at the Project Site. Cellular phone service may not be available throughout the entire Project Site. Make arrangements for the Contractor's phone and fax service during the Project. The cost of Contractor's telephone service, fax service, and usage, shall be included in the Bid Price and no additional compensation will be provided.
- E. Fire Protection: Make all arrangements necessary to ensure that the Project Site and the Work have adequate fire protection services throughout the duration of the Work. Any special fees or charges imposed by governmental units or other organization to provide such services shall be paid by Contractor. The cost of fire protection shall be included in the Bid Price and no additional compensation will be provided.

1.02 OFFICE TRAILER

- A. Contractor shall furnish office trailer space for use by Owner and Owner's On-Site Representative. The space for Owner's On-Site Representative shall have a minimum of 120 square feet of floor area, and at minimum be equipped with a desk, a table, and two chairs. The space shall be furnished with electrical service, operable lighting, heat, and air conditioning. This office space may be located in a trailer with other facilities but must be accessible to Owner and Owner's On-Site Representative at all times and must be secured by a separation wall and lockable door. Owner will provide 240 volt, 110 AMP service to the trailer and will make and disconnect electrical service as requested by the Contractor.

1.03 BASIS FOR COMPENSATION

- A. The Contractor's cost for work under this Section shall be included in the Bid Price and no additional compensation will be provided.

PART 2 PRODUCTS [NOT USED]

PART 3 EXECUTION [NOT USED]

END OF SECTION 01510

PERMITTING

SECTION 01560
STORM WATER EROSION PREVENTION AND SEDIMENT AND DUST CONTROL

PART 1 GENERAL

1.01 DESCRIPTION

- A. This section covers construction of all stormwater erosion prevention and sediment controls as needed to conduct the Work in accordance with the Technical Specifications, Drawings, Agreement, and in compliance with local, county, state, federal and other jurisdictional rules and regulations.
- B. This work consists of: 1) managing storm water runoff and project related water discharges in order to minimize sediment pollution during construction and over the life of the contract and 2) managing the discharges as set forth in any applicable regulatory agency permit. The work includes furnishing, installing, maintaining and utilizing storm water best management practices and any work specified in conjunction therewith as well as removing temporary sediment control devices when no longer necessary.
- C. Control dust generation on access roads to the Project Site and within construction limits. Comply with requirements of project-specific Air Quality Management Plans/Fugitive Emissions Control Plans.

1.02 BASIS FOR COMPENSATION

- A. The Contractor's cost for work under this Section shall be included in the Bid Price and no additional compensation will be provided.

1.03 REFERENCES

- A. Protecting Water Quality in Urban Areas, MPCA 2000.
- B. Stormwater Management for Construction Activities, EPA 1992.
- C. Developing Pollution Prevention Plans and Best Management Practices, EPA 1992.
- D. Erosion Control Handbook, Mn/DOT 2006.
- E. Minnesota Stormwater Manual, Version 2, January 2008.
- F. Stormwater and Wetlands: Planning Evaluation Guidelines, MPCA 1997.
- G. Construction Stormwater Pollution Prevention Plan (SWPPP) – NorthMet Project Plant Site, Barr 2016.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Water used for dust control may be obtained from an on-site location designated by Owner.



- B. Acceptable temporary erosion control devices include, but are not necessarily limited to, silt fence, straw and hay bales, mulch, geotextiles, and vegetative cover.

2.02 EQUIPMENT

- A. Water tank trucks equipped with water cannon capable of delivering water through either front or rear-mounted nozzles. Tank trucks shall be of sufficient size and mobility and carry a sufficient quantity of water to control dust generated by Contractor's activities.

PART 3 EXECUTION

3.01 STORM WATER SEDIMENT AND EROSION CONTROL

- A. The Owner is responsible for obtaining the MPCA General Stormwater Construction Permit (MNR 100001) for authorization to discharge storm water associated with the project construction activity under the National Pollutant Discharge Elimination System (NPDES) program and providing a copy of the permit to the Contractor prior to beginning construction activities at the Project site. The Contractor will be required to co-sign the MPCA Stormwater Permit Application and is jointly responsible for compliance with Parts II.B, Part II.C, and Part IV of the MPCA Stormwater Construction Permit (MNR 100001).
- B. The Owner is responsible for preparing the Storm Water Pollution Prevention Plan (SWPPP) required under the General Stormwater Construction Permit (MNR 100001) and providing a copy of the SWPPP to the Contractor prior to beginning construction activities at the Project Site.
- C. The Owner is responsible for coordinating and obtaining any City, Town, or County permits.
- D. The Contractor is responsible for conducting all construction activities in full compliance with the applicable requirements of the MPCA General Stormwater Construction Permit (MNR 100001), the SWPPP and any additional requirements that may be contained in any City, Town or County permits. The Owner will provide the Contractor with copies of all relevant permits and the SWPPP prior to the start of construction activities.
- E. The Contractor is responsible for compliance with all requirements specified in Section 3.01 D until construction is complete, and the Project Site has undergone final stabilization. Once the Owner is satisfied that these conditions have been met, the Owner will prepare and submit the Notice of Termination (NOT) to the MPCA.
- F. Install erosion control devices and materials at locations as directed by Owner or Owner's On-Site Representative where soil erosion at the Project Site may occur due to Contractor's activities.
- G. Install temporary erosion control devices during the progress of the work and maintain them until permanent erosion control (turf establishment, aggregate surfacing, etc.) has been established.

- H. Strictly follow all additional requirements of Owner's SWPPP (to be provided by Owner under separate cover).

3.02 EROSION PREVENTION AND SEDIMENT CONTROL

- A. The Contractor has responsibility for charge and care of the Project and shall take necessary precautions against injury or damage to the Project by action of the elements. In addition, the Contractor shall take necessary precautions to prevent off site damage resulting from work conducted on the Project or Project related storm water runoff.
- B. The Contractor is responsible for preventing or minimizing sediment loss from the Project by directing storm water runoff to constructed ponds and sediment traps as well as installing temporary sediment control devices in drainage locations where runoff can leave the Project limits and/or enter into environmentally sensitive areas. The Contractor shall schedule, construct and/or install temporary sediment control and storm water management measures as required by the Contract and as stated in the permits required for the Project.
- C. The Contractor shall install temporary storm water management and sediment control devices in conformity with the details, typical sections, and elevation controls shown in the Drawings. The actual installation location of temporary storm water management and sediment control devices may be adjusted from that indicated in the Plan to better accommodate the actual field conditions and increase the effectiveness of a device.
- D. Sediment control measures must be installed down gradient prior to or in conjunction with soil disturbing activities. The Contractor shall schedule, install and maintain temporary sediment control measures as an ongoing effort on a site-by-site basis over the life of the Contract. The Contractor is responsible for minimizing the potential for sedimentation after temporary sediment control devices have been installed by implementing a good quality erosion control program and staging construction as needed.
- E. The Contractor shall schedule and phase construction in critical resource areas to the best of his ability in order to minimize the potential of sediment entering into a critical resource. Critical resources include but are not limited to, protected wetlands, surface waters, trout streams, Special Waters, impaired waters, rivers, and endangered species habitat. Measures to minimize sediment potential include practices such as hand clearing and grubbing, limited bare soil exposure time, and immediate final establishment of vegetation.

3.03 FUGITIVE DUST EMISSIONS CONTROL

- A. The Owner is responsible for obtaining air quality permits and preparing and complying with a Fugitive Dust Emissions Control Plan.
- B. The Contractor is responsible for complying with the Fugitive Dust Emissions Control Plan. A copy of the Plan will be provided by the Owner.
- C. Apply water to roads used by Contractor's equipment as directed by Owner or Owner's On-Site Representative to control dust generated by wind or by Contractor's vehicle traffic.
- D. Apply water to ground surfaces within the construction limits as directed by Owner or Owner's On-Site Representative to control dust generated by Contractor's activities at the Project Site.



- E. Strictly follow all additional requirements of Owner's Fugitive Emissions Control Plan (to be provided by Owner under separate cover).

END OF SECTION 01560

PERMITTING



SECTION 02220
EXCAVATING, BACKFILLING, AND COMPACTING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. All work included in this Section shall be performed in accordance with the following paragraphs, the General Requirements set forth in Division 1 of these Specifications, and the provisions of the other Contract Documents.
- B. Work covered by this section includes furnishing all supervision, labor, materials, and equipment required to complete all earthwork at the Project Site to grade and lines shown on the Drawings including, but not limited to:
 - 1. Material source development to obtain construction materials.
 - 2. Surface preparation of existing ground for dam construction.
 - 3. Placement and compaction of LTVSMC Coarse Tailings fill for dam construction.
 - 4. Placement and compaction of Bentonite Amended Cover on exterior slopes and tops of dams of the Flotation Tailings Basin (FTB).
 - 5. Placement and compaction of Bentonite Amended Cover on interior beaches of the FTB (at final reclamation only).
 - 6. Placement of rock fill for buttress construction.
 - 7. Placement of Rip-Rap at specified locations.
 - 8. Placement of erosion protection material.
 - 9. Controlling dust within work areas.

1.02 BASIS FOR COMPENSATION

- A. Work included under this Section of these Specifications shall be included under the Bid Price.

1.03 SUBMITTALS

- A. Submit soil testing and survey data as specified in Section 01400 – Quality Control.
- B. LTVSMC Coarse Tailings and Granulated Bentonite Mixing and Placement Plan for Flotation Tailings Basin Dams. Placement Plan content to include but not be limited to:
 - 1. LTVSMC Coarse Tailings and Granulated Bentonite Mixing Equipment, Procedures and QAQC to ensure uniform distribution of granulated bentonite with LTVSMC Coarse Tailings.
 - 2. Pre-placement moisture conditioning plans (if any).
 - 3. Material transport, spreading and compaction plan including equipment types and sequencing.
- C. Flotation Tailings and Granulated Bentonite Mixing and Placement Plan for Flotation Tailings Basin Beaches (at final reclamation only at time requested by Owner).
- D. Fugitive Dust Emissions Control Plan.



- E. Granulated Bentonite manufacturer and supplier information and product specifications.

1.04 REFERENCES

- A. American Society for Testing and Materials, Current Edition, hereafter referred to as ASTM.
- B. Minnesota Department of Transportation Standard Specifications for Construction; 2014 Edition.

1.05 SEQUENCING AND SCHEDULING

- A. Owner will evaluate results of the independent registered land surveyor's grade, slope, and material thickness verifications, collect material samples, and conduct field testing of materials throughout the duration of the Project, as described in Section 01400 of these Specifications. Do not proceed with subsequent operations until Owner or Owner's On-Site Representative has been notified, has been given opportunity to test or review the Contractor's test data, and has informed the Contractor of any test results that have been gathered.
- B. The required completion date for the Work as described in these Contract Documents is specified elsewhere in these Contract Documents.

1.06 JOB CONDITIONS

- A. It shall be solely the Contractor's responsibility to review available tests and reports, conduct additional tests, and otherwise determine to its own satisfaction the location and nature of all surface and subsurface features and the soil and water conditions that may be encountered. Owner's information on Project Site conditions may be reviewed at Owner's offices as scheduled with Owner.
- B. Use of explosives will be permitted only at the times and locations approved by Owner.
- C. Contractor shall be solely responsible for determining the means and methods for meeting the excavation and compaction requirements unless otherwise specified herein, except that compaction by flooding or puddling or other means that involve saturation or over-wetting the soil will not be permitted.
- D. Provide all shoring, bracing, sheet piling, trench boxes, tie backs, and other measures required to perform all Work in accordance with Laws and Regulations. Specifically, all excavations shall conform to the requirements of OSHA set forth in 29 CFR 1926, Subpart P (Occupational Safety and Health Standards-Excavations).
- E. Perform all work and maintain all equipment and personnel training in accordance with applicable provisions of Mine Safety and Health Administration (MSHA) Code of Federal Regulations – 30 CFR.
- F. Comply with all Owner site-specific training and safety requirements (to be provided at time of Bidding).

1.07 QUALITY CONTROL

- A. Contract a qualified soils testing firm, subject to approval by Owner, to conduct all sampling and testing of LTVSMC Coarse Tailings and other soil materials, as specified in these Specifications. The testing laboratory shall perform appropriate tests including sieve analysis, standard Proctor moisture-density testing and in-place moisture-density testing, and other tests as needed and/or specified.
- B. Provide testing firm safe access to the Work and materials to be tested, in accordance with the following minimum provisions:
 1. All fill material used shall be assessed on a regular basis by testing firm and Owner or Owner's On-Site Representative. Owner or Owner's On-Site Representative will reject all material which does not conform to the material specifications herein as required for each fill zone. Rejected material placed shall be removed at Contractor's expense.
 2. Particle size samples shall be taken of fill materials at least twice for each material source and at least once for every 20,000 cubic yards of material placed.
- C. Construction Testing: The following testing shall be conducted during construction:
 1. Perform Standard Proctor moisture-density relationship analyses according to ASTM D 698 for at least two samples for each borrow source location.
 2. Conduct soil classification according to ASTM D 2487 for at least two samples for each borrow source location.
 3. Perform in-place moisture-density testing of LTVSMC Coarse Tailings according to ASTM D-2922 (nuclear densometer) at least once every lift at a minimum frequency of approximately 500 feet of dam length, and at least once a day when compaction activities are being performed.
 4. Report whether each in-place moisture-density test passed or failed. If any test fails, report what actions were taken to correct material compaction, and what additional tests will be submitted to demonstrate acceptable (passed) compaction.
 5. Only passing tests will be considered in the count of material tests taken, as specified above.

PART 2 PRODUCTS

2.01 GENERAL

- A. All fill materials shall be free of wood, organic soils, large boulders, topsoil, snow, ice, and other unsuitable materials detrimental to performance of the dam.

2.02 MATERIALS AND MATERIAL SOURCES

- A. LTVSMC Coarse Tailings: Materials conforming to the specifications for Dam Fill and Access Roads are located within designated Owner-supplied material sources. The general location of material sources are indicated on the Drawings as 'Borrow Area 1' through 'Borrow Area 4'. All materials used must be approved by Owner or Owner's On-Site Representative. If unsuitable Owner supplied materials are encountered, Contractor shall notify Owner and Owner will direct Contractor to alternate material source sites. The material for use as the dam fill shall consist of inorganic soil classified as a SM or SP as defined by the Unified Soil Classification System (USCS) from the proposed LTVSMC Coarse Tailings borrow areas (1 through 4).

- B. Granulated Bentonite: A granulated Bentonite manufactured and supplied by Wyo-Ben Inc. American Colloid Company, Bentonite Performance Minerals LLC, or other Owner approved Bentonite product manufacturer and supplier.
- C. Rip-Rap: Rip-Rap materials used shall be in accordance with Section 3601 of Minnesota Department of Transportation's 2014 Edition of Standard Specifications for Construction.
- D. Area 5 Waste Rock: Area 5 Waste Rock shall be obtained from an on-site location designated by Owner. Materials shall be well graded to ensure no large voids are present after placement.

PART 3 EXECUTION

3.01 GENERAL

- A. Locate and protect overhead and underground utilities, unless indicated otherwise on the Drawings.
- B. Provide temporary controls such as diversions and dewatering equipment to prevent surface runoff from entering excavations and to remove ponded water from excavations. Maintain excavations in a dry and stable condition at all times.
- C. Examine the area prior to and while performing earthwork. If unsatisfactory conditions occur during the Work do not proceed with the Work until satisfactory conditions have been established.
- D. Determine the location and nature of all surface and subsurface obstacles, and the soil and water conditions that will be encountered during construction.
- E. Institute and maintain, as directed by Owner, adequate dust control measures such as sprinkling, for all work areas, haul routes, and parking areas.

3.02 PREPARATION

- A. Make arrangements to locate all existing utilities and underground facilities in the areas of the Work. Provide adequate means of protection for utilities and underground facilities that are to remain in place during earthwork operations.
- B. Protect structures, fences, utilities, groundwater quality wells, piezometers, inclinometers, survey benchmarks, and other facilities from damage caused by settlement, lateral movement, undermining, washout and other hazards created by earthwork operations.
- C. Control surface water sufficiently to permit placement of materials in dry conditions.

3.03 EXCAVATION

- A. Construct excavations in accordance with applicable Laws and Regulations.
- B. Excavate LTVSMC Coarse Tailings to the lines, elevations, slopes, and dimensions shown on the Drawings, or as necessary to complete the Work shown on the Drawings.

- C. Materials excavated for construction that are unsuitable for reuse in the project shall be neatly stockpiled as described in Subpart 3.07.

3.04 MATERIAL PLACEMENT AND COMPACTION

- A. Placement of fill materials will be performed over the existing ground as shown on the Drawings. Contractor shall keep Owner or Owner's On-Site Representative informed of its operations so that proper inspection and testing can be implemented. No fill material shall be placed on frozen subgrade unless approved by Owner or Owner's On-Site Representative.
- B. Finish all areas to the lines and grades shown on the Drawings within the tolerances provided in this Specification and as approved by Owner or Owner's On-Site Representative. All finish grading shall be accomplished using normal mechanical construction equipment. The final constructed dam tops shall be covered and finished with materials shown on the Drawings.
- C. Compact the placed Dam Fill and Access Road materials as shown on the Drawings. All fill shall be compacted in approximately horizontal lifts. Compact each layer to required density for each area classification.
- D. Remove and replace fill that is too wet to permit compaction as specified.
- E. Compact the material around structures with hand-compaction equipment which is designed for the compaction of backfill. Heavy equipment shall not be utilized for compaction within three (3) feet of structures, or a greater distance if necessitated by equipment or Project Site conditions.
- F. Place and compact fill as specified on the Drawings to an in-place density as measured by ASTM D 698 (Standard Proctor) or ASTM D 1556 (Modified Proctor) as specified.
 1. Dam and Access Road Fill: Uniformly compact the full depth of each lift with a vibratory compactor. Lifts shall not exceed 15 inches in loose thickness prior to compaction. Compact each lift to at least 95% of Standard Proctor maximum dry density. Moisture content shall be uniform throughout each lift and maintained throughout placement and compaction work.
 2. Bentonite Amended Cover on FTB Dams: Bentonite Amended Cover construction on the exterior slopes and tops of the FTB dams shall be performed in accordance with the Owner-approved Placement Plan. At minimum the amended cover shall be placed to the final thickness specified, within the specified tolerances, and be uniformly compacted to the full depth of each lift. Lifts shall not exceed 12 inches in loose thickness prior to compaction. Compact each lift to at least 95% of Standard Proctor maximum dry density. Moisture content shall be uniform throughout each lift and maintained throughout placement and compaction work.
 3. Bentonite Amended FTB Beach Area: Bentonite Amended FTB interior beach construction shall be performed in accordance with the Owner-approved Placement Plan. Flotation tailings and bentonite shall be mixed after bentonite injection such that the resulting bentonite-tailings mix contains a uniform bentonite content of 3 percent by weight. Compact the bentonite amended tailings to at least 90% of Standard Proctor maximum dry density or as otherwise approved by Engineer. Moisture content shall be uniform throughout each lift and maintained throughout placement and compaction work.

G. Place Waste Rock for buttress construction in uniform 24" lifts to the elevations shown on the Drawings.

H. Place Rip-Rap according to Section 2511.3 of Minnesota Department of Transportation's Standard Construction Specifications, 2014 Edition, and as shown on the Drawings.

3.05 PROJECT SITE GRADING

A. Grade intermediate slopes to minimize erosion potential. Maintain temporary erosion controls as necessary to minimize erosion. Maintain strict compliance with Stormwater Pollution Prevention Plan (SWPP).

B. Smooth-grade finished ground on exterior slopes of berms, along access roads, and other areas disturbed by Contractor's activities, to uniform levels or slopes between points where elevations are shown, or between such points and existing ground.

3.06 ACCESS ROAD CONSTRUCTION

A. Determine location of temporary access roads and ramps to each construction area, subject to approval by Owner.

B. Construct permanent access roads and ramps at the locations shown on the Drawings or as directed by Owner.

C. Access roads and ramps shall be crowned or sloped to promote surface water runoff.

3.07 DISPOSAL OF EXCAVATED SOIL

A. All excavated materials not incorporated into the construction shall be stockpiled in a location designated by Owner. All stockpiles left in place by Contractor shall be left in a neat condition and be appropriately graded so as to provide proper drainage, and appropriately vegetated or contained to prevent off-site sediment transport.

3.08 TOLERANCES

A. Construct the excavation and backfill work within the dimensional tolerances given below. Alignment, elevation and thickness tolerances are acceptable deviations from the elevations and material thicknesses shown on the Drawings. No compensation will be made for additional work or materials required by Contractor as a result of construction beyond specified elevations, thicknesses, or grades.

B. Alignment Tolerances – Horizontal Control:

1. Dam Centerline: +/- 0.2 foot.

2. Crest of Slope:

a. Interior crest of slope: +/- 1.0 foot.

b. Exterior crest of slope: +/- 1.0 foot at any location, +/- 0.5 foot average.

3. Toe of Slope:

a. Interior toe slope: +/- 1.0 foot.



- b. Exterior toe slope: +/- 1.0 foot at any location, +/- 0.5 foot average.
- C. Elevation Tolerances – Vertical Control:
 - 1. Crest of Dams: + 0.2 foot, -0.0 foot.
- D. Thickness Tolerances (Bentonite Amended Cover on FTB dams and beaches)
 - 1. Bentonite-Tailings Mix: -0.0 foot, +0.2 foot
- E. Thickness Tolerances (Rip-Rap)
 - 1. Rip-Rap: -0.0 foot, +0.5 foot
- F. Granulated Bentonite Distribution within LTVSMC Coarse Tailings – Uniformly distributed to achieve average percent by weight specified at sampling and testing interval specified.
- G. Hydraulic Conductivity – Geometric mean hydraulic conductivity of bentonite-amended LTVSMC tailings tests on exterior face and crest of dams shall be equal to or less than 1×10^{-6} cm/sec.

3.09 DEBRIS MANAGEMENT

- A. Manage debris resulting from the Work or encountered on Project Site in accordance with applicable Laws and Regulations. Debris may include abandoned electrical cable, abandoned well materials, abandoned piping, old power poles, miscellaneous refuse, or other man-made objects.

END OF SECTION 02220

SECTION 02240
DEWATERING AND DIVERSION

PART 1 GENERAL

1.01 DESCRIPTION

- A. All work included in this Section shall be done in accordance with the following paragraphs as well as the general requirements as outlined in Division 1 of these Specifications.
- B. The work covered by this section of the Specifications consists of furnishing all labor, equipment, and materials, and performing all operations necessary for dewatering the Project Site during construction.

1.02 REFERENCES

- A. Protecting Water Quality in Urban Areas, MPCA 2000.
- B. Stormwater Management for Construction Activities, EPA 1992.
- C. Developing Pollution Prevention Plans and Best Management Practices, EPA 1992.
- D. Erosion Control Handbook, Mn/DOT 2006.
- E. Minnesota Stormwater Manual, Version 2, January 2008.
- F. Stormwater and Wetlands: Planning Evaluation Guidelines, MPCA 1997.
- G. Construction Stormwater Pollution Prevention Plan (SWPPP) – NorthMet Project Plant Site, Barr 2016.

1.03 BASIS FOR COMPENSATION

- A. Work included under this Section of these Specifications shall be included under the Bid Price.

PART 2 PRODUCTS

2.01 PUMPS

- A. Supply and maintain pumps capable of pumping water from excavation areas to permitted discharge locations in the event of heavy rains or runoff so work will not be significantly delayed and water will not saturate the soils.



PART 3 EXECUTION

3.01 GENERAL

- A. Furnish and operate temporary controls such as diversions and dewatering equipment to prevent surface water and groundwater from entering and ponding in excavations and to allow construction under dry conditions.
- B. Contractor shall be aware that flows will vary in proportion to recent rainfall events, and with rapid and heavy rains, ponded water may accumulate. Contractor shall be responsible for and take measures to protect his personnel, equipment, and supplies from such an event.
- C. Discharge water from construction de-watering to an area designated by Owner. Identify conditions requiring water discharge and propose discharge points to Owner. Provide necessary measures to prevent erosion or transportation of sediments at the discharge locations. Remove and dispose of transported sediment.

END OF SECTION 02240

SECTION 02271

RIP RAP

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Work included in this section includes providing the rip-rap and associated materials as shown on the Drawings and specified herein, including ditch check construction as may be required for erosion control but not shown on Drawings.

1.02 BASIS FOR COMPENSATION

- A. Compensation for all Work included under this Section shall be included in the Bid Price.

1.03 SUBMITTALS

- A. Location of source and type of rip-rap material.
- B. Test results.
- C. Submit in accordance with Section 01300.

1.04 REFERENCES

- A. Minnesota Department of Transportation Standard Specifications for Construction; 2016 Edition.
- B. Latest edition of the following American Society for Testing and Materials (ASTM) standards:
 - 1. ASTM D 5519- Standard Test Methods for Particle Size Analysis of Natural and Man-Made Riprap Materials.

1.05 QUALITY CONTROL

- A. Contractor is responsible for completion of construction quality control as described below, except where specified as the responsibility of the Owner.
 - 1. Rip-rap Soundness: 1 per source.
 - 2. Particle Size Analysis (ASTM D 5519): 1 per source.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Rip-rap shall meet the requirements of MnDOT Construction Standard Specification 2511.2.
- B. Filter Material shall meet the requirements of MnDOT Construction Standard Specification 2511.3.

PART 3 EXECUTION

3.01 PREPARATION

- A. Grade and dress areas on which rip-rap is to be placed to lines and grades shown on Drawings or as required by Owner's On-Site Representative.
- B. Place filter material under rip-rap and cover completely. No filter material shall be exposed along edges or under rip-rap. Place rip-rap so filter material is not damaged.

3.02 INSTALLATION

- A. Place rip-rap in areas as shown on Drawings.
- B. Place rip-rap for ditch checks as needed for permit compliance and as specified herein.

END OF SECTION 02271

SECTION 02610

PIPES AND FITTINGS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Furnishing and installing 18" steel Tailings Discharge Pipelines.
- B. Furnishing and installing 6" HDPE Return Water Pipelines.

1.02 BASIS FOR COMPENSATION

- A. Work included under this Section of these Specifications shall be included under the Bid Price.

1.03 REFERENCES

- A. American Society for Testing and Materials, current edition, hereafter referred to as ASTM.
 - 1. ASTM A-53 Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
 - 2. ASTM A-234 Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
 - 3. ASTM A-307 Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
- B. American National Standards Institute, current edition, hereafter referred to as ANSI.
 - 1. ANSI/ASME B18.2.1 Square, Hex, Heavy Hex, and Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Lobed Head, and Lag Screws (Inch Series).
 - 2. ANSI/ASME B1.1 Unified Inch Screw Threads (UN and UNR Thread Form).
 - 3. ANSI/ASME A-13.1 Standards for Pipe Identification.
 - 4. ANSI/ASME B31 Standards of Pressure Piping.

PART 2 PRODUCTS

2.01 STEEL PIPE AND FITTINGS

A. Pipe

- 1. Less than 150 psi: ASTM A-53, Grade B, seamless or ERW carbon steel, standard weight, black, plain ends, plain end mechanical coupling.
- 2. 150 to 275 psi: Spiral butt-weld pipe, 3/16" wall thickness, 150# forged steel flat face slip on flanges, exterior coal tar epoxy coating, Naylor pipe or equal.
- 3. Greater than 275 psi: Spiral butt-weld pipe, 3/8" wall thickness, 300# forged steel flat face slip on flanges, exterior coal tar epoxy coating, Naylor pipe or equal.

- B. Fittings
 - 1. 3 Inch and Larger: Standard weight, carbon steel, bevel ends, ASTM A-234, Grade WPB, 90-degree elbows—long radius.
 - 2. Branches 2-1/2 inches and larger—nozzle weld.
 - C. Bolting
 - 1. For Flanges: Hex head machine bolts, ASTM A-307, Grade B, nuts to be hexagon, heavy series carbon steel, ANSI B18.2 with coarse thread ANSI B1.1, Class 2.
 - D. Valves
 - 1. Stop Valve, 3 Inch and Larger: Knife gate valve, flanged ends, replaceable gum rubber sleeves, handwheel, air or hydraulic actuator. Clarkson KGA or equal.
 - E. Lining
 - 1. All steel Tailings Discharge pipe: Gum rubber, 40 Durometer, 1/4 inch inside with 1/8 inch on face of flanges.
- 2.02 HIGH-DENSITY POLYETHYLENE PIPE AND FITTINGS
- A. HDPE pipe shall be manufactured from materials meeting the requirement of ASTM D 1248 for Type III, Grade P34, Category 5, Class C, and have a PPE rating of PE3408. The pipe produced from this material shall have the dimensions and wall thickness as set forth in ASTM F 714 for the size and Standard Dimension Ratio (SDR) shown on the Drawings.
 - B. HDPE pipe shall be marked at maximum 5 foot intervals with the manufacturer's name or trademark, nominal size and SDR, cell classification, ASTM D 1248, and extrusion date, period of manufacture, or lot number.
 - C. Polyethylene pipe fittings shall be manufactured from resin having the same classification and properties as the pipe resin, and shall be supplied by the pipe manufacturer. Molded fittings shall be used instead of fabricated fittings, if available. All fittings, bends, and couplings for the HDPE piping shall meet the requirements of this pipe specification and shall have an SDR at or lower than the pipe it is being connected to as shown on the Drawings.
 - D. Electrofusion fittings (if needed) shall be Central Plastics PE3408 Black 3 Pin 150 Class, or approved equal. Electrofusion fittings shall be sized and installed in accordance with manufacturer recommendations for coupling HDPE pipe of the size and class shown on the Drawings.
 - E. Valves:
 - 1. Flanged
 - 2. Non-rising stem
 - 3. Grade E bronze components
 - 4. Nitrile rubber O-rings and gaskets

F. Flanges:

1. Bolts and Nuts for pipe flanges shall be carbon steel conforming to the requirements of ASTM A307, Grade B. Bolts shall have hex heads to conform to ANSI B18.2.1. Hex nuts shall conform to ANSI B18.2.2. Bolt and nut threads shall conform to ANSI B1.1. Plain washers shall conform to ANSI B18.22.1.
2. Slip-on metal flanges shall be 150-lb. stainless steel and furnished with full-face rubber gaskets.
3. Flange adapter and slip-on flanges shall be drilled to ANSI 16.1/16.47/16.5 Class 125/150 bolt circles and AWWA C-207 class D (type).

PART 3 EXECUTION

3.01 INSTALLATION

- A. Provide all materials required to furnish and install the products as specified. Damaged products will not be allowed for installation.
- B. Install piping sized and in locations as shown on the Drawings. Install piping such that it is neat in appearance, convenient to operate, properly supported, and provides for proper expansion and drainage.
- C. Pipe sizes shown on the Drawings are nominal pipe sizes, not outside diameters.
- D. The right is reserved to authorize minor route changes to avoid conflict with other trades or existing obstructions at no additional cost to the Owner.

E. Protection and Cleaning

1. Treat all steel pipes for complete removal of oil and mill scale. Check for the complete removal of such scale and oil before fabrication and installation.
2. Particular care must be exercised to prevent loose welding metal, welding rods, dirt, and miscellaneous scrap from getting into the piping systems.
3. After installation and before final connection to complete the piping systems, hammer each piping section to remove any remaining scale. Flush pipe clean with water until clear of all foreign material. Make temporary connections as required to thoroughly clean pipes.
4. All equipment and accessories shall be cleaned out after all lines have been flushed out.

3.02 HDPE JOINTS AND FUSION

A. General Steps for butt-fusion joints:

1. Surfaces of fusion tools, pipe, and fittings shall be free of contaminants prior to use. Pipe ends shall be trimmed as necessary prior to joining.
2. Heat both pipe ends simultaneously at specified temperature for specified time.
3. Remove heater and press melted surfaces together to form joint.
4. Maintain uniform pressure until solidified. Prevent rough handling (testing, stress movements, pulling, or laying) until fully cooled to ambient material temperatures.

- B. General steps for electrofusion:
1. Surfaces of fusion tools, pipe, and fittings shall be free of contaminants prior to use. Pipe ends shall be trimmed as necessary prior to joining.
 2. Follow manufacturer's recommendations for electrofusion techniques.
 3. Fusion Unit Operators
 - a. Each operator of fusion units shall demonstrate to Owner's or Owner's On-Site Representative's satisfaction that operator is qualified to perform consistently correct fusion joints acceptable to Owner. Contractor shall replace without additional cost to Owner any fusion unit operator to which Owner or Owner's On-Site Representative has reasonable objection based on the operator's failure to perform consistently correct fusion joints as recommended by pipe manufacturer or the provisions of this Section.
 4. Internal fusion bead removal
 - a. The internal fusion bead from each butt weld shall be removed from the return water pipelines by using the Bead Trimmer II or approved equal. This equipment is manufactured by R&L manufacturing and distributed by:

Crookston Welding
Highway 75 South
Crookston, MN 56716
Phone: (218) 281-6911
Fax: (218) 281-7255
 - b. Quality control shall be by inspecting the external and extracted internal fusion bead. The internal bead shall also have a smooth root cut of the wall area; this may include wall mass that has been misaligned during fusion process. However any wall mass that is removed should not exceed 1/10th of the wall thickness of the pipe.

3.03 IDENTIFICATION

- A. Label all new pipe in accordance with ANSI A-13.1 standard, or as directed by Owner's Representative.
- B. Mark pipes at 50-foot maximum intervals on long straight runs, near 90-degree elbows, near either side of wall penetrations and on each branch.
- C. Identify pipes using 2-inch high vinyl marker tape with pressure sensitive adhesive back.

3.04 STEEL PIPE HYDROSTATIC TESTING AND ACCEPTANCE

- A. After completion of Work, thoroughly test, to the satisfaction of the Owner's Representative, all the Work installed hereunder. Test all closed piping systems before the system is placed in operation.
- B. Perform hydrostatic pressure testing in accordance with ASME B31.
- C. Provide temporary equipment for testing, including pump and gages. Test piping systems before insulation is installed wherever feasible and remove control devices before testing. Test each



natural section of each piping system independently but do not use piping system valve to isolate sections where test pressure exceeds valve pressure rating. All piping blanked off or piping components removed in order to perform the test shall be reinstalled at no extra cost. Fill each section with water and pressurize for indicated pressure and time. Heated water or ethylene glycol solution must be used when hydrotesting outdoor piping during freezing weather.

1. Required test period is two hours.
 2. Test each piping system at 150 percent of operating pressure indicated, but not less than 25 psi test pressure.
 3. While holding the test pressure, visually inspect all joints for leaks. Maintain test pressure until released by the Owner's Representative. Test fails if leakage is observed or if pressure drop exceeds 5 percent of test pressure.
- D. Promptly repair piping system sections that fail required piping test by disassembly and reinstallation, using new materials to extent required to overcome leakage. Do not use chemicals, stop-leak compounds, mastics, or other temporary repair methods.
- E. Drain test water from piping systems after testing and repair work has been completed.
- F. Maintain records for each piping installation tested. Records shall include date, system being tested, test fluid, test pressure, and Owner's Representative's approval. Submit test records to Owner.

3.05 HDPE PRESSURE TESTING

- A. HDPE pipelines shall be tested using water as the pressure medium. Testing shall be done in sections not to exceed 700 feet in length. A final pressure test shall be conducted after the pipes have been installed.
- B. The Contractor shall fill the pipelines with water to a pressure of 160 psi for SDR 11 HDPE and 200 psi for SDR 9 HDPE pipe. The contractor shall maintain this pressure in the pipe for a period of one hour.

3.06 FIELD QUALITY CONTROL

- A. Pipe and pipe installations will be subject to rejection for any of the following reasons:
 1. Failure to conform to specifications, particularly compaction under and around pipe.
 2. Fractures or cracks passing through pipe wall.
 3. Chips or fractures on interior of pipes.
 4. Cracks which, in the opinion of Owner or Owner's On-Site Representative, may impair strength, durability, or serviceability of pipe.
 5. Defects indicating improper proportioning, mixing, or molding.
 6. Damaged ends where such damage would prevent making a satisfactory joint.

END OF SECTION 02610

SECTION 03100
BENTONITE-AMENDED TAILINGS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. All work included in this Section shall be performed in accordance with the following paragraphs, the General Requirements set forth in Division 1 of these Specifications, and the provisions of the other Contract Documents.
- B. Work covered by this section includes furnishing all supervision, labor, materials, and equipment required to complete the work summarized below including, but not limited to:
 1. Complete bentonite/tailings mixing for the Work described in these Specifications, unless specified as the responsibility of the Owner.
 2. Retain an independent soil and material testing firm(s) for performing the quality control testing on samples to be sent for laboratory testing. The quality control data shall be available for review at all times by Owner and Owner's On-Site Representative.
 3. All mixing quality control test results will be used by Owner to confirm compliance with Specifications. Tests shall be performed and samples shall be collected at random locations within the designated material source, mixing zones, and placement areas such that the test results may be considered representative. Testing shall be performed or samples collected at specific locations determined by Owner's On-Site Representative, if requested.
 4. Owner's On-Site Representative shall have full authority to direct testing activities of Contractor-retained independent soil and material testing firm(s) including but not limited to: selecting locations and materials for testing, reviewing all raw and final test data, conducting audits of testing company field and in-laboratory testing procedures and equipment.
 5. In cases where testing firm personnel violate Project Site safety procedures or otherwise appear to lack the competence required to fully perform the required testing, Owner's On-Site Representative with concurrence of Owner shall also have the authority to dismiss testing firm personnel from the Project Site.
 6. Conduct a Pilot Test of the bentonite/tailings mixing method, quality control testing, and placement and compaction procedure. The Pilot Test shall be conducted prior to initial bentonite tailings/mixing activities. The Pilot Test shall be agreed to by the Owner's on-site representative, and conducted by the Contractor at the commencement of the project.



7. Pilot Testing shall be repeated prior use of a new tailings borrow source and/or in the event that an alternate approved brand/source of bentonite is used in place of the brand/source initially tested.

1.02 BASIS FOR COMPENSATION

- A. Work included under this Section of these Specifications shall be included under the Bid Price.

1.03 SUBMITTALS

- A. Submit for information on a daily basis to the Owner's on-site representative, the results of all observation documentation and testing of the tailings borrow, the bentonite material, and the bentonite-tailings mixture. Results shall be documented in the Bentonite/Tailings QAQC Template.

PART 2 PRODUCTS

2.01 COARSE TAILINGS BORROW

- A. Coarse Tailings Borrow shall meet the requirements of Section 02220 Excavating, Backfilling, Compacting.

2.02 BENTONITE

- A. Bentonite supplied as a soil sealant shall be high-swelling sodium montmorillonite clay referred to as Wyoming Bentonite or Sodium Bentonite. The bentonite shall be supplied in granulated form and be manufactured by Wyo-Ben, Inc., American Colloid Company, Bentonite Performance Minerals LLC, or an equal approved by Engineer prior to bid.
- B. High swelling is defined as the ability of 2 grams of bentonite, when mechanically reduced to a minus 100 mesh, to swell in water to an apparent volume of 16 cubic centimeters or more when added a little at a time to 100 cubic centimeters of distilled water contained in a graduated cylinder.
- C. The colloid content of the bentonite shall exceed 70% and is measured by evaporating and weighing the suspended portion from a 2% distilled water solution after 24 hours of sedimentation.
- D. Dry fineness of the bentonite product shall be: 97% minimum passing 8 mesh.

PART 3 EXECUTION

3.01 BENTONITE DELIVERY AND STORAGE

- A. Bentonite shall be delivered dry, in bulk, by truck or rail, in bulk or in super sacks. Upon delivery, the dry bentonite shall be incorporated directly into the construction, or transferred by either pneumatic or mechanical conveyance systems into dry storage facilities established for the express purpose of temporary bentonite storage.

3.02 MIXING QUALITY CONTROL

A. Pre-Mixing Activities

1. Prior to bentonite/tailings mixing activities:
 - a. the Contractor shall conduct a Pilot Test to determine the optimal method for mixing, testing, and placement of the bentonite/tailings mixture on the dams,
 - b. the source of tailings borrow shall be identified and associated tailings samples tested as outlined in this specification,
 - c. the Bentonite source shall be identified and documented per this specification,
 - d. the Contractor shall locate the following zones as agreed to by the Owner's on-site representative and confirmed during the Pilot Test:
 1. *Pre-Mixing Zone* – Location of tailings borrow designated as the tailings source for testing and mixing. The pre-mix zone shall be located and marked prior to testing.
 2. *Mixing Zone* – The location for mixing tailings and bentonite to achieve a uniform bentonite-tailings mixture. Testing of the pre-mixed and mixed material shall occur in this zone along with repeated mixing and testing as needed.
 3. *Post-Mixing Zone* – The location for placement and compaction of the bentonite/tailings mixture on the dam.

B. Mixing Activities

1. Within the designated Pre-Mix Zone, the Contractor shall peel off the upper 2.5 feet or less of tailings at the surface to expose underlying tailings borrow. The tailings borrow shall be excavated and staged in the Mixing Zone for testing. Representative samples of the staged tailings borrow shall be tested for moisture content. The quantity of staged



material to be tested will be determined during the Pilot Test, but in all cases shall be sufficient to fully evaluate production-scale equipment types and mixing and compaction procedures.

2. Based on the dry weight of the staged tailings, a quantity of bentonite shall be determined to achieve 3% bentonite by dry weight.
3. Within the Mixing Zone, the calculated quantity of bentonite shall be mixed with the tested tailings. Mixing shall occur until the bentonite is uniformly distributed with the tailings. Visual observations shall be made by the Contractor to ensure thorough mixing. Actual mixing procedures will be determined during the Pilot Test.

C. Post-Mixing Activities

1. Following the addition of bentonite and thorough mixing, a second set of representative field tests shall be made from the tailings/bentonite mixture. The Pilot Test will determine the appropriate tests and specifications prior to placement.
2. Bentonite/tailings mixtures that meet standards determined during the Pilot Test shall be mechanically placed and compacted as an 18-inch thick bentonite-amended cover on the FTB dams according to placement specifications in SECTION 02220. Additional testing of the compacted mixture will be determined during the Pilot Test.

D. Field Testing

1. Field tests of the tailings moisture content shall be made on site by the Contractor in conformance with ASTM D 2216, the standard test method for testing water content of a material. Additional tests will be determined during the Pilot Test.
2. Field tests shall be performed in an on-site testing area furnished with sufficient equipment.

E. Laboratory Testing

1. An independent laboratory shall be retained to verify field tests. Samples for laboratory testing shall be taken from the tailings/bentonite mixture placed and compacted on the dam. In-laboratory material test requirements will be determined during the Pilot Test but may include moisture content, hydraulic conductivity, sieve analysis, or others. In-laboratory material test results shall be available within 5 days from testing to track quality of the bentonite-tailings mixture.

3.03 DOCUMENTATION

- A. Test Results (field or laboratory) - The Contractor shall document in the Bentonite/Tailings QAQC Template all testing information including: the date, time, location coordinates (northing, easting, elevation), and the test results. Test result documentation shall be made for tests in each zone, placed material and compacted material. Actual documentation and tracking methods will be determined during the Pilot Test.
- B. Bentonite Material - The Contractor shall document in the Bentonite/Tailings QAQC Template, the name of the bentonite supplier, source of the bentonite, quantity used in each testing and mixing location, and test results associated with usage of bentonite. Additional documentation includes bentonite deliveries (date, time and quantity.)
- C. Tailings Borrow – The Contractor shall document in the Bentonite/Tailings QAQC Template, the tailings borrow location, volume excavated, and general observations and characteristics of the tailings.
- D. Bentonite Amended Tailings on Dams – The Contractor shall document in the Bentonite/Tailings QAQC Template, the location, volume, and general observations/characteristics of bentonite amended tailings placed on the dams.
- E. Notification- any significant changes in the test results, the bentonite material and/or the tailings borrow that would affect the bentonite-amendment for the dams shall be documented and immediately be brought to the attention of the Owner's On-Site Representative.
- F. Frequency- testing shall be frequent early on during the start of mixing activities and will gradually decrease once a sufficient level of data is obtained. The Pilot Test will determine the frequency of visual observations and testing frequency, which shall include a minimum of three field tests of moisture content and sieve analysis per day during active mixing activities. Testing frequency will be confirmed and adjusted as necessary during the Pilot Test.
- G. Documentation shall occur with each occurrence of tailings excavation, mixing, and placement; field tests, laboratory tests of pre-mixed or mixed material; and deliveries of bentonite.

3.04 AIR QUALITY

- A. Contractor shall be responsible for bentonite handling and bentonite-amendment of tailings activities in a manner so as not to allow visible wind transport of bentonite outside the immediate zone of bentonite/tailings mixing activities.
- B. In cases when visible air quality impacts are occurring, Contractor shall temporarily cease or otherwise adjust construction activities until such time that suitable air quality can be achieved.

- C. Owner's On-Site Representative shall have authority to request temporary stoppage of bentonite application activities until such time activities can resume without air quality impact, at no additional cost to Owner.

END OF SECTION 03100

PERMITTING



Construction QAQC Template -- Bentonite-Amended Tailings (Draft 01 07-27-2015)

Pre-Mixing Zone (Tailings Borrow)						
Source Location	Coordinates			Approximate Dimensions of Excavated Material (ft)		
	Northing	Easting	Elev.	Length	Width	Depth
Source Characteristics	Grain Size	Grading (Poorly Graded/Well Graded)	Moisture Characteristics (Dry/Moist/Wet)	Impurities (vegetation, other) and Other Observations		
Source Volume	Material Excavated for Mixing (cubic yards)					
Source In-Field Testing	Moisture Content					
	Sample Location	Moist Specimen Mass (g)	Oven Dry Specimen Mass (g)	Mass of Water = (Moist Specimen - Oven Dry Specimen)	Mass of Water/Mass of Solid = Water Content	Other Observations
Source In-Laboratory Testing	Sample Location	Laboratory Test1	Laboratory Test 2	Laboratory Test 3	Other Observations	
Bentonite Material						
Granular Bentonite	Supplier	Source	Quantity Delivered	Delivery Date	Comments	
Tailings Bentonite Mix						
Post-Mixing Location	Coordinates			Other Observations		
	Northing	Easting	Elev.			
Mix Quantity	Tailings Quantity	Bentonite Quantity	Bentonite % Weight	Other Observations		
Mix Characteristics	Well Mixed	Poorly Mixed	Mixing Equipment and Method			
Mix In-Field Testing	Moisture Content					
	Sample Location	Moist Specimen Mass (g)	Oven Dry Specimen Mass (g)	Mass of Water = (Moist Specimen - Oven Dry Specimen)	Mass of Water/Mass of Solid = Water Content	Other Observations
Additional Mixing	Additional Tailings Quantity	Additional Bentonite Quantity	Comments			
Mix In-Laboratory Testing	Sample Location	Laboratory Test1	Laboratory Test 2	Laboratory Test 3	Other Observations	

Note: This template is subject to change based on Pilot Testing of the bentonite-amended tailings construction process.



SECTION 31 32 00

CEMENT DEEP SOIL MIXING

PART 1: GENERAL

1.01 SCOPE

- A. The Contractor shall furnish all labor, equipment, and materials necessary to plan and construct the cement deep soil mix (CDSM) columns and associated testing, monitoring, sampling, and recording to meet the performance requirements outlined in these plans and specifications.

1.02 REFERENCES

- A. The following publications form a part of this specification to the extent indicated by the references. The latest publication as of the issue date of this specification should govern, unless indicated otherwise.
1. Federal Highway Administration. (2012). *Deep Mixing Manual for Embankment and Foundation Support*, U.S. Department of Transportation, Washington, DC.
 2. ASTM C150. (2012). "Standard Specification for Portland Cement," *Book of Standards Volume 04.01*, ASTM International, West Conshohocken, PA.
 3. ASTM C192. (2012). "Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory," *Book of Standards Volume 04.02*, ASTM International, West Conshohocken, PA.
 4. ASTM C821-09. (2009). "Standard Specification for Lime for Use with Pozzolans," *Book of Standards Volume 04.01*, ASTM International, West Conshohocken, PA.
 5. ASTM D2166. (2006). "Standard Specification for Unconfined Compressive Strength of Cohesive Soil," *Book of Standards Volume 04.08*, ASTM International, West Conshohocken, PA.
 6. ASTM D4380. (2012). "Standard Test Method for Density of Bentonitic Slurries," *Book of Standards Volume 04.08*, ASTM International, West Conshohocken, PA.

1.03 DEFINITIONS

- A. The technical and construction terms used in this specification are outlined in this section.
1. **Admixtures:** Ingredients in the grout other than binder, bentonite, and water. Admixtures can be fluidifiers, dispersants, or retarding, plugging, or bridging agents that permit efficient use of materials and proper workability of the grout.
 2. **Binder:** Chemically reactive material (i.e., lime, cement, gypsum, blast furnace slag, flyash, or other hardening reagents) that can be used for mixing with in-situ soils to strengthen the soils and form CDSM columns.
 3. **Binder content:** Ratio of weight of dry binder to dry weight of soil to be treated.
 4. **Binder factor:** Ratio of weight of dry binder to volume of soil to be treated.
 5. **Binder factor in-place:** Ratio of weight of dry binder to volume of mixture, which is the volume of the soil to be treated plus the volume of the slurry for the wet method or the volume of the dry binder for the dry method.



6. **Binder slurry:** Stable colloidal mixture of water, binder, and admixtures that assists in loosening the soils for effective mixing and strengthening the in situ soil upon setting.
7. **BRN:** Total number of mixing blade rotations per meter of shaft movement.
8. **Column:** Pillar of treated soil produced in-situ by a single installation process using a mixing tool, typically a rotating auger, to make a round column.
9. **Deep mixing equipment:** Deep mixing equipment with various mixing tools including single vertical shaft mixing tools, multiple vertical shaft mixing tools, horizontal rotating circular cutters, chainsaw-type cutters, etc.
10. **CDSM:** In-situ ground treatment in which soil is blended with cementitious and/or other binder materials to improve strength, permeability, and/or compressibility characteristics.
11. **CDSM Contractor:** A specialty earth-work construction Contractor having the requisite capabilities and experience to complete the CDSM column construction as specified here-in.
12. **Element:** This is an inclusive term that refers to a CDSM element produced by a single stroke of the mixing tools at a single equipment location. A column produced by a single-axis machine, OR a set of overlapping columns produced by a single stroke of a multiple-shaft mixing tool.
13. **Engineer:** The representative of the design Engineer or of the project Owner (Owner). This person may either be a subconsultant to the Owner or a member of the Owner's staff.
14. **Filler:** Non-reacting materials (i.e., sand, limestone powder, etc.).
15. **Mix design:** Ratios of soil, binder, water, and additive quantities required to meet the design requirements of the project.
16. **Mixing process:** Mechanical disaggregation of the soil structure and dispersion of binders and fillers in the soil.
17. **Mixing tool:** Equipment used to disaggregate the soil and distribute and mix the binder with the soil. Consists of one or several rotating units equipped with several blades, arms, and paddles with or without continuous or discontinuous flight augers.
18. **Penetration (downstroke):** Stage/phase of mixing process cycle in which the mixing tool is delivered to the appropriate depth (disaggregation phase).
19. **Penetration/retrieval speed:** Vertical movement per unit time of the mixing tool during penetration or withdrawal.
20. **Restroke:** Additional penetration and withdrawal cycle of the mixing tool to increase the binder content and/or the mixing energy.
21. **Retrieval:** Withdrawal of mixing tool from bottom depth to the ground surface. Binder may be injected during retrieval, which also imparts additional mixing energy.
22. **Rotation speed:** Number of revolutions of the mixing tool per unit time.
23. **Soil-cement:** Product of CDSM consisting of a mixture of the in-situ soil and binder. Also referred to as treated soil or deep mixed material.
24. **Stroke:** One complete cycle (penetration and withdrawal) of the mixing process.
25. **Volume ratio:** Ratio of the volume of slurry injected (in wet mixing) to the volume of soil to be treated.

26. **Wall:** Group of overlapping elements arranged to form a continuous wall.
27. **Water:** Fresh water that is free of deleterious substances that adversely affect the strength and mixing properties of the grout and is used to manufacture grout.
28. **Water-Cement ratio:** Weight of water added to the cement divided by the weight of the cement. In wet mixing, the water-cement ratio of the slurry is determined from the weights of water and cement used to manufacture the slurry in a plant at the ground surface. For wet mixing, the total water-cement ratio is the weight of slurry water plus the weight of soil water divided by the weight of cement.
29. **Wet mixing:** Process of mechanical disaggregation of the soil in-situ and its mixing with slurry consisting of water and binders with or without fillers and admixtures.
30. **Withdrawal (upstroke):** Stage or phase of retrieval of the mixing tool in which the final mixing occurs for penetration injection and initial mixing for withdrawal injection.
31. **Withdrawal rate:** The average up-hole retrieval rate of the mixing tool.

1.04 PROJECT DESCRIPTION AND PERFORMANCE REQUIREMENTS

- A. The purpose of the CDSM column installation is to achieve an incremental improvement in the shear strength of the existing LTVSMC fine tailings/slimes on the northern section of Cell 2E. This in turn will yield elevated slope stability safety factors in the case of a fully liquefied tailings strength condition developing in response to an unknown triggering event.
- B. Any existing tailings removed during the CDSM column construction activities shall be placed such that they remain within Cell 2E; generally to the south of the CDSM construction zone.
- C. Allowable geometric parameters for CDSM construction are outlined in Table 1.

Table 1. Allowable Geometric Parameters for CDSM Column Construction

Parameter	Minimum and/or Maximum	Value
Top elevation of CDSM element	Minimum	See Construction Drawings
Bottom elevation of CDSM element	Minimum	See Construction Drawings. CDSM Contractor to confer with Engineer in event of auger refusal above specified bottom elevation.
Shear wall length, B	Minimum	See Construction Drawings
Column diameter, d	Minimum and maximum	Min = 3 feet Max = 5 feet
Column overlap ratio, e/d	Minimum	0.17
Clear spacing $s_{center} - d$	Maximum	7 feet at $d = 3$ feet For alternate column diameters confer with Engineer.
Area replacement ratio $a_{s,center}$	Minimum	0.30
CDSM Compressive Strength	Minimum	300 psi

- D. Layouts and sizes of deep mixing elements that adhere to the minimum and maximum values of the parameters listed in Table 1 and included in the plans and/or specifications will be deemed acceptable to meet the requirements of the Engineer's design, and additional design calculations will not be required.
- E. CDSM construction activities shall be carried out so as to comply with facility-specific fugitive emissions control requirements.

1.05 QUALIFICATIONS OF CONTRACTOR

- A. The CDSM Contractor must have previous successful experience with CDSM projects for the soil conditions and project scope similar to that of the project being bid (Contractor provides project description(s) and reference list).
- B. The CDSM Contractor must assign a project manager who has had significant experience on at least five CDSM projects (Contractor provides the number of years/projects, project description(s), and reference list).
- C. The CDSM Contractor must assign a project Engineer to supervise the construction of the CDSM work. The project Engineer must have had significant experience on at least five CDSM projects (Contractor provides the number of years/projects, project description(s), and reference list).
- D. The CDSM Contractor must assign a full-time project superintendent with at least five projects and at least 100,000 yd³ of total treatment volume in CDSM construction (Contractor provides the number of years/projects, project description(s), and reference list).
- E. The CDSM Contractor must provide at least one CDSM equipment operator with at least 1 year of experience with the equipment and CDSM construction (Contractor provides the number of years/projects, project description(s), and reference list).
- F. Written requests for substitution of these key personnel must be submitted prior to personnel changes. Documentation must be submitted to the Owner that demonstrates that the substitute meets the requirements listed. Substitution may not be made until written approval is provided by the Owner.

1.06 AVAILABLE INFORMATION

- A. Available information developed by the Owner or by the Owner's duly authorized representative (Engineer) includes the following items:
 1. NorthMet Project Geotechnical Data Package Vol 1 - Flotation Tailings Basin (v7). July 2016.

1.07 CONSTRUCTION SITE SURVEY

- A. Prior to bidding, the Contractor should review the available subsurface information and visit the site to assess the site geometry, equipment access conditions, location of existing structures, and above-ground utilities and facilities.

1.08 SUBMITTALS

- A. Contractor experience profile: The Contractor must submit documentation evidencing the experience requirements outlined in section 1.05.
- B. Bench-scale testing report: The Contractor must submit results from bench-scale tests conducted. The report shall provide all data collected, including, at a minimum, descriptions of

sampling techniques used, boring logs, classifications of all major soil strata to be mixed, site groundwater conditions, binder materials used, mix design proportions, laboratory mixing techniques used, and curing curves for unconfined compressive strength versus time for each major soil type. Discussion of test results shall be provided, including proposed mix designs for use in the field.

- C. Field validation program plan: At least 30 days before the start of the field validation program, the Contractor shall submit a field validation program plan that contains descriptions of the construction procedures, equipment, and ancillary equipment to be used for mixing and binder proportioning and injection; mix design parameters and associated soil strata to be evaluated; operational and material parameters to be monitored during field validation; layout of the CDSM elements to be constructed; a summary of QAQC samples to be collected and tested; and examples of the forms that will be used to document the work.
- D. Deep mixing work plan: Based on the results of the preconstruction testing (bench-scale and field validation program), at least 30 days prior to the start of deep mixing work, the Contractor must submit a deep mixing work plan for review and approval. This plan must include the following items:
 - 1. Detailed descriptions of sequence of construction and all construction procedures, equipment, and ancillary equipment to be used to penetrate the ground, proportion and mix binders, and inject and mix the site soils.
 - 2. Proposed mix design(s), including binder types, additives, fillers, reagents, and their relative proportions, and the required mixing time, water-to-binder ratio of the slurry, and volume ratio for a deep mixed element.
 - 3. Proposed injection and mixing parameters, including mixing slurry rates, slurry pumping rates, air injection pressure and volume flow rates, mixing tool rotational speeds, and penetration and withdrawal rates.
 - 4. Methods for controlling and recording the verticality and the top and bottom elevation of each element.
 - 5. The necessary procedure and measurement to confirm the end-bearing where CDSM elements penetrate into the till or peat layer at the base of the existing tailings.
 - 6. Working drawings and calculations for the CDSM elements showing the site location of the CDSM project as well as the dimensions, layout, and locations of all CDSM elements. Drawings should indicate the identification number of every element if a multi-shaft mixing tool is used and every column if a single-auger mixing tool is used. Calculations and drawings should demonstrate that the element layout, depth, and quantity meet the specification requirements.
 - 7. CDSM schedule information (e.g., preloading or phasing schedule).
 - 8. Sample daily production report, including the items described in section 1.08.
 - 9. Details of all means and methods proposed for QAQC activities, including surveying, process monitoring, sampling, testing, documenting, and marking schedule milestones.
 - 10. Names of any subcontractors used for QAQC activities. An independent laboratory must be used for QAQC testing and must be approved by the Owner/Engineer.
- E. Material certifications: Certificates of compliance must be submitted as proof of conformance to materials standards and requirements for each truckload of binder, and admixtures as needed.

- F. Production records: By the end of the next business day following each deep mixing shift, the Contractor shall submit a daily production report in the approved format. The report shall be completed and signed by the Contractor's project superintendent. The report shall contain at a minimum the following information:
1. Project name.
 2. Day, month, year, and time of work shift (beginning and end).
 3. Name of field superintendent in charge of the work for the Contractor.
 4. Deep mixing equipment (rig numbers) in operation during the shift and specific activities conducted by said equipment.
 5. Type of mixing tool.
 6. Treatment zone and reference drawing number.
 7. Elevation of top and bottom of treatment zone.
 8. Element number, diameter, and location coordinates.
 9. Date and time (start and finish) of element.
 10. Location of each completed column/element installed during the work shift and all zones completed to date on a plan of suitable scale to clearly show the location of the elements.
 11. Mix design.
 12. Slurry specific gravity measurements.
 13. Binder slurry injection rate (gal/min) plotted at each 3-ft depth interval for the full depth of the treated zone. Variations in volumes must be noted.
 14. Mixing tool rotation speed in revolutions per minute versus depth.
 15. Penetration/withdrawal rates of the mixing tool in ft/min plotted at each 3 ft of depth.
 16. Element verticality measurements.
 17. Plots of BRN and binder factor versus depth for each element plotted at least every 3 ft of depth. The total number of rotations should be reported for CDSM.
 18. A description of obstructions, interruptions of binder injections, or other difficulties during installation and their resolution.
 19. Other pertinent observations including but not limited to binder escapes, ground settlement or heave, collapses of the treatment zone, and any unusual behavior of any equipment during the deep mixing process.
 20. For both wet grab samples and coring, provide collection date, time, plan location, elevation, and identification numbers of all deep mixed samples, including unsuccessful attempts to retrieve samples.
 21. For coring operations, provide the coring method, equipment, and personnel; recovery percentage and percent treatment (percent of run length that is treated) for each core run; sample collection, handling, and storage details; and name of person responsible for logging and collecting cores and samples to be tested.
 22. Quantities of all binder materials delivered to the site plus a reconciliation showing the amount actually injected.

23. Summary of any down time or other unproductive time including time, duration, and reason.
 24. Detailed results of all testing.
- G. QAQC records: Calibration data must be submitted for all measurement devices used for binder production, deep mixing operational monitoring, and laboratory testing. Within 3 business days of completing any QAQC testing, the Contractor shall submit the test results, including original data sheets from the laboratory and an evaluation of the compliance of the test results with project acceptance criteria. Equipment shall be calibrated prior to initial use and repeated every 3 months.
- H. As-built field measurement data: After completion of the project, the Contractor must submit as-built field measurement data indicating surveyed as-built plan locations of each CDSM element, including the element center (per site specific coordinates), the element dimension, the column verticality, and the top and bottom elevations of each element to the accuracy required by the project specifications.

1.09 PRECONSTRUCTION MEETING

- A. The Contractor is required to attend a pre-construction meeting at the time and date requested by the Owner.

PART 2: MATERIALS AND EQUIPMENT

2.01 MATERIALS

- A. Cement binder materials shall conform to ASTM C150 low-alkali Type II Portland Cement. All cement shall be homogeneous in composition and properties and shall be manufactured using the same methods at each plant by each supplier.
- B. Water used in drilling, mixing cement grout, and other applications shall be clean and clear and approved for use by Engineer.
- C. Admixtures will not be allowed unless the Contractor submits documentation demonstrating the effects of the admixture and the admixture is approved by the Engineer.
- D. Binder slurry should be a stable homogeneous mixture of approved binder, approved admixtures, and water. The ratios of various components may be proposed for modifications by the Contractor but proposed modifications shall not be implemented until reviewed and accepted by the Engineer. Any proposed deviations from the submitted and approved mix design shall be resubmitted for the Engineer's approval. Revalidation through laboratory or field testing is necessary for changes that exceed 10 percent of previously approved mix designs. Regardless of such changes, the Contractor is responsible for satisfying the acceptance criteria.
- E. Tailings-binder mixture should be a stable mixture of binder slurry and in-situ tailings. The Contractor shall propose the ratios and quantities of various components to achieve the strength specified in section 3.06.

2.02 EQUIPMENT

- A. Deep mixing equipment shall be of sufficient size, capacity, and torque to perform the required deep mixing to the desired depths. Required characteristics of deep mixing equipment are as follows:

1. The equipment shall be capable of advancing through previously installed elements to achieve designed overlapping or remixing as needed and be sufficient to maintain the necessary revolutions per minute and penetration rate at the maximum depth to achieve thorough mixing.
 2. The mixing and injection equipment shall be sufficient to adequately blend and distribute the binder with the in-situ soils to provide the required strength.
 3. The mixing tools shall be adequately marked to allow the Engineer to confirm the penetration depth to within 1 ft (0.3 m) during construction. If rigs with varying mixing tool lengths are used, the shortest tools shall extend to the lowest element termination elevations indicated in the plans.
 4. All equipment shall have monitoring equipment to permit accurate and continuous monitoring, recording, and controlling of mixing tool depth, vertical alignment , binder volume flow rates and factors, binder injection pressures and quantities, tool rotational speeds, tool advancement, and withdrawal rates.
 5. The monitoring equipment shall be calibrated at the beginning of the project, and the data shall be submitted to the Owner. Calibration shall be repeated every 3 months.
 6. The Owner/Engineer shall have access to monitoring equipment.
- B. Binder materials handling and storage:
1. The Contractor shall measure, handle the transport, and store bulk binder in accordance with the manufacturer's recommendations.
 2. Dry materials shall be stored in dry containers. The binder shall be adequately protected from moisture and contamination while in transit and when stored at the project site.
 3. Dry materials shall be transported to the project site and placed in the onsite storage tanks using a closed system. Any air evacuated from the storage tanks during the loading process shall be filtered before being discharged to the atmosphere.
 4. Material that has become caked due to moisture absorption shall not be used. Binder materials containing lumps or foreign matter of a nature and in amounts that may be deleterious to the injection operation shall not be used. In each instance in which the binder source is changed, the batch plant silos shall be completely emptied before storing binder from the new source. Mixing binders from different sources in the same silos is not permitted.
 5. Equipment used for proportioning during binder production shall be calibrated prior to initial use and repeated every 3 months or every time the batch plant is relocated, whichever is sooner. Calibration records must be submitted to the Owner in accordance with section 1.08.
 6. Positive displacement pumps shall be used to transfer the slurry to the injection point. The Contractor shall demonstrate that the equipment can uniformly deliver binder at suitable rates in accordance with the construction plan.

2.03 PRODUCTS

- A. Geometric tolerance: CDSM elements installed shall meet the geometric tolerance outlined in section 3.06.
- B. Strength: The strength of treated soils shall meet the strength criteria outlined in section 3.06.

- C. Uniformity: The uniformity of treated soils shall meet the uniformity criteria outlined in section 3.06.

PART 3: EXECUTION

3.01 GENERAL

- A. Deep mixed elements shall be constructed to the lines, grades, and cross sections indicated in the plans and shall meet the strength and uniformity requirements specified in section 3.06. The Contractor shall establish consistent procedures during construction to ensure that the acceptance criteria are satisfied. The procedures shall be established based on the results of the field validation program.

3.02 FIELD VALIDATION PROGRAM

- A. Prior to production, the Contractor must construct a test section at the location shown in the plans to verify that the Contractor's proposed equipment, procedures, and mix design can uniformly mix the onsite soils and achieve the product requirements outlined in the acceptance criteria in section 3.06.
- B. The Contractor shall submit the results of the field validation program to the Owner as outlined in section 1.08.
- C. Laboratory bench-scale testing shall be used to identify initial mix designs for use in the field validation program. Bulk tailings samples from the site shall be obtained by the Contractor. A suite of three mix designs is required for each major stratum encountered to the expected termination depth of the elements.
- D. The test section shall be installed at the location indicated in the plans. The Contractor shall submit a plan drawing showing the locations of the test section elements. At least three elements shall be installed with different mixing parameters for each element. Each element shall extend from the top elevation to the bottom elevation (or required penetration into bearing layer) if different mixing parameters are used. At least one full-depth core shall be obtained from each element or group of elements installed using the same mixing parameters.
- E. The Contractor shall obtain full-depth core samples from the test elements in accordance with the QAQC requirements outlined in section 3.06. Test samples shall be submitted to an approved independent laboratory for testing. The Contractor may propose other sampling techniques to obtain continuous samples of the deep mixed material which, if approved by the Engineer, could be submitted as further evidence of compliance with the acceptance requirements.

3.03 BINDER PREPARATION (WET METHOD)

- A. The Contractor shall mix dry binder and water in the slurry plant to produce a uniform suspension of binder in the water.
- B. The slurry shall be held in the agitation tank for a maximum holding time of 1-hour. Holding time is calculated from the beginning of the initial mixing.
- C. Slurry density must be measured in accordance with the requirements outlined in section 3.06. If the slurry density is outside the tolerance required by the mix design, the Contractor shall recalibrate monitoring equipment and perform additional testing as required by the Engineer at no additional cost to the Owner. The Contractor may also adjust binder or water quantities appropriately and retest at no additional cost to the Owner. The specific gravity of the binder

slurry measured during production may not deviate by more than 3 percent from the established specific gravity.

- D. Monitoring data shall be recorded in the daily production report.

3.04 LOCATING ELEMENTS

- A. Before beginning installation, the Contractor shall accurately stake the location of the deep mixed elements shown in the plans using a licensed surveyor. The Contractor shall provide an adequate method for locating elements to allow the Engineer to verify the as-built location of the elements during construction. The Contractor will not be compensated for elements that are located outside of the tolerances specified in section 3.06. The Engineer will review the location of misaligned elements to determine if the elements fail to satisfy project objectives. If the Engineer determines that misaligned elements fail to satisfy project objectives, the Contractor shall correct the alignment. The proposed method of correction shall be submitted by the Contractor to the Engineer for review and approval. No additional compensation shall be made by Owner for implementation of required corrections.
- B. If an obstruction is encountered that prevents drilling advancement, the Contractor shall immediately notify the Engineer and investigate the location and extent of the obstruction using methods approved by the Engineer. The Contractor shall propose remedial measures to clear the obstruction for approval by the Engineer. The Contractor will be compensated for removal or clearing of obstructions with prior approval from the Owner. If the element cannot be installed at the design location due to obstructions, the element shall be relocated as directed by the Engineer.

3.05 MIXING

- A. The equipment, installation procedures, materials, and sampling and testing methods established during the field validation program shall be used for production. The Contractor may request that the established mix design, equipment, installation procedure, or test methods be modified; however, the Engineer may require additional testing or a new test section at no additional cost to the Owner to verify that acceptable results can be achieved. The Contractor shall not employ modified mix designs, equipment, installation procedures, or sampling and testing methods until approved by the Engineer in writing.
- B. If the Contractor must modify established methods due to equipment breakdowns, manpower changes, or improved conditions, a new test section shall be installed at no cost to the Owner. If the Owner requests modifications to the means and methods for design or other reasons (e.g., site conditions differ from what were encountered during the geotechnical explorations and the preproduction test program), the Contractor shall be compensated for new test sections.
- C. Installation of each column shall be continuous. If an interruption of more than 1-hour occurs, the element shall be remixed while injecting binder at the design rate for the entire height of the element at no additional cost to the Owner.
- D. Binder slurry injection rate: The Contractor shall record in the daily production report on a real-time basis the weight of dry binder or the volume of binder slurry injected for each 3 ft (measured vertically) during penetration and withdrawal for each element. If the weight of dry binder or the volume of binder slurry injected per vertical foot is less than the amount required to meet the binder factor or volume ratio established during the field validation program, the element shall be remixed, and additional binder shall be injected at the design binder injection rate to a depth at least 3 ft below the deficient zone at no additional cost to the Owner. The binder factor shall be recorded and plotted versus depth, and the records shall be visible to the operator on a screen during construction so that proper adjustments may be made in real time.



- E. Rotational speed and penetration/withdrawal rates: The necessary rotational speeds and penetration/withdrawal rates for the various soil layers encountered shall be determined during the field validation program. The penetration and withdrawal rates must be monitored on a real-time basis. If the BRN is more than 15 percent below the value determined to be reliably acceptable from the field validation program, the column/element section must be remixed while injecting grout at the design binder injection rate.
 - F. Vertical alignment: The Contractor shall monitor and control the vertical alignment of the mixing tool stroke in two directions (longitudinal and transverse to the element alignment). Vertical alignment shall be maintained within 0.5 percent of plumb during the element installation.
 - G. Element top and bottom elevations:
 - 1. The total depth of penetration shall be measured either by observing the length of the mixing shaft inserted below a reference point on the mast or by subtracting the exposed length of shaft above the reference point from the total shaft length. Care shall be taken to note ground surface heave that may affect reference points for measuring mixing shaft length. The Contractor shall note and record on the daily production report the final depth of the stroke. The equipment shall be adequately marked to allow the Engineer to confirm the penetration depth during construction.
 - 2. If the elevations of the top of competent soils are found to be different from those estimated, the Engineer may direct the Contractor to shorten or deepen the elements. Measurements of torque, down pressure, and/or the change in rotational speed may be used as indications of termination depth if a suitable correlation can be developed by the Contractor to the satisfaction of the Engineer. The Contractor will be compensated based on the decreased or increased amount of deep mixing as termination depths vary. The Contractor shall not be compensated for any portions of the elements that are above the top elevations or below the bottom elevations shown on the plans unless approved by the Engineer.
 - H. Bottom mixing:
 - 1. The Contractor shall conduct bottom mixing as established in the field validation program.
 - I. Control of spoils:
 - 1. The Contractor shall control and dispose of all waste materials produced as a result of the mixing operation in accordance with the project requirements. The areas designated by the Owner shall be used for containing and processing the spoils.
- 3.06 QAQC
- A. The Contractor should provide all the personnel and equipment necessary to implement the QAQC requirements of the project. The Engineer will review daily production reports and QAQC test reports to verify that QAQC procedures are being properly implemented.
 - B. Deep mixing work plan: The Contractor's deep mixing work plan shall include descriptions of all QAQC activities and reporting as outlined in section 1.08. After the field validation program is conducted, the Contractor may revise the QAQC procedures, if approved by the Engineer. The Contractor should maintain the established and approved QAQC procedures throughout production to ensure consistency in the deep mixing installation and to verify that the work complies with all requirements indicated in the approved working drawings.
 - C. Daily production records shall be submitted as outlined in section 1.08.

- D. Binder slurry density: The Contractor shall measure the specific gravity of the binder slurry at least twice per shift per slurry plant using the methods outlined in ASTM D4380. The specific gravity of the binder slurry measured during production may not deviate by more than 3 percent from the established specific gravity. If the slurry density deviates by more than 3 percent, the Contractor shall recalibrate monitoring equipment and perform additional testing as required by the Engineer at no additional cost to the Owner. The Contractor may also adjust binder or water quantities appropriately and retest at no additional cost to the Owner.
- E. The Contractor shall make simple routine checks of material quantities such as counting the number of bags or truckloads of binder materials that have been used. These quantities shall be recorded in the daily production report.
- F. Wet sampling and testing:
1. The Contractor shall perform all wet sampling in the presence of the Engineer. The Contractor shall notify the Engineer at least 1 business day in advance of beginning sampling operations.
 2. The Contractor shall propose locations for wet sampling while considering input from the Owner/Engineer. Sample locations shall be distributed uniformly both laterally and vertically within the deep mixed zone. Sampling depths shall be selected to ensure that wet samples are retrieved from every main soil stratum underlying the site.
 3. The Contractor shall report the information required in the daily production report (see section 1.08) for all attempts, successful and unsuccessful, to obtain wet samples.
 4. The Contractor shall collect a minimum of three wet bulk samples (each sample is taken at one selected depth at one location) for each mix design used in each test section. At least one wet bulk sample (one selected depth at one location) shall be collected from within each main soil layer from elements produced using each mix design.
 5. One wet bulk sample (one selected depth at one location) shall be retrieved every 2 production days or for every 2,000 yd³ (1500 m³) of treated soil, whichever produces the higher sampling frequency.
 6. Wet bulk samples shall be collected using a bailer-type sampling tool or similar.
 7. Eight test specimens from each wet bulk sample shall be made with 3-inch diameter and 6-inch length, using the following general procedures:
 - a. Pour the sample into a container, screening for oversized lumps (gravel versus unmixed soil). Place the sample in specimen molds in three to five layers. Tap, vibrate, or rod the specimens to remove trapped air bubbles. Use care to avoid additional mixing or kneading action as much as possible on the sample during screening and specimen preparation so that the sample is representative of in-place mixing conditions.
 - b. Measure and describe the volume and composition of oversized lumps.
 - c. Seal the specimen to prevent moisture from entering or leaving, and store the specimen in a humid environment in accordance with ASTM C192.
 - d. The Engineer may request additional test specimens for QA testing.
- G. Coring:
1. The Contractor shall perform all coring operations in the presence of the Engineer. The Contractor shall notify the Engineer at least 1 business day in advance of beginning sampling operations.

2. The Contractor shall determine the time interval between element installation and coring except that the interval shall be no longer than required to conduct 28-day strength testing.
3. The full-depth samples shall be obtained along a vertical alignment located one-fourth of a column diameter from the column center. If it is difficult to avoid drilling out of the column at this coring location, the Contractor may drill one-fourth of a column diameter along the centerline of an element or shear wall so the core enters the adjacent column in the same element.
4. Core samples shall be retrieved using standard triple-tube or equivalent continuous coring techniques.
5. Samples shall have a diameter of at least 2.5 inches, and each core run shall be at least 3 ft in length.
6. For each field validation test section, the Contractor shall collect at least one full-depth core for each mix design at locations defined by the Owner/Engineer.
7. The Contractor shall collect one full-depth core from 3 percent of elements or 860 ft² of treated area, whichever produces a larger number of cored elements. The cores shall be drilled at locations defined by the Owner/Engineer. An element is defined as the treated soil produced by one setup of either a single- or multiple-axis machine.
8. The Contractor shall photograph each core run.
9. Upon retrieval, the Contractor shall provide the cores to the Engineer for logging and test specimen selection.
10. Following logging, the Engineer will select at least five specimens from each full-depth continuous core for strength testing. Each test specimen shall have a length-to-diameter ratio of 2 or greater.
11. Immediately following logging and test specimen selection by the Engineer, the Contractor shall seal the entire full-depth sample, including the designated test specimens, in plastic wrap to prevent drying and transport the sealed sample to the laboratory. The samples shall be protected against drying and mechanical damage prior to and during transport.
12. The samples shall be stored in a moist room in accordance with ASTM C192 until the test date.
13. Samples must not be submerged in water during curing unless they are sealed in a watertight plastic bag (e.g., a Ziploc® bag) with as much air removed as possible prior to sealing to avoid swelling.
14. The Contractor shall retain portions of the samples that are not tested until completion and acceptance of all CDSM work for possible future inspection and confirmation testing by the Engineer. If a large volume of samples cannot be reasonably stored on the job site, cores from columns deemed satisfactory may be disposed of prior to project completion if approved by the Engineer.
15. All core holes should be filled with cement grout that will obtain a 28-day unconfined compressive strength equal to or greater than the 28-day unconfined compressive strength of the deep mixed material.

H. Strength testing:

1. Strength testing shall be conducted by an independent testing laboratory retained by the Contractor and approved by the Engineer.
2. Testing for unconfined compressive strength shall be conducted in accordance with ASTM D2166, except that loading shall continue on all specimens until the cylinders break sufficiently to examine the interior of the specimen.
3. The broken specimen shall be photographed so that the Engineer may document any apparent segregation, lenses, and pockets in the specimen.
4. For field validation testing, unconfined compressive strength testing shall be performed on specimens from wet grab samples 3, 7, 28, and 56 days or more after mixing.
5. For full production work, unconfined compressive strength testing shall be performed on specimens from wet grab samples 7 and 28 days after mixing.
6. For specimens obtained by coring, unconfined compressive strength testing shall be performed 28 days after mixing.
7. Laboratory permeability testing shall be performed on cylinders at 7 and 28 days for the test section and at 28 days for the production elements. Laboratory permeability testing shall be conducted in accordance with ASTM D5084.

I. Uniformity evaluation: The Contractor shall provide the continuous core samples to the Engineer for logging and assessing uniformity in accordance with the acceptance criteria outlined in section 3.6.

J. Both the Contractor's testing and the Engineer's testing (if performed) must demonstrate that the required strengths are met prior to accepting the work. The Contractor shall conduct additional coring and testing required to demonstrate the acceptability of the CDSM product due to non-conformance at no additional cost to the Owner.

K. Strength acceptance criteria:

1. The Engineer shall make the sole determination as to whether the test results satisfy the following strength acceptance criteria.
2. The specified unconfined compressive strength of the deep mixed material as determined by ASTM D2166 at 28 days curing time shall be equal to or greater than the value specified in Table 1.
3. 80 percent of unconfined compressive strength test results as determined by ASTM D2166 from each tested deep mixed element shall equal or exceed the specified strength. If a strength specimen falls below the specified strength due to an obviously unrepresentative lump of unmixed tailings in the specimen, the Engineer has the option to select another specimen from the same core run and allow the Contractor's laboratory to test the replacement specimen and substitute the strength from the replacement specimen for the strength from the unrepresentative specimen that failed to satisfy the strength requirement. Only one such retest will be allowed per core run.
4. To prevent a weak layer at one elevation in the CDSM system, strengths below the specified strength are not permitted within 10 ft. of the same elevation in more than two nearby cored elements. "Nearby cored elements" refer to cored elements without an intervening cored element that has a passing test result in the suspect elevation zone.
5. 90 percent of all of the test results across the site shall equal or exceed the specified strength.

- L. Uniformity criteria:
1. The Engineer shall make the sole determination as to whether the test results satisfy the uniformity acceptance criteria.
 2. Full-depth continuous core samples retrieved by the Contractor from the CDSM element shall be used to evaluate uniformity.
 3. Core recovery (expressed as a percentage) shall be reported for each run and is equal to the total length of recovered core divided by the total core run length. Length of recovered core includes lengths of treated and untreated soil.
 4. Percent treatment is calculated as the total length of recovered core minus the sum of the lengths of unmixed or poorly mixed soil regions or lumps that extend across the entire diameter of the core divided by the total core run length expressed as a percentage. Percent treatment must be at least 80 percent for every 5 ft core run. If 80 percent treatment cannot be confirmed by coring in coarse sandy or gravelly soil, video logs can be used to confirm uniformity.
 5. If the Contractor uses core runs shorter than 5 ft (e.g., 3 ft), then the recovery and percent treatment can be calculated taking into equal amounts of core run length on either side of the short core run length to make up a total 5-ft run length for calculation purposes
- M. Non-conformance:
1. The Contractor is responsible for correcting the location or alignment of misplaced elements that will adversely affect the project quality. The Contractor shall correct misaligned elements that interfere with the project in a manner acceptable to the Engineer.
 2. If the strength and uniformity acceptance criteria are not achieved for production elements, the Contractor shall submit a proposed plan for investigating, remixing, or repairing failed sections for review and approval by the Engineer.
 3. To prove acceptability of the failed element, the Contractor may core elements on both sides of the failed element. If those two cores meet the criteria, then the element shall be accepted. If the additional cores fail, then the Contractor can propose additional investigations and remedial measures, which the Engineer will review and has the option to accept or reject depending on whether the proposed remedial measures meet the design intent.

PART 4: MEASUREMENT AND PAYMENT

- A. Measurement and payment items are detailed in Table 2.

Table 2. Measurement and Payment Items for CDSM Contract

Item	Unit of Measurement
Mobilization/Demobilization	Lump sum
Preproduction test program	Lump sum
CDSM production works (CDSM columns/elements including working platform)	Production CDSM works
	Add/deduct individual elements
	Add/deduct overlapping column/elements

Item	Unit of Measurement
QAQC testing (including tests required for the preproduction test program)	QAQC program
	Add/deduct coring
	Add/deduct unconfined compression testing of cores
	Add/deduct unconfined compression testing of wet samples (includes collection of sample and forming cylinder)
	Add/deduct permeability testing
Instrumentation	Lump sum

END OF SECTION 31 32 00

PERMITTING



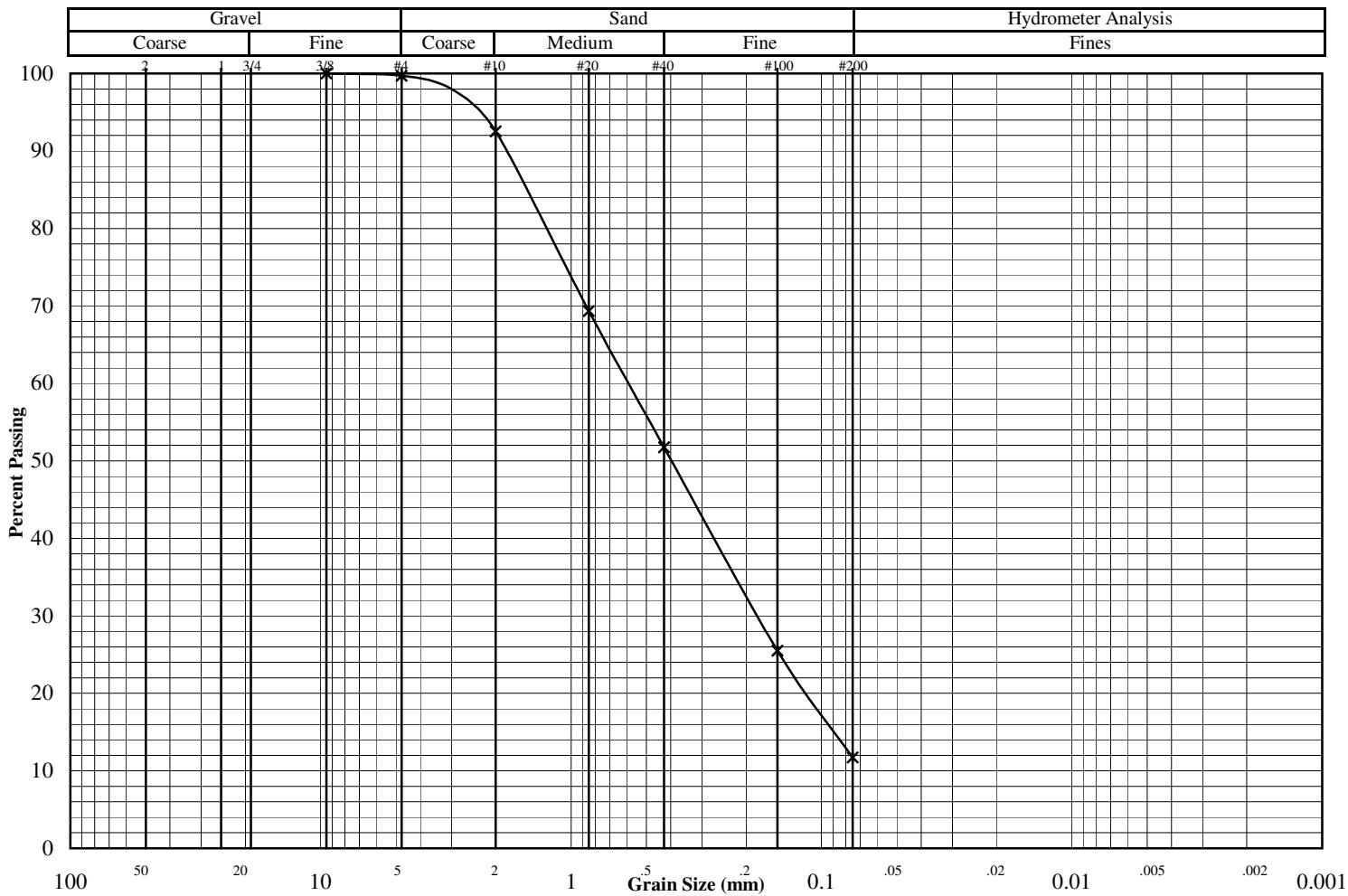
Attachment D

FTB Bentonite Amended Coarse Tailings Test Data

Grain Size Distribution ASTM D422

Job No. : 9911

Project:	PolyMet	Test Date:	6/29/15		
Reported To:	Barr Engineering Company	Report Date:	6/30/15		
	Location / Boring No.	Date Sampled	Sample Type	Soil Classification	
*	5274108.40 MN 567108.26 ME	Polymet Tailings	6/24/15	Bucket	Sand w/ silt and a trace of grass (SP-SM/SM)
●					
◊					



	Other Tests		
	*	●	◇
Liquid Limit			
Plastic Limit			
Plasticity Index			
Water Content	20.5		
Dry Density (pcf)			
Specific Gravity			
Porosity			
Organic Content			
pH			
Shrinkage Limit			
Penetrometer			
Qu (psf)			

(* = assumed)

	Percent Passing		
	*	●	◇
Mass (g)	14863.0		
2"			
1.5"			
1"			
3/4"			
3/8"	100.0		
#4	99.7		
#10	92.5		
#20	69.3		
#40	51.8		
#100	25.5		
#200	11.7		

	*	•	◇
D ₆₀			
D ₃₀			
D ₁₀			
C _U			
C _C			

Remarks:

Hydraulic Conductivity Test Data ASTM D5084

Project: PolyMet Date: 7/13/2015

Reported To: Barr Engineering Company Job No.: 9911

Boring No.:							
Sample No.:	Tailings +3% Bentonite						
Date Sampled:	6/24/2015						
Location:	5274108.40 MN 567108.26 ME						
Sample Type:	Bucket						
Soil Type:	Sand w/ silt and a trace of grass (SP-SM/SM)						
Atterberg Limits							
LL							
PL							
PI							
Permeability Test	Reconstituted						
Test Conditions:	Saturation %:						
Porosity:							
Before Test	Ht. (in):	3.00					
Confining press.	Dia. (in):	2.85					
(Effective-psi):	Dry Density (pcf):	111.6					
Water Content:	Water Content:	20.0%					
Test Type:	Falling						
Max Head (ft.):	5.0						
Confining press.							
(Effective-psi):	2.0						
Trial No.:	8-12						
Water Temp °C:	22.0						
% Compaction	90.1%						
% Saturation (After Test)	95.0%						

Coefficient of Permeability

K @ 20 °C (cm/sec)	1.8 x 10⁻⁷						
K @ 20 °C (ft/min)	3.5 x 10⁻⁷						

Notes:

Moisture Density Curve ASTM: D698, Method B

Project: PolyMet

Date: 7/3/15

Client: Barr Engineering Company

Job No. 9911

Sample: Tailings + 3% Bentonite

Date: 6/24/15

Location: 5274108.40 MN, 567108.26 ME

Soil Type: Sand w/ silt and a trace of grass(SP-SM/SM)

As Received W.C. (%) 20.5

LL:

PL:

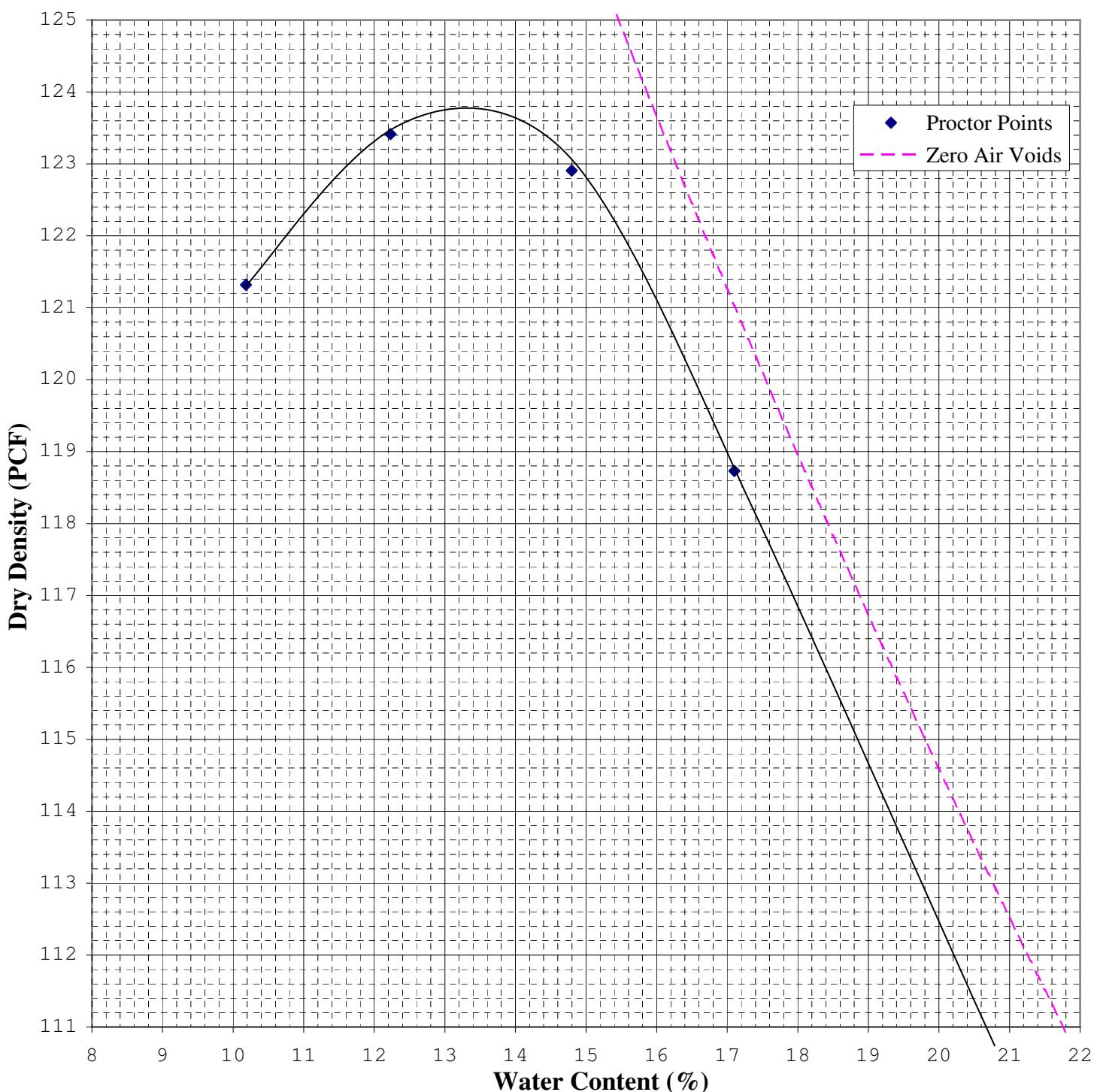
PI:

Specific Gravity: 2.90

*Assumed

Maximum Dry Density (pcf): 123.8

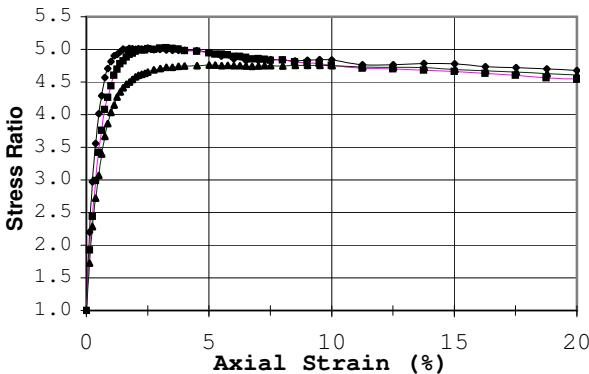
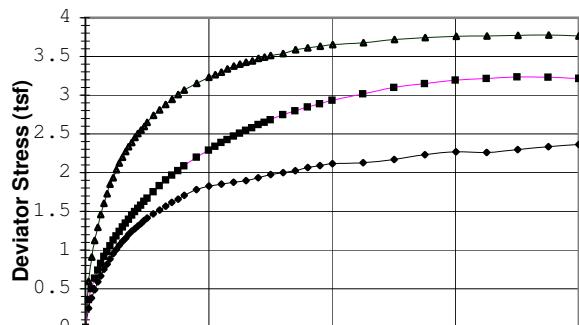
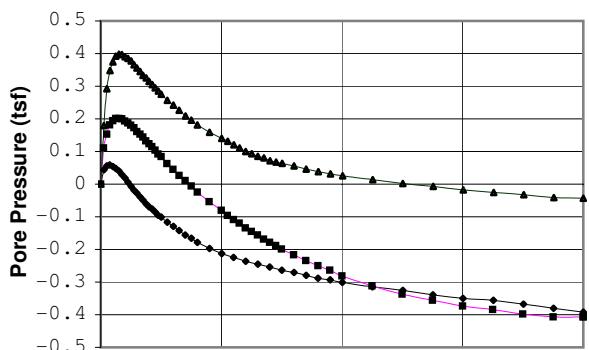
Opt. Water Content (%): 13.3



TRIAXIAL TEST ASTM: D 4767

Job No. 9911
Date: 7/13/15

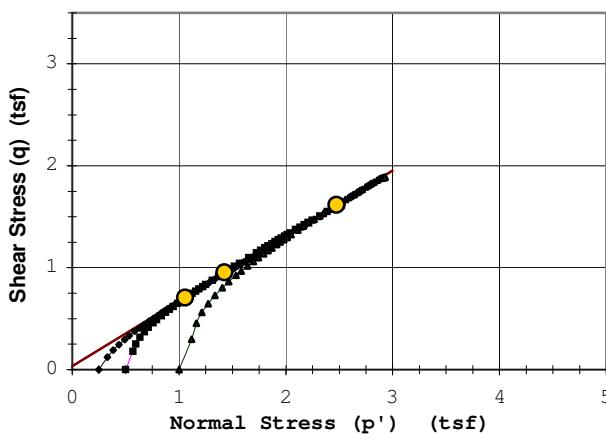
Project: PolyMet
Sample Tailings +3% Bentonite
Soil Type: Composite: 97% Sand w/silt and a trace of grass (SP-SM/SM) and 3% Bentonite



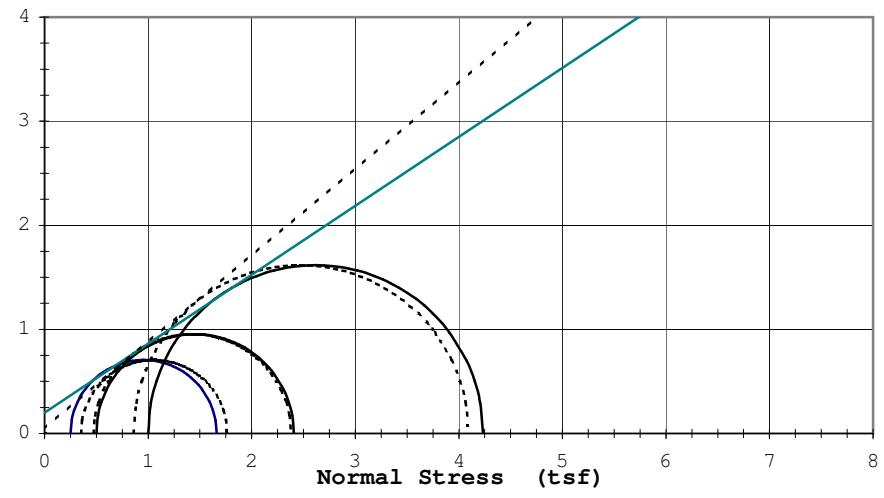
Failure Criterion:		Max. Stress Ratio				
		Angle of internal friction, ϕ' = 39.8 °				
		Apparent Cohesion, c' = 0.04 (tsf)				
		Test Date: 7/6/15				
		Test Type: CU w/pp				
		Strain Rate (in/min): 0.001				
		Strain Rate (%/min): 0.025				
<i>Before Consolidation</i>		Liquid Limit: Plastic Limit: Plasticity Index: Spec. Gravity (Assumed): 2.90				
		Diameter (in)	A	B	C	D
		Height (in)	1.94	1.94	1.94	
		Water Content (%)	4.00	4.00	4.00	
		Dry Density (pcf)	19.7	19.7	19.4	
		Void Ratio	120.8	120.9	121.6	
<i>After Consolidation</i>		E	0.50	0.50	0.49	
		Diameter (in)	1.93	1.93	1.92	
		Height (in)	4.00	4.00	3.99	
		Water Content (%)	17.1	16.7	16.1	
		Dry Density (pcf)	121.1	122.1	123.5	
		Void Ratio	0.50	0.48	0.47	
		Back Pressure (tsf)	6.6	4.4	5.5	
		Minor Principal Stress (tsf)	0.25	0.50	1.00	
		Max. Deviator Stress (tsf)	2.36	3.24	3.78	
		Ultimate Deviator Stress (tsf)	2.36	3.21	3.76	
		Deviator Stress at Failure (tsf)	1.41	1.91	3.23	
		Max. Pore Pressure Buildup (tsf)	0.06	0.20	0.40	
		Pore Pressure Parameter "B"	0.95	0.95	0.95	
		Pct. Axial Strain at Failure	2.5	3.3	5.0	

"These test results are for informational purposes only and must be reviewed by a qualified professional engineer to verify that the test parameters shown are appropriate for any particular design"

Remarks: Radial drainage strips applied to compacted specimen; Saturated, backpressured until "B" response was 0.95 to 1.00; Consolidated; All Drainage valves closed and immediately sheared.



Rupture Envelope at Failure
 $\alpha = 32.6^\circ$ $a = 0.03$ (tsf)

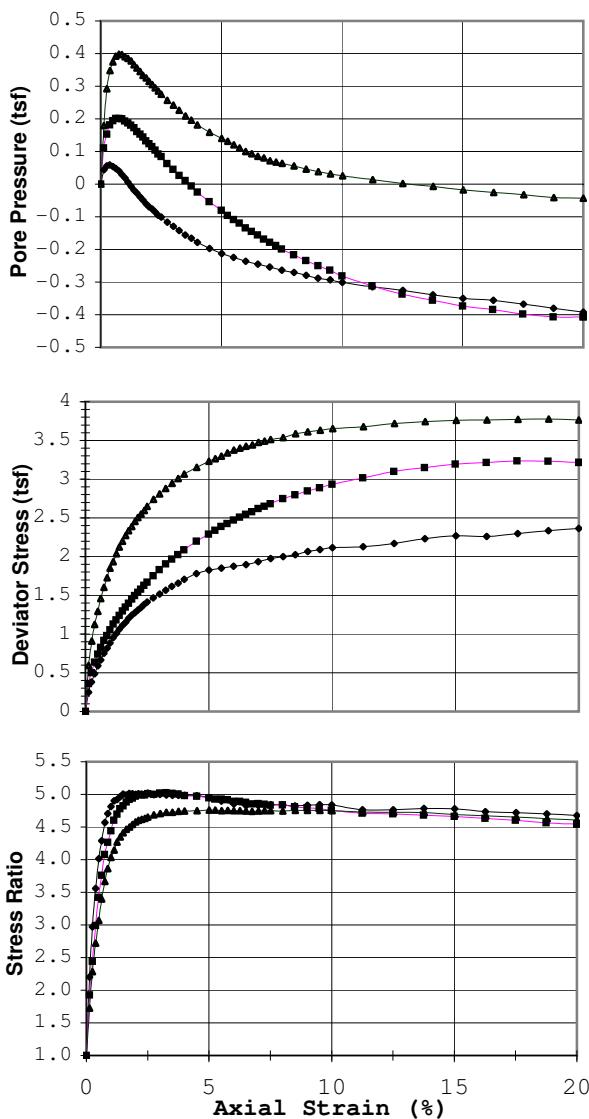


----- Effective ϕ' : 39.8 ° $c' = 0.04$ (tsf)
Total ϕ : 33.5 ° $c = 0.20$ (tsf)

TRIAXIAL TEST ASTM: D 4767

Job No. 9911
Date: 7/13/15

Project: PolyMet
Sample Tailings +3% Bentonite
Soil Type: Composite: 97% Sand w/silt and a trace of grass (SP-SM/SM) and 3% Bentonite



Failure Criterion: **Max. Deviator Stress**

Angle of internal friction, $\phi' = 39.7^\circ$
Apparent Cohesion, $c' = 0.02$ (tsf)

Test Date: 7/6/15 Liquid Limit:
Test Type: CU w/pp Plastic Limit:
Strain Rate (in/min): 0.001 Plasticity Index:
Strain Rate (%/min): 0.025 Spec. Gravity (Assumed): 2.90

Before Consolidation

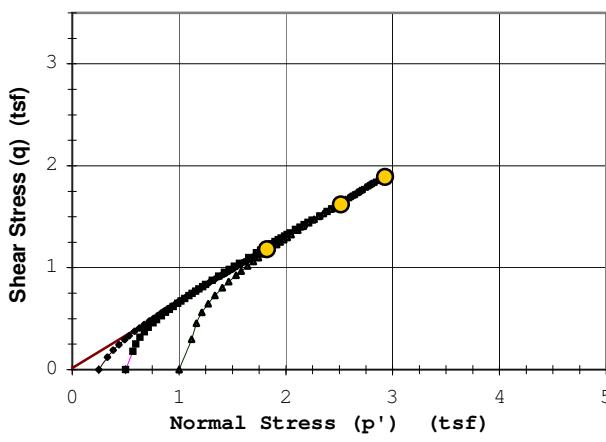
	A	B	C	D	E
Diameter (in)	1.94	1.94	1.94		
Height (in)	4.00	4.00	4.00		
Water Content (%)	19.7	19.7	19.4		
Dry Density (pcf)	120.8	120.9	121.6		
Void Ratio	0.50	0.50	0.49		

After Consolidation

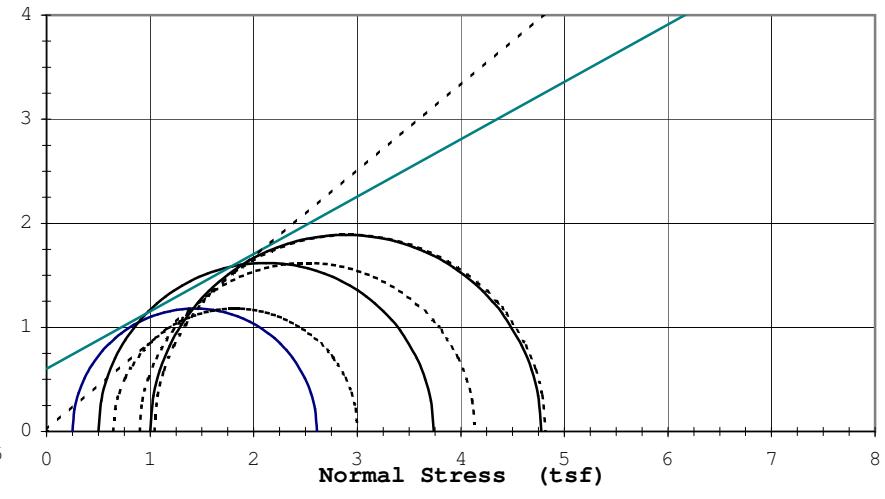
	A	B	C	
Diameter (in)	1.93	1.93	1.92	
Height (in)	4.00	4.00	3.99	
Water Content (%)	17.1	16.7	16.1	
Dry Density (pcf)	121.1	122.1	123.5	
Void Ratio	0.50	0.48	0.47	
Back Pressure (tsf)	6.6	4.4	5.5	
Minor Principal Stress (tsf)	0.25	0.50	1.00	
Max. Deviator Stress (tsf)	2.36	3.24	3.78	
Ultimate Deviator Stress (tsf)	2.36	3.21	3.76	
Deviator Stress at Failure (tsf)	2.36	3.24	3.78	
Max. Pore Pressure Buildup (tsf)	0.06	0.20	0.40	
Pore Pressure Parameter "B"	0.95	0.95	0.95	
Pct. Axial Strain at Failure	20.0	17.5	18.8	

"These test results are for informational purposes only and must be reviewed by a qualified professional engineer to verify that the test parameters shown are appropriate for any particular design"

Remarks: Radial drainage strips applied to compacted specimen; Saturated, backpressured until "B" response was 0.95 to 1.00; Consolidated; All Drainage valves closed and immediately sheared.



Rupture Envelope at Failure
 $\alpha = 32.6^\circ$ $a = 0.01$ (tsf)

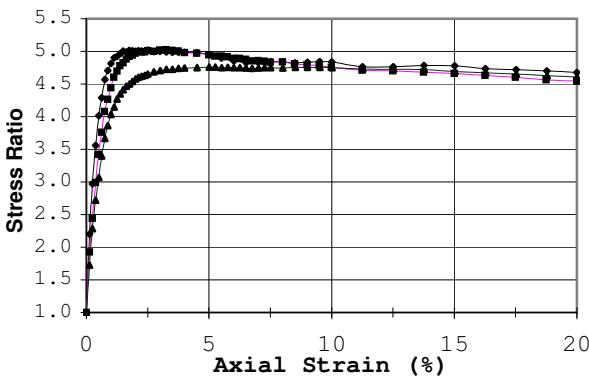
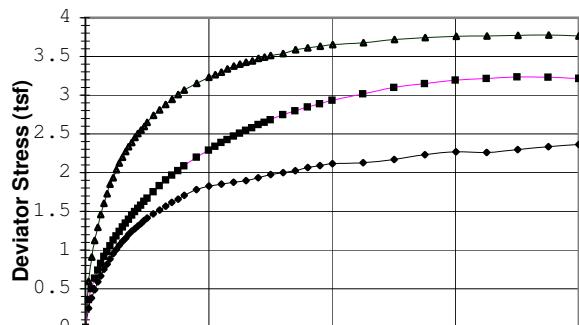
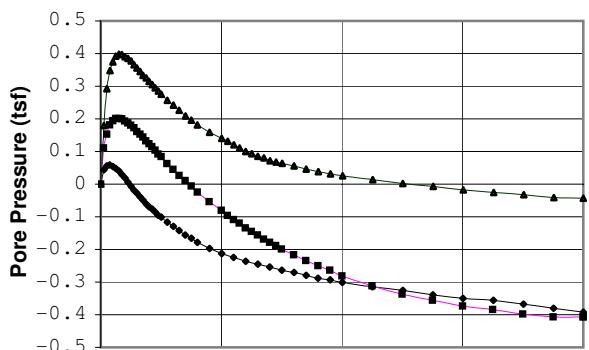


Effective $\phi' = 39.7^\circ$ $c' = 0.02$ (tsf)
Total $\phi' = 28.9^\circ$ $c = 0.60$ (tsf)

TRIAXIAL TEST ASTM: D 4767

Job No. 9911
Date: 7/13/15

Project: PolyMet
Sample Tailings +3% Bentonite
Soil Type: Composite: 97% Sand w/silt and a trace of grass (SP-SM/SM) and 3% Bentonite



Failure Criterion: Given Strain of: 15%

Angle of internal friction, ϕ' = 40.0 °
Apparent Cohesion, c' = 0.02 (tsf)

Test Date: 7/6/15
Test Type: CU w/pp
Strain Rate (in/min): 0.001
Strain Rate (%/min): 0.025

Before Consolidation

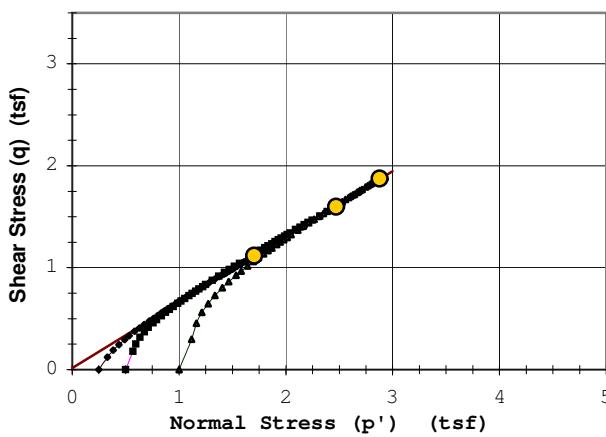
	A	B	C	D	E
Diameter (in)	1.94	1.94	1.94		
Height (in)	4.00	4.00	4.00		
Water Content (%)	19.7	19.7	19.4		
Dry Density (pcf)	120.8	120.9	121.6		
Void Ratio	0.50	0.50	0.49		

After Consolidation

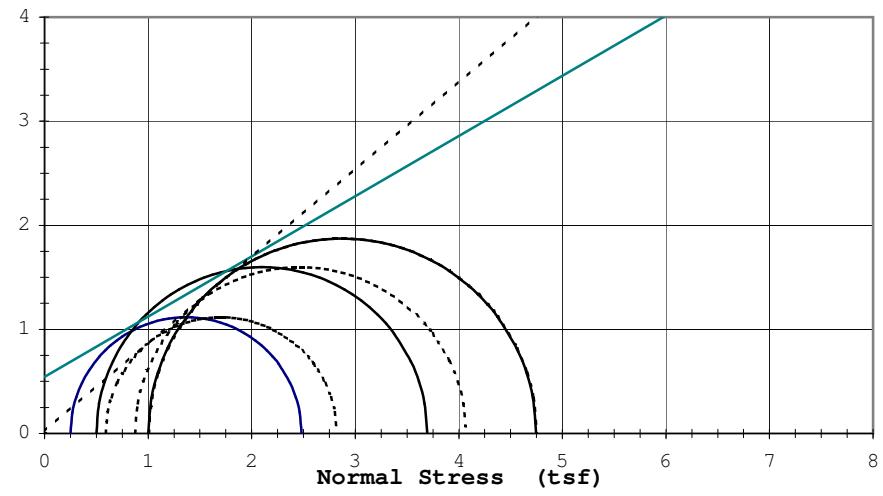
	A	B	C	D	E
Diameter (in)	1.93	1.93	1.92		
Height (in)	4.00	4.00	3.99		
Water Content (%)	17.1	16.7	16.1		
Dry Density (pcf)	121.1	122.1	123.5		
Void Ratio	0.50	0.48	0.47		
Back Pressure (tsf)	6.6	4.4	5.5		
Minor Principal Stress (tsf)	0.25	0.50	1.00		
Max. Deviator Stress (tsf)	2.36	3.24	3.78		
Ultimate Deviator Stress (tsf)	2.36	3.21	3.76		
Deviator Stress at Failure (tsf)	2.23	3.19	3.75		
Max. Pore Pressure Buildup (tsf)	0.06	0.20	0.40		
Pore Pressure Parameter "B"	0.95	0.95	0.95		
Pct. Axial Strain at Failure	15.0	15.0	15.0		

"These test results are for informational purposes only and must be reviewed by a qualified professional engineer to verify that the test parameters shown are appropriate for any particular design"

Remarks: Radial drainage strips applied to compacted specimen; Saturated, backpressured until "B" response was 0.95 to 1.00; Consolidated; All Drainage valves closed and immediately sheared.



Rupture Envelope at Failure
 $\alpha = 32.7^\circ$ $a = 0.02$ (tsf)



Effective ϕ' : 40.0 °	$c' = 0.02$ (tsf)
Total ϕ : 30.0 °	$c = 0.54$ (tsf)

Sample: Tailings +3% Bentonite

Triaxial Data

Job: 9911
Date: 7/13/15

Sample 1			Sample 2			Sample 3			Sample 4			Sample 5		
Strain (%)	Deviator Stress (tsf)	Pore Pressure (tsf)	Strain (%)	Deviator Stress (tsf)	Pore Pressure (tsf)	Strain (%)	Deviator Stress (tsf)	Pore Pressure (tsf)	Strain (%)	Deviator Stress (tsf)	Pore Pressure (tsf)	Strain (%)	Deviator Stress (tsf)	Pore Pressure (tsf)
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.13	0.25	0.04	0.13	0.36	0.11	0.13	0.59	0.18						
0.25	0.38	0.06	0.25	0.50	0.15	0.25	0.91	0.29						
0.38	0.49	0.06	0.38	0.63	0.18	0.38	1.12	0.35						
0.50	0.59	0.05	0.50	0.74	0.19	0.50	1.29	0.37						
0.63	0.66	0.05	0.63	0.83	0.20	0.63	1.46	0.39						
0.75	0.75	0.04	0.75	0.92	0.20	0.75	1.61	0.40						
0.88	0.82	0.03	0.87	0.98	0.20	0.88	1.73	0.40						
1.00	0.88	0.02	1.00	1.06	0.19	1.00	1.85	0.39						
1.13	0.95	0.01	1.13	1.13	0.19	1.13	1.94	0.39						
1.25	1.01	-0.01	1.25	1.18	0.18	1.25	2.04	0.38						
1.38	1.06	-0.02	1.38	1.24	0.17	1.38	2.12	0.37						
1.50	1.11	-0.03	1.50	1.30	0.16	1.51	2.20	0.36						
1.63	1.15	-0.04	1.63	1.35	0.15	1.63	2.27	0.34						
1.75	1.20	-0.05	1.75	1.40	0.14	1.76	2.33	0.33						
1.88	1.24	-0.06	1.88	1.45	0.13	1.88	2.39	0.33						
2.00	1.28	-0.07	2.00	1.49	0.12	2.01	2.45	0.31						
2.13	1.31	-0.08	2.13	1.54	0.11	2.13	2.50	0.30						
2.25	1.34	-0.09	2.25	1.58	0.10	2.26	2.55	0.29						
2.38	1.38	-0.09	2.38	1.63	0.09	2.38	2.60	0.29						
2.50	1.41	-0.10	2.50	1.67	0.08	2.51	2.65	0.28						
2.76	1.47	-0.12	2.75	1.75	0.06	2.76	2.74	0.26						
3.01	1.52	-0.13	3.00	1.83	0.04	3.01	2.81	0.24						
3.26	1.56	-0.14	3.25	1.91	0.03	3.26	2.88	0.23						
3.51	1.62	-0.16	3.50	1.96	0.01	3.51	2.95	0.21						
3.76	1.66	-0.17	3.75	2.03	-0.01	3.76	3.01	0.20						
4.01	1.71	-0.18	4.00	2.09	-0.02	4.01	3.06	0.18						
4.51	1.78	-0.20	4.50	2.20	-0.05	4.51	3.15	0.16						
5.01	1.83	-0.21	5.00	2.29	-0.08	5.01	3.23	0.14						
5.51	1.85	-0.22	5.25	2.34	-0.10	5.26	3.27	0.13						
6.01	1.87	-0.24	5.50	2.39	-0.11	5.51	3.30	0.12						
6.51	1.89	-0.24	5.75	2.43	-0.12	5.76	3.34	0.11						
7.01	1.93	-0.25	6.00	2.47	-0.13	6.01	3.37	0.10						
7.51	1.97	-0.26	6.25	2.51	-0.15	6.26	3.40	0.09						
8.01	2.00	-0.27	6.50	2.55	-0.16	6.51	3.43	0.09						
8.51	2.03	-0.28	6.75	2.58	-0.17	6.76	3.44	0.08						
9.01	2.07	-0.29	7.00	2.62	-0.18	7.01	3.48	0.07						
9.51	2.09	-0.29	7.25	2.65	-0.19	7.26	3.49	0.07						
10.01	2.12	-0.30	7.50	2.68	-0.20	7.52	3.51	0.06						
11.26	2.13	-0.32	8.00	2.75	-0.22	8.02	3.54	0.06						
12.51	2.17	-0.33	8.50	2.80	-0.23	8.52	3.59	0.05						
13.76	2.23	-0.34	9.00	2.85	-0.25	9.02	3.61	0.04						
15.02	2.27	-0.35	9.50	2.89	-0.26	9.52	3.63	0.03						
16.27	2.26	-0.36	10.00	2.93	-0.28	10.02	3.65	0.03						
17.52	2.30	-0.37	11.25	3.01	-0.31	11.27	3.68	0.01						
18.77	2.33	-0.38	12.50	3.10	-0.34	12.52	3.72	0.00						
20.00	2.36	-0.39	13.75	3.15	-0.36	13.78	3.75	-0.01						
			15.00	3.19	-0.37	15.03	3.76	-0.02						
			16.25	3.21	-0.38	16.28	3.76	-0.03						
			17.50	3.24	-0.40	17.53	3.77	-0.03						
			18.75	3.23	-0.41	18.79	3.78	-0.04						
			20.00	3.21	-0.41	20.00	3.76	-0.04						