OU3 DRAFT FINAL REMEDIAL DESIGN

BASIS OF DESIGN REPORT

CALLAHAN MINE SUPERFUND SITE
BROOKSVILLE, MAINE

Prepared for:

Maine Department of Transportation
16 State House Station
Augusta, Maine 04333

Prepared by:

AMEC Environment & Infrastructure, Inc.
511 Congress Street
Portland, Maine 04101

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AMEC Project No. 3612112201.06/07

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M Drawings
N Technical Specifications
O Stormwater Management Plan

LIST OF ACRONYMS AND ABBREVIATIONS

AMEC	AMEC Environment & Infrastructure, Inc.
ARAR	Applicable or Relevant and Appropriate Requirements
bgs	below ground surface
BOD	Basis of Design
CaCO3	calcite limestone
Callahan	Callahan Mining Corporation
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CERCLIS	Comprehensive Environmental Response, Compensation, and Liability Information System
cm/sec	centimeters per second
CY	cubic yards
FOS	Factor of Safety
ft	feet
gpd	gallons per day
gpm	gallons per minute
Gram Mol Wt	gram molecular weight
HASP	Health and Safety Plan
HRS	Hazard Ranking System
K	hydraulic conductivity
MACTEC	MACTEC Engineering and Consulting, Inc.
Maine DEP	Maine Department of Environmental Protection
MaineDOT	Maine Department of Transportation
mg/L	milligrams per liter
MgCO3	dolomitic limestone
mmole	millimole
NA	not available
NAD	North American Datum
NPL	National Priorities List
OU	Operable Unit

psf	pounds per square foot
psi	pounds per square inch
RI/FS	Remedial Investigations/Feasibility Study
ROD	Record of Decision
s.u.	standard units
SCB	Soil-Cement-Bentonite
SESCP	Soil Erosion and Sediment Control Plan
Site	Callahan Mine Superfund Site, Brooksville, Maine
T	transmissivity
USEPA	U.S. Environmental Protection Agency
WRP	waste rock piles

1.0 INTRODUCTION

This Basis of Design Report (BOD) summarizes the scope and technical approach for remediation of the Tailings Impoundment at the Callahan Mine Superfund Site (Site) in the village of Harborside in the Town of Brooksville, Maine.

A massive sulfide ore deposit was discovered at the Site in 1880. From the 1880s to the 1970s, the Site was the subject of intermittent exploration and mining for copper, lead, and zinc. The Callahan Mining Corporation (Callahan) implemented the largest of these mining operations, from 1968 through 1972. During this timeframe, Callahan mined approximately five million tons of waste rock and approximately 800,000 tons of ore-bearing rock from an open-pit mine. The waste rock was disposed of on the Site in large stockpiles (i.e., waste rock piles [WRPs]) and was also utilized for a starter dike and subsequent lifts of the Tailings Impoundment dam. The ore-bearing rock was crushed to 0.5-inch minus size particles and then pulverized using two ball mills. The milling process produced a slurry comprised of water and fine sand, silt, and clay-sized rock particles. Copper, lead, and zinc were separated from the slurry via a floatation-separation process. Subsequently, the slurry was discharged to the Tailings Impoundment.

The outside footprint of the Tailings Impoundment encompasses approximately 17-acres and contains about 716,000 cubic yards of mining related waste, including the fine sand, silt, and clay-sized rock particles (i.e., tailings) from the Callahan-era mining operations. The tailings are contained by a three-sided dam that was raised against a sloping hillside. Most of the dam is constructed of cobble and boulder-sized waste rock materials. The eastern side of the dam is about 60 feet tall and has an average slope of about 1.3H to 1V (horizontal to vertical).

Prior geotechnical investigations and stability evaluations indicate that the impoundment, in its present condition/configuration, is marginally stable under long-term static conditions and that it may become unstable during or immediately following a long-term-design-magnitude earthquake. A slope failure could result in a release of tailings to a "downstream" salt marsh. Site investigations have also noted that tailings that left the impoundment area during mine operations and during ongoing surface erosion are believed to be a source of sediment contamination. Seepage from the Impoundment also appears to contribute to surface water contamination.

The Site was added to the U.S. Environmental Protection Agency (USEPA) National Priorities List (NPL) in September 2002. The Site has undergone investigation and clean-up activities pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). The Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS) ID number for the Site is MED980524128.

Remediation of the Tailings Impoundment (OU 3) is part of a larger remedy included in the OU 1 Feasibility Study report prepared by MACTEC Engineering and Consulting, Inc. (MACTEC), now AMEC Environment & Infrastructure, Inc. (AMEC), in 2009, to identify and evaluate cleanup alternatives for waste materials, soil, and sediments at the Callahan Mine. The OU 1 ROD was

signed in 2009. This design was prepared for the Maine Department of Transportation (MaineDOT) in accordance with the requirements set forth in Administrative Settlement Agreement and Order on Consent for Remedial Design for OU 1 Record of Decision (ROD) and OU 2 Early Action between USEPA and the State of Maine. MaineDOT is representing the State of Maine on this initiative.

OU 1 Remediation activities were initiated in 2010 by the Maine Department of Environmental Protection (Maine DEP) and were completed in 2013. This effort involved excavation and disposal of soils from the residential, mine operations, and ore pad areas. Some of the contaminated soils from this work were placed on the Tailings Impoundment. The soils placed at the Tailings Impoundment contain metals and PCBs (less than 50 ppm) exceeding clean up levels set in the ROD.

1.1 Design Objectives

The design objectives for the Tailings Impoundment remedy as described in the OU 1 ROD include: 1) reduce the contaminant load to Goose Pond from surface water runoff and seep discharge from the Tailings Impoundment; 2) stabilization measures (e.g., crest improvements, toe improvements, and/or dewatering) to improve both static and seismic stability and thereby minimize the potential for a slope failure to occur; and 3) minimize truck traffic to and from the Site (a concern of local residents) by generating the extent practicable, materials necessary for remedial construction from on-site sources.

1.2 Design Overview

The Tailings Impoundment Draft Final Design has been prepared in a manner that considers:

- Design objectives and remediation goals;
- Design data availability;
- Constructability;
- Impacts to local residents; and
- Cost.

To meet the environmental remediation goals, regulatory requirements and increase the Factor of Safety (FOS) of the Tailings Impoundment relative to global stability for long term static and seismic conditions, the Remedial Design provides the following key features:

- Dewatering of the Tailings Impoundment;
- Excavation and regrading of the Tailings Impoundment; and Reduction of water recharge, infiltration and seepage by capping.

This section presents the strategy of the Draft Final Remedial Design to explain how the design comes together.

A low-permeability cover system is proposed to reduce the runoff and discharge of metals-laden surface water and seepage of metals-contaminated groundwater from the Tailings Impoundment. These waters currently discharge to the Goose Pond estuary. The cover will minimize infiltration and facilitate the dewatering of the Tailings Impoundment to improve stability.

To the extent possible, materials for the cover system will be generated from on-site resources. The roads leading to the site are narrow and winding and local residents have expressed concerns about the amount of truck traffic generated by the remediation project. Therefore, a concerted effort has been made to minimize the amount of imported materials. A rock quarry is proposed to provide for crushed stone and rip rap needed for the cover, road and ditch building, rip rap stabilization, etc.

To achieve the FOS required for long-term static stability, a substantial excavation and re-grading of the Tailings Impoundment is required. The proposed subgrade plan will require regrading of the crest and areas proximate to the crest of the Impoundment. Between 10 and 30 vertical feet of material is to be relocated to the interior and upland western half of the Impoundment area. Excavation of this quantity of material to the depths proposed will require dewatering of the tailings prior to excavation. The tailings are generally coarser-grained (silty fine sands) along the outside edge of the impoundment and finer-grained toward the interior where the “slimes” (silt/clay) are located. The majority of excavation is to occur along the perimeter of the Impoundment, which will result in an unloading of the Impoundment foundation soils and improve both static and seismic stability. The coarse-grained tailings are suitable to dewatering in a relatively short period of time.

A groundwater model was developed to support the Draft Final Design, and it was used to evaluate dewatering of the Tailings Impoundment both prior to construction and after capping. An evaluation of potential dewatering methods indicates that horizontal wells (i.e., drains) would be an effective means of dewatering. Pre-construction dewatering will be required to drop current water levels below proposed excavation/cap subgrade elevations and support the excavation process by limiting the quantity of water that flows into the excavation. A thorough review of existing hydrogeologic data, including pumping test data, permeability, grain-size distribution and stratigraphy, indicates that upper horizontal drains, located at a maximum elevation of +35 feet would provide the needed water table drawdown to allow for excavation. Additional horizontal drains will be installed along the tailings-native and/or reworked soils interface, to fully dewater the Tailing Impoundment, allowing it to achieve required long-term seismic stability.

Discharge from the horizontal drains will be treated using a compost bioreactor (i.e., engineered treatment wetland). The Draft Final Design presents an evaluation of treatment chemistry, sizing, and loading based on a worst-case scenario of total metals concentrations and the flows predicted by the groundwater modeling conducted.

Relocation of tailings, to the interior and upland (west) side of the Tailings Impoundment will require strengthening of the soft interior section of the impoundment (slimes area) and/or

bridging of the surface to support the weight of construction equipment and fill materials as well as Stone columns, geogrid, and bridging lift. The filling operation was evaluated for short-term and long-term slope stability. The magnitude and duration of settlement was also analyzed.

Wetlands will be affected by the proposed remedy. The Operable Unit (OU) 1 FS documented the delineation, function and values of the wetlands on-site. The wetland acreage affected is approximately 4.1 acres. Consistent with the OU 1 ROD, the compensatory mitigation would consist of removal of mine waste deposits from Goose Cove and/or Dyer Cove. Mitigation will occur during the sediment remediation phase of the overall project. Therefore, the compensatory wetland mitigation design will be part of a future design package for the Sediment and Waste Rock Pile 3 remediation.

The Tailings Impoundment was used to stockpile soils from remediation of OU 1. Contaminated soils (PCBs and Metals) from the Residential Area, Ore Pad and Mine Operations Area have been excavated and placed along the western edge of the Tailings Impoundment. The OU 1 remediation is complete. The final as-built topographic elevations of the Tailings Pile and location of PCB, metal contaminated soils were provided to MaineDOT in the winter of 2014 by CES (through its Maine DEP OU 1 contract) and have been used to update the existing topographic conditions.

1.3 Pre-Design Investigations

Pre-design studies consisted of the following items:

- Topographic survey updates provide by MEDEP/CES and MaineDOT;
- Bedrock geophysical surveys to assess bedrock groundwater flux into tailings;
- Hydrogeologic pumping test to evaluate dewatering capabilities and develop design criteria for dewatering of the tailings;
- Pre-design evaluation of compost bioreactors (treatment wetlands); and
- On-site quarry siting evaluation.

2.0 SITE DESCRIPTION

The Site is located approximately 15 miles west of the Town of Blue Hill and 35 miles west of the Town of Bar Harbor on the northwest side of the Cape Rosier peninsula on Penobscot Bay. The Site includes the former Callahan Mine property, an elongated 120-acre property oriented north-south and accessed from Goose Falls Road. Goose Pond and Holbrook Island Sanctuary State Park are immediately east of the site property. Private residences and seasonal homes are located adjacent to the site property on Goose Falls Road and Cape Rosier Road.

2.1 Callahan-Era Mining Operations

The former Callahan Mine was a hard-rock, open-pit mine developed in Goose Pond, a shallow tidal estuary of approximately 75 acres. To allow extraction of the ore body, the Callahan Mining Corporation (Callahan) drained Goose Pond by constructing two dams: an earthen dam across Goose Pond (Marsh Creek) near the southern site boundary, and a concrete dam with stop-logs at Goose Falls. Water that previously entered Goose Pond from Marsh Creek was diverted through a newly constructed channel to the south, allowing water to drain into Weir Cove. The Goose Falls dam prevented tidal exchange with Goose Cove. Following construction of the dams, water was drained and pumped from Goose Pond. Callahan also constructed several berms and dams within the dewatered Goose Pond to control/divert precipitation and site runoff and facilitate maintaining suitable conditions in the pit for mining operations.

Between approximately 1968 and 1972, Callahan mined approximately 5,000,000 tons of waste rock to access and remove approximately 800,000 tons of ore-bearing rock at the Site. Rock was blasted from inside the open pit and hauled out in trucks. Ore-grade rock was taken directly to on-site processing or to an ore storage area (i.e., the Ore Pad). Waste rock was disposed of at WRP 1, 2, and 3, or used for construction projects (e.g., construction of containment dams at the Tailings Impoundment and WRP-1 and for construction of roads). Tailings from the flotation mill were pumped as a slurry to the Tailings Impoundment.

Site-specific geotechnical data, historical site photographs, and anecdotal information indicate that the Tailings Impoundment was constructed as an “upstream” raised embankment/dam with the tailings slurry discharged via a series of spigots spaced around the perimeter of the topmost lift of the dam. Most of the coarser-grained tailings (i.e., silty fine sands) settled from the slurry relatively close to the point of discharge (i.e., near the dam) and the finer-grained tailings (i.e., silt/clay-sized) settled-out in central portions of the impoundment. The above-water sandy “beach” then became the foundation for next lift of the embankment/dam. Following the end of the mining operations, portions of Goose Pond were regraded. Large berms that lined the edges of the former mine pit to the north and adjacent to Stink Cove were either bulldozed or blasted into the abandoned pit. The mine pit and Goose Pond were flooded with seawater by opening the dam at Goose Falls, and the mine pit is currently submerged. Bathymetric mapping of the pit indicates that it is approximately 600 feet in diameter and 300 feet deep. The portion

of the pit between the pit bottom and 30 feet below mean sea level has a volume of approximately 1,300,000 cubic yards.

2.2 Tailings Impoundment Existing Conditions

The Tailings Impoundment is located at the southern end of the Site, adjacent to a Salt Marsh at the edge of South Goose Pond. The impoundment encompasses an approximately 17-acre trapezoidal-shaped footprint. The impoundment contains fine sand, silt, and clay-sized rock particles (i.e., tailings) from the Callahan-era mining operations.

The tailings are contained by a three-sided dam constructed against a sloping hillside. This dam configuration is commonly termed a side-hill impoundment (USEPA, 1994). Most of the dam is constructed with cobble and boulder-sized waste rock materials. The bottom part of the dam (i.e., the starter dike) is interpreted to either be constructed with waste rock and back-stopped with clay fill/re-work (from site) or constructed with clay fill/re-work and then faced extensively with waste rock. The eastern side of the dam is about 60 feet tall and has an average slope of about 1.3H to 1V (horizontal to vertical).

The existing ground surface elevation is roughly +75 feet along the crest of the dam and about +70 feet in central portions of the impoundment. The impoundment surface is concave and surface water ponds in the middle. The pond covers about 2 to 2.5 acres of the impoundment and typically holds surface water throughout the summer months such that a cattail marsh has developed. The remainder of the impoundment surface is unvegetated.

It is our understanding that the Tailings Impoundment had an engineered structure (i.e., decant pipe) to remove water from inside the impoundment and discharge it under the berm. A drainage pipe was found at the western edge of the impoundment. Based on geophysical surveys and dye tracer testing the pipe was determined to discharge at a previously mapped seep at the base of the Tailings Impoundment berm. During the OU 1 remediation work the inlet pipe was extended above the stockpiled soils to allow access, if needed. Runoff from the Tailings Impoundment drains through a low area in the berm at the northwest corner of the Tailings Impoundment and into an overland drainage swale, which discharges to Goose Pond.

The existing ground surface elevation averages about +15 feet along the eastern toe. East of the toe, the existing ground surface slopes down gradually to the edge of the Salt Marsh/Goose Pond floodplain (at approximately elevation +7 feet). In some areas, the salt marsh/floodplain extends to the east on the order of 1500 feet.

The existing features and topography of the Tailings Impoundment are depicted in the Design Drawings provided in Appendix M. As previously noted, topography and site features were altered in 2013 as part of the on-going OU 1 remediation, and the as-built topographic elevations for the stock-piled soils area were used to update the existing topographic information. In addition, MaineDOT provided supplemental survey topographic data in April 2012 for the impoundment toe of slope and perimeter areas.

2.2.1 Impoundment Soils

The soils within and/or beneath the Tailings Impoundment consist of the following principal strata:

- Tailings;
- Clay (Fill/Re-Work);
- Clay (Presumpscot Formation); and
- Glacial Till.

The thickness of the tailings ranges from about 5 to 60 feet, and the thickness generally increases from west to east. Tailings "slimes" dominate central portions of the impoundment. The slimes consist almost exclusively of silt and clay-sized particles with trace amounts of fine sand. Conversely, tailings "sands", consisting primarily of loose silty fine-grained sand, dominate the perimeter of the impoundment (i.e., in close proximity to the dam). A zone of highly stratified and/or laminated tailings is generally found in between the slimes and the sands.

Clay fill/re-work (interpreted to have been derived from the site) materials were encountered beneath waste rock and/or tailings in explorations performed on or immediately adjacent to the crest of the impoundment dam. The location and depth of the clay fill/re-work materials indicates that the starter dam is constructed of waste rock and back-stopped with clay fill/re-work and/or constructed with clay fill/re-work and then faced extensively with waste rock.

Native clay was identified and/or inferred in most of the explorations and is estimated to be widespread but may not necessarily be continuous across the footprint of the impoundment. The thickness of the clay beneath the impoundment ranges from approximately 1 to 15 feet. The clay is described as very stiff to soft and usually transitions from very stiff/stiff to medium stiff to soft with increasing depth below the ground surface (bgs). The clay is typically underlain by a thin layer of glacial till.

2.2.2 Impoundment Water Levels

The phreatic surface slopes from an elevation of about +70 feet on the west side of the impoundment to an elevation of about +50 feet near the eastern dam face. As a result, most of the tailings are presently saturated. There is a slight downward gradient through the tailings in the eastern two-thirds of the impoundment.

2.2.3 Impoundment Toe Conditions

The principal soil strata along the eastern toe of the impoundment dam typically consist of:

- Organic Silt/Clay, Peat, and Clay (Estuarine);
- Clay (Presumpscot Formation); and
- Glacial Till.

Soft estuarine soils/sediments are found at the ground surface in the Salt Marsh beyond the toe of the impoundment dam. The estuarine deposit ranges from about 1 to 5 feet in thickness beyond the toe. But, it appears that most of this deposit was removed prior to construction of the starter dike. Test pits excavated at the toe of the dam indicate that waste rock extends about 1 to 2 feet bgs and that the rock at the toe is founded on clay soils and/or fill materials. The native clay along the toe ranges from about 5 to 30 feet in thickness. The clay is described as very stiff to soft and typically transitions from very stiff/stiff to medium stiff to soft with increasing depth bgs. The clay is usually underlain by a thin layer of glacial till.

2.3 Survey

Horizontal ground control for the survey information shown in this design is based on North American Datum (NAD) of 1983, Maine State Plane, East Zone, U.S. Feet. Vertical control for this design is based on North American Vertical Datum (NAVD) 1988. Site coordinates are 44° 20' 32" north latitude and 68° 48' 20" west longitude.

The existing conditions depicted on the design drawings are based on aerial mapping provided by USEPA RAC contractor TRC. During the fall of 2011 and the summer of 2012 ore pad and polychlorinated biphenyl materials were removed from the mine operations area and placed along the western edge of the tailing impoundment. Ground surveys and design contours provided by CES, Inc. (consultant to Maine DEP for the OUI work) were utilized in this area to update historical mapping and develop the current conditions depicted on the design drawings. Additional ground survey was completed by MaineDOT in April 2012 in the area around the perimeter of the Tailings Impoundment to provide more detailed and accurate topographic contours. This information was also incorporated into the existing conditions drawings.

2.4 Regulatory History

As previously started, the Site was added to the USEPA NPL in September 2002. The Site is undergoing investigation and clean-up activities pursuant to the CERCLA and the NCP. The CERCLIS ID number for the Site is MED980524128. The following items summarize regulatory history at the Site since 1987.

Year	Event
1987	The four underground storage tanks located in the vicinity of the metal shop building were removed in 1987. No indication of releases or contaminated soil was observed during the tank removals.
1995	Maine DEP completes the Site Inspection Prioritization Report.
1999	Maine DEP conducts Expanded Site Inspection, but no report is issued.
2001	USEPA issues Hazard Ranking System (HRS) package indicating a Hazard Ranking Score of 50 based on surface water contamination. Other contaminated media were not addressed in the HRS package.

Year	Event
2002	Site is added to NPL.
2005	The State of Maine takes lead on implementation of Remedial Investigations/Feasibility Study (RI/FS). MaineDOT is named the lead State agency managing the project. Maine DEP and USEPA provide regulatory oversight. USEPA Administrative Order by Consent is signed by USEPA Region 1, MaineDOT, and Maine DEP in June 2005.
2009	RI/FS Completed.
2009	ROD Signed.
2010	OU1 Construction started.
2013	OU1 Construction completed.
2013	30% Design for Tailings Impoundment was submitted to USEPA and Maine DEP in March of 2013.

3.0 CONSTRUCTION ACTIVITIES AND PHASING

Remediation of the Tailings Impoundment will include:

- Installation of a horizontal drain system to dewater the tailings prior to excavation and regrading activities, and additional horizontal drains installed following regrading and c apping to enable post-remediation dewatering of the Tailings Impoundment;
- The collection and treatment of the discharge from the horizontal drain system in compost bioreactors (treatment wetlands);
- Grading the impoundment area in accordance with the design; and
- Installation of a low-permeability cover system to contain and isolate the tailings.

3.1 Site Mobilization and Staging

Prior to site mobilization the selected Remedial Construction Contractor will develop a Health and Safety Plan (HASP). Site mobilization activities will include the following:

- Trailer setup with temporary utilities, sewer, water, electrical and telephone;
- Mark-out of capping, staging and lay down areas;
- Establishment of vehicular traffic pathways and staging areas;
- Implementation of the perimeter air monitoring plan;
- Site preparation (soil erosion controls and stormwater controls);
- Stabilization measures, as necessary; and
- Installation of security fencing, and es tablishment of exclusion zones, reduction zones and support zones throughout the execution of remediation activities

3.2 Perimeter Air Monitoring

The primary source of contamination at the Site is interpreted to be historical mine operations. The primary contaminants at the Site are metals (cadmium, copper, lead, zinc) which are present as metal sulfides associated with tailings in the Tailings Impoundment.

Contaminated media at the Site include upland soil, groundwater, Goose Pond and Goose Cove sediment, and Goose Pond surface water. Portions of the upland areas at the Site are contaminated with metals, especially arsenic, cadmium, copper, lead, and zinc. The presence and widespread distribution of these metals is attributed to spillage during transport, storage, and handling of ore and ore concentrate; disposal of tailings, disposal of waste rock, and and to a lesser extent, contaminated wind-blown dust. Although much of the waste rock removed during development of the open pit was not mineralized, other sub-ore grade waste rock was mineralized with pyrite (iron sulfide) and lesser amounts of copper-, lead-, and zinc-bearing

minerals. Use of waste rock to construct containment dams and site roads and pave/surface work areas contributed to site contamination.

Contaminated soils will be di sturbed during the Tailings Impoundment cap construction activities. The Remedial Construction Contractor will be required to prepare and implement a Perimeter Air Monitoring Program.

3.3 Construction Phasing

Implementation of the remedy is anticipated to be completed in two phases over a two year period. A general description of the activities to be undertaken during each phase is as follows.

3.3.1 Phase 1

Phase 1 Remedial Construction (Initial Impoundment Dewatering and Instrumentation Installation) will consist of the following steps and activities.

1. Mobilize to Site
2. Install E&SC
3. Establish on-site quarry & crushing operation
4. Construct/improve access road to Impoundment Toe
5. Construct BioReactor Treatment Areas
6. Construct temporary drill pads for horizontal drains
7. Install upper N/S horizontal drain and associated collection piping
8. Construct working surface
9. Install Prefabricated Vertical Drains (EQ Drains)
10. Install geotechnical instrumentation per GMP
11. Monitor water levels for 1 year (+/-)

The upper horizontal drains are anticipated to sufficiently drain the Tailings Impoundment in 180 days to allow for excavation.

3.3.2 Phase 2

Once monitoring data confirms that dewatering has been achieved, Phase 2 of the remedy implementation may begin.

Phase 2 Remedial Construction (Site Re-Grading/Earthworks and Cover System) will consist of the following steps and activities.

1. Install E&SC
2. Install additional horizontal drains (lower N/S drain and/or E/W drains) if necessary (if adequate dewatering has not occurred) to begin construction
3. Staged cut/fill operations. Fill placement rates governed by response of tailings to loading/unloading evidenced by geotechnical instrumentation and monitoring (see GMP)
4. Cut/fill balance and grading adjustments
5. Cover system installation

4.0 IMPOUNDMENT DEWATERING

The central portion of the Tailings Impoundment contains a gentle depression as a result of settlement of the fine grained tailings ("slimes") present in this area. The oval shaped depression historically held surface water throughout the summer months, although recent grading and ditching updradient of the slimes has reduced the accumulation of stormwater in this area.

Based upon investigations conducted at the site, overburden groundwater occurs at approximately 20 feet below grade on the east side of the Tailings Impoundment, but rises to near ground surface beneath the slimes in the center of the impoundment. Groundwater elevations measured at multi depth wells within and below the tailings indicate a downward groundwater migration through the shallow and mid-depth tailings. These observations, along with results of borehole logging and groundwater modeling described below, suggests only a very small flow rate of groundwater (on the order of 0.1 gpm) flows into the tailings over entire bottom of the impoundment.

Due to the manner in which the dam encompassing the Tailings Impoundment was constructed, dewatering, treatment, and discharge of Tailings Impoundment groundwater will be required to stabilize the tailings materials. It will also be necessary to regrade the Tailings Impoundment to remove load from critical areas and promote proper surface water drainage.

The dewatering system(s) for groundwater within the Tailings Impoundment will include multiple horizontal dewatering wells (discussed below). While these wells are anticipated to contribute to dewatering of the slimes, a separate system and technology is proposed for dewatering the central slimes and is discussed in Section 9.0.

4.1 Surface Water Management

The general process for managing stormwater and surface water (i.e., precipitation, horizontal drains, and EQ drains) collected during construction will be to prevent water from contacting the remediation area. However, this will not be possible where surface water/stormwater and incidental precipitation falls on active construction areas.

In order to minimize the impacts of surface water on construction activities, run-on from areas outside the construction will be directed away from the remediation work area. Upgradient grading and ditching completed since 2012 has already served to divert upgradient stormwater away from the Tailings Impoundment. In addition, temporary berms and/or sandbags berms will be constructed and maintained along the perimeter of the Site to prevent the stormwater runoff from going into the remediation work area. Sumps are anticipated to be used within work areas to locally manage surface water and stormwater during construction. Long term, post remediation storm water management is discussed in detail in Section 12.0

4.2 Groundwater Management – Tailings Impoundment Dewatering

To enhance the stability of the Tailings Impoundment and support the construction of the cap, AMEC evaluated various dewatering approaches. To refine our understanding of the hydrogeologic conditions that control dewatering, borehole logging and a pumping test were completed. The results of these efforts were then used to evaluate dewatering alternatives and to develop the selected dewatering alternative – horizontal wells. The groundwater model that was constructed, calibrated and run for the 30% Design Submission was refined and simulations were run to further understand the effects of dewatering the Tailings Impoundment with horizontal wells for the Draft Final Design. Detailed results of these activities are provided in Appendix A and are summarized below.

4.2.1 Geophysical Logging of Bedrock Boreholes

Borehole geophysical logging was completed on three bedrock wells along the western margin of the Tailings Impoundment to evaluate groundwater flux from the bedrock into the impoundment. These efforts indicated there is a wide range of strike and dip orientations in the boreholes. However, fractures interpreted to be most likely transmissive have either shallow dips or dip towards the east to southeast toward the Tailings Impoundment. Bedrock groundwater is present in shallow transmissive fractures at depths of 13 to 43 feet below ground surface. Artesian flow of about 1 gallon per minute (gpm) was observed at RC-1143 in the southwest corner of the Tailings Impoundment, and upward flow from depth to a fracture at 28 feet below ground was observed at RC-1145 located along the central western side of the impoundment. At RC-1144, located northwest of the impoundment a small downward flow was observed into a fracture at 43 feet below ground, below which there was no flow. Water level measurements for the two bedrock wells installed near the dam crest at the southeast (MW-722R) and northeast (MW-604R) corners of the tailings impoundment are consistent with the upgradient bedrock well observations: groundwater is six feet above the bottom of tailings at MW-722R, and is three feet below the bottom of tailings at MW-604R. Based on these data bedrock groundwater levels in the center of the tailings are anticipated to be at or near the bottom of the tailings. The seeps along the toes of the dam are further evidence of free drainage of tailings groundwater out through the rock dam.

These conditions indicate a small contribution of bedrock groundwater into the impoundment. The flow from the discrete fracture at RC-1143 is unimpeded by low permeability glacial till and clay which overlies the bedrock surface beneath the Tailings Impoundment. Based on these conditions we do not expect flows into the Tailings of the scale reported for the open fracture at RC-1143.

The artesian flow at RC-1143 will be routed via pipe to the drainage ditch located along the south side of the Tailings Impoundment. The borehole logging report along with supporting information for the limited contribution of bedrock groundwater to the Tailings Impoundment is discussed below and in Appendix A1 Borehole Logging.

4.2.2 Pumping Test

A fully penetrating four-inch diameter dewatering test well (DW-1) was installed at the location shown in Figure 4.2a. A 30-hour pumping test was completed on the well with monitoring at seven (7) monitoring wells and 14 vibrating wire piezometers. These locations represented radial distances of 60 to 130 feet from DW-1. The resulting zone of influence from the test is shown on Figure 4.2a and the conditions and results are summarized as follows:

- Flow rate = 0.25 gpm;
- Duration = 30 hours;
- Initial depth to groundwater (from top of casing) = 21.5;
- Observed steady maximum drawdown at DW-1 = 23 feet;
- Specific capacity = 0.25 gpm/23 feet (ft) of drawdown = 0.011 gpm/ft of drawdown;
- Radius of influence = 60 to 130 feet (indicating anisotropy);
- Projected long-term drawdown at 60 feet from DW-1 = 2.5 feet in first year; and
- Less drawdown was observed in shallow wells.

Calculations of transmissivity (T) for the tailings materials at DW-1 indicate an estimated T value of 7.6 gallons per day per foot (gpd/ft). Considering the fully penetrating well construction and saturated thickness at DW-1, a hydraulic conductivity (K) value of 0.034 ft/day (1.2x10-5 centimeters per second [cm/sec]) was calculated. A T value of 15 gpd/ft was calculated using the distance drawdown data from observation wells and piezometers that were influenced by the pumping test at DW-1. Using this data and considering the same saturated thickness used above, a K value of 0.067 ft/day (2.4 x10-5 cm/sec) was calculated. The range of K testing reported in the Final RI report was 0.30 to 0.012 feet/day (1.1 x 10-4 to 4.4 x 10-6 cm/sec). The geometric mean of these two values is 0.062 feet/day (2.2 x 10-5 cm/sec). These results indicate the pumping test results are consistent with prior testing at the Tailings Impoundment.

Based on the observed radius of influence during this test and the pumping test reported by Maine DEP in March 2012, meaningful drawdown with respect to dewatering the Tailings Impoundment (i.e., greater than 10 feet) appears to only be possible at close distances to pumping wells (i.e., on the order of feet from a pumping well). These results indicate that 20 or more pumping wells would be needed to achieve the dewatering required for excavation and construction of the cap for the Tailings Impoundment.

Details of the pumping test methods and results are provided in Appendix A2 Pumping Test.

4.2.3 Evaluation of Dewatering Alternatives

Dewatering is necessary for excavation of the dam crest and regrading of the east side of the Tailing Impoundment. Excavation of between 15 to 20 vertical feet of tailings is proposed on the east side of the Tailings Impoundment, with cuts up to 30 feet in the north draining swale

(proposed subgrade elevations are presented on the Design Drawings in Appendix M). Three dewatering alternatives were considered for the Tailings Impoundment in the 30% design: multiple vertical wells, a deep trench, and a horizontal well (or wells). These alternatives are presented again for reference along with additional information to respond to Agency comments on the 30% Design report.

Vertical Wells - Based on the results of the pumping test, it was estimated that 20 or more vertical wells would need to be installed along a north-south line 100 feet west of the east perimeter road. Each well would require a pump, piping and a power supply (either brought into the site or from solar panels). These wells would need to be operated for months to years to achieve meaningful drawdown in the target dewatering area. Considering access requirements to the surface of the Tailings Impoundment during excavation, grading and placement of the cover materials, multiple well heads in this critical eastern portion of the impoundment would represent a significant challenge for equipment operators. Finally, a preliminary cost comparison between multiple vertical wells and a long horizontal well indicated similar per footage costs (i.e., no cost benefit for vertical wells). Based on all of the above factors, vertical wells were not further evaluated.

Deep Trench – A deep trench would conceptually provide the most effective drainage of the saturated thickness of the tailings if installed to the full required depth of dewatering (i.e., to approximately elevation 35 feet for construction, lower for long term stability). However, pump, power and piping infrastructure would need to be installed at one or both ends of the trench to pump captured groundwater to the wetland treatment system. Preliminary costing information for a deep trench system – either excavated or installed with the DeWind system – indicated an installed trench cost on the order of $1,000,000 or more. Preliminary costing for multiple horizontal drains indicates installed costs on the order of $320,000. Finally, one or more horizontal wells were estimated to have a similar dewatering effect over time as a fully penetrating trench. Based on these considerations, the deep trench alternative was not further evaluated.

Horizontal Well – A horizontal well (or wells) was the third alternative evaluated. Based on several advantages of this approach and a proven track record at another mine tailings site in New England, this alternative was selected to develop in the 30% design submission. The primary benefits of horizontal well(s) are:

- If installed into the Tailings Impoundment at and below elevation 35 feet, drains would provide gravity drainage to an outlet point where the dewatering wetland treatment systems would be located.
- The deep invert elevations of the wells beneath the Tailings Impoundment water table will provide a driving head for drainage.
- The entire surface of the Tailings Impoundment would remain clear for grading and construction activities.
- Horizontal wells (drains) have been successfully installed and operated at the Elizabeth Mine Site in Vermont.

Selected Alternative (Horizontal Wells) and Groundwater Modeling - To evaluate the ability of a horizontal well to drain the Tailings Impoundment, a groundwater model was developed for the 30% Design using the United States Geological Survey's MODFLOW code. Results of this effort indicated that a single horizontal drain at elevation 35 feet located 100 feet west of the perimeter road resulted in dewatering to approximately elevation 41 feet after 180 days of operation (about a 9 foot decline of the water table at the drain location). These results provide the basis for construction dewatering (described below) and are shown in Figure 4.2b

To support the Draft Final Design, the groundwater model was updated with the following refinements:

- A new bottom of tailings surface based on a thorough review of all geotechnical and monitoring well borings and test pits.
- Extending the constant head boundary (located at the toe of east slope) around the north and south end of the tailings to more realistically represent seepage in these areas.
- Incorporating deep full length north-south drains (at elevation 20) beneath the elevation 35 drain previously modeled, and adding six deep drains of varying length from the east face of the dam into the tailings to evaluate effects of multiple drains.
- Refining the model grid in the eastern portion of the model to more accurately represent the proposed drain locations.

Figure 4.2c (Profile E3) has been prepared based on review of geotechnical and monitoring well boring logs to support geotechnical evaluations and indicates the geology at the impoundment consists of tailings over thin clay and till over bedrock. Each of these three layers (layer 1 = tailings, layer 2 = clay/till, layer 3 = bedrock) are represented in the model as well as the thicknesses and slope of the layer surfaces. Because the central portion of the tailings contains clay and silt material ("slimes") and the perimeter materials are a silty fine sand, a zone within model layer 1 was designated as "slimes" with lower permeability conditions than the rest of layer 1. Based on the location and approximate elevation of observed seeps along the east toe of the dam, the model allows outflows from the three layers along the east side of the model through constant head boundaries that wrap around the easterly portion of the northern and southern sides of the Tailings Impoundment. Water enters the model via infiltrating precipitation into the uppermost saturated layer in the model (almost entirely layer 1) and to a much lesser extent via upward groundwater flow from the bedrock. The total model area is approximately 17 acres.

Following re-calibration of the updated model, initial runs were made to compare output with the original 30% design model output - with favorable results. The final run with the updated model incorporated the above changes and simulated the long term dewatered condition of the capped Tailings Impoundment with all drains operating.

Figure 4.2d provides the modeled groundwater surface (at the same scale as Figure 4.2b and Figure 4.2c) after 10.2 years of capped operation with the six easterly drains and two full length

north south drains all working. The results indicated the tailings are substantially dewatered with the water table lowered to the clay/till. This condition is caused by no vertical recharge entering the model through the cap and the very small flow rate (on the order of 0.1 gpm) that enters the model from the bedrock being largely captured by the deep full-length north-south drain. The shorter easterly drains provide relatively small quantities of water and essential none at the 10.2 year time step. Some small flow exits through the clay/till and bedrock strata as collected by the models eastern perimeter constant head nodes. Methodology and detailed results of the modeling effort including drain flows and additional water level profiles through time are provided in Appendix A3.

5.2.4 Draft Final Design Drain Configuration

The 30% Design and modeling provided results that indicated the potential effectiveness of a single 870-foot horizontal dewatering well installed beneath the east side of the Tailings Impoundment at elevation 35 msl. Based on a detailed review of stratigraphy and clay/till topography, the updated groundwater model, this Draft Final Design includes a total of 10 horizontal drains at different elevations to intercept different permeable layers within the tailings, to ensure proper drainage and to provide redundancy. The following summarizes the key elements of the Draft Final Design Drain Configuration:

Objectives – The objectives for the proposed drain configuration within the tailings are to:

1. Provide for pre-construction dewatering in the eastern portion of the tailings where 15 to 30 feet of material will need to be removed for stability and drainage purposes; and
2. Provide post-construction dewatering of the tailings to a depth approaching the till/clay surface to provide long term stability of the Tailings Impoundment.

Layout – The proposed horizontal drain layout is shown on Drawings C-104 through C-109 in Appendix M. The drains have been numbered for reference to their respective construction details (see Appendix A3 Table 1) and to their predicted flow rates over time (see Appendix A3 Table 5). East-west drains were located considering low elevation depressions or valleys in the clay/till surface in an effort to collect the most groundwater from the base of the tailings, and to provide drainage along the northern and southern sides of the impoundment. The general location of seeps at the toe of the dam was also considered, as was clustering the well head end of the drains at drill pad locations reasonably close to proposed wetland treatment systems. The upper North and upper South drains were located approximately beneath the areas of deepest required excavation on the east side of the impoundment. The lower North and lower South drains were located beneath the upper drains and as close to the clay/till surface as possible.

Sequencing – The sequence of drain installation will be driven by the actual construction schedule, but is anticipated to include the following elements:

- Initial mobilization:
  a. Construct drill pads for upper North, lower North, upper South, lower South drains.
  b. Construct North and South compost bioreactors (treatment wetland systems);
- Install upper and lower North drains;
- Install upper and lower South drains;
- Development of drains with jetting and flushing;
- Start construction dewatering (upper North and South drains) and operation of North and South compost bioreactors;
- Monitor dewatering progress;
- Start lower North and South drains and adjust flow rate to be compatible with both the compost bioreactors treatment system capacity and the rate of dewatering progress;
- Initiate cap construction when target groundwater elevations have been reached;
- Install pads and drains for East drains following completion of earthwork/capping on the east crest of the dam.

Operation Maintenance and Monitoring

Drains will be developed (i.e., cleaned out) following installation by flushing/jetting with a high pressure water jet. Drains will be connected by gravity flow piping to the north or south compost bioreactors systems with valves to control flows from each drain. Redevelopment of drains will be undertaken a minimum two times per year during construction. The need for additional cleaning will be determined based on monitoring data. Specifications for the installation, operation and maintenance of the drains are provided in Appendix N.

The following monitoring wells and piezometers, at five eastern locations, will be used for periodic water level monitoring to demonstrate the effectiveness and progress of dewatering.

- PZ-602, MW-602S, MW-602D, MW-722R (southeast corner of impoundment)
- PZ-605D, MW-605S, MW-605D (east central impoundment)
- MW-604S, MW-604D, MW-604R (northeast corner of impoundment)
- PZ-706, MW-706 (south dam crest)
- PZ-705, MW-705 (central dam crest)

It is anticipated that these wells/peizometers will be removed during the regrading/capping construction phase and will need to be re-installed following completion of the regrading/ capping.

5.0 TREATMENT OF DEWATERING FLOWS

5.1 Compost Bioreactor

Currently, the surface of the Tailings Impoundment is open to precipitation and infiltration, and, although there has been some draining of groundwater from the higher elevation and coarser tailings around the edges, the majority of the tailings remain saturated. This saturated condition and the fine-grained nature of the tailings contribute to potential instability of the tailings impoundment during seismic events. Consequently, there are plans to cover the Tailings Impoundment with a low permeability cover system and to install drains to dewater the tailings to improve seismic stability. In addition, lowering of the water table within the Tailings Impoundment is a prerequisite to planned construction activities associated with regrading and covering the Tailings Impoundment. After capping, drainage may continue to discharge at a slow rate through the drains, thereby maintaining the water table at its lowered elevation. In both cases, this drainage will need to be treated to meet USEPA Aquatic Life saltwater chronic criteria for the contaminants of concern identified in the Record of Decision (i.e., cadmium, copper, lead, and zinc) and other toxic metals.

Compost bioreactors, also called sulfate-reducing bioreactors or anaerobic treatment wetlands, have been selected for treatment of dewatering flows from the Tailings Impoundment at Callahan Mine. Compost bioreactors are passive treatment systems and require relatively little operation and maintenance compared to active treatment systems which typically require continuous/ongoing energy inputs, chemical feeds, and daily operation. This makes passive systems desirable for locations where electric power is not available and where access and/or operation and maintenance resources are limited.

In compost bioreactors, untreated water containing dissolved sulfate and divalent metal cations passes through organic rich substrates where sulfate-reducing bacteria (SRB) utilize sulfate as a terminal electron acceptor during the oxidation/metabolism of organic matter. During this process, sulfate is converted to sulfide on a 1: 1 molar basis, and bicarbonate alkalinity is increased. The basic equation for this process is represented by the following equation in which CH_2O represents organic matter:

$$2CH_20 + SO_4^{=} \rightarrow H_2S + 2HCO_3^{-}$$

The sulfide quickly reacts with cations such as cadmium 2+, copper 2+, lead 2+, nickel 2+, silver, and zinc 2+ to form dense metal-sulfide precipitates as represented by the following equation where Me is a divalent metal cation:

$$Me^{++} + H_2S \rightarrow MeS + 2\,H^{+}$$

Iron and manganese also form sulfide precipitates, but iron and manganese have greater solubility products than cadmium 2+, copper 2+, lead 2+, nickel 2+, silver, and zinc 2+. These cations will preferentially form sulfide precipitates in the presence of iron and manganese, and

iron and manganese may be only partially precipitated as sulfides. Metal exchange and complexation reactions and precipitation as carbonates may also contribute to precipitation and removal of metals. Sulfate-reducing bioreactors may be designed to operate in either upflow or downflow modes.

It is noted that mercury was below the reporting limit of 0.00001 mg/L in nearly all RI groundwater samples from the Tailing Impoundment, with only a few reported detections up to a maximum 0.00007 mg/L. This is an order of magnitude less than the EPA salt water chronic criteria for mercury, and mercury is not expected to be an issue in the discharge from the bioreactors.

Substrates that have been shown to provide sufficient dissolved organic carbon to support SRB activity include the following materials, typically in combination with one another: wood chips, sawdust, hay and straw, compost, spent mushroom compost, animal manure, and walnut shells (Doshi, 2006; Gilbert et al., 2004; ITRC, 2014; Skousen et al., 2000; Venot et al., 2008). If low pH is a concern, or as part of a conservative design approach, limestone may be mixed with the substrate to raise pH and alkalinity. The treatment substrate would be placed as a homogenous mixture. The design substrate mixture proposed for use at Callahan Mine is described below.

Wood chips [1]	30%
Pea gravel / crushed stone	10%
Chitin (Chitorem SC-20 or equal)	20%
Crushed/pebble limestone [2]	20%
Compost [3]	15%
Cow manure [4]	5%

Notes: All % are on a volume basis

[1] White pine wood chips. No more than 5% less than ¼-inch thick, no more than 5% greater than 1-inch thick. No painted, pressure-treated, or otherwise chemically treated wood; scrap wood; or demolition debris.

[2] Crushed limestone 0.5 to 1 inch in size. Material should be calcite limestone ($CaCO_3$) or dolomitic limestone ($CaCO_3/MgCO_3$) with a minimum $CaCO_3$ equivalence of 90 percent.

[3] Composted green organic material, aged or adjusted to near neutral pH.

[4] Partially aged to improve workability.

The sizing of Compost bioreactors is dependent on ensuring that sulfate is reduced and sulfide produced at a rate sufficient to precipitate the metals of concern. A rate of 0.3 moles of sulfate reduction per cubic meter substrate per day is often cited as a rule of thumb for mixtures similar to the compost mixture described above; however, cold weather may reduce the sulfate reduction rate substantially (Gusek, 2005; ITRC, 2014). For Callahan Mine, reactor sizing

based on sulfate reduction was compared to sizing based on a two-day liquid retention time, and the more conservative retention time approach selected.

Effluent from the bioreactor will be discharged to a rip-rap lined ditch for aeration prior to discharge to Goose Pond. The bioreactor for Callahan Mine is designed as an upflow reactor with a flooded surface.

5.2 Design Basis

5.2.1 Flow

As discussed in Section 4.0, a series of horizontal, directionally drilled drains are planned for dewatering the Tailings Impoundment. These consist of four drains, north upper and lower, and south upper and lower, oriented approximately north-south parallel to the east Tailings Impoundment berm. These drains will be installed through the north and south berms of the Tailings Impoundment. In addition, six east-west oriented drains, are planned for installation through the east impoundment berm and below the elevation of the north-south drains. Flow from the two northern north-south drains and the three northern east west drains will be treated at a location north of the Tailing Impoundment, and flow from the two southern north-south drains and the three southern east-west drains will be treated at a location south of the Tailings Impoundment. Drainage flow through the drains was estimated by groundwater modeling described in Subsection 4.2.3 and Appendix A3. The modeling indicates that drainage flow will decrease rapidly during the first 30 to 90 days that the drains are in operation. Tables in Appendix A3 summarizes “north” and “south” drainage flows, and illustrates how rapidly the flows decrease over time. The flows are based on the assumption that all the drains are initially opened at the same time. A crosswalk between the drain labeling on design drawings and labeling used during the modeling is shown below.

Drain ID on Design Drawings	Drain ID During Modeling
HD-1	#9, Lower, full length, north-south
HD-2	#8, Upper, north; #7, Upper south
HD-3	#1, East-west drain (southern group)
HD-4	#5, East-west drain (southern group)
HD-5	#2, East-west drain (southern group)
HD-6	#3, East-west drain (northern group)
HD-7	#6, East-west drain (northern group)
HD-8	#4, East-west drain (northern group)

The treatment systems will also be used to treat dewatering flows from EQ drains used to dewater and consolidate the Tailing Impoundment slimes as excavated tailing material from the east edge of the impoundment is placed over the slimes area. The flow from these drains is expected to occur over a 6 month period beginning after initial Tailing Impoundment pre-construction dewatering using the north-south drains. This EQ drain flow, based on 1 foot of

settlement /consolidation aver a 5-acre area is estimated to be approximately 1,630,000 gallons, for a 6-month average of 9,060 gpd or 6.26 gpm. Actual flows will be zero or very low at the start of this dewatering, increase to a maximum as increasing amounts of material are placed over the slimes, and then decrease as free-water is squeezed from the slimes.

The operation of the horizontal drains and wick drains will be sequenced to spread out flow spikes associated with initial drain flows (e.g., upper north-south drains are opened first, then lower north-south drains are added) and in response to construction schedules. Some brief flow peaks above design flows may occur, but this is not expected to result untreated/undertreated, because sulfate-reducing bioreactors have the ability to treat brief periods of high flow. In addition, the flow from individual drains will be controllable with valves (as shown on drawing C-304). The sequencing of drain operation is not expected to delay site activities. Table 5-1 shows flows based on the following conceptual drain sequencing.

	Elapsed Time (months)									
Drainage Component	**0**	**3**	**6**	**9**	**12**	**15**	**18**	**21**	**24**	**24 - 120**
Upper north and south drains										
Lower north and south drains										
East-west drains										
Wick drains										

The design flows for the treatment systems are shown below.

Design flow north treatment system	8.0 gpm
Design flow south treatment system	8.0 gpm

Table 5-1: Sequenced Flows from Tailing Impoundment Drains

Elapsed Time	Upper South	Upper North	Lower South	Lower North	South, E-W 1,5,2	North, E-W 3,6,4	Wick Drain	Wick Drain	Total South	Total North
Months	(gpm)	(gpm)	(gpm)	(gpm)	(gpm)	(gpm)	(gpm)	(gpm)	(gpm)	(gpm)
0	3.00	3.00	0.00	0.00	0.00	0.00	0.00	0.00	3.00	3.00
1	2.12	2.12	0.00	0.00	0.00	0.00	0.00	0.00	2.12	2.12
3	1.25	1.25	6.25	6.25	0.00	0.00	0.00	0.00	7.50	7.50
4	1.13	1.13	1.50	1.50	0.00	0.00	0.00	0.00	2.63	2.63
6	1.00	1.00	1.31	1.31	0.00	0.00	0.00	0.00	2.31	2.31
9	0.88	0.88	1.20	1.20	0.00	0.00	0.00	0.00	2.08	2.08
12	0.75	0.75	0.00	0.00	0.00	0.00	2	2	2.75	2.75
15	0.68	0.68	0.00	0.00	0.00	0.00	7.5	7.5	8.18	8.18
18	0.60	0.60	0.00	0.00	0.00	0.00	0.5	0.5	1.10	1.10
21	0.55	0.55	0.97	0.97	0.00	0.00			1.52	1.52
24	0.50	0.50	0.82	0.82	3.5	3.0			4.79	4.35
25			0.76	0.76	2.7	1.9			3.49	2.70
27			0.67	0.67	2.2	1.3			2.86	2.01
30			0.63	0.63	1.7	1.0			2.36	1.59
33			0.59	0.59	1.40	0.77			2.00	1.37
36			0.56	0.56	1.1	0.6			1.63	1.15
39			0.52	0.52	0.91	0.52			1.43	1.03
42			0.46	0.46	0.7	0.4			1.20	0.90
48			0.41	0.41	0.5	0.3			0.92	0.74
54			0.36	0.36	0.4	0.3			0.72	0.63
60			0.32	0.32	0.3	0.2			0.57	0.52
67			0.28	0.28	0.16	0.13			0.43	0.41
88			0.16	0.16	0.06	0.06			0.22	0.22
109			0.12	0.12	0.02	0.02			0.14	0.14
120			0.09	0.09	0.00	0.00			0.09	0.09

Notes:
Tabulated flows in upper N-S drains, months 0 through 24, based on Model Run CalM2R16, uncapped conditions.
Tabulated flows in lower N-S drains, months 0 through 21, based on Model Run CalM2R304, uncapped conditions.
Remaining flows based on Model Run CalM2R305, capped conditions
Table assumes lower N-S drains opened at the end of 3 months and east-west drains opened at end of 24 months.
Upper N-S drains assumed dry at end of 24 month.
Green highlight indicates interpreted flows for elapsed times between modeled times.
Blue highlight indicates time delay before operation of drain.

5.2.2 Untreated Water Characteristics

The average total metal concentrations in Tailings Impoundment monitoring well samples collected by Maine DEP in August 2011 were selected to represent future dewatering flow from the Tailings Impoundment. Table 5-2 summarizes the analytical results from individual wells in that sampling. Average concentrations were calculated without inclusion of SB1142S, as those data appear anomalously high and non-representative when compared with historical data. Overall, the 2011 Maine DEP data show higher metals concentrations than either Tailing Impoundment seep data or Tailing Impoundment monitoring well data collected during the remedial investigation. Total concentrations were selected in lieu of dissolved concentrations because of the limited amount of available characterization data, limited knowledge about the overall chemical composition of the samples, and lack of knowledge of how chemical composition may change over time. These factors contribute to what is considered a conservative estimate of metals loading. Table 5-3 tabulates millimoles per liter of metals expected to form sulfide precipitates based on the average concentrations in Table 5-2. The total millimoles of divalent metals expected to form sulfide precipitates is 0.29 millimoles per liter, based on the assumed flow and the average concentrations in Table 5-2.

Table 5-2: Analytical Results for August 10, 2011, Maine DEP Sampling

Parameter		Units	Saltwater Aquatic Life Criteria [1]	602-S	602-D	605-S	605-D	SB1142-S	SB1142-D	SB1123	604-S	Average*
Aluminum	Al	mg/L	NA	0.000	0.000	0.000	0.087	277	3.92	26.85	0.000	4.41
Antimony	Sb	mg/L	NA	0.014	0.006	0.015	0.007	0.045	0.035	0.053	0.034	0.02
Arsenic	As	mg/L	0.036	0.004	0.001	0.007	0.005	0.376	0.015	0.048	0.030	0.02
Barium	Ba	mg/L	NA	0.009	0.007	0.112	0.007	0.639	0.052	0.088	0.009	0.04
Cadmium	Cd	mg/L	0.0088	0.002	0.000	0.001	0.000	0.124	0.009	0.021	0.002	0.01
Calcium	Ca	mg/L	NA	179	90.7	19.0	2.59	946	242	588	624	249
Chromium	Cr	mg/L	0.050	0.008	0.009	0.009	0.010	0.101	0.015	0.042	0.008	0.01
Cobalt	Co	mg/L	NA	0.000	0.000	0.000	0.000	0.100	0.001	0.027	0.019	0.01
Copper	Cu	mg/L	0.0031	0.002	0.001	0.003	0.004	5.26	0.324	0.703	0.002	0.15
Iron	Fe	mg/L	NA	0.073	0.101	0.057	0.035	247	5.02	30.63	21.33	8.18
Lead	Pb	mg/L	0.0081	0.000	0.000	0.000	0.000	4.99	0.283	0.885	0.026	0.17
Magnesium	Mg	mg/L	NA	71.2	88.0	77.9	3.02	272	341	67.9	23.4	96.0
Manganese	Mn	mg/L	NA	0.18	0.08	0.01	0.01	25.0	1.11	6.51	7.51	2.20
Molybdenum	Mo	mg/L	NA	0.017	0.060	0.047	0.146	0.170	0.085	0.040	0.026	0.06
Nickel	Ni	mg/L	0.0082	0.001	0.001	0.002	0.001	0.209	0.004	0.045	0.108	0.02
Potassium	K	mg/L	NA	16.3	61.7	65.7	10.4	26.7	131	18.8	4.91	44.1
Selenium	Se	mg/L	0.071	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.011	0.00
Silver	Ag	mg/L	0.0019	0.000	0.000	0.000	0.001	0.026	0.002	0.003	0.003	0.00
Sodium	Na	mg/L	NA	23.7	154	45.56	235	10.9	3274	116	6.28	551
Vanadium	V	mg/L	NA	0.000	0.000	0.000	0.001	0.121	0.002	0.020	0.000	0.00
Zinc	Zn	mg/L	0.081	0.398	0.032	0.062	0.030	69.13	2.08	6.62	3.74	1.85
Sulfate	SO4	mg/L	NA	654	798	109	96	1967	1872	1339	1345	888
pH	pH	s.u.	6.5 - 8.5	7.41	7.15	8.05	7.95	7.74	7.77	7.19	7.01	7.50

Notes:
[1] USEPA Aquatic Life saltwater chronic criteria, except silver where saltwater acute criteria are listed.
All metal concentrations are total recoverable concentrations.
*Average calculated without SB1142-S as those data are considered non-representative compared to historical data.
mg/L = milligrams per liter
s.u. = standard units
NA = not available

Table 5-3: Tabulation of Millimoles Metals Per Liter for Sulfide Precipitation

Parameter	Concentration (mg/L)	Gram Mol Wt (mg/mmole)	mmole/L
Cadmium	0.005	112.40	0.000004
Cobalt	0.007	58.90	0.00012
Copper	0.148	63.50	0.00234
Iron	8.18	55.80	0.21985
Lead	0.171	106.40	0.00160
Manganese [1]	2.20	54.90	0.04007
Nickel	0.023	58.70	0.00040
Silver	0.001	107.90	0.00001
Zinc	1.85	65.40	0.02830
		Total	0.29
Sulfate	880	96	9.2

Notes:

[1] Because of the high solubility product of manganese sulfide precipitate compared to the other tabulated metals, incomplete sulfide precipitation is expected. Therefore, the concentration for manganese is shown as 50% of the concentration in Table 5-2.

mg/L=milligrams per liter

Gram Mol Wt = gram molecular weight

mmole = millimole

5.2.3 Sulfate Reduction Rate

A sulfate reduction rate of 0.15 moles per cubic meter of substrate per day was chosen to account for potential decreases in sulfate reduction as a result of low winter temperatures. This is a 50 percent reduction from the 0.3 moles per cubic meter of substrate per day rule of thumb cited previously.

5.2.4 Required Substrate Volume

The required substrate volume was calculated based on the parameters shown in the following table:

Parameter	Value
Flow - north	8.0 gallons per minute (30.3 liters per minute)
Flow - south	8.0 gallons per minute (30.3 liters per minute)
Metal loading	0.29 millimoles metal per liter
Sulfate loading	9.2 millimoles metal per liter

Parameter	Value
Sulfate reduction rate	0.15 moles per cubic meter of substrate per day
Substrate thickness	3 feet (0.91 meters)
Substrate porosity	0.32

5.2.5 Sizing and Loading

Sizing and loading calculations are contained on Appendix B. The following table summarizes bioreactor volumes and retention times.

Parameter	Sizing, Sulfate Reduction	Sizing, Two-Day Minimum Retention Time	Selected
North Treatment System			
Substrate volume, cubic yards	110	356	356
Substrate volume, cubic meters	84	273	273
Liquid retention time, days	0.62	2.0	2.0
South Treatment System			
Substrate volume, cubic yards	110	356	356
Substrate volume, cubic meters	84	273	273
Liquid retention time, days	0.62	2	2

6.0 LONG-TERM STATIC SLOPE STABILITY EVALUATION

The selected remedy for the Tailings Impoundment requires stabilization measures (e.g., dewatering and crest improvements) to improve both static and seismic stability and thereby minimize the potential for a slope failure to occur. The stabilization measures are required because prior geotechnical investigations and stability evaluations indicate that the impoundment, in its present condition/configuration, is marginally stable under long-term static conditions (i.e., the FOS is on the order of 1.1 to 1.2 but does not meet the regulatory-standard FOS of 1.5) and that it may become unstable (i.e., FOS < 1.0) during or immediately following a long-term-design-magnitude earthquake.

Accordingly, AMEC performed a long-term static slope stability evaluation of the Tailings Impoundment to support the Draft Final Design. The evaluation was made utilizing SLOPE/W, an industry-standard two-dimensional slope stability software program developed and distributed by Geo-Slope International, Ltd. The primary objective of this evaluation was to assess the minimum long-term static FOS of the impoundment relative to global (deep-seated) stability, considering both the existing site conditions and the planned remediation. SLOPE/W model development and long-term static slope stability analyses and results are summarized in the subsections below. Additional details, notes, and assumptions are provided in Appendix C.

6.1 Model Development

AMEC identified seven representative profiles of interest (designated S1, S2, E1, E2, E3, E4, and N1) considering the existing impoundment dam configuration (i.e., steepness, height, etc.), the Draft Final Design conditions, and the available geotechnical and hydro-geologic data. Figure C-1 in Appendix C depicts the profile locations. AMEC developed SLOPE/W models for Profiles S2, E1, E2, E3, E4, and N1 to support the Draft Final Design.

6.1.1 Existing Conditions

AMEC developed an existing conditions model for each profile (S2, E1, E2, E3, E4, and N1) as follows:

1. The overall geometry was defined based on site-specific topographic data;
2. The impoundment dam configuration was established considering upstream raised embankment construction methods, anecdotal information, and available geotechnical investigation data;
3. Soil stratigraphy was defined based on geotechnical investigation data;
4. Soil unit weight and strength parameters were assigned based on soil type, in-situ conditions (e.g., relative compactness/consistency, above/below water table, etc.), in-situ testing, laboratory testing, empirical correlations to published literature values, and engineering judgment; and
5. Impoundment water levels were defined based on hydro-geological data obtained from site-specific borings, wells, piezometers, and pore pressure dissipation tests.

6.1.2 Long-Term Post-Remediation Conditions

Long-term post-remediation conditions were evaluated by modifying the existing conditions models based on the Draft Final Design, as follows:

1. The overall geometry (i.e., grading) was revised based on the proposed grading. The proposed grading is depicted in plan view on Figure C-1 and in cross-section in Figures C-2 and C-3 in Appendix C.
2. Impoundment water levels were updated based on the locations and elevations of the proposed horizontal drains (Figure C-1) and the results of groundwater modeling (Appendix A).

6.2 Overview of Analyses

The primary objective of this evaluation is to estimate the minimum long-term static FOS relative to global stability following implementation of the remedy, as described herein. As such, AMEC performed effective stress (i.e., long-term conditions) stability analyses using the Spencer method, a limit equilibrium analysis method that evaluates stability with respect to both moment equilibrium and horizontal force equilibrium.

First, long-term static stability was assessed for existing impoundment conditions to check and/or calibrate the SLOPE/W model. Multiple "runs" were evaluated for each profile, considering both circular (i.e., rotational) and composite (i.e., part circular and part planar) failure surfaces. Selected SLOPE/W output files (with the resulting minimum FOS and the critical slip surface) are provided in Appendix C.

Second, static stability was assessed considering the long-term post-remediation conditions following the installation of horizontal drain(s), excavation/unloading at the crest, and filling in central and western portions of the impoundment. Three potential modes of failure were evaluated for each profile, as applicable:

1. Impoundment dam crest to impoundment dam toe;
2. Fill slope crest to impoundment dam toe; and
3. Fill slope crest to fill slope toe.

Multiple model runs were evaluated for each failure mode, considering both circular and composite failure surfaces. Selected SLOPE/W output files are included in Appendix C.

6.3 Summary of Results

The results of our analyses indicate that the long-term static FOS is 1.50 or greater for long-term post-remediation conditions. The results are summarized in Table 6-1 below.

Table 6-1
Summary of Long-Term Static FOS for Post-Remediation Conditions

Profile	Potential Mode of Failure					
	Impoundment Dam Crest to Impoundment Dam Toe		Fill Slope Crest to Impoundment Dam Toe		Fill Slope Crest to Fill Slope Toe	
	Estimated Minimum FOS		Estimated Minimum FOS		Estimated Minimum FOS	
	Composite	Circular	Composite	Circular	Composite	Circular
S2	2.10	2.25	2.34	3.03	NA	NA
E1	1.60	1.72	1.84	2.80	2.87	3.25
E2	1.50	1.75	2.55	2.55	3.71	3.71
E3	1.50	1.76	2.30	3.42	3.60	3.60
E4	1.97	1.97	3.71	3.78	3.67	3.67
N1	1.65	1.88	2.24	2.35	NA	NA

These results satisfy the applicable regulatory standard FOS (1.50), indicating that the impoundment is expected to be stable following implementation of the remedy as described herein.

7.0 SEISMIC SLOPE STABILITY EVALUATION

AMEC performed a seismic slope stability evaluation of the Tailings Impoundment to support the Draft Final Design. The Draft Final Design calls for dewatering the impoundment via a series of horizontal drains, crest improvements, and installation of a low-permeability cover system. Groundwater modeling (Appendix A) indicates that the drains will effectively draw impoundment water levels down to the bottom of the tailings/top of the clay.

The evaluation of seismic slope stability was made via two distinct approaches/methods of analysis:

1. Pseudo-static stability analysis. This method simulates earthquake-induced loads via the inclusion of a *static* horizontal force in a limit equilibrium analysis and is considered appropriate based on dewatered tailings within 100 to 150 feet of the perimeter impoundment dam.
2. Post-earthquake stability evaluation. This method applies strength reductions to specific saturated soils to represent/model their behavior immediately after the earthquake.

The evaluation was made utilizing SLOPE/W (GeoStudio 2012, Version 8.12.3.7901), an industry-standard two-dimensional slope stability software program developed and distributed by Geo-Slope International, Ltd. The primary objective of this evaluation was to assess the minimum long-term seismic FOS of the impoundment relative to global (deep-seated) stability, considering the planned remediation. SLOPE/W model development, stability analyses, and results are summarized in the subsections below. Additional details, notes, and assumptions are provided in Appendix D.

7.1 Model Development

AMEC identified seven profiles of interest (designated S1, S2, E1, E2, E3, E4, and N 1) considering the existing impoundment dam configuration (i.e., steepness, height, etc.), the Draft Final Design, and the available geotechnical and hydro-geologic data. The profile locations are depicted on Figure C-1 in Appendix C.

7.1.1 Existing Conditions

AMEC developed existing conditions SLOPE/W models for Profiles S2, E1, E2, E3, E4, and N1 to support the Draft Final Design. Existing conditions model development is summarized in Section 6.1.1. Development details, notes, and assumptions are provided in Appendix C.

7.1.2 Long-Term Post-Remediation Conditions

Long-term post-remediation conditions were evaluated by modifying the existing conditions models based on the Draft Final Design, as follows:

1. The overall geometry (i.e., grading) was revised based on the proposed grading. The proposed grading is depicted on Figure C-1 in Appendix C.
3. Impoundment water levels were updated based on the locations and elevations of the proposed horizontal drains (Figure C-1) and the results of groundwater modeling (Appendix A).

7.2 Pseudo-Static (Seismic) Slope Stability Evaluation

A pseudo-static analysis can be used to evaluate the seismic response of earthen embankments. Numerous studies and field observations indicate that the pseudo-static method can be useful in evaluation of the performance of embankments constructed of (and on) soils that do not lose significant strength during an earthquake. Such soils include clays, clayey/cohesive soils, unsaturated cohesionless soils, and dense cohesionless soils.

The pseudo-static method simulates earthquake-induced inertial forces via the inclusion of a *static* horizontal force in a limit equilibrium analysis. The horizontal force is assumed to be proportional to the weight of the potential sliding mass times a seismic coefficient, k_h, expressed in terms of the acceleration (in units of *g*) of the underlying earth.

For long-term conditions, the design earthquake loading is based on a peak ground acceleration (PGA) associated with a probability of exceedance (PE) of 2% in 50 years (equivalent to a 10% PE in 250 years). The PGA is the maximum amplitude of the ground acceleration time-history. According to the United States Geological Survey's (USGS) 2014 seismic hazards mapping data, the applicable PGA for the site is 0.146*g*. Additional details are provided in Appendix D.

7.2.1 Overview of Analyses

The pseudo-static analysis method was employed to assess seismic stability based on the long-term post-remediation conditions. SLOPE/W was used to perform stability analyses using the Spencer method, a limit equilibrium method that evaluates stability with respect to both moment equilibrium and horizontal force equilibrium.

The long-term post-remediation static stability evaluation (Appendix C) yielded the lowest FOS for the impoundment dam crest to impoundment dam toe mode of failure considering composite (i.e., part circular and part planar) failure surfaces. As such, the pseudo-static analysis targeted an impoundment dam crest to toe mode of failure considering composite failure surfaces.

7.2.2 Summary of Results

The results of the pseudo-static analyses indicate a FOS of 1.12 or greater for long-term post-remediation conditions. The results are summarized in Table 7-1.

Table 7-1
Summary of Pseudo-Static (Seismic) FOS for Long-Term Post-Remediation Conditions

Profile	Estimated Minimum FOS
S2	1.57
E1	1.26
E2	1.14
E3	1.12
E4	1.36 (Shallow failure within waste rock dam face); 1.70 (Deep)
N1	1.31

These results satisfy the applicable regulatory standard FOS (1.00), indicating that the impoundment is expected to remain stable following implementation of the remedy and the resultant long-term steady-state impoundment water levels, as described herein.

7.3 Post-Earthquake (Seismic) Slope Stability Evaluation

Post-earthquake stability analyses were performed for Profile E3, which is considered the most critical profile, based on the results of the long-term static slope stability evaluation (Appendix C). With this method, strength reductions are applied to the initial/static strengths of applicable soils (i.e., soils that may be susceptible to liquefaction and/or cyclic softening), as described herein. A seismic coefficient is not applied. Instead, the reduced strengths model the behavior of the applicable soils following the earthquake.

7.3.1 Overview of Analyses

Two distinct scenarios were evaluated:

1. Long-term post-remediation conditions with predicted (Appendix A) steady-state impoundment water levels based on continued operation and maintenance of the horizontal drains.
2. Long-term post-remediation conditions with “rebounded” impoundment water levels based on an assumed failure of the horizontal drains (“doomsday” scenario).

The post-earthquake stability evaluation of the Tailings Impoundment was made utilizing SLOPE/W. The primary objective of the analysis is to estimate the minimum post-earthquake FOS, relative to global stability, for the long-term post-remediation conditions described herein. Additional details are provided in Appendix D.

7.3.2 Summary of Results

The results of the post-earthquake stability analyses indicate a FOS of 1.24 or greater for long-term post-remediation conditions, assuming continued operation and maintenance of the

horizontal drains. The results satisfy the applicable regulatory standard FOS (1.00), indicating that the impoundment is expected to remain stable during a design-magnitude seismic event following implementation of the remedy and development of long-term steady-state impoundment water levels, as described herein.

The "doomsday" scenario assumes that the bottom 5 to 10 feet of the tailings slimes becomes saturated due to a failure of the horizontal drains and that this saturated zone liquefies during the design earthquake (2% probability of exceedance in 50 years). The analyses indicate that the liquefied zone would have to maintain an undrained shear strength of 215 psf for a FOS of 1.00. We believe that the likelihood that all of the factors that come together to form the doomsday scenario is very remote. Further, the addition of EQ Drains, used to accelerate consolidations of the slimes in fill areas, will provide some benefit in mitigating the generation of excess pore pressures in the event this doomsday scenario were to develop.

8.0 GEOTECHNICAL INSTRUMENTATION AND MONITORING

The selected remedy for the Tailings Impoundment requires stabilization measures (e.g., dewatering and crest improvements) to improve stability. AMEC recommends the installation of geotechnical instrumentation at the perimeter toe of and within the Tailings Impoundment. This instrumentation will be installed prior to horizontal drain installation and construction to monitor the response of the Tailings Impoundment to dewatering and prior to the construction of the crest improvements to monitor stability, locally and globally, during construction.

The main components of the monitoring include the following:

- Visually observe and document conditions within and around the impoundment during construction;
- Monitor horizontal/lateral deformation along the impoundment fill slope toe and along the outer perimeter/toe of the impoundment dam;
- Monitor piezometric elevation head within the tailings prior to and during construction;
- Monitor pore pressure generation/dissipation in the tailings during fill placement;
- Monitor vertical settlement in the tailings during and following fill placement;
- Utilize the geotechnical monitoring data in conjunction with the visual observations to evaluate the response of the Tailings Impoundment during dewatering and construction and to adjust the rate of fill placement, as necessary, to promote stability.

The Tailings Impoundment currently contains installed instrumentation. It is anticipated that the existing instrumentation will be utilized during dewatering operations. Instrumentation in cut areas will likely be abandoned and/ or removed during construction. AMEC recommends that existing instrumentation be utilized during geotechnical monitoring, where possible. The existing instrumentation, within and at the toe of the impoundment, consists of monitoring wells, observation wells, standpipe piezometers, and vibrating wire piezometers.

AMEC proposes that the following supplemental/additional instrumentation be installed in support of the plan objectives as follows:

- 10 Slope Inclinometers;
- 7 Standpipe Piezometers;
- 6 Vibrating Wire Piezometer (VWP) Locations; and
- 8 Settlement Platforms.

Additional details are provided in the Geotechnical Monitoring Plan (Appendix E).

9.0 IMPOUNDMENT RE-GRADING/EARTHWORKS

9.1 Earthwork Details

The footprint of the Tailings Impoundment covers about 17 acres and contains approximately 716,000 cubic yards of material. The material was hydraulically placed during former mining operations with the central and western portion of the Tailings Impoundment consisting of saturated silt and clay size particles referred to as "slimes." The remaining portion of the Impoundment consists of silty fine sands which will be excavated and placed over the "slimes" area to achieve the required subgrade elevation. Perimeter dams along the north, east, and south perimeter of the impoundment were constructed of with cobble and boulder-sized waste rock with a diameter of approximately 5 feet. The proposed subgrade elevations have been established to remove waste rock and tailings along and adjacent to the dam crest to reduce instability immediately behind the dam that could contribute to failure. Investigation data indicates that the Tailings Impoundment consists of 5 to 60 feet of tailings material underlain by a native clay layer ranging in thickness of approximately 1 to 15 feet.

Information gathered during design investigations indicates that the rock dam encompassing the Tailings Impoundment was constructed in multiple stages (i.e., lifts). Site data suggests that the embankment was constructed in lifts on the order of 15-feet tall, and that each lift has a relatively limited width and/or a steep backslope (i.e., inside face). Test pit data indicate the toe of the Tailings Impoundment dam along the perimeter of the Tailings Impoundment rest directly on the underlying clay and does not appear to be keyed into this unit, and therefore, does not meet standard criteria for long-term stability.

Placement of excavated tailings across the "slimes" area will require the construction of a working platform to provide necessary stability for equipment access. The working platform will consist of an underlying crushed stone drainage layer and a gravel working surface. The drainage layer will collect discharge from the proposed vertical earthquake (EQ) drains to be installed within the "slimes" area to dissipate pore water pressure developed during fill placement. The crushed stone layer shall be installed to slope towards pre-determined sump locations which will collect and pump discharge water to the compost bioreactor ponds for treatment prior to release to the Goose Pond Estuary. The rate of fill placement within the "slimes" area will be controlled based on geotechnical monitoring of developed and dissipated pore water pressure.

Waste rock removed from the Tailings Impoundment perimeter berms shall be transported to the on-site quarry area located along the west side of the former mining operations area. Waste rock may be processed through crushing operations to produce crushed stone materials to be used in the construction of the working platform across the "slimes" area within the Tailings Impoundment. The proposed working platform will remain in place during fill placement and eventually covered with the infiltration barrier cap (low-permeability cover system).

Proposed subgrade elevations within the Tailings Impoundment have been developed to increase static and seismic stability as well as provide a balanced earthwork condition and avoid any import or export requirements to complete the remedy. Table 9-1 summarizes the anticipated earthwork volumes within the Tailings Impoundment.

Table 9-1 Tailings Impoundment Earthwork Summary

Material / Location	Cut (CY)	Fill (CY)
Waste Rock Removal	30,000	-
Tailings Impoundment Soils	164,000	150,000

The projected fill placement within the Tailings Impoundment is based on an anticipated 15,000 CY of settlement within the "slimes" material and an assumed compaction factor of 15% on placement of waste soils. Additional tailings soils may also be required to create a leveling surface on top of the waste rock prior to installation of the infiltration barrier cap. It is anticipated that the final design will balance the cut/fill and that offsite transportation and disposal will not be required. If necessary, excess Tailings may be stockpiled on the Site in a secure area and managed in accordance with an approved Soil Erosion and Sediment Control Plan (SESCP). The excess tailings would be incorporated into the final remedy for OU 3.

The planned cap limits/extents and grading are depicted in the design drawings provided in Appendix M. A maximum final grade/elevation of about +94.5 feet is indicated on the central-western area of the impoundment. From this apex, the western portion of the cap will slope downward gently at approximately 5% to the north and south, transitioning to 20% slopes near the impoundment dam perimeter. The eastern portion of the cap will slope downward at approximately 20% from west to east (toward a drainage swale feature). To the east of the swale, the cap will slope upward at approximately 33%, for a relatively short horizontal distance, and then transition to 3% near the eastern perimeter of the impoundment dam.

9.2 Short-Term (Temporary) Global Stability

AMEC performed a static slope stability evaluation to assess short-term global stability, considering specific conditions that may be applicable prior to and/or during construction of the remedy, to support the Draft Final Design. The Draft Final Design remedy calls for dewatering the impoundment via a series of horizontal drains, crest improvements, and installation of a low-permeability cover system.

The specific short-term conditions that were evaluated are as follows:

1. Construction of the proposed drill-pad (for installation and maintenance of horizontal drains), prior to dewatering and remedial construction operations, at the toe of the impoundment dam proximate to stability profile S2; and

2. Equipment load (i.e., large excavator) near the crest of the dam during the start of remedial construction (along critical profile E3).

The evaluation was made utilizing SLOPE/W, an industry-standard two-dimensional slope stability software program developed and distributed by Geo-Slope International, Ltd. The primary objective of this evaluation was to assess the short-term static FOS of the impoundment relative to global (deep-seated) stability, considering temporary site conditions. Additional details, notes, and assumptions regarding the development of existing conditions SLOPE/W models are provided in Appendix C.

9.2.1 Drill-Pad Stability Evaluation (Profile S2)

Construction of a drill-pad is proposed for the installation and continued maintenance of horizontal drains at the toe of the impoundment dam proximate to stability profile S2. The drill-pad is located approximately 120 feet from the toe of the impoundment dam, and consists of a trapezoidal excavation (in profile view) with 3H:1V side slopes and a 20 to 30-foot wide bottom. The bottom of the drill-pad is at approximately elevation +17 feet. A maximum cut, relative to existing grade, of approximately 10 feet is anticipated.

For this evaluation, the location of the drill-pad was hypothetically “projected” approximately 40 feet to the west, so that the bottom of the drill-pad (elevation +17 feet) fell along the S2 alignment. In its designed location, the drill-pad construction will result in a maximum cut of approximately 10 feet; however, if the drill-pad is projected to profile S2, the maximum cut, relative to existing grade along S2, is approximately 13 feet. Existing Tailings Impoundment conditions were utilized for this evaluation, as the drill-pad construction will occur prior to any dewatering or remedial construction activities.

Additional drill-pads are proposed along the toe of the impoundment dam; however, the other drill-pad locations will require minimal regrading and/or filling atop existing grade. As such, no other proposed drill-pad locations were evaluated.

Existing and proposed grading and the location of profile S2 are presented in Appendix C (Figure C-1).

The results indicate that the construction of the drill-pad, prior to dewatering and remedial construction activities, will reduce the FOS at profile S2 from 1.27 (see Appendix C) to 1.18. This condition will be valid/applicable for approximately one year, and the impoundment dam is expected to remain stable over that time period. The FOS will increase as the Tailings Impoundment is dewatered and as remedial construction (i.e., crest improvements) progresses. The pad is also of limited width (20 to 30 feet), however, a 2-dimensional analysis in the section was evaluated. If 3-dimensional effects on the stability are considered, the FOS would be considerably higher. The SLOPE/W output file is presented in Appendix F.

The drill-pads are anticipated to remain as permanent features to support maintenance of the horizontal drains. Refer to Appendices C and D for long-term static and seismic, respectively, stability of profile S2 with the proposed drill-pad.

9.2.2 Equipment Loading Stability Evaluation (Profile E3)

The effect of an equipment load approximately 30 feet from the crest of the impoundment dam on the static global stability of profile E3 (critical profile), prior to construction, was evaluated. The evaluation considered existing Tailings Impoundment topography (i.e., no crest improvements), anticipated groundwater conditions at the start of construction (i.e., groundwater elevations after approximately one year of dewatering via horizontal drains; see Appendix A), and an equipment surcharge load of 1250 psf (see Appendix F for assumed excavator weight and dimensions).

The results indicate that the FOS will increase from 1.03 (existing conditions; see Appendix C) to 1.07 with groundwater conditions at the start of construction and a 1250 psf surcharge load near the impoundment dam crest. Thus, the short-term, transient conditions prior to construction will not be worse than existing conditions along profile E3, and the impoundment dam is expected to remain marginally stable. The FOS is expected to increase as remedial construction (i.e., crest improvements) progresses. SLOPE/W output files are presented in Appendix F.

9.3 Settlement Evaluation

AMEC conducted a settlement evaluation, to assess the magnitude and time-rate of settlement (i.e., primary and secondary consolidation) of tailings slimes and re-worked/native clay resulting from the increased soil loading associated with the remedy, to support the Draft Final Design.

The remedy for the Tailings Impoundment calls for stabilization measures (e.g., dewatering and crest improvements) to improve global stability. The crest improvements require an extensive cut/fill operation; up to approximately 23 feet of waste rock and/or dewatered tailings will be removed from the perimeter impoundment dam crest and permanently relocated within central and western portions of the Tailings Impoundment beneath a low-permeability cover system. As a result, up to approximately 23 feet of waste rock and/or dewatered tailings will be placed (in lifts) and compacted atop approximately 10 to 40 feet of highly compressible, saturated tailings “slimes”, which overlay up to approximately 15 feet of native clay.

Based on the results of the evaluation, primary consolidation settlement may range from less than 6 inches (where minimal grade increase is expected) to a maximum of approximately 32 inches where grade is anticipated to be approximately 23 feet above existing grade. The average settlement is anticipated to be approximately 17 inches. The majority of the settlement should occur in the tailings slimes; settlement contribution from the native clay is expected to be 1.5 inches or less.

AMEC estimated the time required for primary consolidation (90% and 99%) to occur based on the Terzaghi theory of consolidation. It is anticipated that the time required to achieve 90% of primary consolidation of the slimes/clay under proposed subgrade fill ranges from approximately 1.5 months to 3.5 years; the time required to achieve 99% of primary consolidation ranges from approximately 3.5 months to 7.5 years per lift of fill. To reduce consolidation time, for

constructability purposes, prefabricated vertical drains (PVDs) (i.e., wick drains, EQ drains, etc.) should be installed in proposed fill areas.

Secondary consolidation settlement in the proposed fill area is expected to range from 1 to 2 inches over a time span of approximately 50 years.

Additional details, assumptions, methodology, and results are presented in Appendix G.

9.4 EQ Drains

AMEC performed an evaluation to determine the spacing requirements for the proposed prefabricated vertical drains (PVDs) to be installed within proposed fill areas of the Tailings Impoundment.

Appendix G to the BOD presents the results of a settlement evaluation that indicate an average of approximately 17 inches of settlement will occur under the weight of the proposed fill. The estimated time for 90 percent consolidation is approximately 3.5 years, at a maximum, per lift of fill. The staged construction stability (presented in Appendix J) relies on the efficient dissipation of excess pore pressures so that additional lifts of fill can be placed safely. In order to accelerate consolidation, for constructability purposes, PVDs will be required in fill areas.

The PVD evaluation was performed using methods outlined in FHA (1986) and Bergado, et al (1996). The evaluation assesses the time to achieve 90 percent of the average consolidation through radial drainage. The recommended PVD is a 3-inch diameter Earthquake (EQ) Drain manufactured by Hayward-Baker (HB) Wick Drains.

Through a number of iterations, it was determined that an EQ Drain spacing of 6 feet, installed in a triangular pattern, will allow the tailings to achieve an estimated 90 percent average consolidation in 12 to 28 days, based on a range in the horizontal coefficient of consolidation (c_h) of 1 to 5 ft^2/day. The calculations supporting the EQ Drain evaluation are included in Attachment H.

The EQ Drains will also provide protection against liquefaction, allowing pore pressures in saturated tailings to dissipate quickly, in the event of an earthquake. However, the recommended EQ Drain spacing above was based solely on accelerating pore pressure dissipation for construction, not based on dissipating pore pressures in the event of a design magnitude earthquake.

The recommended EQ Drain layout and details are provided in the Design Drawings in Appendix M and in the project Specifications provided in Appendix N.

9.5 Working Surface/Haul Road Across Tailings

The placement of fill over very soft slimes in the central portion of the Tailings Impoundment will require the construction of an initial working surface/pad. This working surface will be

necessary to allow placement of subsequent lifts of fill, as well as to allow installation of the EQ Drains and geotechnical instrumentation. The aerial extent of the working surface is shown in the Design Drawings. AMEC has performed a conceptual evaluation of the feasibility of constructing a working surface to support the low ground pressure equipment that the contractor will likely need to perform the work. This evaluation has identified several items that will be necessary in order to construct the working surface. The items are as follows:

- A non-woven geotextile on the existing tailings surface to act as a separation between the tailings and surficial organics and the high permeability drainage layer above it;
- A geogrid reinforcement layer to support the weight of the fill and construction equipment;
- AMEC recommends the working surface be composed of the following:
  - A one foot thick, highly permeable drainage layer consisting of crushed stone from quarrying operations on site, meeting the requirements of MDOT 703.02 gradation AA ¾ inch Crushed Stone;
  - A surface layer of 1 to 2 feet of additional crushed stone (D_{50} of approximately 1 to 2 inches), with thickness and gradation depending on the type and size of equipment the contactor proposes to use to construct the working pad and install the EQ Drains and instrumentation;
- The EQ Drains shall be installed following the construction of the working surface, and terminated within the working surface, or additional crushed stone should be placed around and atop the EQ Drain terminations for drainage and protection; and
- The required geotechnical instrumentation shall be installed after the working pad has been constructed and the EQ Drains have been installed.

Preliminary working surface calculations are presented in Appendix I. A conceptual design detail is presented in the Design Drawings. The contractor will be required to submit a plan and design for the working surface, as well as the means and methods proposed to construct the pad, including the type of equipment proposed, the methods for placement of the fill, and the equipment and methods proposed for installation of the EQ Drains. The thorough plan shall also address the penetration of the geogrid and geotextile with the EQ Drain installation equipment. Based on the results of this evaluation, it is anticipated that careful construction techniques will need to be employed by a contractor with experience in soft ground construction.

9.6 EQ Drainage Collection System

Placing fill atop tailings slimes will generate excess pore water pressures in the slimes and underlying native clay. These pore pressures will be allowed to dissipate, via radial (horizontal) drainage, to the EQ Drains. The pore pressures will force the water up and out of the drains at the surface. The top of the EQ Drains will be fitted with an elbow and terminated in a highly permeable crushed stone blanket. Discharge from the drains will flow across the surface of the slimes through the drainage layer toward several sumps (collection manholes). The sumps are

located in areas of the site that are likely to experience the most settlement. The contractor will utilize these sumps to pump the expelled pore water from consolidation of the slimes to the compost bioreactor treatment units.

The amount of pore water that is expected to be generated is on the order of 2.2 million gallons total. This volume represents the total volume of estimated settlement across the slimes fill area. The pore water will only be expelled during and following fill placement as consolidation occurs. The pore water generation is expected to be greatest immediately following placement of a lift of fill and should slowly diminish as consolidation progresses. When the next lift of fill is placed, the fluid generation will again increase. The flow quantity indicated above is only that generated from the consolidation process. Fluid volume from precipitation is not included.

The collection manholes will need to be raised during fill placement so that the temporary pumps can be accessed. After fill placement and consolidation are complete, the manholes will be abandoned in-place and filled with crushed stone.

9.7 Fill Embankment Stability

Excavated material generated from the crest improvements will be placed on top of the existing tailings slimes in central and western portions of the impoundment in a balanced cut-fill operation. This filling operation will have to proceed slowly and methodically in a staged construction process, whereby thin lifts of fill are placed, followed by a wait period to allow the tailings to consolidate and gain strength such that additional lifts of fill can be placed. The analyses included in Appendix J provide the details of a staged construction stability evaluation that was made to document the prescribed maximum lift thicknesses, wait periods, and reinforcing that will be required in order to complete the filling operation. The analyses were performed using two distinct approaches/methods of analysis:

1. An Effective Stress Analysis (ESA) was performed utilizing drained shear strength (i.e., friction angle, ϕ') in the slimes, in conjunction with estimates of the excess pore pressures generated within the tailings during fill placement; and
2. An Undrained Strength Analysis (USA) was performed utilizing undrained shear strength (i.e., cohesion) in the slimes, in conjunction with estimates of strength gain due to consolidation of the slimes induced by the fill loads.

The ESA utilized drained strength parameters of the tailings and an estimate of excess pore pressures that will develop during filling. As fill is placed on top of the tailings slimes, the pore water within the slimes matrix will initially take the weight of the overlying fill, and thereby generate “excess” pore pressures. These excess pore pressures will reduce the effective stress in the stratum and thereby reduce the available mobilized shear resistance. As the slimes consolidate, the excess pore pressures will dissipate and lead to an increase in the effective stress and ultimately higher factors of safety.

The analyses performed for the effective stress analysis provide an estimate of the factor of safety during the initial fill placement when the excess pore pressures are highest and at

subsequent periods following fill placement when these pore pressures have dissipated to levels of 50 percent and 10 percent of the initial excess pressure. The analyses indicate that lift thicknesses of 2 feet can be placed, and that subsequent lifts cannot be placed until the pore pressures have reduced to 10 percent or less of the initial excess pressure (i.e., 90 percent consolidation). Pore pressures will be monitored by instrumentation installed as part of the geotechnical monitoring plan (Appendix E). As discussed in Appendix H, EQ Drains will be required at 6 foot spacing in order to accelerate the dissipation of excess pore pressure within the stratum.

The USA of the staged construction was performed using estimates of the undrained shear strength of the tailings slimes. The strengths used were based on in situ vane shear and CPT testing, and the laboratory triaxial shear testing on the slimes, Mactec (2009a) and Credere (2012). As with the effective stress analysis, it is assumed that PVDs will be installed within the slimes stratum, in fill areas, to accelerate the consolidation.

The USA utilized undrained strength parameters of the tailings slimes (i.e., the slimes behave as a purely cohesive material). In this case, the effects of pore pressure generated during the fill placement will not influence the available strength. The analyses assume that the slimes will gain shear strength as they consolidate under the weight of the overlying fill. This rate of strength gain is based on an undrained strength ratio (c/p') described in Appendix J.

Based on the results of the USA, AMEC recommends fill placement in 2-foot lifts with biaxial geogrid every 2 feet.

9.8 Geotechnical Monitoring, Rate of Fill Placement and Stability

The EQ Drain analysis indicates that the wait period between lifts of fill will be on the order of 2 to 4 weeks in order to consolidate the slimes sufficiently (90 percent consolidation), such that additional lifts of fill can be placed. This wait time will also be dependent on the results of the geotechnical monitoring program that will be implemented during the fill placement. The results of inclinometer measurements of horizontal deformations, piezometers measurements of excess pore pressures, and settlement platform measurements of vertical deformation will be evaluated continuously during construction. The wait time between lifts will be extended if the results of geotechnical monitoring indicate unacceptable deformations and/or development of excess pore pressures above prescribed limits. It will therefore be necessary to include a provision in the contract that dictates that fill placement will ultimately depend on careful evaluation of the monitoring data and that the monitoring results ultimately dictate acceptable fill placement rates.

Construction atop the tailings slimes will require a specialty geotechnical contractor with demonstrated experience dealing with soft ground construction and installation of vertical EQ Drains. The selected contractor shall also have or retain expertise in the installation and monitoring of geotechnical monitoring instrumentation and interpretation of the monitoring data. It is recommended that prospective bidders for this construction be pre-qualified. It is also recommended that an independent, third party geotechnical consultant be retained to review the monitoring data and oversee fill placement.

10.0 ON-SITE QUARRY

This design includes the use of onsite quarrying, to minimize the importation of large volumes of construction materials needed for the project. The quarry area will be located at Dyer Hill, west of the Ore Pad Haul Road and north of the Ore Pad. Processed material for the Tailings Impoundment remediation will be produced through drilling, blasting, and crushing of virgin bedrock. Waste rock scheduled to be removed from the Tailings Impoundment may also be processed utilizing crushing equipment to produce materials scheduled for placement beneath the infiltration barrier or low-permeability cap (i.e. working platform). The crushing operations and staging area will be located just south of the proposed Quarry Area on the Ore Pad as shown on the Drawings. This Draft Final Design includes the original conceptual design outlined in the 30% design and has not been advanced to allow for Contractor developed means and methods to most effectively produce the required materials for the project. The selected contractor for the remediation will be required to provide a full Quarry Design and Restoration Plan that complies with state and federal regulations, primarily following the Performance Standards for Quarries, Article 8-A of the Maine Revised Statues for Title 38: Waters and Navigation.

The onsite quarry and crushing operations will provide all stone and gravel materials necessary to complete the Tailings Impoundment remedy. Table 10-1 summarizes the anticipated materials and estimated volumes to be produced.

Table 10-1 On-Site Quarry Summary

Material Type	Estimated Volume (CY)
Infiltration Cap Barrier Protection Layer	32,000
Working Platform	10,000
Crushed Gravel	2,000
Underdrain Gravel	15,000

From the face of the existing Ore Pad Haul Road, the Quarry Area will be cut back towards to the 100-foot property line setback, as shown in the Drawings, covering an area of approximately 76,500 square feet. Approximately 70,000 cubic yards of rock could be produced during excavation and blasting from this area and the actual volume produced will be based on Contractor means and methods to produce the required material from on-site resources.

The proposed Quarry Area covers an area of abundant andesite. Other areas of the Callahan site, just north of the proposed Quarry Area, are dominated by rhyolite. Rhyolite is a very hard mineral formed from silica-rich magma, making it more difficult to process, and has been avoided in the quarry area footprint.

The onsite quarrying and crushing approach was chosen to utilize natural resources and minimize the amount of heavy-truck traffic bringing material onto the site over the narrow and twisting local roads. The quarry procedures will result in construction related concerns (e.g.

natural resource encroachment, noise, dust, erosion and sediment transport, reclamation and blasting) which will be controlled under the design guidelines listed in the Performance Standards for Quarries, Article 8-A. Protective measures to be provided in the remedial contractors Quarry Plan will include the following:

- A 100-foot wide buffer strip maintained between area of excavation and property boundaries.
- A 100-foot wide buffer maintained between the area of excavation and high-water line of Dyer Pond.
- a pre-blast survey will be conducted using a minimum radius of ½ a mile from the blast site.
- A designated area for crushing and staging procedures.
- Chain link fence surrounding the construction area.
- Diversion swales to convey any stormwater runoff from the construction site to a possible sediment trap or stormwater detention pond.
- Standards for noise levels so that applicable noise limits are not exceeded.
- Dust control measures implemented by watering or other best management practices for control of fugitive emissions.
- Restoring the affected land back to a condition compatible with the existing conditions. The quarry face will be left in a condition that minimizes the possibility of rock falls, slope failures and collapse

A fall/winter quarry operation is preferred, to minimize impacts on local seasonal residences and could be more cost effective. With the implementation of these protective measures, neighboring properties and water bodies will be protected from negative environmental impacts and environmental standards for human health and safety will be met.

11.0 LOW PERMEABILITY COVER SYSTEM

11.1 Cap Overview

The main design objectives for the Tailings Impoundment remedy, as described in the OU 1 ROD, include reducing the contaminant load to the Goose Pond Tidal Estuary and stabilization of the Tailings Impoundment through crest improvements and dewatering to improve both static and seismic stability and thereby minimize the potential for a slope failure to occur. Minimizing infiltration and prohibiting surface water runoff from coming in contact with tailings material will assist in achieving both to these objectives.

Upon completion of earthwork activities, an Infiltration Barrier Cap or low permeability cover system will be installed within the limits of the Tailings Impoundment. The following table summarizes the proposed cap components that will be installed to achieve the remedial objectives:

Cap Component	Proposed Material
Protective Layer	15-inch layer of Stone (D50=4”)
Geocomposite Drainage (i.e., cushion) Layer	Transmissivity ≥ 1.7 x 10-3 cm2/s
Two-Layer Low Permeability Layer	60-mil Linear Low Density Polyethylene (LLDPE) Membrane underlain by a Geosynthetic Clay Liner Hydraulic Conductivity ≤ 5 x 10-9 cm/s

The Infiltration Barrier Cap will prevent surface runoff from coming in contact with tailing materials and be directed from the cap area through drainage swales that will discharge to stormwater treatment ponds prior to final release into the Goose Pond Estuary. The cap will also significantly reduce infiltration into the Tailings Impoundment and allow horizontal drains to create and maintain low water levels in the impoundment; hence improving overall static and seismic stability.

11.2 Geomembrane Puncture Protection

AMEC has performed a Geomembrane Puncture Evaluation to support of the Draft Final Design. The purpose of the evaluation was performed to verify the 15-inch Protective Layer (D_{50}=4”) will not subject the 60-mil Linear Low Density Polyethylene Membrane to puncture during or after remediation activities are complete.

The proposed protection layer will be placed in a single lift directly on the Geocomposite Drainage Layer (GDL) utilizing a low ground pressure dozer. However, construction/haul trucks delivering material for placement will exert a larger force on the geomembrane when driven directly on the installed 15-inch Protection Layer. An analysis was completed to evaluate the puncture resistance of the geomembrane during the described construction loading. The

puncture resistance index property determined by ASTM D 4833 was reduced by a factor of four for the analysis to provide a conservative factory of safety against puncture. Additionally, the protective effects of the overlying Geocomposite Drainage Layer (GDL) were ignored in the evaluation. Refer to Appendix K for complete technical memorandum and supporting calculations indicating the proposed cover system will not subject the LLDPE Geomembrane to puncturing during or after remediation activities.

11.3 Interface Friction Analysis

AMEC has performed an interface stability evaluation in support of the Draft Final Design. The purpose of the evaluation is to establish the interface strength parameters necessary to provide for acceptable interface stability within the proposed low-permeability cover system.

The analyses performed for the 5% slopes indicate the following minimum required interface strength parameters (assuming no cohesion):

- Peak Strength = 8.0 degrees; and
- Residual Strength = 7.0 degrees.

The analyses performed for the 20% slopes indicate the following minimum required interface strength parameters (assuming no cohesion):

- Peak Strength = 16.5 degrees; and
- Residual Strength = 15.0 degrees.

The analyses performed for the 33.3% slopes indicate the following minimum required interface strength parameters (assuming no cohesion):

- Peak Strength = 23.5 degrees; and
- Residual Strength = 21.5 degrees.

A reduction in the peak and/or residual friction angles may be justified based on the inclusion of interface cohesion

11.4 Drawings and Technical Specifications

Following is the list of Drawings (Appendix M) and Technical Specifications (Appendix N) developed for the Draft Final Design:

LIST OF DRAWINGS

G-001	COVER SHEET
G-002	LEGEND ABBREVIATIONS AND GENERAL NOTES
C-101	OVERALL SITE PLAN
C-102	EXISTING CONDTIONS PLAN – TAILINGS IMPOUNDMENT

C-103 EXISTING CONDITIONS PLAN – TAILINGS IMPOUNDMENT
C-104 OVERALL HORIZONTAL DRAIN PLAN
C-105 HORIZONTAL DRAIN PAD GRADING PLAN
C-106 HORIZONTAL DRAIN PAD GRADING PLAN
C-107 HORIZONTAL DRAIN PROFILES
C-108 HORIZONTAL DRAIN PROFILES
C-109 HORIZONTAL DRAIN PROFILES
C-110 WORKING SURFACE, EQ DRAIN AND GEOTECHNICAL MONITORING PLAN
C-111 CAP SUBGRADE AND EROSION CONTROL PLAN
C-112 CAP SUBGRADE AND EROSION CONTROL PLAN
C-113 FINAL GRADING AND DRAINAGE PLAN
C-114 FINAL GRADING AND DRAINAGE PLAN
C-115 CAP CROSS SECTIONS
C-116 CAP CROSS SECTIONS
C-117 ON-SITE QUARRY PLAN
C-301 CIVIL DETAILS
C-302 CIVIL DETAILS
C-303 COMPOST BIOREACTOR AND HORIZONTAL DRAIN DETAILS
C-304 COMPOST BIOREACTOR AND HORIZONTAL DRAIN DETAILS
C-305 EQ DRAIN AND WORKING SURFACE DETAILS DETAILS
C-306 SOIL EROSION AND SEDIMENT CONTROL DETAILS
C-307 SOIL EROSION AND SEDIMENT CONTROL NOTES
C-308 CAP DETAILS

LIST OF SPECIFICATIONS

DIVISION 1 – GENERAL REQUIRMENTS

01 11 00 Summary of Work
01 33 00 Submittal Procedures
01 41 00 Regulatory Requirements
01 45 00 Contractor Quality Control
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03 37 13 Shotcrete

DIVISION 31 – EARTHWORK

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31 25 00	Erosion and Sediment Control
31 35 26.15	Geosynthetic Clay Liner

DIVISION 32 – EXTERIOR IMPROVEMENTS

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DIVISION 33 – UTILITIES

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33 41 00	Storm Culvert Piping
33 46 16.16	Geocomposite Drainage Layer
33 49 00	Precast Concrete Structures
33 20 00	Vertical Earthquake Drains

12.0 STORMWATER

12.1 Existing Stormwater Management

The Tailings Impoundment drainage area covers approximately 39 acres consisting of pervious cover including gravel, bare earth, and woodlands. Existing stormwater flows into the impoundment area from a steep hillside located along the western edge. Refer to Figure 1 Existing Conditions Watershed Map included in Appendix O. Drainage within the Tailings Impoundment generally flows to the north and exits via a 48-inch CMP culvert. This culvert discharges to a steep rock lined swale leading to an existing wetland prior to ultimate discharge to the downstream Goose Pond Estuary. Surface erosion within the Tailings Impoundment is believed to be the most significant source of sediment contamination within the receiving estuary. Refer to Appendix O for complete HydroCAD model results of the existing drainage conditions within the defined watershed of the Tailings Impoundment.

12.2 Post-Remediation Stormwater Management

Remediation of the Tailings Impoundment will incorporate an infiltration barrier cap (low permeability cover system) to eliminate surface water runoff from coming in contact with the underlying tailings material. Post-remediation stormwater management will incorporate a series of swales, existing culverts, and stormwater treatment ponds, and constructed wetlands to convey stormwater around and away from the Tailings Impoundment. Refer to Figure 2 Post Remediation Watershed Map included in Appendix O. The proposed swales have been designed to provide adequate capacity to convey the 100-year storm event and the proposed crushed stone Protective Layer will provide adequate stability to control surface erosion during high flow events. The stormwater treatment ponds have been designed in accordance the Maine Department of Environmental Protection BMP Stormwater Manual. Refer to Appendix O for stormwater design technical memorandum and complete HydroCAD model results for post-remediation conditions.

12.3 Flood Protection

The Tailings Impoundment is located outside the 100-year floodplain and is not subject to flooding from the adjacent estuary. Run-on from the adjacent hillside will be diverted around the work area during construction to reduce the volume of stormwater coming in contact with the tailings materials. Stormwater within the Tailings Impoundment during construction will be collected in sumps and directed to temporary sedimentation basins prior to discharging to the estuary.

13.0 OTHER CONSIDERATIONS

13.1 Site Perimeter

The Site is located in a relatively isolated location on the northwest side of the Cape Rosier peninsula on Penobscot Bay. The Site includes the former Callahan Mine property, an elongated 120-acre property oriented north-south and accessed from Goose Falls Road. Goose Pond and Holbrook Island Sanctuary State Park are immediately east of the site property.

The site is accessed from Goose Falls Road. Private residences and seasonal homes are located adjacent to the site property on Goose Falls Road and Cape Rosier Road.

Site security will be established during the mobilization phase. A perimeter fence line will be established as indicated on the Design Drawings. Where new fence is required on the exterior property border, an 8-foot chain-link fence will be installed. Construction signage will be provided in accordance with MaineDOT requirements.

13.2 Site Access

Existing Site ingress and egress locations will be utilized during construction as indicated on the Design Drawings. Construction signage will be provided in accordance with MaineDOT requirements.

13.3 Temporary Site Utilities

In support of remedial activities, water, sanitary sewer, electrical, and telephone/internet feeds will be required. Sanitary facilities will likely be provided using portable toilet facilities or restrooms provided in office trailers onsite. Electrical power will likely be brought into the Site by using portable generators and/or from existing infrastructure by temporary overhead lines. Bottled drinking water will be provided by individual Contractors. Site water for construction and dust suppression activities will be trucked in, or obtained from existing on-site wells.

13.4 Traffic Control

The site is accessed from Goose Falls Road. Construction signage will be provided in accordance with MaineDOT requirements.

On-site traffic associated with remedial activities will be controlled by using designated routes. These routes will be marked using orange snow fence, traffic barricades, jersey barriers, signage, and/or other types of traffic control devices, to ensure that the traffic associated with the remediation will be managed within the designated areas.

13.5 Dust Control

Dust control is a required component of the Tailings Impoundment Remedial Design. Dust is expected to be controlled during remedial work using one or more of the following measures, as appropriate:

- Covering the perimeter security fence with a fabric to provide a wind barrier screen;
- Closely managing all field activities to ensure compliance with good housekeeping practices;
- Operating effective dust monitoring procedures and responding to elevated dust levels;
- Limiting the size of the active excavation face;
- Applying water (or other dust control agents) to roadways, gravel surfaces, the backfill surface or exposed subgrades;
- Keeping the excavation face moist;
- Covering the inactive excavation face with a spray-on sealer to prevent drying or erosion;
- No stockpiles;
- Covering and cleaning trucks;
- Minimizing haul distances onsite;
- Controlling speed of construction equipment;
- Sweeping and watering traffic areas;
- Washing excavation tools and road surfaces regularly;
- Keeping imported backfill moist and covered to reduce nuisance dust; and
- Placement of final cover as soon as practicable.

Real-time air monitoring for dust will be required and will be addressed in the Remedial Construction Contractor's perimeter air monitoring program.

14.0 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARAR)

The ARARS tables from the OU 1 ROD are included herein.

Table 59
Location-Specific ARARs for OU1 Remedial Action (Alternative CMS2)
Capping of Tailings Impoundment; Off-Site Disposal of PCB and Petroleum Contaminated Soil; Subaqueous Disposal of Source Area Material (from the Ore Pad, Mine Operations Area, and WRP-3), Residential Use Area Soil, and Sediment in a Confined Aquatic Disposal (CAD) Cell in the Former Mine Pit

Regulatory Authority	Location Characteristic	Requirement	Status	Requirement Synopsis	Action to be Taken to Attain Requirement
Federal	Navigable waters	Rivers and Harbors Act of 1899 (33 U.S.C. § 403 *et seq.*; 33 C.F.R. Parts 320-323)	Relevant and Appropriate	Section 10 of the Rivers and Harbors Act prohibits unauthorized obstruction or alteration of navigable waters. No activity that impacts waters of the United States shall be permitted if a practicable alternative that has less adverse impact exists. If there is no other practicable alternative, the impacts must be mitigated.	Site activities will be designed and implemented to avoid obstruction and minimize alteration of navigable waters during dredging and CAD disposal. Disturbed areas may be restored.
Federal	Wetlands and aquatic habitats	Clean Water Act, Sec 404 (33 U.S.C. § 1344); Section 404(b)(1) Guidelines for Specification of Disposal Sites for Dredged or Fill Material (40 C.F.R. Parts 230 and 231 and 33 C.F.R. Parts 320-323)	Applicable	These regulations outline the requirements for the discharge of dredged or fill materials into surface waters including Federal jurisdictional wetlands. No activity that impacts waters of the United States shall be permitted if a practicable alternative that has less adverse impact exists. If there is no other practicable alternative, the impacts must be mitigated.	The dredging/excavation of Goose Pond sediments and salt marsh will result in the unavoidable destruction of existing Federal jurisdictional wetlands and aquatic habitats; although during remedial design the effects of remedial activities on the wetlands and aquatic habitats will be evaluated and minimized. Compensatory habitat mitigation will be performed, including the removal of mine waste from Dyer and Goose Coves to comply with this ARAR. The selected remedy (CMS2) has been identified as the least damaging practicable alternative as it achieves the remedial action objectives with the lowest degree of permanent wetland loss in the salt marsh and Goose Pond. Deposition of material into the CAD cell will also comply with these standards regarding the filling of aquatic habitats. The alteration of any freshwater Federal jurisdictional wetlands will also be addressed under these standards. A final determination of Federal jurisdiction and any additional wetland mitigation, beyond the Dyer and Goose Cove restorations, will be made during the predesign phase.

Table 59

Location-Specific ARARs for OU1 Remedial Action (Alternative CMS2)

Capping of Tailings Impoundment; Off-Site Disposal of PCB and Petroleum Contaminated Soil; Subaqueous Disposal of Source Area Material (from the Ore Pad, Mine Operations Area, and WRP-3), Residential Use Area Soil, and Sediment in a Confined Aquatic Disposal (CAD) Cell in the Former Mine Pit

Regulatory Authority	Location Characteristic	Requirement	Status	Requirement Synopsis	Action to be Taken to Attain Requirement
Federal	Surface waters and wetlands	Fish and Wildlife Coordination Act (16 U.S.C. § 661 *et seq.*)	Applicable	This Act requires Federal agencies involved in actions that will result in the control of structural modification of any stream or body of water for any purpose, to take action to protect the fish and wildlife resources that may be affected by the action. USEPA must consult with appropriate Federal and State resource agencies to ascertain the means and measures necessary to mitigate, prevent, and compensate for project-related losses of fish and wildlife resources and to enhance the resources.	Measures to mitigate or compensate adverse project-related impacts to fish and wildlife resources will be taken, if determined necessary. The appropriate Federal and State resource agencies will be consulted.
Federal	Coastal zone	Coastal Zone Management Act (16 U.S.C. § 1451 *et seq.*)	Applicable	This Act requires activities in the designated coastal zone be conducted in a manner consistent with coastal zone management plans.	The substantive environmental requirements of this standard will be achieved.
Federal	Historic protection	National Historic Preservation Act of 1966 (16 U.S.C. § 470 *et seq.*); Protection of Historic Properties (36 C.F.R. Part 800)	Applicable	Section 106 of the NHPA requires Federal agencies to take into account the effects of their undertakings on historic properties and afford the Advisory Council on Historic Preservation a reasonable opportunity to comment.	Features with potential historical/cultural significance will be evaluated during the remedial design phase. Should this alternative impact historical properties/structures protected by these standards activities will be coordinated with the Advisory Council on Historic Preservation.
State	Natural resources	Maine Natural Resources Protection Act (NRPA) (38 M.R.S.A. §§ 480-A to 480-Z)	Applicable	The NRPA regulates activities affecting protected natural resources: coastal sand dune systems, coastal wetlands, significant wildlife habitat, fragile mountain areas, freshwater wetlands, great ponds and rivers, streams or brooks. The NRPA regulates the disposal of dredge spoil in coastal wetlands.	Remedial activities affecting regulated natural resources, particularly the alteration of coastal and freshwater wetlands from capping and dredging activities, as well as disposal in the CAD cell, will meet substantive environmental standards under the Act.

Table 59
Location-Specific ARARs for OU1 Remedial Action (Alternative CMS2)
Capping of Tailings Impoundment; Off-Site Disposal of PCB and Petroleum Contaminated Soil; Subaqueous Disposal of Source Area Material (from the Ore Pad, Mine Operations Area, and WRP-3), Residential Use Area Soil, and Sediment in a Confined Aquatic Disposal (CAD) Cell in the Former Mine Pit

Regulatory Authority	Location Characteristic	Requirement	Status	Requirement Synopsis	Action to be Taken to Attain Requirement
State	Wetlands	Maine NRPA, Wetlands Protection Rule (06-096 C.M.R., Chapter 310)	Applicable	The regulations prohibit activities which would have an unreasonable impact on wetlands (or within 75 feet of the outer boundary of the wetland) or cause a loss in wetland area, functions, and values. Under the Rules, "Wetlands of Special Significance" are defined as all coastal wetlands and great ponds as well as certain freshwater wetlands which include (a) Significant wildlife habitat, as defined by 38 M.R.S.A. § 480-B(10); (b) A freshwater wetland area located within 250 feet of a coastal wetland; (c) A freshwater wetland containing under normal circumstances at least 20,000 square feet of aquatic vegetation, emergent marsh vegetation or open water; (d) Wetlands subject to flooding during a 100-year flood event; and (e) A freshwater wetland area located within 25 feet of a river, stream, or brook. If there is no practicable alternative, there must be minimal alteration of the wetland and compensation (off-setting) may be required.	Function and value assessments will be performed, if necessary, for existing freshwater and coastal wetland/habitat, particularly any "Wetlands of Special Significance." The impacts associated with excavation of the sediments as part of this alternative are unavoidable and efforts will be made to minimize adverse effects on wetlands. Restoration actions will be taken to restore natural and beneficial values of the wetlands through the removal of mine wastes from Dyer and Goose Coves. A final determination of State jurisdiction and any additional wetland mitigation, beyond the Dyer and Goose Cove restorations, will be made during the predesign phase.
State	Wetlands Surface Waters	Maine NRPA, Permit-by-Rule Standards (06-096 C.M.R., Chapter 305)	Applicable	This rule prescribes standards for specific activities that may take place in or adjacent to wetlands and water bodies. The standards are designed to ensure that the disturbed soil material is stabilized to prevent erosion and siltation of the water.	Response actions will be performed to minimize impacts to freshwater and coastal wetlands or water bodies.

Table 59
Location-Specific ARARs for OU1 Remedial Action (Alternative CMS2)
Capping of Tailings Impoundment; Off-Site Disposal of PCB and Petroleum Contaminated Soil; Subaqueous Disposal of Source Area Material (from the Ore Pad, Mine Operations Area, and WRP-3), Residential Use Area Soil, and Sediment in a Confined Aquatic Disposal (CAD) Cell in the Former Mine Pit

Regulatory Authority	Location Characteristic	Requirement	Status	Requirement Synopsis	Action to be Taken to Attain Requirement
State	Shoreland areas	Maine Mandatory Shoreland Zoning Act (38 M.R.S.A. §§ 435-449; 06-096 CMR Chapter 1000)	Applicable	This Act protects and conserves shoreland areas by controlling activities within 250 feet of high water mark, as defined in State law.	Measures will be taken during selection, design, and implementation of remedial actions to comply with the substantive environmental requirements under the Act.
State	Subtidal, tidal, and filled tidal lands	Submerged and Intertidal Lands Act (12 M.R.S.A. §§ 1861-1867)	Applicable	The statute establishes the State's ownership and management of submerged, intertidal, and filled tidal land throughout the State.	The substantive environmental requirements of this standard will be achieved, including the development of land use restrictions for State submerged lands to protect the CAD cell, if required by the remedy.
State	Coastal zone	Coastal Management Policy Act (38 M.R.S.A. § 1801 *et seq.*)	Applicable	This Act provides for the regulation, conservation, beneficial use, and management of coastal resources.	The substantive environmental requirements of this standard will be achieved.
State	Facility siting	Maine Site Location of Development Law and Regulations (38 M.R.S.A. §§ 481-490. Also 06-096 C.M.R. Chapters 374 and 375)	Applicable	These regulations apply to control activities at certain developments so that there are minimal adverse impacts to natural resources, including erosion and sedimentation control, noise control, historic protection, and air quality control. Metallic mineral mining is designated as development of State or regional significance that may substantially affect the environment.	The selected remedy will comply with applicable environmental requirements. Storm water management, erosion and sedimentation controls, and traffic controls will be designed and implemented so that adverse effects on natural resources are minimized.

Notes:
ARAR = Applicable or Relevant and Appropriate Requirement
C.F.R. = Code of Federal Regulations
C.M.R. = Code of Maine Regulations
ME DEP = Maine Department of Environmental Protection
M.R.S.A. = Maine Revised Statutes Annotated
U.S.C. = United States Code
USEPA = U.S. Environmental Protection Agency

Table 60

Chemical-Specific ARARs and TBCs for OU1 Remedial Action (Alternative CMS2)

Capping of Tailings Impoundment; Off-Site Disposal of PCB and Petroleum Contaminated Soil; Subaqueous Disposal of Source Area Material (from the Ore Pad, Mine Operations Area, WRP-3), Residential Use Area Soil; and Sediment in a Confined Aquatic Disposal (CAD) Cell in theFormer Mine Pit

Regulatory Authority	Chemical Medium	Requirement	Status	Requirement Synopsis	Action to be Taken to Attain Requirement
Federal Criteria, Advisories and Guidance	Soil and sediment	U.S. Environmental Protection Agency (USEPA) Risk Reference Doses (RfDs)	To Be Considered	RfDs are estimates of daily exposure levels that are unlikely to cause significant adverse non-carcinogenic health effects over a lifetime.	The selected remedy will meet these standards by removing contaminants that pose non-carcinogenic risks in the residential properties and disposing of them in the CAD cell or capping within the Tailings Impoundment and achieving recreational risk levels elsewhere in OU1.
Federal Criteria, Advisories and Guidance	Soil and sediment	Guidelines for Carcinogen Risk Assessment EPA/630/P-03/001F (March 2005)	To Be Considered	Guidance for assessing cancer risk.	The selected remedy will meet these standards by removing contaminants that pose carcinogenic risks in the residential properties and disposing of them in the CAD cell or capping within the Tailings Impoundment and achieving recreational risk levels elsewhere in OU1.
Federal Criteria, Advisories and Guidance	Soil, and Sediment	Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens EPA/630/R-03/003F (March 2005)	To Be Considered	Guidance for assessing cancer risks to children.	The selected remedy will meet these standards by removing contaminants that pose carcinogenic risks to children in the residential properties and disposing of them in the CAD cell or capping within the Tailings Impoundment and achieving child recreational risk levels elsewhere in OU1.
Federal Criteria, Advisories and Guidance	Soil and Sediment	USEPA Carcinogen Assessment Group, Cancer Slope Factors (CSFs)	To Be Considered	CSFs are used to compute the incremental cancer risk from exposure to site contaminants and represent the most up-to-date information on cancer risk from USEPA's Carcinogen Assessment Group.	The selected remedy will meet these standards by removing contaminants that pose carcinogenic risks in the residential areas and disposing of them in the CAD cell or capping within the Tailings Impoundment and achieving recreational risk levels elsewhere in OU1.

Table 60

Chemical-Specific ARARs and TBCs for OU1 Remedial Action (Alternative CMS2)

Capping of Tailings Impoundment; Off-Site Disposal of PCB and Petroleum Contaminated Soil; Subaqueous Disposal of Source Area Material (from the Ore Pad, Mine Operations Area, WRP-3), Residential Use Area Soil; and Sediment in a Confined Aquatic Disposal (CAD) Cell in theFormer Mine Pit

Regulatory Authority	Chemical Medium	Requirement	Status	Requirement Synopsis	Action to be Taken to Attain Requirement
Federal Criteria, Advisories and Guidance	Soil	Recommendations of the Technical Review Workgroup for Lead for an Approach to Assessing Risks Associated with Adult Exposure to Lead in Soil	To Be Considered	EPA guidance for evaluating the risks posed by lead in soil.	The selected remedy will meet this standard by excavating lead-impacted soil exceeding adult (and child) risk levels in the residential properties and disposing of the soil in the CAD cell or capping within the Tailings Impoundment. Lead contaminated soil elsewhere in OU1 will be cleaned up to recreational risk levels either by capping within the Tailings Impoundment or disposal in the CAD cell.
State	Soil	Maine Solid Waste Rules, Lead Management Regulations (06-096 C.M.R. Chapter 424]	Relevant and Appropriate	These regulations establish lead safe standards for soil containing lead – if lead in soil exceeds 375 parts per million (ppm) in bare soil in potential play areas or 1000 ppm in other than play areas, the soil in these areas shall be considered a lead hazard.	Lead contaminated soil in the residential properties that exceeds 375 ppm will be excavated and disposed of in the CAD cell or capped within the Tailings Impoundment so that it meets lead safe standards and permits unrestricted use.
State Criteria, Advisories and Guidance	Soil	Maine Voluntary Response Action Program, Remedial Action Guidelines for Hazardous Substances in Soil (May 20, 1997)	To Be Considered	These guidelines provide specific chemical concentrations determined by the ME DEP to be protective of human health under various direct exposure scenarios and protective of groundwater. State standards for cadmium are more stringent than Federal standards. These guidelines include standards for copper and zinc that do not have Federal standards.	The selected remedy will meet these standards by capping wastes that exceed these standards in the Tailings Impoundment area, treating runoff from the capped area in a treatment wetland, and disposing of all other contaminated soils and sediment exceeding these standards within OU1 in the CAD cell.

Notes:
ARAR=Applicable or Relevant and Appropriate Requirement
C.F.R. = Code of Federal Regulations
C.M.R. = Code of Maine Regulations
ppm = parts per million
CSF = Cancer Slope Factor
RfD = Risk Reference Dose
ME DEP = Maine Department of Environmental Protection
USEPA = U.S. Environmental Protection Agency

Table 61
Action-Specific ARARs and TBCs for OU1 Remedial Action (Alternative CMS2)
Capping of Tailings Impoundment; Off-Site Disposal of PCB and Petroleum Contaminated Soil; Subaqueous Disposal of Source Area Material (from the Ore Pad, Mine Operations Area, WRP-3), Residential Use Area Soil; and Sediment in a Confined Aquatic Disposal (CAD) Cell in the Former Mine Pit

Regulatory Authority	Action	Requirement	Status	Requirement Synopsis	Actions to be Taken to Attain Requirement
Federal	Surface water discharge	Clean Water Act Section 402 National Pollutant Discharge Elimination System (NPDES) (40 C.F.R. §§ 122-125 and 131)	Applicable	This act and regulations establish discharge limitations, monitoring requirements, and best management practices. Point-source discharges of effluent to surface water must comply with NPDES requirements (e.g., Federal and State water quality criteria).	On-site discharges to surface waters, including Goose Pond and adjacent wetlands, shall meet these substantive discharge standards, particularly from the treatment wetland. These discharge limitations shall also be used to develop monitoring standards for surface waters.
Federal	Cleanup and disposal of polychlorinated biphenyl (PCB) remediation waste	Toxic Substances Control Act (TSCA); PCB Remediation Waste (40 C.F.R. § 761.61(c)	Applicable	This section of the TSCA regulations provides risk-based cleanup and disposal options for PCB remediation waste based on the risks posed by the concentrations at which the PCBs are found. Written approval for the proposed risk-based cleanup must be obtained from the Director, Office of Site Remediation and Restoration, U.S. Environmental Protection Agency (USEPA) Region 1.	The cleanup and off-site disposal of PCB contaminated soil will be performed in a manner to comply with TSCA. This ROD includes a finding by the Director, Office of Site Remediation and Restoration, EPA Region 1, that the PCB cleanup level selected will not pose an unreasonable risk to human health or the environment.
Federal	Cleanup and disposal of hazardous waste	Resource Conservation and Recovery Act (RCRA) (42 U.S.C. § 6901 *et seq.*), Subtitle C- Hazardous Waste Identification and Listing Regulations; Generator and Handler Requirements (40 C.F.R. Parts 260-262)	Applicable	Federal standards used to identify, manage, and dispose of hazardous waste. Maine has been delegated the authority to administer these RCRA standards through its State hazardous waste management regulations. These provisions have been adopted by the State.	Wastes generated as part of remedial activities that will be disposed of off-site (PCB and petroleum contaminated material, treatment wetland waste) will be characterized as hazardous or non-hazardous. If determined to be hazardous waste, then they will be managed in accordance with these standards.
Federal	Surface water quality	Clean Water Act (33 U.S.C. § 1251 *et seq.*); National Recommended Water Quality Criteria ("NRWQC") (40 C.F.R. § 122.44)	Relevant and Appropriate	These criteria were used to establish water quality standards for the protection of aquatic life.	These standards will be used for monitoring water quality during sediment/mine waste excavation/dredging; disposal of material into the CAD cell; monitoring of the discharge from the treatment wetland; long-term water quality monitoring of the Tailing Impoundment cap, treatment wetland, and CAD cell; and other remedial activities.

Table 61
Action-Specific ARARs and TBCs for OU1 Remedial Action (Alternative CMS2)
Capping of Tailings Impoundment; Off-Site Disposal of PCB and Petroleum Contaminated Soil; Subaqueous Disposal of Source Area Material (from the Ore Pad, Mine Operations Area, WRP-3), Residential Use Area Soil; and Sediment in a Confined Aquatic Disposal (CAD) Cell in the Former Mine Pit

Regulatory Authority	Action	Requirement	Status	Requirement Synopsis	Actions to be Taken to Attain Requirement
Federal	Groundwater monitoring	Safe Drinking Water Act (42 U.S.C. § 300f *et seq.*); National primary drinking water regulations (40 C.F.R. Part 141, Subpart B and G)	Relevant and Appropriate	These regulations establish maximum contaminant levels (MCLs) for common organic and inorganic contaminants applicable to public drinking water supplies. MCLs were used as relevant and appropriate cleanup standards for aquifers and surface water bodies that are potential drinking water sources.	MCLs were used to establish standards for groundwater monitoring for the capped Tailings Impoundment area to assess the protectiveness of the cap.
Federal	Groundwater monitoring	Safe Drinking Water Act (42 U.S.C. § 300f *et seq.*); National primary drinking water regulations (40 C.F.R. 141, Subpart F)	Relevant and Appropriate	These regulations establish maximum contaminant level goals (MCLGs) for public water supplies. MCLGs are health goals for drinking water sources. These unenforceable health goals are available for a number of organic and inorganic compounds.	MCLGs were used to establish standards for groundwater monitoring for the capped Tailings Impoundment area to assess the protectiveness of the cap.
Federal	Groundwater monitoring	Health Advisories (Office of Drinking Water)	To Be Considered	Health Advisories are estimates of risk due to consumption of contaminated drinking water; they consider non-carcinogenic effects only. They are to be considered for contaminants in groundwater that may be used for drinking water where the standard is more conservative than either Federal or State statutory or regulatory standards. The Health Advisory standard for manganese is 0.3 mg/L.	Health Advisories were used to establish standards for groundwater monitoring for the capped Tailings Impoundment area to assess the protectiveness of the cap.
Federal Criteria, Advisories and Guidance	PCBs	EPA's Polychlorinated Biphenyl (PCB) Site Revitalization Guidance Under the Toxic Substances Control Act (November 2005)	To Be Considered	This guidance provides information on characterizing, cleaning up, containing, and disposing of PCB waste (e.g., soil and other debris generated as a result of any PCB spill cleanup) and guidance in complying with the PCB regulations at 40 C.F.R. Part 761.	The cleanup and off-site disposal of PCB contaminated soil will be performed in a manner to comply with TSCA.

Table 61
Action-Specific ARARs and TBCs for OU1 Remedial Action (Alternative CMS2)
Capping of Tailings Impoundment; Off-Site Disposal of PCB and Petroleum Contaminated Soil; Subaqueous Disposal of Source Area Material (from the Ore Pad, Mine Operations Area, WRP-3), Residential Use Area Soil; and Sediment in a Confined Aquatic Disposal (CAD) Cell in the Former Mine Pit

Regulatory Authority	Action	Requirement	Status	Requirement Synopsis	Actions to be Taken to Attain Requirement
Federal Criteria, Advisories and Guidance	Generation of investigation derived waste	USEPA OSWER Publication 9345.3-03 FS, January 1992	To Be Considered	Management of Investigation-Derived Waste (IDW) must ensure protection of human health and the environment.	IDW will be managed in a manner to protect human health and the environment.
State	Remediation of metallic mining sites	Maine Metallic Mineral Exploration, Advanced Explorations, and Mining (06-096 C.M.R. Chapter 200)	Relevant and Appropriate	These rules define mine waste and contain requirements for reclamation, closure, and post-closure activities at metallic mineral mines. Except for land clearing debris and wood waste, Subchapter 5 (*Mine Waste Treatment and Management*) applies to mine waste in lieu of Solid Waste Management Rules at 06-096 CMR Chapter 400-409.	The selected remedy will meet the substantive portions of these regulations for reclamation, closure, and post-closure activities by capping waste in the Tailing Impoundment area, using a treatment wetland for runoff, and disposing of all other contaminated soil/sediment in OU1 in the CAD cell. The Dyer and Goose Cove wetland restorations will also remove mine waste from Site waterbodies and dispose of the waste in the CAD cell.
State	Cleanup and disposal of hazardous waste	Maine Hazardous Waste Rules for Identification and Listing of Hazardous Wastes (38 M.R.S.A. § 1301 *et seq.*; 06-096 C.M.R. 850)	Applicable	These standards establish requirements for determining whether wastes are hazardous based on either characteristics or listing.	Wastes generated as part of remedial activities that will be disposed of off-site (PCB and petroleum contaminated material, treatment wetland waste) will be characterized as hazardous or non-hazardous.
State	Cleanup and disposal of hazardous waste	Maine Hazardous Waste Management Rules - Requirements for Generators (38 M.R.S.A. § 1301 *et seq.*; 06-096 C.M.R. 851)	Applicable	These regulations contain requirements for generators of hazardous waste.	Wastes generated as part of remedial activities that will be disposed of off-site (PCB and petroleum contaminated material, treatment wetland waste), if characterized as hazardous, will be managed of in accordance with these standards.
State	Management of land clearing debris and wood waste	Maine Solid Waste Management Rules (06-096 C.M.R. Chapter 400-409)	Applicable	These rules apply to land clearing debris and wood wastes at mining sites, in lieu of 06-096 CMR Chapter 200.	To the extent that land clearing debris and wood wastes are generated and landfilled as part of site remediation, they will be handled and disposed in accordance with these regulations.

Table 61
Action-Specific ARARs and TBCs for OU1 Remedial Action (Alternative CMS2)
Capping of Tailings Impoundment; Off-Site Disposal of PCB and Petroleum Contaminated Soil; Subaqueous Disposal of Source Area Material (from the Ore Pad, Mine Operations Area, WRP-3), Residential Use Area Soil; and Sediment in a Confined Aquatic Disposal (CAD) Cell in the Former Mine Pit

Regulatory Authority	Action	Requirement	Status	Requirement Synopsis	Actions to be Taken to Attain Requirement
State	Surface water discharge	Maine Waste Discharge Licenses (38 M.R.S.A. § 413 *et seq.*) and Waste Discharge Permitting Program (06-096 C.M.R. Chapter 520-529)	Applicable	These standards regulate the discharge of pollutants from point sources.	All substantive requirements of these standards will be met with respect to any point source discharge to surface water, particularly from the treatment wetland. Appropriate controls and best management practices will be implemented.
State	Actions that may degrade surface water quality	Maine Water Classification Program (38 M.R.S.A., Section 464-470)	Applicable	This program sets forth standards for the classification of Maine's water. Activities in a water body cannot lower water quality below the designated classification. Marsh Creek, Goose Pond, and Goose Cove are Class SB. Designated uses for Class SB waters include recreation in and on the water, fishing, aquaculture, propagation and harvesting of shellfish, industrial process and cooling water supply, hydroelectric power generation, navigation and as habitat for fish and other estuarine and marine life.	Site activities will be designed and implemented in a manner that does not degrade the chemical, physical, or biological integrity of Marsh Creek, Goose Pond, or Goose Cove. Water quality will be monitored during dredging/excavation operations and during disposal into the CAD cell. Long-term water quality monitoring of the Tailing Impoundment cap, treatment wetland, and CAD cell will also be conducted.
State	Actions that may degrade surface water quality	Maine Surface Water Toxics Program (38 M.R.S.A. §. 420; 06-096 C.M.R. Chapter 530)	Applicable	These rules set forth the State water quality criteria for toxic water pollutants and procedures necessary to control levels of toxic pollutants in surface waters.	Site activities will be designed and implemented in a manner that does not degrade the chemical, physical, or biological integrity of Marsh Creek, Goose Pond, or Goose Cove. Water quality will be monitored during dredging/excavation operations and during disposal into the CAD cell. Long-term water quality monitoring of the Tailing Impoundment cap, treatment wetland, and CAD cell will also be conducted.

Table 61
Action-Specific ARARs and TBCs for OU1 Remedial Action (Alternative CMS2)
Capping of Tailings Impoundment; Off-Site Disposal of PCB and Petroleum Contaminated Soil; Subaqueous Disposal of Source Area Material (from the Ore Pad, Mine Operations Area, WRP-3), Residential Use Area Soil; and Sediment in a Confined Aquatic Disposal (CAD) Cell in the Former Mine Pit

Regulatory Authority	Action	Requirement	Status	Requirement Synopsis	Actions to be Taken to Attain Requirement
State	Actions that may degrade surface water quality	Maine Surface Water Quality Criteria for Toxic Pollutants (06-096 C.M.R. Chapter 584)	Applicable	Except if they naturally occur, levels of toxic pollutants in surface waters must not exceed State water quality criteria.	Site activities will be designed and implemented in a manner that does not degrade the chemical, physical, or biological integrity of Marsh Creek, Goose Pond, or Goose Cove. Water quality will be monitored during dredging/excavation operations and during disposal into the CAD cell. Long-term water quality monitoring of the Tailing Impoundment cap, treatment wetland, and CAD cell will also be conducted.
State	Quarrying of rock	Performance Standards For Quarries (38 M.R.S.A. §§ 490-W – 490-EE)	Applicable	This law provides standards that apply to any quarry that is more than one acre in size, including reclaimed and unreclaimed areas, or at which underground production blasting is proposed.	If on-site rock is quarried to provide material for constructing the Tailings Impoundment cover, these standards will be complied with (including reclamation of the area once the remedy no longer needs a source of quarried rock).
State	Activities that expose soil with potential for erosion	Maine Erosion and Sedimentation Control (38 M.R.S.A. § 420-C)	Applicable	Activities that involve filling, displacing, or exposing soil or other earthen materials must take measures to prevent unreasonable erosion of soil or sediment beyond the project site or into a protected natural resource. Erosion control measures must be in place before the activity begins. Measures must remain in place and functional until the site is permanently stabilized.	Appropriate controls will be implemented to address erosion, sedimentation, and storm water.

Table 61
Action-Specific ARARs and TBCs for OU1 Remedial Action (Alternative CMS2)
Capping of Tailings Impoundment; Off-Site Disposal of PCB and Petroleum Contaminated Soil; Subaqueous Disposal of Source Area Material (from the Ore Pad, Mine Operations Area, WRP-3), Residential Use Area Soil; and Sediment in a Confined Aquatic Disposal (CAD) Cell in the Former Mine Pit

Regulatory Authority	Action	Requirement	Status	Requirement Synopsis	Actions to be Taken to Attain Requirement
State	Activities that expose soil with potential for erosion	Maine Storm Water Management (38 M.R.S.A. § 420-D), Maine Storm Water Management Rules (06 096 C.M.R. Chapter 500), and Direct Watershed of Waterbodies Most at Risk from New Development and Sensitive or Threatened Regions or Watersheds (06-096 C.M.R. Chapter 502)	Applicable	Storm water quality standards for projects with 3 acres or less of impervious surface may address phosphorus, nitrates, and suspended solids, but may not directly address other dissolved or hazardous materials unless infiltration is proposed. The Storm Water Management Rules establish standards to prevent and control the release of pollutants to water bodies, wetlands, and groundwater, and reduce impacts associated with increases and changes in flow.	Where activities described in 38 M.R.S.A. 420-D occur at the Site, appropriate controls to address erosion, sedimentation, and storm water will be implemented. Erosion control measures will be in place prior to the construction of the Tailing Impoundment cap, treatment wetland, and excavation of all upland OU1 contaminated material to be disposed of into the CAD cell
State	Generation of air emissions	Maine Air Quality Control Laws; Protection and Improvements of Air (38 M.S.R.A. §§ 581-608-A), Chapters 101, 105, 110, 115)	Applicable	This law and its associated regulations detail the requirements, limitations, and exemptions of State air emissions, including fugitive dust. The standard for particulate matter is 150 µg/m3 (micrograms per cubic meter), 24 hour average concentration.	Dust suppression will be utilized as needed to comply with this standard.

Table 61
Action-Specific ARARs and TBCs for OU1 Remedial Action (Alternative CMS2)
Capping of Tailings Impoundment; Off-Site Disposal of PCB and Petroleum Contaminated Soil; Subaqueous Disposal of Source Area Material (from the Ore Pad, Mine Operations Area, WRP-3), Residential Use Area Soil; and Sediment in a Confined Aquatic Disposal (CAD) Cell in the Former Mine Pit

Regulatory Authority	Action	Requirement	Status	Requirement Synopsis	Actions to be Taken to Attain Requirement
State Criteria, Advisories and Guidance	Generation of air emissions	Maine Department of Human Services Interim Ambient Air Guidelines, Memorandum February 23, 1993.	To Be Considered	Interim ambient air guidelines are derived from risk assessment-based criteria or from occupational exposure criteria that are protective of ambient air quality.	These guidelines will be considered during the design of emissions controls.

Notes:
ARAR = Applicable or Relevant and Appropriate Requirement
CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act, as amended
C.F.R. = Code of Federal Regulations
C.M.R. = Code of Maine Regulations
IDW = Investigation-Derived Waste
ME DEP = Maine Department of Environmental Protection
M.R.S.A. = Maine Revised Statutes Annotated
µg/m3 = micrograms per cubic meter
NPDES = National Pollutant Discharge Elimination System
OSWER = Office of Solid Waste and Emergency Response
U.S.C. = United States Code
USEPA = U.S. Environmental Protection Agency

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FIGURES

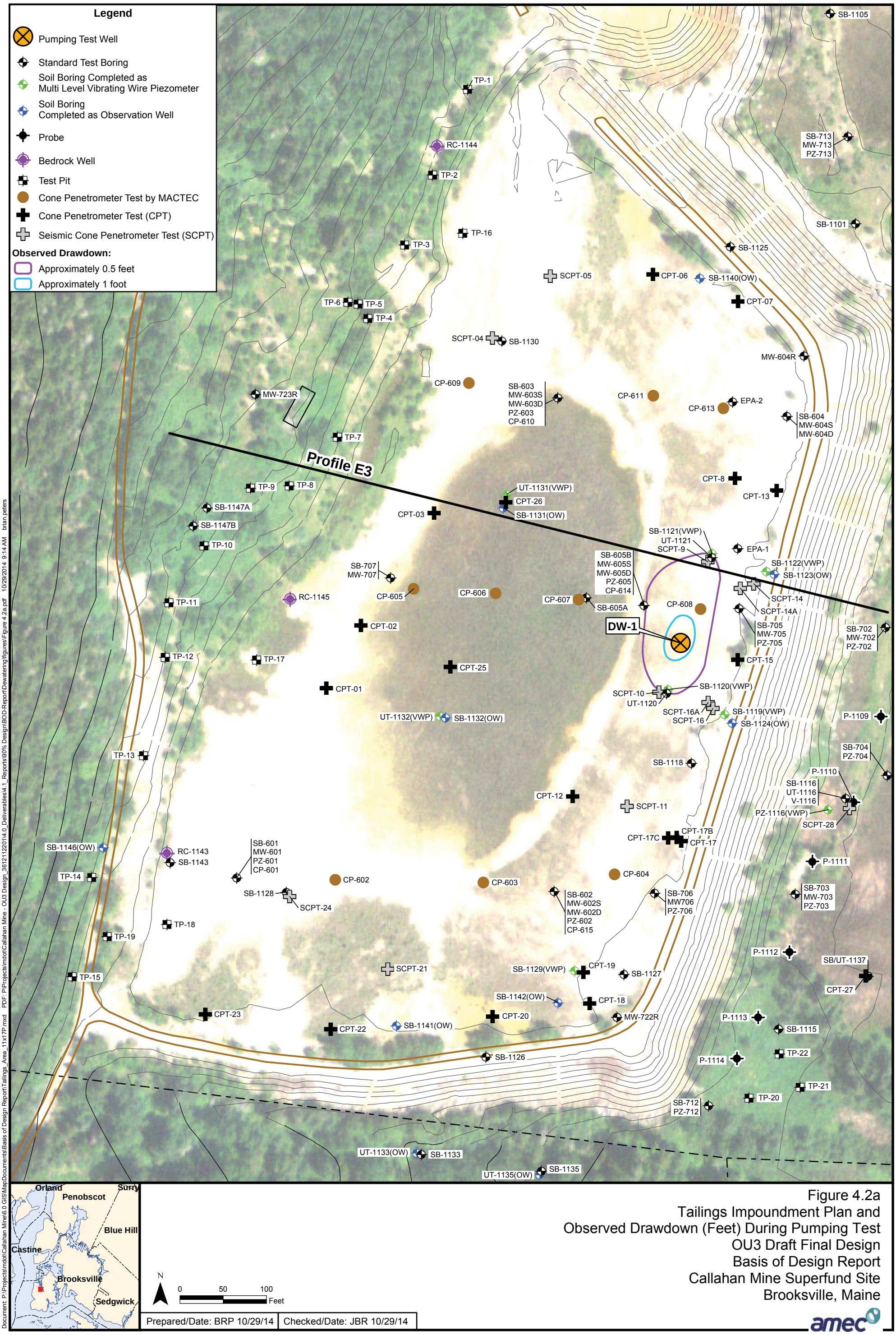

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Figure 4.2a
Tailings Impoundment Plan and
Observed Drawdown (Feet) During Pumping Test
OU3 Draft Final Design
Basis of Design Report
Callahan Mine Superfund Site
Brooksville, Maine

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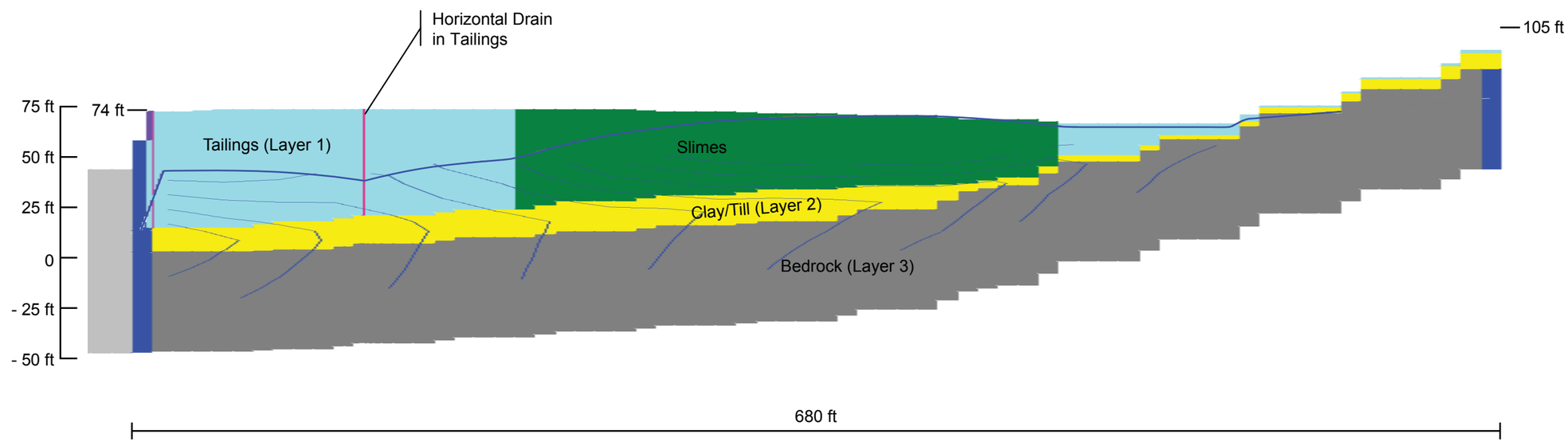
Document: P:\Projects\mdot\Callahan Mine\6.0 GIS\MapDocuments\Basis of Design Report\Tailings_Area_11x17P.mxd PDF: P:\Projects\mdot\Callahan Mine - OU3 Design_361211220\14.0_Deliverables\4.1_Reports\90% Design\BOD-Report\Dewatering\figures\Figure 4.2a.pdf 10/29/2014 9:14 AM brian.peters



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Horizontal Scale

0 15 60 Feet
Vertical Scale

Figure 4.2b
Groundwater Model Results – Run 16 – Single Drain Elevation 35 and No Cap – 180 Days
OU3 Draft Final Design
Basis of Design Report
Callahan Superfund Site
Brooksville, Maine

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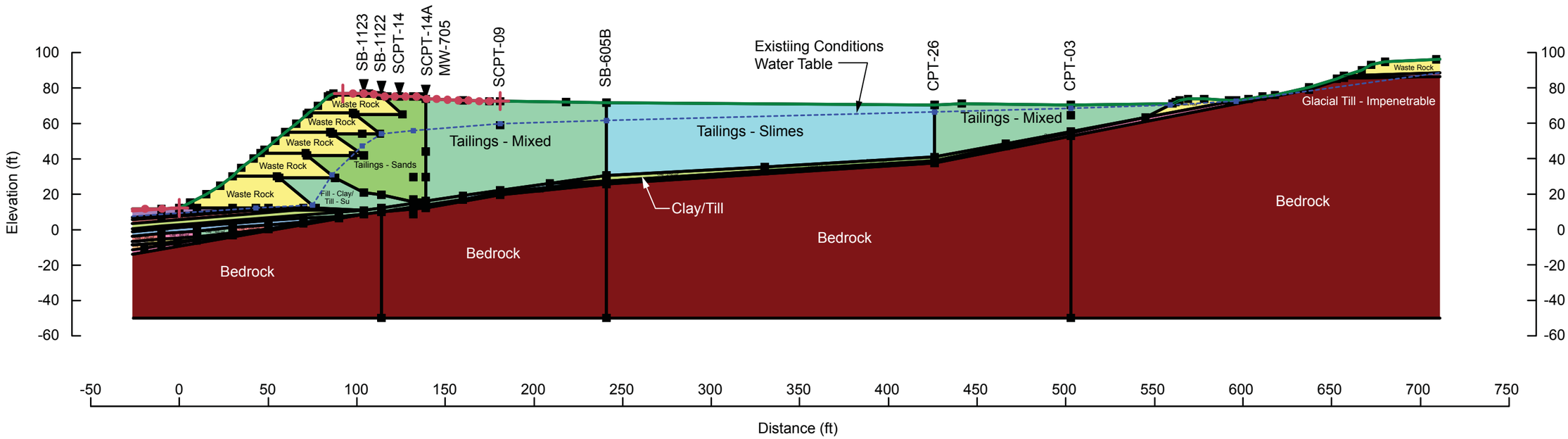

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Figure 4.2c
Profile E3
OU3 Draft Final Design
Basis of Design Report
Callahan Superfund Site
Brooksville, Maine

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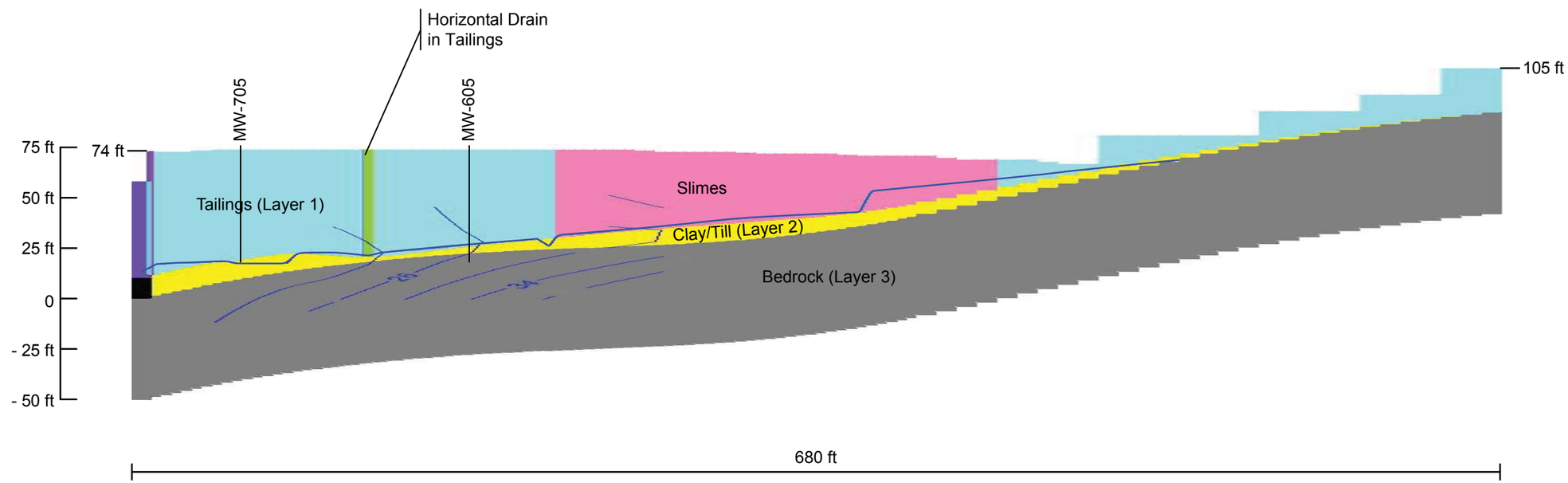

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Vertical Scale

Figure 4.2d
Groundwater Model Results – Run 305 – All Drains and Cap – 10 Years
OU3 Draft Final Design
Basis of Design Report
Callahan Superfund Site
Brooksville, Maine

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APPENDICES

(COMPLETE REPORT & APPENDICES PROVIDED ON ENCLOSED CD-ROM)