FINAL
OPERABLE UNIT 1 FEASIBILITY STUDY REPORT
CALLAHAN MINE SUPERFUND SITE
BROOKSVILLE, MAINE

Prepared for:

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

Prepared by:

MACTEC Engineering and Consulting, Inc.
511 Congress Street
Portland, Maine 04101

MACTEC Project 3612062047

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LIST OF ACRONYMS AND ABBREVIATIONS

ABA	acid base accounting
ARAR	applicable or relevant and appropriate requirement
ATV	all terrain vehicle
AVS/SEM	acid volatile sulfides/simultaneously extracted metals
BERA	Baseline Ecological Risk Assessment
bgs	below ground surface
CAD	confined aquatic disposal
Callahan	Callahan Mining Corporation
CERCLA	Comprehensive Environmental, Response, Compensation, and Liability Act
CERCLIS	Comprehensive Environmental, Response, Compensation, and Liability Information System
CFR	Code of Federal Regulations
COC	chemical of concern
COPC	chemical of potential concern
CTE	central tendency exposure
DRO	diesel range organics
EFDC	Environmental Fluid Dynamics Code
EPC	exposure point concentration
ELCR	excess lifetime cancer risk
FS	feasibility study
FOS	factor of safety
gpm	gallons per minute
GRO	gasoline range organics
HHRA	human-health risk assessment
HI	hazard index
HQ	hazard quotient
HRS	hazard ranking system
ICP	inductively coupled plasma
LOAEL	lowest observed adverse effects level
MACTEC	MACTEC Engineering and Consulting, Inc.
Maine DEP	Maine Department of Environmental Protection
MaineDOT	Maine Department of Transportation
MCL	Maximum Contaminant Level
MCLG	Maximum Contaminant Level Goal
MEG	Maine Maximum Exposure Guidelines for Drinking Water
mg/L	milligrams per liter
mg/kg	milligrams per kilogram
MS	mass spectrometry

LIST OF ACRONYMS AND ABBREVIATIONS – CONTINUED

MW	monitoring well
NAPL	nonaqueous phase liquid
NCP	National Oil and Hazardous Substance Pollution Contingency Plan
NNP	net neutralization potential
NOAEL	no observed adverse effects level
NPL	National Priorities List
NRWQC	National Recommended Water Quality Criteria
OSHA	Occupational Safety and Health Administration
OU	operable unit
PCB	polychlorinated biphenyl
ppm	parts per million
PRG	preliminary remediation goal
RCRA	Resource Conservation and Recovery Act
RfD	reference dose
RI	remedial investigation
RME	reasonable maximum exposure
ROD	Record of Decision
SIP	Site Inspection Prioritization
Site	Callahan Mine Superfund Site
SPLP	Synthetic Precipitation Leaching Procedure
TAL	target analyte list
TBC	to-be-considered guidance
TOC	total organic carbon
TRC	TRC Environmental Corporation
TRV	toxicity reference value
TSCA	Toxic Substances Control Act
UCL	upper confidence limit
USEPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey
UST	underground storage tank
UTL	upper tolerance level
µg/dl	micrograms per deciliter
µg/L	micrograms per liter
VOCs	volatile organic compounds
WHG	Woods Hole Group
WRP	waste rock pile
XRF	X-ray fluorescence

EXECUTIVE SUMMARY

INTRODUCTION

This Feasibility Study (FS) report was prepared by MACTEC Engineering and Consulting, Inc., to identify and evaluate cleanup alternatives for waste materials, soil, and sediments for Operable Unit (OU) 1 at the Callahan Mine Superfund Site (Site) in the village of Harborside in the Town of Brooksville, Maine. The report was prepared for the Maine Department of Transportation (MaineDOT) in accordance with the requirements set forth in a 2005 Administrative Order by Consent for Remedial Investigation and Feasibility Study between the U.S. Environmental Protection Agency (USEPA) and the State of Maine.

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 (Figure ES-1) and the associated areas where contamination has come to be located, including Goose Pond, Goose Cove, and other contaminated wetland areas. 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. Site coordinates are 44° 21’ 05.9” north latitude and 68° 48’ 35.5” west longitude.

Intermittent exploration and mining for copper and zinc occurred at the Site from the 1880s to the 1970s. For five years from 1968 through 1972, the massive-sulfide ore deposits were mined with an open pit mine in the drained Goose Pond estuary. Copper-, lead-, and zinc-ore was crushed, milled, and concentrated on Site, and the concentrate was shipped off Site for smelting. Waste rock and tailings were disposed of on Site.

The Site is a Superfund site and was added to the USEPA National Priorities List (NPL) in September 2002. The Site is undergoing 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.

Purpose and Scope

To facilitate the evaluation and implementation of actions to reduce, eliminate, or control actual or potential human-health and ecological risks, the Site has been divided into two OUs. Operable units are discrete actions that comprise incremental steps toward a final remedy. An OU eliminates or mitigates a release, a threat of a release, or an exposure pathway, and may reflect the final remediation of a defined portion of a site, or may be implemented as an interim measure. When implemented as an interim action, an OU facilitates the collection of data that will reduce uncertainty at the site and lead to more effective final remedy.

This FS report addresses OU 1 which comprises the following areas:

- Soil contaminated with polychlorinated biphenyls (PCBs).
- Soil that may represent the most significant threat to surface water, sediments, and groundwater. These areas are the former Ore Pad, portions of the Mine Operations Area, Waste Rock Pile 3 (WRP-3), and the Tailings Impoundment.
- Areas of sediment that were shown to be acutely toxic in laboratory tests and may represent a food chain threat. This is primarily the area of sediments and the salt marsh that resides adjacent to WRP-3 and the Tailings Impoundment.
- Soil contaminated with arsenic, lead, and thallium in current residential use areas (i.e., seasonal residential lots located along Old Mine Lane, the access road to the Site).

This FS does not select a preferred alternative for OU 1, but describes the alternatives under consideration. The preferred alternative will be identified in the Proposed Plan and will be subject to public comment. After addressing State and public comments on the proposed alternative, a final remedy selection will be described in a Record of Decision (ROD).

The remaining areas of the Site, as well as groundwater, will be further evaluated as part of a second OU (OU 2) and will be subject to a FS in the future, if it is determined that a response action is necessary. There will be an early action for OU 2 to prevent land uses that would result in an unacceptable exposure to contamination or consumption of contaminated groundwater (as discussed in Section 6.0)

Background and History

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 (Figure ES-2).

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. The ore consisted primarily of sphalerite (zinc sulfide [ZnS]) or zinc-iron sulfide [(Zn,Fe)S]), chalcopyrite (copper-iron sulfide [$CuFeS_2$]), and minor occurrences of galena (lead sulfide [PbS]). 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 WRPs-1, -2, and -3, or used for construction projects (e.g., construction of containment berms 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. Figure ES-3 shows major site features at the mine based on recent aerial photography, as well as topographic and bathymetric elevation contours.

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.

Site Contamination

Environmental sampling has been performed at the Site since 1967. The most extensive sampling of site media was completed during the remedial investigation (RI) from 2004 through 2008 following Site listing on the NPL in 2002. Table ES-1 provides a summary listing of investigations completed at the Site between 1967 and 2008. A summary of the RI, including the Human-Health Risk Assessment (HHRA) and Baseline Ecological Risk Assessment (BERA) can be found in Subsection 1.4 of the FS. Detailed information can be found in the RI, HHRA, and BERA.

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 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 berms and site roads and pave/surface work areas contributed to site contamination. The Ore Pad and WRP-3 contain the highest percentages of mineralized waste rock.

In addition, mixed with the waste rock in the former Mine Operations Area is a relatively small area of PCB contamination attributed to historical transformer leakage and another relatively small area of petroleum-contaminated soil (as measured by diesel range organics and gasoline range organics [DRO/GRO]) attributed to leaking underground storage tanks removed in 1987.

Soil at three seasonal residential properties along the mine entrance road connecting the former Callahan property to Goose Falls Road is contaminated with arsenic, lead, and thallium. The placement of waste rock as fill in the access road resulted in elevated concentrations of lead in soil. It should be noted that one of these properties was divided into two exposure areas for the purposes of risk assessment, resulting in the designation of four “Lots” (A, B, C, and D) in the RI report, when in fact there are only three true lots.

Overburden groundwater, where it exists, and bedrock groundwater are also contaminated beneath portions of the former Callahan property, and concentrations of aluminum, antimony, arsenic,

cadmium, chromium, copper, lead, manganese, nickel, sodium, and zinc exceed federal drinking water Maximum Contaminant Levels (MCLs), Maine Maximum Exposure Guidelines for Drinking Water (MEGs), and/or federal risk levels at one or more locations. Concentrations in excess of federal and state groundwater standards are most frequent and typically greatest at the Ore Pad, followed by the Mine Operations Area, WRP-1, and WRP-3. Groundwater at the Tailings Impoundment and WRP-2 has the lowest number of exceedances. The presence of these metals in groundwater is attributed predominantly to release from mineralized rock as a result of leaching by acid rock drainage. GRO was detected in one bedrock monitoring well at a concentration less than the MEG and the Maine Remediation Goal for Stringent Sites. The presence of GRO in bedrock groundwater is attributed to soil contamination observed in the Mine Operations Area. DRO and PCBs were not detected in groundwater samples.

Limited sampling and analysis of Goose Pond surface water during the RI showed exceedances of federal and state water quality criteria for copper at 10 of 14 sampled locations and for zinc at 9 of 14 sampled locations.

Goose Pond sediments are contaminated with metals, especially copper, lead, and zinc. Concentrations of these metals exceed background throughout Goose Pond; however, the highest concentrations are located in four areas: 1) an area of southern Goose Pond extending from the southern site boundary northward past the Tailings Impoundment and WRP-3; 2) Dyer Cove; 3) a small area east of the mine pit near the mouth of Stink Cove, and 4) a second small area in Goose Pond east of Dyer Point. In addition, an area of salt marsh sediments between the Tailings Impoundment and Goose Pond are also contaminated. A small area in Goose Cove has high concentrations of copper, lead, and zinc contamination coinciding with mine waste deposits similar to those in Goose Pond. PCBs and DRO/GRO contamination have not been detected in Goose Pond or Goose Cove sediments.

The primary source of contamination at all areas of the Site is interpreted to be historical mine operations.

In the absence of remedial actions, ongoing discharges from the Tailings Impoundment may result in dissolved-phase metals, including copper, lead, and zinc, reaching groundwater and surface water. Surface water may also erode friable material and transport suspended material to Goose Pond. Acid rock drainage from mineralized waste rock in upland areas may continue to contribute

contaminants to groundwater. Transport by windblown dust, thought to have been significant during mine operations, is now expected to be minor. Because of the volume and exposed nature of mine waste material at the Site, these release and transport mechanisms are expected to persist. Figure ES-4 depicts these transport mechanisms.

Human-Health and Ecological Risks

Human Health Risks

The baseline HHRA of the RI identified the following potential human health risks:

Soil. Estimated cancer, non-cancer, and/or lead exposure risks are in excess of USEPA risk management criteria (excess lifetime cancer risk [ELCR] range of $1x10^{-6}$ to $1x10^{-4}$, hazard index (HI) of 1, and/or 5 percent or more of exposed population with a geometric mean blood lead level of 10 micrograms per deciliter [µg/dl] or greater) at the following areas:

- Residential Exposure Area A soil (current residential land use) because of lead
- Residential Exposure Area C soil (current residential land use) because of lead
- Residential Exposure Area D soil (current residential land use) because of lead and thallium
- Source area soil (current and future recreational use because of PCBs; future residential use because of PCBs and lead)

For the exposure scenario based on current recreational land use of the former Callahan Mine property portion of the Site, only PCBs were identified as representing a human health threat exceeding the USEPA target risk range of range of $1x10^{-6}$ to $1x10^{-4}$, HI of 1, and/or 5 percent or more of exposed population with a geometric mean blood lead level of 10 µg/dl or greater). Arsenic and lead were not identified as an unacceptable threat based on the current land use (recreational use) scenario for the former Callahan Mine property portion of the Site.

Groundwater and Groundwater Seeps. Estimated cancer, non-cancer, and/or lead exposure risks are in excess of USEPA risk management criteria (ELCR range of $1x10^{-6}$ to $1x10^{-4}$, HI of 1, and/or 5 percent or more of exposed population with a geometric mean blood lead level of 10 µg/dl or greater) at the following areas:

- overburden groundwater (future use as potable water) because of aluminum, arsenic, cadmium, chromium, lead, manganese, and zinc
- bedrock groundwater (future use as potable water) because of cadmium, copper, manganese, and zinc

Ecological Risks

The BERA evaluated several exposure scenarios for varying receptors and exposure media and concluded that potential adverse risks exist for the following receptors:

Benthic Invertebrates. Risk to the benthic invertebrate community varies with location. Sediment toxicity tests demonstrated ecologically significant effects to benthic invertebrates in Goose Cove at location GC-05 with respect to the *Neanthes arenaceodentata* growth endpoint. However, no adverse ecologically significant effects were observed for the two other Goose Cove toxicity test locations, where sediment concentrations were higher.

The weight of evidence from acid volatile sulfide (AVS)/simultaneously extracted metals data and quantitative benthic community surveys compared to reference suggested that only a few areas of the sediment should present a high risk. However, the sediment toxicity test data suggest that the mine waste hot spot area adjacent to WRP-3 and the Tailings Impoundment, as defined by locations GP-22 and GP-12, is acutely toxic. Pore water data for that area also suggest the potential for adverse impacts despite the high AVS. Although GP-07 and GP-13 exhibited ecologically significant risk for *Leptocheirus plumulosus* (*L. plumulosus*) survival (GP-07) and growth (GP-13), sediment and pore water concentrations at GP-07 and GP-13 were frequently lower than other locations which did not demonstrate significant risk. Risk at GP-07 is likely overestimated and unlikely to result in adverse population-level effects based on relatively low sediment and pore water contaminant concentrations. Risk at GP-13 is likely overestimated and therefore not likely to result in adverse population-level effects, as evidenced by toxicity limited to the growth endpoint for *L. plumulosus* and relatively low metals availability based on pore water chemistry.

The toxicity test for the Goose Pond Irregularly Flooded sediment (i.e., south of the earthen dam) within the mine waste hot spot was ambiguous as one sample indicated potential toxicity and the other did not. Other samples from the Goose Pond Irregularly Flooded sediment outside the mine waste hot spot did not show toxicity. It should be noted that dramatic fluctuations in temperature,

dissolved oxygen concentrations, and salinity concentrations observed in the Goose Pond Irregularly Flooded sediment area do not provide a stable environment for most freshwater or marine species.

Salt Marsh Plants. There is a high risk to salt marsh plants in three areas of readily apparent harm, where vegetation is absent or stunted, located at the upland fringe of the salt marsh exposure area. However, multivariate statistical analyses could not identify a significant dose-response relationship with site chemicals of potential concern, though benchmark comparisons suggest copper and cadmium as possibly contributing to adverse population-level effects. In other areas of salt marsh outside of the areas of readily apparent harm, the weight of evidence suggested that the risk of harm is unlikely; areas of readily apparent harm comprise less than 0.5 percent salt marsh habitat in Goose Pond.

Aquatic Insectivorous Birds. Adverse population-level effects to insectivorous birds (spotted sandpiper) are possible in the Goose Pond Irregularly Flooded exposure area as a result of copper (high confidence) and lead (low confidence), and in the salt marsh as a result of copper (high confidence). Adverse population-level effects were generally unlikely for other ecological exposure areas.

Aquatic Piscivorous Birds. Adverse population-level effects to piscivorous birds (great blue heron) are possible in the Goose Pond Irregularly Flooded exposure area as a result of zinc (low confidence) and in the salt marsh as a result of copper (high confidence) and zinc (low confidence). Adverse population-level effects were generally unlikely for other ecological exposure areas.

DEVELOPMENT OF REMEDIAL ACTION OBJECTIVES

Remedial action objectives consist of medium- or operable unit-specific, quantitative goals defining the extent of cleanup required to protect human health and the environment. They specify chemicals of concern, exposure routes and receptors, and preliminary remediation goals (PRGs). They also must address applicable or relevant and appropriate requirements (ARARs) and "to-be-considered" (TBC) guidance. Remedial action objectives are used as the framework for developing remedial alternatives. The remedial action objectives are formulated to achieve the overall goal of USEPA of protecting human health and the environment.

Maine Mining Regulations

USEPA has identified the primary ARAR for the Callahan Mine Superfund Site as the Maine Metallic Mineral Exploration, Advanced Explorations, and Mining regulation at 06-096 CMR Chapter 200. In particular, Subchapter 5 - Mine Waste Treatment and Management classifies mine waste and regulates the location, design, construction, operation, maintenance, closure, and long-term care for the treatment, storage, and disposal of mine wastes. USEPA has determined that these regulations, which were promulgated after Callahan Mine ceased operations, are not "applicable" to the Site, but are "relevant and appropriate". The following general performance standards are found at 06-096 CMR Chapter 200, Section 32A:

1. Meet the performance requirements for groundwater, surface water, air, and soils or surficial materials established under Section 26(I)
2. Minimize acid generation and acid rock drainage
3. Provide structural stability
4. Protect public health and the environment
5. Otherwise comply with applicable legal requirements

Preliminary Remediation Goals

PRGs are long-term numerical goals used during analysis and selection of remedial alternatives. PRGs should comply with ARARs and result in residual risks consistent with NCP requirements for protection of human health and the environment. Therefore, PRGs are based both on risk-based concentrations and on ARARs. Eventually, PRGs become the basis for final remediation goals for the selected remedy. PRGs developed for protection of human health and ecological receptors are listed in Tables ES-2 and ES-3.

Remedial Action Objectives

Remedial action objectives for OU 1 are listed below.

- Protect current and future recreational visitors by preventing direct contact and incidental ingestion of site soils and waste material containing PCBs that represent a non-cancer threat with a hazard quotient (HQ) greater than 1 and a cancer risk greater than $1x10^{-6}$ using the site-specific risk assessment assumptions for current and future recreational use.

- Protect current residents by preventing direct contact and incidental ingestion of soils and waste material in the current residential use area of the Site containing lead that would result in greater than 5 percent of the exposed population with a blood lead level above 10 µg/dl, or exceeding the Maine Solid Waste Lead Remediation Regulations, whichever is lower, using the site-specific risk assessment assumptions for current and future residential use.

- Protect current residents by preventing direct contact and incidental ingestion of site soils and waste material in the current residential use area of the Site containing arsenic that represents a non-cancer threat with a HQ greater than 1 and a cancer risk greater than 1.4×10^{-5} using the site-specific risk assessment assumptions for current and future residential use.

- Prevent exposure of biota to sediment, including the sediment/soil in the salt marsh, with concentrations of copper, lead, or zinc that may represent a threat to insectivorous and piscivorous birds, fish, and other aquatic organisms.

- Minimize acid rock drainage from mineralized waste rock and tailings that may act as a continuing source of copper, lead, and zinc to groundwater, surface water, and sediment.

- Stabilize the Tailings Impoundment berm to achieve acceptable stability criteria.

- Compliance with all federal and state ARARs, including achieving closure standards under State mining regulations.

Volumes and Areas of Media Exceeding Preliminary Remediation Goals

Media identified for remedial action as part of OU 1 consist of source area soil and waste, residential use area soil, Goose Pond sediment, and salt marsh sediment.

Source Areas

Based on the definition of source material in Subsection 2.1 of the FS and review of the nature and extent of contamination, there are four significant source areas at the Site: the Ore Pad, Mine Operations Area, WRP-3, and Tailings Impoundment (Figure ES-5).

- Ore Pad: This area covers about 2.1 acres and contains about 16,000 cubic yards of waste rock. The Ore Pad is considered to be the most significant source of groundwater contamination and a major contributor to surface water contamination.

- Mine Operations Area: This area covers about 5.2 acres and contains about 44,000 cubic yards of waste rock. The PCB contamination and waste oil contamination is also located in this area.

- WRP-3: This area covers about 6.6 acres and contains about 216,000 cubic yards of waste rock. WRP-3 is the most significant source of surface water contamination and also contributes to sediment contamination.

- Tailings Impoundment: The outside footprint of the Tailings Impoundment covers about 21 acres and contains about 716,000 cubic yards of material. Tailings that left this area during mine operations and during ongoing surface erosion are believed to be the most significant source of sediment contamination. Seepage from the Tailings Impoundment also contributes to surface water contamination. The Tailings Impoundment berm along the perimeter of the Tailings Impoundment does not meet standard criteria for long-term stability.

In addition, as discussed in Subsection 1.4.6 of the FS, a relatively small area of PCB contamination exists at the Mine Operations Area. Figures ES-5 and ES-6 depict the extent of PCB contamination exceeding the PCB PRG (Table ES-2).

In addition to CERCLA contaminants on Site, there is also petroleum waste that is regulated under state standards, rather than CERCLA. Because these petroleum-contaminated soils are commingled with soil contaminated with CERCLA waste, they will be addressed concurrently with the CERCLA wastes. Based on the Maine Hydrocarbon Spill Decision Tree, the Maine DEP has classified the DRO/GRO contamination in the Mine Operations Area as meeting the criteria as a Stringent Site requiring the removal or remediation of soils containing concentrations in excess of 5 parts per million (ppm) GRO and 10 ppm DRO. Figures ES-5 and ES-6 also show the estimated extent of DRO/GRO contamination exceeding the Maine remediation goals for GRO and DRO.

Residential Use Area of Site

Surface soil exceeding the residential use PRGs in lawn, residential use, and road areas adjacent to residences within the residential use area of the Site will be excavated to a depth at which PRG exceedances no longer occur. Extensive bedrock outcropping in the area will provide horizontal bounds for much of the excavation. Figures ES-5 and ES-7 depict the OU 1 areas to be remediated within the residential use area of the Site.

Sediment, Including Salt Marsh

After completion of the BERA, the conceptual site model was refined, and four areas of the Site with high levels of contamination and the presence of mine waste were identified as hot spots. These areas are:

- Goose Pond mine waste hot spot. This 10-acre area is located within the 75-acre Goose Pond and is adjacent to WRP-3 and the Tailing Impoundment. Mine waste, particularly tailings, has accumulated in the sediments in this area.

- Salt Marsh mine waste hot spot. These 7 acres of salt marsh are within the 23 acres of salt marsh at the Site and are co-located with the Southern Goose Pond mine waste hot spot and are also likely contaminated as result of tailings deposition.

- Dyer Cove. Dyer Cove is an 8-acre area in Goose Pond that was used as a settling basin for the sediment pumped out of the mine pit during operation. The distribution of contamination in this area is more variable than at other areas.

- Goose Cove mine waste hot spot. This 1.5-acre area of the 4-acre Goose Cove is associated with the discharge from a pipe that was used to dewater the mine pit during operation of the mine.

Table ES-4 provides the summary information used to delineate these four areas from the other areas of the Site. Table ES-5 and Figures ES-8 through ES-11 summarize the combination of the analytical data with the ecological risk evaluation to identify the areas that should be targeted for cleanup. The Goose Pond and Salt Marsh mine waste hot spots were identified as areas having the potential for adverse ecological effects and therefore meeting thresholds for requiring remediation. Dyer Cove and Goose Cove did not meet the thresholds and would only be excavated/dredged if the design identifies those actions as part of the wetland mitigation.

Table ES-6 lists areas and volumes identified for remediation of those areas as part of OU 1.

IDENTIFICATION OF REMEDIAL ALTERNATIVES

Subsection 2.5 of the FS and the associated tables screen a number of technology options that may be applicable to the Callahan Mine Superfund Site. As a result of the screening, Section 3.0 of the FS develops three source control and two sediment alternatives for a more comprehensive screening. Of these, one soil/source-control alternative and one sediment alternative were eliminated from further consideration based on consideration of effectiveness, implementability,

and cost. As part of the screening, alternatives that require the off-site transport of the waste rock, sediment, or tailings were eliminated because of cost and community concerns. In addition, the only approach that was retained for the sediment cleanup was excavation or dredging, because the site conditions would not allow for in-place capping or monitored natural recovery. The no action alternatives for soil/source-control and sediment were not screened, but passed through screening to the detailed evaluation as required by the NCP. After screening, the two remaining soil/source alternatives and one remaining sediment alternative were combined into the two site-wide alternatives for detailed evaluation. In addition, the no action alternatives for soil/source control and sediment were combined into a single site-wide no action alternative. Each of these is briefly described in the following paragraphs.

Alternative CMS1 – No Action

Alternative CMS1, the No Action alternative, was retained as a baseline with which to compare the other alternatives. This alternative would not include remedial action components to reduce the contribution of site source areas to groundwater, surface water, or sediment contamination. No action would be taken to reduce, control, or eliminate direct exposure risks to residents of seasonal properties along Old Mine Lane. No action would be taken to reduce, eliminate, or control risks to ecological receptors in Goose Pond or salt marsh areas. No institutional controls would be implemented to prohibit potable use of site groundwater and residential development of the Site. Statutorily required Five-Year Reviews would be conducted which would document the status of site conditions.

Alternative CMS2 – Capping of Tailings Impoundment; Off-Site Disposal of PCB- and Petroleum-Contaminated Soil; and Subaqueous Disposal of Source Area Material (from the Ore Pad, Mine Operations Area, and WRP-3), Residential Use Area Soil, and Sediment in Confined Aquatic Disposal (CAD) Cell in Former Mine Pit

Alternative CMS2 includes constructing surface water diversions to reduce the amount of upslope runoff flowing onto and infiltrating the Tailings Impoundment, installation of a low-permeability cover system to contain and isolate the Tailings Impoundment, installation of a horizontal drain system to facilitate the post-cap dewatering of the Tailings Impoundment, and the collection and treatment of the discharge from the horizontal drain system in a constructed wetland; subaqueous disposal of WRP-3, Ore Pad, and Mine Operations Area source material, and residential use area soil exceeding PRGs in a confined aquatic disposal (CAD) cell in the former mine pit; and off-site disposal of material contaminated with PCBs and soil/waste commingled with petroleum. It is

possible that additional measures, including a toe shear key or buttress would be identified during design as a necessary component to stabilize the Tailings Impoundment berm. Alternative CMS2 also includes the dredging and subaqueous disposal of sediments exceeding PRGs in southern Goose Pond and the adjacent salt marsh in a CAD cell in the former mine pit. Goose Pond and salt marsh sediments exceeding PRGs would be dredged and disposed of in the CAD cell in the former mine pit. Dyer Cove and Goose Cove sediments that contain mine waste and exceed PRGs may also be dredged and disposed in the CAD cell in the former mine pit as part of Site restoration and wetland mitigation activities. Additional components include institutional controls, environmental monitoring, and five-year reviews. This alternative would consist of the following key components:

- Predesign Investigations and Studies
- Tailings Impoundment Improvements
    - Diversion of upslope surface water
    - Construction of low-permeability cover system
    - Stabilization measures, as necessary
    - Installation of a horizontal drain system
    - Treatment of the horizontal drain system discharge in a constructed wetland
- Excavation and subaqueous disposal of WRP-3, Ore Pad, and Mine Operations Area source material in the CAD cell in the former mine pit
- Excavation of soil containing arsenic and lead above the cleanup levels in the residential use area of the Site and disposal in the CAD cell in the former mine pit
- Excavation and off-site disposal of PCB-contaminated soil exceeding PRGs
- Excavation and off-site disposal of petroleum-contaminated soil/waste commingled with CERCLA waste
- Dredging of Goose Pond and salt marsh sediment exceeding PRGs and subaqueous disposal in the CAD cell in the former mine pit
- Establishment of institutional controls to protect the components of the remedy (including caps, treatment wetlands, monitoring well, and the CAD cell)
- Wetland restoration and mitigation
- Installation of monitoring wells
- Long-term operation and maintenance; monitoring, including institutional control inspections
- Five-year reviews.

The estimated cost of CMS2 is $22.8 million. Figure ES-12 shows the major features of Alternative CMS2. Figure ES-13 depicts a cross-section through the CAD cell that would contain the waste material and sediment along with a profile of the cover system for the Tailings Impoundment.

Alternative CMS3 – Capping of Tailings Impoundment; Off-Site Disposal of PCB- and Petroleum-Contaminated Soil; Capping of Source Area Material (from the Ore Pad, Mine Operations Area, WRP-3) and Residential Use Area Soil; and Subaqueous Disposal of Sediment in a Confined Aquatic Disposal (CAD) Cell in the Former Mine Pit

Alternative CMS3 includes constructing surface water diversions to reduce the amount of upslope runoff flowing onto and infiltrating the Tailings Impoundment, installation of a low-permeability cover system to contain and isolate the Tailings Impoundment, installation of a horizontal drain system to facilitate the post-cap dewatering of the Tailings Impoundment, and the collection and treatment of the discharge from the horizontal drain system in a constructed wetland; upland disposal of WRP-3, Ore Pad, and Mine Operations Area source material, and residential use area soil exceeding PRGs into a on-site waste cell that would then have a low-permeability cover system installed over the waste; and off-site disposal of material contaminated with PCB and soil/waste commingled with petroleum. It is possible that additional measures, including a toe shear key or buttress, would be identified during design as a necessary component to stabilize the Tailings Impoundment berm. Alternative CMS3 also includes the dredging and subaqueous disposal of sediments exceeding PRGs in southern Goose Pond and the adjacent salt marsh in a CAD cell in the former mine pit. Dyer Cove and Goose Cove sediments that contain mine waste and exceed PRGs may also be dredged and disposed in the CAD cell in the former mine pit as part of site restoration and wetland mitigation activities. Additional components include institutional controls, environmental monitoring, and five-year reviews. This alternative would consist of the following key components:

- Predesign Investigations and Studies
- Tailings Impoundment Improvements;
    - Diversion of upslope surface water
    - Construction of low-permeability cover system
    - Stabilization measures, as necessary
    - Installation of a horizontal drain system
    - Treatment of the horizontal drain system discharge in a constructed wetland

- Excavation, on-site consolidation, and capping of WRP-3, Ore Pad, and Mine Operations Area source material
- Excavation, on-site consolidation of soil containing arsenic and lead above the cleanup levels in the residential use area of the Site
- Excavation and off-site disposal of PCB-contaminated soil exceeding PRGs
- Excavation and off-site disposal of petroleum-contaminated soil/waste commingled with CERCLA waste
- Dredging of Goose Pond and salt marsh sediment and subaqueous disposal in the CAD cell in the former mine pit
- Establishment of institutional controls to protect the components of the remedy (including caps, treatment wetlands, monitoring well, and the CAD cell)
- Wetland restoration and mitigation
- Installation of monitoring wells
- Long-term operation and maintenance; monitoring, including institutional control inspections
- Five-year reviews

The estimated cost of CMS3 is $25.5 million. Figure ES-14 shows the major features of Alternative CMS3. Figure ES-13 depicts a cross-section through the CAD cell that would contain the sediment along with a profile of the cover system for the Tailings Impoundment and waste material

APPROACH TO EVALUATION OF REMEDIAL ALTERNATIVES

The FS includes both a detailed analysis of the individual alternatives using the first seven of the nine evaluation criteria identified in the NCP and a comparative analysis. The comparative analysis identifies the advantages and disadvantages of alternatives relative to one another to aid in the eventual selection of a preferred remedial alternative. In the Proposed Plan, USEPA will identify its preferred remedial alternative and solicit public comment. Based on public and state comments, USEPA will either choose the preferred alternative as the selected remedy in the ROD, modify the proposed remedy to reflect public and state input, or go back to the FS stage to re-evaluate other remedial alternatives. USEPA categorizes the NCP evaluation criteria into three

groups: threshold, balancing, and modifying. The criteria are listed below and discussed in the following paragraphs.

Threshold Criteria

- overall protection of human health and the environment
- compliance with ARARs

Primary Balancing Criteria

- long-term effectiveness and permanence
- reduction of toxicity, mobility, or volume through treatment
- short-term effectiveness
- implementability
- cost

Modifying Criteria

- state acceptance
- community acceptance

Threshold Criteria

The NCP designates (1) overall protection of human health and the environment, and (2) compliance with ARARs as the two threshold criteria. An alternative must meet both criteria to be eligible for selection as the preferred site remedy.

Primary Balancing Criteria

The five primary balancing criteria are long-term effectiveness and permanence; reduction of toxicity, mobility, or volume through treatment; short-term effectiveness; implementability; and cost. These balancing criteria provide a preliminary assessment of the extent to which permanent solutions and treatment can be used practicably and in a cost-effective manner.

An alternative that is protective of human health and the environment, is ARAR-compliant, and affords the best balance among these criteria is identified as the preferred alternative in the Proposed Plan. The balancing emphasizes long-term effectiveness and reduction of toxicity, mobility, or volume through treatment.

Modifying Criteria

State and community acceptance are factored into a final balancing that determines the preferred remedy and the extent of permanent solutions and treatment practicable for the Site. The state-regulatory-agency may provide comments on the FS and Proposed Plan during the public comment period. Community concerns will be factored into the remedy selection process following the public comment period on the Proposed Plan.

COMPARATIVE ANALYSIS OF ALTERNATIVES

The following paragraphs present a comparative analysis of the alternatives.

Overall Protection of Human Health and the Environment

According to CERCLA, this criterion must be met for a remedial alternative to be chosen as a final site remedy. Alternative CMS1 is the No Action Alternative, which was developed as a baseline with which to compare the other alternatives. It would not eliminate, reduce, or control source areas or potential future exposure to contaminants exceeding PRGs and would not meet remedial action objectives. Therefore, it is not protective of human health and the environment and cannot be chosen as a final remedy.

Alternatives CMS2 and CMS3 would each be protective of human health and the environment. Both alternatives would eliminate the direct contact and incidental ingestion risks from PCBs, arsenic, and lead within the OU 1 areas through removal and/or capping of this material. The PCBs would be taken to an appropriate off-site facility, and the arsenic and lead in the residential use area would either be disposed of in the CAD cell in the former mine pit (CMS2) or capped on Site (CMS3). The removal of the Ore Pad material would also control the most significant source of groundwater contamination. The removal of Ore Pad, Mine Operations Area, and WRP-3 source material and either its disposal in the CAD cell (CMS2) or on-site capping (CMS3) would also remove and/or control significant sources of surface water contamination. Removal of WRP-3 and capping/stabilization of the Tailings Impoundment would prevent these areas from acting as a source of sediment and surface water contamination. Removal of the sediments that were found to be acutely toxic and which also represent a food chain threat and disposal into the CAD cell would eliminate that threat to the site biota. Both alternatives would implement institutional controls to

prevent site use that could damage the components of the cleanup (particularly capped areas and the CAD cell).

Alternatives CMS2 and CMS3 are very similar in the degree to which they achieve protection of human health and the environment. CMS2 is more protective because of the greater long-term effectiveness afforded by placement of the material in the mine pit versus reliance on an on-site cover system. Both alternatives are equal with regard to protecting wetlands resources. Because of the greater degree of permanence associated with the disposal of the waste in the CAD cell versus the maintenance of a second cover system, CMS2 has a greater degree of overall protectiveness of human health and the environment than CMS3.

Compliance with ARARs

CERCLA requires that a selected alternative must also meet a second threshold criterion of compliance with ARARs, or a waiver must be obtained if the criterion cannot be met. According to CERCLA, this criterion must be met for a remedial alternative to be chosen as a final remedy.

Location-specific ARARs. Alternative CMS1 is the No Action Alternative, which was developed as a baseline with which to compare the other alternatives. Because this alternative does not include any actions, the alternative does not trigger location-specific ARARs.

Alternatives CMS2 and CMS3 would be designed and implemented to comply with regulations pertaining to coastal zone, facility siting, subtidal lands, fish and wildlife habitat, floodplains, and, wetlands, and endangered species. All identified location-specific ARARs can be satisfied by both alternatives.

Chemical-specific ARARs. Alternative CMS1 would not attain protective concentrations for arsenic, lead, and PCBs in soil and would not comply with chemical-specific ARARs and TBCs. Alternatives CMS2 and CMS3 would attain protective concentrations for arsenic, lead, and PCBs in soil and would, therefore, comply with chemical-specific ARARs and TBCs.

Action-specific ARARs. Because alternative CMS1 does not include any actions, it does not trigger action-specific ARARs. Alternatives CMS2 and CMS3 would improve Tailings Impoundment stability by regrading and capping the Tailings Impoundment. Therefore,

Alternatives CMS2 and CMS3 would meet one of the potentially relevant and appropriate criteria under the State of Maine mining rules pertaining to the stability of the Tailings Impoundment. Alternative CMS1 would not include actions to improve the Tailings Impoundment Factor of Safety (FOS). In addition, Alternative CMS1 would not include actions to improve the FOS at WRP-3. Therefore, Alternative CMS1 would not attain ARARs pertaining to the stability of the Tailings Impoundment. Alternative CMS1 does not control infiltration to groundwater and therefore, reduction in groundwater concentrations of metals is not expected. Alternatives CMS2 and CMS3 would be designed and implemented to attain all identified action-specific ARARs.

Both CMS2 and CMS3 are equally ARAR compliant. In particular, they would comply with the State of Maine mining rules and Clean Water Act. As part of complying with the Toxic Substances Control Act and its regulations, this FS includes an USEPA finding that the 1 ppm cleanup level for PCBs selected for the remedy would not pose an unreasonable risk of injury to health or the environment.

Long-Term Effectiveness and Permanence

This criterion evaluates the magnitude of residual risk and the reliability of controls after response objectives have been met. Alternative CMS1 would not eliminate, reduce, or control source areas, or prevent current or potential future exposure to contaminants exceeding PRGs and, therefore, would not provide long-term effectiveness at protecting human health and the environment.

Alternatives CMS2 and CMS3 would both provide similar actions to control exposure risk at residential use areas. These actions would provide good long-term effectiveness and permanence.

Alternatives CMS2 and CMS3 would improve Tailings Impoundment stability by regrading and capping the Tailings Impoundment. These actions would enhance long-term effectiveness and permanence.

Alternatives CMS2 and CMS3 take actions to cap the Tailings Impoundment and excavate and dispose of Ore Pad, Mine Operations Area, and WRP-3 source areas, thereby controlling the generation of acid mine drainage at these source areas. Under Alternative CMS2 excavated material would be disposed of and isolated in the CAD cell in the former mine pit. Under Alternative CMS3, excavated material would be disposed of and isolated by consolidation and

capping at WRP-1 or by a combination of disposal in the CAD cell and consolidation at WRP-1. Disposal of source material and contaminated sediment in the CAD cell is a permanent disposal solution, no maintenance is required to maintain the integrity of the pit, and in the long term the natural sediment accretion would cover the material placed in the pit. The disposed material would be located below the depth at which mixing occurs with upper water strata in Goose Pond. Consolidation of source material at WRP-1 as part of Alternative CMS3 is also considered a long-term solution, but with the caveat that at some indeterminate future time, repair to the WRP-1 cover or berm could be required. Therefore, the alternatives with greater reliance on disposal in the CAD cell are considered to have slightly greater long-term effectiveness and permanence than alternatives that consolidate at WRP-1.

Alternatives CMS2 and CMS3 would reduce ecological risk from exposure to contaminated sediments by excavating/dredging salt marsh (including areas of readily apparent harm) and Goose Pond and Goose Cove sediments exceeding PRGs and isolating the dredged material in the CAD cells.

For CMS2 and CMS3, the wetland treatment system would provide a "polishing" role to further reduce the discharge of contaminants to Goose Pond during the time period for the cover system to reduce the flow of water from the Tailings Impoundment.

The relative ranking of long-term effectiveness is CMS2 > CMS3 > CMS1 because of the long-term effectiveness of the CAD cell versus a cover system.

Reduction of Toxicity, Mobility, and Volume Through Treatment

This criterion evaluates whether the alternatives meet the statutory preference for treatment under CERCLA. The criterion evaluates the reduction of toxicity, mobility, or volume of contaminants through treatment and the type and quantity of treatment residuals.

Alternative CMS1 does not contain any components to reduce the toxicity, mobility, or volume of contaminants through treatment.

Alternatives CMS2 and CMS3 rely on off-site disposal rather than treatment for the principal threat waste (PCBs) because the vast majority of PCB-contaminated material is below USEPA's

guidance levels for treatment for PCBs, and the quantity of PCBs materials is too small to warrant consideration of on-site treatment. The major components of CMS2 and CMS3 are source control measures for large volumes of low-level threat wastes, which is consistent with USEPA guidance. Both CMS2 and CMS3 would achieve some level of reduction in toxicity, mobility, and volume as a result of the sulfide reduction to immobilize the metals in the treatment wetland.

Short-Term Effectiveness

CERCLA requires that potential adverse short-term effects to workers, the surrounding community, and the environment be considered during implementation of a remedial action and until response objectives have been met. Under this criterion, the time period to achieve protectiveness is also evaluated. Alternative CMS1 does not lead to any exposure risks and, therefore, results in no short-term effects; however, it never achieves protectiveness of human health or the environment.

Alternatives CMS2 and CMS3 would both achieve protectiveness in a similar time frame. Once the PCBs and lead contaminated soil in residential use areas are removed and safely disposed of, the current threats to human health would be under control. Once the sediments are removed and the area restored, the areas with contaminated sediments would begin biological recovery and should achieve recovery within several years. The control of the source areas (WRP-3, Mine Operations Area, Ore Pad, and Tailings Impoundment) would immediately reduce the contaminant loading to surface water and groundwater and solids loading to sediments.

Alternatives CMS2 and CMS3 have similar short-term effects with regard to current residential use area of the Site. Seasonal residents in this portion of the Site would continue to be exposed to residential use area soil until its excavation and disposal, estimated to be within 1 to 2 years of remedy selection.

Each of the alternatives utilizes on-site materials and resources to reduce short-term risks to the community from construction traffic to and from the Site. On-site quarrying to produce crushed stone for capping at the Tailings Impoundment (Alternatives CMS2 and CMS3) and at WRP-1 (Alternative CMS3) would result in construction related concerns (e.g., blasting, noise, and dust) and would permanently alter a small area of habitat in the vicinity of the Ore Pad Haul Road. Use of the CAD cell for disposal of source material (Alternatives CMS2) and for disposal of dredged sediment and salt marsh material (Alternatives CMS2 and CMS3) would also result in construction

related concerns. Each alternative would result in some short-term effects to the community from truck traffic to deliver equipment and materials. Alternatives CMS2 and CMS3 would require delivery of similar amounts of geomembrane and geocomposite for the Tailings Impoundment cover and of media for the treatment wetlands. Alternative CMS3 would require delivery of geomembrane and geocomposite for the WRP-1 cover.

Alternatives CMS2 and CMS3 would result in short-term destruction of emergent wetlands (salt marsh) (which would be restored) and subtidal wetlands (Goose Pond) from remedial dredging. Disposal of source material and dredged sediment in the CAD cell has potential to cause adverse short-term water quality impacts in proportion to the volume of disposed material; however, silt curtains, water quality monitoring, and other engineering controls would be used to minimize these impacts. All of these impacts are short-term and less significant than the ongoing impacts from the source areas.

The remedial excavation/dredging of salt marsh and Goose Pond sediments as part of Alternatives CMS2 and CMS3 would result in short-term disruption of sediment biota and habitat. These impacts are short-term and less significant than the ongoing impacts from the source areas. The biological communities of these areas are expected to fully recover.

The capping of the Tailings Impoundment (Alternatives CMS2 and CMS3), consolidation at WRP-1 (Alternative CMS3), and excavation of source areas would result in adverse short-term effects to upland habitat in approximate proportion to the areas of disturbance (i.e., adverse effects for CMS3 > CMS2 > CMS1).

The overall relative ranking of the alternatives at short-term effectiveness (i.e., lack of adverse effects) is CMS1 > CMS2 > CMS3.

Implementability

This criterion evaluates each alternative's ease of construction and operation, and availability of services, equipment, and materials to construct and operate the alternative. Also evaluated is the ease of undertaking additional remedial actions and administrative feasibility.

Alternative CMS1 does not include any actions, other than Five-Year Reviews and, therefore, would be technically easy to implement. No permits would be required, and administrative feasibility would be good.

Services and equipment are available to implement Alternatives CMS2 and CMS3. Construction of the Tailings Impoundment cover and the WRP-1 cover would require large volumes of soil/crushed stone which is not available on Site. On-site quarrying would be performed to obtain material. None of these alternatives would interfere with the ability to undertake additional remedial actions.

The administrative feasibility of obtaining regulatory approvals and the necessary permits for any off-site actions is considered good to the extent required for Alternatives CMS2 and CMS3, although coordination with regulatory agencies would be required, especially for an innovative capping approach. The establishment of institutional controls would need to be coordinated between the property owners and the local and state regulatory authorities.

The relative ranking of technical implementability is CMS1 > CMS2 > CMS3.

The relative ranking of administrative implementability is CMS1 > CMS2 > CMS3.

Cost

The following table summarizes capital, present worth, and total estimated non-discounted costs for the evaluated alternatives. Of the two alternatives that would protect human health and the environment and comply with ARARs, CMS2 is the less expensive of the alternatives that meet the threshold criteria.

Cost Category	**CMS1**	**CMS2**	**CMS3**
Capital Costs	$0	$21,515,800	$24,131,500
Total Present Worth (30 yrs @ 7%)	$19,000	$22,839,800	$25,455,500
Total Present Worth (100 yrs at 2.7%)	$56,000	$24,913,800	$27,529,500
T. Non-Discounted Costs (100 yrs)	$171,000	$31,233,800	$33,849,500

Summary of Comparative Analysis

Of the two alternatives that achieve protection of human health and the environment and comply with ARARs, CMS2 provides the best balance of the five criteria. Table 5.2-1 in the FS summarizes the comparative analysis of alternatives.

OU 2 EARLY ACTION

USEPA has identified the need for an early cleanup action for the OU 2 area. Specifically, since the finalization of the OU 2 RI/FS and selection of an OU 2 cleanup action is dependent upon the completion of the OU 1 Remedial Action, many years will pass before an OU 2 cleanup can be implemented. The Callahan Mine HHRA identified future consumption of contaminated groundwater and direct contact with lead and arsenic contaminated soil in a residential setting as potential threats to human health. To address this threat to human health, USEPA would implement an early cleanup action to prevent residential development or groundwater use within the former Callahan Mine portion of the Site. Figure ES-15 shows the extent of the area of the former Callahan Mine portion of the Site that would be subject to land use restrictions based on existing site data.

Remedial Action Objectives

The remedial action objectives for the early cleanup action are:

- Prevent exposure to soil or waste with concentrations of lead or arsenic above the site-specific cleanup levels for future residential use within the former Callahan Mine portion of the Site
- Prevent ingestion of bedrock groundwater in excess of federal safe drinking water act MCLs; Maximum Contaminant Level Goals (MCLGs); MEGs; or USEPA risk standards within the former Callahan Mine portion of the Site

The design for the early cleanup action would identify the extent of the former Callahan Mine portion of the Site that exceeds the residential PRGs for arsenic and lead developed for the OU 1 cleanup and the extent of groundwater that exceeds MCLs, MCLGs, MEGs, or risk-based standards, whichever is more stringent.

The early cleanup action would include the placement of land use restrictions that run with the land to effectively prevent future residential use or installation of water supply wells within the former Callahan Mine portion of the Site. Restrictive covenants are the primary mechanism to achieve this objective with local and/or state ordinances or zoning to supplement the property restriction.

Because the only remedial action objectives for OU 2 are to prevent the use of the Site, and not restore groundwater or contain/remove contaminated soil, no other technologies or alternatives were considered, other than No Action. The OU 2 FS would develop and analyze technologies with respect to any groundwater restoration, migration control, or soil remediation. A very simplified NCP criteria analysis was performed in Section 6.0 of the OU 1 FS for the No Action and Institutional Controls alternatives.

USEPA has determined that an early cleanup action is appropriate for OU 2 at the Callahan Mine Superfund Site. The early cleanup action provides the best balance of the NCP criteria to ensure protection of human health prior to the implementation of the OU 2 response action. The early cleanup may be the only remedial action for OU 2, or may be the first component of additional remedial actions that would be evaluated in the OU 2 FS and selected in a future OU 2 ROD.

1.0 INTRODUCTION

This Feasibility Study (FS) report was prepared by MACTEC Engineering and Consulting, Inc. (MACTEC), to identify and evaluate cleanup alternatives for waste materials, soil, and sediments for Operable Unit (OU) 1 at the Callahan Mine Superfund Site (Site) in the village of Harborside in the Town of Brooksville, Maine. The report was prepared for the Maine Department of Transportation (MaineDOT) in accordance with the requirements set forth in a 2005 Administrative Order by Consent for Remedial Investigation and Feasibility Study between the U.S. Environmental Protection Agency (USEPA) and the State of Maine.

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 (Figure 1.0-1) and the associated areas where contamination has come to be located, including Goose Pond, Goose Cove, and other contaminated wetland areas. Goose Pond and Holbrook Island Sanctuary State Park are immediately east of this Site property. Private residences and seasonal homes are located adjacent to this Site property on Goose Falls Road and Cape Rosier Road. Site coordinates are 44° 21’ 05.9” north latitude and 68° 48’ 35.5” west longitude.

Intermittent exploration and mining for copper and zinc occurred at the Site from the 1880s to the 1970s. For five years from 1968 through 1972, the massive sulfide ore deposits were mined with an open pit mine in the drained Goose Pond estuary. Copper, lead, and zinc ore was crushed, milled, and concentrated on Site, and the concentrate shipped off site for smelting. Waste rock and tailings were disposed of on Site.

The Site is a Superfund site and was added to the USEPA National Priorities List (NPL) in September 2002. The Site is undergoing investigation and clean-up activities pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act, as amended (CERCLA), 42 USC § 9601 *et seq.*, and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), 40 CFR Part 300. The Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS) ID number for the Site is MED980524128.

1.1 PURPOSE AND SCOPE

To facilitate the evaluation and implementation of actions to reduce, eliminate, or control actual or potential human-health and ecological risks, the Site has been divided into two OUs. OUs are discrete actions that comprise incremental steps toward a final remedy. An OU eliminates or mitigates a release, a threat of a release, or an exposure pathway (USEPA, 1988b), and may reflect the final remediation of a defined portion of a site, or may be implemented as an interim measure. When implemented as an interim action, an OU facilitates the collection of data that will reduce uncertainty at the Site and lead to more effective final remedy.

This FS report addresses OU 1 which comprises the following areas:

- Soil contaminated with polychlorinated biphenyls (PCBs).
- Soil that may represent the most significant threat to surface water, sediments, and groundwater. These areas are the former Ore Pad, portions of the Mine Operations Area, Waste Rock Pile 3 (WRP-3), and the Tailings Impoundment.
- Areas of sediment that were shown to be acutely toxic in laboratory tests and may represent a food chain threat. This is primarily in the area of sediments and the salt marsh that resides adjacent to WRP-3 and the Tailings Impoundment.
- Soil contaminated with lead and arsenic in current residential use areas (i.e., seasonal residential use lots located along Old Mine Lane, the access road to the Site).

This FS does not select a preferred alternative for OU 1, but describes the alternatives under consideration. The preferred alternative will be identified in the Proposed Plan and will be subject to public comment. After addressing State and public comments on the proposed alternative, a final remedy selection will be described in a Record of Decision (ROD).

The remaining areas of the Site, as well as groundwater, will be further evaluated as part of a second OU (OU 2) and will be subject to a FS in the future, if it is determined that a response action is necessary. There will be an early action for OU 2 to prevent land uses that would result in an unacceptable exposure to contamination or consumption of contaminated groundwater. Section 6.0 describes the early action.

1.2 REPORT ORGANIZATION

Section 1.0 introduces the FS report and its purpose, and presents report topics. Section 1.0 briefly describes the FS process to enhance the reader's understanding when reviewing relevant sections of the report. A brief background description of the installation, including Site location, facility history, and previous investigations and removal actions is included.

In addition, Section 1.0 summarizes site characteristics and the contamination assessment for the Site, and presents a site conceptual model that considers the interrelationships of contaminant source areas, site geology, site hydrogeology, contaminant persistence, and contaminant distribution. Section 1.0 also summarizes human-health and ecological risks.

Section 2.0 identifies the basis for remediation, and then identifies and screens remedial technologies for the corresponding response actions. This section links the results of the risk assessments to the selection of remedial technologies by identifying preliminary remediation goals (PRGs), developing remedial action objectives, and listing the resultant general response actions. This section initiates the risk-management decision process.

Section 3.0 describes the assembly of these technologies into remedial alternatives, and screens the alternatives against the criteria of implementability, effectiveness, and cost.

Section 4.0 provides a detailed analysis of the retained alternatives and contains an evaluation of each alternative against the first seven evaluation criteria listed in the NCP.

Section 5.0 presents a comparison of the retained alternatives that were the focus of the detailed evaluation, highlighting relative advantages and disadvantages of the alternatives with respect to the seven evaluation criteria.

Section 6.0 describes the OU 2 early actions.

Figures, tables, and appendices are presented at the end of this document.

1.3 FEASIBILITY STUDY PROCESS

The FS process as described in this subsection, from remedial action objective identification through detailed analysis of remedial alternatives, is consistent with USEPA Remedial Investigation (RI)/FS guidance (USEPA, 1988b). The initial steps of the FS process consist of the following items:

- establishing remedial action objectives to reduce actual or potential risks to human health and the environment;
- identifying the types of response actions for each OU and medium necessary to achieve the remedial action objectives;
- identifying and screening specific remedial technologies that may be capable of attaining remedial action objectives; and
- assembling the selected representative technologies into alternatives which represent a range of treatment and containment combinations as appropriate, and screening these alternatives with respect to the criteria of effectiveness, implementability, and cost.

Following development and screening of the remedial alternatives, this FS report presents a detailed evaluation and comparison of the alternatives not eliminated during screening. Retained alternatives are evaluated in detail using criteria identified in the NCP and RI/FS guidance (USEPA, 1988b, 1990). Based on the results of the detailed evaluation, the remedial alternatives are compared to one another in the comparative analysis to highlight relative advantages and disadvantages, and to facilitate selection of the preferred remedial alternative.

1.4 BACKGROUND INFORMATION

This subsection summarizes background information on the Callahan Mine Superfund Site. Topics include a site description and general site history, a history of environmental investigations leading up to this FS, supporting studies – including geotechnical evaluations – performed as part of this FS, a summary of the nature and extent of contamination, a discussion of contaminant fate and transport, conceptual site model, and a summary of the human-health and ecological risk assessments. Additional detail pertaining to these subjects is provided in the RI report (MACTEC, 2009b).

1.4.1 Site Background and General Site History

1.4.1.1 Mining History

Mining for copper and zinc began at the Site in 1880 when an outcrop of massive zinc and copper ore was discovered in Goose Pond at low tide. Mining began in that year with the advancement of Shaft #1 approximately 400 feet along the strike of the ore body. Shafts #2 and #3 were advanced the following year. Between 1881 and 1883, about 10,000 tons of ore were mined. The ore reportedly contained 20 percent zinc, 2.8 percent copper, and some lead (Levin and Sanford, 1948). Sporadic mining continued from 1883-87 when the mine closed because of low metal prices. Intermittent exploration continued at the Site through the 1950s, although little mining occurred.

In 1956, the mine property was optioned by the Penobscot Mining Company, Ltd., of Toronto. The Penobscot Mining Company drilled a few exploratory boreholes that indicated more promising economic conditions at the Site, cleaned out the old workings, and mined some ore from underground shafts and tunnels. Mining soon ceased because of a decline in metal prices and lack of funds.

In 1964, the mine property was brought to the attention of Callahan Mining Corporation (Callahan). Historical tunnel mining at the Site had proved uneconomical. Re-evaluation of past work and Callahan's own investigations indicated that sufficient values might exist to warrant an open-pit mining operation. Based on this analysis, Callahan negotiated a lease with the Penobscot Mining Company. Permits were secured with the State of Maine.

Callahan began pre-construction activities at the mine in 1965 with ditch digging to control water flow and site work at the Mine Operations Area. Dam construction to enable draining of Goose Pond was completed in 1966, and a $4 million ore processing facility was completed. Open-pit mining operations commenced on February 17, 1968. When the pit reached a depth of approximately 100 feet, mining operations were interrupted when approximately 225,000 tons of mud flowed into the pit from Stink Cove leaving a 33-foot thick layer of organic silt covering some excavation equipment. Callahan spent six months removing silt and disposing it at WRP-1.

At the time mining operations ceased in 1972, the mine consisted of a roughly circular open pit approximately 600 feet in diameter and 320 feet deep. Figure 1.4-1 is an aerial photograph from a

1972 newspaper article showing the open pit excavation and dewatered Goose Pond, and Figure 1.4-2 shows historical mine features and facilities present during the time of active mining.

1.4.1.2 Mine Operations

Hard rock mining operations of this type involved the removal of large quantities of non-valuable rock (referred to as "waste rock") in order to expose the high-quality ore body for mining. Waste rock may have some degree of mineralization, but the concentrations of valuable minerals are too low to be economically recovered; therefore, waste rock was typically discarded or used as general fill material in the area immediately surrounding the mining operation. 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. The ore consisted primarily of sphalerite (zinc sulfide [ZnS]) or zinc-iron sulfide [(Zn,Fe)S]), chalcopyrite (copper-iron sulfide [$CuFeS_2$]), and minor occurrences of galena (lead sulfide [PbS]). Rock was blasted from inside the open pit and hauled out in trucks. Ore-grade rock was taken directly to processing or to an ore storage area (the Ore Pad). Waste rock was disposed of at WRPs-1, -2, and -3, or used for construction projects (e.g., construction of containment berms at the Tailings Impoundment and WRP-1 and for construction of roads). Figure 1.4-3 shows major site features at the mine based on recent aerial photography, as well as topographic and bathymetric elevation contours.

At some juncture in the mining operations, two tunnels were advanced to follow the ore body to the southwest toward Dyer Hill. Reportedly, the two tunnels were located over each other and were referred to as the '920' and the '860'. (The naming convention was derived by making sea level the arbitrary reference point 1000; therefore, the first tunnel is located approximately 80 feet below the current water level in Goose Pond). The tunnels were advanced approximately 500 feet, as the ore in the ceilings was blasted and removed (open stope mining). Each tunnel is reportedly 8- to 10-feet wide by 40 feet high and 500 feet long. The '860' followed the '920' and was mined in much the same manner.

Callahan produced an ore concentrate on Site from the ore, and approximately 18 percent of the processed ore-bearing rock was recovered as copper/lead and zinc concentrates. The ore concentrate was prepared by crushing the ore-bearing rock into particles smaller than 0.5-inch diameter using a three stage crushing process (a jaw crusher and two cone crushers). The crushed ore was then milled to fine sand using two ball mills. The milling process produced a slurry of

sand- and silt-sized ore particles from which copper, lead, and zinc sulfide minerals were separated and concentrated by flotation.

Flotation separation utilizes the "surface active" property of sulfide mineral particles. The slurry of finely ground ore is passed through flotation cells where it is mixed with flotation reagents, and air is bubbled through it. The flotation reagents mixed with the slurry cause the metal-sulfide mineral particles to adhere to the surface of the air bubbles, forming a froth that was collected from the surface. Chemical compounds used in the flotation cell process included dithiophosphate, diethyldithiophosphate, aryl phosphorodithioate, cyclohexanol, and cresol. The metal-rich froth was collected, washed, dried, and stockpiled in a portion of the mill where it awaited transportation to a smelter. Callahan used a series of flotation processes to concentrate the individual metals separately. The average ore prior to processing was 1.30 percent copper, 4.91 percent zinc, 0.35 percent lead, and 0.50 ounces per ton of silver.

After removal of the float or concentrate, the remaining slurry was pumped to the Tailings Impoundment for disposal. The Tailings Impoundment consisted of a series of stacked berms constructed of waste rock, coarse tailings, and clay along Goose Pond at the south end of the Site. When tailings reached the top of each berm, a new berm was built on top of it, and filling with tailings resumed. Figure 1.4-4 shows an interpreted east-west cross-section through the Tailings Impoundment berm. Tailings were discharged to the impoundment along the periphery, where coarse tailings settled out. Finer, slower-settling tailings migrated to the center of the impoundment. A decant pipe currently exists at the Tailings Impoundment, and it is believed that it was used during the period of mine operations to decant excess water from the Tailings Impoundment. The pipe discharges at the toe of the impoundment berm, and discharged liquid flows to Goose Pond. In addition, information gathered during the RI indicates that excess water was decanted via a surface drainage ditch along the western edge of the Tailings Impoundment. This decant water flowed to Goose Pond and may have transported entrained tailings to Goose Pond.

Because of the depth of the open mine pit, water seeped into the pit. This water and entrained sediment (rock flour and silt) created from drilling and blasting were pumped out of the pit and discharged through a pipe to Goose Cove for a period of time. Because of concerns about sediment discharge to Goose Cove, an embayment within Goose Pond (i.e., Dyer Cove) was dammed off and used as a settling pond for de-watering the open pit. Following settling, water in Dyer Cove was

pumped to the mine water sump, where it was then pumped through a pipe that discharged into Goose Cove.

1.4.1.3 Pre-, Active-, and Post-Mining Conditions in Goose Pond

Goose Pond is a shallow estuary that connects to Penobscot Bay through Goose Falls and Goose Cove to the north. Goose Falls is a reversing tidal falls, and, prior to the construction of the Callahan Mine, salt water entered Goose Pond from Goose Cove over Goose Falls during incoming tides and drained from Goose Pond over Goose Falls during ebbing tides. Freshwater entered Goose Pond from the south via Marsh Creek. The maximum depth of Goose Pond is approximately 13 feet, except in the area of the mine pit which is now approximately 300 feet deep (TRC, 2005). Goose Pond occupies approximately 75 acres between Goose Falls and Marsh Creek.

To allow extraction of the ore body, the 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 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 (see Figure 1.4-2). A berm was also constructed to prevent Stink Cove sediments from sliding into the pit.

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. The mine pit is currently under water.

1.4.2 Site Geology and Hydrogeology

This subsection summarizes site geologic and hydrogeologic information from the RI report. The reader is encouraged to review Subsections 3.1 through 3.3 of that report for a more detailed discussion of geologic and hydrogeologic conditions.

1.4.2.1 Regional Bedrock Geology

The following description of bedrock geology is based largely on the work of Levin and Sanford (1948). The country rock of Cape Rosier and the adjacent portion of the mainland is composed of a series of volcanics — rhyolitic and andesitic flows, agglomerates, and pyroclastics folded with northeasterly regional strike and intruded by sills and dikes of diorite. Agglomerates, or volcanic breccias, consist of large blocks of igneous volcanic rock, embedded in a finer grained igneous mix. These coarse volcanic deposits are typically located in proximity to volcanic vents, within or near formerly active volcanic craters. The volcanics are collectively called the Castine formation and tentatively assigned to the early or middle Paleozoic age.

The Callahan Mine massive sulfide deposit occurs as lenses of mixed sulfides of zinc (sphalerite), copper (chalcopyrite), lead (galena), and iron (pyrite) in close association with highly sheared and altered agglomerate. The cover of glacial till averages only a few feet in thickness and bedrock outcrops are numerous, especially along the shores. The contact between the volcanics and the southwestern end of a late Paleozoic batholith of granite and diorite is located four miles east of the Site. In the immediate vicinity of the mine Site, two agglomerates, the Goose Falls and Dyer Point, and a black rhyolite are recognized.

The Goose Falls agglomerate is characterized by ¼- to 5-inch grayish-buff fragments. The Dyer Point agglomerate is characterized by 5- to 7-inch angular fragments of black rhyolite, which weathers white in a fine-grained groundmass that weathers gray.

The rhyolite is black, massive, and very fine-grained. The general strike of these structures and the mineralized zone is approximately N 17E and the dip is southeasterly. In the area drilled (for mine exploration) the Goose Falls agglomerate is intruded by two diorite sills and several minor tongues of variable thickness and characterized by pinching, swelling and splitting. Typical diorite is massive, un-sheared, and fresh; the color is light gray with a slight greenish tone.

Traces of mineralization (i.e., presence of copper, lead, and zinc sulfides) at the surface are rare, but subsurface drilling established a mineralized zone that coincides approximately with the zone of intensely sheared and thoroughly altered agglomerate lying chiefly below and to a lesser extent between the diorite sills. The sheared agglomerate has been converted into: 1) a green-black

macroscopically mono-mineralic chlorite schist; or 2) a coarse aggregate of creamy-white non-foliated talc and white calcite, in which the carbonate appears to be healing a talc breccia; or 3) a chlorite-talc-calcite rock. The mineralized zone dips about 55° SE near the surface and flattens with the diorite to about 30° SE at depths down dip of 200 to 400 feet. The thickness of the mineralized zone (not the ore) beneath the lower diorite ranges from a few inches up to 100 feet.

Within the mineralized zone defined by the sheared altered agglomerate (fragmental pyroclastics, including tuffs and breccias) with disseminated sulfides, there occurred several sphalerite-chalcopyrite-galena ore shoots of lens-like habit. The largest of these massive sulfide bodies was in the thickest part of the mineralized zone, in the vicinity of Shafts 1 and 2. In this area, three ore lenses occurred beneath and were essentially conformable in dip with the lower diorite. These lenses were separated by a very lean (low grade) mineralized zone.

1.4.2.2 Site Geology

General stratigraphy at the Site consists of a variable thickness of mine waste fill composed of material ranging from processed fine sand, silt, and clay-sized particles (tailings) at the Tailings Impoundment, to a thick fill unit composed of large waste rock cobbles and boulders at WRP-1, more weathered pyritic waste rock material at WRP-3, a thin veneer of waste rock at WRP-2, and road fill in parts of the Mine Operations Area. The waste rock material and tailings are typically underlain by a glaciomarine clay unit, a thin layer of glacial till, and bedrock.

Bedrock is generally composed of very fine grained felsic rhyolite (felsite), banded rhyolite, and andesite flows and pyroclastics, which include finer grained tuffs to coarser agglomerates. Most bedrock encountered contained trace to low percentages of disseminated pyrite. The stratigraphy at each site area is presented in more detail in the following paragraphs.

1.4.2.3 Groundwater

Groundwater elevation data collected during the RI indicate that on-site groundwater occurs primarily in the bedrock. The on-site existence of a permanent, naturally saturated overburden occurs only at the Mine Operations Area where a thick wedge of till and marine sediments occurs between a rocky ridge to the west and WRP-1 to the east. This wedge of sediments receives discharge from the bedrock aquifer, as noted by artesian conditions at MW-610R, and storm water

runoff from the surrounding topographic highs. This combined groundwater discharge and surface water runoff infiltrates into the coarse waste rock at the northern and eastern end of the Mine Operations Area, ultimately discharging to Dyer Cove.

Overburden groundwater also occurs at the Tailings Impoundment; however, this groundwater is interpreted as perched above the natural groundwater surface. Groundwater elevations in bedrock wells MW-604R and MW-722R, installed within the Tailings Impoundment footprint, are roughly 30 and 15 feet, respectively, below the elevation of the impoundment water.

Overburden water at the three waste rock piles and the Ore Pad generally occurs only intermittently and with a limited saturated thickness. The overburden water in these areas appears to result from precipitation and storm water runoff infiltrating through mine waste fill and forming areas of groundwater perched on the underlying clay and till layers. This subsurface water is considered to not be a naturally occurring and continuously connected overburden groundwater system.

Sand and gravel aquifers have not been identified on the Cape Rosier Peninsula, and most residential wells near the Site are completed in the bedrock aquifer.

Figure 1.4-5 shows interpreted overburden groundwater elevation contours, including areas of perched and intermittent overburden groundwater. The interpreted bedrock groundwater potentiometric surface is shown on Figure 1.4-6. Both overburden and bedrock groundwater flow generally to the east towards Marsh Creek and Goose Pond, with a local component of flow to the north in the area of WRP-1 and Dyer Cove.

1.4.2.4 Surface Water

The principal surface water feature at the Site is Goose Pond, a tidal estuary that empties to Penobscot Bay via Goose Falls and Goose Cove. Goose Pond is bordered along its western shore by uplands formed by Dyer Hill and is largely occupied by the former Callahan Mine property. The uplands range from heavily forested woodland to barren waste rock piles and soil, and bedrock exposures. The heavily forested uplands of the Holbrook Island Sanctuary bound the eastern shore of Goose Pond. The Goose Pond watershed encompasses approximately 5.14 million square meters or approximately 1,270 acres.

Goose Pond occupies approximately 75 acres and had a maximum depth of approximately 30 feet prior to development of the mine. Maximum depth is now approximately 13 feet, except at the location of the former mine pit where the depth is approximately 300 feet (TRC, 2005) (see Figure 1.4-3). Freshwater enters Goose Pond from Marsh Creek, surface water runoff from the Site, seeps located at the base of waste rock piles and the Tailings Impoundment, and groundwater discharge.

In addition to Goose Pond, several small surface water bodies exist at the Site. These include a small surface water body on the Tailings Impoundment. The depth of water here varies seasonally and was observed to be less than one foot in May 2005. Three small surface water bodies were mapped in the wetland area located in the lower tier of WRP-1 (area where Stink Cove silt/clay was placed) and range from 1 to 2 feet in depth.

Overland flow of surface water typically develops rapidly at the Site during steady rainfall events and downpours, resulting in large volumes of surface runoff being directed to Goose Pond and Dyer Cove by drainage features at the Site. These drainage features are ephemeral streams, running only when there are large amounts of runoff. Subsection 3.3 of the RI report provides additional discussion pertaining to surface water runoff and contaminant transport at the Site.

1.4.3 History of Site Investigations and Enforcement Actions

Environmental sampling has been performed at the Site since 1967. The most extensive sampling of site media was completed during the RI from 2004 through 2008 following Site listing on the NPL in 2002. Table 1.4-1 provides a summary listing of investigations completed at the Site between 1967 and 2008.

1.4.4 Related Investigations and Studies

Several studies and evaluations were performed as part of the RI and this FS to provide additional information pertinent to understanding the fate and transport of contaminants, the stability of the Tailings Impoundment, and potential effects of remedial actions. These include the following:

- Hydrodynamic Observations at the Former Callahan Mine Property (WHG, 2007)
- Hydrodynamic Characterization and Sediment Transport Potential at the Former Callahan Mine Property (WHG, 2008a)

- Technical Memorandum Modeling of Potential Future Hydrodynamic Scenarios and Analytical Sediment Transport Modeling of Goose Cove (Appendix A)
- Wetland Delineation and Functional Assessment Report (Appendix B)
- Geotechnical Evaluation Report (MACTEC, 2009a)
- Dewatering Rate Estimates the Tailings Impoundment, Callahan Mine (Appendix C)
- Technical Memorandum, Slope Stability Evaluations for OU 1 Feasibility Study Report (Appendix D)

1.4.4.1 Hydrodynamic Observations at the Former Callahan Mine Property

Between August 24, and October 29, 2006, Woods Hole Group (WHG) collected hydrodynamic observations in the Goose Pond estuary to provide a general understanding of the hydrodynamic characteristics of the system, but also to provide the appropriate data for utilization in the development of a hydrodynamic model (WHG, 2007). Depth varying current velocities, water surface elevation, salinity, temperature, and turbidity were observed at three monitoring sites throughout the estuary. In addition, a brief bathymetric survey and a conductivity, temperature, and depth survey were collected to further quantify the hydrodynamics of the system. The Hydrodynamic Observations Report was included in Appendix O of the RI report.

1.4.4.2 Hydrodynamic Characterization and Sediment Transport Potential at the Former Callahan Mine Property

Following hydrodynamic observation data collection, Woods Hole Group developed a 3-D hydrodynamic model utilizing the Environmental Fluid Dynamics Code (EFDC) to simulate extreme rainfall event discharge and storm surge events. The simulated extreme rainfall discharge events revealed increased velocities at the former earthen dam and upstream into Marsh Creek (WHG, 2008a). The storm surge events had the greatest effect on velocities near Goose Falls, within both Goose Cove and Goose Pond, while rainfall events (combined with an ebb flow) had an influence on the regions near the former earthen dam.

An assessment of sediment transport potential was made using the results from the hydrodynamic model and the Shield's critical stress criteria for the initiation of sediment mobility (modified for fine cohesive sediments where required). Results showed the Goose Pond Estuary was largely

depositional under typical tidal and flow conditions. The report concluded that although there is a possible influx/outflux of sediments between Goose Pond and Goose Cove, the sediments likely to be mobilized from within the system would be in the vicinity of Goose Falls, and are not likely to be derived from the deeper portions of Goose Pond. Therefore, under typical conditions, material within Goose Pond would remain sequestered within the system.

Simulations of extreme rain event discharge indicated the potential for erosion in the surrounding areas of Goose Falls, near the former earthen dam, and in Marsh Creek. As with the existing conditions, though, the report concluded that suspension of existing sediments from the deeper portions of Goose Pond is not likely during the high rain events. The mobilized material for Marsh Creek is likely transported into the deeper portions of Goose Pond; however, once in the Pond, cannot be easily transported out into Goose Cove.

When compared to the rainfall events, storm surge event simulations revealed an increase in the erosion potential in the paths of the hydraulic jet features formed during the flood and ebb conditions at Goose Falls. Simulations of the storm surge events did not significantly increase sediment transport potential near the former mine pit, or in the upstream portions of the estuary, including Marsh Creek. However, the areas surrounding Goose Falls experienced marked increases in potential for contaminated sediment transport to Penobscot Bay.

Overall, the report concluded that the Goose Pond system is primarily depositional. The hydrodynamic and sediment transport modeling indicate that contaminated sediments currently residing in the Goose Pond estuary are likely to remain sequestered in Goose Pond, and not be transported into Penobscot Bay. Although some sediment movement is expected to occur in Marsh Creek during higher rainfall events, this material will only be mobilized within the Goose Pond system and deposited in the former mining pit. Sediment near Goose Falls, and seaward of the falls specifically, does have a greater potential for mobilization and movement into Penobscot Bay.

The Hydrodynamic Characterization and Sediment Transport Potential report was included in Appendix O of the RI report.

1.4.4.3 Technical Memorandum Modeling of Potential Future Hydrodynamic Scenarios and Analytical Sediment Transport Modeling of Goose Cove

As a follow-up to the initial hydrodynamic modeling, Woods Hole Group used the 3-D hydrodynamic EFDC model to evaluate the following potential future scenarios under the extreme storm conditions (e.g., 100-year rainfall and 100-year storm surge):

- removal of anthropogenic and natural features at Goose Falls
- complete erosion of the earthen dam in Marsh Creek
- evaluation of the potential turnover of waters within the mine pit

Two scenarios were evaluated for removal of anthropogenic features at Goose Falls: 1) removal of dam and bridge abutments, and 2) removal of anthropogenic and natural features (i.e., removal of dam and bridge abutments, roadbed and land southwest of bridge, and the deepening of the channel to allow full tidal exchange). Both scenarios yielded similar results and showed little change in sediment transport potential in Goose Pond compared to existing conditions. The removal of the anthropogenic features at Goose Falls Dam would increase the potential for erosion of the sediments within Goose Cove and upstream of the former earthen dam. The sediments that exist in Goose Cove could be exposed and mobilized under these conditions.

Complete erosion of the remaining earthen dam in Marsh Creek did not greatly affect the hydrodynamics of the system. The potential future scenario was simulated in a 100-year precipitation event and similar trends were seen in current velocities and areas of potential erosion when compared to existing conditions. Therefore, the complete erosion of the earthen dam will not significantly impact the overall hydrodynamics or sediment transport within the system.

The technical memorandum concluded that turnover of waters within the deep former mine pit is unlikely. Under normal (existing) conditions, the dense waters in the pit are confined, and mixing only occurs in the upper 10 meters of the water column. During the simulation of 100-year extreme storm conditions coupled with the removal of the restriction at Goose Falls (i.e., removal of dam remnants and bridge abutments and widening the channel to approximately 200 feet and deepening it to allow full tidal exchange), vertical mixing increased to the upper 40 meters, but did not entrain the bottom layers within the mine pit. This scenario was evaluated as a worst case, although unlikely, future condition.

The hydrodynamic modeling technical memorandum is attached to this report as Appendix A.

1.4.4.4 Wetland Delineation and Functional Assessment Report

In mid-June 2008, MACTEC performed a wetland delineation survey at the Site to support potential remediation activities at the Site. The objective of the survey was to identify and delineate Maine Department of Environmental Protection (Maine DEP) Protected Natural Resources at the Site. The wetland delineation survey included salt marsh/tidal wetlands, freshwater wetlands, and streams, and a review of potential vernal pools.

The area of investigation included Goose Pond from the outlet to Goose Cove to the upper marsh where the pond transitions to Marsh Creek. The area of investigation associated with Goose Pond ended at the point where an old beaver dam bisects Marsh Creek. The area of investigation also included the portion of the property within 250 feet of on-site areas where remediation activities may occur. The wetland delineation included flagging the upland-wetland boundary and locating wetland flags using a differentially corrected global positioning system. The wetland delineation also included a survey of the property for potential vernal pools.

Six wetland features (i.e., wetlands A, B, C, D, E, and GP) were identified and delineated. An area of ponded water in a closed depression was observed within Wetland A at the western edge of the Mine Operations Area was identified as a potential vernal pool. Because of the time of year when the field work was conducted (i.e., outside the spring amphibian breeding season), it was not possible to document any breeding amphibian use. Four of the wetlands delineated on Site, including Wetlands B, C, D and E, appear to have developed in areas that have been impacted by mine activities and are a direct result mine operations (i.e., man-made). Wetland B developed in an area where seeps discharging from below WRP-3 and the Tailings Pile were cut off from direct discharge to the Goose Pond salt marsh by an access road. Wetland C exists in a low-lying area between the toe of the Tailings Impoundment and an access road running along the edge of the salt marsh and appears to have been constructed as a drainage ditch. Wetland D formed on the top of the Tailings Impoundment, in an area that was used to pond and settle aqueous mine wastes. Wetland E formed on the top of WRP-1 in an area where Stink Cove sediments excavated from the mine pit were placed during mine operations. All of these wetlands were created as a direct result of mine operations or the cessation of mine operations.

The principal functions and values for the estuarine wetlands are fish and shellfish habitat. In addition, the estuarine salt marsh provides sediment/toxicant reduction and sediment/shoreline stabilization as a primary function/value. The Wetland Delineation and Functional Assessment Report is attached to this report as Appendix B.

The Site contains both federal and state jurisdictional wetlands. For purposes of this FS, federal jurisdictional wetlands at the Site consist of waters of the United States within Goose Pond and Goose Cove, and adjacent salt marsh areas. For purposes of this FS, freshwater Wetlands A, B, D, and E are not contiguous with waters of the United States and are not considered federal jurisdictional wetlands, since they appear not to meet current federal jurisdictional standards. However, this determination will be re-evaluated during the remedial design stage, and, if any of these wetlands are determined to be federal jurisdictional wetlands, they may require mitigation if disturbed by the remediation. Freshwater Wetland C is a drainage ditch and is not considered a federal jurisdictional wetland. State jurisdictional wetlands at the Site include all coastal wetlands (i.e., salt marsh and low-land areas subject to tidal action), subtidal land, and freshwater wetlands. Coastal wetlands are considered Wetlands of Special Significance under the Maine Wetlands Protection Rule (06 096 CMR 310), as are freshwater wetlands within 250 feet of coastal wetlands along the toe of the southern Tailings Impoundment berm. For purposes of this FS, freshwater Wetlands B, C, D, and E, which are all man-made, were not considered state Wetlands of Special Significance. A final determination of federal and state jurisdiction and wetland mitigation will be made by the Maine DEP and U.S. Army Corps of Engineers/USEPA during the predesign phase. The following table summarizes this information.

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Wetland	Man-made	Federal Jurisdiction	State Jurisdiction
Wetland A	No	No	Yes [1]
Wetland B	Yes	No	Yes [1]
Wetland C	Yes	No	Yes [1]
Wetland D	Yes	No	Yes [1]
Wetland E	Yes	No	Yes [1]
Freshwater wetlands south of Tailings Impoundment	No	Yes	Yes [2]
Coastal wetland and tidal areas	No	Yes	Yes [3]

Note:
[1] Does not meet criteria for State Wetland of Special Significance
[2] Portions of these wetlands within 250 feet of coastal wetlands are State Wetlands of Special Significance
[3] State Wetland of Special Significance

1.4.4.5 Geotechnical Evaluation Report

In 2006 and 2007, MACTEC carried out subsurface explorations and geotechnical laboratory testing in general accordance with Interim Work Plan No. 2 (MACTEC, 2005) and the Phase 1B Work Plan (MACTEC, 2007). The purpose of the work was to obtain field and laboratory data to carry out geotechnical evaluations in support of a RI and FS.

Following the data collection activities, slope stability evaluations were carried out for the Tailings Impoundment, WRP-1, and WRP-3 utilizing SLOPE/W (GeoStudio 2004, Version 6.22). The objectives of these evaluations were to assess the static, pseudo-static, and/or post-earthquake factors of safety (FOS) relative to global stability, based on the existing site-specific conditions. Effective stress (i.e., long-term condition) stability analyses were performed using the Spencer method. Multiple "runs" were evaluated for each area of the Site, considering both circular (i.e., rotational) and wedge-type (i.e., sliding block) failure surfaces.

MACTEC issued a Geotechnical Evaluation Report (MACTEC, 2009a) in January of 2009. The report documented the 2006 and 2007 geotechnical data collection activities and presented static and seismic slope stability evaluations of the Tailings Impoundment, WRP-1, and WRP-3, based on existing site conditions. The results are summarized as follows:

Tailings Impoundment. The estimated long-term static FOS is on the order of 1.1 to 1.2. The results also indicate that the FOS following a design magnitude 5.5 earthquake would range from about 0.85 to 0.95.

WRP-1. The estimated long-term static FOS is 1.45 to 1.55. Pseudo-static and post-earthquake FOS are on the order of 1.15 to 1.20 and 1.35 to 1.40, respectively.

WRP-3. The estimated long-term static FOS is 1.15 to 1.20. The pseudo-static FOS is estimated to be 1.00 to 1.05, and the post-earthquake FOS is on the order of 1.10 to 1.15.

Evaluation of short-term, temporary, and/or construction-related conditions at the Tailings Impoundment and WRP-3 would be required during design of WRP-3 removal. Additional evaluation of WRP-1 would be required if it were to be used as a location for consolidation of site materials.

1.4.4.6 Dewatering Rate Estimates for the Tailings Impoundment, Callahan Mine

MACTEC used a groundwater modeling approach to estimate the rate that the Tailings Impoundment would dewater if covered with a low-permeability cap with and without the addition of horizontal drains. Hydraulic conductivities used in the model were based on field data for MW 603S and MW604S, and the model was calibrated to groundwater elevations recorded in those monitoring wells. Simulations were performed for specific yields of 0.1 and 0.2. Model results are summarized in the following table.

Scenario	Specific Yield	Years to Drain
1. Capping – natural drainage	0.2	9 to 10
2. Capping – horizontal drains	0.2	6 to 7
3. Capping – natural drainage	0.1	6
4. Capping – horizontal drains	0.1	3 to 4

It should be noted that the model represents a rough approximation of the real system, and actual dewatering rates will depend on several factors for which actual data are not available. Therefore, the results should be considered to be order-of-magnitude and used only for comparison among remedial alternatives. A modeling memorandum is attached to this report as Appendix C.

1.4.4.7 Slope Stability Evaluations for OU 1 Feasibility Study Report, Tailings Impoundment Area

To support the evaluation of remedial alternatives, slope stability evaluations of the above approaches were made utilizing SLOPE/W (Appendix D). Effective stress (i.e., long-term conditions) stability analyses were performed using the Spencer method. The primary objectives of these evaluations were to estimate the long-term FOS relative to global stability following implementation of the remedial alternative, as described herein. The final approach to be implemented to achieve stability criteria for the long-term, as well as short-term, temporary, and/or construction-related conditions, will be evaluated during design of the selected alternative.

Development of the base/existing conditions SLOPE/W stability model was documented and presented in the Geotechnical Evaluation Report (MACTEC, 2009a). Slope stability evaluations of the remedial alternatives are based on the existing conditions model, with changes for impoundment geometry (e.g., re-grading/capping), long-term water levels (due to capping/storm

water diversion), long-term soil strength gains (e.g., toe buttress/surcharge), and other toe improvements (e.g., toe shear key) incorporated.

One factor that was a critical part of the stability evaluation was the outcome of the preliminary groundwater modeling (Appendix C) which indicates that Tailings Impoundment water levels will decrease to or below the bottom of the tailings within 5 to 10 years of capping and diversion of surface water run-on.

The remedial alternatives discussed in Section 4.0 of this FS incorporate the findings of the slope stability evaluations.

1.4.5 Regulatory History

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 (SIP) 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.
2002	Site is added to NPL.
2005	The State of Maine takes lead on implementation of 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.

1.4.6 Nature and Distribution of Contamination for OU 1 Areas

This subsection summarizes the nature and distribution of contamination detected in surface soil, groundwater, Goose Pond surface water, and Goose Pond sediment at the Site.

1.4.6.1 Nature and Distribution of Surface Soil Contamination

The RI identified several upland subareas at the Site to facilitate the collection, evaluation, and presentation of data. Factors used to identify the subareas included historical use, geology, nature of contamination, and exposure pathways. The primary contaminants in surface soil are inorganics, especially arsenic, cadmium, copper, lead, and zinc. In addition, a small area within the Mine Operations Area is contaminated with PCBs, and a second area is contaminated with petroleum as indicated by diesel range organics (DRO) and gasoline range organics (GRO).[1] The volume of mine waste material at most subareas was estimated with AutoCAD by comparing current to 1965 topography. Exceptions were the volume of soil at the residential use areas and volume of soil exceeding 1 part per million (ppm) PCBs, 5 ppm GRO, and 10 ppm DRO at the Mine Operations Area. Table 1.4-2 summarizes the estimated volumes.

The following subsections summarize the nature and distribution of surface soil contamination at these subareas. Section 4.0 of the RI report provides an extensive discussion of the nature and distribution of contamination, and the reader is encouraged to review that document for additional detail.

Ore Pad

The Ore Pad is where ore was stockpiled prior to crushing and milling. The unlined Ore Pad covers approximately 2.1 acres and contains an estimated 16,000 cubic yards of waste rock. Today, fragments of ore and mineralized rock are visible over much of the Ore Pad. Surface soil in the area is conspicuously limonite-stained, imparting a yellow-brown to orange-brown, and brownish-black color and coating on soil and rock surfaces that stretches from the top of the exposed slope downhill to the Mine Operations Area. In addition to zinc, copper, and lead sulfide ore fragments, the soils in this area also have a considerable number of blue and blue-green mineral fragments and rarer whitish mineral coating that may have been supergene ore minerals (copper, lead, and zinc carbonates and sulfates), or hydrated copper sulfates and soluble sulfate salts

[1] Although CERCLA does not regulate the remediation of petroleum, the petroleum at the Site is intermixed with soil contaminated with CERCLA contaminants, so the CERCLA remedy will address this intermixed soil as part of the remedial process. Any remedial alternative chosen that addresses the intermixed soil will also meet State regulatory requirements for petroleum remediation.

produced from more recent weathering of material remaining on the Ore Pad. The primary crushers were located downslope from the Ore Pad.

The waste rock fill at the Ore Pad is relatively thin, consisting of 2 to 3 feet of waste rock that is mixed together with the till at the till contact. The till varies in thickness up to 11 feet. Bedrock was encountered at depths ranging from 9 to 15 feet below ground surface (bgs). The Ore Pad has some of the most highly oxidized surface soils containing mineralized waste rock and ore observed at the Site.

During the RI, two surface soil samples were collected from the Ore Pad for off-site metals analysis by inductively coupled plasma and mass spectrometry (ICP-MS). The results of ICP-MS metals analysis are summarized in RI Table 4.1-2 (MACTEC, 2009b). Summary statistics for the analytical results are shown in the following table.

Summary Statistics for Ore Pad Surface Soil Off-Site Analytical Results - Arsenic, Cadmium, Copper, Lead, and Zinc

Analyte	Background Concentration	Frequency of Detection	Range of Detected Concentrations	Average Concentration	Percent > Background
Arsenic	14	2 / 2	46 - 50	48	100
Cadmium	0.15	2 / 2	0.37 - 24	12	100
Copper	11	2 / 2	6,600 - 14,000	10,300	100
Lead	37	2 / 2	350 - 1,600	975	100
Zinc	89	2 / 2	110 - 8,800	4,455	100

Notes:
All concentrations in milligrams per kilogram (mg/kg).
Statistics based on off-site ICP-MS analyses for metals.
Average calculations use half the detection limit for non-detects.
Background concentration is based on off-site 95-percent upper tolerance level (UTL)
Source: MACTEC, 2009b, Subsection 4.1

Data collected to assess the potential for acid rock drainage included whole rock analysis, mineralogy, acid base accounting (ABA), Synthetic Precipitation Leaching procedure (SPLP), field paste pH, and field leaching tests from SB-612 and SB-619. Field leach tests indicated that cadmium and lead could leach at concentrations above the federal drinking water Maximum Contaminant Level (MCL) and/or the Maine Maximum Exposure Guidelines for Drinking Water (MEGs). In addition, SPLP results show potential for antimony, cadmium, copper, and lead to leach at concentrations above the MCL/MEG. Other metals that may leach include aluminum, cobalt, and zinc. ABA and paste pH data indicate net acid producing conditions persist at the Ore

Pad, though some samples have a net neutralizing potential (NNP). The presence of NNP does not mean, however, that metals leaching will not occur, but resulting acidity will be neutralized.

Mine Operations Area

The Mine Operations Area is the former location of the machinery that was used to mill and process the ore that was staged in the Ore Pad. The Mine Operations Area covers approximately 5.2 acres and contains an estimated 44,000 cubic yards of waste rock. At least two underground fuel storage tanks were located in this area (2,000 and 4,000 gallons), but these were removed in 1987. The Mine Operations Area included a machine shop, and assay laboratory, the two rock crushers, and the concentrator building. All of these structures have been removed from the Site; except for some of the building foundations and breached walls of the concentrator building.

The Mine Operations Area is underlain by variable thicknesses of waste rock fill and native soil consisting of clay and silt overlying glacial till. The overburden thickness varies greatly from 12.5 feet to as much as 82 feet. In general, a thin layer (2 to 3 feet) of sandy and gravelly fill overlies the fine grained stratified clay and silt. In the absence of the clay and silt, the gravelly, sandy fill extends to bedrock (12.5 feet) near the former flotation building (near SB-614). The clay and silt varies in thickness from 10 to 31 feet across the Site. Up to 72 feet of till was encountered at SB-610, indicating the presence of a narrow and deep channel between the northern and southern ridges that dominated the pre-mine topography of the Site.

During the RI, 34 soil samples were collected at the Mine Operations Area for analysis for PCBs, seven were collected for on-site x-ray fluorescence (XRF) analysis for metals, and five were collected for off-site metals analysis by ICP-MS. The results of PCB analyses are summarized in RI Table 4.1-1, results for field XRF metals screening are summarized in RI Appendix R, and results for ICP-MS metals analysis are summarized in RI Table 4.1-3 (MACTEC, 2009b). Summary statistics for the PCB and XRF analytical results are shown in the following table. XRF data are shown because they represent a larger data set than the ICP-MS data.

Summary Statistics for Mine Operations Area Surface Soil Analytical Results – PCBs, Arsenic, Cadmium, Copper, Lead, and Zinc

Analyte	Background Concentration	Frequency of Detection	Range of Detected Concentrations	Average Conc.	Percent > Background
Aroclor-1242	NC	9 / 34	0.051 - 7,900	245	NC
Aroclor-1248	NC	13 / 34	0.16 - 1,800	59	NC
Arsenic	15	7 / 7	34 - 99	62	100

Summary Statistics for Mine Operations Area Surface Soil Analytical Results – PCBs, Arsenic, Cadmium, Copper, Lead, and Zinc

Analyte	Background Concentration	Frequency of Detection	Range of Detected Concentrations	Average Conc.	Percent > Background
Cadmium	NC	6 / 7	43 - 98	58	NC
Copper	99	7 / 7	1,900 - 21,000	7,543	100
Lead	124	7 / 7	520 - 3,000	1,613	100
Zinc	177	7 / 7	12,000 - 64,000	28,714	100

Notes:
All concentrations in mg/kg.
Statistics based on off-site analysis for PCBs and on-site XRF analysis for metals.
Average calculations use half the detection limit for non-detects.
Background concentration is based on on-site analysis 95-percent UTL.
NC = not calculated
Source: MACTEC, 2009b, Subsection 4.1

The detected concentrations of metals in the Mine Operations Area are among the highest in surface soils at the Site.

Data collected to assess the potential for acid rock drainage included whole rock analysis, mineralogy, ABA, SPLP, field paste pH, and field leaching tests. Field leach and SPLP tests did leach metals above the MCL/MEG. ABA data indicate net acid producing conditions exist near the concentrator building, but net neutralizing conditions elsewhere.

The presence of PCBs in the Mine Operations Area may be related to former transformers located near the southern portion of the Primary and Secondary Crusher buildings. A 10- by 20-foot buried concrete pad was identified just north of SS-7207 at the location of SS-7221. The pad may have served as a transformer location serving the Secondary Crusher building. Very high concentrations of PCBs in surface soils suggest direct discharge of transformer oils to the ground surface.

Two test pits completed in the Mine Operations Area showed the presence of oily soils. Oil stained subsurface soils were exposed in TP-7119 and TP-7124. TP-7124 was excavated in what is interpreted to be a tank grave associated with underground storage tanks (USTs) reportedly removed in 1987. Oil stained silt and clay materials were observed extending from 3 to 6 feet bgs. The sample collected at 3 feet bgs showed the presence DRO and GRO at concentrations of 13,000 mg/kg and 390 mg/kg, respectively.

TP-7119 was excavated downgradient of the tank grave depression. Oil stained soils were observed at the interface between waste rock and the underlying silty clay at 9 feet bgs. The

sample collected at 9 feet bgs showed the presence DRO and GRO at concentrations of 4,900 mg/kg and 160 mg/kg, respectively. The presence of these DRO and GRO is likely associated with fuel storage and dispensing. The Maine DEP has classified the DRO/GRO contamination in the Mine Operations Area as meeting the criteria of a Stringent Site according to the Maine Hydrocarbon Spill Decision Tree.

Waste Rock Pile 3

WRP-3 is located between WRP-1 and the Tailings Impoundment. This waste rock pile covers approximately 6.6 acres and contains an estimated 216,000 cubic yards of waste rock. WRP-3 has abundant sulfide waste rock with conspicuous iron staining (limonite) along its top and eastern slope. WRP-3 is referred to in some historic records as a "prior tailings pile," though no tailings were encountered during drilling of this area. Dead and stressed vegetation occurs along the base of WRP-3 and near an area where a copper-rich, blue-green seep discharges to Goose Pond (identified in the Baseline Ecological Risk Assessment [BERA] as an area of readily apparent harm). The U.S. Geological Survey (USGS) collected samples of the gray to light brown and blue-green precipitates from SP-509 and has determined the presence of gypsum ($CaSO_4*2H_2O$) and glaucocerinite, a hydrated copper aluminum sulfate ($Cu_4Al_2(SO_4)(OH)_{12}*3H_2O$), in addition to other detrital minerals including quartz and chlorite.

Borings installed in WRP-3 encountered 40 feet of waste rock in the southern end and 19 feet in the northern end. Up to 11 feet of till is present over bedrock which was encountered at 51 feet bgs. Prior seismic and ground penetrating radar data indicated that depth to bedrock is up to 60 feet bgs. Waste rock core from within the top twenty feet contained pyritic rhyolite and abundant limonite staining and strongly weathered rock fragments. Surface soils at WRP-3 are the most visibly stained at the Site. Pyritic rhyolite and mineralized waste rock cover almost 80 percent of the surface area of WRP-3 including abundant fragments of talc-carbonate host rock.

During the RI, two soil samples were collected at WRP-3 for off-site metals analysis by ICP-MS and the results are summarized in RI Table 4.1-6 (MACTEC, 2009b). Summary statistics are shown in the following table.

Summary Statistics for Waste Rock Pile 3 Surface Soil Off-Site Analytical Results - Arsenic, Cadmium, Copper, Lead, and Zinc

Analyte	Background Concentration	Frequency of Detection	Range of Detected Concentrations	Average Conc.	Percent > Background
Arsenic	14	2 / 2	23 - 130	77	100
Cadmium	0.15	2 / 2	0.78 - 0.79	1	100
Copper	11	2 / 2	340 - 3,600	1,970	100
Lead	37	2 / 2	240 - 700	470	100
Zinc	89	2 / 2	400 - 420	410	100

Notes:
All concentrations in mg/kg.
Statistics based on off-site ICP-MS analyses for metals.
Average calculations use half the detection limit for non-detects.
Background concentration is based on off-site 95-percent UTL
Source: MACTEC, 2009b, Subsection 4.1

Data collected to assess the potential for acid rock drainage conditions included whole rock analysis, mineralogy, ABA, SPLP, field paste pH, and field leaching tests from SB-612 and SB-619. In addition, SPLP results show potential for cadmium, antimony, lead, and molybdenum to leach above MCLs and MEGs. Other metals that may leach include aluminum, copper, and zinc. ABA and paste pH data indicate overall primarily net neutralizing conditions, though some samples are net acid producing.

Tailings Impoundment

The Tailings Impoundment covers approximately 21 acres and contains an estimated 716,000 cubic yards of tailings and waste rock. Anecdotal information gathered during the RI indicates that the berm encompassing the Tailings Impoundment was constructed in multiple stages (i.e., lifts). This type/method of construction is commonly termed a “raised embankment” (Vick, 1990). Typically, the first lift (i.e., a “starter dike”) is constructed of natural soil borrow or available fill materials and is sized (vertically) to accommodate the first year or two of the mill’s tailings output, with necessary/appropriate allowances for storage of surface water and/or flood inflows. The embankment is then raised in stages to keep pace with the rising elevation of the tailings and surface water/flood water storage requirements (Vick, 1990). Raised embankments are generally characterized as “upstream,” “downstream,” or “centerline” embankments, depending on which direction the crest of the embankment moves in relation to the starter dike, as subsequent lifts are added (Vick, 1990). For an upstream type of embankment, tailings are discharged peripherally from the crest of the starter dike to form an above-water sandy “beach,” which then becomes the foundation for second lift of the embankment (Vick, 1990). Site data supports the conclusion that the Tailings Impoundment berm was constructed as an upstream embankment. Data also suggest

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).

Additional anecdotal information indicates that the inside face of each embankment lift was lined/chinked with clay and/or glacial till in order to contain the finer grained tailings and to limit drainage of the decant pond. Given the grain-size characteristics of the tailings, it is evident that some form of chinking or sealing of the upstream slope must have occurred; otherwise the tailings would have piped through the voids in the waste rock fill materials used to construct the berm.

Reportedly, the Tailings Impoundment had an engineered structure to remove water from inside the impoundment and discharge it under the berm. A drainage pipe was found at the western edge of the Tailings Impoundment. Based on geophysical surveys and dye tracer testing the pipe was determined to discharge at a previously mapped seep (SP-511) at the base of the Tailings Impoundment berm. The pipe currently drains impounded surface water from the Tailings Impoundment when surface water elevations rise as a result of precipitation and/or snowmelt events. In addition, 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 between the Tailings Impoundment and WRP-3

During mine operations, tailings were pumped into the impoundment through spigots along pipes that were placed around the periphery of the berm. Sand to silt/clay sized tailings settled out of the water. Filling of the impoundment in this manner resulted in coarser grained tailings settling near the edges of the berm structure while finer grained particles (slimes) settled out in the central portion of the Tailings Impoundment. The central portion of the Tailings Impoundment contains a gentle depression as a result of settlement that parallels the long axis of the impoundment. The oval shaped depression typically holds surface water throughout the summer months and a cattail marsh has developed. The remaining portion of the Tailings Impoundment surface is unvegetated.

Waste rock types in the Tailings Impoundment berm are primarily agglomerate, andesite, pyritic rhyolite and black rhyolite. Trace amounts of mineralized waste rock are observed. Current data indicate that the Tailings Impoundment consists of 11 to 56 feet of tailings materials (i.e., angular stratified sands and silts) underlain by a native clay layer ranging in thickness from approximately three to 16 feet. The Tailings Impoundment thickens to the east, and the clay layer thins to the east. Test pit data indicate the toe of the Tailings Impoundment berm rest directly on the

underlying clay and does not appear to be keyed into this unit. Underlying the clay is a thin layer of silty glacial till which overlies bedrock. Boring data within the Tailings Impoundment indicate that the top of bedrock is encountered at from 32 to 75 feet bgs. The bedrock surface slopes downward to the east toward Goose Pond. The depth to groundwater ranges from 1 to 28 feet bgs, deepening to the east towards Goose Pond. Groundwater flows east towards the estuary. Approximately 60 percent of the tailings are located below the water table.

During the RI, 22 samples were collected from the Tailings Impoundment for on-site XRF analysis for metals, and 5 were collected for off-site metals analysis by ICP-MS. The results for field XRF metals analyses are summarized in RI Appendix R, and results for ICP-MS metals analysis are summarized in RI Table 4.1-8 (MACTEC, 2009b). Summary statistics for the XRF analytical results are shown in the following table. XRF data are shown because they represent a larger data set than the ICP-MS data.

Summary Statistics for Tailings Impoundment Surface Soil On-Site XRF Analytical Results - Arsenic, Cadmium, Copper, Lead, and Zinc

Analyte	Background Concentration	Frequency of Detection	Range of Detected Concentrations	Average Conc.	Percent > Background
Arsenic	15	22 / 22	28 - 160	63	100
Cadmium	NC	4 / 22	44 - 56	26	NC
Copper	99	22 / 22	1,000 - 4,000	2,764	100
Lead	124	22 / 22	230 - 1,400	946	100
Zinc	177	22 / 22	3,200 - 22,000	7,355	100

Notes:
All concentrations in mg/kg.
Statistics based on on-site XRF analyses for metals.
Average calculations use half the detection limit for non-detects.
Background concentration is based on on-site analysis 95-percent UTL.
NC = not calculated.
Source: MACTEC, 2009b, Subsection 4.1

Based on ABA testing, the tailings exhibit acid neutralizing characteristics. The field leachate tests on the Tailings Impoundment materials indicate the potential to leach concentrations of dissolved arsenic, cadmium, lead, and selenium that exceed groundwater quality standards.

Residential Use Area Soil

As part of the Halo Area assessment, the RI included surface soil sampling in residential areas bordering the northern portion of the former Callahan Mine property along Old Mine Lane and Harborside Road. In addition, residential areas south of the former Callahan Mine property were

sampled along the southern access road. These samples were used to assess whether surface soils had been affected by fugitive dust and/or contaminated fill.

During the RI, 50 residential area soil samples were collected for on-site XRF analysis for metals, and 6 were collected for off-site metals analysis by ICP-MS. The results for field XRF metals analyses are summarized in RI Appendix R, and results for ICP-MS metals analysis are summarized in RI Table 4.1-11 (MACTEC, 2009b). Summary statistics for the XRF analytical results are shown in the following table. XRF data are shown because they represent a larger data set than the ICP-MS data.

Summary Statistics for Residential Area Surface Soil On-Site XRF Analytical Results - Arsenic, Cadmium, Copper, Lead, and Zinc

Analyte	Background Concentration	Frequency of Detection	Range of Detected Concentrations	Average Conc.	Percent > Background
Arsenic	15	38 / 50	10 - 86	24	52
Cadmium	NC	2 / 50	37 - 39	21	NC
Copper	99	41 / 50	25 - 1,400	297	46
Lead	124	48 / 50	22 - 1,500	395	58
Zinc	177	50 / 50	59 - 11,000	1,706	68

Notes:
All concentrations in mg/kg.
Statistics based on on-site XRF analyses for metals.
Average calculations use half the detection limit for non-detects.
Background concentration is based on on-site analysis 95-percent UTL.
NC = not calculated.
Source: MACTEC, 2009b, Subsection 4.1

Higher concentrations of metals contamination were observed primarily in the vicinity of Old Mine Lane. Residential areas bordering Harborside Road and the southerly access road to the former Callahan Mine property show relatively low concentrations of metals in surface soils. Metals data suggest that airborne migration of dust during mine operations most likely occurred and affected surface soils peripheral to Old Mine Lane.

1.4.6.2 Nature and Distribution of Groundwater Contamination

This subsection summarizes the nature and distribution of contamination in site groundwater and leachate based on discussion presented in Subsection 4.5 of the RI report. Except for the Tailings Impoundment, overburden groundwater is permanently present only at the Mine Operations Area. The Tailings Impoundment also contains overburden groundwater; however, it is interpreted to be perched above an underlying low-permeability clay/till layer and contained within the Tailing

Impoundment berm. Arsenic and metals including aluminum, antimony, cadmium, chromium, copper, lead, manganese, nickel, sodium, and zinc have been detected at concentrations greater than their respective MCL or MEG in groundwater and leachate at the Site. The order of frequency of detected concentrations above the MCL or MEG (from greatest to least) is sodium, manganese, cadmium, zinc, lead, aluminum, arsenic, antimony, chromium, copper, and nickel. Figures 1.4-7 and 1.4-8 show concentrations of copper and zinc in seep and fresh surface water. Low-concentrations of volatile organic compounds (VOCs) have been detected in groundwater samples collected at the Tailings Impoundment; however, the RI did not identify them as chemicals of concern (COCs). In addition, GRO were detected in one monitoring well at the Mine Operations Area.

MCL exceedances for overburden and bedrock groundwater are shown in Figure 1.4-7 and Figure 1.4-8, respectively, and summarized in Table 1.4-3. In addition, water quality criteria are included to provide for an evaluation as to whether the groundwater may cause surface water to exceed National Recommended Water Quality Criteria (NRWQC). The shaded areas of the table identify the concentrations that are more than five-fold greater than the drinking water/groundwater standard. Review of the figure sand table supports the following conclusions:

- The Ore Pad and Mine Operations Area are source areas for bedrock groundwater contamination.
- The Ore Pad and Mine Operations Area may also be source area for surface water contamination.
- The Ore Pad, Mines Ops Areas, WRP-3, and Tailings Impoundment are the most significant sources of surface water contamination based on seep data and loading evaluation.

The reader is encouraged to review Subsection 4.5 of the RI report (MACTEC, 2009b) for additional detail.

<u>Ore Pad</u>

An overburden well (MW-615) and a bedrock well (MW-615R) were installed in the Ore Pad Area in a small sediment-filled depression, where surface water has been observed to pond and infiltrate. The overburden and bedrock wells in the Ore Pad contained the highest concentrations of cadmium, copper, and zinc at the Site. The concentrations are an order of magnitude greater than other areas of the Site, suggesting that the Ore Pad is a significant source of groundwater

contamination. Overburden leachate was only present in MW-615 during the November 2006 sampling event and aluminum, antimony, arsenic, cadmium, chromium, lead, manganese, nickel, sodium, and zinc were detected in the leachate at concentrations above MCLs, and MEGs, and/or USEPA risk levels in the total fraction sample. Analysis of the dissolved fraction sample detected cadmium, manganese, sodium, and zinc at concentrations above MCLs, MEGs, and/or USEPA risk levels. The bedrock groundwater sample contained fewer metals above MCLs, MEGs, and/or USEPA risk levels and MEGs (i.e., aluminum, cadmium, copper, manganese, and zinc) in the total sample fraction. With a few exceptions, concentrations of metals were greater in the November 2006 sampling event than the August 2006 and the August 2007 sampling events.

Sulfate ranged from 2,100 milligrams per liter (mg/L) in overburden leachate to 680 mg/L in bedrock groundwater, indicating acid rock drainage impacts from oxidation of sulfide minerals.

Mine Operations Area

Four overburden monitoring wells (MW-610, MW-613, MW-614, and MW711) and two paired bedrock monitoring wells (MW-610R, and MW-614R) were installed in the Mine Operations Area. The MW-610/610R well pair was installed hydraulically upgradient from the physical operations area. MW-613 was installed in the vicinity of the office and maintenance building where the flotation cells were located and concentrates were produced. The well pair MW-614/614R was installed near the northeast corner of the former mineral processing buildings. The ground surface and concrete at that location contains abundant green and blue minerals as coatings and botryoidal forms, which are likely hydrated copper sulfate/carbonate supergene minerals formed from leaching of sulfide mineral concentrates formerly produced at the mine and stored in vicinity of the buildings. MW-711 was installed in near the toe of WRP-1.

Analysis of the upgradient overburden groundwater samples from MW-610 did not detect metals at concentrations above the MCLs, MEGs, and/or USEPA risk levels in the August 2006 and the November 2006 sampling events. However, the August 2007 sampling event detected total aluminum, arsenic, lead, and dissolved arsenic above MCLs/MEGs. Sulfate ranged from 23 to 25 mg/L. The bedrock well, MW-610R, is screened in a talc-carbonate bedrock lithology that contains numerous small quartz veins mineralized with pyrite, galena, chalcopyrite, and sphalerite. The rock here is similar in appearance to the talc-carbonate rock that hosted the ore zone in the mine pit. Groundwater samples collected during all sampling events from MW-610R contained lead at concentrations above the MCL/MEG. Sodium was also detected above MCLs/MEGs

during the first two sampling rounds, and samples from the first round also contained aluminum and antimony at concentrations slightly above MEGs. Sulfate in this well was slightly to moderately elevated, at 50 to 91 mg/L.

Analysis of the overburden groundwater samples from MW-613 detected sodium and manganese at concentrations above MEGs and/or USEPA risk levels during all sampling events. Sulfate appears to be moderately elevated at concentrations which ranged from 72 to 98 mg/L.

Analysis of the overburden groundwater samples from MW-711 detected aluminum, cadmium, manganese, and sodium at concentrations above MEGs and/or USEPA risk levels during the February 2008 sampling event. Sulfate was elevated at a concentration of 300 mg/L.

Analysis of the overburden groundwater samples collected in August 2006 from MW-614 detected cadmium, manganese, sodium, and zinc at concentrations above MCLs/MEGs/USEPA risk levels. Only cadmium concentrations exceeded the MCL/MEG in the sample collected during the November 2006 monitoring event, although zinc concentrations were very close to the MEG. During the August 2007 sampling event cadmium, sodium, and zinc concentrations exceeded the MCL/MEGs. Sulfate concentrations were elevated in all three sample rounds and ranged from 130 to 350 mg/L. Groundwater samples from MW-614 and MW-614R were analyzed for GRO during the August 2007 event because of observations in upgradient test pits. GRO was not detected in monitoring well MW-614.

Analysis of bedrock groundwater samples collected during the August 2006, November 2006, and August 2007 monitoring events from bedrock well MW-614R also detected cadmium, manganese, sodium, and zinc at concentrations above MCLs/MEGs/USEPA risk levels. The cadmium, manganese, and sodium concentrations detected in bedrock groundwater were similar to those in overburden groundwater, but the concentrations of zinc during the first two sampling events, were slightly higher than in overburden groundwater. Sulfate concentrations were elevated at 460 to 470 mg/L. GRO (34 micrograms per liter [µg/L]) was detected in the MW-614R monitoring well at concentrations below the MEG. The presence of GRO in bedrock groundwater is most likely related to soils contamination observed upgradient in test pits.

In contrast to bedrock groundwater and leachate in the Ore Pad, and in groundwater upgradient of the Mine Operations Area, the elevated metals and sulfate concentrations near the concentrator

building are not co-located with elevated aluminum. The sulfide minerals leached at the Ore Pad, upgradient Mine Operations Area bedrock, and waste rock piles are contained within host rocks with abundant alumino-silicate minerals. The sulfide minerals at the processing plant (MW-614/614R) had been separated from their host rock by the ore milling and beneficiation processes, and leaching of those materials appears to have produced a slightly different chemistry leachate with respect to aluminum.

Waste Rock Pile 3

One overburden well, MW-612, was installed in the southeast end of WRP-3 and screened across the waste rock / till contact. MW-612 historically has had very little water and is sampled using a dedicated bailer. Total metals samples contained a large amount of suspended solids. Analysis of overburden leachate samples collected from MW-612 during the August 2006 and November 2006 monitoring events detected total metal concentrations of aluminum, antimony, arsenic, cadmium, chromium, lead, manganese, sodium, and zinc greater than MCLs/MEGs/USEPA risk levels. During the February 2008 monitoring event, total aluminum, antimony, arsenic, cadmium, lead, sodium, and zinc were detected at concentrations above MCL/MEGs. The leachate also contained high concentrations of iron, nickel, mercury, calcium, barium, cobalt, potassium, and magnesium, relative to other monitoring well leachate samples. Dissolved metals concentrations generally showed elevated concentrations of the same metals, but at much lower concentrations, with the August 2006 event detecting manganese and sodium above MEGs and/or USEPA risk levels and the November 2006 event with concentrations of cadmium, lead, and sodium above MCL/MEGs. Arsenic was also detected at estimated and uncertain concentrations above the MCL/MEGs. Sulfate was detected at elevated concentrations of 2,000 to 2,400 mg/L. Chloride was detected at relatively low concentrations of 5.7 to 7 mg/L.

Tailings Impoundment

In 2006, five overburden monitoring well pairs were installed in the Tailings Impoundment (MW-601/ PZ-601, MW-602S/602D, MW-603S/603D, MW-604S/604D, and MW-605S/605D). One paired bedrock well was also installed (MW-604R).

In 2007, seven additional monitoring wells or piezometer/monitoring well pairs were installed in the Tailings Impoundment (MW-705/PZ-705, MW-706/PZ-706, and MW-707) and at the toe of the Tailings Impoundment retention berm (MW-701, MW-702/PZ-702, MW-703/PZ-703, and PZ-704). Two additional bedrock wells were also installed. MW-722R was installed in the southeast

corner of the Tailings Impoundment, and MW-723R was installed to the west upgradient from the Tailings Impoundment.

Analysis of overburden groundwater samples collected from MW-601S/PZ-601, MW-602S/602 D, MW-603S/603D, MW-604S/604D, and MW-605S/605D during the August 2006, November 2006, and August 2007 monitoring events detected sodium and/or manganese at a concentration above their respective MCL/MEG/USEPA risk level. Aluminum and lead were detected at concentrations above the MCL/MEG in the August 2006 and the August 2007 samples from MW-605D. Aluminum was detected above MEG in the August 2006 sample from MW-601S. Sodium concentrations in the deep wells MW-602D, MW-603D, and MW-605D were an order of magnitude or more greater than in shallow well pairs. Sulfate and chloride concentrations were also typically higher in these samples as well. MW-603S and MW-602S water samples also contained moderately elevated concentrations of sulfate and chloride. Other wells contained low to moderate sulfate concentrations. Analysis of overburden groundwater water samples collected from MW-604S in August 2006 detected arsenic and manganese at concentrations above the MCL/MEG/USEPA risk level. In November 2006, arsenic, manganese, and zinc were detected at concentrations above MCLs/MEGs/USEPA risk levels, and in August 2007, arsenic, lead, manganese, and zinc were detected at concentrations above the MCL/MEGs/USEPA risk level.

Analysis for VOCs in Tailings Impoundment groundwater detected low concentrations of 2-butanone, 4-hexanone, 4-methyl-2-pentanone, acetic acid, acetone, carbon disulfide, and several fuel-related compounds including ethyl benzene, methyl tertbutyl ether, toluene, and xylenes. No VOC was detected at concentrations that exceeded an MCL or MEG.

Analysis of bedrock groundwater samples from MW-604R detected sodium and manganese at concentrations greater than MEGs and/or USEPA risk level in all three sampling events. The bedrock groundwater sample analysis from the low yield monitoring well MW-722R detected only sodium in excess of MEGs and the analytical results from upgradient background well MW-723R detected lead above MEGs, but below MCLs. Sulfate was detected at concentrations ranging from 1,300 to 1,500 mg/L in MW-604R, and chloride at a concentration ranging from 950 to 1,700 mg/L. VOCs, including 2- butanone, 4-methyl-2-pentanone, acetone, ethyl benzene, toluene, and xylenes, were detected at low, estimated concentrations. Sulfate was detected at a concentration of 59 mg/L in MW-720R, and chloride was detected at a concentration of 600 mg/L. In the background well MW-723R, sulfate was detected at a concentration of 49J mg/L and chloride at a

concentration of 5.8 mg/L. These results indicate the migration of water from the Tailings Impoundment to underlying bedrock groundwater in the vicinity of MW-604R.

1.4.6.3 Nature and Distribution of Goose Pond Surface Water Contamination

A limited number of surface water samples were collected during the RI to characterize water quality in Goose Pond. Five background surface water samples were collected at reference locations in Horseshoe Cove. Of fourteen samples collected in Goose Pond in 2005, 10 exceeded NRWQC for copper (Figure 1.4-9). Nine of these 14 samples were in excess of the screening criteria for zinc (Figure 1.4-10). Background surface water locations in Horseshoe Cove, approximately 1½ miles east of the Site, were nondetect for zinc and copper.

Copper and zinc detected in surface water may be the result of several inputs to the Goose Pond estuary. These inputs include surface discharge of groundwater via seeps, and may include subsurface discharge of groundwater, surface water transport during runoff events, and leaching of metals from bedrock exposures along the pond edge, especially near the former mine pit. Sources of metals in groundwater include leaching from mineralized rock in waste rock piles, roads, and work areas at the Site. Sources of metals in surface runoff also include leaching of metals from mineralized rock in waste rock piles, roads, and work areas located in the pond, plus erosion/transport of metal-bearing particulates. Although some exchange of metals may occur between Goose Pond sediments and surface water, this is not thought to be a major source of surface water contamination. Table 1.4-4 shows the maximum concentrations of cadmium, copper, lead, and zinc in seeps and groundwater discharging to Goose Pond from Site source areas. The data show that OU 1 contributes substantially greater amounts of these contaminants than OU 2.

The extent to which exposed mineralized rock in the pit wall and the former underground workings (i.e., adits located at approximately 80 and 140 feet below sea level and discharge of groundwater within these structures) may affect surface water quality in the pit is unclear. However, the highest copper and zinc concentrations detected in Goose Pond are located proximal to the bedrock exposure of the former mine pit. Vertical profile data are available from samples collected by USGS (USGS, 2007). Copper and zinc exceed the saltwater NRWQC over at least a 60-foot vertical interval within the mine pit. At the 120-foot depth level, the concentration of copper and zinc drop below NRWQC. It should be noted a mixing boundary exists in the pit at a depth of approximately 30 feet below mean sea level (i.e., the pit is stratified) and water below this depth

does not mix with the overlaying water. The USGS data for copper and zinc are summarized in the following table.

Vertical Profile of Copper and Zinc in Surface Water in Mine Pit

Location ID	Location	Depth, feet	Dissolved Oxygen, mg/L	Temp., °C	Copper, µg/L	Zinc, µg/L
CLPT1-1 RA	Mine pit	3.0	11.4	9.75	3.74	58.21
CLPT1-10 RA	Mine pit	29.8	9.61	1.63	9.25	181.72
CLPT1-20 RA	Mine pit	60.0	7.9	1.38	8.46	111.62
CLPT1-40 RA	Mine pit	120.4	8.13	1.19	2.04	41.06
CLPT1-50 RA	Mine pit	149.9	7.96	1.19	1.34	33.00
CLPT1-60 RA	Mine pit	179.7	7	1.24	0.98	28.78
CLPT1-65 RA	Mine pit	195.2	5.6	1.3	0.71	21.63
CLPT1-70 RA	Mine pit	210.2	2.46	1.49	0.69	14.25
CLPT1-80 RA	Mine pit	240.1	0.37	1.75	0.25	5.64

Note: Shaded cells indicate copper and zinc in excess of saltwater NRWQC (3.1 µg/and 81 µg/L, respectively).

1.4.6.4 Nature and Distribution of Goose Pond Sediment Contamination

Goose Pond sediments contain a widespread distribution of metals at concentrations above risk screening values and background. The concentrations are highest in an area adjacent to WRP-3 and the Tailing Impoundment, which has been identified as the area containing mine waste. During the RI, a total of 447 samples from Goose Pond were analyzed by field XRF screening. The results of the field XRF screening are summarized in RI Appendix R (MACTEC, 2009b). Summary statistics for all areas of Goose Pond combined for arsenic, cadmium, copper, lead, and zinc are shown in the following table.

Summary Statistics for Goose Pond Sediment On-Site XRF Analytical Results - Arsenic, Cadmium, Copper, Lead, and Zinc

Analyte	Background Concentration	Frequency of Detection	Range of Detected Concentrations	Number > Background	Percent > Background
Arsenic	13	360 / 447	10 - 95	320	72
Cadmium	0.8	20 / 447	40 - 67	20	4
Copper	21	251 / 447	20 - 5,700	239	54
Lead	35	399 / 447	16 - 2,700	213	48
Zinc	130	432 / 447	38 - 26,000	279	62

Notes:
All concentrations in mg/kg.
Statistics based on on-site XRF analyses for metals.
Background concentration based on off-site 95-percent UTL for arsenic, cadmium, and copper, and on-site XRF 95-percent UTL for lead and zinc (MACTEC, 2009b, Subsection 4.3.1)

The summary table shows arsenic, copper, lead, and zinc were detected in the majority of Goose Pond samples, with arsenic, copper, and zinc also exceeding background concentrations in the majority of them. Lead was detected in 89 percent of the samples, and exceeded background in just fewer than 50 percent of them. Zinc was detected most frequently, in 97 percent of the samples. In contrast, cadmium was only detected in 4 percent of sampled locations, but all cadmium detections exceeded background. Detected concentrations of copper (up to 5,700 mg/kg) and zinc (up to 26,000 mg/kg) exceeded background by over two orders of magnitude.

Eighty-five samples were collected from Goose Pond and submitted to an off-site laboratory for analysis. The results of the off-site metals analyses are summarized in RI Tables 4.3-4 through 4.3-9 (MACTEC, 2009b). Summary statistics for all areas of Goose Pond combined for arsenic, cadmium, copper, lead, and zinc are shown in the following table for comparison with the XRF summary.

Summary Statistics for Goose Pond Sediment Off-Site Analytical Results - Arsenic, Cadmium, Copper, Lead, and Zinc

Analyte	Background Concentration	Frequency of Detection	Range of Detected Concentrations	Number > Background	Percent > Background
Arsenic	13	85 / 85	4 - 64	46	85
Cadmium	0.8	85 / 85	1 - 41	70	82
Copper	21	83 / 85	17 - 10,000	68	82
Lead	27	85 / 85	10 - 1,860	63	74
Zinc	98	85 / 85	81 - 40,000	70	82

Notes:
All concentrations in mg/kg.
Statistics based on off-site ICP-MS analyses for metals.
Background concentration based on off-site 95-percent UTL for arsenic, cadmium, copper, lead, and zinc (MACTEC, 2009b, Subsection 4.3.1).

Although background exceedances of arsenic, cadmium, copper, lead, and zinc are widespread, the distribution of concentrations varies widely. Samples from Dyer Cove contained the highest concentrations of cadmium (94 mg/kg) and zinc (26,000 mg/kg) and second highest concentrations of arsenic (88 mg/kg) and copper (4,700 mg/kg). The highest lead concentration of 2,700 mg/kg was detected at both Dyer Cove and in South Goose Pond (in vicinity of the Tailings Impoundment and WRP-3). Samples from the South Goose Pond area that contains mine waste also contained the highest concentrations of arsenic (95 mg/kg) and copper (5,700 mg/kg) and second highest concentrations of cadmium (82 mg/kg) and zinc (19,000 mg/kg). In contrast, relatively low

concentrations of arsenic, cadmium, copper, lead, and zinc were detected in the remaining areas of Goose Pond outside the South Goose Pond mine waste area.

In general, the concentrations of contaminants are highest near the surface (e.g., 0 to 0.5 feet bgs) and decrease with depth at a majority of locations. However, at locations just downstream of the old earthen dam and east of WRP-3, the highest concentration of metals in sediments is at 0.5 to 1.5 feet bgs. In this area, below the 1.5-foot depth, the concentrations decrease significantly. These areas extending approximately 1,000 feet above and below the upstream face of the earthen dam correspond to areas of talcose mine waste deposits. These deposits are believed to be the result of overflows from the Tailings Impoundment and use of the area for solids settling during mine operations. In a few locations east of WRP-1, metal concentrations in sediment first decrease with depth, then increase in samples in the 5- to 10-foot depth range. At the south end of Dyer Cove, the highest concentrations were reported in 4- to 6-foot deep sediment. High concentrations were also detected in samples collected near a sump located along the northeastern periphery of the open pit.

Metals contamination in Goose Pond sediment is attributed primarily to historical mine operations. Dyer Cove was used as a settling basin for pit dewatering after sedimentation of Goose Cove became a concern, and historical drawings indicate that South Goose Pond adjacent to WRP-3 may have been used for removal of solids from Tailings Impoundment decant water. Overflow from the Tailings Impoundment via a drainage ditch at the northwest corner may have also contributed to Goose Pond contamination, as may have use of mineralized mine waste materials (i.e., waste rock) to build berms and roads in the dewatered Goose Pond. Highly contaminated sediments in Goose Pond are typically associated with the presence of talcose mine waste related materials. In addition, discharge of contaminated groundwater via seeps and subsurface discharge, sediment laden storm water runoff, windblown dust all likely contributed contamination. Precipitation of metals from surface water has likely also contributed to sediment contamination.

1.4.6.5 Nature and Distribution of Salt Marsh Sediment Contamination

The salt marsh includes the wetland areas between Goose Pond and the Tailings Impoundment and WRP-3, and between Marsh Creek and the adjacent upland forested areas. The salt marsh contains grasses and vegetation with small areas of standing water and small channels that convey water during tidal movements.

During the RI, a total of 140 samples from the salt marsh area were analyzed by field XRF screening. The results of the field XRF screening are summarized in RI Appendix R (MACTEC, 2009b). Summary statistics for all of the salt marsh areas sampled as part of the RI for arsenic, cadmium, copper, lead, and zinc are shown in the following table.

Summary Statistics for Salt Marsh Sediment On-Site XRF Analytical Results - Arsenic, Cadmium, Copper, Lead, and Zinc

Analyte	Background Concentration	Frequency of Detection	Range of Detected Concentrations	Number > Background	Percent > Background
Arsenic	13	60 / 140	10 - 100	57	41
Cadmium	0.8	12 / 140	35 - 67	12	9
Copper	21	119 / 140	20 - 20,000	114	81
Lead	35	113 / 140	16 - 2,000	107	76
Zinc	130	140 / 140	57 - 25,000	111	79

Notes:
All concentrations in mg/kg.
Statistics based on on-site XRF analyses for metals.
Background concentration based on off-site 95-percent UTL for arsenic, cadmium, and copper, and on-site XRF 95-percent UTL for lead and zinc (MACTEC, 2009b, Subsection 4.3.1).

The summary table shows arsenic, cadmium, copper, lead, and zinc each exceed background concentrations, with all except arsenic exceeding by 1 to 2+ orders of magnitude. Copper was detected in 119 of 140 samples at concentrations ranging from 21 to 20,000 mg/kg, nearly 3 orders of magnitude greater than the background value. Lead was detected in 113 of 140 samples at concentrations ranging from 16 to 2,400 mg/kg, and zinc was detected in 140 of 140 samples at concentrations ranging from 57 to 25,000 mg/kg. Maximum copper and zinc concentrations were collocated at location SD-7112.

Thirty-three samples were collected from the salt marsh area and submitted to an off-site laboratory for analysis. The results of the off-site metals analyses are summarized in RI Table 4.3-14 (MACTEC, 2009b). Summary statistics for arsenic, cadmium, copper, lead, and zinc are shown in the following table.

Summary Statistics for Salt Marsh Sediment Off-Site Analytical Results - Arsenic, Cadmium, Copper, Lead, and Zinc

Analyte	Background Concentration	Frequency of Detection	Range of Detected Concentrations	Number > Background	Percent > Background
Arsenic	13	32 / 33	6 - 50	29	88
Cadmium	0.8	30 / 33	0.32 - 216	28	85
Copper	21	32 / 33	27 - 29,800	33	100

Summary Statistics for Salt Marsh Sediment Off-Site Analytical Results - Arsenic, Cadmium, Copper, Lead, and Zinc

Analyte	Background Concentration	Frequency of Detection	Range of Detected Concentrations	Number > Background	Percent > Background
Lead	27	32 / 33	33 - 1,260	33	100
Zinc	98	32 / 33	77 - 61,900	33	100

Notes:
All concentrations in mg/kg.
Statistics based on off-site ICP-MS analyses for metals.
Background concentration based on off-site 95-percent UTL for arsenic, cadmium, copper, lead, and zinc (MACTEC, 2009b, Subsection 4.3.1).

The off-site analysis supports the results of the field XRF screening. The results indicate that nearly all of the sediment samples sent for off-site analysis exceeded background concentrations for arsenic, cadmium, copper, lead, and zinc. The analytes arsenic, chromium, manganese, and nickel were also detected at high frequencies. The highest concentrations were observed in samples collected from the portion of the salt marsh east of the Tailings Impoundment and WRP-3 adjacent the area of mine waste in South Goose Pond.

Cadmium was detected in 30 of 33 samples at concentrations ranging from 0.32 to 216 mg/kg. Twenty eight of these samples were detected at concentrations above background. The maximum detected concentration of cadmium was from sample location GP-3.

Copper, lead, and zinc were detected in 33 of 33 samples, with nearly all of the detected concentrations above screening values. The maximum detected concentration of copper and zinc were collocated at sample location GP-24.

Measurements of total organic carbon (TOC) indicate sediments in the salt marsh range from 1.8 percent to 21 percent organic carbon.

There are several surface water seeps within the salt marsh area along the slope east of the Tailings Impoundment and WRP-3 that have relatively high concentrations of inorganic analytes as discussed in Subsections 2.5 and 4.4 of the RI report, and there may be a drain system that connects to the Tailings Impoundment decant structure that allows migration of metals into this area. The high concentrations of metals observed in this area are likely a result of the historical and on-going discharge of seeps to the salt marsh. In addition, overflow of the Tailings Impoundment at its northwest corner and surface water runoff from WRP-3 may have contributed to salt marsh contamination.

Three areas of readily apparent harm were identified near the WRP-3 seeps. In these locations, dead vegetation, and, in some cases, discoloration of the soil surface was observed. Field XRF screening data showed some of the highest concentrations of metals in these locations. Copper and lead concentrations exceeded screening values by greater than 1.5 orders of magnitude. Zinc exceeded the screening value by greater than two orders of magnitude.

The salt marsh is subjected to on-going contamination from seep discharges. Also, the upper portion of Goose Pond periodically floods the salt marsh, which may result in the deposition of suspended sediment containing elevated metals.

The area of salt marsh south of the mine waste portion of South Goose Pond/ Marsh Creek does not appear to be significantly impacted. Detected concentrations of copper, lead, and zinc in this portion of the salt marsh are consistent with screening values and background concentrations.

1.4.7 Contaminant Fate and Transport

The environmental fate and transport of contaminants is controlled by the contaminants' physical and chemical properties and by the physical, chemical, and biological processes that occur in the environment where the contaminant exists. The identification and understanding of environmental fate and transport mechanisms is basic to making rational decisions about the potential for human and ecological receptor exposure risk and about the effectiveness of remedial alternatives. Examples of contaminant properties that affect fate and transport include water solubility, density or specific gravity, particle size (for solids), and vapor pressure. Examples of environmental processes affecting contaminant fate and transport include wind and water erosion and deposition, chemical sorption and desorption, chemical degradation, biodegradation, bioturbation, and food chain transport/accumulation. These contaminant properties and environmental processes combine to affect contaminant fate (persistence), transport (advection, dilution, diffusion, dispersion, volatilization), and availability for exposure to receptors.

The primary contaminants at the Site are metals (cadmium, copper, lead, zinc) which are present as metal sulfides in ore and mineralized waste rock fragments at several locations across the Site, especially at the Ore Pad, Mine Operations Area, and WRP-3. Metal sulfides are also associated

with tailings in the Tailings Impoundment. Iron pyrite (iron sulfide, fool's gold) is closely associated with these minerals.

1.4.7.1 Acid Rock Drainage and Groundwater and Surface Water Transport

When sulfide minerals are exposed to air and moisture, oxidation occurs, resulting in the generation of sulfuric acid and the release of metallic ions. Acid rock drainage is commonly associated with iron pyrite as expressed in the following equations:

$$2FeS_2(s) + 7O_2(g) + 2H_2O(l) \rightarrow 2Fe^{2+}(aq) + 4SO_4^{2-}(aq) + 4H^+(aq)$$

$$4Fe^{2+}(aq) + O_2(g) + 4H^+(aq) \rightarrow 4Fe^{3+}(aq) + 2H_2O(l)$$

The ferric ion (Fe^{3+}) produced can also oxidize additional pyrite:

$$FeS_2(s) + 14Fe^{3+}(aq) + 8H_2O(l) \rightarrow 15Fe^{2+}(aq) + 2SO_4^{2-}(aq) + 16H^+(aq)$$

Ferric ion is a powerful oxidizing agent and can facilitate the attack of most base metal sulfides as expressed in the following equation:

$$MS + nFe^{3+} \rightarrow M^{n+} + S + nFe$$

Sulfide ores such as chalcopyrite (copper-iron-sulfide) and sphalerite (zinc sulfide or zinc-iron-sulfide) are also subject to the oxidation reactions. The most significant problem with acid generation is that it may accelerate over time and, once begun, is difficult to stop. However, if the rock has a natural buffering capacity (i.e., carbonate minerals), the acid generated will be neutralized until either the buffering capacity or the acid-generating potential is consumed. Means for control of acid rock drainage include removal of the sources of water and/or oxygen. In the case of tailings, two approaches are 1) dewatering/draining to remove the water term from the acid rock drainage equation and also prevent acid migration, and 2) confined wet or submerged storage to remove the supply of oxygen.

As discussed in the RI report, and summarized in Subsection 1.4.6 of this report, the leaching of metals from tailings and mineralized waste rock is likely at the Site. Acid neutralizing capacity in

non-mineralized rock is available at the Tailings Impoundment, waste rock piles, and Ore Pad. This has reduced the acidity of leachate, but has not stopped release of metals.

Acid rock drainage is readily transported by surface water runoff and infiltrating precipitation/groundwater, and site data indicate elevated metal concentrations in both groundwater and surface water. Based on the current understanding of the hydrologic setting, all contaminated groundwater originating at the Site flows toward Goose Pond and is expected to ultimately discharge to either Dyer Cove or Goose Pond. Some groundwater discharges as seeps, especially along the toe of the Tailings Impoundment and WRP-3, and then flows to Goose Pond, while the remainder discharges directly to Goose Pond.

The mobility of dissolved cadmium, copper, lead, and zinc can be reduced by sorption to soil organic material or to aluminum, iron, and manganese hydroxide precipitates. Metals may also be precipitated as carbonate minerals (if pH is sufficiently elevated) or metal-hydroxysulfates, at slightly lower pH conditions, in the range that has been documented at the Site (pH 5-6.5). The extent to which metals are precipitating as hydroxides, carbonates, or sulfates, or sorbing to aluminum, iron, and manganese hydroxides is not known.

The transport of dissolved copper, lead, and zinc in surface water runoff (including seeps) contributes to metals loading of Goose Pond and to exceedances of the NRWQC for copper and zinc.

Once in the water column, a portion of dissolved metals will remain dissolved and a portion will be incorporated into surface sediments, most likely as carbonate and hydroxide precipitates or by being sorbed onto iron and manganese oxyhydride precipitates. As sediments accumulate and conditions within the sediment column become reducing, or pH changes, the fate of metals may be governed by the re-solubilization of ferric hydroxides, soluble sulfate minerals, and precipitation of metal sulfides, or additional aqueous transport out of the sedimentary system. Based on the high concentrations of copper and zinc in Goose Pond surface water, it is likely that the majority of copper and zinc in the water column remains dissolved and does not precipitate.

If groundwater discharges up into Goose Pond through anaerobic sediments, it is likely that dissolved cadmium, copper, lead, and zinc would become bound to the organic material and/or the sulfides in Goose Pond sediment.

1.4.7.2 Wind Erosion and Transport

Based on air sampling performed in 2006, wind does not appear to be a major, current transport mechanism at the Site, although sparse vegetation, fine-grained material, and elevated topographic position of the source areas does allow for some particulate transport by wind. Based on the elevated concentration of metals in Halo Area soil, windblown material may have been more prevalent during mine operations.

1.4.7.3 Erosion and Surface Water Transport

Large areas of the Site are unvegetated and subject to surface water erosion. The greatest potential exists at the Tailings Impoundment, Mine Operations Area, Ore Pad, and Dyer Point because of small soil particle size, while a predominance of boulders and large rock fragments at the waste rock piles reduces the erosion potential at those locations. Relatively steep slopes at the Ore Pad contribute to erosion potential at that area. Turbid runoff observed in the eastern Mine Operations Area and turbidity plumes observed in Goose Pond following heavy rains provide evidence surface water erosion and transport. Water within drainage ditches associated with the Tailings Impoundment, Mine Operations Area, Ore Pad, and waste rock piles contains dissolved and suspended metals. In addition, the Tailings Impoundment decant system remains operational and discharges water and tailings through the Tailings Impoundment embankment, and ultimately to Goose Pond.

1.4.7.4 Sediment Transport

To assess the potential for mobilization and transport of Goose Pond and Goose Cove sediment, hydrodynamic modeling was performed (WHG, 2007; 2008). The model evaluated the effects of Marsh Creek, tidal exchange, and storm events. Details of data and the modeling are presented in the RI report (MACTEC, 2009b).

Model simulations indicated little potential for erosion within the Goose Pond estuarine system under typical tidal and flow conditions. During a flood tide, the potential for sediment mobility (erosion) only exists in Goose Pond near the dam at Goose Falls. During an ebb tide, the reverse trend occurs where erosion potential increases within Goose Cove at Goose Falls. Therefore, under

normal tidal conditions, the Goose Pond estuary will sequester most of the sediment and COC within the system. The hydraulic jet features that were shown to occur on a typical tidal exchange between Goose Cove and Goose Pond produce bottom currents swift enough to move sediments in the immediate vicinity of the opening at Goose Falls. Although some mobility is expected in areas where there are elevated concentrations of contaminant (e.g., upstream of the earthen dam), the potential for erosion is low, and, if mobilized, the sediment will not be transported out of the system. The typical conditions occurring at the Site indicate that a majority of the system is depositional. During normal conditions, the potential for sediment movement within Goose Pond is minimal, and it is unlikely that any sediment from Goose Pond would be transported out of the local system.

Model simulations of a 100-year precipitation event indicate that the majority of the Goose Pond Estuary remains depositional, but show an increased potential for erosion of sediments within Goose Cove in the path of the hydraulic jet. However, the model simulations indicate that Goose Cove areas that may contain mine waste are for the most part outside the expected zone of erosion. There is also the potential for erosion of sediments at the former earthen dam, where the greatest current velocities were shown to exist, and upstream into Marsh Creek.

The model simulations indicate that turnover of stratified waters within the deep former mine pit is unlikely. Under normal conditions, the dense waters in the pit are confined and mixing only occurs in the upper 10 meters of the water column. The modeling shows that removal of the remaining portion of the earthen dam does not appreciably affect the hydrodynamics of the pond, deposition, or erosion potential.

1.4.8 Current and Potential Future Land Use

The former Callahan Mine property portion of the Site is currently abandoned and unoccupied. Access is unrestricted, and the former Callahan Mine property is used for recreation (e.g., hiking, rock collecting, and all-terrain vehicle (ATV) riding). The remaining areas of the Site include the current residential use area, where contamination was detected in the yards along Old Mine Lane, and the wetland/aquatic areas of Goose Cove, Dyer Cove, Goose Pond, and the impacted areas of salt marsh. There is no use of, or exposure to, site groundwater. There are no plans to redevelop this site property or neighboring upland area to the west, although, in the absence of institutional controls, this cannot be ruled out. There are three seasonal residential use areas along the mine

entrance road connecting the former Callahan Mine property to Goose Falls Road. Recreational uses of Goose Cove and Goose Pond, including boating, also occur; however, the shallow depth of water at Goose Falls prevents passage between Goose Pond and Goose Cove by large watercraft. Commercial and recreational lobster harvesting occurs in Penobscot Bay and occasionally in Goose Cove. These activities have not been observed in Goose Pond. Commercial fishing is not known to occur in Goose Cove or Goose Pond. Recreational fishing occurs in Goose Cove, and may occur in Goose Pond.

The shellfish beds in Goose Cove have been closed by the State, and no shellfish harvesting is known to occur in that area. The shellfish (clam and mussel) beds of Goose Pond are also closed by the State, although there are anecdotal accounts that some harvesting may occur on a very infrequent basis. The shellfish ban is listed as Closed Area No. 36, Bagaduce River and Harborside (Castine, Penobscot, Brooksville) [DMR Chapter 95.04(C)] (Appendix E). The State has placed a ban, because of pollution, on digging, taking, or possessing any clams, quahogs, oysters, or mussels taken from the flats and waters of Goose Cove or Goose Pond. Based on shellfish collecting activities performed as part of the RI, clam density in Goose Pond is low, and clam harvesting is slow and difficult. Because very little mud flat is exposed at low tide in Goose Pond, clam harvesting must be performed in one or two feet of water.

Land use in the vicinity of the Site is rural residential and open space. The land surrounding the former mine area, including the Halo Area to the west, is mostly forested. Holbrook Island Sanctuary State Park is located across Goose Pond immediately east of the Site. Adjacent land cover types consist mostly of mixed hardwood and softwood and softwood-dominated woodlands sloping to the shore.

Evidence of recreational and general public access to, and use of, the mine area is apparent. These areas are accessed by foot and by ATV by recreational visitors to the Penobscot Bay area, and by geology enthusiasts. Area residents, sportsmen, and visitors to the Penobscot Bay area may access the Halo Area by foot or by ATV. The land use of the Site and Halo Area is not expected to change in the future. However, development, including residential development, cannot be ruled out for the Halo Area. Area residences obtain their water supply from private water wells located on their properties, and there is no current use of contaminated site groundwater. The seasonal residences on the Site obtain their water supply from private water wells on their properties, and the groundwater in this area of the Site meets federal and state drinking water standards.

The Goose Pond Estuary is primarily a shallow impounded flowage with features of a broad tidal channel in its middle and southern sections. Flow restrictions at the inlet of the Goose Pond (from both ledge outcrop and Goose Falls Dam) drive tidal patterns, resulting in unique conditions throughout the estuary. The estuary has extreme swings in salinity and/or flow depending on lunar phase, precipitation amounts, and the period of the daily tidal cycle. At its most extreme, the southernmost portion of the Goose Pond was found to intermittently have a high proportion of its substrate drained for days at a time during the first and third quarter lunar phase. During the full and new moon periods, these same areas were inundated for several days.

Representative aquatic ecological receptors include aquatic plants, benthic macroinvertebrates, water column invertebrates, fish, semi-aquatic birds (e.g., spotted sandpiper, great blue heron, osprey, and bald eagle), and semi-aquatic mammals (e.g., river otter). Representative terrestrial receptors include invertebrates, birds (e.g., robin, red tailed hawk), and mammals (e.g., white-footed mouse and short-tailed shrew).

1.4.9 Conceptual Site Model Summary

Contaminated media at the Site include upland soil, groundwater, Goose Pond and Goose Cove sediment, and Goose Pond surface water. Major 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 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 iron sulfide and lesser amounts of copper-, lead-, and zinc-bearing minerals. Use of waste rock to construct containment berms and site roads and pave/surface work areas contributed to site contamination. The Ore pad and WRP-3 contain the highest percentages of mineralized waste rock.

In addition, there is a relatively small area of PCB contamination attributed to historical transformer leakage as well as a relatively small area of DRO/GRO contamination attributed to leaking underground storage tanks removed in 1987. Both these areas are at the Mine Operations Area. PCBs were detected at concentration up to 7,900 mg/kg. DRO and GRO were reported in two soil samples at concentration up to 13,000 and 390 mg/kg, respectively, well above the

Stringent Cleanup Goals of 10 mg/kg for DRO and 5 mg/kg for GRO applicable under the Maine Hydrocarbon Spill Decision Tree, as determined by the Maine DEP. Soil at seasonal residential use areas along the mine entrance road connecting the former Callahan Mine property to Goose Falls Road is contaminated with arsenic and lead.

Overburden groundwater, where it exists, and bedrock groundwater are also contaminated beneath portions of the Site, and concentrations of aluminum, antimony, arsenic, cadmium, chromium, copper, lead, manganese, nickel, sodium, and zinc often exceed MCLs, MEGs, and/or USEPA risk levels at one or more locations. Concentrations in excess of MCL, MEGs, and/or USEPA risk levels most frequent and typically greatest at the Ore Pad, followed by the Mine Operations Area, WRP-1, and WRP-3. Groundwater at the Tailings Impoundment and WRP-2 has the lowest number of exceedances. The presence of these metals in groundwater is attributed predominantly to release from mineralized rock as a result of leaching by acid rock drainage. An exception may be sodium whose presence may also be associated with use of salt water during ore concentration and with drainage from Stink Cove sediments impounded at WRP-1. GRO was detected in one bedrock monitoring well (MW-614R) at a concentration less than the MEG and the Maine Remediation Goal for Stringent Sites. The presence of GRO in bedrock groundwater is attributed to soil contamination observed in the Mine Operations Area. DRO and PCBs were not detected in groundwater samples.

Goose Pond and Goose Cove sediments are contaminated with metals, especially copper, lead, and zinc. Concentrations of these metals exceed background throughout Goose Pond; however, the highest concentrations are located in four areas: 1) an approximate 10.6-acre, 2,400-foot reach of southern Goose Pond extending from the southern site boundary northward past the Tailings Impoundment and WRP-3; 2) Dyer Cove (3.6 acres); 3) a relatively small area east of the mine pit near the mouth of Stink Cove, and 4) a second small area in Goose Pond east of Dyer Point. In addition, approximately 6.9 acres of salt marsh sediments between the Tailings Impoundment and Goose Pond are also contaminated. An approximate 1.5-acre area in Goose Cove has high concentrations of copper, lead, and zinc contamination coinciding with mine waste deposits similar to those in Goose Pond. PCBs and DRO/GRO contamination have not been detected in Goose Pond sediments.

The primary source of contamination to Goose Pond and Goose Cove sediments is interpreted to be historical mine operations. The area of highest contaminant concentration in Goose Cove

corresponds to an area of mapped mine waste thought to result from mine pit dewatering. Four of the five high concentration areas in Goose Pond also correspond to areas of mapped mine waste. The largest area, adjacent to the Tailings Impoundment and WRP-3, has mine waste deposits up to 3 feet thick. Based on historical information, the primary source of these deposits is overflow from the Tailings Impoundment – either through the decant pipe or via an overflow ditch at the northwest corner. Overflow from the northwest corner was also a likely major source of salt marsh contamination. In addition, discharge of contaminated groundwater through seeps and weathering of waste rock via acid rock drainage, followed by surface water transport of suspended and dissolved material, likely contributed to historical sediment contamination. It is unlikely, however, that precipitation from groundwater discharge (i.e., seeps and submerged groundwater discharge) could have created the 3-foot thick deposits documented during the RI. Overflow from the Tailings Impoundment and groundwater/seep discharge continue today. At WRP-3, weathering of waste rock via acid rock drainage followed by groundwater/seep and surface water transport of suspended and dissolved material are interpreted as historical and ongoing contributors to Goose Pond estuary.

The primary source of contamination to Dyer Cove sediments is interpreted to be use of the cove as a settling pond to remove suspended solids from mine pit water after sedimentation of Goose Cove became a concern. In addition, although data are limited, contaminated surface water runoff during and after mine operations as well as the discharge of contaminated groundwater may be historical and ongoing contributors to Dyer Cove sediment contamination.

The primary source of contamination to the other areas of high contaminant concentration in Goose Pond sediment is interpreted to be historical berm and road building in Goose Pond using mine waste materials. These areas do not border upland portions of the Site, and the discharge of contaminated surface water runoff during and after mine operations as well as the discharge of contaminated groundwater are interpreted as relatively minor contributors to sediment contamination in these areas.

Limited sampling of Goose Pond surface water shows elevated concentrations of several metals, especially copper and zinc which exceed NRWQC. Surface water is continually flushed through Goose Pond as a result of tidal exchange, surface water and groundwater discharge, and precipitation. The presence of elevated concentration of metals may be the result of the ongoing discharge of contaminated surface water and groundwater/seeps from the upland portion of the

Site. Dissolution of metals from sediment precipitates may also contribute and weathering of exposed mineralized rock in the pit walls and in the "920" and "860" shafts may also contribute to metals to Goose Pond surface water.

In the absence of remedial actions, acid rock drainage from mineralized rock in upland areas and tailings at the Tailings Impoundment is expected to result in leaching of metals, including copper, lead, and zinc, and contamination of groundwater and surface water runoff with dissolved-phase metals. Groundwater and surface water runoff will transport these metals to discharge locations in Goose Pond. Surface water will also erode friable material and transport suspended material to Goose Pond. Transport by windblown dust, thought to have been significant during mine operations, is now expected to be minor. Because of the volume of mine waste material at the Site, these release and transport mechanisms are expected to persist for decades. Figure 1.4-11 depicts these transport mechanisms.

If the groundwater passes up through organic and anaerobic bottom sediments as it discharges to Goose Pond, a substantial portion of the dissolved metals is expected to precipitate within the sediments as sulfides, while the remaining, smaller portion reaches surface water. If the groundwater is able to discharge directly to surface water (e.g., through bedrock fractures or the "920" and "860" shaft adits in the pit wall), the dissolved metals will mix in the water column. Once in the water column, a portion of dissolved metals will remain dissolved and a portion will be incorporated into surface sediments, most likely as carbonate and hydroxide precipitates or by being sorbed onto iron and manganese oxyhydride precipitates. Based on the high concentrations of copper and zinc in Goose Pond surface water, it may be that much of the copper and zinc in the water column remains dissolved and does not precipitate.

Calculations using metals concentration data for groundwater (i.e., seep and monitoring well samples) collected during the RI and groundwater flux estimates from a conceptual site water balance, indicate that in the vicinity of the Tailings Impoundment and WRP-3, estimated loadings to Goose Pond result in sediment PRG exceedances only when a series of conservative assumptions are applied (e.g., 100 percent precipitation of metals, sediment accretion of 0.5 millimeters (mm) per year, and limited area of metals precipitation). Less conservative, but still reasonable assumptions (e.g., less than 50 percent precipitation of metals, 1 mm of sediment accretion per year, and a greater area of precipitation) do not result in PRG exceedances. Zero precipitation of metals or sorbtion of metals to sediments is unlikely, and it is probable that

groundwater discharge is contributing to sediment contamination; however, available data indicate PRG exceedances are unlikely to result. It should be noted that available data do not quantify the contribution of contaminated surface water runoff resulting from storm events.

Similar calculations performed using metals concentration data for groundwater and groundwater flux estimates from a conceptual site water balance, indicate that in the vicinity of Dyer Cove, estimated loadings result in sediment PRG exceedances when a series of conservative assumptions are applied (i.e., 100 percent precipitation of metals, sediment accretion of 0.5 mm per year, and limited area of metals precipitation). Less conservative, but still reasonable assumptions (e.g., 10 percent precipitation of metals, 1 mm of sediment accretion per year, and greater areas of precipitation) do not result in PRG exceedances. As stated previously, zero precipitation of metals or sorbtion of metals to sediments is unlikely, and it is probable that groundwater discharge is contributing to sediment contamination in the vicinity of Dyer Cove; however, it is not clear that PRG exceedances will result. It should be noted that available data do not quantify the contribution of contaminated surface water runoff resulting from storm events, and that visual observation of runoff-induced turbidity in Goose Pond suggest that this contribution may be substantial in the vicinity of Dyer Cove.

When the same estimated mass loadings are used in simple dilution calculations and assuming no precipitation of metals, the results indicate that concentrations of copper in Goose Pond surface water may slightly exceed the NRWQC if it is also conservatively assumed that mixing is restricted to one-half the pond volume. If no constraint is applied on surface water mixing, NRWQC exceedances are not predicted. In contrast, the dilution calculations indicate that zinc concentrations in Goose Pond surface water will not exceed the NRWQC even if it is conservatively assumed that mixing is restricted to one-half the pond volume. The results of these calculations are contrary to the fact that measured concentrations of copper and zinc show several fold exceedances of NRWQC in Goose Pond surface water. This suggests that that the copper and zinc loading to Goose Pond may not be fully quantified.

In fact, the fate and transport of metals in Goose Pond is complex. There is continual exchange between metals in the water column and metals in sediment. In addition, it is estimated that 10 to 20 percent of the water column mass is flushed from Goose Pond to Goose Cove and out of the system each day by tidal exchange.

PCBs have relatively low water solubility and tend to sorb to soil particles. The PCBs at the Mine Operations Area are expected to remain sorbed to soil and degrade only slowly, with minimal migration in groundwater. DRO also have relatively low water solubility and tend to sorb to soil particles. However, the shorter and more water soluble carbon-chain molecules within DRO are more amenable to aerobic degradation than longer carbon-chain molecules, and, considering the age of the Site, may have already degraded leaving a relatively immobile and stable higher molecular weight fraction behind. GRO consist of shorter carbon-chain, more water soluble, and more biodegradable molecules than DRO. It is expected that the GRO at the source (i.e., residual contamination at the UST grave) will continue to dissolve and migrate in groundwater. However, as the source is depleted, concentrations are expected to decrease. As long as groundwater remains aerobic, biodegradation is expected, and long distance migration is not expected.

Copper, lead, and zinc in Goose Pond and Goose Cove sediments are expected to exist primarily as sulfide precipitates (where sediments are organic and anaerobic) or carbonate or hydroxide precipitates where sediments are aerobic. They may also sorb onto iron and manganese oxyhydrides in shallow aerobic sediments. Although equilibrium exists between precipitated and dissolved metals, the tendency will be for copper, lead, and zinc to remain as sulfide/carbonate/hydroxide precipitates as long as redox conditions do not change substantially. If redox conditions change, there may be dissolution/reprecipitation reactions among sulfide/carbonate/hydroxide species as redox conditions shift back and forth between anaerobic and aerobic conditions. Sediments, however, are expected to remain a sink for copper, lead, and zinc.

Goose Pond is a low-energy environment, and, based on hydrodynamic modeling, mechanical suspension of shallow sediments by wave action and currents and longitudinal transport is expected to be minimal (WHG, 2008). Goose Cove is a higher energy environment, but potential for suspension of shallow sediments by wave action and currents and longitudinal transport, while greater than in Goose Pond, remains low. Sediment resuspension by watercraft is more likely in Goose Cove than in Goose Pond.

Sediment accumulation rates in Goose Pond and Goose Cove are estimated to be 0.5 to 1 mm per year, and hundreds of years could be required to accumulate a 6- to 12-inch thick layer of clean sediment to cover contaminated material to a depth at which bioturbation would be expected to result in no significant mixing of clean and contaminated material. However, mixing of clean accumulating material with underlying sediments by bioturbation would reduce sediment surface

concentrations in a shorter time frame. Bioturbation consists of various processes by which organisms move sediment particles within the sediment matrix.

1.4.10 Human-Health Risk Assessment Summary

A baseline human-health risk assessment (HHRA) was performed as part of the RI. The purpose of the HHRA was to quantify the human-health risks associated with potential exposures to site-related contaminants under current and reasonably foreseeable future land use conditions, in the absence of any remedial actions. The HHRA was performed using USEPA national and Region 1 CERCLA guidance for risk assessment, as described in the Risk Assessment Guidance for Superfund document series.

The HHRA evaluated cancer and non-cancer health risks associated with potential exposures to media that have been potentially affected by site-related contamination, including soil, surface water, sediment, groundwater, and biota. The land uses evaluated in the HHRA included:

- Current residential use. This land use included evaluation of child and adult residents who may potentially be exposed to surface soil located at each of three private residential properties located along Old Mine Lane. It should be noted that one of these properties was divided into two exposure areas for the purpose of risk assessment, resulting in the designation of four "Lots" (A, B, C, and D) in the RI report, when in fact there are only three true lots.

- Current and continuing future recreational use. This land use included evaluation of child, older child, and adult recreational visitors who may potentially be exposed to source area and Halo Area soil, groundwater seeps at the source area, as well as at the water bodies associated with the Site (Goose Cove, Goose Pond, Goose Pond Irregularly Flooded Area, salt marsh, and Marsh Creek) during activities such as swimming, wading, or boating.

- Current and future recreational angling. Under current land use, this included evaluation of recreational anglers who may contact surface water while pulling and placing traps for lobsters and crabs, and who may be exposed to contaminants that have accumulated in crab or lobster tissue by consuming their catch of lobster and crabs. Under future land use, this included evaluation of recreational anglers who may dig for clams or mussels and be exposed to surface water and sediment, and who may be exposed to contaminants that have accumulated in clam or mussel tissue, by consuming their catch of clams or mussels.

- Current and future commercial angling. Under current land use, this included evaluation of commercial anglers who may contact surface water while pulling and placing traps for lobsters, and who eat a portion of their catch of lobster. Under future land use, this included evaluation of commercial anglers who may contact surface water while pulling and placing traps for crabs, who may dig for clams or mussels and be exposed to surface

water and sediment, and who may be exposed to contaminants that have accumulated in biota tissue, by consuming a portion of their catch of crabs, clams, or mussels.

- Future residential use. Although residential development is unlikely, an assessment was performed assuming that the former Callahan Mine property portion of the Site was developed for residential purposes. This included evaluation of child and adult residents who may potentially be exposed to soil at the source area and Halo Area if the areas are developed for residential use in the future, and to groundwater under the assumption that drinking water supply wells are installed in the overburden and bedrock aquifers where site-related contamination has been identified. In addition, this land use included evaluation of construction workers who may potentially be exposed to soil at the Halo Area and source area during re-development activities.

Current area residents, as well as future residents, could also visit other areas of the Site (e.g., surface water bodies) as recreational visitors, or shellfish as recreational anglers. The risk characterization accounted for these potential multi-media exposures.

Health risks were calculated for the chemicals of potential concern (COPCs) in each of the exposure media. COPCs were identified using a concentration-toxicity screen performed in accordance with USEPA risk assessment guidance. The primary COPCs identified in all media were metals, including arsenic, cadmium, copper, lead, manganese, and zinc. PCBs were also retained as COPCs in source area soil, because of PCB contamination identified in soils in the vicinity of the Ore Pad.

For each COPC in each medium and exposure point evaluated in the HHRA, a representative exposure concentration (termed the exposure point concentration [EPC]) was calculated as the lesser of the maximum detected concentration or the 95% upper confidence limit in the arithmetic mean concentration (95% Upper Confidence Limit [UCL]). For groundwater, the maximum detected concentrations were used as the EPCs.

Health risks were calculated and evaluated by three metrics:

- Excess lifetime cancer risks (ELCR) were calculated for potentially carcinogenic COPCs using cancer slope factors and unit risk values obtained from USEPA-approved sources. At this Site, the potentially carcinogenic COPCs include arsenic and PCBs. Cancer risk estimates were compared to an ELCR range of $1x10^{-6}$ (one in a million) to $1x10^{-4}$ (one in ten-thousand) as stipulated in the NCP.

- Non-cancer hazard index (HI) values were calculated for all COPCs using reference dose (RfD) and reference concentration values obtained from USEPA-approved sources. Non-cancer hazards were compared to a HI value of 1, which corresponds to levels of exposure

that people (including sensitive individuals such as children) could experience without expected adverse effects.

- Risks associated with potential exposures to lead were evaluated using lead uptake models developed by USEPA, which provide estimates of blood lead levels that may result from exposures to lead in environmental media. The estimated blood lead levels are compared to a threshold blood lead level of 10 micrograms per deciliter (µg/dl), which is a multi-Agency goal that has been designated by the U.S. Centers for Disease Control and the Agency for Toxic Substances and Disease Registry as a level of concern to protect sensitive populations, including neonates, infants, and children. USEPA indicates that 95% of the exposed population should have a blood lead level that does not exceed 10 µg/dl. In addition, State "lead safe" standards for residential exposure were utilized.

Table 1.4-5 provides a summary of the HHRA results, which are discussed below.

Soil

Estimated cancer, non-cancer, and lead exposure risks are within or below the USEPA risk management criteria (ELCR range of $1x10^{-6}$ to $1x10^{-4}$, HI of 1, and 95 percent or more of exposed population with a geometric mean blood lead level of 10 µg/dl or less) at the following areas:

- residential Lot B soil (current residential land use)
- source area subsurface soil (future residential use)
- Halo Area soil (current and future recreational use and future residential use)

Estimated cancer, non-cancer, and/or lead exposure risks are in excess of USEPA risk management criteria (ELCR range of $1x10^{-6}$ to $1x10^{-4}$, HI of 1, and/or 5 percent or more of exposed population with a geometric mean blood lead level 10 µg/dl or more) at the following areas:

- Residential Lot A soil (current residential land use) due to lead
- Residential Lot C soil (current residential land use) due to lead
- Residential Lot D soil (current residential land use) due to lead and thallium
- source area soil (current and future recreational use due to PCBs; future residential use due to PCBs and lead)

Groundwater and Groundwater Seeps

Estimated cancer and non-cancer risks are below the USEPA risk management criteria (ELCR range of $1x10^{-6}$ to $1x10^{-4}$, HI of 1 for potential exposure to groundwater seeps.

Estimated cancer, non-cancer, and/or lead exposure risks are in excess of USEPA risk management criteria (ELCR range of $1x10^{-6}$ to $1x10^{-4}$, HI of 1, and/or 5 percent or more of exposed population with a geometric mean blood lead level 10 µg/dl or more) for the following exposure scenarios:

- future use of overburden groundwater (future use as potable water) due to aluminum, arsenic, cadmium, chromium, lead, manganese, and zinc
- future use of bedrock groundwater (future use as potable water) due to cadmium, copper, manganese, and zinc

Surface Water and Sediment

Estimated cancer, non-cancer, and lead exposure risks are within or below the USEPA risk management criteria (ELCR range of $1x10^{-6}$ to $1x10^{-4}$, HI of 1, and 95 percent or more of exposed population with a geometric mean blood lead level of 10 µg/dl or less) at all exposure points evaluated in the HHRA, for potential exposures by recreational visitors who may wade, swim, or boat, and recreational and commercial anglers who may fish for lobsters or crabs, or dig for clams and mussels. In addition, the conclusions of the risk characterization results for residential exposures to soil would not be altered when additive risks are considered for potential exposures to surface water/sediment at any of the water bodies.

Cancer and non-cancer risks are estimated below the USEPA risk management criteria (ELCR range of $1x10^{-6}$ to $1x10^{-4}$, HI of 1 for potential exposure to seeps.

Biota

Estimated cancer, non-cancer, and/or lead exposure risks are within or below USEPA risk management criteria (ELCR range of $1x10^{-6}$ to $1x10^{-4}$, HI of 1, and/or 95 percent or more of exposed population with a geometric mean blood lead level 10 µg/dl or less) for the following biota evaluated in the HHRA:

- Goose Cove mussels
- Goose Pond clams

Cancer, non-cancer, and/or lead exposure risks associated with the remainder of the biota evaluated in the HHRA (Goose Cove lobster, crabs, clams; Goose Pond crabs; and Weir Cove clams) are

estimated to be within or below USEPA risk management criteria (ELCR range of $1x10^{-6}$ to $1x10^{-4}$, HI of 1, and/or 95 percent or more of exposed population with a geometric mean blood lead level 10 µg/dl or less) when incremental risks are considered. In other words, for these biota, the risks associated with biota collected from the Site that are over and above the risks that are associated with biota collected from background locations are within USEPA risk management criteria. In addition, for these biota the principal contributor to calculated risks is arsenic. However, arsenic in biota does not appear to be related to arsenic release from the Site, as evidenced by a lack of association between sediment arsenic EPCs and tissue EPCs, similarity in arsenic tissue EPCs among all biota from Site and background areas, and biota data sets with limited sizes that result in use of maximum detected concentrations as EPCs.

1.4.11 Ecological Risk Assessment Summary

A BERA was performed as part of the RI. The objective of the BERA was to evaluate the risk of ecological harm associated with site-related contaminants which consist primarily of metals. The ecological risk assessment process at the Callahan Mine Superfund Site follows the USEPA *Ecological Risk Assessment Guidance For Superfund, Process for Designing and Conducting Ecological Risk Assessments* (USEPA, 1997a). The BERA considered nine assessment endpoints to evaluate risk in aquatic exposure areas, and six assessment endpoints to evaluate risk in terrestrial exposure areas.

1.4.11.1 Exposure Assessment and Effects Assessment

Assessment and measurement endpoints were evaluated for the six aquatic exposure areas and two terrestrial areas. The specific methods used to assess each measurement endpoint generally included:

- comparison of COPC EPCs in surface water, sediment, surface soil, and tissue to screening and effects benchmarks; most benchmarks were derived from the scientific literature though some were derived based on site-specific factors
- evaluation of acid volatile sulfides/simultaneously extracted metals (AVS/SEM) data
- sediment toxicity tests (chronic 10-day survival and growth for *L. plumulosus* and 28-day survival and growth for *N. arenaceodentata*), with statistical analysis of co-located sediment and porewater data to try to identify a dose-response relationship to observed effects

- fish condition factors
- quantitative benthic and terrestrial invertebrate surveys
- quantitative salt marsh and terrestrial vegetation surveys

Food chain modeling for terrestrial and semi-aquatic birds and mammals by which modeled doses were compared to toxicity reference values (TRVs) based on no observable adverse effects levels (NOAELs) and lowest observable adverse effects levels (LOAELs).

Assessment populations evaluated in aquatic exposure area food chain models included:

- spotted sandpiper, representing insectivorous birds
- great blue heron, representing piscivorous birds
- osprey, representing predatory birds (Bald eagle was used as surrogate for osprey, with emphasis on population-level effects rather than effects on individuals.)
- river otter, representing semi-aquatic mammals
- bald eagle[2], representing rare, threatened, and endangered species (Because of their special status, bald eagles were evaluated for individual effects rather than population effects.)

Assessment populations evaluated in terrestrial exposure area food chain models included:

- robin, representing omnivorous song birds
- red-tailed hawk, representing predatory birds
- white-footed mouse, representing omnivorous small terrestrial mammals
- short-tailed shrew, representing worm-eating small terrestrial mammals

Reference locations were identified and paired with exposure areas based on important habitat characteristics including salinity, community characteristics, and tidal patterns for aquatic reference areas, and surrounding land use and natural community composition for terrestrial areas.

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[2] The bald eagle was delisted from the Federal Endangered and Threatened Species List prior to the BERA and was removed from the Maine Threatened and Endangered Species List after completion of the BERA.

Both reasonable maximum exposures (RME) and central tendency exposures (CTE) were considered when assessing and characterizing risk. CTE represents the most likely concentration to which a population of receptors would be exposed. RME EPCs were calculated as the lower of the 95% upper confidence limit or the maximum concentration. CTE EPCs were based on the average (arithmetic mean) concentration using one half the sample quantitation limit for non-detects. RME EPCs for reference areas were selected as the maximum detected concentrations due to generally smaller data sets; reference CTE EPCs were also based on the average (arithmetic mean) concentration using one half the sample quantitation limit for non-detects.

Pathways that were evaluated included direct contact with surface soil for terrestrial plants and invertebrates, direct contact with surface water and sediment for aquatic life (invertebrates and fish), and ingestion of surface water, incidental ingestion of soil or sediment, and ingestion of prey items for wildlife receptors.

1.4.11.2 Risk Characterization

Risk characterization involves the integration of exposure and effects data to determine the likelihood of adverse effects. A weight of evidence approach was used to make conclusions regarding risk of harm for assessment endpoints with more than one measurement endpoint. Measurement endpoints were each assigned an inference weight, based upon how closely they represent the assessment endpoint. Conclusions regarding risks to an assessment endpoint were reached by considering the inference weight for each measurement endpoint (i.e., the overall weight of evidence).

Measurement endpoints involving food chain models and comparison of media concentrations to benchmarks were assessed using a hazard quotient (HQ). When HQs were calculated as part of the Effects Assessment, the likelihood of adverse population-level effects was first determined using a Four-Way Interpretative Risk Matrix that incorporated all four outcomes from RME and CTE EPC and NOAEL and LOAEL TRV (or screening and effects benchmark) combinations.

Four-Way Interpretative Risk Matrix					
RME/NOAELHQ	**RME/LOAEL HQ**	**CTE/NOAEL HQ**	**CTE/LOAEL HQ**	**Risk Conclusion: (Adverse population-level effects)**	**Confidence Level**
≤ 1	≤ 1	≤ 1	≤ 1	Unlikely	High
> 1	≤1	≤ 1	≤ 1	Unlikely	High
> 1	> 1	≤ 1	≤ 1	Unlikely	Moderate
> 1	≤ 1	> 1	≤ 1	Possible	Low
> 1	> 1	≥ 1	≤ 1	Possible	Moderate
> 1	> 1	> 1	> 1	Possible	High (increases with higher HQs)

HQs calculated for fish, benthic invertebrates, *Spartina,* and soil invertebrate tissue were based only on tissue effects benchmarks combined with the RME and CTE scenarios; hence, only two sets of HQ conditions were calculated. In such cases, the Two-Way Interpretative Risk Matrix was used as a guide to address the range of risk conclusions and confidence levels:

Two-Way Interpretative Risk Matrix			
RME/Effects Benchmark HQ	**CTE/Effects Benchmark HQ**	**Risk Conclusion:** Adverse population-level effects:	**Confidence Level**
≤ 1	≤ 1	Unlikely	High
> 1 and <10	≤ 1	Unlikely	Moderate
> 1 and >10	≤ 1	Possible	Low
> 1	> 1	Possible	High (increases with higher HQs)

When possible, the risk matrices relied on incremental risk HQs which accounted for the background contribution to site risk.

The Four-Way and Two-Way risk matrices were the first steps to estimate and characterize risk. Then, underlying assumptions and uncertainties such as bioavailability were considered to derive final risk conclusions.

Other assessment endpoints which were not based on HQs, such as quantitative benthic and terrestrial invertebrate community surveys, fish condition factors, quantitative salt marsh and terrestrial plant surveys, and sediment toxicity tests were compared to conditions in reference areas. AVS/SEM data were compared to threshold concentrations established by USEPA (USEPA, 2005).

1.4.11.3 Ecological Risk Assessment Conclusions

Risk levels identified in the BERA are summarized in Table 1.4-6 (aquatic exposure areas) and Table 1.4-7 (terrestrial exposure areas) and presented in the following text.

Salt Marsh Plants

There is a high risk to salt marsh plants in areas of readily apparent harm, where vegetation is absent or stunted, located at the upland fringe of the salt marsh exposure area; however, multivariate statistical analyses could not identify a significant dose-response relationship with site COPCs. No statistically significant dose-response relationship could be identified, though benchmark comparisons suggest copper and cadmium as possibly contributing to adverse population-level effects. In other areas of salt marsh outside of areas of readily apparent harm, the weight of evidence suggested that the risk of harm is unlikely; areas of readily apparent harm comprise less than 0.5 percent salt marsh habitat in Goose Pond.

The cause of the areas of readily apparent harm is not known; it could be because of an episodic event from a seep discharge, chronic exposure to site seeps or sediments, or other naturally occurring environmental stressors. The *Spartina* sampled in the salt marsh is subject to periods of prolonged inundation and prolonged emergence and is generally growing in a higher intertidal elevation. A reduction of tidal flow may also causes changes in soil chemistry. Sea water naturally contains large quantities of sulfur, which is reduced by soil bacteria into sulfide in the normally anoxic marsh soil conditions.

Benthic Invertebrates

Risk to the benthic invertebrate community varies with location. Sediment toxicity tests demonstrated ecologically significant effects to benthic invertebrates in Goose Cove at location GC-05 with respect to the *N. arenaceodentata* growth endpoint. However, no adverse ecologically significant effects were observed for the two other Goose Cove toxicity test locations, where sediment concentrations were higher.

The weight of evidence from AVS/SEM data and quantitative benthic community surveys compared to reference suggested that few areas of the sediment should present a high risk. However, the sediment toxicity test data suggest that at least portions of the mine waste hot spot area adjacent to WRP-3 and the Tailings Impoundment, as defined by locations GP-22 and GP-12,

are acutely toxic. Pore water data for that area also suggest the potential for adverse impacts despite the high AVS. Although GP-07 and GP-13 exhibited ecologically significant risk for *L. plumulosus* survival (GP-07) and growth (GP-13), sediment and pore water concentrations at GP-07 and GP-13 were frequently lower than other locations which did not demonstrate significant risk. Risk at GP-07 is likely overestimated and unlikely to result in adverse population-level effects based on relatively low sediment and pore water contaminant concentrations. Risk at GP-13 is likely overestimated and therefore not likely to result in adverse population-level effects, as evidenced by toxicity limited to the growth endpoint for *L. plumulosus* and relatively low metals availability based on pore water chemistry.

The toxicity test for the Goose Pond Irregularly Flooded sediment was ambiguous as one sample indicated potential toxicity and the other did not. Other samples from the Goose Pond Irregularly Flooded sediment outside the mine waste hot spot did not show toxicity. It should be noted that dramatic fluctuations in temperature, dissolved oxygen concentrations, and salinity concentrations observed in the Goose Pond Irregularly Flooded sediment area do not provide a stable environment for most freshwater or marine species.

Water Column Invertebrates

Risk to water column invertebrates ranged from unlikely to possible, however, there is high uncertainty associated with this conclusion.

Fish

Adverse population-level effects to fish in all aquatic exposure areas is unlikely given fish condition factors that were consistent with background and fish tissue concentrations that resulted in HQs less than 1. Risk to fish based on comparison of surface water concentrations to benchmarks suggested risk ranged from unlikely to possible, however, there is high uncertainty associated with this conclusion. It should be noted that dramatic fluctuations in temperature, dissolved oxygen concentrations, and salinity concentrations observed in South Goose Pond and in the Irregularly Flooded area do not provide a stable environment for most freshwater or marine species; however, there are estuarine species that are adapted to the environment.

Aquatic Insectivorous Birds

Adverse population-level effects to insectivorous birds (spotted sandpiper) are possible in the Goose Pond Irregularly Flooded exposure area due to copper (high confidence) and lead (low

confidence), and in the salt marsh due to copper (high confidence). Adverse population-level effects were generally unlikely for other ecological exposure areas.

Aquatic Piscivorous Birds

Adverse population-level effects to piscivorous birds (great blue heron) are possible in the Goose Pond Irregularly Flooded exposure area due to zinc (low confidence), in the salt marsh due to copper (high confidence) and zinc (low confidence). Adverse population-level effects were generally unlikely for other ecological exposure areas.

Aquatic Predatory Birds, Semi-Aquatic Mammals, and Rare, Threatened, & Endangered Species

The risk assessment concluded that in all six aquatic exposure areas, risk of harm to Predatory Bird (osprey), Semi-Aquatic Mammal (river otter), and Threatened, & Endangered Species (bald eagle[3]) is unlikely regardless of exposure scenario.

Terrestrial Plants and Soil Invertebrates, Terrestrial Insectivorous Birds, Terrestrial Predatory Birds Terrestrial Small Omnivorous Mammals, and Terrestrial Small Worm-Eating Mammals

Based on the weight of evidence and confidence and uncertainties in the data, adverse population-level impacts to terrestrial plants, terrestrial invertebrates, birds (robin, hawk), and mammals (white-footed mouse and short-tailed shrew) in the source area may be possible from metals including cadmium, copper, lead, and zinc, and PCBs. The high incremental risk HQs support the high confidence in this conclusion. Much of the former mine operations area contains no vegetation or very sparse vegetation because soils were grubbed and then left bare during mining operations, or because the soils consist of material left from mining operations. The materials that remain provide little or no growth medium for plants because of their texture, and provide poor habitat for terrestrial invertebrates which serve as food sources for robin. Receptors are, therefore, not likely to forage frequently at the source area.

Based on the weight of evidence and confidence and uncertainties in the data, risk of harm to terrestrial plant, terrestrial invertebrate, bird, and mammal communities in the Halo Area from most COPCs is unlikely. The risk assessment concluded that confidence for adverse population-level effects to occur terrestrial insectivorous birds (robin) and small worm-eating mammals

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[3] The bald eagle has been delisted from the Federal Endangered and Threatened Species List and has been proposed for removal from the Maine Threatened Species List.

(shrew) in the Halo Area due to arsenic, copper, chromium, lead, selenium, and/or zinc was low due to low HQs and assumptions in the food chain models that tend to overestimate risk. Furthermore, risk in the Halo Area was driven principally by two samples located at the source area boundary (SS-5148 and TH-5).

1.5 OPERABLE UNITS

The RI, HHRA, and BERA for the Callahan Mine Superfund Site evaluated the entire Site and all identified exposure pathways. USEPA often implements a cleanup action in phases or "Operable Units." This allows for a focus on the portions of the Site where more immediate risk reduction is necessary and can provide more time to better understand other areas of the Site. For the Callahan Mine Superfund Site, two OUs are being created. OU 1 will target the following areas:

- Soil and waste contaminated with PCBs
- Soil and waste that represent the most significant threat to surface water, sediments, and groundwater (i.e., the former Ore Pad, portions of the Mine Operations Area, WRP-3, and the Tailings Impoundment)
- Sediment areas that were shown to be acutely toxic and represent a food chain threat (i.e., primarily the area of sediments and salt marsh in southern Goose Pond adjacent to WRP-3 and the Tailings Impoundment)
- Soil and waste contaminated with lead and arsenic in areas with current residential use.

The remaining areas of the Site will be further evaluated as part of a second OU (OU 2), which includes site groundwater and remaining site soil risk, and will be subject to a FS in the future, if it is determined that a response action is necessary for these areas. USEPA is proposing an Early Action for OU 2. The Early Action will consist of establishing institutional controls to prevent the use of drinking water on areas of the Site where federal and state drinking water standards are exceeded. The Early Action will also include a restriction on the use of the entire site properties, except for the areas already used for residential purposes. The basis for establishing these institutional controls in the OU 2 Early Action is the site data and risk information contained in the HHRA and BERA of the recent RI report (MACTEC, 2009). The OU 2 Early Action is discussed further in Section 6.0.

2.0 IDENTIFICATION AND SCREENING OF TECHNOLOGIES

This section identifies and screens remedial technologies using the process outlined in USEPA RI/FS guidance, Principal Threats Guidance, Groundwater Presumptive Strategy, and the NCP (USEPA, 1988b, 1990, 1991, and 1993). The process begins with the identification of remedial response objectives which establish general cleanup goals and identification of applicable or relevant and appropriate requirements (ARARs), the regulatory requirements that must be complied with. Next, chemical-specific numerical cleanup goals are established and, in conjunction with remedial response objectives and ARARs, used to identify remedial action objectives. Once these tasks are completed, estimates are made of the areas and volumes of media which exceed numerical cleanup goals, and potential cleanup technologies are identified and screened to produce an inventory of suitable technologies that can be assembled into remedial alternatives capable of mitigating actual or potential risks at the site.

The national goal of the Superfund program as stated in the NCP at 40 CFR 300.430(a)(1)(i) is to select remedies that are protective of human health and the environment, that maintain protection over time, and that minimize untreated waste. To reach this goal, the NCP enumerates several expectations at 40 CFR 300.430(a)(1)(iii)(A-F):

- to use treatment to address principal threats posed by a site wherever practicable
- to use engineering controls, such as containment, for waste that poses a relatively low long-term threat or where treatment is impracticable
- to use a combination of methods, as appropriate, to achieve protection of human health and the environment
- to use institutional controls, such as water use and deed restrictions to supplement engineering controls as appropriate for short- and long-term management to prevent or limit exposure to hazardous substances, pollutants, or contaminants
- to consider innovative technology where such technology offers the potential for comparable or superior performance or implementability, fewer or less adverse impacts than other available approaches, or lower costs for similar levels of performance than demonstrated technologies
- to return usable groundwater to beneficial uses wherever practicable, within a time frame that is reasonable given the particular circumstances of the site; when restoration of ground water to beneficial uses is not practicable, prevent further migration of the plume, prevent exposure to the contaminated ground water, and evaluate further risk reduction

2.1 IDENTIFICATION OF PRINCIPAL AND LOW-LEVEL THREAT WASTES

The NCP establishes an expectation that treatment will be used to address the principal threats at a site wherever practicable, whereas engineering controls, such as containment, may be used for wastes that pose a relatively low long-term threat or where treatment is impracticable (40 CFR 300.430(a)(1)(iii)). The concept of principal threat and low-level threat wastes is applied on a site-specific basis when characterizing source material. Source material is defined as material that includes or contains hazardous substances, pollutants, or contaminants that act as a reservoir for migration of contamination to groundwater, to surface water, to air, or acts as a source for direct exposure (OSWER 9380.3-06FS [USEPA, 1991c]). Contaminated groundwater generally is not considered to be source material, although nonaqueous phase liquids (NAPLs) may be.

Principal threat wastes are those source materials considered to be highly toxic or highly mobile which cannot be reliably contained or that would present a significant risk to human health or the environment should exposure occur (USEPA, 1991). The manner in which principal threats are addressed generally will determine whether the statutory preference for treatment as a principal element is satisfied. The reasonably anticipated future land use at a site is significant in defining principal threat waste areas. Pursuant to the NCP and the 1995 guidance *Land Use in the CERCLA Remedy Selection Process* (USEPA, 1995), current land use and reasonably anticipated future land use should be considered in identifying realistic exposure scenarios for estimating site risks. When baseline risks associated with the reasonably anticipated future land use trigger action, the definition of principal threat waste may be determined by the reasonably anticipated future land use scenario as well. For example, soil contamination that could be considered a principal under a residential exposure scenario might not be considered a principal threat under a non residential exposure scenario. Although no "threshold level" of risk has been established to identify principal threat waste, a general rule of thumb is to consider a principal threat those source materials with toxicity and mobility characteristics that combine to pose a potential risk several orders of magnitude greater than the risk that is acceptable for the current or reasonably anticipated future land use, given realistic exposure scenarios (USEPA, 1997b). Furthermore, characterizing a waste as a principal threat does not necessarily mean that the waste poses the primary risk at a site. Examples of source materials that generally constitute principal threats include liquid wastes in drums, lagoons, or tanks; NAPLs floating on or under groundwater; soil, sediment, sludge, or debris containing high concentrations of mobile or potentially mobile contaminants; buried non-

liquid wastes; and soil containing significant concentrations of highly toxic material (OSWER 9200.1-23P [USEPA, 1999]).

Low-level threat wastes are those source materials that generally can be readily contained and that would present only a low risk in the event of a release or exposure. Examples of wastes generally considered to constitute low-level threats include soil containing contaminants that are relatively immobile in air or groundwater (i.e., non-liquid, low volatility, low leachability) in the specific environmental setting and soil containing contaminants not greatly above RfD levels or presenting an excess cancer risk near the acceptable risk range (USEPA, 1999).

Investigations at the Callahan Mine Superfund Site have not identified liquid waste in drums, tanks or impoundments; free-phase NAPLs; or significant concentrations of highly toxic or mobile contaminants in soil or other source material. The PCB contamination, however, represents a significant threat to human health. PCB contamination is several orders of magnitude greater than what is considered a safe level. As a result, the PCB contamination is considered a principal threat waste. The waste rock and tailings are low-level threats waste, because, although metals will continue to leach from waste materials, they pose a chronic risk rather than a short-term or acute risk.

2.2 DEVELOPMENT OF REMEDIAL ACTION OBJECTIVES

Remedial action objectives consist of medium- or operable unit-specific, quantitative goals defining the extent of cleanup required to protect human health and the environment. They specify COCs, exposure routes and receptors, and PRGs. In the case of groundwater, they also include a restoration time frame. Remedial action objectives are used as the framework for developing remedial alternatives. The remedial action objectives are formulated to achieve the overall goal of USEPA of protecting human health and the environment. To develop remedial action objectives, it is first necessary to identify ARARs and PRGs.

2.2.1 Applicable or Relevant and Appropriate Requirements

CERCLA and the NCP require that on-site Superfund remedial actions must attain federal standards, requirements, limitations, or more stringent state standards determined to be legally applicable or relevant and appropriate to the circumstances at a given site. ARARs are federal

environmental and state environmental and facility siting requirements used to: (1) evaluate the appropriate extent of site cleanup; (2) define and formulate remedial action alternatives; and (3) govern implementation and operation of the selected action. Inherent in the interpretation of ARARs is the assumption that protection of human health and the environment is ensured.

2.2.1.1 Definition of ARAR Categories

To properly consider ARARs and to clarify their function in the remedy selection process, the NCP defines two ARAR components: (1) applicable requirements; and (2) relevant and appropriate requirements. These definitions are discussed in the following paragraphs:

Applicable Requirements. Applicable requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site (40 CFR 300.400(g)). Basically, to be applicable, a requirement must directly and fully address a CERCLA activity. For example, Resource Conservation and Recovery Act (RCRA) regulations governing the operation and design of a hazardous waste incinerator (40 CFR Part 264, Subpart O) apply to hazardous waste incinerators used at Superfund sites. To be considered applicable, state standards must be of general applicability and legally enforceable (i.e., promulgated), identified by the state in a timely manner, and more stringent than federal requirements (40 CFR 300.400(g)(4)).

Relevant and Appropriate Requirements. Relevant and appropriate requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations that, while not applicable to a hazardous substance, pollutant, contaminant, remedial action, location or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the site that their use is well-suited to the particular site (40 CFR 300.400(g)(2)). For example, RCRA landfill design standards could be relevant and appropriate to a landfill at a Superfund site, if the wastes being disposed of were sufficiently similar to RCRA hazardous wastes.

Requirements under federal or state law may be either applicable or relevant and appropriate to CERCLA cleanup actions, but not both. However, requirements must be both relevant and appropriate for compliance to be necessary. In the case where both a federal and a state ARAR are

available, or where two potential ARARs address the same issue, the more stringent regulation must be selected. The final NCP states that a state standard must be legally enforceable and more stringent than a corresponding federal standard to be relevant and appropriate (40 CFR 300.400(g)(4)).

The NCP at 40 CFR 300.430(f)(1)(ii)(C) provides several ARAR waiver options that may be invoked, providing that the basic premise of protection of human health and the environment is not ignored:

1. The alternative is an interim measure and will become part of a total remedial action that will attain the applicable or relevant and appropriate federal or state requirement.
2. Compliance with the requirement will result in greater risk to human health and the environment than other alternatives.
3. Compliance with the requirement is technically impracticable from an engineering perspective.
4. The alternative will attain a standard of performance that is equivalent to that required under the otherwise applicable standard, requirements, or limitation through use of another method or approach.
5. With respect to a state requirement, the state has not consistently applied, or demonstrated the intention to consistently apply, the promulgated requirement in similar circumstances at other remedial actions within the state.
6. For Fund-financed response actions only, an alternative that attains the ARAR will not provide a balance between the need for protection of human health and the environment at the site and the availability of Fund monies to respond to other sites that may present a threat to human health and the environment.

Substantive requirements pertain directly to the actions or conditions at a site, while administrative requirements facilitate their implementation. CERCLA on-site remedial response actions must only comply with all substantive requirements that are "applicable" or "relevant and appropriate," but not the administrative requirements, such as any requirement to obtain federal, state, or local permits (CERCLA §121(e)). The NCP defines on-site as "the aerial extent of contamination and all suitable areas in very close proximity to the contamination necessary for implementation of the response action." Off-site response actions must comply with both the substantive and administrative requirements of an applicable (but not a relevant and appropriate) regulation, but such regulations pertaining to off-site actions are not classified as ARARs (OSWER 9347.1-0; USEPA, 1998b)

As noted in the ARARs guidance (USEPA, 1988a):

> "The CERCLA program has its own set of administrative procedures, which assure proper implementation of CERCLA. The application of additional or conflicting administrative requirements could result in delay or confusion."

To ensure that CERCLA response actions proceed as rapidly as possible, USEPA has reaffirmed this position in the final NCP. The USEPA recognizes that certain administrative requirements, such as consultation with state agencies and reporting, are accomplished through the state involvement and public participation requirements of the NCP.

In the absence of federal- or state-promulgated regulations, there are many criteria, advisories, and guidance values that are not legally binding, but may serve as useful guidance for response actions. These are "to-be-considered" (TBC) guidance (USEPA, 1988a). These guidelines or advisory criteria should be identified if used to develop clean-up goals or if they provide important information needed to properly design or perform a remedial action. Three categories of TBC information are: (1) health effects information with a high degree of certainty (e.g., RfDs); (2) technical information on how to perform or evaluate site investigations or response actions; and (3) regulatory policy or proposed regulations (53 Federal Register [FR] 51436).

ARARs are divided into the three categories listed below.

Location-specific ARARs set restrictions upon the concentration of hazardous substances or the conduct of activities solely because they are in special locations (USEPA, 1998a). In determining the use of location-specific ARARs for selected remedial actions at CERCLA sites, one must investigate the jurisdictional prerequisites of each of the regulations. Basic definitions and exemptions must be analyzed on a site-specific basis to confirm the correct application of the requirements.

Chemical specific ARARs are usually health- or risk-based numerical values or methodologies that establish the acceptable amount or concentration of a chemical that may remain in, or be discharged to, the environment (USEPA, 1988a). They govern the extent of site remediation by providing either actual cleanup levels, or the basis for calculating such levels. For example, groundwater MCLs may provide the necessary cleanup goals for sites with contaminated groundwater. Chemical-specific ARARs may also be used to indicate acceptable levels of

discharge in determining treatment and disposal requirements, and to assess the effectiveness of future remedial alternatives.

Action-specific ARARs are usually technology- or activity-based requirements or limitations on remedial actions taken (USEPA, 1988a). Selection of a particular response action at a site will invoke the appropriate action-specific ARARs that may specify particular performance standards or technologies, as well as specific environmental levels for discharged or residual chemicals.

The Occupational Safety and Health Administration (OSHA) has promulgated standards for protection of workers who may be exposed to hazardous substances at RCRA or CERCLA sites (29 CFR Part 1910.120 and 1926.65). USEPA requires compliance with the OSHA standards in the NCP (40 CFR 300.150), not through the ARAR process. Therefore, the OSHA standards are not considered as ARARs. Although the requirements, standards, and regulations of OSHA are not ARARs, they will be complied with during response activities.

2.2.1.2 Location-Specific Applicable or Relevant and Appropriate Requirements

Location-specific ARARs are triggered by the presence of specific natural or manmade features or potentially affected resources at a disposal or cleanup site. Features and resources that can trigger location-specific ARARs include the following:

- seismic faults
- caves, salt domes, salt beds, and underground mines
- floodplains, wetlands, and water bodies
- sensitive ecosystems
- wilderness areas, wildlife refuges, wildlife resources, and scenic rivers
- rare, threatened, or endangered species
- archaeological resources and historic sites

Of these, coastal zone, wetlands, water bodies, facility siting, and wildlife resources will affect response actions at the Callahan Mine Superfund Site: the wetland and coastal areas of the Site include Goose Pond and associated salt marsh areas and portions of Goose Cove. Although

portions of the Holbrook Island Sanctuary State Park are located on the east side of Goose Pond, remedial activities at the Site are not expected to adversely affect the park.

Section 404 of the Clean Water Act (CWA)(33 USC § 1344), and regulations promulgated under the CWA, prohibit activities that adversely affect waters of the United States if a practicable alternative that has less adverse effect exists. If there is no other practicable alternative, adverse effects must be mitigated. The excavation/dredging of sediment and salt marsh as a part of remedial activities will result in the unavoidable destruction of existing wetlands and aquatic habitats; although the effects of remedial activities on the wetlands and aquatic habitats will be evaluated and minimized during design. The use of the submerged mine pit as a CAD cell is also regulated by these standards. In addition, freshwater wetlands on Site may be affected by the remedial action. Freshwater wetlands that are contiguous to "waters of the United States" are federal jurisdictional wetlands subject to Section 404 of the CWA; however, swales and ditches are generally not jurisdictional waters. Compensatory habitat mitigation will be performed as necessary to comply with this ARAR.

Additional federal location-specific ARARs address coastal zone management, navigable waters, and fish and wildlife resources.

The Maine Natural Resource Protection Act (NRPA)(38 M.R.S.A. §§480-A *et seq.*) is one of the primary State location-specific ARARs for the Site. The NRPA establishes standards for the protection of the State's natural resources, including coastal wetlands, significant wildlife habitat, freshwater wetlands, and rivers, streams, or brooks. The Maine Wetlands Protection Rule (06-096 Code of Maine Regulations [CMR], Chapter 310), promulgated under the NRPA, prohibits activities which would have an unreasonable impact on state-jurisdictional wetlands, with jurisdiction under the Rules extending for 75 feet upland of the upper edge of a protected wetland. Under the Rules, Wetlands of Special Significance include all coastal wetlands and certain freshwater wetlands which include: (a) significant wildlife habitat as defined by 38 M.R.S.A. § 480-B(10); (b) freshwater wetland areas located within 250 feet of a coastal wetland; (c) wetlands subject to flooding during a 100-year flood event; and (e) freshwater wetland areas located within 25 feet of a river, stream or brook. The Wetland Rules call for the avoidance of activities that cause a loss in wetlands area, functions, and values if there is a practicable alternative that would be less damaging to the environment. If there is no practicable alternative, there must be minimal alteration of the wetland and compensation (off-setting) may be required.

Additional State location-specific ARARs address coastal zone management, facility siting requirements, shorelines, and submerged and intertidal lands.

Location-specific ARARs and TBCs for each evaluated remedial alternative are identified in Section 4.0.

2.2.1.3 Chemical-Specific Applicable or Relevant and Appropriate Requirements

There are no federal chemical-specific ARARs for the Callahan Mine Superfund Site, but there are TBCs that were used to develop risk-based cleanup numbers for contaminants at the Site. The only State chemical-specific ARAR for the Callahan Mine Superfund Site is the Maine Solid Waste, Lead Management Regulations (06-096 CMR Chapter 424). These regulations establish lead safe standards for soil containing lead – if lead in soil exceeds 375 ppm in bare soil in potential play areas or 1,000 ppm in other than play areas, the soil in these areas is be considered a lead hazard.

Because OU 1 does not include cleanup of groundwater, National Primary Drinking Water Regulation MCLs, Maximum Contaminant Level Goals (MCLGs), and MEGs for Drinking Water are not chemical-specific ARARs.

Chemical-specific ARARs and TBCs for each remedial alternative are identified in Section 4.0.

2.2.1.4 Action-Specific Applicable or Relevant and Appropriate Requirements

Federal action-specific ARARs address the remediation of PCBs (Toxic Substances Control Act (TSCA), 40 CFR § 761.61(a) and (c)), discharge limits to surface waters, and monitoring standards for surface and groundwater. TSCA regulations provide cleanup and disposal options for PCB remediation waste based on the concentrations at which the PCBs are found and are applicable to the cleanup of PCBs at the site.

The primary State action-specific ARAR for the Site is the Maine Metallic Mineral Exploration, Advanced Explorations, and Mining regulation at 06-096 CMR Chapter 200. In particular, Subchapter 5 - Mine Waste Treatment and Management classifies mine waste and regulates the location, design, construction, operation, maintenance, closure, and long-term care for the

treatment, storage, and disposal of mine wastes. USEPA has determined that these regulations, which were promulgated after Callahan Mine ceased operations, are not "applicable" to the Site, but are "relevant and appropriate." The following general performance standards are found at 06-096 CMR Chapter 200, Section 32A:

1. Meet the performance requirements for groundwater, surface water, air, and soils or surficial materials established under Section 26(I)
2. Minimize acid generation and acid rock drainage
3. Provide structural stability
4. Protect public health and the environment
5. Otherwise comply with applicable legal requirements

The second and third performance standards relate to the discussion of acid rock drainage in Subsection 1.4.7.1 and the discussion of geotechnical evaluation in Subsection 1.4.4.5 and slope stability in Subsection 1.4.4.7, and are discussed in the context of the scope and extent of remedial alternatives in Sections 3.0 and 4.0 of this report.

It is important to note that Subchapter 5 explicitly applies to mine waste in lieu of Maine Solid Waste Management Rules at 06-096 CMR 400-409 with the exception that land-clearing debris and wood waste are not considered mine waste for the purposes of the mining regulations. In addition, mine waste is not considered hazardous waste to the extent that mine waste has been excluded by Section 3001(b)(3)(A)(ii) of the Resource Conservation and Recovery Act, 42 USC 6921(b)(3)(A)(ii) (known as the Bevill exclusion) and Maine regulations at 06-096 CMR Chapter 850, Section 3.A(3) and (4). Under these regulations, mining overburden returned to the mine site is not a hazardous waste. Furthermore the Maine regulations note that wastes from the extraction and beneficiation of metallic ores and minerals that are left on Site are regulated under Chapter 200 of Maine DEP rules, not Chapters 850-857. It is important to note that for any material that is sent off Site, applicable state and federal transportation and disposal regulations would apply. Waste material could be considered a hazardous waste if testing revealed that it met the criteria.

Other State action-specific ARARs include those intended to control erosion and sedimentation as a result of site activities; manage storm water; monitor and protect surface water, groundwater, and air quality; establish shellfish harvesting restrictions within the Site; and manage solid wastes.

Action-specific ARARs and TBCs for each remedial alternative are identified in Section 4.0.

2.2.2 Development of Preliminary Remediation Goals

PRGs are long-term numerical goals used during analysis and selection of remedial alternatives. PRGs should comply with ARARs and result in residual risks consistent with NCP requirements for protection of human health and the environment. Therefore, PRGs are based both on risk-based concentrations and on ARARs. Eventually, PRGs become the basis for final remediation goals for the selected remedy.

2.2.2.1 Human-Health Preliminary Remediation Goals for OU 1

Human-health PRGs were developed for COCs, for media which posed health risks in excess of the NCP risk management limits, as identified from the results of the baseline HHRA (MACTEC, 2009b, Volume II). A PRG is a COC concentration that is protective for media exposures at *de minimis* risk levels. PRGs include risk-based concentrations that are back-calculated from the site-specific exposure scenarios at a target ELCR of $1x10^{-6}$ and a HI of 1, ARARs, and background concentrations. A COC is a chemical that is associated with an excess lifetime cancer risk greater than $1x10^{-6}$ or a HI greater than 1. The determination of whether a response action is required is generally made by determining if a medium (or, more specifically, an exposure area such as source area soil or Goose Pond sediment) is associated with health risks that exceed risk management limits as defined in the NCP or in USEPA guidance documents. A response action is generally warranted if one or more of the following conditions is met:

- The cumulative excess carcinogenic risk to an individual exceeds $1x10^{-4}$ (using reasonable maximum exposure assumptions for either the current or reasonably anticipated future land use).
- The non-carcinogenic HI is greater than one (using reasonable maximum exposure assumptions for either the current or reasonably anticipated future land use).
- Site contaminants cause adverse environmental impacts.
- Chemical-specific standards or other measures that define acceptable risk levels are exceeded and exposure to contaminants above these acceptable levels is predicted for the RME. Examples include: drinking water standards that are exceeded in ground water when that ground water is a current or potential source of drinking water; or water quality

standards that are exceeded in surface or ground waters that support the designated uses of these waters (e.g., support aquatic life).

For sites with lead contamination, the Revised Interim Soil Lead Guidance for CERCLA sites and RCRA Corrective Action Facilities (EPA 540-F-94-043, July 1994) provides the following guidance for how the remedial action objectives should be described for site contaminated with lead: "EPA will generally take a response action if circumstances indicate that there is a greater than 5% probability that the blood lead levels of a child (age 6 to 84 months) may exceed 10 micrograms per deciliter. In accordance with this policy, one of the remedial action objectives at this site is that there will be no more than a 5 percent chance of a child's blood lead value exceeding 10 micrograms per deciliter."

The NCP stipulates that PRGs must initially be established as concentrations that correspond to an excess lifetime cancer risk greater than $1x10^{-6}$ or a HI of 1, but can be modified upwards in consideration of site-specific factors, ARARs, background, *etc*.

OU 1 targets the areas that represent a significant current threat to human health. This includes the portions of the Site which have current residential use and the area with PCB contamination. As a result, human-health based PRGs will be developed that are protective of current and future residential use for the current residential areas of the Site and current and future recreational exposure in the area of PCB contamination. The institutional controls that will be implemented as part of an early action for OU 2 will prevent any future residential use of the former Callahan Mine property portion of the Site. Any potential human-health threats from contaminated groundwater across the entire Site or for soil within the area of the former Callahan Mine property will be addressed as part of a future OU 2 cleanup. As a result, any necessary site-wide PRGs for soil and groundwater will be set as part of the OU 2 Feasibility Study, as necessary. Human-health based PRGs were not necessary for surface water, sediment, or biota as these media were not identified as representing a threat to human health based on the OU 1 HHRA.

From the risk assessment results summarized in Table 1.4.5, Table 2.2-1 lists exposure scenarios and COCs associated with risks exceeding these thresholds in the HHRA. At the Site, source area soil posed cancer risks greater than $1x10^{-4}$ and HI values greater than 1 for current/future recreational use, and future residential use.

ARARs that were consulted in the development of PRGs for the Site include:

- Maine Solid Waste Lead Management Regulations
- Toxic Substances Control Act 40 CFR § 761.61(a) and (c) – PCB Remediation Waste

Table 2.2-2 presents a summary of the media that require human-health PRGs, the COCs for those media, and the basis of the PRGs. Note that PRGs for protection of human health are only required for Source Area surface soil and residential lot surface soil. Human-health PRGs are not required for any other media at OU 1 (i.e., Halo Area soil, surface water, sediment, or biota).

Risk-based PRG values were derived using a simple algebraic equality as follows:

(PRG)	=	*(EPC as shown in HHRA)*
(target risk for PRG)		*(risk associated with EPC as shown in HHRA)*

Table 2.2-3 presents the final human-health PRGs for residential and recreational use areas. The residential use PRGs will apply to the OU 1 area that is currently used for residential purposes. The recreational use PRGs will be used for the site source areas. The PRGs were selected in consideration of risk-based values, ARARs, and background values. Table 2.2-3 also presents the cancer and non-cancer risks that would be associated with exposure to the COCs at the concentrations that were identified as PRGs. The risks were calculated using a simple algebraic equality as shown above. The bases of the PRG values are as follows:

- PCBs: The PCB cleanup level is based upon the sites-specific risk assessment, and the TSCA unrestricted use soil cleanup goals. As shown, these values are associated with health risks below a HI of 1 and very close to the cancer risk point of departure ($1x10^{-6}$).
- Lead: PRGs for lead were established by the Maine Solid Waste Lead Management Regulation lead-safe residential standards that are consistent with, or lower than, values that would be derived using biokinetic uptake modeling (i.e., risk-based values).
- Thallium: The PRG for thallium was established as the risk-based value because no ARARs for thallium are available.
- Arsenic: For residential use areas, the PRG is based on the background value for arsenic. The risks associated with the background value are below a HI of 1 and are within the USEPA cancer risk range of $1x10^{-6}$ to $1x10^{-4}$.

2.2.2.2 Ecological Preliminary Remediation Goals

PRGs were developed for marine surface water and sediment COCs that demonstrated ecologically significant risks in the BERA (MACTEC, 2009b, Volume III). Ecological PRGs were not developed for terrestrial soil because site-wide PRGs for the upland/terrestrial will be addressed as part of OU 2. COPCs were identified in the BERA by first screening maximum contaminant concentrations against ecological screening benchmarks for each medium and exposure area. COPCs were further evaluated using site-specific data evaluations that included chronic sediment toxicity tests, tissue analyses, population surveys, food chain models, and additional comparisons to effects-based media concentrations and background conditions to identify COCs (i.e., those chemicals which resulted in or could potentially result in ecologically significant adverse effects) and to eliminate those chemicals were not COCs.

Complete exposure pathways exist for organisms inhabiting aquatic exposure areas (Goose Cove, Goose Pond Permanently Flooded, Goose Pond Irregularly Flooded, salt marsh, Marsh Cove, and Weir Cove). The aquatic exposure areas are located in a tidal estuary and subjected to oscillating water levels, salinities, and temperatures. The aquatic portions of the Site provide habitat for marine and shoreline plants, benthic invertebrates, water column invertebrates, fish, semi-aquatic birds and mammals, and predatory birds (including bald eagles).

Aquatic and semi-aquatic receptors may be exposed to COCs though ingestion of sediment (benthic invertebrates), surface water (aquatic life, including invertebrates and fish), and contaminated prey (semi-aquatic birds and mammals) at each of the aquatic exposure areas. Exposure pathways and assessment endpoints are summarized in the following table.

Ecological Exposure Pathways of Concern

Exposure Medium	Receptor	Exposure Routes	Assessment Endpoints
Surface Water	Aquatic invertebrates, fish, semi-aquatic birds and mammals, and predatory birds	Ingestion and direct contact with chemicals in surface water or contaminated aquatic prey	Maintenance (growth, survival reproduction) of local populations of aquatic and semi-aquatic organisms
	Bald eagle	Ingestion and direct contact with chemicals in surface water or contaminated benthic prey	Maintenance (growth, survival reproduction) of individual bald eagles

Ecological Exposure Pathways of Concern

Exposure Medium	Receptor	Exposure Routes	Assessment Endpoints
Sediment	Benthic invertebrates, semi-aquatic birds and mammals	Ingestion and direct contact with chemicals in sediment or contaminated prey	Maintenance (growth, survival reproduction) of local populations of aquatic and semi-organisms

The BERA evaluated risk to sandpiper (insectivorous birds), great blue heron (semi-aquatic piscivorous birds), osprey (semi-aquatic predator birds), river otter (semi-aquatic mammal), and bald eagle (rare, threatened, and endangered species). The BERA also evaluated risk to salt marsh plants (salt marsh only), benthic invertebrates (all except salt marsh), water column invertebrates (all except salt marsh and Weir Cove), and fish (all except salt marsh and Weir Cove). Table 2.2-4 summarizes LOAEL HQs for RME as identified in the BERA. Although the BERA identified copper as the main risk driver in Goose Pond and the salt marsh, PRGs were also derived for lead and zinc. Lead HQs were above 1 for the sandpiper, and zinc was identified as a COC for the benthic community.

The following subsections describe the three methodologies used to derive potential soil and sediment PRGs: Food Chain Models, Effects Concentration 20 (EC-20) values, and Dose-Response Curves generated from sediment toxicity test results and sediment concentration data. PRGs were not derived for receptors which the BERA determined were not at risk.

Food Chain Models

Food chain models were used in the BERA to calculate HQs from measured soil or sediment concentrations. In order to calculate a PRG, the same food chain models were algebraically rearranged to solve for the soil or sediment concentration (as appropriate) at which the HQ would equal 1. PRGs calculated using food chain models therefore represent the soil/sediment concentration at which the HQ equals 1, and thus are protective of receptor populations.

Food chain models were used to derive PRGs for great blue heron and the spotted sandpiper. The specific equations and input parameters used for each receptor are shown in Tables 2.2-5 and 2.2-6.

The input parameters used for the calculation of sediment PRGs in the Goose Pond Permanently Flooded, Goose Pond Irregularly Flooded, and salt marsh exposure areas were the same as parameters used in the BERA, with slight modification to better represent site-specific exposure

conditions. Literature based biota-sediment accumulation factors used in the BERA for the Goose Pond Irregularly Flooded and salt marsh exposure areas were also updated with site-specific biota-sediment accumulation factors calculated from benthic macroinvertebrate tissue data were available for the Goose Pond Permanently Flooded exposure area. Sediment invertebrate biota-sediment accumulation factors calculations are presented in Table 2.2-7. Food chain model PRGs were not calculated for Goose Cove since the BERA did not identify a risk to those receptors evaluated for Goose Cove using food chain models.

EC-20s

Sediment samples were collected from the Goose Cove and Goose Pond Permanently Flooded exposure areas and subjected to chronic 10-day *Leptocheirus plumulosus* tests for survival and growth, and for chronic 28-day *Neanthes arenaceodentata* tests for survival and growth. Copper, lead, and zinc were examined as indicators of toxicity by performing a forward stepwise regression analyses using SYSTAT 11 (SYSTAT Software Inc., 2004). For each toxicity test measurement endpoint that exhibited ecologically adverse effects, the endpoint was regressed for bulk sediment, total concentrations in pore water, and dissolved concentrations in pore water.

Results of the forward stepwise regression suggested that bulk sediment lead and zinc, total pore water copper and lead, and dissolved pore water copper best explained observed toxicity in the Goose Pond Permanently Flooded exposure area. COC concentrations in the Goose Pond Permanently Flooded exposure area that were significantly associated with a 20 percent reduction in observed effects were estimated using the smoothed linear interpolation method (USEPA, 1994) (i.e., the EC-20). The smoothed linear interpolation method synthetically creates a monotonically decreasing dose-response relationship by averaging concentrations associated with similar results in a systematic way. The standard errors of the estimated EC-20s were also estimated (Campbell, 1982). In some cases, either the limited number of samples used to define the EC-20s, the variance in observed toxicological responses, or both effects combined resulted in estimated EC-20s that were associated with high uncertainty. If the standard error in the EC-20 exceeded half of the estimated value (relative standard error > 0.5), the EC-20 was not considered sufficiently reliable to use as the basis for establishing PRGs.

For Goose Cove, regression and correlation equations could not explain the observed toxicity in terms of any COPC concentrations. In Goose Cove, toxicity tests were run on three samples. Location GC-04 exhibited an ecologically significant effect on *N. arenaceodentata* growth while

locations GC-05 and GC-06 did not exhibit any ecologically significant effects even though concentrations where higher than at GC-04. Therefore, EC-20s could not be derived for Goose Cove.

Dose-Response Curves

Appendix E of the BERA presented scatter-plots of sediment concentrations versus effects endpoints (survival and growth) for *N. arenaceodentata* and *L. plumulosus* toxicity tests at Goose Pond Permanently Flooded exposure area. The scatter-plots for copper, lead, and zinc were reviewed to identify dose-response curves and to estimate no-effects concentrations and lowest-observable-effects concentrations for each test species and endpoint combination.

Toxicity test results from Goose Cove suggested that metal concentrations at location GC-04 may cause ecologically significant adverse population-level impacts to the benthic community based on effects to *N. arenaceodentata* growth. However, concentrations of copper, lead, and zinc at the two other Goose Cove toxicity test sampling locations (GC-05 and GC-06) did not exhibit any ecologically significant effects even though concentrations where higher than at GC-04. Furthermore, there were no effects on *N. arenaceodentata* growth, or *L. plumulosus* survival and growth in Goose Cove. PRGs, therefore, could not be derived for Goose Cove using dose-response curves.

2.2.2.3 Ecological Preliminary Remediation Goals

Table 2.2-8 provides a matrix of potential sediment PRGs based on evaluation method and exposure area (Goose Pond Permanently Flooded and Irregularly Flooded Areas and salt marsh). Table 2.2-9 presents the selected sediment PRGs. For copper and lead, the lowest food chain model LOAEL-based concentration among ecological receptors (see Table 2.2-8) was selected as the chemical-specific PRG. For zinc, the benthic-macroinvertebrate dose-response value (high) was selected as the chemical-specific PRG. PRGs were not calculated for Goose Cove as explained above. Because there were no areas of the Site above the PRG for cadmium, cadmium was eliminated as a COC.

PRGs based on great blue heron and spotted sandpiper have limited geographical applicability. Spotted sandpiper feed only along shoreline habitat, and great blue heron feed only in water that is shallow enough for them to stand. PRGs for spotted sandpiper and great blue heron should,

therefore, not be applied to areas outside of their respective normal feeding ranges. Also, since approximately 80 percent of risk to great blue heron and approximately 30 percent of risk to sandpiper comes from incidental ingestion of sediment, remediation of sediment alone in those feeding areas will reduce risk to levels that sufficiently protect ecological receptors.

2.2.3 Identification of Remedial Action Objectives for OU 1

Remedial action objectives consist of medium- or operable unit-specific, quantitative goals defining the extent of cleanup required to protect human health and the environment. Remedial action objectives are used as the framework for developing remedial alternatives. The remedial action objectives are formulated to achieve the overall goal of USEPA of protecting human health and the environment. Remedial action objectives for OU 1 are listed below.

- Protect current and future recreational visitors by preventing direct contact and incidental ingestion of site soils and waste material containing PCBs that represent a non-cancer threat with a HQ greater than 1 and a cancer risk greater than $1x10^{-6}$ using the site-specific risk assessment assumptions for current and future recreational use.

- Protect current residents by preventing direct contact and incidental ingestion of site soils and waste material in the current residential use area of the Site containing lead that would result in greater than 5 percent of the exposed population with a blood lead level above 10 µg/dl, or exceeding the Maine Solid Waste Lead Remediation Regulations, whichever is lower using the site-specific risk assessment assumptions for current and future residential use.

- Protect current residents by preventing direct contact and incidental ingestion of site soils and waste material in the current residential use area of the Site containing arsenic that represent a non-cancer threat with a HQ greater than 1 and a cancer risk greater than $1.4x10^{-5}$ using the site-specific risk assessment assumptions for current and future residential use.

- Prevent exposure of biota to sediment, including the sediment/soil in the salt marsh, with concentrations of copper, lead, or zinc that may represent a threat to insectivorous and piscivorous birds, fish, and other aquatic organisms.

- Minimize acid rock drainage from mineralized waste rock and tailings that may act as a continuing source of copper, lead, and zinc to groundwater, surface water, and sediment.

- Stabilize the Tailings Impoundment berm to achieve acceptable stability criteria.

- Compliance with all federal and state ARARs, including achieving closure standards under State mining regulations.

2.3 GENERAL RESPONSE ACTIONS

General response actions are categories of remedial actions that may be used to satisfy remedial action objectives by either reducing the contaminant concentration in each medium below the PRG or by preventing receptor exposure to the contaminated medium. General response actions describe categories of remedial actions that may be employed to satisfy remedial action objectives and provide the basis for identifying specific remedial technologies.

Potential general response actions for source areas, soil, and sediment at Site are identified below.

- No Action
- Institutional Controls
- Containment
- Excavation/Consolidation
- Disposal

2.4 VOLUMES AND AREAS OF MEDIA EXCEEDING PRELIMINARY REMEDIATION GOALS

Media identified for remedial action as part of OU 1 consist of source area soil, residential use area soil, Goose Pond sediment, and salt marsh sediment.

2.4.1 Source Areas:

Based on the definition of source material in Subsection 2.1 and review of the nature and extent of contamination, there are four significant source areas at the Site: the Ore Pad, Mine Operations Area, WRP-3, and Tailings Impoundment. WRP-3 and the Tailing Impoundment contain material that acts as a source of surface water and sediment contamination in Goose Pond, including the salt marsh. The former Ore Pad and Mine Operations Area contribute to groundwater contamination as well as sediment and surface water contamination in Dyer Cove and Goose Pond. The highest concentrations of cadmium, copper, and zinc in the bedrock groundwater are detected under the Ore Pad. The extent of these source areas is shown on Figure 2.4-1. The horizontal extent of each

area is based on observation of physical characteristics and/or mineralogy. Thus, the horizontal extents of the Tailings Impoundment and WRP-3 source areas are based on their physical footprints. The horizontal extents of the Ore Pad and Mine Operations Area source areas are based on footprint and mineralogy. The vertical extent of these source areas is based on exceedance of recreational-use PRGs (see Table 2.2-3).

As discussed in Subsection 1.4.6, a relatively small area of PCB contamination also exists at the Mine Operations Area. Figure 2.4-2 depicts the extent of PCB contamination exceeding the PRG for PCBs (see Table 2.2-3).

In addition to CERCLA contaminants on Site, there also is petroleum waste that is regulated under state standards, rather than RCRA. Because these petroleum-contaminated soils are commingled with soil contaminated with CERCLA waste, they will be addressed concurrently with the CERCLA wastes. Based on the Maine Hydrocarbon Spill Decision Tree, the Maine DEP has classified the DRO/GRO contamination in the Mine Operations Area as meeting the criteria as a Stringent Site requiring the removal or remediation of soils containing concentrations in excess of 5 ppm GRO and 10 ppm DRO. Figure 2.4-2 also shows the estimated extent of DRO/GRO contamination exceeding the Maine remediation goals for GRO and DRO.

2.4.2 Residential Use Area of Site

The volume of soil exceeding the residential use PRGs (see Table 2.2-3) within the residential use area of the Site is based on excavation of surface soil in lawn, residential use, and road areas adjacent to residences to a depth at which PRG exceedances no longer occur. Extensive bedrock outcropping in the area will provide horizontal bounds for much of the excavation. Figures 2.4-3 through 2.4-5 show exceedances of human-health PRGs for arsenic, lead, and thallium at individual sample locations, and Figure 2.4-6 depicts the areas to be remediated within the residential use area of the Site.

2.4.3 Sediment, including Salt Marsh

After completion of the BERA, the conceptual site model was refined and four areas of the Site with high levels of contamination and the presence of mine waste were identified as hot spots. These areas consist of the following:

- Goose Pond mine waste hot spot. This 10-acre area within the 75-acre Goose Pond is adjacent to WRP-3 and the Tailings Impoundment. Mine waste, particularly tailings, has accumulated in the sediments in this area.

- Salt Marsh mine waste hot spot. These 7 acres of salt marsh within the 23 acres of salt marsh at the Site are co-located with the Goose Pond mine waste hot spot and are also likely contaminated as result of tailings deposition.

- Dyer Cove. Dyer Cove is an 8-acre area in Goose Pond that was used as a settling basin for the sediment pumped out of the mine pit during operation. The distribution of contamination in this area is more variable than at other areas.

- Goose Cove mine waste hot spot. This 1.5-acre area of the 4-acre Goose Cove is associated with the discharge from a pipe that was used to dewater the mine pit during operation of the mine.

Figures 2.4-7, 2.4-8, and 2.4-9 show these potential hot spot locations based on sediment sampling results for copper, lead, and zinc. Figure 2.4-10 shows potential hot spots based on the combined copper, lead, and zinc data. The remaining areas were then designated as:

- Goose Pond outside hot spot, which represents the remaining 57 acres of Goose Pond.
- Goose Cove outside hot spot, which represents the remaining 2.5 acres of Goose Cove.
- Salt Marsh outside hot spot, which represents the remaining 16 acres of Salt Marsh.

The revised conceptual site model along with the results of the RI and BERA were used to assess whether there are significant differences in contaminant concentration and ecological impact among these four areas. A multi-tier evaluation was performed (Appendix F). First (Tier I), analytical data were separated into groups representing mine waste and non-mine waste areas for calculation of mean concentrations and 95% upper confidence limits (UCLs) for comparison to PRGs. This evaluation demonstrated that the hot spot areas contained concentrations of copper, lead, and zinc substantially greater than the other areas. Table 2.4-1 summarizes the data for the Tier I evaluation. Figures 2.4-11 through 2.4-13 compare the mean and UCLs of the mean concentrations for the four hot spot areas to the remaining areas of the Site.

If the data set for an area revealed that: 1) the mean concentrations and 95% UCLs that did not exceed PRGs; 2) the BERA had not identified a significant threat from that area, and 3) sufficient mine waste was not present to require its removal under ARARs requirements, then that area was

eliminated from further evaluation as an area that may require remediation. As a result, the areas of Goose Pond, salt marsh, and Goose Cove without mine waste, representing 75.4 acres of sediment, were eliminated from further consideration. Data sets with 95% UCLs and/or average concentrations which exceeded PRGs were further evaluated using the results from the RI and BERA that allow for an assessment of the potential ecological significance of the contamination in the hot spot areas. This other ecological data included Habitat Analysis, Toxicity Tests, Tissue Concentrations, food chain modeling results, pore water data, and benthic community data (both quantitative and qualitative) (Tier II). A summary of this evaluation is presented below.

- The Southern Goose Pond mine waste hot spot was identified as an area that represents a unacceptable threat to ecological receptors for the following reasons:

    - The average and UCL exceed the PRG for copper, lead, and zinc. 72 percent of the samples tested for copper, 37 percent of the samples tested for lead, and 64 percent of the samples tested for zinc were above the PRG.

    - Sediment toxicity testing identified areas of acute toxicity. In fact, two of the three toxicity tests in this area demonstrated acute toxicity.

    - The habitat analysis confirmed that the insect eating and fish eating receptors could use this area. Food chain modeling identified the potential for adverse impacts to these receptors in this area.

    - Clam tissue concentrations for lead are more than 10 times background. Copper and zinc concentrations in tissue are also greater than background and other areas of the Site.

    - Fish tissue concentrations for the mine waste hot spot, and the area immediately south of the hot spot, which likely includes fish that forage in the hot spot are above background for lead, copper, and zinc.

    - While benthic community data did not reveal any significant change when compared to reference locations, the information collected as part of the clam survey suggests that there are fewer clams, and the resident clams are smaller than in other areas of the site.

    - Pore water data for this area showed concentrations in pore above NRWQC.

- Salt Marsh mine waste hot spot was identified as an area that represents an unacceptable threat to ecological receptors for the following reasons:

    - The average and UCL exceed the PRG for copper, lead, and zinc. 82 percent of the samples tested for copper, 42 percent of the samples tested for lead, and 59 percent of the samples tested for zinc were above the PRG.

- The habitat analysis confirmed that the insect eating and fish eating receptors could use this area. Food chain modeling identified the potential for adverse impacts to these receptors in this area.

- Plant tissue concentrations are greater than background for lead, copper, and zinc.

- Areas of dead vegetation (readily apparent harm) were identified at the locations of several seeps.

- Dyer Cove was not identified as an area that represents an unacceptable threat to ecological receptors for the following reasons:

  - Although the average and UCL for copper and zinc exceeded the PRGs, the toxicity testing and food chain modeling did not suggest the potential for significant ecological impacts that would require remediation. Clam and fish tissue concentrations were above background, but were lower than the other mine waste hot spots.

- Goose Cove was not identified as an area that represents an unacceptable threat to ecological receptors for the following reasons.

  - Only copper exceeded the PRG based on the average concentration and copper and zinc when the UCL was considered. The area of Goose Cove containing the mine waste is too deep to be considered accessible habitat for the insect eating or fish eating birds. Toxicity testing did not reveal acute toxicity in this area.

In summary, the Tier II evaluation identified the Southern Goose Pond mine waste and Salt Marsh mine waste hot spots as having the potential for adverse ecological effects and, therefore, meeting thresholds for remediation. Table 2.4-2 summarizes the salt marsh and sediment hot spot Tier II evaluation. Figure 2.4-14 depicts highlights of the evaluation.

Figure 2.4-15 depicts OU 1 areas identified for remediation, including the sediment and salt marsh areas identified for remediation based on extent of PRG exceedances, presence of mine waste, and the potential for exposure by the representative populations evaluated in the BERA.
Table 2.4-3 lists areas and volumes identified for remediation.

2.5 IDENTIFICATION AND SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS

This subsection identifies and screens remedial technologies using the process outlined in USEPA RI/FS guidance and the NCP (USEPA, 1988b, 1990, and 1993). First, technologies are identified to attain the remedial action objectives established in Subsection 2.2 and to correspond to the categories of general response actions described in Subsection 2.3. Demonstrated performance of each technology for site contaminants and conditions is considered during technology identification. The result is a list of potential remedial technologies that are then screened based on their applicability to site- and waste-limiting characteristics. The purpose of the screening is to produce an inventory of suitable technologies that can be assembled into remedial alternatives capable of mitigating actual or potential risks at the site. An extensive list of potential technologies representing a range of general response actions (i.e., no action, institutional controls, containment, in-situ treatment, collection, ex-situ treatment, treatment, and disposal) was considered to develop the remedial alternatives. This process is consistent with USEPA guidance.

2.5.1 Technology Identification

Categories of remedial technologies and specific process options were identified based on a review of literature, vendor information, performance data, and experience in developing other FSs under CERCLA. Process options considered potentially applicable to attaining the remedial response objectives were selected for screening.

2.5.2 Technology Screening

The technology screening process reduces the number of potentially applicable technologies and process options by evaluating factors that may influence process-option effectiveness and implementability. This overall screening is consistent with guidance for performing FSs under CERCLA (USEPA, 1988b).

The screening process assesses each technology or process option for its effectiveness and implementability with regard to site-specific conditions, known and suspected contaminants, and affected environmental media. The effectiveness evaluation focuses on: (1) whether the technology is capable of handling the estimated areas or volumes of media and meeting the

contaminant reduction goals identified in the remedial action objectives; (2) the effectiveness of the technology in protecting human health and the environment during the construction and implementation phase; and (3) how proven and reliable the technology is with respect to contaminants and conditions at the Site. Implementability encompasses both the technical and administrative feasibility of implementing a technology.

Waste-limiting characteristics primarily establish the effectiveness and performance of a technology; site-limiting characteristics affect implementability of a technology. Waste-limiting characteristics consider the suitability of a technology based on contaminant types, individual compound properties (e.g., volatility, solubility, specific gravity, adsorption potential, and biodegradability), and interactions that may occur between mixtures of compounds (e.g., chemical reactions or increased solubility). Site-limiting characteristics consider the effect of site-specific physical features on the implementability of a technology, including topography, buildings, underground utilities, available space, and proximity to sensitive operations. Technology screening based on waste- and site-limiting characteristics serves a twofold purpose of screening out technologies whose applicability is limited by site-specific waste or site considerations, while retaining as many potentially applicable technologies as possible. At this stage in the process, relative costs are considered to eliminate technologies that are substantially less cost-effective.

Tables 2.5-1, 2.5-2, and 2.5-3 show the technology screening process for soil, sediment, and seeps, respectively. Technologies and process options judged ineffective or not implementable were eliminated from further consideration. The technologies retained following screening represent an inventory of technologies considered most suitable for remediation of soil, sediment, and groundwater seeps at the site. Technologies/process options retained in this subsection may be used either alone or integrated with other technologies to develop remedial alternatives.

It should be noted that the sediment screening identified only one technology as appropriate for sediment remediation. In particular, the screening confirmed that in-situ capping and monitored natural recovery were not suitable based on site conditions. The majority of the Salt Marsh and the southern Goose Pond sediment does not have a sufficient depth of water to allow a one foot cover to accumulate. A cover of that thickness could change much of the Salt Marsh to upland.

3.0 DEVELOPMENT AND SCREENING OF ALTERNATIVES

In this section, alternatives are developed to meet the remedial action objectives presented in Subsection 2.2, using the general response actions identified in Subsection 2.4 either singly or in combination. Developed remedial alternatives then are screened with respect to the criteria of effectiveness, implementability, and cost to meet the requirements of CERCLA and the NCP (40 CFR 300.430(e)(7)).

3.1 ALTERNATIVE SCREENING CRITERIA

The objective of the alternative screening step is to eliminate impractical alternatives or higher cost alternatives (i.e., order of magnitude cost differences) that provide little or no increase in effectiveness or implementability over their lower-cost counterparts. The effectiveness and implementability criteria used for screening the alternatives are discussed below.

Effectiveness. This criterion focuses on the degree to which an alternative reduces toxicity, mobility, or volume through treatment, minimizes residual risks and affords long-term protection, complies with ARARs, minimizes short-term impacts, and how quickly it achieves protection. The NCP indicates that both short- and long-term aspects of effectiveness should be considered. Short-term is considered to be the construction and implementation period, while long-term begins once the remedial action is complete and remedial action objectives have been met (EPA, 1988b, 1989a). Short-term effectiveness considerations include the effects of the alternatives during the construction and implementation period, the alternative's ability to meet remedial action objectives, and the relative time frame required to achieve remedial action objectives. Long-term effectiveness, considers the magnitude of the remaining residual risk because of residual contaminant sources, and the adequacy and reliability of specific technical components and control measures to maintain compliance with remedial action objectives over the life of the remediation. Alternatives that do not provide adequate protection of human health and the environment are eliminated from further consideration as required by the NCP.

Implementability. Each alternative is also evaluated in terms of technical and administrative feasibility. In the assessment of short-term technical feasibility, availability of a technology for construction or mobilization and operation, as well as compliance with action-specific ARARs during the remedial action, are considered. Long-term technical feasibility considers the ease of

operation and maintenance, technical reliability, the ease of undertaking additional remedial actions, and the degree of monitoring of technical controls for residuals and untreated wastes. Administrative feasibility for implementing a given technology addresses the ability to obtain approvals from pertinent offices and agencies for off-site activities, the availability of treatment storage and disposal services, and the commercial availability of required services and trained specialists or operators. Alternatives that are technically or administratively infeasible or that would require equipment, specialists, or facilities that are not available within a reasonable period of time may be eliminated from further consideration (NCP, 40 CFR 300.430(e)(7)).

Costs. This criterion considers the costs of construction and any long-term costs to operate and maintain the alternatives. As noted in USEPA guidance, the overall goal of the remedy selection process is to remediate contaminated sites to the maximum extent practicable, which requires a co-equal mandate for remedies to be cost-effective (USEPA, 1996). The NCP thus requires consideration of the use of engineering and institutional controls, as an alternative to treatment, when appropriate. Costs that are grossly excessive compared to the overall effectiveness of alternatives may be considered as one of several factors used to eliminate alternatives. Alternatives providing effectiveness and implementability similar to that of another alternative by employing a similar method of treatment or engineering control, but at greater cost, may also be eliminated (NCP, 40 CFR 300.430(e)(7)).

This section does not formally evaluate costs. Rather, based on knowledge of relative costs, professional judgment is used to identify the relative cost-effectiveness of each alternative. Detailed cost evaluations are presented in Section 4.0 as part of the detailed evaluation of alternatives passing this section's screening.

The No Action Alternative is not evaluated according to the screening criteria; it will pass through screening to be evaluated during the detailed analysis as a baseline for other retained alternatives (USEPA, 1988b).

3.2 IDENTIFICATION AND DESCRIPTION OF ALTERNATIVES

This subsection develops remedial alternatives for source areas and for sediment the Callahan Mine Site. The alternatives consider the residual source that remains at the Site, the hydrogeologic system, affected media, and contaminant type and distribution. In assembling these alternatives,

general response actions and process options chosen to represent the various technology types are combined to form alternatives for the Site as a whole. Alternatives are developed to provide a range of options consistent with USEPA RI/FS guidance (USEPA, 1988b).

To facilitate consideration of several remedial approaches for upland source areas as well as sediment, alternatives are developed and screened separately for source areas and sediment. Retained alternatives will then be combined into alternatives with site-wide applicability for detailed evaluation. Four remedial alternatives (including No Action) are identified to address remedial action objectives for contaminant source areas. These alternatives are listed below.

- Alternative SC1 – No Action
- Alternative SC2 – Capping of Tailings Impoundment; Off-Site Disposal of PCB- and Petroleum-Contaminated Soil; and Subaqueous Disposal of Source Area Material from the Ore Pad, Mine Operations Area, WRP-3, and Residential Use Area Soil in a Confined Aquatic Disposal (CAD) Cell in Former Mine Pit
- Alternative SC3 – Capping of Tailings Impoundment; Off-Site Disposal of PCB- and Petroleum-Contaminated Soil; and Capping of Source Area Material from the Ore Pad, Mine Operations Area, WRP-3, and Residential Use Area Soil
- Alternative SC4 – Collection and Treatment of Tailings Impoundment and WRP-3 Seeps Using a Passive Wetland; Subaqueous Disposal of Source Area Material from the Ore Pad, Mine Operations Area, and Residential Use Area Soil in a Confined Aquatic Disposal (CAD) Cell in Former Mine Pit; and Off-Site Disposal of PCB- and Petroleum-Contaminated Soil

Three remedial alternatives (including No Action) are identified to address remedial action objectives for contaminated sediments. These alternatives are listed below.

- Alternative SED1 – No Action
- Alternative SED2 – Excavation of Salt Marsh and Goose Pond mine waste hot spot sediments and Subaqueous Disposal in the CAD cell in the Former Mine Pit.
- Alternative SED 3 – Excavation of Salt Marsh and Goose Pond and Goose Cove Sediment and Disposal in an upland confined disposal facility

The following subsections describe the alternatives developed for source areas and sediment at the Callahan Mine Site.

Alternative SC1 – No Action

Alternative SC1, the No Action alternative, does not include remedial action components to reduce, control, or eliminate potential risks from exposure to contaminants in source area soil. No action will be taken to reduce leachate generation or the migration of leachate via seeps and groundwater to Goose Pond where it may contribute to surface water exceedances of NRWQC and exceedance of sediment PRGs. Alternative SC1 would not implement an environmental monitoring program to assess long-term changes in contaminant concentrations in soil in order to protect human health and the environment. Alternative SC1 would include statutorily-required five-year reviews.

CERCLA requires that the No Action alternative be evaluated to establish a baseline for comparison to other remedial alternatives. Alternative SC1 will not be evaluated according to screening criteria, and will pass through screening to be evaluated during detailed analysis (USEPA, 1988b).

Alternative SC2 – Capping of Tailings Impoundment; Off-Site Disposal of PCB- and Petroleum-Contaminated Soil; and Subaqueous Disposal of Source Area Material from the Ore Pad, Mine Operations Area, WRP-3, and Residential Use Area Soil in Confined Aquatic Disposal (CAD) Cell in Former Mine Pit

Alternative SC2 includes constructing surface water diversions to reduce the amount of upslope runoff flowing onto and infiltrating the Tailings Impoundment, installation of a low-permeability cover system to contain and isolate the Tailings Impoundment, installation of a horizontal drain system to facilitate the post-cap dewatering of the Tailings Impoundment, and the collection and treatment of the discharge from the horizontal drain system in a constructed wetland; subaqueous disposal of WRP-3, Ore Pad, and Mine Operations Area source material, and residential use area soil exceeding PRGs in a CAD cell in the former mine pit; and off-site disposal of material contaminated with PCBs and petroleum. Additional components include institutional controls, environmental monitoring, and five-year reviews. It is possible that additional measures, including a toe shear key or buttress would be identified during design as a necessary component to stabilize the Tailings Impoundment berm. This alternative would consist of the following key components:

- Predesign Investigations and Studies
- Tailings Impoundment Cover System with surface water diversion and stabilization measures, possibly including a toe shear key or buttress

- Installation of a horizontal drain within the Tailings Impoundment and passive treatment of the horizontal drain system discharge in a constructed wetland
- Excavation and disposal of WRP-3, Ore Pad, and Mine Operations Area source material in a CAD cell in the former mine pit.
- Excavation of soil containing arsenic and lead above the cleanup levels in the residential use area of the Site and disposal in a CAD cell in the former mine pit.
- Excavation and off-site disposal of PCB-contaminated soil exceeding PRGs
- Excavation and off-site disposal of petroleum-contaminated soil commingled with CERCLA waste
- Institutional controls to protect the response actions: including protection of the cover system, surface water diversion, wetland treatment system, CAD cell, and restoration areas.
- Wetland restoration and mitigation, including potential dredging of mine waste from Goose and Dyer Coves and deposition in the CAD cell
- Installation of monitoring wells
- Long-term operation and maintenance
- Environmental monitoring
- Institutional control inspections
- Five-year reviews

The containment of the Tailings Impoundment using a low-permeability cover system and a horizontal drain system will minimize the discharge from the Tailings Impoundment and improve the overall stability of the Tailings Impoundment and Tailings Impoundment berm. These activities will reduce human contact with PCBs, lead, and arsenic above cleanup levels, eliminate the sediment that are contributing to ecological impairment, improve surface water and groundwater quality, and comply with ARARs. The excavation and subaqueous disposal of source material will, in addition to controlling direct exposure risks, reduce leaching and erosion that contribute to exceedances of NRWQC in Goose Pond surface water and exceedances of ecologically protective concentrations in Goose Pond sediments.

Alternative SC3 – Capping of Tailings Impoundment; Off-Site Disposal of PCB- and Petroleum-Contaminated Soil; and Capping of Source Area Material from the Ore Pad, Mine Operations Area, WRP-3, and Residential Use Area Soil

Alternative SC3 includes constructing surface water diversions to reduce the amount of upslope runoff flowing onto and infiltrating the Tailings Impoundment, installation of a low-permeability cover system to contain and isolate the Tailings Impoundment, installation of a horizontal drain system to facilitate the dewatering of the Tailings Impoundment, and the collection and treatment of the discharge from the horizontal drain system in a constructed wetland; disposal of WRP-3, Ore Pad, and Mine Operations Area source material, and residential use area soil exceeding PRGs into an on-site waste cell that would then have a low-permeability cover system installed over the waste; and off-site disposal of material contaminated with PCB and petroleum. Additional components include institutional controls, environmental monitoring, and five-year reviews. It is possible that additional measures, including a toe shear key or buttress, would be identified during design as a necessary component to stabilize the Tailings Impoundment berm. This alternative would consist of the following key components:

- Predesign Investigations and Studies
- Tailings Impoundment Cover System with surface water diversion and stabilization measures, possibly including a toe shear key or buttress
- Installation of a horizontal drain within the Tailings Impoundment and passive treatment of the horizontal drain system discharge in a constructed wetland
- Excavation and disposal of WRP-3, Ore Pad, and Mine Operations Area source material in a waste cell with a low-permeability cover system
- Excavation of soil containing arsenic and lead above the cleanup levels in the residential use area of the Site and disposal in a waste cell with a low-permeability cover system
- Excavation and off-site disposal of PCB-contaminated soil exceeding PRGs
- Excavation and off-site disposal of petroleum-contaminated soil commingled with CERCLA waste
- Institutional controls to protect the response actions: including protection of the cover systems, surface water diversion, wetland treatment system, and restoration areas
- Wetland restoration and mitigation, including potential dredging of mine waste from Goose and Dyer Coves and deposition in the CAD cell
- Installation of monitoring wells
- Long-term operation and maintenance

- Environmental monitoring
- Institutional control inspections
- Five-year reviews

The containment of the Tailings Impoundment using a low-permeability cover system and the horizontal drain system will minimize the discharge from the Tailings Impoundment and improve the overall stability of the Tailings Impoundment and Tailings Impoundment berm. These activities will reduce human contact with PCBs, lead, and arsenic exceeding cleanup levels, eliminate sediment that is contributing to ecological impairment, improve surface water and groundwater quality, and comply with ARARs. The excavation and upland disposal of source material will, in addition to controlling direct exposure risks, reduce leaching and erosion that contribute to exceedances of NRWQC in Goose Pond surface water and exceedances of ecologically protective concentrations in Goose Pond sediments.

Alternative SC4 – Collection and Treatment of Tailings Impoundment and WRP-3 Seeps Using a Passive Wetland; Subaqueous Disposal of Source Area Material from the Ore Pad, Mine Operations Area, and Residential Use Area Soil in a Confined Aquatic Disposal (CAD) Cell in Former Mine Pit; and Off-Site Disposal of PCB- and Petroleum-Contaminated Soil

Alternative SC4 includes constructing surface water diversions to reduce the amount of upslope runoff flowing onto and infiltrating the Tailings Impoundment, collection of the discharge from the Tailings Impoundment and WRP-3 and treatment using a 13-acre constructed wetland; subaqueous disposal of Ore Pad and Mine Operations Area source material, and residential use area soil exceeding PRGs in a CAD cell in the former mine pit; and off-site disposal of material contaminated with PCBs and petroleum. The overall stability of the Tailing Impoundment or Tailings Impoundment berm would not be addressed by the alternative. Additional components include institutional controls, environmental monitoring, and five-year reviews. This alternative would consist of the following key components:

- Predesign Investigations and Studies
- Tailings Impoundment Surface Water Diversion and seep treatment
    - Diversion of upslope surface water
    - Constructed wetland to treat seeps
- Excavation and disposal of Ore Pad and Mine Operations Area source material in the CAD cell

- Excavation and disposal of residential use area surface soil exceeding PRGs in the CAD cell
- Excavation and off-site disposal of PCB-contaminated soil exceeding PRGs
- Excavation and off-site disposal of petroleum-contaminated soil commingled with CERCLA waste
- Institutional controls to prohibit disturbance of the Tailings Impoundment, CAD cell, and other components of the remedy
- Wetland restoration and mitigation, including potential dredging of mine waste from Goose and Dyer Coves and deposition in the CAD cell
- Installation of monitoring wells
- Long-term operation and maintenance
- Environmental monitoring
- Institutional control inspections
- Five-year reviews

The excavation and subaqueous disposal of source material will, in addition to controlling direct exposure risks, reduce leaching and erosion that contribute to exceedances of NRWQC in Goose Pond surface water and exceedances of ecologically protective concentrations in Goose Pond sediments. The collection and treatment of the seeps from WRP#3 and the Tailings Impoundment would also improve water quality and reduce the loading of contamination to the sediments of the salt marsh and Goose Pond.

Alternative SED1 – No Action

Alternative SED1, the No Action alternative, does not include remedial action components to reduce, control, or eliminate potential risks from ecological receptor exposure to contaminants in salt marsh and Goose Pond sediments. Alternative SED1 would not implement an environmental monitoring program to assess long-term changes in contaminant concentrations in sediment the long-term effects on human health and the environment. Alternative SED1 would include statutorily-required five-year reviews.

CERCLA requires that the No Action alternative be evaluated to establish a baseline for comparison to other remedial alternatives. Alternative SED1 will not be evaluated according to screening criteria, and will pass through screening to be evaluated during detailed analysis (USEPA, 1988b).

Alternative SED2 – Excavation of Salt Marsh and Goose Pond Sediment and Subaqueous Disposal in a CAD Cell in Former Mine Pit

Alternative SED2 is based on the excavation of salt marsh and Goose Pond sediments exceeding PRGs for subaqueous disposal in a CAD cell in the former mine pit. This alternative would consist of the following key components:

- Excavation of salt marsh and Goose Pond sediments exceeding PRGs and disposal in the CAD cell in the former mine pit
- Restoration of excavated salt marsh areas and potential mitigation for wetland impacts, including dredging of mine waste in Goose and Dyer Coves and disposal in the CAD cell
- Institutional controls to prohibit disturbance of the CAD cell and other components of the remedy
- Long-term operation and maintenance
- Institutional control inspections
- Environmental monitoring
- Five-year reviews

This alternative would remove sediments that are acting as a source of ecological impairment or that violate ARARs and contain these sediments in a unit that would prevent future ecological impacts from these sediments.

Alternative SED 3 – Excavation of Salt Marsh and Goose Pond Sediment and Disposal in an upland confined disposal facility

Alternative SED3 is based on the excavation of salt marsh and Goose Pond sediments exceeding PRGs and placement in an on-site upland confined disposal facility. This alternative would consist of the following key components:

- Excavation of salt marsh and Goose Pond sediments exceeding PRGs and placement in an on-site upland confined disposal facility
- Restoration of excavated salt marsh areas and potential mitigation for wetland impacts, including dredging of mine waste in Goose and Dyer Coves and disposal in the CAD cell
- Institutional controls to prohibit disturbance of the confined disposal facility cover system and other components of the remedy
- Long-term operation and maintenance
- Institutional control inspections
- Environmental monitoring
- Five-year reviews

This alternative would remove sediments that are acting as a source of ecological impairment or that violate ARARs and contain these sediments in a unit that would prevent future ecological impacts from these sediments.

3.3 SCREENING OF ALTERNATIVES

Tables 3.3-1 through 3.3-5 present the screening of source control and sediment alternatives. Alternatives SC1 and SED1, the no action alternatives, were not included in the screening step and passed through to the detailed evaluation, consistent with CERCLA and USEPA guidance. The following table summarizes the results of the screening.

Summary of Alternative Screening		
Alternative	**Eliminated**	**Retained**
SC2		X
SC3		X
SC4	X	
SED2		X
SED3	X	

4.0 DETAILED ANALYSIS OF ALTERNATIVES

This section presents the detailed analyses of remedial action alternatives for OU 1 source areas, salt marsh, sediment, and use area soil at the Callahan Mine Superfund Site. The detailed analysis is intended to provide decision makers information on specific statutory requirements for remedial actions that must be addressed in the ROD (USEPA, 1988b). Remedial actions must:

- protect human health and the environment
- attain ARARs (or provide grounds for invoking a waiver)
- utilize permanent solutions and alternative treatment technologies or resource-recovery technologies to the maximum extent practicable
- satisfy the preference for treatment that reduces toxicity, mobility, or volume of hazardous substances as a principal element or provide an explanation why it does not
- be cost-effective

The detailed analysis was performed in accordance with CERCLA Section 121, the NCP (USEPA, 1990), and USEPA RI/FS guidance (USEPA, 1988b). The detailed analysis contains the following items:

- a detailed description of each remedial alternative, emphasizing the application of various component technologies
- an assessment of each alternative compared to the first seven of the nine evaluation criteria described in the NCP (USEPA, 1990)

The detailed description of technologies or processes used for each alternative includes, where appropriate, preliminary site layouts and a discussion of limitations, assumptions, and uncertainties for each component. The alternative descriptions provide a conceptual design of each alternative and are intended for alternative-comparison and cost-estimation purposes only.

Remedial alternatives are evaluated according to the first seven of nine NCP evaluation criteria (USEPA, 1988b). The following definitions of the nine NCP evaluation criteria are based on USEPA RI/FS guidance (USEPA, 1988b).

Overall Protection of Human Health and the Environment. This criterion assesses how well an alternative, as a whole, achieves and maintains protection of human health and the environment.

Compliance with ARARs. This criterion assesses how the alternative complies with location-, chemical-, and action-specific ARARs, and whether a waiver is required or justified.

Long-Term Effectiveness and Permanence. This criterion evaluates the effectiveness of the alternative in protecting human health and the environment after response objectives have been met. This criterion includes consideration of the magnitude of residual risks and the adequacy and reliability of controls.

Reduction of Toxicity, Mobility, and Volume through Treatment. This criterion evaluates the anticipated effectiveness of treatment processes used to reduce toxicity, mobility, and volume of hazardous substances. It also considers the degree to which treatment is irreversible, and the type and quantity of residuals remaining after treatment.

Short-Term Effectiveness. This criterion examines the effects of the alternative on human health and the environment during the construction and implementation of a remedy until response objectives have been met. This criterion also evaluates the time frame required to achieve protectiveness.

Implementability. This criterion assesses the technical and administrative feasibility of an alternative and availability of required goods and services. Technical feasibility considers the ability to construct and operate a technology and its reliability, the ease of undertaking additional remedial actions, and the ability to monitor the effectiveness of a remedy. Administrative feasibility considers the ability to obtain approvals from other parties or agencies for off-site activities and the extent of required coordination with other parties or agencies.

Cost. This criterion evaluates the capital, and operation and maintenance costs of each alternative. Present worth estimates are presented to help compare costs among alternatives.

State Acceptance. This criterion considers the state's preferences among, or concerns about, the alternatives, including comments on ARARs or the proposed use of waivers. This criterion is addressed following state inputs on the FS and Proposed Plan.

Community Acceptance. This criterion considers the community's preferences or concerns about the alternatives. This criterion is addressed following community inputs on the FS and Proposed Plan.

The detailed analysis of each alternative includes an estimate of the time necessary for completion of the alternative (i.e., remedial duration) and a cost estimate.

Costs are presented as a present worth and as a total cost based on the estimated duration of each the alternatives. Tables presenting a summary of the costs for each alternative and identifying capital, operation and maintenance, total, and present worth are included in each alternative's cost description.

The cost estimates are based on the best available information regarding the anticipated scope of the remedial alternative. Assumptions used to develop and cost alternatives, however, may or may not remain valid during alternative implementation. For example, new information and data collected during the engineering design of the remedial alternative may change the scope of remedial actions, and assumptions associated with long-term monitoring, such as the number and location of monitoring wells, may change with time in response to recommendations in monitoring reports and five-year reviews. This FS provides assumptions regarding the scope of the Long-Term Monitoring Plan (LTMP) for purposes of detailed analysis and cost estimation. This and other cost uncertainties are discussed in the text. Costs are intended to be within the target accuracy range of minus 30 to plus 50 percent of actual cost (USEPA, 1988b).

Each cost estimate includes a present worth analysis to evaluate expenditures that occur over different time periods. The analysis discounts future costs to a present worth and allows the cost of remedial alternatives to be compared on an equal basis. Present worth represents the amount of money that, if invested now and disbursed as needed, would be sufficient to cover costs associated with the remedial action over its planned life. Consistent with USEPA policy present worth was calculated using a real discount rate of 7 percent for 30 years. For comparison purposes, present worth was also calculated using a real discount rate of 2.7 percent (OMB Circular A-94, App. C [Revised Dec. 2008]) for 100 years.

Each cost estimate includes the following items, as applicable:

- engineering design at a percentage of direct capital costs
- project and construction management, including health and safety, legal, and administrative fees, at a percentage of direct capital costs
- a contingency to account for unforeseen project complexities such as adverse weather, the need for additional and unexpected site characterization, and increased construction standby times at a percentage of direct capital costs

Details and assumptions pertaining to the cost estimates are also included in each alternative's cost description. Detailed cost spreadsheets are contained in Appendix G.

In addition to the No Action alternatives, two source control alternatives and one sediment remedial alternative were retained in Section 3.0. These source control and sediment alternatives have been combined into three alternatives designated Alternatives CMS1 through CMS3 in which the components of the retained sediment alternatives are combined with the components of source control alternatives. To streamline the detailed evaluation, the combinations have been limited in number and represent three basic remedial approaches: No Action for source control or sediment; capping of tailings and use of a CAD unit for sediments and waste rock; and capping of tailings and a separate cap for waste rock with use of a CAD unit only for sediments. The no action alternatives for source control and sediment, SC1 and SED1, respectively, are combined into a single no action alternative, CMS1. The pairings are summarized below:

Pairing of Source Control and Sediment Alternatives		
Combined Alternative	**Source Control Component**	**Sediment Component**
CMS1	SC1	SED1
CMS2	SC2	SED2
CMS3	SC3	SED2

The combined alternatives are listed below and evaluated in Subsections 4.1 through 4.3.

- Alternative CMS1 – No Action (except for Five-Year Reviews)
- 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 Former Mine Pit

- Alternative CMS3 – Capping of Tailings Impoundment; Off-Site Disposal of PCB- and Petroleum-Contaminated Soil; Capping of Source Area Material (from the Ore Pad, Mine Operations Area, WRP-3) and Residential Use Area Soil; and Subaqueous Disposal of Sediment in a Confined Aquatic Disposal (CAD) Cell in Former Mine Pit

4.1 EVALUATION OF ALTERNATIVE CMS1 – NO ACTION

Alternative CMS1, the No Action alternative, was retained as a baseline with which to compare the other alternatives, as required by the NCP. This alternative would not include remedial action components to reduce the contribution of site source areas to groundwater, surface water, or sediment contamination. No action would be taken to reduce, control, or eliminate direct exposure risks to residents of seasonal properties along Old Mine Lane. No action would be taken to reduce, eliminate, or control risks to ecological receptors in Goose Pond or salt marsh areas. Alternative CMS1 would not protect potential future site residents by implementing institutional controls to prohibit potable use of site groundwater and residential development of the Site. The alternative includes statutorily required Five-Year Reviews. The following assessment of the No Action alternative is based on the first seven evaluation criteria of the NCP.

4.1.1 Overall Protection of Human Health and the Environment

For OU 1, the areas that represent a current human-health threat are the areas of current residential use with elevated concentrations of arsenic and lead and the areas of current recreational use with elevated concentrations of PCBs. All other areas of potential human-health risk (groundwater and future residential and recreational exposure to on-site soil) will be addressed in OU 2. Alternative CMS1 would not protect human health from exposure to PCB contamination above the site-specific PRGs. Alternative CMS1 would not protect human health in the in the areas of current residential use from arsenic and lead contamination above the site-specific PRGs. Therefore, Alternative CMS1 would not be protective of human health under current and potential future land-use conditions for those response areas identified within OU 1.

Alternative CMS1 would not reduce, control, or eliminate contaminant source areas that contribute to exceedances of NRWQC in Goose Pond surface water or that contribute to salt marsh and sediment contamination that exceeds protective concentrations. Alternative CMS1 would also not

eliminate the sediments that are causing ecological impacts. Therefore, Alternative CMS1 is not considered protective of the environment.

4.1.2 Compliance with Applicable or Relevant and Appropriate Requirements

Alternative CMS1 would not attain protective concentrations for arsenic, lead, and PCBs in soil based on the chemical-specific ARARs and TBCs identified in Table 4.1-1.

Because no action is proposed, neither location-specific nor action-specific ARARs would be triggered by this alternative.

4.1.3 Long-Term Effectiveness and Permanence

Alternative CMS1 would not provide controls to reduce, control, or eliminate contaminant source areas. Further, inorganic contaminants at the Site are not expected to naturally degrade. This alternative would not improve the stability FOSs for the Tailings Impoundment and WRP-3. Alternative CMS1 would not provide long-term effectiveness or permanence for protection of human health or the environment.

4.1.4 Reduction of Toxicity, Mobility, and Volume through Treatment

The No Action alternative would not provide active removal, treatment, or control processes to address source areas; therefore, the alternative would not satisfy CERCLA's statutory preference for treatment as a principal component of remedial action.

4.1.5 Short-Term Effectiveness

Alternative CMS1 does not result in short-term impacts. Therefore, Alternative CMS1 would not provide good short-term effectiveness.

4.1.6 Implementability

Because Alternative CMS1 does not propose remedial action, there would be no technical difficulties associated with implementation. Five-Year Reviews would be easily implemented.

The No Action alternative would not limit or interfere with the ability to perform future remedial actions.

4.1.7 Cost

There is no cost associated with the No Action alternative except for the cost of Five-Year Reviews, because no remedial actions would be performed. Table 4.1-2 presents a summary of the estimated present worth and total non-discounted costs to implement Alternative CMS1. The present worth represents the amount of money that, if invested now and disbursed as needed, would be sufficient to cover costs associated with the remedial action over its planned life, whereas the total non-discounted costs estimate assumes that all costs are paid as they accrue. Both present worth and total costs estimates include direct and indirect capital costs; annual costs such as operation and maintenance, quarterly monitoring, and annual reporting; and periodic costs such as five-year reviews.

The present worth for Alternative CMS1 based on a 7 percent discount rate and a 30-year duration is estimated to be $1919,000. For informational purposes, Table 4.1-2 also contains a present worth based on a 2.7 percent discount rate and a 100-year duration and total non-discounted cost estimate based on cash outlays for 100 years. The estimated 100-year present worth is $56,000 and the 100-year total non-discounted cost is $171,000. Appendix G contains additional cost assumptions and a detailed cost estimate for this alternative.

4.2 EVALUATION OF 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 FORMER MINE PIT

This subsection describes Alternative CMS2, provides a cost estimate, and evaluates the alternative using the first seven evaluation criteria of the NCP.

Alternative CMS2 includes: constructing surface water diversions to reduce the amount of upslope runoff flowing onto and infiltrating the Tailings Impoundment; installation of a low-permeability cover system to contain and isolate the Tailings Impoundment; installation of a horizontal drain to facilitate the dewatering of the Tailings Impoundment and the collection and treatment of the

discharge from the horizontal drain in a constructed wetland; subaqueous disposal of WRP-3, Ore Pad, and Mine Operations Area source material, and residential use area soil exceeding preliminary remediation goals (PRGs) in a CAD cell in the former mine pit; and off-site disposal of material contaminated with PCBs and waste commingled with petroleum. It is possible that additional measures, including a toe shear key or buttress will be identified during design as a necessary component to stabilize the Tailings Impoundment. Alternative CMS2 also includes the dredging and subaqueous disposal of sediments exceeding PRGs in southern Goose Pond and the adjacent salt marsh in a CAD cell in the former mine pit. Dyer Cove and Goose Cove sediments that contain mine waste may also be dredged and disposed in the CAD cell in the former mine pit as part of site restoration and wetland mitigation activities. Additional components include institutional controls to prevent disturbance to the components of the remedy, environmental monitoring, and five-year reviews to control potential human-health and ecological risks due to exposure to contaminated waste material.

This alternative would consist of the following key components:

- Predesign Investigations and Studies
- Tailings Impoundment Cover System with surface water diversion and stabilization measures, possibly including a toe shear key or buttress
- Installation of a horizontal drain within the Tailings Impoundment and passive treatment of the horizontal drain system discharge in a constructed wetland
- Excavation and subaqueous disposal of WRP-3, Ore Pad, and Mine Operations Area source material in a CAD cell in the former mine pit
- Excavation of soil containing arsenic and lead above the cleanup levels in the residential use area of the Site and subaqueous disposal in a CAD cell in the former mine pit
- Excavation and off-site disposal of PCB-contaminated soil exceeding PRGs
- Excavation and off-site disposal of petroleum-contaminated soil/waste commingled with CERCLA waste
- Dredging of Goose Pond, and salt marsh sediment and subaqueous disposal in the CAD cell in the former mine pit
- Establishment of institutional controls to protect the components of the remedy (including caps, treatment wetlands, monitoring well, and the CAD cell)
- Wetland restoration and mitigation, which may include dredging and subaqueous disposal in the CAD cell of mine waste located in Goose Cove and Dyer Cove;

- Installation of monitoring wells
- Long-term operation and maintenance
- Environmental monitoring
- Institutional control inspections
- Five-year reviews

Figure 4.2-1 is an alternative remedy map showing the major construction components of this alternative.

Predesign Investigations and Studies. Predesign studies would consist of the following items:

- Topographic survey;
- Pre-excavation sampling to refine estimates of the extent of PCB contamination exceeding 1 mg/kg and exceeding 50 mg/kg at the Mine Operations Area. The pre-design program would include an in-situ sampling program to delineate the over 1 ppm and over 50 ppm areas;
- Pre-excavation sampling to refine estimates of the extent of DRO/GRO contamination at the Mine Operations Area;
- Pre-dredge sampling to refine estimates of the extent of sediment contamination exceeding PRGs;
- Geotechnical pre-design investigation(s);
- Borings within the Tailings Impoundment to characterize physical properties and spatial variability of tailings in cut/fill areas (excavations, construction traffic, settlement, dewatering, *etc*.);
- Borings along and adjacent to the toe of the Tailings Impoundment berm to characterize physical properties and spatial variability of estuarine deposits and native clay soils (long-term and short-term global stability evaluations, design of toe improvements, *etc*.);
- Borings along and adjacent to the toe of WRP-3 to characterize estuarine deposits and native clay soils (short-term global stability evaluation, construction-related issues, *etc*.);
- Predesign of treatment wetlands;
- An assessment of wetland mitigation requirements and design options; and
- Final delineation of areas of wetland to be impacted and establishment of functional objectives and baseline monitoring for wetland restoration.

A topographic survey would be performed for the Tailings Impoundment surface and upslope area to the west for use in designing surface runoff diversions/controls and treatment wetlands.

Pre-excavation sampling would be performed to refine estimates of the extent of PCB and DRO/GRO contamination at the Mine Operations Area to facilitate planning of excavation and disposal. Pre-dredge sampling would be performed to better refine estimates of the extent of sediment contamination exceeding PRGs for use in planning and directing dredge operations.

Tailings Impoundment Cover System and Stabilization Measures. Alternative CMS2 would include regrading the tailings surface and berm to reduce modeled instability beneath and immediately behind the berm that could contribute to berm failure, and installing a low-permeability cover system. Additional measures, including a shear key or buttress could be included if determined necessary during the design. The cover system would include surface water diversions along its western edge to reduce the amount of upslope runoff potentially infiltrating under the edge of the cover system and infiltrating the Tailings Impoundment. The existing access road along the toe of the Tailings Impoundment berm would be retained and connected with the WRP-3 Haul Road after removal of WRP-3 to provide construction, maintenance, and long-term inspection/monitoring access to the area along the toe of the Tailings Impoundment berm.

The re-contoured surface would be capped with a low-permeability cover system to minimize infiltration/recharge and prevent human and ecological receptor contact with exposed tailings. For cost estimating purposes this FS assumes that the cover system would consist of, from bottom to top, a cushion layer of regraded tailings or ½-inch minus crushed stone, a 40-mil geomembrane, a geocomposite drainage layer, and approximately 15 inches of crushed stone. Figure 4.2-2 shows conceptual ground surface contours, and Figure 4.2-3 depicts a conceptual east-west cross-section through the Tailings Impoundment, and Figure 4.2-4 shows a conceptual detail of cap construction. The design would determine the actual cap design and thickness of the membrane most appropriate for a stone cover. Also, a geosynthetic cushion may be needed to protect the geomembrane. The crushed stone would be obtained on Site by quarrying rock from the area west of the Ore Pad Haul Road and crushing it. This on-site quarrying and crushing approach was chosen to minimize the amount of heavy-truck traffic bringing material onto the site over the narrow and twisting local roads. The estimated volume of required crushed stone is 53,400 cubic yards; therefore, on-site quarrying would eliminate the equivalent of 3,814 14-cubic yard dump truck loads. To eliminate

the need to import large volumes of soil/loam for a vegetative layer on the cover system, a vegetative layer is not proposed, further minimizing truck traffic.

For this remedial alternative, the estimated long-term static FOS is on the order of 1.4 (sliding block) to 1.5 (rotational). The pseudo-static FOS are estimated to be 1.15 (sliding block) to 1.25 (rotational). The global stability evaluations indicate similar FOS for both the southern cross-section and the centerline cross-section. Details, assumptions, and SLOPE/W output files from the slope stability evaluation of this alternative are provided in Appendix D. Several cut/fill scenarios were evaluated for their ability to adequately shed water and at the same time attain static slope stability goal of a 1.5 FOS. This goal was not attained with modest cut/fill scenarios, leading to the crest-bench described below.

- The impoundment crest would be cut back significantly to create a bench, beginning at elevation 60.0 feet.
- The bench surface would extend into the impoundment horizontally for approximately 10 feet and then slope downward at a 33H:1V slope for approximately another 100 linear feet before rising at a 5H:1V slope to the new/re-graded crest, located about 250 feet inward from the former crest location.
- Excavated materials would be placed as subgrade fill across the western half of the impoundment.

Preliminary design efforts indicate that surface slopes of five percent or greater can be maintained to facilitate surface drainage. It should be noted that recontouring the Tailings Impoundment surface would involve excavating materials that may be difficult to work with and that could present short-term construction and stability issues. The cut-fill balance for the conceptual grading design is a 1,700-cubic yard net cut. On-site materials (i.e., excavated use area soil and/or source material from the Ore Pad or Mine Operations Area) would be used to the extent practical to satisfy this fill requirement.

If the design concludes that an acceptable FOS cannot be achieved through installation of the cover system, grading, and the horizontal drain system, then additional measures will be considered to stabilize the Tailings Impoundment berm. A toe shear key and/or toe buttress along the toe of the Tailings Impoundment berm are the most likely additional measures, although other approaches may also be identified as feasible during design. The cover system would be revised if toe

stabilization measures are included in the design. The alternative cover design, based on the inclusion of a buttress or toe shear key, would be configured as described below.

- The impoundment crest would be re-graded/cut back at a 10H:1V slope, beginning at approximately elevation 62.5 feet.
- Excavated materials would be placed as subgrade fill across the western three-quarters of the impoundment.
- An approximately 10-foot wide toe shear key extending from the existing ground surface down to bedrock would be constructed along the toe of the impoundment. For cost estimating purposes, the shear key is assumed to be constructed via shallow soil mixing (wet method and addition of 12 percent cement by total weight) with a 10-foot diameter auger and columns spaced approximately 8 feet on center. A final/cured undrained shear strength, Su, of 7,500 pounds per square foot was assumed based on discussions with a specialty geo-construction contractor.

An approximately 15-foot tall by 30-foot wide toe buttress would also be constructed along the toe of the impoundment, atop the toe shear key. The buttress was assumed to be constructed of compacted granular fill only (i.e., no geogrid reinforcement). The buttress would likely be constructed with processed stone quarried on Site from the area west of the Ore Pad Haul Road. The estimated volume of stone required (before compaction) is approximately 37,500 cubic yards. Figures 4.2-5, 4.2-6, and 4.2-7 depict conceptual Tailings Impoundment surface grading, Tailings Impoundment surface cross-section, and toe shear key cross section, respectively, for this alternative design approach.

With a low-permeability cover system to reduce infiltration, the seepage of contaminated groundwater along the toe of the Tailings Impoundment berm is expected to decrease as groundwater within the Tailings Impoundment slowly drains. To further reduce adverse impacts on Goose Pond surface water and salt marsh areas, a horizontal drain system would be installed, running south to north, within the tailings just above the clay/till layer, and near the eastern edge of the Tailings Impoundment to capture water draining from the tailings. The drain would provide several benefits compared to capture in the ditch at the toe of the berm: reducing the estimated time needed to dewater near the Tailings Impoundment by about a third, improving capture of tailings drainage, and reducing capture of runoff and the amount of water requiring subsequent treatment. (Use of the drainage ditch at the toe of the berm would result in capture of runoff as well as seepage flow.) Based on the modeling discussed in Subsection 1.4.4, the drainage rate is estimated to be 0.92 gallons per minute (gpm) per 10-foot section at day 1. The flow drops rapidly to 0.33 gpm per 10-foot section at 30 days, and continues to decrease after that.

A passive treatment system using an anaerobic wetlands system would be used to treat the water from the horizontal drain. In light of the expected decrease in estimated flow, three scenarios were evaluated to assess required treatment wetland area. The first scenario was based on a flow of 0.92 gpm per 10-foot section and a design area of 28.8 square meters per liter per minute of flow (Higgins, 2003), the second scenario was based on a flow of 0.92 gpm per 10-foot section and a design area of 15 square meters per liter per minute of flow (Todd and Reddick, 1997), and the third was based on a flow of 0.33 gpm per 10-foot section and a design area of 28.8 square meters per liter per minute of flow. Assuming a 900-foot drain, the required wetland area is 9,026 square meters (2.3 acres) for the first scenario, 4,700 square meters (1.2 acres) for the second scenario, and 3,238 square meters (0.8 acres) for the third scenario. For cost estimating purposes, this FS assumes the second scenario and 1.2 acres of treatment wetland. During the design phase, required treatment areas based on groundwater/seep should be investigated and compared to required areas based on hydraulic loading. A pilot-scale treatability test is strongly recommended during the design phase to develop site-specific loading rates (Higgins, 2003) and refine flow estimates. Up to approximately one acre appears available northeast of the Tailings Impoundment while perhaps two acres are available within the property boundary at the southeast corner. Use of either area would require clearing and excavating of land, some of which is existing wetland. Some use of off-site property may be required. Figure 4.2-8 shows a cross-section schematic of wetland construction.

The existing access road along the toe of the Tailings Impoundment berm would be retained and connected with the WRP-3 Haul Road after removal of WRP-3 to provide construction, maintenance, and long-term inspection/monitoring access to the area along the toe of the Tailings Impoundment berm.

Excavation and Subaqueous Disposal of WRP-3, Ore Pad, and Mine Operations Area Source Material in the CAD Cell in the former mine pit. Source material for groundwater contamination and surface runoff contamination with metals at WRP-3 (including portions of the WRP-3 Haul Road), Ore Pad, and Mine Operations Area would be excavated for subaqueous disposal in the CAD cell in the former mine pit. Horizontal boundaries for the excavation would be delineated based on interpretation of RI data as to the areas with the greatest potential to contribute to groundwater and surface water contamination (see Figure 2.4-15). In addition, for cost estimating purposes this FS assumes a 200-foot-wide strip at the western edge of WRP-2

between the Ore Pad and the Mine Operations Area is also excavated. The vertical limit of excavation would be based the PRGs for cleanup of the recreational use area of the Site. The use of these PRGs will ensure that these areas would not require further remediation under OU 2. Excavation would be performed with conventional earth moving equipment. Excavated material would be transported to the mine pit by a combination of trucks and a floating conveyor system to deliver material to the approximate center of the pit. Figure 2.4-1 shows the areas identified for excavation. If fill material is needed under the Tailings Impoundment cap, some material designated for disposal in the mine pit may be used under the cap.

Disposing of excavated material from the WRP-3, Ore Pad, and Mine Operations Area on Site in lieu of off Site would greatly reduce the amount of heavy-truck traffic on local roads. The excavated volume of these three areas (including portions of WRP-2 and the WRP-3 Haul Road) after accounting for 33 percent "swell" during excavation is estimated to be 434,000 cubic yards. Off-site disposal of this volume of material would require approximately 31,000 14-cubic yard dump truck loads.

Information gathered during the RI (Woods Hole Group, 2006; USGS, 2007) identified a mixing boundary within the 300-foot deep mine pit about 30 feet below mean sea level. Water below this boundary does not mix with the upper waters of Goose Pond. Source material placed below this boundary would not be expected to contaminate surface water in the remainder of Goose Pond. The following table shows the estimated pit volume for various fill depths. As can be seen, there is sufficient volume in the mine pit to hold up to 1,300,000 cubic yards of source material and dredged sediment without filling above the mixing boundary.

Volume of CAD Cell (Former Mine Pit) at Various Fill Depths

Depth below MSL (ft)	Depth of Fill in Pit (ft)	Volume Fill (cy)		Depth below MSL (ft)	Depth of Fill in Pit (ft)	Volume Fill (cy)
30	270	1,362,000		140	160	356,000
40	260	1,223,000		150	150	305,000
60	240	982,000		160	140	258,000
80	220	777,000		170	130	216,000
100	200	608,000		180	120	178,000
120	180	471,000		300	0	0
130	170	411,000				

Volume of CAD Cell (Former Mine Pit) at Various Fill Depths

Notes:
Volumes calculated using AutoCAD and bathymetric data from TRC (2005).
MSL= mean sea level
ft = feet
cy = cubic yards

Excavation of Residential Use Areas of the Site and Subaqueous Disposal in the CAD Cell. Surface soil exceeding the PRGs (see Table 2.2-3) within the residential use area of the Site would be excavated to a depth at which PRG exceedances no longer occur, and disposed of in a CAD cell in the former mine pit. In light of the many bedrock outcrops in the area, this FS assumes excavation to 2 feet for cost estimation purposes. The estimated volume is listed in Table 2.4-3. Excavated lawn areas would be backfilled with clean borrow and topsoil, fertilized, and seeded. Driveways and roadways would be backfilled with clean gravel. Figure 2.4-6 shows the approximate extent of excavation based on RI data and site observation of the location of buildings and bedrock outcrops. If fill material is needed under the Tailings Impoundment cap, some material designated for disposal in the CAD cell may be used under the cap. At the completion of the remediation, the area will be available for unrestricted residential use based on the lack of any CERCLA risk from either soil or groundwater contamination.

Excavation and Off-Site Disposal of PCB-Contaminated Soil. Soil with PCBs exceeding a concentration of 1 ppm would be excavated and segregated in temporary stockpiles for testing prior to disposal. The pre-design program would include an in-situ sampling program to delineate the over 1 ppm and over 50 ppm areas. Current estimates are that up to 2,197 cubic yards of soil would exceed 1 ppm PCBs, which includes an estimated 220 cubic yards of soil with concentrations equal to or greater than 50 ppm. Excavated material with PCB concentrations equal to or greater than 50 ppm would be disposed of in a hazardous waste landfill permitted for PCB disposal (or at a PCB disposal facility approved under 40 CFR Part 761). Excavated material with PCB concentrations above 1 ppm but less than 50 ppm would be disposed of at a facility permitted, licensed, or registered to manage municipal solid waste, non-municipal non-hazardous solid waste, or a permitted hazardous waste landfill or PCB disposal facility. Excavated PCB-contaminated soil will be characterized and shipped in accordance with the requirements of the disposal facility. Excavation of PCB-contaminated soil would occur as part of the larger excavation of the Mine Operations Area and separate backfilling of the PCB excavation is not planned.

Excavation and Off-Site Disposal of Petroleum-Contaminated Soil commingled with CERCLA Waste. Petroleum-contaminated soil with DRO/GRO exceeding the Maine remediation goals (DRO, 10 mg/kg; GRO, 5 mg/kg) for oil-contaminated soil at Stringent Sites and commingled with CERCLA waste would be excavated for off-site disposal. Current estimates are that up to 600 cubic yards of soil contain DRO/GRO above these concentrations. Excavation of oil-contaminated soil would occur as part of the larger excavation of the Mine Operations Area and separate backfilling of the excavation is not planned.

Dredging of Goose Pond and Salt Marsh Sediment and Disposal in the CAD Cell. Goose Pond and salt marsh mine-waste deposits and sediment exceeding the PRGs in Table 2.2-9 and depicted in Figures 2.4-15 and 4.2-1 would be dredged and disposed of in the CAD cell in the former mine pit. Dyer Cove and Goose Cove sediments may also be dredged and disposed in the CAD cell in the former mine pit as part of wetland mitigation activities. This FS assumes the use of a hydraulic dredge that pumps dredged material directly to the mine pit through high-density polyethylene piping. This would eliminate the need for on-shore handling and dewatering. A drop tube would be used to lower the actual discharge point and reduce entrainment of material in the upper portion of the water column. Silt curtains would be placed around the mine pit to reduce potential for turbid water to migrate to other areas of Goose Pond. Proper selection and operation of dredge equipment will help minimize migration of suspended material from the dredge site. In addition, silt curtains will be used as appropriate to minimize migration of suspended material from the area being dredged. Water quality monitoring will be conducted to ensure that water quality standards are maintained during disposal operations.

Dredged material will be placed below the mixing boundary in the mine pit to prevent long-term contamination of surface water in the remainder of Goose Pond. The available data indicate that the mine pit can hold up to 1,300,000 cubic yards of source material and dredged sediment without filling above the mixing boundary. This is more than adequate to hold the estimated 74,000 cubic yards of sediment (not including a potential 27,000 cubic yards from Goose Cove and Dyer Cove) and 329,000 cubic yards of source material and soil identified for disposal in the pit. The estimated volume for material that may be placed in the pit is 440,000 cubic yards, which would fill the pit to an estimated depth of 120 feet below sea level. Figure 4.2-9 shows a cross-section of the CAD cell in the former mine pit and the estimated depth of fill for Alternative CMS2. Disposing of excavated material from Goose Pond and the salt marsh on-site in the CAD cell in lieu of off-site

disposal would reduce the amount of heavy-truck traffic on local roads. Off-site disposal of this volume of material would require approximately 7,200 14-cubic yard dump truck loads.

Backfilling of dredged areas in Goose Pond is not planned. This is primarily because the mine waste has filled Goose Pond and removal would partially re-establish the pre-mine hydrology. Salt marsh areas excavated or disturbed during remedial activities would be restored or otherwise mitigated in accordance with ecological objectives identified during design.

Mitigation of Altered Wetlands. Implementation of Alternative CMS2 would result in alteration of freshwater Wetlands B, C, D, and (potentially) E; coastal wetlands; and subtidal wetlands. Salt marsh areas and freshwater wetlands impacted during remediation activities would be restored as required under applicable federal and/or state standards. Compensatory wetland mitigation objectives and requirements will be identified as part of the design. This subsection discusses potential elements of mitigation, if required.

This alternative would excavate/dredge approximately 6.3 acres of coastal wetlands (salt marsh) containing mine waste and hot spot concentrations of copper, lead, and zinc exceeding PRGs east of the Tailings Impoundment and WRP-3 (see Figure 2.4-15). In addition, this alternative would excavate/dredge approximately 10.6 acres of subtidal wetlands containing mine waste and hot spot concentrations of copper, lead, and zinc exceeding PRGs east of the Tailings Impoundment and WRP-3 (see Figure 2.4-15). Temporal impacts to wetland functions and values as a result of these actions are unavoidable; however, excavated salt marsh would be restored and both salt marsh and subtidal wetlands are expected to recover quickly, and no permanent loss of wetland would occur as a result of these actions.

For planning purposes under this FS, Alternative CMS2 would not include mitigation for alteration of several small wetlands (Wetlands C, D, and E) that appear to have developed in areas that are a direct result of mine operations (i.e., man-made wetlands) (Appendix B). However, the regulatory status of these wetlands and any requirements to conduct mitigation will be reevaluated during remedial design with the input of federal and state regulatory authorities. Figure 4.2-10 identifies state and federal jurisdictional wetlands.

The calculation of impacted wetland area that may require mitigation is shown in the following table.

Potential Wetland Impacts – Alternative CMS2

Activity	Estimated Area (acres)	Estimated Disturbed Area (acres)
Storm Water Pond (s)	0.6	0.7
Treatment Wetlands	1.2	1.5
Area	1.8	2.2

Note: Disturbed area includes berms and access roads. Disturbed area estimated as 120% of required area.

If mitigation is required for construction of storm water detention ponds and treatment wetlands, the following potential elements may be included (Figure 4.2-11):

- Salt marsh restoration could include replacement of excavated material with Stink Cove sediment, historically stockpiled at WRP-1, and could include plantings of salt marsh cordgrass (*Spartina alterniflora*) and saltmeadow cordgrass (*S. pattens).*

- Dyer Cove could be dredged to remove approximately 3.6 acres of mine waste deposits with concentration of copper, lead, and zinc that exceed the ecological PRGs established for Goose Pond. A portion of the area identified for dredging is near the mouth of Dyer Cove and is relatively shallow, and dredging would result in a more uniform and natural bottom profile and better tidal exchange. In addition, plantings could be done to help establish eel grass (*Zostera marina*) beds. If necessary, Stink Cove sediment could be used create bottom condition suitable for establishing the eel grass. These actions would reduce ecological exposure to high concentrations of mine waste constituents and provide a more natural habitat for aquatic and benthic organisms. These actions would enhance the primary functions and values identified for Goose Pond.

- Goose Cove could be dredged to remove approximately 1.5 acres of mine waste deposits with concentrations of copper, lead, and zinc that exceed the ecological PRGs established for Goose Pond. Similar to Dyer Cove, plantings could be done to help establish eel grass beds. These actions would enhance the primary functions and values identified for Goose Cove.

- The channel at the former earthen dam could be widened and deepened to improve tidal exchange above the dam. This would enhance value and function in approximately 32 acres of subtidal and emergent wetland.

The results of the wetland functions and values assessment (see Appendix B) indicated the coastal wetlands (Goose Pond and adjacent salt marsh) principal functions are fish and shell fish habitat and wildlife habitat. In addition, the estuarine salt marsh provides sediment/toxicant retention and sediment/shoreline stabilization. These mitigation actions would have an overall positive effect on these functions and values.

The values of recreation, education/scientific, uniqueness/heritage, and visual quality and aesthetics were not considered suitable and/or principal values for the coastal wetlands delineated on Site. However post remediation and restoration of the Site, it is likely that the coastal wetlands would provide these values. Recreational use of the pond including canoeing, kayaking, wildlife viewing, and visual quality and aesthetics would likely increase and improve post remediation. In addition, study of the restored wetland habitat could provide future education/scientific value.

Institutional Controls to Prohibit Disturbance of Capped Areas, the CAD Cell, and other Components of the Remedy. The former Callahan Mine property portion of the Site is not used for commercial or residential purposes; although recreational use does occur. As part of this alternative, institutional controls would be drafted and implemented to prohibit disturbance of the components of the remedy. Land-use restrictions would be stated in full or by reference within zoning ordinances and/or deeds, easements, covenants, or other instruments of property conveyance. These controls will be drafted, implemented, and enforced in cooperation with the landowner of the Site, as well as state and local government. Institutional controls to prevent disturbance of the CAD cell will need to be established with the State, which is the owner of the subtidal lands in Goose Pond. Other institutional controls would be implemented as part of the OU 2 Early Cleanup Action described in Section 6.0.

Installation of Monitoring Wells. This FS assumes the installation of an overburden/bedrock monitoring well pair east of the site road and approximately mid-way between MW 617R and MW609/MW609R to help monitor groundwater quality downgradient of the source area excavations. Existing monitoring wells damaged during remedial activities will be replaced. This could amount to six monitoring wells (MW-611, MW-613, MW614/MW614R, and MW-615/MW615R) at the Ore Pad and Mine Operations Area, and one at WRP-3 (MW-612). In addition, damaged monitoring wells at the Tailings Impoundment will be replaced.

Long-Term Operation and Maintenance. This alternative would require minimal long-term operation and maintenance. Active operation of remedial facilities would not be required. Anticipated maintenance activities would be expected to include maintenance of the low-permeability cover system at the Tailings Impoundment, maintenance of storm water diversions and drainage structures to prevent/repair erosion damage, possible addition of media to the treatment wetland, possible repair of reconstructed salt marsh, and repair /replacement of damaged

monitoring wells. Any contaminated material that is removed from the treatment wetland will be disposed in the CAD cell in the former mine pit or within the Tailings Impoundment cover system.

Environmental Monitoring. Environmental monitoring would be conducted during the sediment cleanup to evaluate the success of measures design to minimize suspended material that may be deposited outside the CAD cell and to confirm compliance with water quality criteria. Long-term environmental monitoring would also include collection of groundwater, surface water, and sediment samples, samples of influent to and effluent from the constructed wetland, samples of constructed wetland media, and clam tissue from Goose Pond. Groundwater sampling would also be conducted around the capped Tailings Impoundment. Groundwater sampling would include overburden and bedrock monitoring wells and analyses of the samples for parameters agreed to in the LTMP. Groundwater elevation data would be collected at the time of sample collection to allow interpretation of the direction of groundwater flow and contaminant migration. Field parameter measurements for dissolved oxygen, oxidation-reduction potential, pH, temperature, turbidity, and specific conductance would be made prior to sample collection.

Monitoring perimeters for the CAD cell will need to be developed to ensure no contaminants are released to the environment over the long-term.

Details of the monitoring program, including target monitoring wells, analytes, and quality assurance/quality control (QA/QC) protocols, would be specified in an LTMP to be submitted for USEPA and Maine DEP review and approval.

For cost estimating purposes, this FS has assumed the following samples will be collected.

Sampling and Analysis for Alternative CMS2 Long-Term Monitoring

Sampled Media	Number of Locations	Frequency	Analytes
Groundwater			
Years 1 -10	10 wells	Annually	TAL metals (total and dissolved)
Years 15-100	10 wells	Every 5 years	TAL metals (total and dissolved)
Surface Water (Goose Pond)			
Years 1-2	8	Semiannually	TAL metals (total and dissolved), field parameters
Years 3-10	8	Annually	TAL metals (total and dissolved), field parameters

Sampling and Analysis for Alternative CMS2 Long-Term Monitoring

Sampled Media	Number of Locations	Frequency	Analytes
Years 15-100	8	Every 5 years	TAL metals (total and dissolved), field parameters
Sediment			
Years 1-100	8	Every 5 years	TAL metals, AVS/SEM
Clam Tissue			
Years 1-5	4	Years 3, 4, and 5	Lead
Years 10-100	4	Every 5 years	Lead
Constructed Wetland inf/eff			
Year 1	8	Semiannually	TAL metals (total and dissolved), NO2/NO3, SO4, PO4, sulfide, alkalinity, field parameters
Years 2-100	8	Annually	TAL metals (total and dissolved), NO2/NO3, SO4, PO4, sulfide, alkalinity, field parameters
Constructed Wetland Media			
Year 1	8	Semiannually	TAL metals, NO2/NO3, SO4, PO4, sulfide, alkalinity
Years 2-100	8	Annually	TAL metals, NO2/NO3, SO4, PO4, sulfide, alkalinity

Institutional Control Inspections. At a minimum, yearly scheduled inspections would be performed to confirm that land- and water-use restrictions are implemented and adhered to as required to prevent disturbance of the components of the remedy.

An Institutional Control Monitoring Plan would be prepared as part of the site LTMP. The LTMP would detail the water- and land-use restrictions to be incorporated/referenced within instruments of property transfer. The plan would include a checklist of elements to be assessed during regularly scheduled on-site inspections. For cost estimating purposes, it is assumed that the institutional control inspections would be performed once per year.

Five-Year Reviews. Under § 121(c) of CERCLA (42 USC § 9621(c)), any remedial action that results in contaminants remaining on Site at concentrations above those allowing unlimited exposure and unrestricted use must be reviewed at least once every five years. During five-year site reviews, an assessment is made as to whether the implemented remedy continues to be protective of human health and the environment, or whether the implementation of additional remedial action is appropriate. The USEPA document Comprehensive Five-Year Review Guidance (USEPA, 2001) provides guidance on the performance of five-year reviews. The five-year review for this alternative would be considered a statutory review. The five-year period is

typically triggered by the actual remedial action start date at federal facilities (USEPA, 2001). Although the definition of "start date" varies in USEPA guidance, it may correspond to on-site mobilization or to the signature of the ROD, depending on the nature of the selected remedy.

4.2.1 Overall Protection of Human Health and the Environment

For OU 1, the areas that represent a current human-health threat are the areas of current residential use with elevated concentrations of arsenic and lead and the areas of current recreational use with elevated concentrations of PCBs. All other areas of potential human-health risk (groundwater and future residential and recreational exposure to on-site soil) will be addressed in OU 2. Alternative CMS2 would protect human health by removing PCB contamination above the site-specific PRGs and arranging for proper disposal of this material at an off-site facility. After completion of this activity, direct contact and incidental ingestion of PCBs would no longer be an unacceptable threat to human health. Alternative CMS2 would protect human health in the area of current residential use by removing arsenic and lead contamination above the site-specific PRGs and arranging for proper disposal of this material on Site in the CAD cell such that human contact with this material would no longer occur. After completion of this activity, direct contact and incidental ingestion of lead and arsenic would no longer be an unacceptable threat to human health in the adjacent residential use area of the Site, and PCBs would no longer be an unacceptable threat in the former Callahan Mine property portion use area of the Site.

While there is no current human exposure to contaminated groundwater at the Site, the HHRA did identify groundwater as an unacceptable threat under a future use scenario. The long-term remediation of the groundwater is an OU 2 issue; however, the removal of waste material at the Ore Pad will address the most significant source of groundwater contamination and contribute to the overall protection of future users of the groundwater. Therefore, Alternative CMS2 would be protective of human health under current and potential future land-use conditions for those response areas identified within OU 1.

The excavation of Ore Pad, Mine Operations Area, and WRP-3 source material followed by its disposal in the CAD cell in the former mine pit below the mixing depth, would eliminate the contribution of those materials to exceedances of NRWQC in Goose Pond surface water and to salt marsh and sediment contamination that exceeds ecologically protective concentrations. The capping of the Tailings Impoundment combined with surface drainage improvements and a

horizontal drain system with a treatment wetland would reduce the leaching of metals from the tailings. Capping of the Tailings Impoundment and excavation of WRP-3 would also reduce surface water erosion and transport of dissolved and suspended contaminants that contribute to exceedances of NRWQC in Goose Pond surface water, salt marsh, and sediment contamination that exceeds ecologically protective concentrations.

The dredging and disposal of Goose Pond and salt marsh sediments exceeding PRGs in the CAD cell in the former mine pit would protect ecological receptors by eliminating those sediments as a pathway for direct contact and food chain exposure above protective concentrations. Dyer Cove and Goose Cove would only be excavated/dredged if the design identified these measures as part of the wetland mitigation.

CMS2 and CMS3 have identical wetland impacts. Each has been identified as the least damaging practical alternative with respect to impacts on wetlands at the Site.

Alternative CMS2 would be protective of the environment.

In accordance with federal Executive Order 11990, entitled "Protection of Wetlands," USEPA has determined that there may be unavoidable adverse impacts to wetlands and aquatic resources. To the extent that federally regulated wetlands and aquatic resources are located within and adjacent to the Ore Pad, Mine Operations Area, Waste Rock Pile-3, or the Tailings Impoundment, the contaminated portions of Goose Pond and the adjacent Salt Marsh may be removed and/or altered as part of the cleanup actions. Wherever possible, wetland areas will be restored. USEPA has evaluated the requirements of the applicable regulations, including Section 404 of the Clean Water Act and identified the proposed actions as the least damaging practicable alternatives to protect federally regulated wetland and aquatic resources from exposure to contaminated sediments and contaminated surface water. These wetland areas at the Site are shown in Figure 4.2-10.

To ensure the protectiveness of CMS2, institutional controls would be implemented to prevent future use of the Site that would disturb the cap, surface water diversion systems, treatment wetland, and monitoring wells, or disturb the material that will be disposed of in the CAD cell.

4.2.2 Compliance with Applicable or Relevant and Appropriate Requirements

Implementation of Alternative CMS2 would result in the dredging of subtidal sediment and excavation/dredging of salt marsh. The temporary impacts on existing wetlands and aquatic habitats as part of this alternative is considered unavoidable; although, during remedial design the effects of remedial activities on the wetlands and aquatic habitats will be evaluated to minimize damage consistent with Section 404(b) of the Clean Water Act and 06-096 CMR 310. Compensatory habitat mitigation for the construction of storm water ponds and treatment wetlands will be performed if required to comply with these ARARs. To the extent that remedial activities affect protected resource areas, the location-specific ARARs in Table 4.2-1 will apply. It is expected that all such activities can be designed and implemented to comply with all location-specific ARARs identified in Table 4.2-1.

Chemical-specific ARARs and TBCs triggered by Alternative CMS2 are presented in Table 4.2-2. Primary among these are the Maine Solid Waste Regulations, Lead Management Regulations (06-096 CMR 424). These regulations establish a lead safe standard of 375 ppm in bare soil in potential play areas, which would be achieved in the residential use area, but not in other areas of the Site that aren't used residentially. This alternative would attain chemical-specific ARARS and TBCs.

Action-specific ARARs and TBCs that may be triggered by Alternative CMS2 are listed in Table 4.2-3. It is expected that all activities can be designed and implemented to comply with action-specific ARARs, including TSCA regulations for cleanup of PCBs. USEPA has made a finding under the TSCA PCB Regulations at 40 CFR Part 761 (a) and (c), that the cleanup level of 1 ppm established for PCBs at this Site will not pose an unreasonable risk of injury to health or the environment.

Alternative CMS2 would be designed and implemented to attain the performance standards of the Maine Mining regulations at 06-096 CMR Chapter 200, Section 32A.

4.2.3 Long-Term Effectiveness and Permanence

With proper design, construction, and maintenance, the low-permeability cover system of CMS2 would provide long-term effectiveness at minimizing infiltration of precipitation and runoff into

the Tailings Impoundment. In addition, the conceptual regrading plan for the Tailings Impoundment surface improves the FOS of the Tailings Impoundment, providing greater confidence in the long-term effectiveness and permanence of this alternative, compared to existing conditions. If identified as necessary during the design, additional stabilization measures would be implemented to achieve an acceptable FOS. The excavation/removal of WRP-3 addresses long-term stability concerns associated with the FOS for WRP-3.

The excavation of Ore Pad, Mine Operations Area, and WRP-3 source material and dredging of Goose Pond and salt marsh sediments combined with subaqueous disposal of those materials in the CAD cell would provide source control for this waste material that has a high degree of long-term effectiveness and permanence. Excavation of this material would interrupt existing exposure and transport mechanisms. No major long-term adverse effects to groundwater or surface water are expected from as a result of placement of material in the mine pit. Both observations and modeling indicate if the level of disposed material in the CAD cell is maintained more than approximately 30 feet below mean sea level, the material would be isolated from atmospheric oxygen which is a critical component in the generation of acid rock drainage and there would be no transport of this material via erosion. Calculations indicate there is more than enough volume within the CAD cell to accommodate all of the material generated under this alternative without approaching the mixing boundary.

The excavation of arsenic and lead contaminated soil in the residential use portion of the Site and its consolidation and capping on Site at WRP-1 would provide long-term effectiveness and permanence at protecting residents from exposure to contaminated soil exceeding PRGs.

Institutional controls to prevent disturbance of the remedy would provide long-term effectiveness as long as they are adhered to by property owners and enforced by state and local regulatory agencies. Institutional controls are generally considered to provide a lesser degree of protection than engineering controls.

Results of long-term environmental monitoring would be used to assess the effectiveness and permanence of this alternative.

4.2.4 Reduction of Toxicity, Mobility, and Volume through Treatment

Alternative CMS2 will reduce the mobility of contaminants in Tailings Impoundment seeps through treatment in a wetland constructed for that purpose; however, the alternative relies primarily on removal, containment, and isolation to control source areas and reduce exposure. Alternative CMS2 would rely on off-site disposal rather than treatment for the principal threat waste (PCBs) because the vast majority of PCB-contaminated material is below USEPA's guidance levels for treatment for PCBs, and the quantity of PCB materials is too small to warrant consideration of on-site treatment. The major components of CMS2 are source control measures for large volumes of low-level threat wastes, which is consistent with USEPA guidance. CMS2 would achieve some level of reduction in toxicity, mobility, and volume through treatment as a result of the sulfide reduction to immobilize the metals in the treatment wetland.

4.2.5 Short-Term Effectiveness

Short-term effectiveness addresses the period of time needed to achieve protection and any adverse impacts on human health and the environment that may be posed during the construction and implementation period, until cleanup goals are achieved.

The protection of human health and the environment for the areas targeted for remediation under OU 1 would achieve protection upon completion of the cleanup. The time period to implement the cleanup, once design and administrative issues have been addressed, would be 1-4 years. Some potential for seepage discharge from the Tailings Impoundment would exist until the water table within the Tailings Impoundment drops to a level that would results in an insignificant discharge from the seeps. The horizontal drain system will be designed to minimize the uncontrolled discharge from the seeps. The water from the horizontal drain system will be subject to treatment using a passive wetland. Alternative CMS2 would require the excavation and dredging of large volumes of material with heavy construction equipment under potentially adverse conditions. The alternative also would require the quarrying and crushing of on-site rock to produce construction materials. These activities would present a potential risk to construction workers and would result in construction related concerns (e.g., blasting, noise, and dust) to area residents.

To minimize short-term risks to the community and area residents, Alternative CMS2 would minimize the movement of construction equipment on the narrow and twisting roads approaching

the Site. Most construction equipment (e.g., bulldozers, excavators, dredges) would be expected to remain on Site and move on/off Site infrequently. Most excavated/dredged material would be disposed of on Site, with only relatively small volumes of PCB and petroleum-contaminated material planned for off-site transport and disposal. Alternative CMS2 minimizes the importation of large volumes of construction materials by relying on the on-site quarrying and crushing of rock to create crushed stone for construction of the Tailings Impoundment cover. Compared to a scenario in which materials are transported off Site for disposal and crushed stone is imported onto the Site for construction, this alternative would eliminate an estimated 46,000 dump truck loads on local roads (Table 4.2-4). Some increase in traffic would occur, however, as a result of construction and material transport vehicles (e.g., geomembrane and geocomposite for cap construction, and media for treatment wetland) and would create a short-term increase in traffic hazards and potential road impacts in the area. Table 4.2-5 contains an estimate of heavy truck traffic that may occur. To reduce adverse effects along Goose Falls Road near Harborside and on Old Mine Lane, the south entrance to the Site would be opened up and used to extent practical. Dust control measures would be implemented on Site to minimize dust generation and airborne transport of contaminants.

Short-term risks to the environment would include short-term loss of salt marsh habitat as a result of excavation activities. Dredging would cause short-term impacts to sediment habitat and the benthic community in Goose Pond. In addition, dredging of Goose Pond and disposal of dredged material and of source material in the CAD cell may result in temporary impacts to Goose Pond water quality, although a robust water quality monitoring plan should allow for the maintenance of water quality throughout the disposal period. Dyer Cove and Goose Cove would only be excavated/dredged if the design identified these measures as part of the wetland mitigation. The quarrying of on-site rock would destroy a small area of existing upland habitat in the vicinity of the Ore Pad Haul Road. Because of the poor quality of upland habitat, excavation of source material would not result in significant habitat disruption or short-term risks.

4.2.6 Implementability

The key components of Alternative CMS2 are implementable using conventional and readily available construction equipment. Some specialized equipment may be needed to dispose of contaminated material into the CAD cell. Operation of the treatment wetland is readily implementable, but will involve regular monitoring and periodic removal of contaminated media.

The groundwater characterization and environmental monitoring needed to assess the effectiveness of this alternative are routine environmental activities and many qualified firms are available to perform them. Implementation of this alternative would not interfere with the ability to implement additional remedial actions in the future if they became necessary.

Administrative implementability is expected to be good. Close communication and coordination with the landowners (including the State of Maine as the landowner of all subtidal lands) environmental protection and natural resource agencies (e.g., Maine DEP, Maine Department of Marine Resources, USEPA, U.S. Fish and Wildlife Service) and U.S. Army Corps of Engineers would be necessary to establish institutional controls.

4.2.7 Cost

Table 4.2-6 presents a summary of the estimated present worth and total non-discounted costs to implement Alternative CMS2. The present worth represents the amount of money that, if invested now and disbursed as needed, would be sufficient to cover costs associated with the remedial action over its planned life, whereas the total non-discounted costs estimate assumes that all costs are paid as they accrue. Both present worth and total costs estimates include direct and indirect capital costs; annual costs such as operation and maintenance, quarterly monitoring, and annual reporting; and periodic costs such as five-year reviews.

The present worth for Alternative CMS2 based on a 7 percent discount rate and a 30-year duration is estimated to be $22,839,800. For informational purposes, Table 4.2-6 also contains a present worth based on a 2.7 percent discount rate and a 100-year duration and total non-discounted cost estimate based on cash outlays for 100 years. The estimated 100-year present worth is $24,913,800 and the 100-year total non-discounted cost is $31,233,800. Appendix G contains additional cost assumptions and a detailed cost estimate for this alternative. It should be noted that these cost estimates include the cost of compensatory wetland mitigation. If it turns out that mitigation is not required, costs will be reduced. If the additional stabilization measures for the Tailings Impoundment are necessary, the 100-year present worth cost could increase by about $1.8 million.

4.3 EVALUATION OF ALTERNATIVE CMS3 – CAPPING OF TAILINGS IMPOUNDMENT; OFF-SITE DISPOSAL OF PCB- AND PETROLEUM-CONTAMINATED SOIL; CAPPING OF SOURCE AREA MATERIAL (FROM THE ORE PAD, MINE OPERATIONS AREA, WRP-3) AND RESIDENTIAL USE AREA SOIL; AND SUBAQUEOUS DISPOSAL OF SEDIMENT IN A CONFINED AQUATIC DISPOSAL (CAD) CELL IN FORMER MINE PIT

This subsection describes Alternative CMS3, provides a cost estimate, and evaluates the alternative using the first seven evaluation criteria of the NCP.

Alternative CMS3 includes: constructing surface water diversions to reduce the amount of upslope runoff flowing onto and infiltrating the Tailings Impoundment; installating a low-permeability cover system to contain and isolate the Tailings Impoundment; installating a horizontal drain to facilitate the dewatering of the Tailings Impoundment and the collection and treatment of the discharge from the horizontal drain in a constructed wetland; disposing of WRP-3, Ore Pad, and Mine Operations Area source material, and residential use area soil exceeding PRGs into an on-site waste cell that would then have a low-permeability cover system installed over the waste; and off-site disposal of material contaminated with PCBs and waste commingled with petroleum. It is possible that additional measures, including a toe shear key or buttress would be identified during design as a necessary component to stabilize the Tailings Impoundment. Alternative CMS3 also includes the dredging and subaqueous disposal of sediments exceeding PRGs in southern Goose Pond and the adjacent salt marsh in a CAD cell in the former mine pit. Dyer Cove and Goose Cove sediments that contain mine waste may also be dredged and disposed in the CAD cell in the former mine pit as part of site restoration and wetland mitigation activities. Additional components include institutional controls, environmental monitoring, and five-year reviews. This alternative would consist of the following key components:

- Predesign Investigations and Studies
- Tailings Impoundment Cover System with surface water diversion and stabilization measures, possibly including a toe shear key or buttress
- Installation of a horizontal drain within the Tailings Impoundment and passive treatment of the horizontal drain system discharge in a constructed wetland
- Excavation, on-site consolidation, and capping of WRP-3, Ore Pad, and Mine Operations Area source material

- Excavation, on-site consolidation of soil containing arsenic and lead above the cleanup levels in the residential use area of the Site
- Excavation and off-site disposal of PCB-contaminated soil exceeding PRGs
- Excavation and off-site disposal of petroleum-contaminated soil commingled with CERCLA waste
- Dredging of Goose Pond and salt marsh sediment and subaqueous disposal in the CAD cell in the former mine pit
- Establishment of institutional controls to protect the components of the remedy (including caps, treatment wetlands, monitoring well, and the CAD cell)
- Wetland restoration and mitigation, which may include dredging and subaqueous disposal in the CAD cell of mine waste located in Goose Cove and Dyer Cove
- Installation of monitoring wells
- Long-term operation and maintenance
- Environmental monitoring
- Institutional control inspections
- Five-year reviews

Figure 4.3-1 is an alternative remedy map showing the major construction components of this alternative.

Predesign Investigations and Studies. Predesign studies for Alternative CMS3 would be similar to those for Alternative CMS2 except that the topographic survey would be expanded to include WRP-1, and the geotechnical investigation/studies would be expanded to include borings within and along the toe of WRP-1 as necessary to support additional slope stability evaluations of WRP-1 (both long-term and short-term/construction-related). The additional survey would allow refinement of the estimates of the space available for consolidation of excavated site materials. The WRP-1 berm, similar to the Tailings Impoundment berm, is approximately 70 feet tall, and geotechnical investigation and evaluation are recommended if substantial fill is to be placed behind it.

Tailings Impoundment Cover System. The Tailings Impoundment cover system components for Alternative CMS3 would be the same as for Alternative CMS2.

Excavation and On-Site Consolidation and Capping of WRP-3, Ore Pad, and Mine Operations Area Source Material. The only upland area identified as potentially suitable for on-site consolidation of large volumes of material is the northwestern slope of WRP-1. Small volumes could potentially be placed on the surface of the Tailings Impoundment, but concerns about the stability of that structure lead to the conclusion that it is unsuitable for consolidation of large volumes of material. The limited footprint available at the Ore Pad and Mine Operations Area, shallow water table, and the desire to direct all surface runoff toward Goose Pond, all speak against consolidation at that location.

The estimated volume of material from WRP-3 (including an estimated 75 percent of the WRP-3 Haul Road), the Ore Pad, and Mine Operations Area to be consolidated is approximately 322,000 cubic yards, plus an estimated 7,400 cubic yards from the bordering WRP-2 for a total of 329,000 cubic yards, and the estimated space available for placement of material at WRP-1 is 292,000 cubic yards, suggesting that enough space is not available at WRP-1. If this is proved to be true, excess material would be consolidate under the Tailings Impoundment cap. Consolidated material would be capped with a low-permeability cover system similar to the one at the Tailings Impoundment.

Consolidation of source materials at WRP-1 would need to be sequenced in a manner to allow reuse of Stink Cove sediment for wetland restoration and not cover it with consolidated material. This could require excavation and temporary stockpiling of Stink Cove sediment which would lead to concerns about control of stockpile erosion and the cost of additional handling.

Excavation of Residential Use Areas of the Site Disposal in the CAD Cell or Tailings Impoundment. Soil within the residential use area of the Site would be handled the same as for Alternative CMS2, except that it would be consolidated on land rather than disposed of in the CAD cell.

Excavation and Off-Site Disposal of PCB-Contaminated Soil. The excavation and disposal of PCB-contaminated soil would be the same as for Alternative CMS2.

Excavation and Off-Site Disposal of Petroleum-Contaminated Soil commingled with CERCLA Waste. Petroleum-contaminated soil commingled with the CERCLA waste would be handled the same as for Alternative CMS2.

Dredging of Goose Pond and Salt Marsh Sediment and Subaqueous Disposal in the CAD Cell (Former Mine Pit). Dredging of Goose Pond and Salt Marsh for Alternative CMS3 would be the same as for Alternative CMS2. Figure 4.3-2 shows a cross-section of the CAD cell in the former mine pit and the estimated depth of fill for Alternative CMS3.

Mitigation of Altered Wetlands. Compensatory wetland mitigation requirements have not been established. For cost estimating purposes, wetland mitigation, if necessary, would be the same as for Alternative CMS2.

Institutional Controls to Protect the Caps, CAD Cell, and Other Remedial Components. Institutional controls for Alternative CMS3 would be the similar as for Alternative CMS2, except institutional controls would need to be established for the consolidated cap at WRP-1.

Installation of Monitoring Wells. Monitoring well installation for Alternative CMS3 would be the similar as for Alternative CMS2, except additional wells may be needed for long-term monitoring of the cap at WRP-1.

Long-Term Operation and Maintenance. Long-term operation and maintenance for Alternative CMS3 would be the similar as for Alternative CMS2, except there will be additional operation and maintenance required for the cap at WRP-1.

Environmental Monitoring. Environmental monitoring for Alternative CMS3 would be the similar as for Alternative CMS2, except that there will be additional environmental monitoring for the cap at WRP-1 and less monitoring of disposal into the CAD cell, since only sediment will be disposed into the CAD cell in Alternative CMS3.

Institutional Control Inspections. Institutional control inspections for Alternative CMS4 would be the similar as for Alternative CMS2, except for additional inspections required to monitor the cap at WRP-1.

Five-Year Reviews. Five-year reviews for would be the similar as for Alternative CMS2, except for additional assessment of the cap at WRP-1.

4.3.1 Overall Protection of Human Health and the Environment

For OU 1, the areas that represent a current human-health threat are the areas of current residential use with elevated concentrations of arsenic and lead and the areas of current recreational use with elevated concentrations of PCBs. All other areas of potential human-health risk (groundwater and future residential and recreational exposure to on-site soil) will be addressed in OU 2. Alternative CMS3 would protect human health by removing PCB contamination above the site-specific PRGs and arranging for proper disposal of this material at an off-site facility. After completion of this activity, direct contact and incidental ingestion of PCBs would no longer be an unacceptable threat to human health. Alternative CMS3 would protect human health in the residential use area of the Site by removing arsenic and lead contamination above the site-specific PRGs and arranging for proper disposal of this material on Site at WRP-1 or at the Tailings Impoundment cap such that human contact with this material would no longer occur. After completion of this activity, direct contact and incidental ingestion of lead and arsenic would no longer be an unacceptable threat to human health in the residential use area of the Site and PCBs would no longer be an unacceptable threat in the recreational use area of the Site.

While there is no current human exposure to contaminated groundwater at the Site, the HHRA did identify groundwater as an unacceptable threat under a future use scenario. The long-term remediation of the groundwater is an OU 2 issue. However, the removal of waste material at the Ore Pad and its consolidation and capping elsewhere on Site will address the most significant source of groundwater contamination as long as the low-permeability cover system is designed to prevent infiltration of the consolidated contaminants into the groundwater. Alternative CMS3 would be protective of human health under current and potential future land-use conditions for those response areas identified within OU 1.

The excavation of Ore Pad, Mine Operations Area, and WRP-3 source material followed by its disposal and capping in an on-site area at WRP-1 would eliminate the contribution of those materials to exceedances of NRWQC in Goose Pond surface water and to salt marsh and sediment contamination that exceeds ecologically protective concentrations. The capping of the Tailings Impoundment combined with surface drainage improvements and a horizontal drain system and treatment wetland would reduce the leaching of metals from the tailings. Capping of the Tailings Impoundment and excavation of WRP-3 would also reduce surface water erosion and transport of dissolved and suspended contaminants that contribute to exceedances of NRWQC in Goose Pond

surface water, salt marsh, and sediment contamination that exceeds ecologically protective concentrations.

The dredging and subaqueous disposal of Goose Pond and salt marsh sediments exceeding PRGs in the CAD cell in the former mine pit would protect ecological receptors by eliminating those sediments as a pathway for direct contact and food chain exposure above protective concentrations.

In accordance with federal Executive Order 11990, entitled "Protection of Wetlands," USEPA has determined that there may be unavoidable adverse impacts to wetlands and aquatic resources. To the extent that federally regulated wetlands and aquatic resources are located within and adjacent to the Ore Pad, Mine Operations Area, Waste Rock Pile-3, or the Tailings Impoundment, the contaminated portions of Goose Pond and the adjacent Salt Marsh may be removed and/or altered as part of the cleanup actions. Wherever possible, wetland areas will be restored. USEPA has evaluated the requirements of the applicable regulations, including Section 404 of the Clean Water Act and identified the proposed actions as the least damaging practicable alternatives to protect federally regulated wetland and aquatic resources from exposure to contaminated sediments and contaminated surface water. These wetland areas at the Site are shown in Figure 4.3-3**.**

To ensure the protectiveness of CMS3, institutional controls would be implemented to prevent future use of the Site that would disturb the caps, surface water diversion systems, treatment wetland, and other remedial components or disturb the material that will be buried in the CAD cell.

Alternative CMS3 would be protective of human health and the environment, as long as the low-permeability cover system over the consolidated waste can prevent the wastes from remaining a source of groundwater contamination.

4.3.2 Compliance with Applicable or Relevant and Appropriate Requirements

Implementation of Alternative CMS3 would result in the dredging of subtidal sediment and excavation/dredging of salt marsh. The destruction of existing wetlands and aquatic habitats as part of this alternative is considered unavoidable; although, during remedial design the effects of remedial activities on the wetlands and aquatic habitats will be evaluated to minimize damage consistent with Section 404(b) of the Clean Water Act and 06-096 CMR310. Compensatory habitat mitigation will be performed as necessary to comply these ARARs. To the extent that

remedial activities affect protected resource areas, the location-specific ARARs in Table 4.3-1 will apply. It is expected that all such activities can be designed and implemented to comply with location-specific ARARs identified in Table 4.3-1.

Chemical-specific ARARs and TBCs triggered by Alternative CMS3 are presented in Table 4.3-2. Primary among these are the Maine Solid Waste Regulations, Lead Management Regulations (06-096 CMR 424). These regulations establish a lead safe standard of 375 ppm in bare soil in potential play areas. Federal TBCs establish risk-based cleanup standards. This alternative would attain chemical-specific ARARS and TBCs identified in Table 4.3-2

Action-specific ARARs that would be triggered by Alternative CMS3 are listed in Table 4.3-3. It is expected that all activities can be designed and implemented to comply with action-specific ARARs, including TSCA regulation for cleanup of PCBs. Alternative CMS3 would be designed and implemented to attain the performance standards of the Maine Mining regulations at 06-096 CMR Chapter 200, Section 32A. However, as previously noted, the low-permeability cover system over the consolidated wastes would need to be designed and constructed to prevent infiltration of the consolidated contaminants into groundwater in order to achieve source control standards for the protection of groundwater (which will be addressed in OU 2). EPA has made a finding under the TSCA PCB Regulations at 40 CFR Part 761 (a) and (c), that the cleanup level of 1 ppm established for PCBs at this Site will not pose an unreasonable risk of injury to health or the environment.

4.3.3 Long-Term Effectiveness and Permanence

With proper design, construction, and maintenance, the low-permeability cover system of CMS3 would provide long-term effectiveness at minimizing infiltration of precipitation and runoff into the Tailings Impoundment and the consolidated waste at WRP-1. In addition, the conceptual regrading plan for the Tailings Impoundment surface improves the FOS of the Tailings Impoundment, providing greater confidence in the long-term effectiveness and permanence of this alternative, compared to existing conditions. The excavation/removal of WRP-3 addresses long-term stability concerns associated with the FOS for WRP-3.

The excavation of Ore Pad, Mine Operations Area, and WRP-3 source material and consolidation at WRP-1, and dredging of Goose Pond and salt marsh sediments combined with subaqueous disposal of those sediments in the CAD cell in the former mine pit would provide long-term

effectiveness and permanence. Existing exposure and transport mechanisms would be interrupted. Excavated material would be isolated beneath a low-permeability cover, and dredged material would be isolated in the CAD cell. No major long-term adverse effects to groundwater or surface water are expected from as a result of placement of material in the mine pit. Both observation and modeling indicate if the level of material disposed of in the CAD cell is maintained more than approximately 30 feet below mean sea level the water surface, the material would be isolated. Calculations indicate there is more than enough volume within the CAD cell to accommodate all of the material generated under this alternative without approaching the mixing boundary.

The excavation of arsenic and lead contaminated soil in the residential use portion of the Site and its consolidation and capping on Site at WRP-1 would provide long-term effectiveness and permanence at protecting residents from exposure to contaminated soil exceeding PRGs.

Institutional controls to prohibit disturbance of the caps, CAD cell, and other remedial components would provide long-term effectiveness as long as they are adhered to by property owners and enforced by state and local regulatory agencies. Institutional controls are generally considered to provide a lesser degree of protection than engineering controls.

Results of long-term environmental monitoring would be used to assess the effectiveness and permanence of this alternative.

4.3.4 Reduction of Toxicity, Mobility, and Volume through Treatment

Alternative CMS3 will reduce the mobility of contaminants in Tailings Impoundment seeps through treatment of the discharge from the horizontal drain system in a wetland constructed for that purpose. The alternative relies primarily on removal, containment, and isolation to control source areas and reduce exposure so the primary components of this alternative do not meet this criterion. Alternative CMS3 relies on off-site disposal rather than treatment for the principal threat waste (PCBs) because the vast majority of PCB-contaminated material is below USEPA's guidance levels for treatment for PCBs, and the quantity of PCBs materials is too small to warrant consideration of on-site treatment. The major components of CMS3 are source control measures for large volumes of low-level threat wastes, which is consistent with USEPA guidance. CMS3 would achieve some level of reduction in toxicity, mobility, and volume through treatment as a result of the sulfide reduction to immobilize the metals in the treatment wetland.

4.3.5 Short-Term Effectiveness

Because there is no current exposure to groundwater or residential use of the Site, potable use of groundwater and residential use do not present short-term human-health risks to residents. Exposure of seasonal residents to use area soil would present short-term-risks until completion of residential use area cleanup (estimated to occur within 1 to 2 years). Alternative CMS3 would require the excavation and dredging of large volumes of material with heavy construction equipment under potentially adverse conditions. This would present a potential risk to construction workers and would result in construction related concerns (e.g., blasting, noise, and dust) to area residents.

The protection of human health and the environment for the areas targeted for remediation under OU 1 would achieve protection upon completion of the cleanup. The time period to implement the cleanup, once design and administrative issues have been addressed, would be 1-4 years. Some potential for seepage discharge from the Tailings Impoundment would exist until the water levels within the Tailings Impoundment drop to a level that results in an insignificant discharge from the seeps. The horizontal drain system will be designed to minimize the uncontrolled discharge from the seeps. The water from the horizontal drains will be subject to treatment using a passive wetland.

To minimize short-term risks to the community and area residents, Alternative CMS3 would minimize the movement of construction equipment on the narrow and twisting roads approaching the Site. Most construction equipment (e.g., bulldozers, excavators, dredges) would be expected to remain on Site and move on/off Site infrequently. Most excavated/dredged material would be disposed of on Site, with only relatively small volumes of PCB and petroleum-contaminated material planned for off-site transport and disposal. Similar to Alternative CMS2, Alternative CMS3 minimizes the importation of large volumes of construction materials by relying on the on-site quarrying and crushing of rock to create crushed stone for construction of the Tailings Impoundment and WRP-1 consolidation cover. This would significantly reduce the volume of truck traffic; however, use of the local roads by construction and material transport vehicles is still anticipated to create a short-term increase in traffic hazards in the area. The increased area to be capped as part of this alternative compared to Alternative CMS2 would result in slightly more traffic to deliver capping materials (i.e., geocomposite and geomembrane). Table 4.4-4 contains an

estimate of heavy truck traffic that may occur as part of this alternative. Dust control measures would be implemented on Site to minimize dust generation and airborne transport of contaminants.

Short-term risks to the environment would include the short-term loss of the salt marsh habitat as a result of excavation activities. Dredging would result in short-term impacts to sediment habitat in Goose Pond; however, the dredging would remove mine waste deposits and areas with contaminants exceeding PRGs. In addition, dredging of Goose Pond and disposal of dredged material in the CAD cell may result in temporary impacts to Goose Pond water quality, although these would be monitored during the disposal activity. Overall, the dredging of Goose Pond is expected to result in overall habitat improvements. The quarrying of on-site rock would destroy a small area of existing upland habitat in the vicinity of the Ore Pad Haul Road. Because of the poor quality of upland habitat, excavation of source material would not result in significant habitat disruption or short-term risks.

4.3.6 Implementability

The key components of Alternative CMS3 are implementable using conventional and readily available construction equipment. Dredging operations will like pose some implementability issues, but disposal of contaminated sediments into CAD cell is an established technology. The groundwater characterization and environmental monitoring needed to assess the effectiveness of this alternative are routine environmental activities and many qualified firms are available to perform them. Implementation of this alternative would not interfere with the ability to implement additional remedial actions in the future if they became necessary.

Although there may be concerns about the short-term effects of this alternative on salt marsh and, especially, Goose Pond, administrative implementability is expected to be good. Close communication and coordination with landowners (including the State which owns the subtidal lands in Goose Pond), environmental protection and natural resource agencies (e.g., Maine DEP, Maine Department of Marine Resources, USEPA, U.S. Fish and Wildlife Service), and U.S. Army Corps of Engineers would be necessary to implement the remedy and establish institutional controls.

4.3.7 Cost

Table 4.3-5 presents a summary of the estimated present worth and total non-discounted costs to implement Alternative CMS3. The present worth represents the amount of money that, if invested now and disbursed as needed, would be sufficient to cover costs associated with the remedial action over its planned life, whereas the total non-discounted costs estimate assumes that all costs are paid as they accrue. Both present worth and total costs estimates include direct and indirect capital costs; annual costs such as operation and maintenance, quarterly monitoring, and annual reporting; and periodic costs such as five-year reviews.

The present worth for Alternative CMS3 based on a 7 percent discount rate and a 30-year duration is estimated to be $25,455,500. For informational purposes, Table 4.3-5 also contains a present worth based on a 2.7 percent discount rate and a 100-year duration and total non-discounted cost estimate based on cash outlays for 100 years. The estimated 100-year present worth is $27,529,500, and the 100-year total non-discounted cost is $33,849,500. Appendix G contains additional cost assumptions and a detailed cost estimate for this alternative. It should be noted that these cost estimates include the cost of compensatory wetland mitigation. If it turns out that mitigation is not required, costs will be reduced. If the additional stabilization measures for the Tailings Impoundment are necessary, the 100-year present worth cost could increase by about $1.8 million.

5.0 COMPARATIVE ANALYSIS OF ALTERNATIVES

The comparative analysis compares the remedial alternatives with respect to the evaluation criteria used during the detailed analysis of alternatives. The purposes of the comparative analysis are to identify the advantages and disadvantages of alternatives relative to one another, and to aid in the eventual selection of a preferred remedial alternative that will be identified for public comment in the Proposed Plan and documented in the ROD for the Callahan Mine Site OU 1. Subsection 5.1 presents the approach of the comparative analysis based on the NCP with respect to these three categories. Subsection 5.2 presents the comparison of groundwater remedial alternatives.

5.1 APPROACH TO THE COMPARATIVE ANALYSIS

The NCP outlines the approach for performing the comparative analysis of site alternatives. The remedy proposed must reflect the scope and purpose of the actions being undertaken and how these actions relate to other remedial actions and the long-term response at the site. Identification of the preferred alternative and final remedy selection are based on an evaluation of the major tradeoffs among alternatives in terms of the nine evaluation criteria. USEPA categorizes the evaluation criteria into three groups: threshold, balancing, and modifying. Each criteria group is discussed in the following subsections.

5.1.1 Threshold Criteria

USEPA designated (1) overall protection of human health and the environment, and (2) compliance with ARARs as the two threshold criteria. An alternative must meet both criteria to be eligible for selection as the preferred site remedy.

5.1.2 Primary Balancing Criteria

The five primary balancing criteria are long-term effectiveness and permanence; reduction of toxicity, mobility, or volume through treatment; short-term effectiveness; implementability; and cost. These balancing criteria provide a preliminary assessment of the extent to which permanent solutions and treatment can be used practicably and in a cost-effective manner.

An alternative that is protective of human health and the environment, is ARAR-compliant, and affords the best balance among these criteria is identified as the preferred alternative in the Proposed Plan. The balancing emphasizes long-term effectiveness and reduction of toxicity, mobility, or volume through treatment.

5.1.3 Modifying Criteria

State and community acceptance are factored into a final balancing that determines the preferred remedy and the extent of permanent solutions and treatment practicable for the site. Formal state-regulatory-agency comments will not be received until after the agencies have reviewed the FS Report. Community concerns will be factored into the remedy selection process following the public comment period on the Proposed Plan.

5.2 COMPARATIVE ANALYSIS OF ALTERNATIVES

This subsection contains a comparative analysis of alternatives associated with the Callahan Mine Site OU 1. The remedial alternatives that are the focus of this comparative analysis are:

- Alternative CMS1 – No 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 Former Mine Pit
- Alternative CMS3 – Capping of Tailings Impoundment; Off-Site Disposal of PCB- and Petroleum-Contaminated Soil; Capping of Source Area Material (from the Ore Pad, Mine Operations Area, WRP-3) and Residential Use Area Soil; and Subaqueous Disposal of Sediment in a Confined Aquatic Disposal (CAD) cell in Former Mine Pit

5.2.1 Overall Protection of Human Health and the Environment

According to CERCLA, this criterion must be met for a remedial alternative to be chosen as a final site remedy. Alternative CMS1, the No Action Alternative, would not eliminate, reduce, or control source areas or potential future exposure to contaminants exceeding PRGs and would not meet remedial action objectives. Therefore, it is not protective of human health and the environment and cannot be chosen as a final remedy.

Alternatives CMS2 and CMS3 would each be protective of human health and the environment. Both alternatives would eliminate the direct contact and incidental ingestion risks from PCBs, arsenic, and lead within the OU 1 areas through removal and/or capping of this material. The PCBs would be taken to an appropriate off-site facility and the arsenic and lead in the residential area would either be disposed of in the CAD cell in the former mine pit (CMS2) or capped on Site (CMS3). The removal of the Ore Pad material would also control the most significant source of groundwater contamination. The removal of the Ore Pad, Mine Operations Area, and WRP-3 source material and either its disposal in the CAD cell (CMS2) or on-site capping (CMS3) would also remove and/or control significant sources of surface water contamination. Removal of WRP-3 and capping/stabilization of the Tailings Impoundment would prevent these areas from acting as a source of sediment and surface water contamination. Removal of the sediments that were found to be acutely toxic and which also represent a food chain threat and disposal into the CAD cell would eliminate that threat to the site biota. Both alternatives would implement institutional controls to prevent site use that could damage the components of the cleanup (particularly capped areas and the CAD cell).

Alternatives CMS2 and CMS3 are very similar in the degree to which they achieve protection of human health and the environment. CMS2 is more protective because of the greater long-term effectiveness afforded by placement of the material in the mine pit versus reliance on an on-site cover system. Both alternatives are equal with regard to protecting wetlands resources.

5.2.2 Compliance with ARARs

CERCLA requires that a selected alternative must also meet a second threshold criterion of compliance with ARARs, or a waiver must be obtained if the criterion cannot be met. According to CERCLA, this criterion must be met for a remedial alternative to be chosen as a final remedy.

Location-Specific ARARs. Alternative CMS1 is the No Action Alternative, which was developed as a baseline with which to compare the other alternatives. Because this alternative does not include any actions, the alternative does not trigger location-specific ARARs.

Alternatives CMS2 and CMS3 would be designed and implemented to comply with regulations pertaining to coastal zone, subtidal lands, fish and wildlife habitat, floodplains, and wetlands. All identified location-specific ARARs can be satisfied by both alternatives.

Chemical-Specific ARARs. Alternative CMS1 would not attain protective concentrations for arsenic, lead, and PCBs in soil and would not comply with chemical-specific ARARs and TBCs. Alternatives CMS2 and CMS3 would attain protective concentrations for arsenic, lead, and PCBs in soil for the OU 1 areas and would, therefore, comply with chemical-specific ARARs and TBCs.

Action-Specific ARARs. Because Alternative CMS1 does not include any actions, the alternative does not trigger location-specific ARARs. Alternatives CMS2 and CMS3 would improve Tailings Impoundment stability by regrading and capping the Tailings Impoundment. Therefore, Alternatives CMS2 and CMS3 would meet one of the potentially relevant and appropriate criteria pertaining to the stability of the Tailings Impoundment. Alternatives CMS2 and CMS3 would be designed and implemented to attain all identified action-specific ARARs.

Both CMS2 and CMS3 are equally ARAR compliant.

5.2.3 Long-Term Effectiveness and Permanence

This criterion evaluates the magnitude of residual risk and the reliability of controls after response objectives have been met. Alternative CMS1 would not eliminate, reduce, or control source areas or potential future exposure to contaminants exceeding PRGs and would not provide long-term effectiveness at protecting human health and the environment.

Alternatives CMS2 and CMS3 would both provide similar actions to control exposure risk at residential use areas and for the PCBs in the former Callahan Mine property portion of the Site. These actions would provide good long-term effectiveness and permanence. Alternatives CMS2 and CMS3 take actions to cap the Tailings Impoundment and excavate and dispose of Ore Pad, Mine Operations Area, and WRP-3 source areas, thereby controlling the generation of acid mine drainage at these source areas. Under Alternative CMS2 excavated material would be disposed of and isolated in the CAD cell in the former mine pit. Under Alternative CMS3, excavated material would be disposed of and isolated by consolidation and capping at WRP-1. Disposal of source material and contaminated sediment in the CAD cell in the former mine pit is a permanent disposal solution, no maintenance is required to maintain the integrity of the pit, and in the long term the natural sediment accretion would cover the material placed in the pit. The disposed material would be located below the depth at which mixing occurs with upper water strata in Goose Pond.

Consolidation of source material at WRP-1 as part of Alternative CMS3 is also considered a long-term solution, but with the caveat that at some indeterminate future time, repair to the cover system and supporting berm could be required. Therefore, Alternative CMS2 with greater reliance on disposal in the CAD cell is considered to have slightly greater long-term effectiveness and permanence than Alternative CMS3 that relies upon consolidation at WRP-1.

Alternatives CMS2 and CMS3 would reduce ecological risk from exposure to contaminated sediments by excavating/dredging salt marsh and Goose Pond and Goose Cove sediments exceeding PRGs and isolating the dredged material in the CAD cells.

For CMS2 and CMS3, the wetland treatment system would provide a "polishing" role to further reduce the discharge of contaminants to Goose Pond during the time period for the cover system to reduce the flow of water from the Tailings Impoundment.

The relative ranking of long-term effectiveness is CMS2 > CMS3 > CMS1 due to the long-term effectiveness of the CAD cell versus a cover system.

5.2.4 Reduction of Toxicity, Mobility, and Volume Through Treatment

This criterion evaluates whether the alternatives meet the statutory preference for treatment under CERCLA. The criterion evaluates the reduction of toxicity, mobility, or volume of contaminants, and the type and quantity of treatment residuals.

Alternative CMS1 does not contain any components to reduce the toxicity, mobility, or volume of contaminants through treatment. Alternatives CMS2 and CMS3 rely on off-site disposal rather than treatment for the principal threat waste (PCBs) because the vast majority of PCB-contaminated material is below USEPA's guidance levels for treatment for PCBs and the quantity of PCBs materials is too small to warrant consideration of on-site treatment. The major components of CMS2 and CMS3 are source control measures for large volumes of low-level threat wastes, which is consistent with USEPA guidance. The wetlands treatment systems installed for both CMS2 and CMS3 would achieve some level of reduction in toxicity, mobility, and volume through treatment as a result of the sulfide reduction to immobilize the metals in the treatment matrix.

The relative ranking of the alternatives at reducing the toxicity, mobility, or volume of contaminants through treatment is CMS2 = CMS3 > CMS1.

5.2.5 Short-Term Effectiveness

CERCLA requires that potential adverse short-term effects to workers, the surrounding community, and the environment be considered during implementation of a remedial action and until response objectives have been met. Under this criterion, the time period to achieve protectiveness is also evaluated. Alternative CMS1 does not lead to any exposure risks and, therefore, results in no short-term effects; however, it never achieves protectiveness of human health or the environment.

Alternatives CMS2 and CMS3 would have short-term effects with regard to the removal of the lead and arsenic contamination in the Residential Use Area. This work would be scheduled to avoid periods when the seasonal residents occupy these homes. The homes themselves would not be altered by the cleanup. Seasonal residents in this portion of the Site would continue to be exposed to contaminated soil until its excavation and disposal, estimated to be within 1 to 2 years of remedy selection. Alternatives CMS2 and CMS3 have similar short-term effects with regard to current residential use area of the Site.

For the common components of CMS2 and CMS3, there would also be similar short-term impacts resulting from truck traffic transporting the PCB- and petroleum-contaminated material off Site for disposal and bringing the necessary materials to the Site for the remediation activities. There would also be truck traffic associated with the importation of the materials for the wetland treatment system and, over the long-term, removal of contaminated material from the treatment wetland systems.

Each of the alternatives utilizes on-site materials and resources to reduce short-term risks to the community from construction traffic to and from the Site. The cover systems would be constructed using geosynthetic material, which would require a relatively low volume of traffic, along with the use of stone from an on-site quarry. The use of on-site material eliminates several thousand truck trips on local roads. In addition, the fundamental approach to consolidate on-site under a cap or within a CAD cell, eliminates tens of thousands of truck trips that would be required on local road if the waste material was transported off Site. On-site quarrying to produce crushed stone for capping at the Tailings Impoundment (Alternatives CMS2 and CMS3) and at WRP-1 (Alternative

CMS3) would result in construction related concerns (e.g., blasting, noise, and dust) and would permanently alter a small area of habitat in the vicinity of the Ore Pad Haul Road. Use of the CAD cell for disposal of source material (Alternatives CMS2) and for disposal of dredged sediment and salt marsh material (Alternatives CMS2 and CMS3) would also result in construction related concerns. Each alternative would result in some short-term effects to the community from truck traffic to deliver equipment and materials. Alternatives CMS2 and CMS3 would require delivery of similar amounts of geomembrane and geocomposite for the Tailings Impoundment cover and of media for the treatment wetlands. Alternative CMS3 would require delivery of geomembrane and geocomposite for the WRP-1 cover.

Both CMS2 and CMS3 would result in short-term impacts to the wetland areas that are subject to excavation. Some permanent loss of these areas may occur to accommodate storm water control structures and the wetland treatment system associated with the cover system for the Tailings Impoundment. The areas that are not subject to permanent loss are expected to fully recover and achieve a higher level of function and value post-cleanup with the removal of the site contaminants. In addition, there would be a permanent loss of the wetland areas that reside within the footprint of the Tailings Impoundment, WRP-3, and the Mine Operations Area. Some portion, and possibly all, of the wetland on WRP-1 that contains the Stink Cove sediments would also be lost, depending upon the amount of material from this area that may be used for on-site restoration activities. There would be short-term impacts to sub-tidal areas subject to dredging or excavation. However, the permanent removal of mine material from these areas would create a long-term benefit to the environment. Natural restoration is expected to occur relatively quickly, in addition to any supplemental restoration activity that may be implemented, such as the establishment of eel-grass beds.

For CMS2 and CMS3, the time period to achieve the remedial action objectives would be short. The remedial action objectives would be achieved once the source control and sediment activities are completed.

Overall, CMS2 and CMS3 are equal in time needed to achieve protection. CMS2 has a slightly lower degree of short-term impacts because CMS3 requires additional quantities of materials to construct the second cover system.

5.2.6 Implementability

This criterion evaluates each alternative's ease of construction and operation, and availability of services, equipment, and materials to construct and operate the alternative. Also evaluated is the ease of undertaking additional remedial actions and administrative feasibility.

Alternative CMS1 does not include any actions, other than Five-Year Reviews, and, therefore, would be technically easy to implement. No permits would be required, and administrative feasibility would be good.

Services and equipment are available to implement Alternatives CMS2 and CMS3. Construction of the Tailings Impoundment cover and the WRP-1 cover would require large volumes of soil/crushed stone which is not available on Site. On-site quarrying would be performed to obtain material. None of these alternatives would interfere with the ability to undertake additional remedial actions.

The administrative feasibility of obtaining regulatory approvals and the necessary permits for any off-site actions is considered good to the extent required for Alternatives CMS2 and CMS3. The administrative process to obtain institutional controls to protect the components of the remedy (caps, treatment wetland, monitoring wells, the CAD) also may be implemented for both CMS2 and CMS3. CMS2 and CMS3 are equal with respect to implementability.

5.2.7 Cost

The following table summarizes capital, present worth, and total estimated non-discounted costs for the evaluated alternatives.

Cost Category	**CMS1**	**CMS2**	**CMS3**
Capital Costs	$0	$21,515,800	$24,131,500
Total Present Worth (30 yrs @ 7%)	$1919,000	$22,839,800	$25,455,500
Total Present Worth (100 yrs at 2.7%)	$56,000	$24,913,800	$27,529,500
T. Non-Discounted Costs (100 yrs)	$171,000	$31,233,800	$33,849,500

5.2.8 Summary

Of the two alternatives that achieve protection of human health and the environment and comply with ARARs, CMS2 provides the best balance of the five criteria. Table 5.2-1 summarizes the comparative analysis of alternatives.

6.0 OU 2 EARLY ACTION

USEPA has identified the need for an Early Action for the OU 2 area. Specifically, because the finalization of the OU 2 RI/FS and selection of an OU 2 cleanup action is dependent upon the completion of the OU 1 Remedial Action, many years will pass before the final OU 2 RI/FS will be completed. The Callahan Mine HHRA identified the future consumption of contaminated groundwater and direct contact with lead and arsenic contaminated soil as potential threats to human health if the former Callahan Mine portion of the Site were developed and residential use or groundwater consumption were to occur. To address this threat to human health, USEPA will implement an Early Action to prevent residential development or groundwater use within the former Callahan Mine portion of the Site. Figure 6.0-1 shows the extent of the land use restrictions that would be included in the OU 2 Early Action, based on existing site data.

The remedial action objectives for the Early Action are:

- Prevent exposure to soil or waste with concentrations of lead or arsenic above the site-specific cleanup levels for future residential use within the Callahan Mine portion of the Site
- Prevent ingestion of bedrock groundwater in excess of federal safe drinking water act MCLs, MCLGs, MEGs, MEGs, or USEPA risk standards

The design for the Early Action would identify the extent of the former Callahan Mine portion of the Site that exceeds the residential PRGs for arsenic and lead developed for the OU 1 cleanup and the extent of groundwater that exceeds MCLs and MCLGs or more stringent, MEGs, or USEPA risk-based standards.

The Early Action would include the placement of land use restrictions that run with the land to effectively prevent future residential use or installation of water supply wells within the former Callahan Mine portion of the Site. Restrictive covenants are the primary mechanism to achieve this objective with local and/or state ordinances or zoning to supplement the property restriction.

Because the only remedial action objectives are to prevent the use of the Site and not restore groundwater or contain/remove contaminated soil, no other technologies or alternatives were considered, other than No Action. The OU 2 FS will develop and analyze technologies with

respect to any groundwater restoration, migration control, or soil remediation. A very simplified NCP criteria analysis was performed for the No Action and Institutional Controls alternatives.

6.1 OVERALL PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT

Will the alternative protect human health and plant and animal life from the contamination released by the Site? The chosen cleanup plan must meet this criterion.

The Early Action would provide overall protection of human health and the environment by preventing a change in land use that could result in an exposure that was identified as unacceptable from a human-health perspective. The OU 2 FS and ROD will determine whether addition response measures are necessary in addition to institutional controls. The No Action alternative would allow land use changes that could result in an unacceptable threat to human health from direct contact with lead and arsenic contaminated soil and ingestion of contaminated groundwater.

6.2 COMPLIANCE WITH APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARS)

Does the alternative meet all pertinent federal and state environmental statutes, regulations, and requirements? Is a waiver is required? The chosen cleanup plan must meet this criterion.

The Early Action would achieve chemical-specific standards for preventing exposure to contamination that would pose a risk for residential use of the non-residential areas of the Site and would prevent risks from the ingestion of contaminated groundwater from the Callahan Mine area of the Site. There are no location-specific ARARs that pertain to establishing institutional controls. The institutional controls would be compliant with action-specific standards for the management of mine sites. The No Action alternative would not achieve any chemical-specific standards. Because no action would be taken, the alternative does not have location- or action-specific ARARs.

6.3 LONG-TERM EFFECTIVENESS AND PERMANENCE

How reliable will the alternative be at long-term protection of human health and the environment? Is contamination likely to present a potential risk again?

The long-term effectiveness of the Early Action would be dependent upon the successful implementation and maintenance of the land use restrictions that would prevent residential use or the installation of water supply wells. The Early Action would not reduce the level of contamination or contain the contamination; therefore, the OU 2 FS and ROD would need to determine whether addition response measures are necessary in addition to institutional controls. The No Action alternative does not provide any long-term effectiveness or permanence.

6.4 REDUCTION OF TOXICITY, MOBILITY, OR VOLUME THROUGH TREATMENT

Does the alternative incorporate treatment to reduce the harmful effects of the contaminants, their ability to spread, and the amount of contaminated material present?

Neither the Early Action nor the No Action alternative would reduce the toxicity, mobility, or volume of contamination through treatment.

6.5 SHORT-TERM EFFECTIVENESS

How soon will the risks be adequately reduced? Are there short-term hazards to workers, the community, or the environment that could occur during the cleanup process?

There are no short-term hazards for either the Early Action or the No Action alternative. The Early Action could be implemented within 1 year of the ROD.

6.6 IMPLEMENTABILITY

Is the alternative technically and administratively feasible? Are the materials and services needed to implement the cleanup alternative (e.g., treatment machinery, space at an approved disposal facility) readily available?

There are no implementation issues for the No Action alternative. The Early Action has a high degree of implementability. The Early Action is dependent, however, on landowner cooperation to achieve the implementation of the institutional controls within the shortest time frame.

6.7 COST

What is the cost of constructing and maintaining the cleanup alternative? Capital costs and the present value of all costs over the anticipated life of the cleanup alternative are presented?

There are no costs associated with the OU 2 No Action alternative other than Five-Year Reviews. For the Early Action, some costs would be associated with establishment of the land use restrictions. There would also be costs associated with inspections and monitoring of the land use restrictions.

6.8 STATE ACCEPTANCE

Do state environmental agencies agree with the recommendations? This criterion considers the state's preferences among or concerns about the alternatives, including comments on ARARs or the proposed use of waivers. This criterion is addressed following state input on the FS and Proposed Plan.

6.9 COMMUNITY ACCEPTANCE

What suggestions or modifications do residents of the community offer during the comment period? What are their preferences and concerns about the alternatives? This criterion would be considered is addressed following community inputs on the FS and Proposed Plan.

6.10 SUMMARY

USEPA has determined that a cleanup action is appropriate for OU 2 at the Callahan Mine Superfund Site. The early cleanup action provides the best balance of the NCP nine criteria to ensure protection of human health prior to the implementation of the OU 2 response action. The early cleanup may be the only cleanup action for OU 2 or may be the first component of additional cleanup actions that would be evaluated in the OU 2 FS and selected in a future OU 2 ROD.

7.0 REFERENCES

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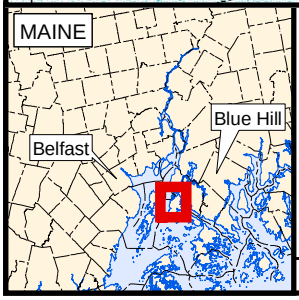
FIGURES



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N

0 2,000 4,000 Feet

Prepared/Date: DBW 03/04/09 | Checked/Date: SWR 03/04/09

Figure ES-1
Site Location Map

OU1 Feasibility Study Report
Callahan Mine Superfund Site
Brooksville, Maine
MACTEC, Inc.

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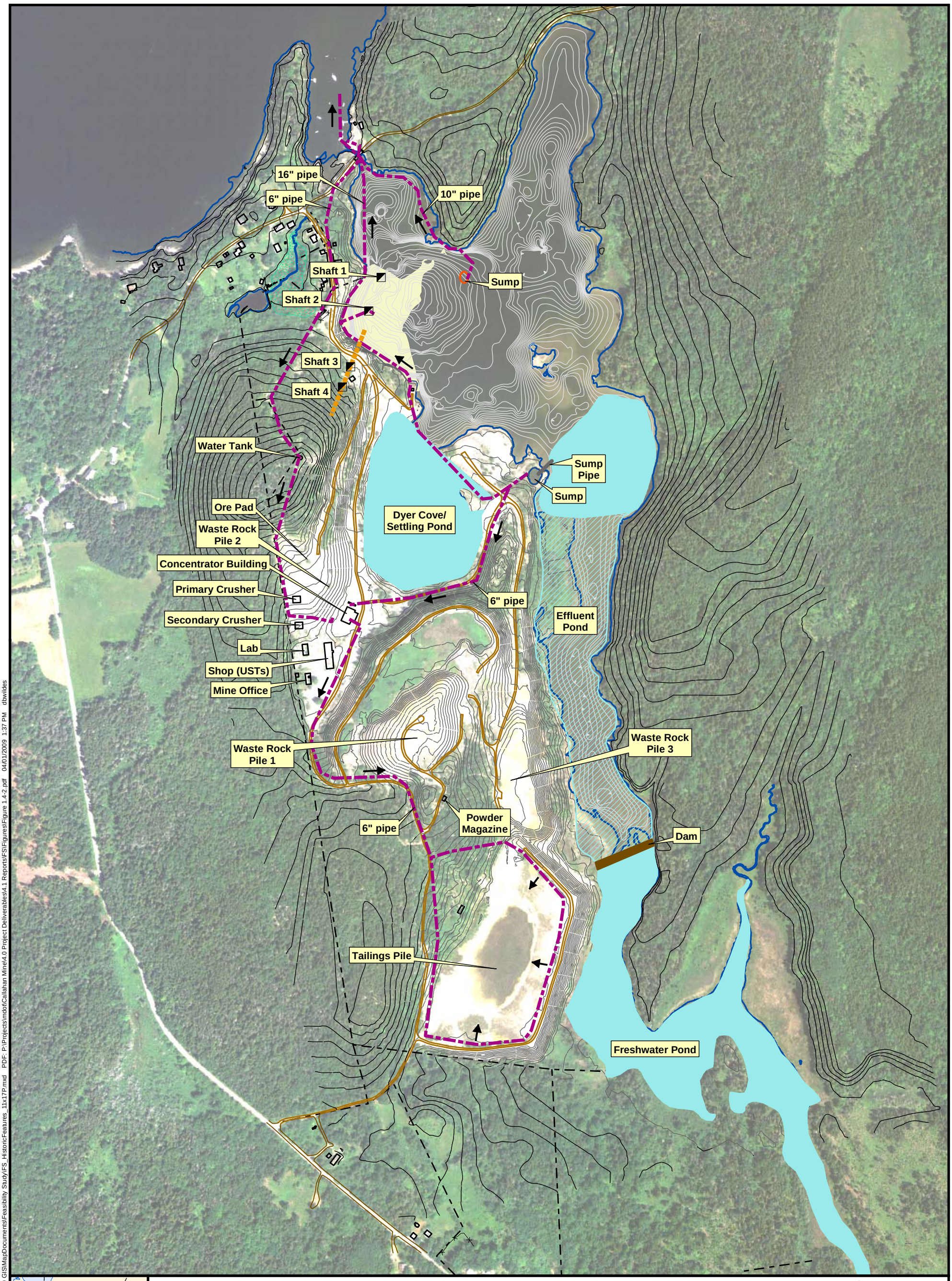

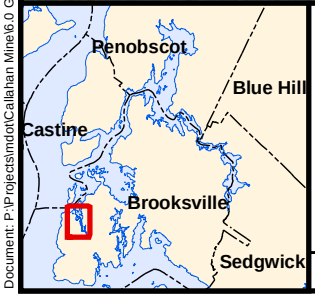

Legend

- Mine Shaft
- Purported Lateral Mine Shafts The "920" and the "860"
- Operations Piping
- Water
- Intermittent Water
- Pre-Mine Shoreline Excavated

N

0 250 500 Feet

Prepared/Date: DBW 04/01/09 | Checked/Date: SWR 04/01/09

Figure ES-2
Historical Mine Features (1972)

OU1 Feasibility Study Report
Callahan Mine Superfund Site
Brooksville, Maine
MACTEC, Inc.

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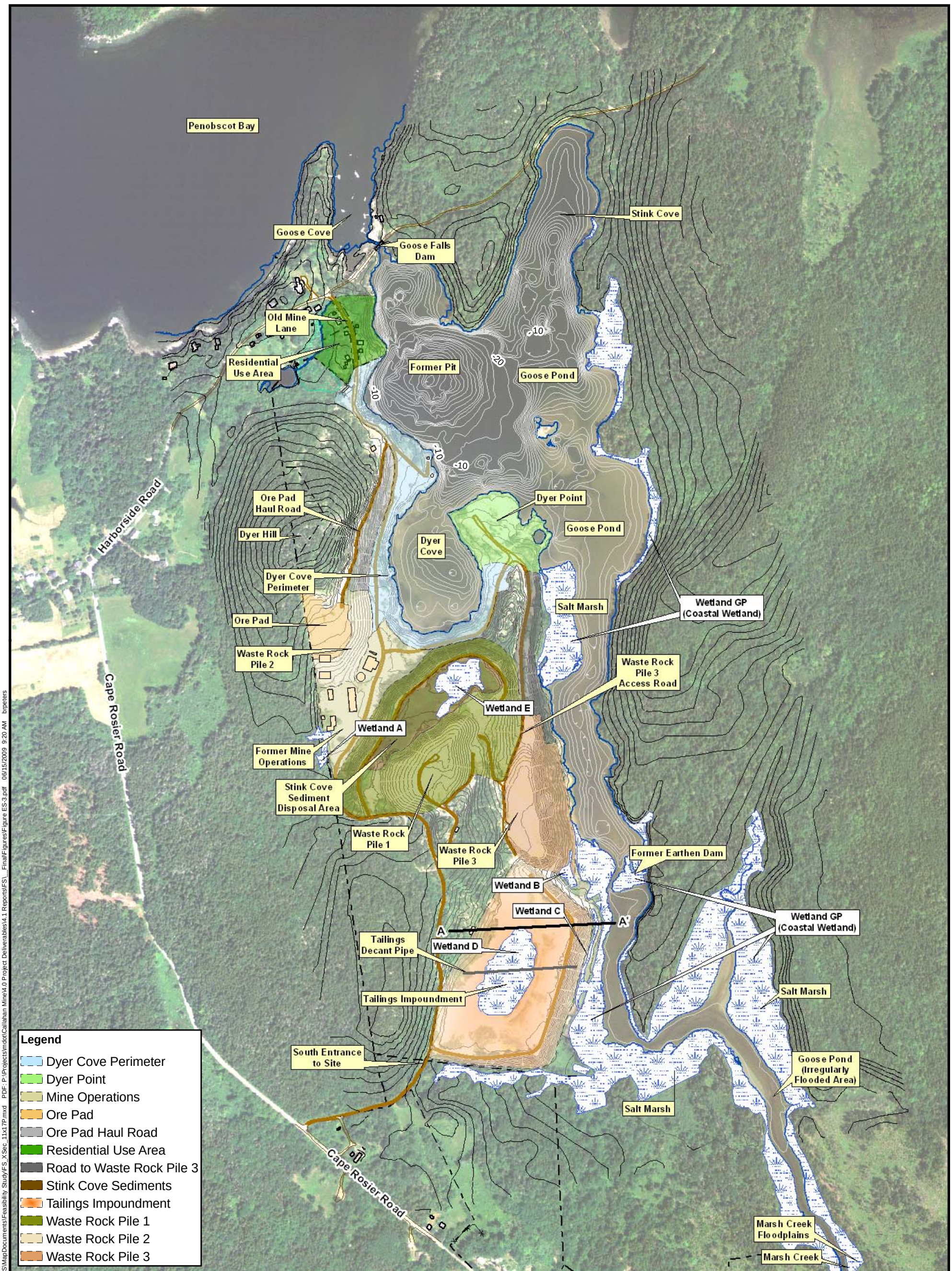

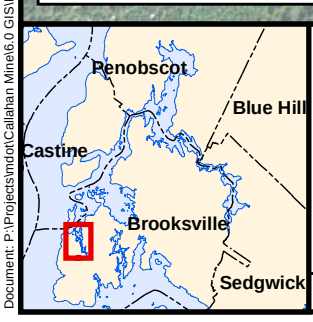

Note:
Contour intervals vary.
Off-site topo 10 foot
On-site topo 5 foot
Bathymetry 1 foot
Pit Bathymetry 20 foot

Legend
- Cross Section Profile
- Bathymetric Contour
- Delineated Wetlands

N

0 275 550 Feet

Prepared/Date: BRP 06/15/09 | Checked/Date: SWR 06/15/09

Figure ES-3
Site Features

OU1 Feasibility Study Report
Callahan Mine Superfund Site
Brooksville, Maine
MACTEC, Inc.

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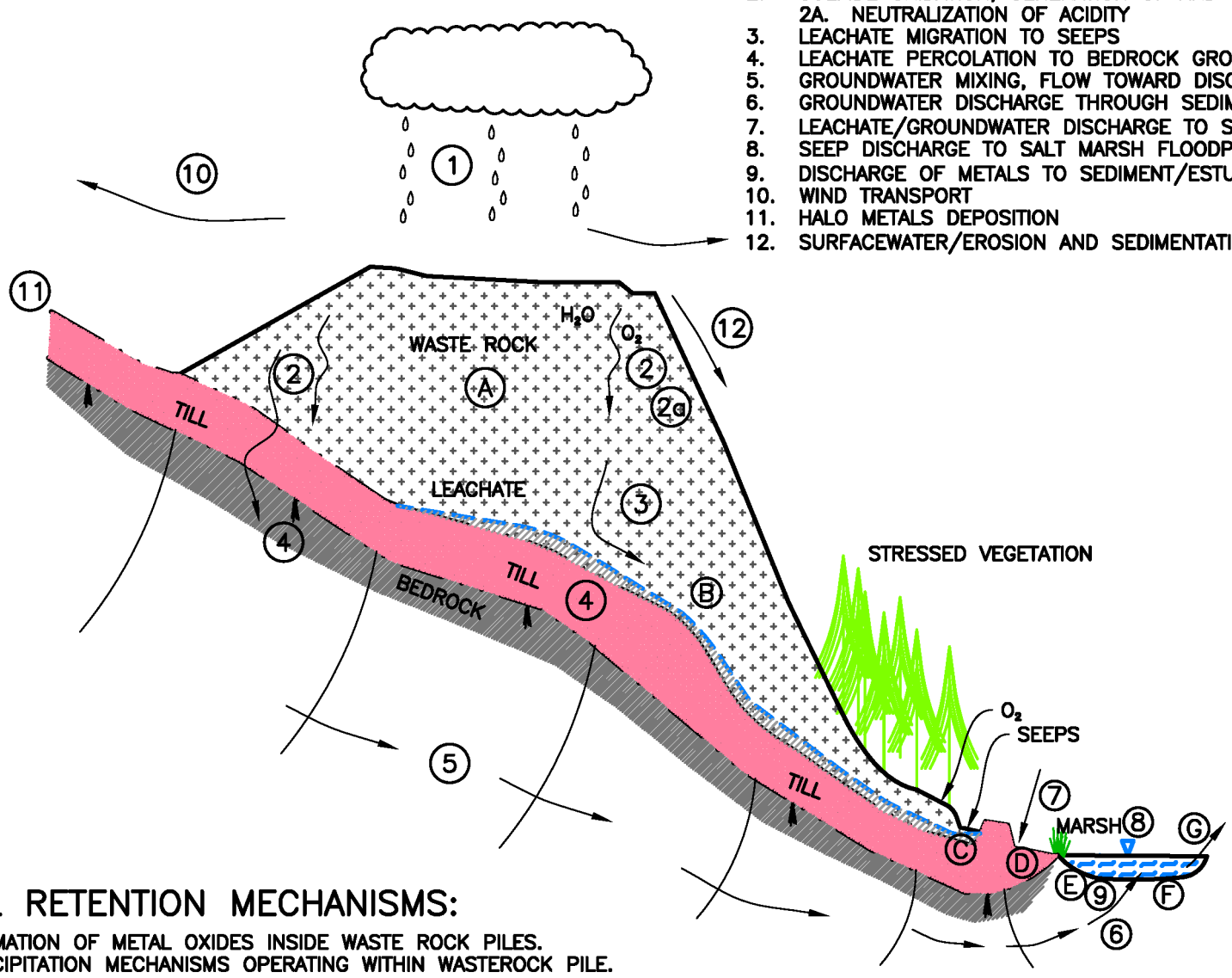
WASTE ROCK PILES AND ORE PAD

TRANSPORT PROCESSES:

1. PRECIPITATION
2. SULFIDE OXIDATION, GENERATION OF ARD
   2A. NEUTRALIZATION OF ACIDITY
3. LEACHATE MIGRATION TO SEEPS
4. LEACHATE PERCOLATION TO BEDROCK GROUNDWATER
5. GROUNDWATER MIXING, FLOW TOWARD DISCHARGE
6. GROUNDWATER DISCHARGE THROUGH SEDIMENT TO SURFACE WATER
7. LEACHATE/GROUNDWATER DISCHARGE TO SEEPS AND SURFACE WATER
8. SEEP DISCHARGE TO SALT MARSH FLOODPLAIN SOILS
9. DISCHARGE OF METALS TO SEDIMENT/ESTUARY COLUMN
10. WIND TRANSPORT
11. HALO METALS DEPOSITION
12. SURFACEWATER/EROSION AND SEDIMENTATION



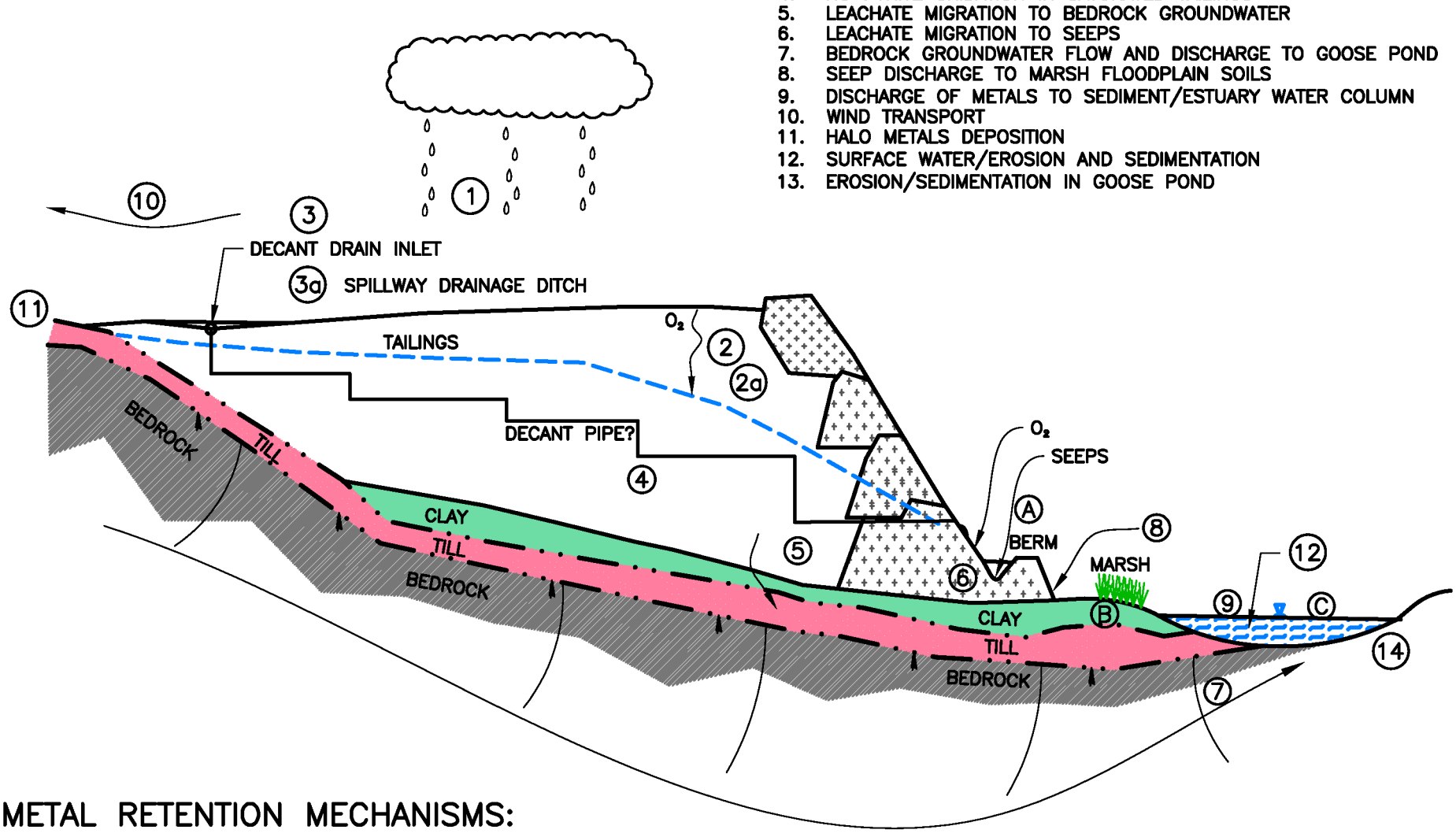
METAL RETENTION MECHANISMS:

A. FORMATION OF METAL OXIDES INSIDE WASTE ROCK PILES.
B. PRECIPITATION MECHANISMS OPERATING WITHIN WASTEROCK PILE.
C. MINERAL PRECIPITATES IN SURFACEWATERS/SEEP DISCHARGE AREAS.
D. SORPTION/RETENTION OF METALS IN SALT MARSH SEDIMENTS.
E. METALS IN GROUNDWATER; DISCHARGED TO AND RETAINED BY SEDIMENTS.
F. METALS RETAINED IN "MINE WASTE" LAYER IN SEDIMENT.
G. AREAS OF EROSION AND SEDIMENTATION IN GOOSE POND.

TAILINGS IMPOUNDMENT

TRANSPORT PROCESSES:

1. PRECIPITATION
2. SULFIDE OXIDATION, GENERATION OF ARD ABOVE WATERTABLE
   2A. NEUTRALIZATION OF ACIDITY
3. SURFACE WATER RUN-OFF TO VERTICAL CAST IRON DRAIN PIPE
   3A. SURFACE WATER RUN-OFF TO DRAINAGE DITCH
4. NO PYRITE OXIDATION IN SATURATED TAILINGS
5. LEACHATE MIGRATION TO BEDROCK GROUNDWATER
6. LEACHATE MIGRATION TO SEEPS
7. BEDROCK GROUNDWATER FLOW AND DISCHARGE TO GOOSE POND
8. SEEP DISCHARGE TO MARSH FLOODPLAIN SOILS
9. DISCHARGE OF METALS TO SEDIMENT/ESTUARY WATER COLUMN
10. WIND TRANSPORT
11. HALO METALS DEPOSITION
12. SURFACE WATER/EROSION AND SEDIMENTATION
13. EROSION/SEDIMENTATION IN GOOSE POND



METAL RETENTION MECHANISMS:

A. SEDIMENTATION IN DITCH BETWEEN TAILINGS IMPOUNDMENT AND SMALL BERM.
B. SORPTION AND EXTENT OF METALS IN MARSH FLOOD PLAIN SOILS.
C. METALS RETAINED IN "MINE WASTE" LAYER IN SEDIMENT.

Prepared/Date: MRS 06/11/09
Checked/Date: SWR 06/11/09

Project 3612-06-2047.30

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Figure ES-4
CONCEPTUAL SITE MODEL
OU1 FEASIBILITY STUDY REPORT
CALLAHAN MINE SUPERFUND SITE
BROOKSVILLE, MAINE

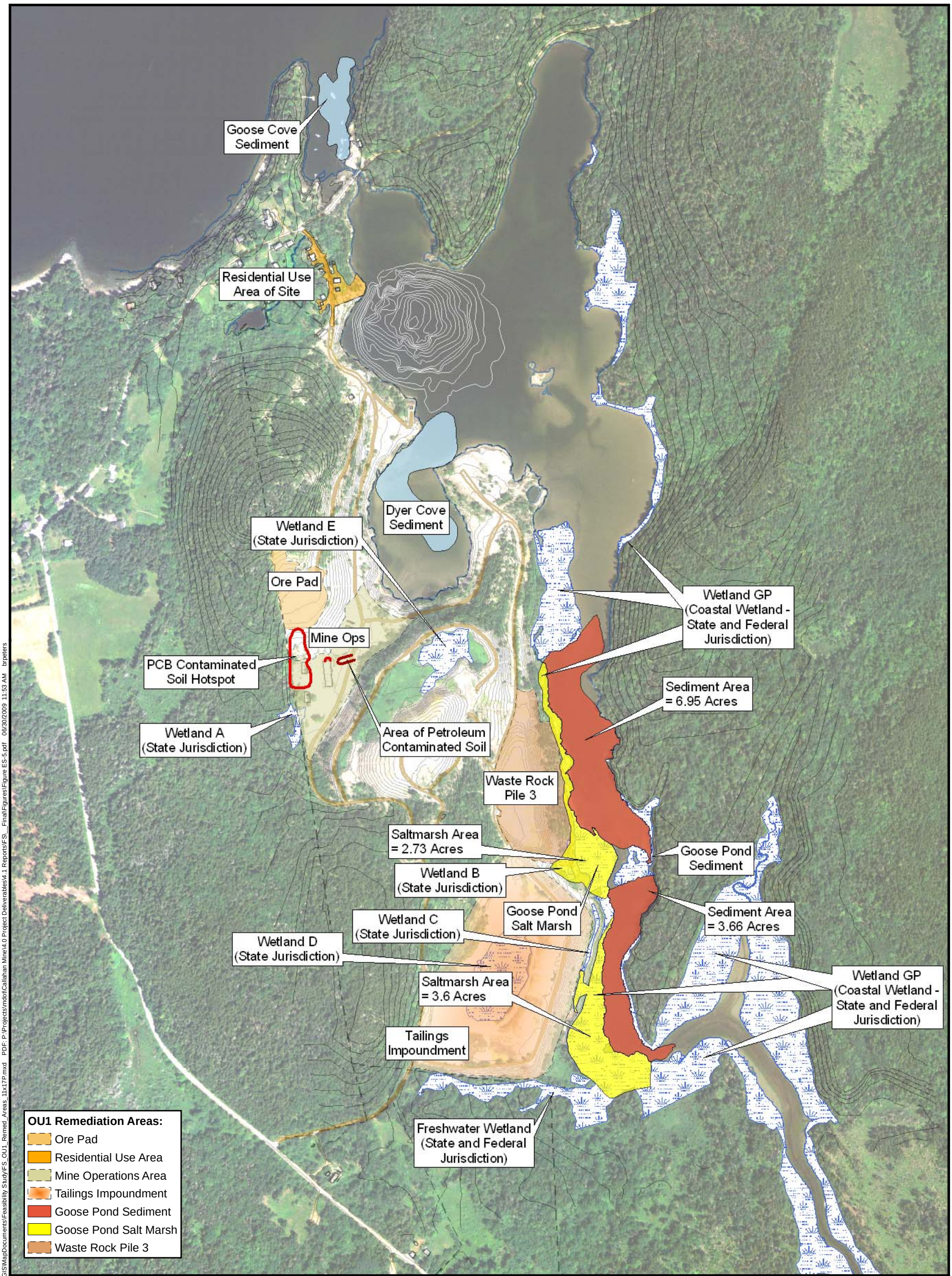

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Figure ES-5
OU1 Remediation Areas

OU1 Feasibility Study Report
Callahan Mine Superfund Site
Brooksville, Maine
MACTEC, Inc.

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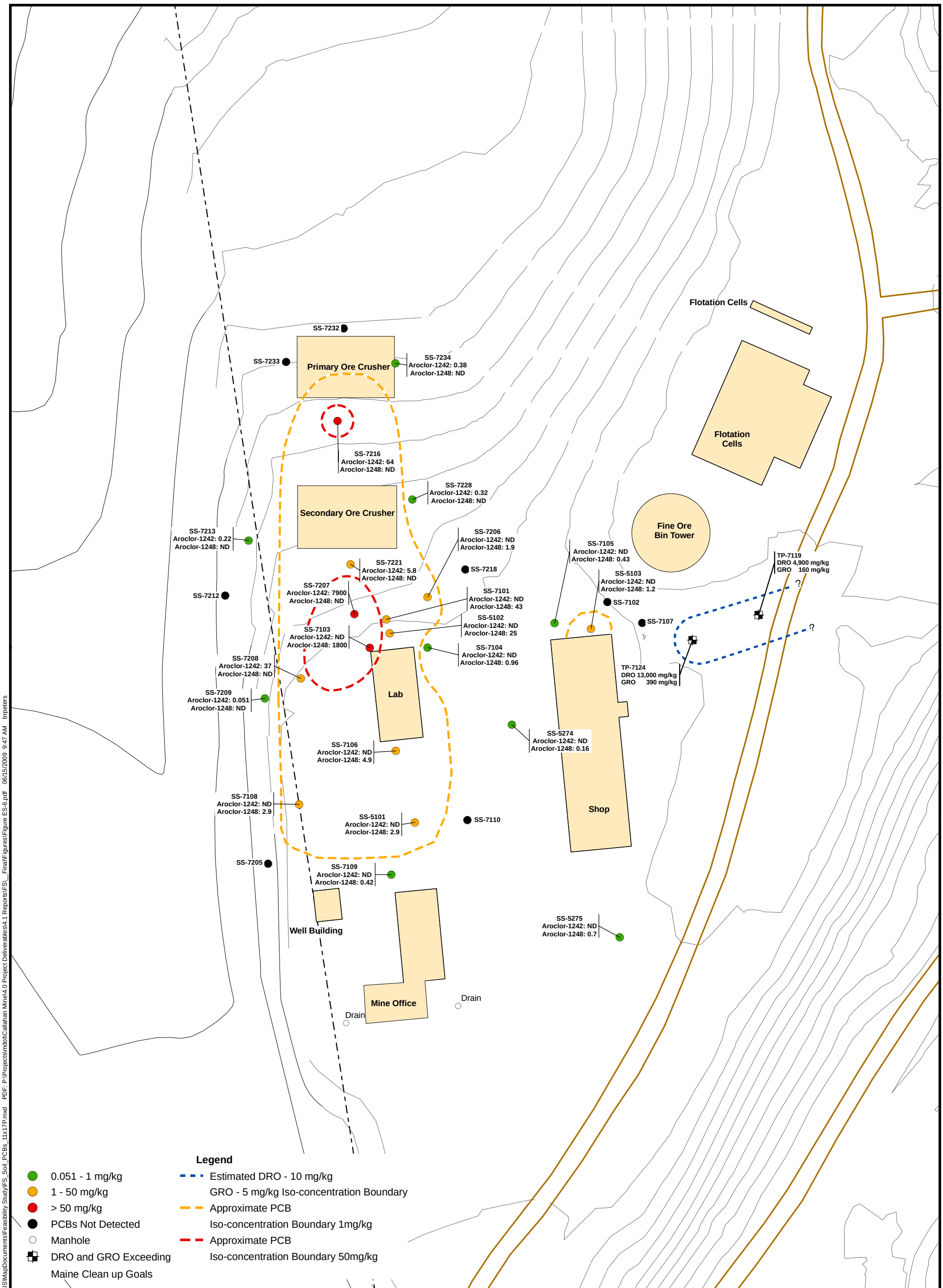

Figure ES-6
Areas Exceeding PCB PRGs and DRO/GRO Cleanup Goals

OU1 Feasibility Study Report
Callahan Mine Superfund Site
Brooksville, Maine
MACTEC, Inc.

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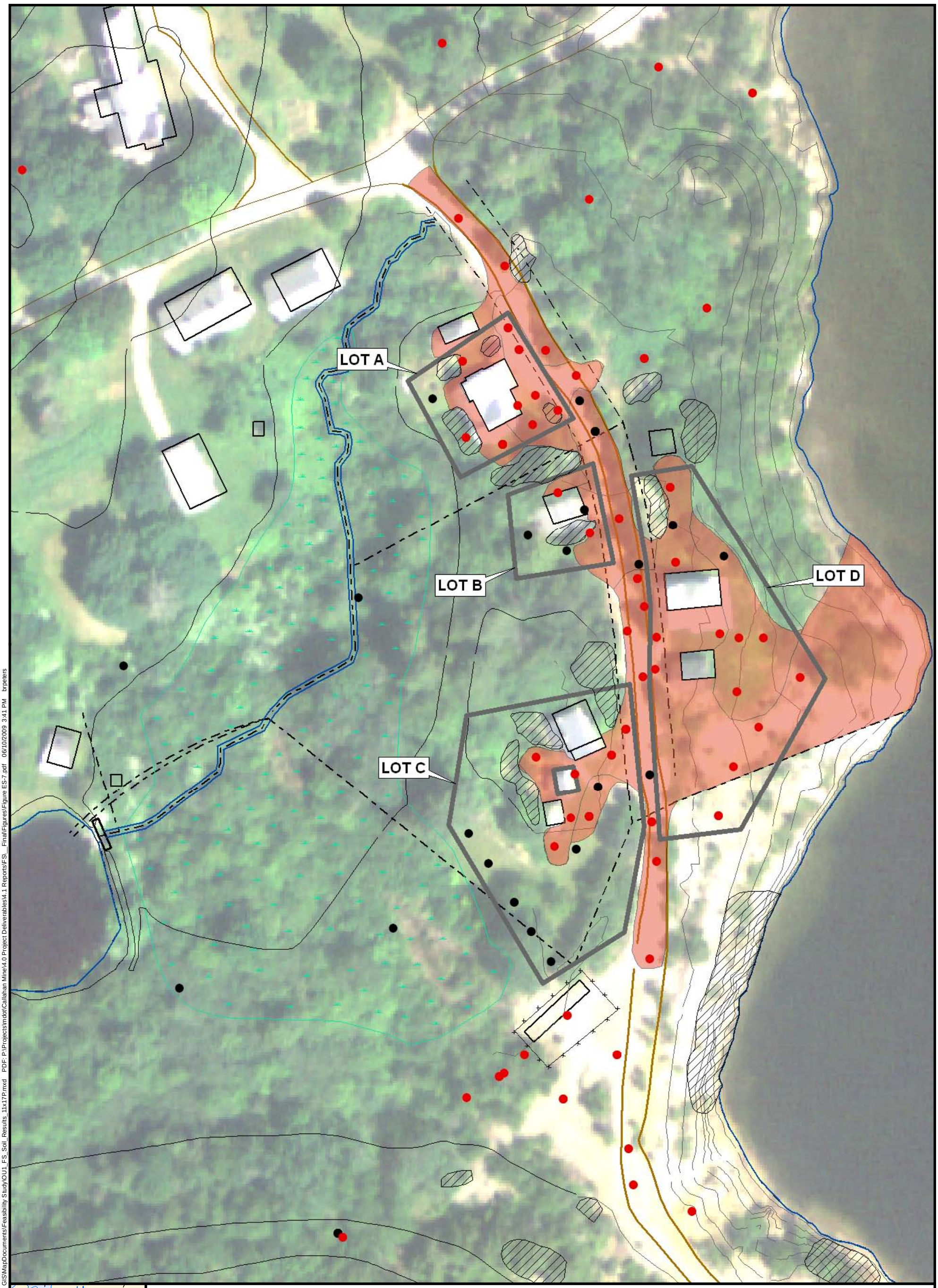

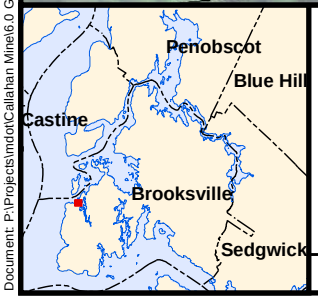

Legend

- Arsenic <= 14, Lead <= 375, and Thallium <= 15 mg/kg
- Arsenic > 14, Lead > 375, and Thallium > 15 mg/kg
- Bedrock Outcrops
- Risk Assessment Data Groups
- Area to be excavated - 41060 Sq. Feet
- Property Line

0 30 60 Feet

N

Prepared/Date: BRP 06/10/09 | Checked/Date: SWR 06/10/09

Figure ES-7
Residential Use Area Remediation

OU1 Feasibility Study Report
Callahan Mine Superfund Site
Brooksville, Maine
MACTEC, Inc.

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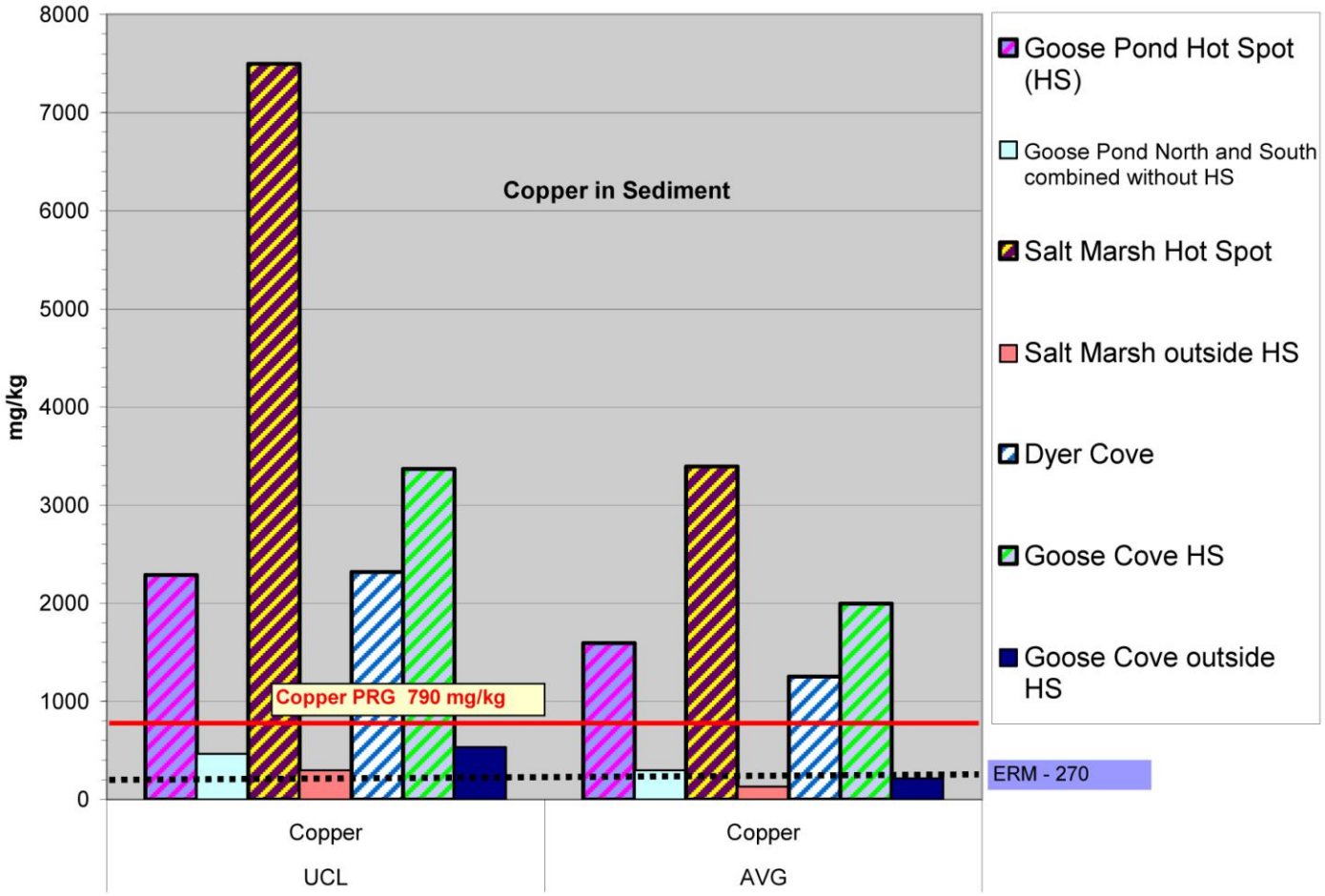

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CALLAHAN MINE SUPERFUND SITE

MACTEC

Comparison of Sediment Hot Spot and Non-Hot-Spot Concentrations for Copper
OU1 Feasibility Study Report
Callahan Mine Superfund Site
Brooksville, Maine

3612062047-30

Figure ES-8

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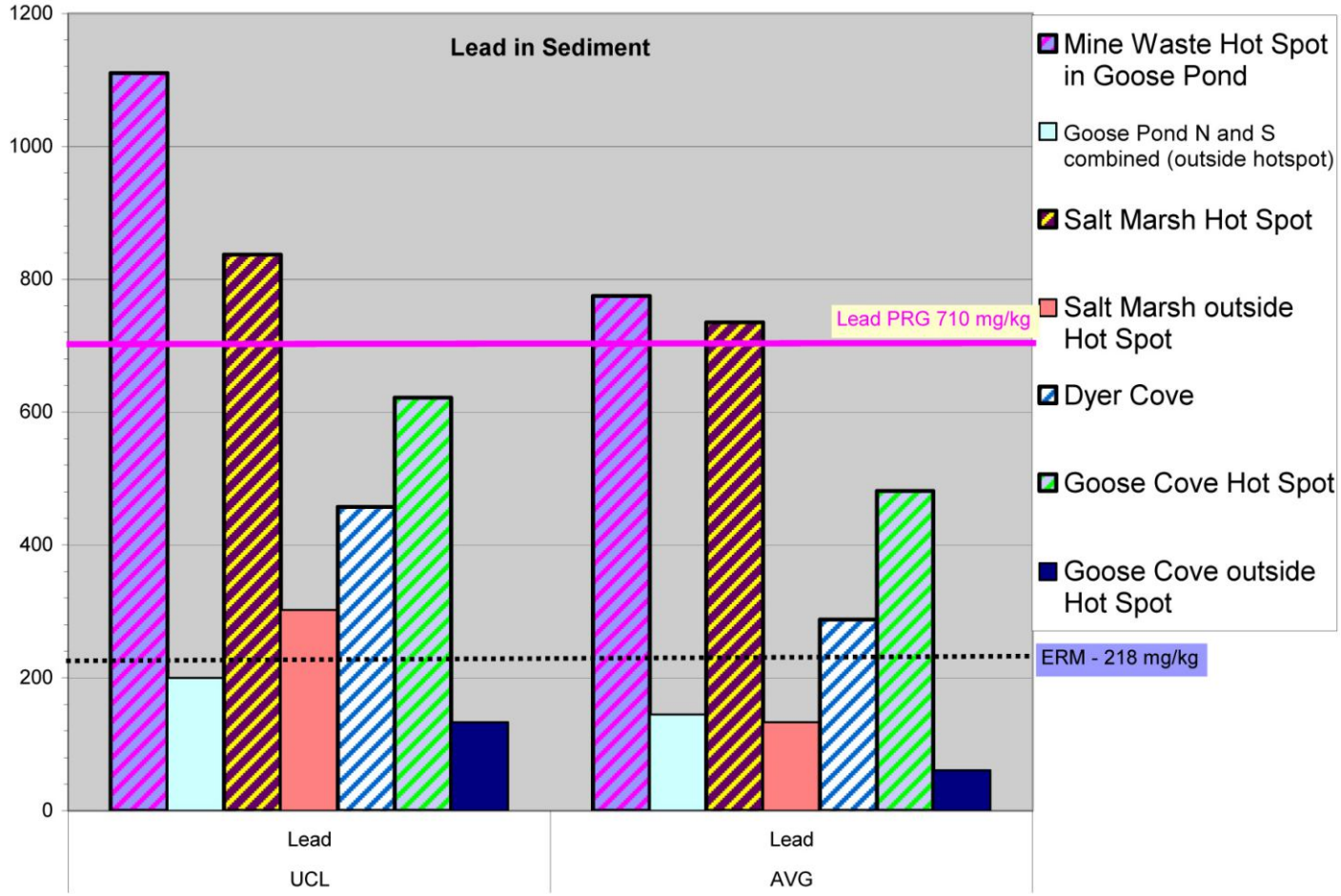

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CALLAHAN MINE SUPERFUND SITE

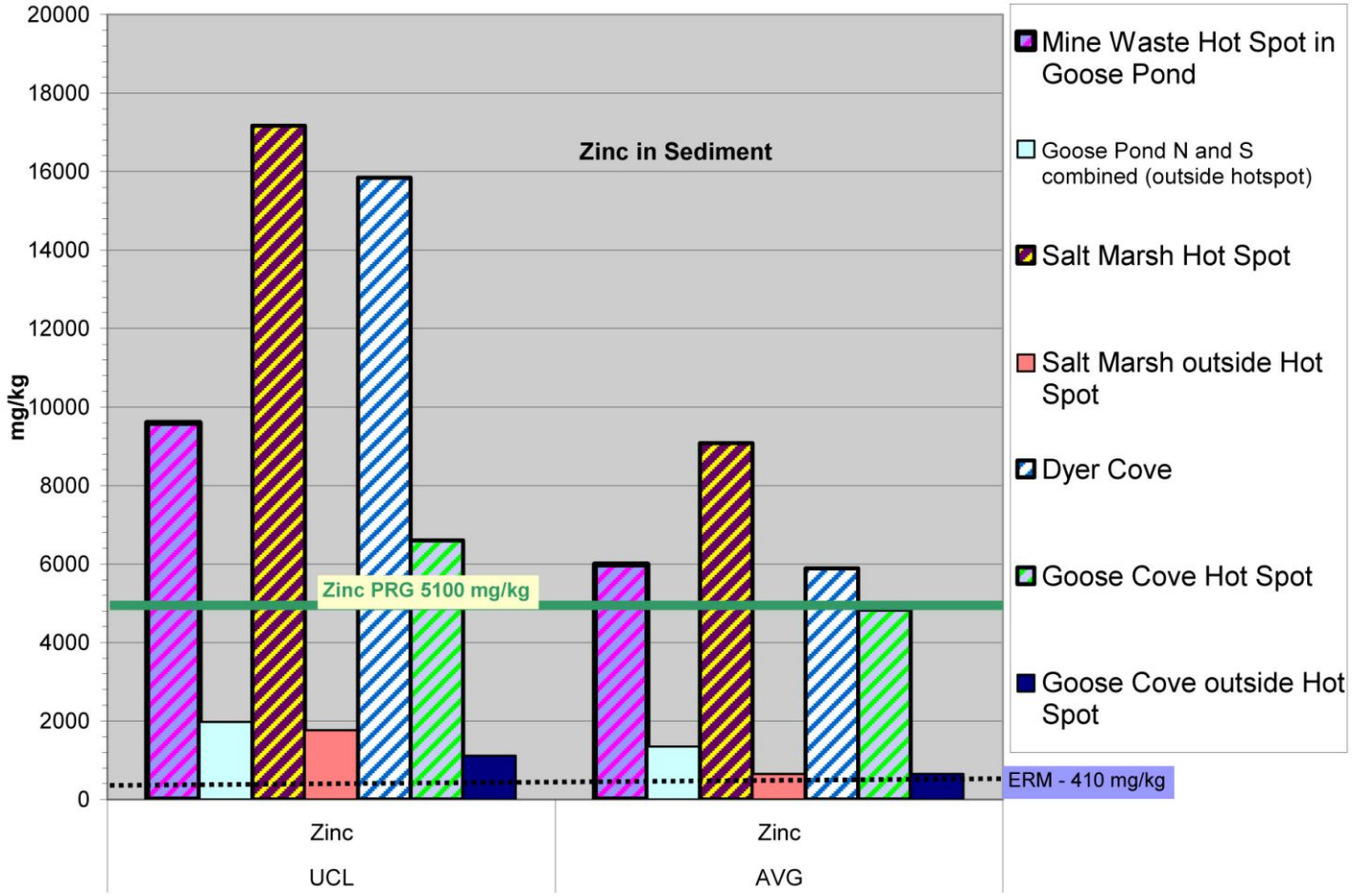
MACTEC

Comparison of Sediment Hot Spot and Non-Hot-Spot Concentrations for Lead
OU1 Feasibility Study Report
Callahan Mine Superfund Site
Brooksville, Maine

3612062047-30

Figure ES-9

PORT2009013c-pg2.cdr



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CALLAHAN MINE SUPERFUND SITE

MACTEC

Comparison of Sediment Hot Spot and Non-Hot-Spot Concentrations for Zinc
OU1 Feasibility Study Report
Callahan Mine Superfund Site
Brooksville, Maine

3612062047-30

Figure ES-10

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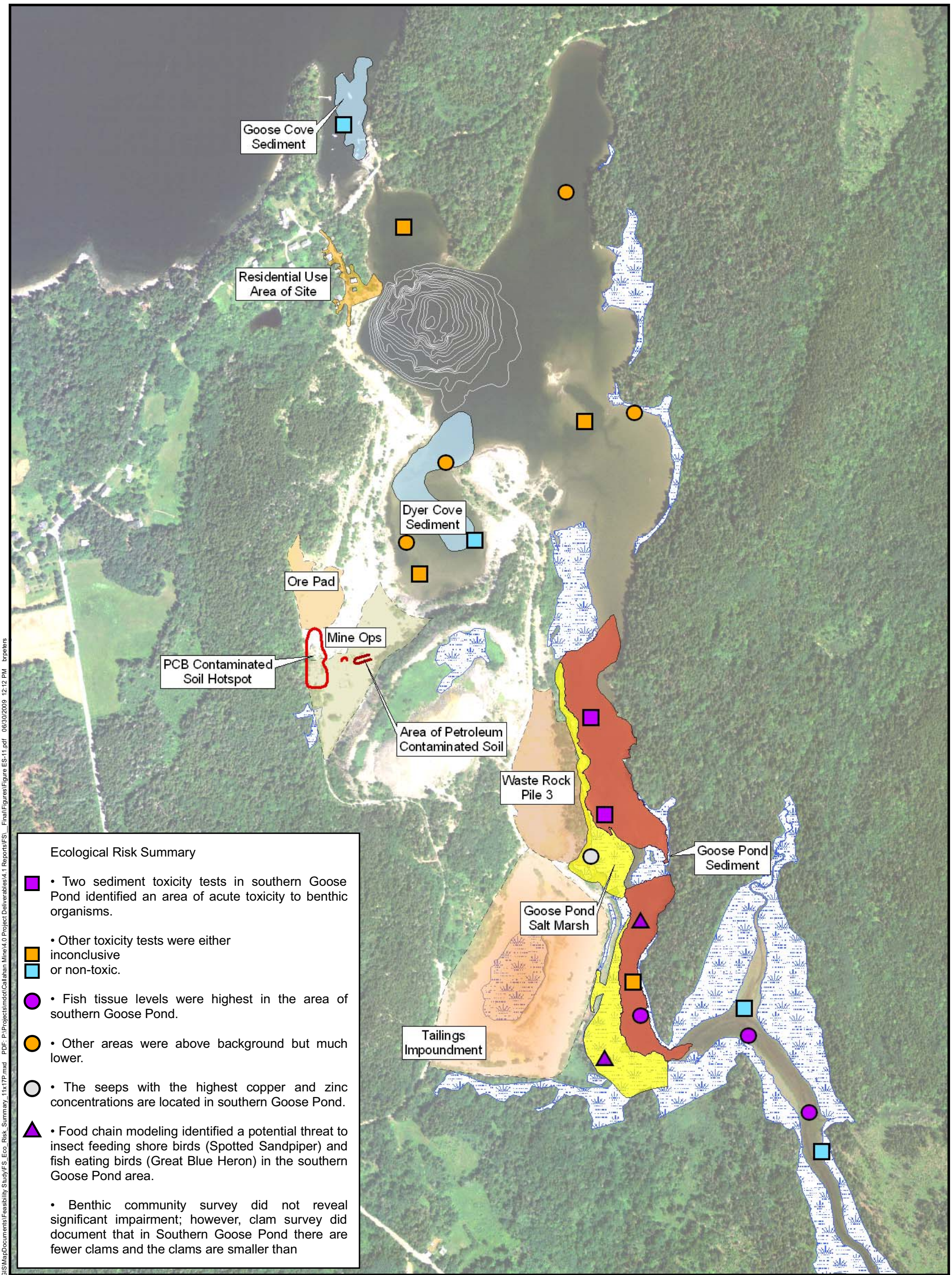

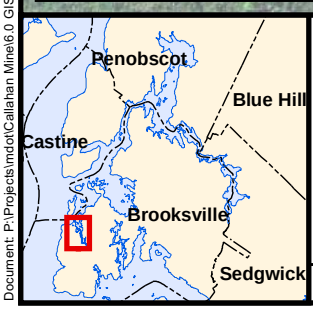

Legend

Bathymetric Contour

Delineated Wetlands

N

0 250 500 Feet

Prepared/Date: BRP 06/30/09 | Checked/Date: SWR 06/30/09

Figure ES-11
Highlights of Tier II Evaluation

OU1 Feasibility Study Report
Callahan Mine Superfund Site
Brooksville, Maine
MACTEC, Inc.

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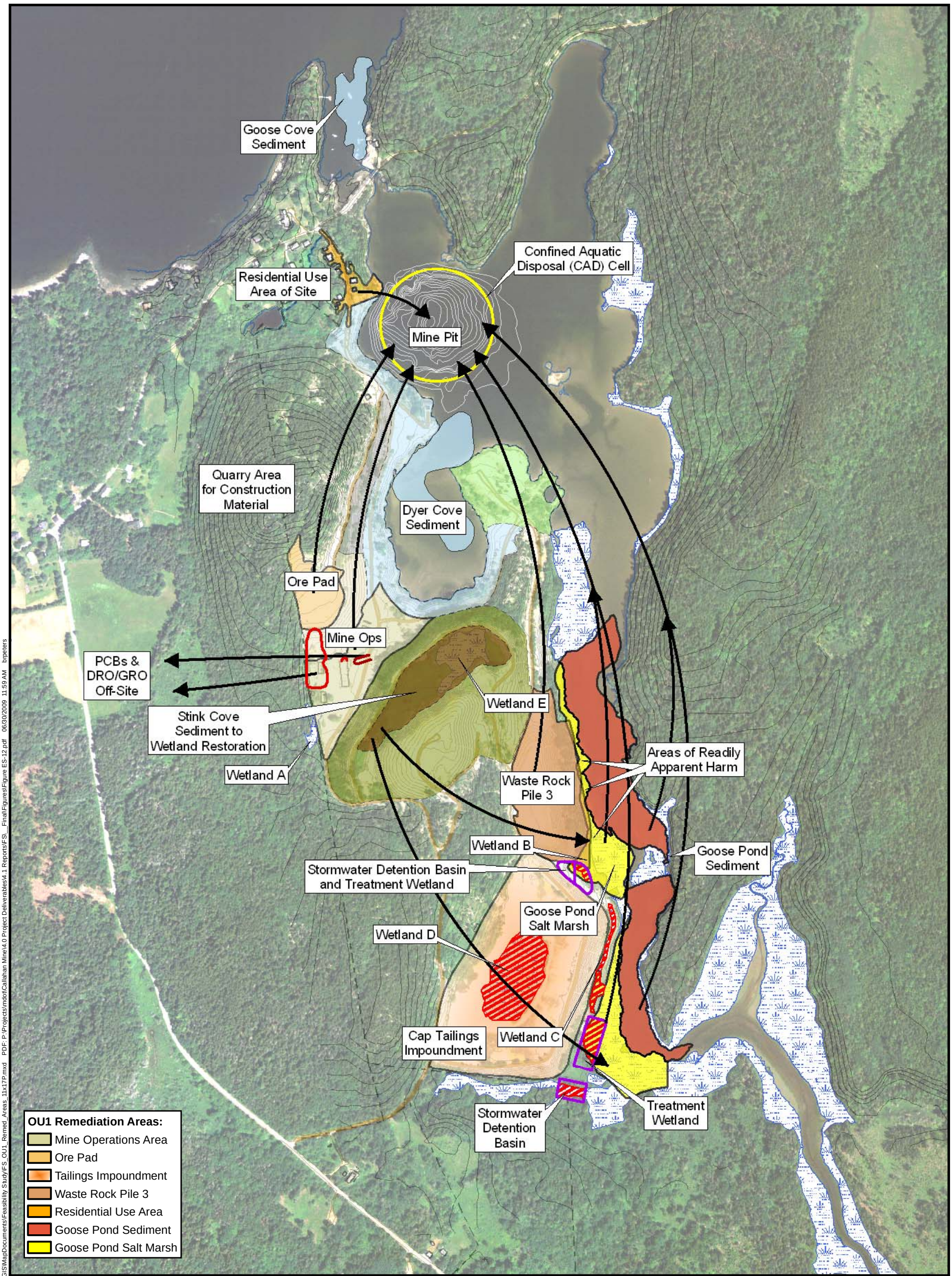

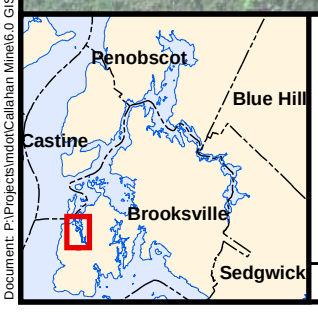

Legend

- Bathymetric Contour
- Delineated Wetlands
- Area of Permanent Wetland Loss

N

0 250 500 Feet

Prepared/Date: BRP 06/30/09 | Checked/Date: SWR 06/30/09

Figure ES-12
Alternative CMS2
Proposed Remedy Map

OU1 Feasibility Study Report
Callahan Mine Superfund Site
Brooksville, Maine
MACTEC, Inc.

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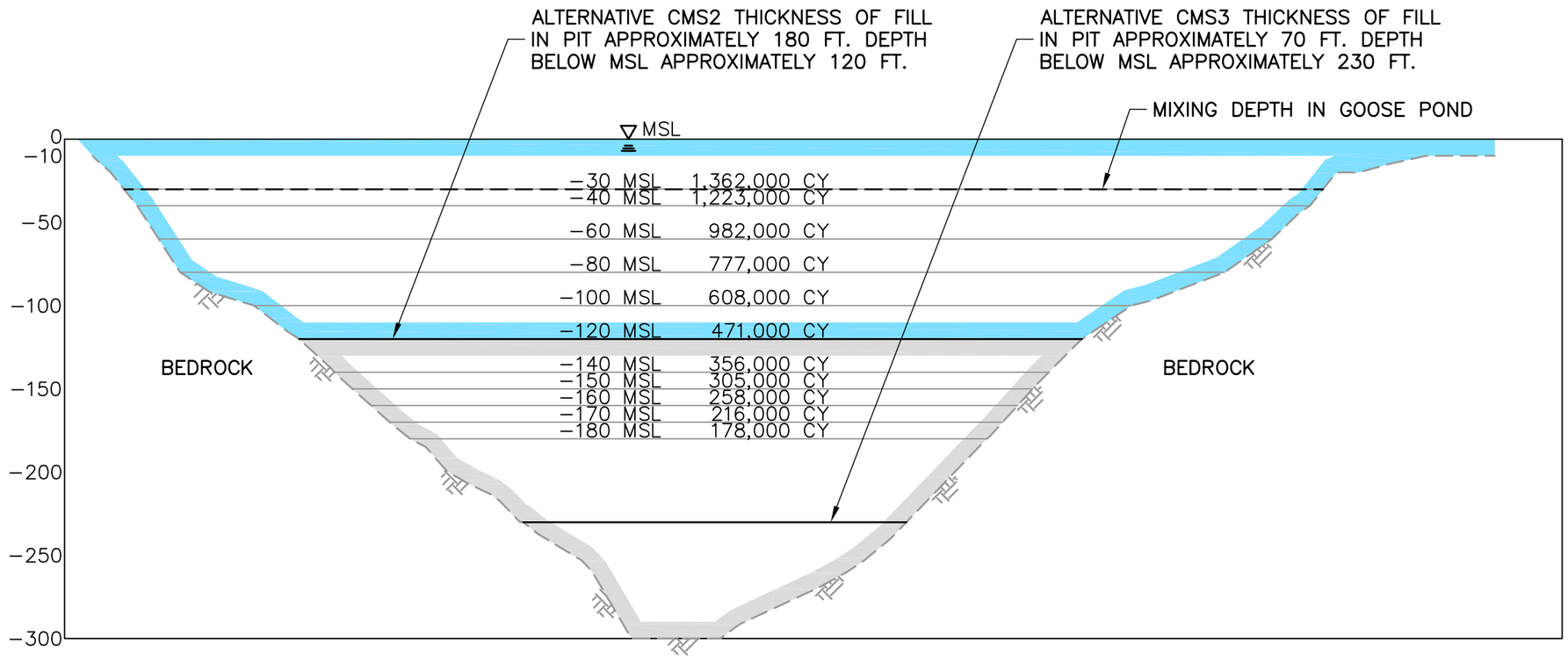
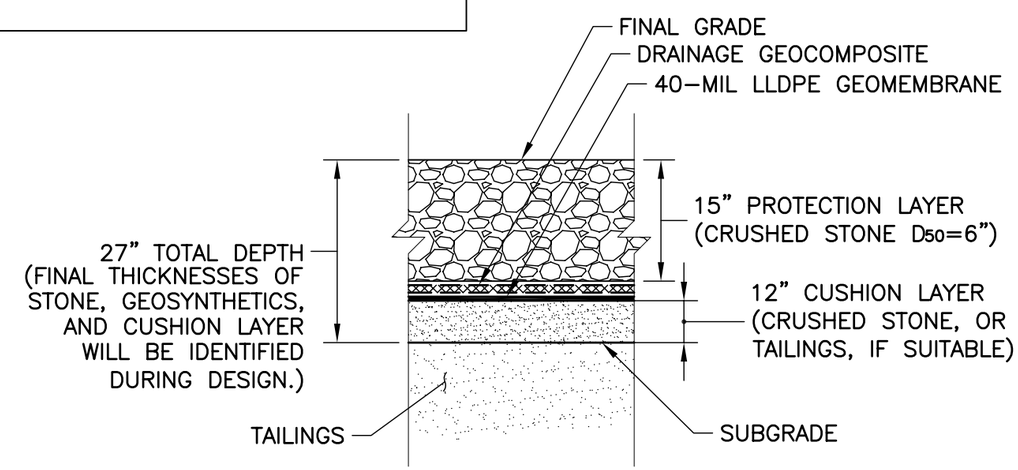


WEST TO EAST CROSS–SECTION THROUGH MINE PIT

0 40 80 160
SCALE IN FEET



INFILTRATION BARRIER CAP
NTS

Prepared/Date: DEL 06/17/09
Checked/Date: SWR 06/17/09

CALLAHAN MINE SUPERFUND SITE
BROOKSVILLE, MAINE

MACTEC

CAD CELL AND TAILINGS IMPOUNDMENT COVER SYSTEM
OU1 FEASIBILITY STUDY REPORT
Project 3612-06-2047.30
Figure ES-13

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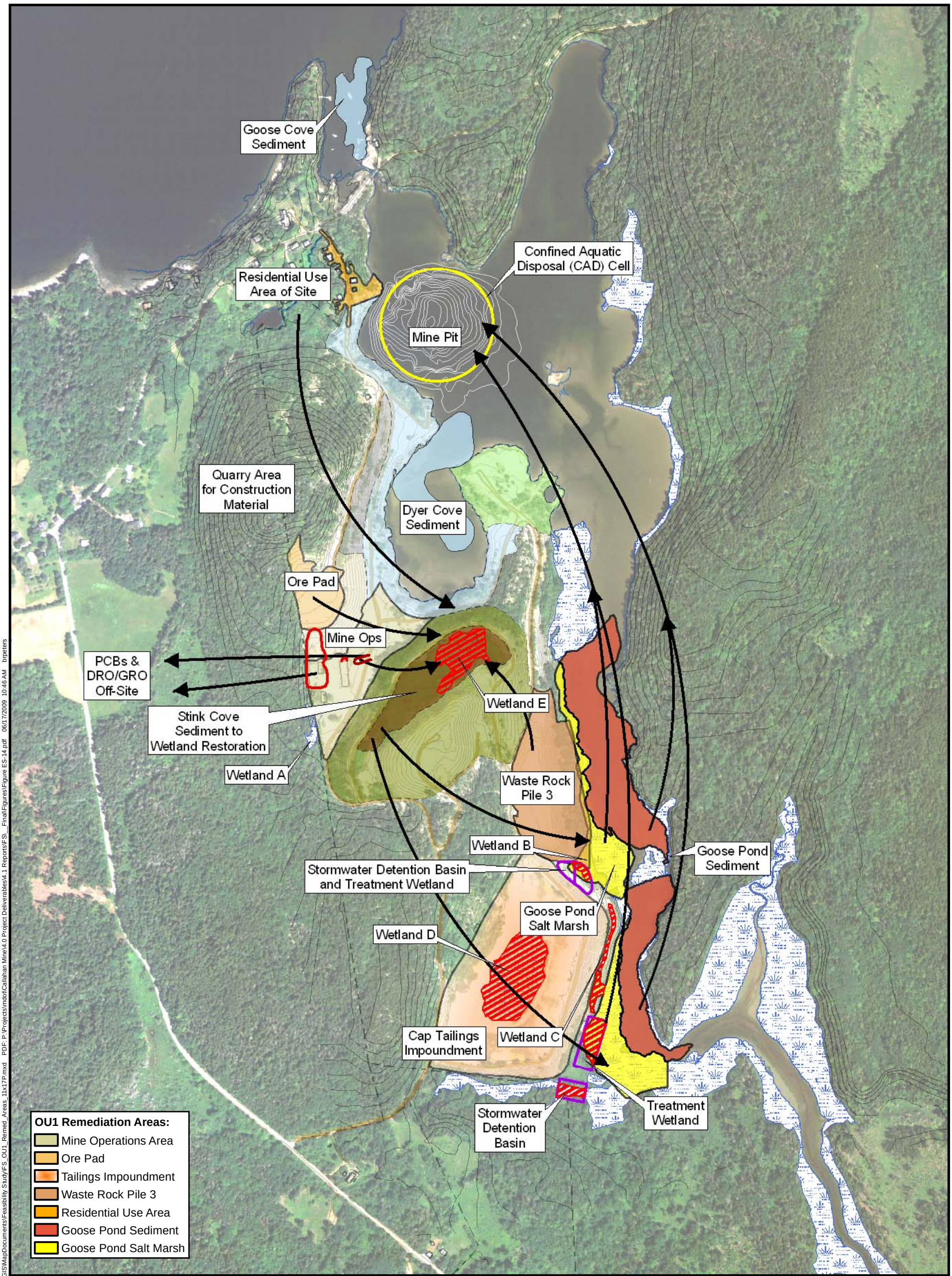

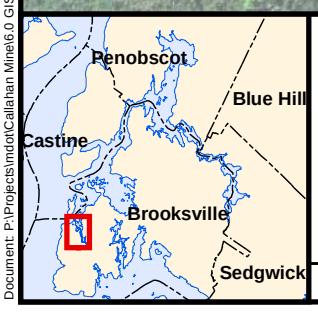

Legend

- Bathymetric Contour
- Delineated Wetlands
- Area of Permanent Wetland Loss

N

0 250 500 Feet

Prepared/Date: BRP 06/17/09 | Checked/Date: SWR 06/17/09

Figure ES-14
Alternative CMS3
Proposed Remedy Map

OU1 Feasibility Study Report
Callahan Mine Superfund Site
Brooksville, Maine
MACTEC, Inc.

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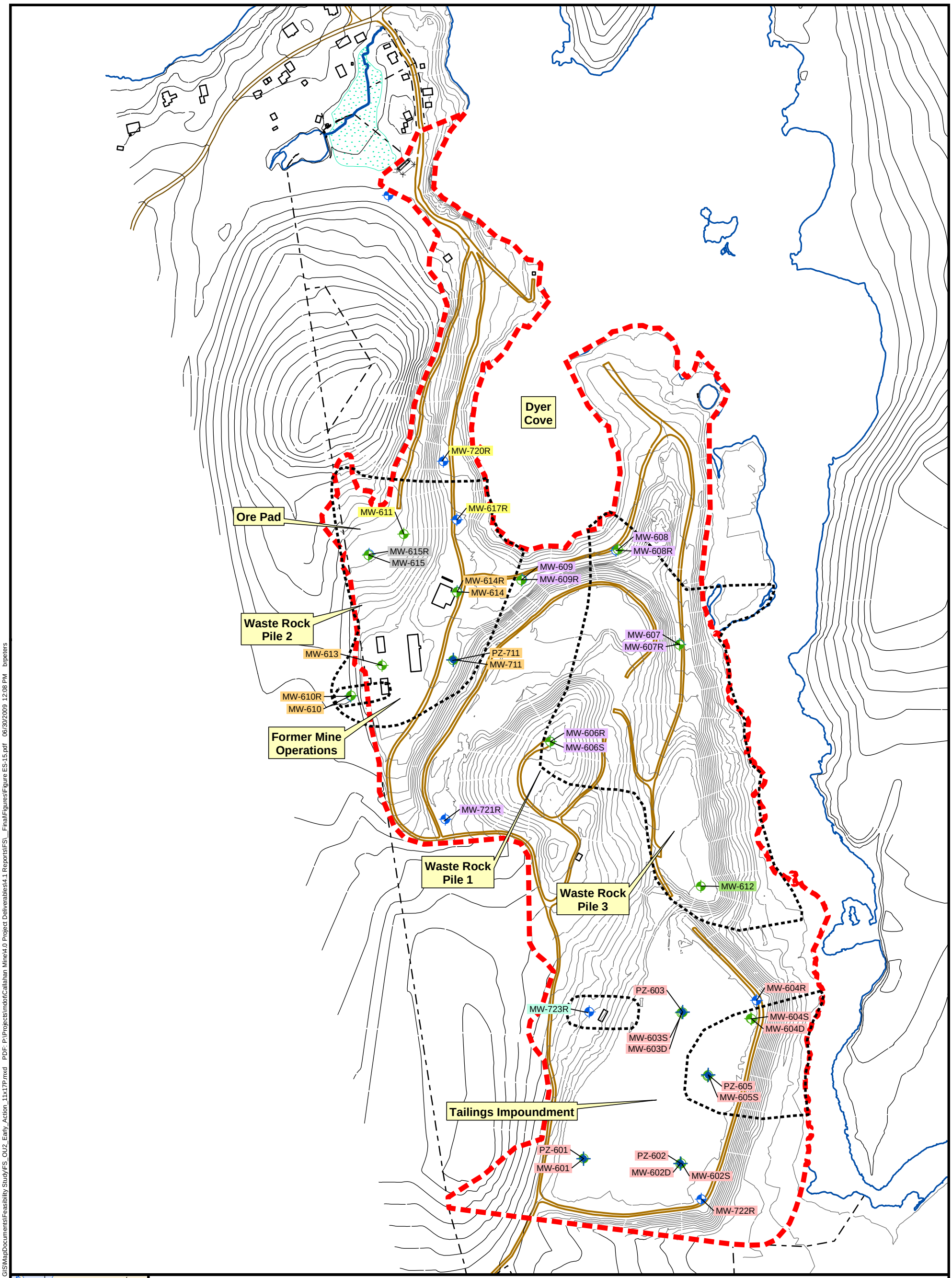

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Figure ES-15
OU2 Early Action IC Areas

OU1 Feasibility Study Report
Callahan Mine Superfund Site
Brooksville, Maine
MACTEC, Inc.

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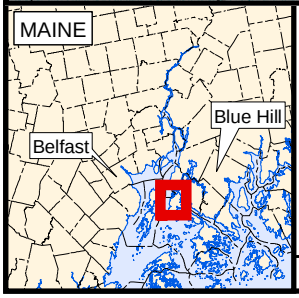

1:24,000 scale digital topographic map obtained from Maine Office of GIS at http://apollo.ogis.state.me.us/catalog

N

0 2,000 4,000 Feet

Prepared/Date: DBW 03/04/09 | Checked/Date: SWR 03/04/09

Figure 1.0-1
Site Location Map

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Figure 1.4-1
Site Photo (looking south), 1972

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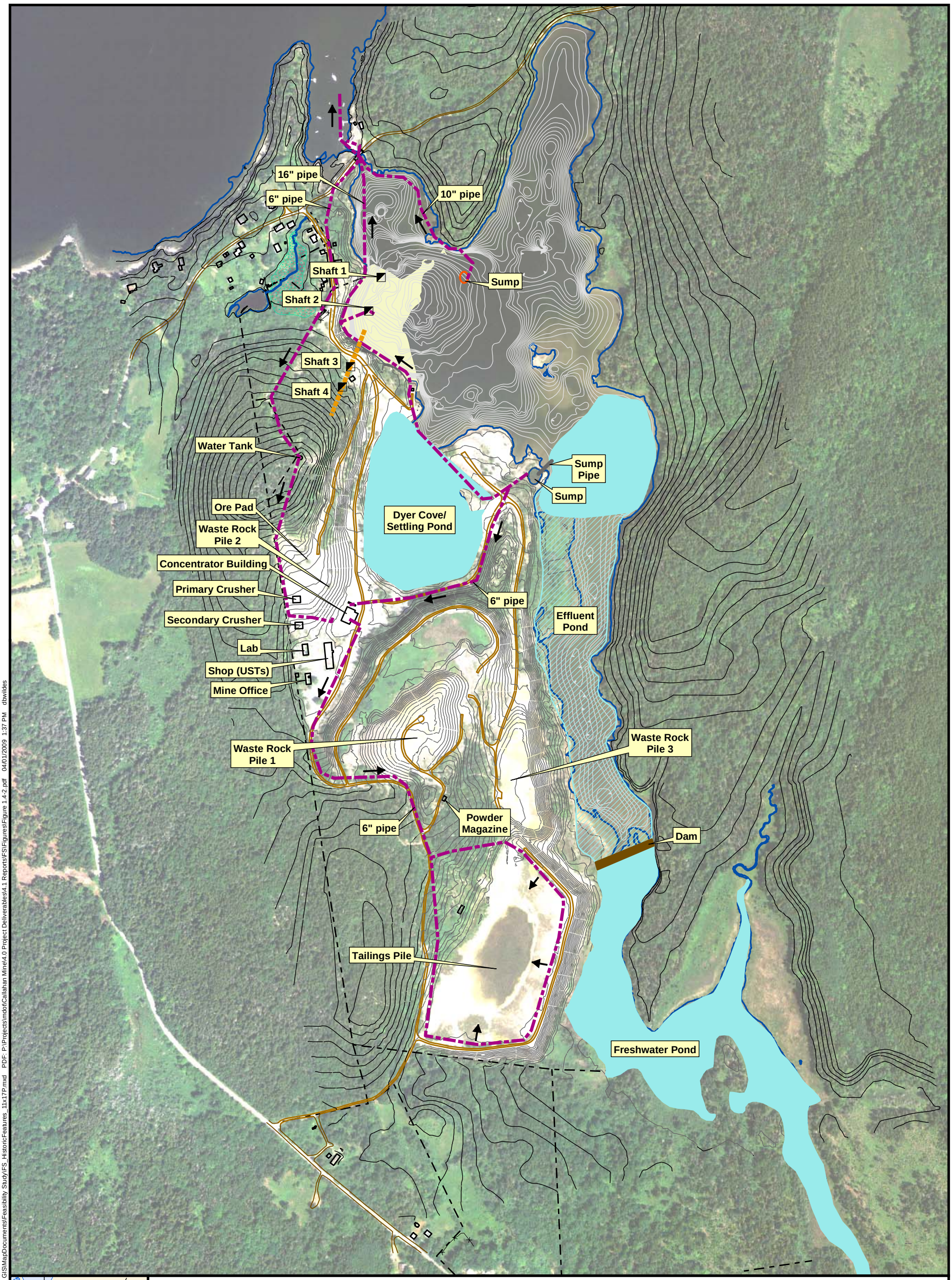
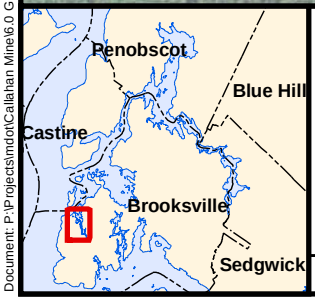
PORT2009008a.cdr





Legend

- Mine Shaft
- Purported Lateral Mine Shafts The "920" and the "860"
- Operations Piping
- Water
- Intermittent Water
- Pre-Mine Shoreline Excavated

N

0 250 500 Feet

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Figure 1.4-2
Historical Mine Features (1972)

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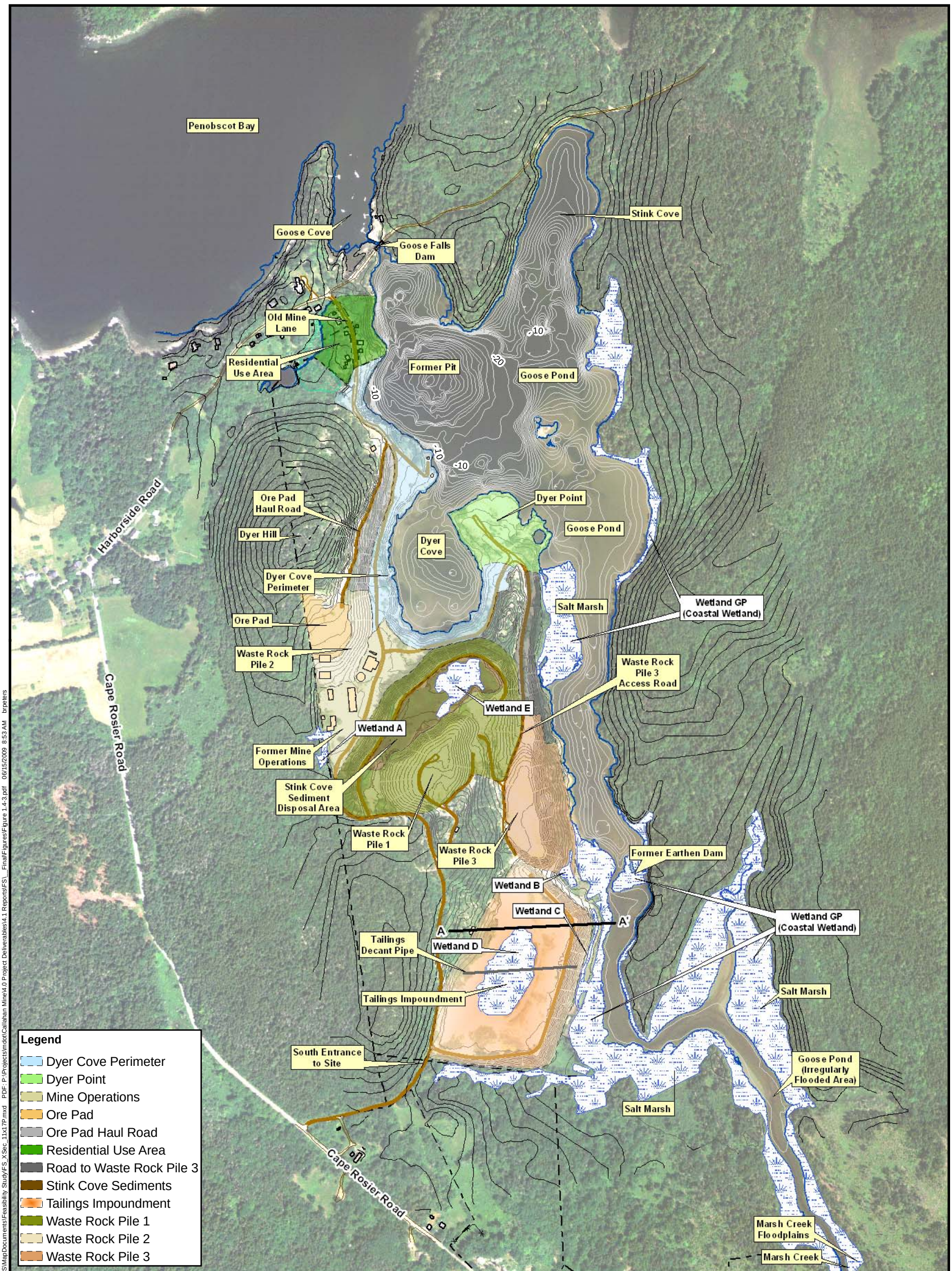

Note:
Contour intervals vary.
Off-site topo 10 foot
On-site topo 5 foot
Bathymetry 1 foot
Pit Bathymetry 20 foot

Legend
- Cross Section Profile
- Bathymetric Contour
- Delineated Wetlands

N

0 275 550 Feet

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Figure 1.4-3
Site Features

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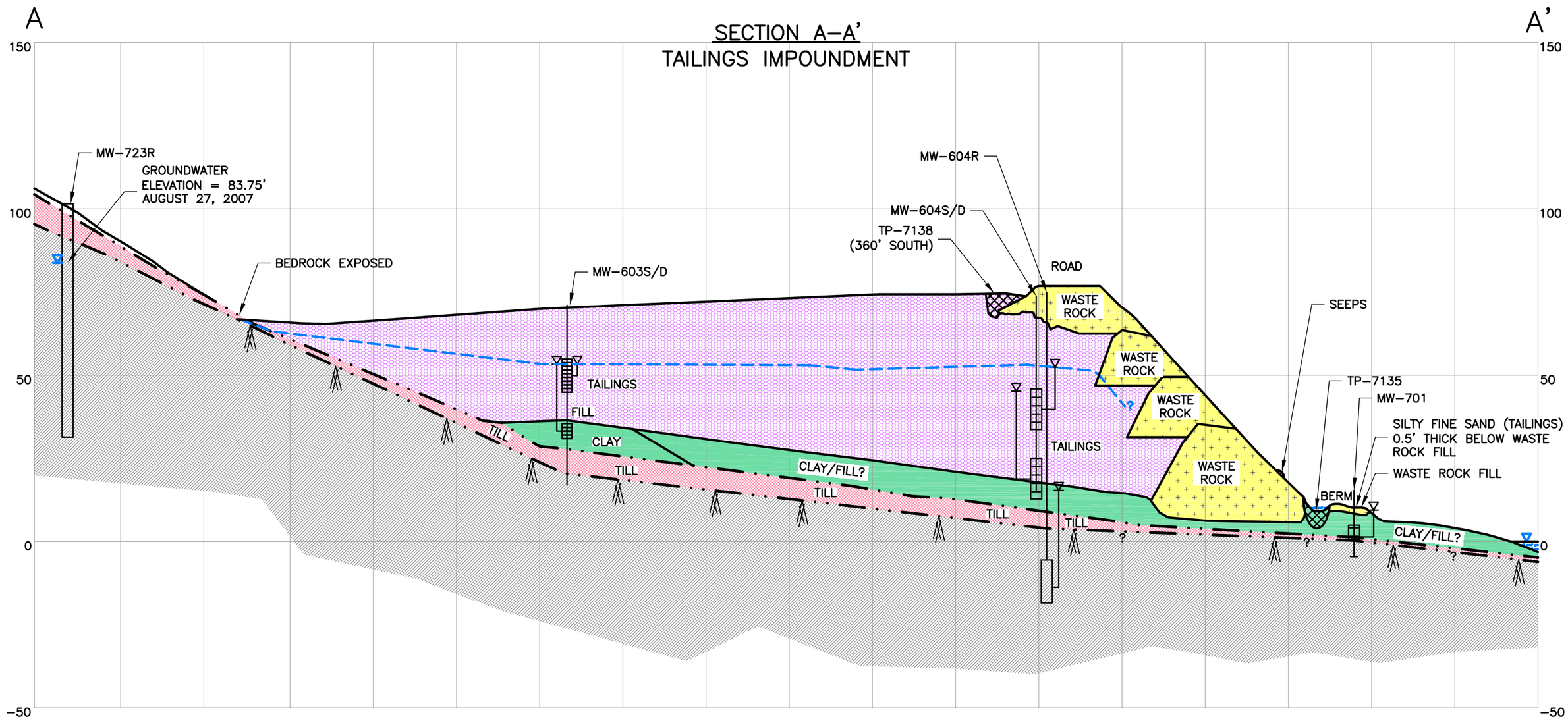

LEGEND

- TAILINGS
- WASTE ROCK
- CLAY
- TILL
- BEDROCK

SCREENED MONITORING WELL

WATER LEVEL IN MONITORING WELL
OPEN HOLE BEDROCK WELL

WATER ELEVATION DATA FROM 08/27/07

SURFACE WATER LEVEL

0 30 60 120
HORIZONTAL SCALE IN FEET

0 15 30 60
VERTICAL SCALE IN FEET

Prepared/Date: JVM 03/04/09
Checked/Date: SR 03/04/09

Project 3612-06-2047.30

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Figure 1.4-4
CROSS SECTION A-A'
OU1 FEASIBILITY STUDY REPORT
CALLAHAN MINE SUPERFUND SITE
BROOKSVILLE, MAINE

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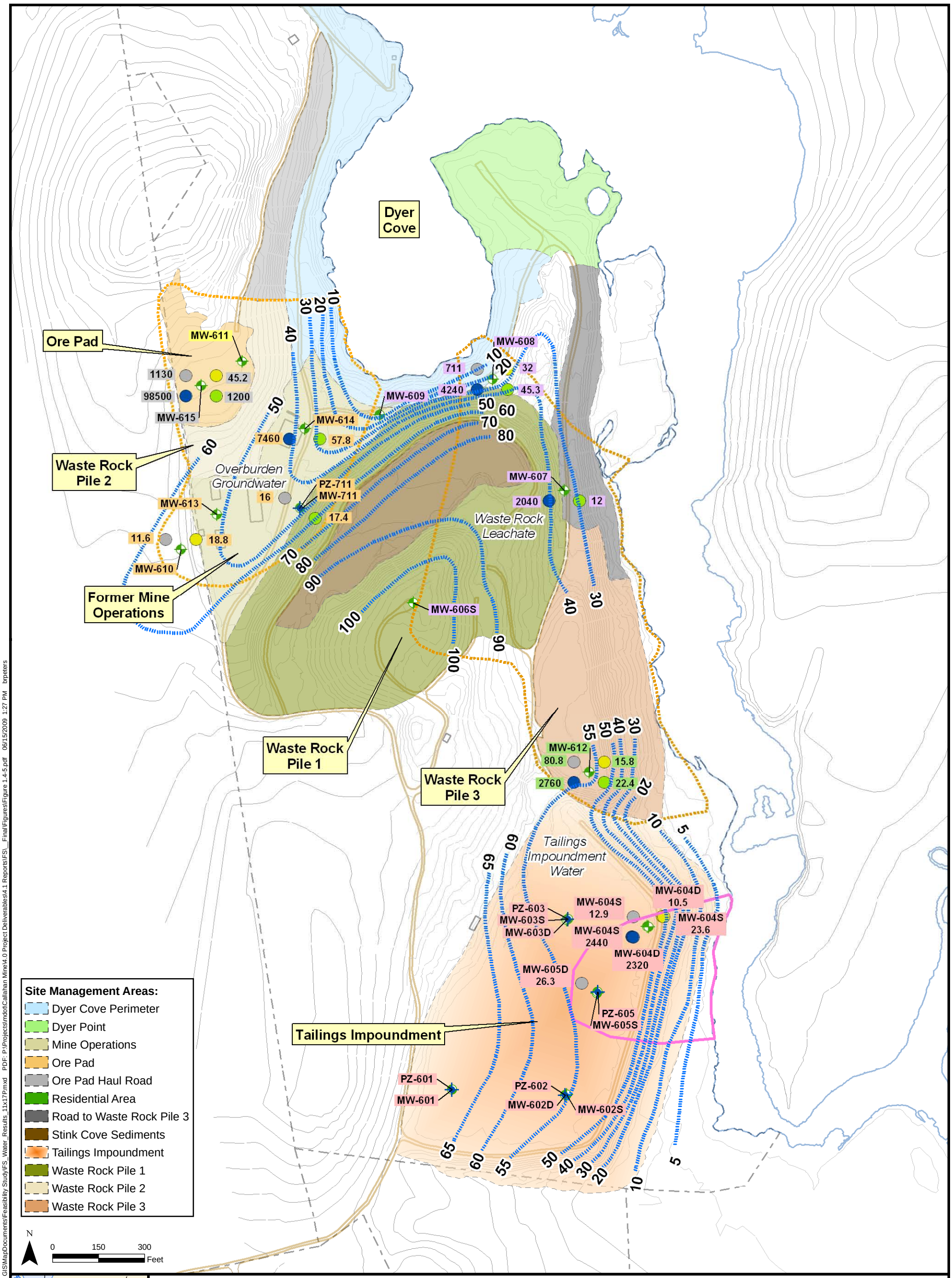

Legend

- Piezometer
- Overburden Monitoring Well
- Contour (8/27/07)
- Ore Pad/Mine Ops
- Tailings Impoundment Water
- Waste Rock Leachate
- Arsenic >MCL/MEG 10 ug/L
- Cadmium > MEG 3.5 ug/L (MCL 5.0 ug/L)
- Copper > MCL/MEG 1,300 ug/L
- Lead > MEG 10 ug/L (MCL 15 ug/L)
- Zinc > MEG 2,000 ug/L (MCL 5,000 ug/L)

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Figure 1.4-5
Overburden Groundwater Exceeding As, Cd, Cu, Pb, and Zn MCLs/MEGs

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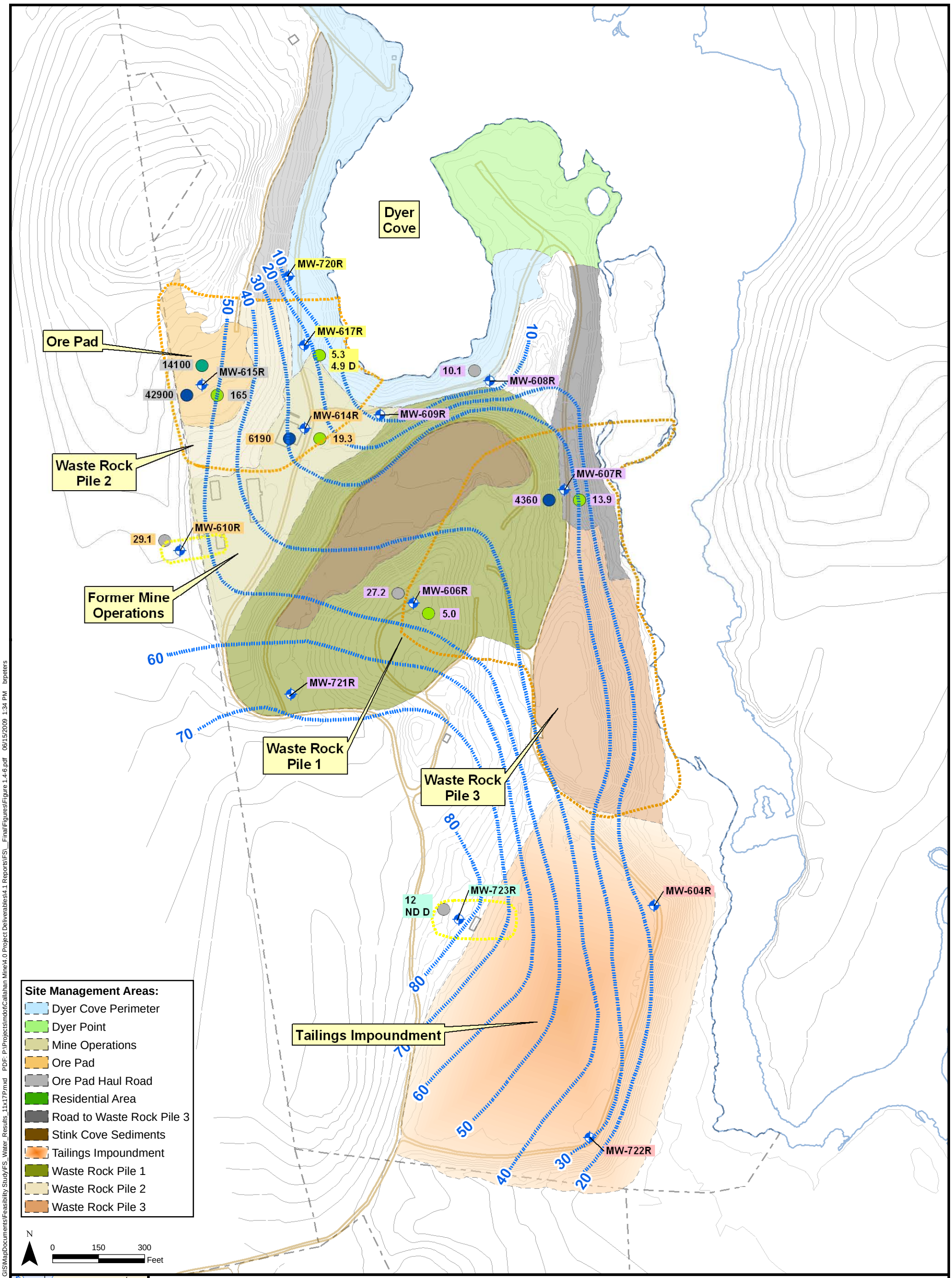

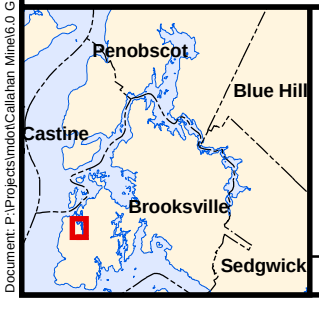

Legend

- Bedrock Groundwater Contour (8/27/07)
- Bedrock Groundwater in Excess of MCLs/MEGs:
  - Background Mine Ops/Tailings Impoundment
  - Ore Pad/Mine Ops
  - Waste Rock Pile 1 & 3
- Bedrock Monitoring Well
- Arsenic >MCL/MEG 10 ug/L
- Cadmium > MEG 3.5 ug/L (MCL 5.0 ug/L)
- Copper > MCL/MEG 1,300 ug/L
- Lead > MEG 10 ug/L (MCL 15 ug/L)
- Zinc > MEG 2,000 ug/L (MCL 5,000 ug/L)

D - Duplicate Sample ND - Non-Detect

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Figure 1.4-6
Bedrock Groundwater Exceeding
As, Cd, Cu, Pb, and Zn MCLs/MEGs

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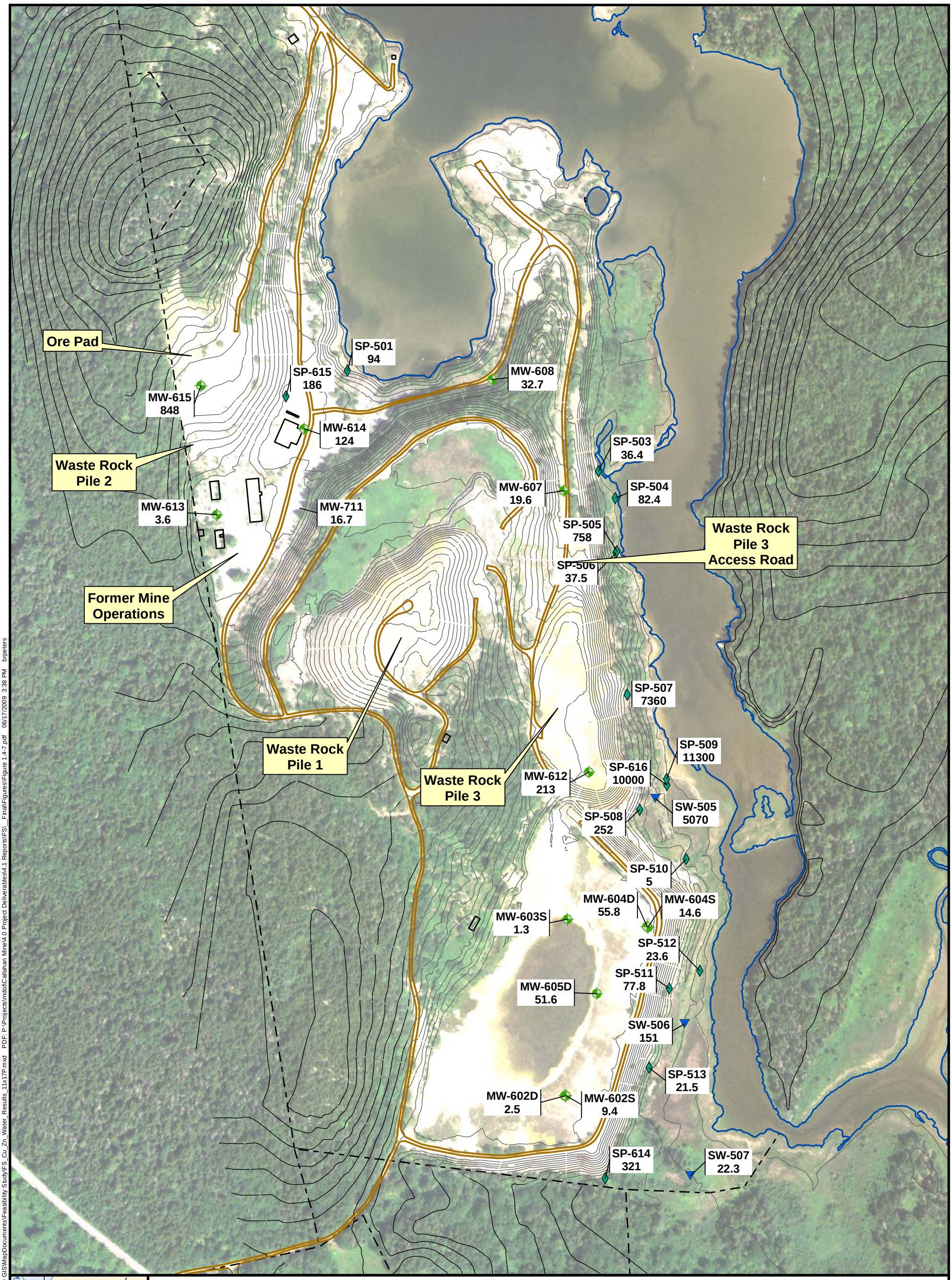

Figure 1.4-7
Copper in Seep, Surface Water, and Overburden Groundwater

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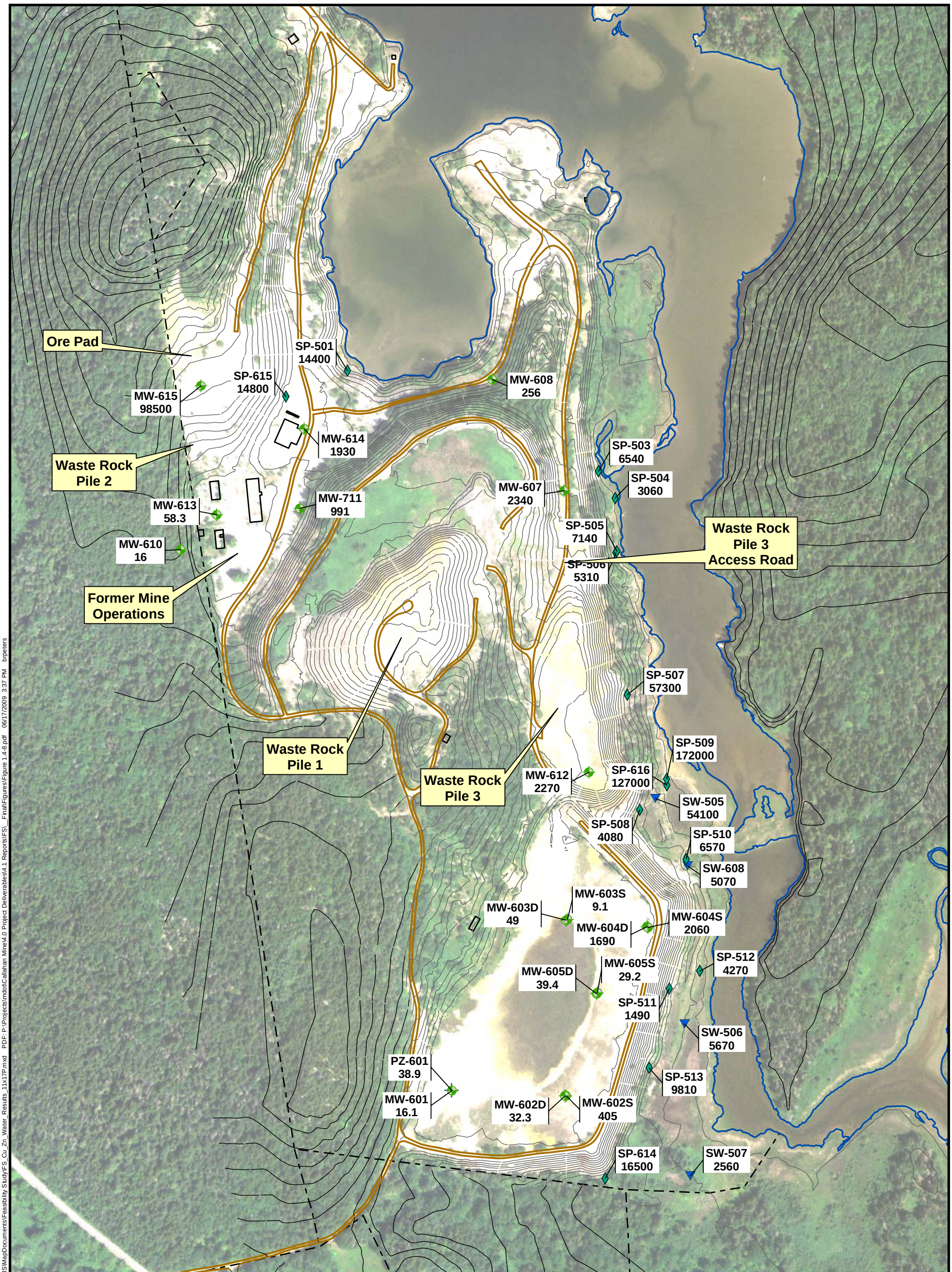

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Figure 1.4-8
Zinc in Seep, Surface Water, and Overburden Groundwater

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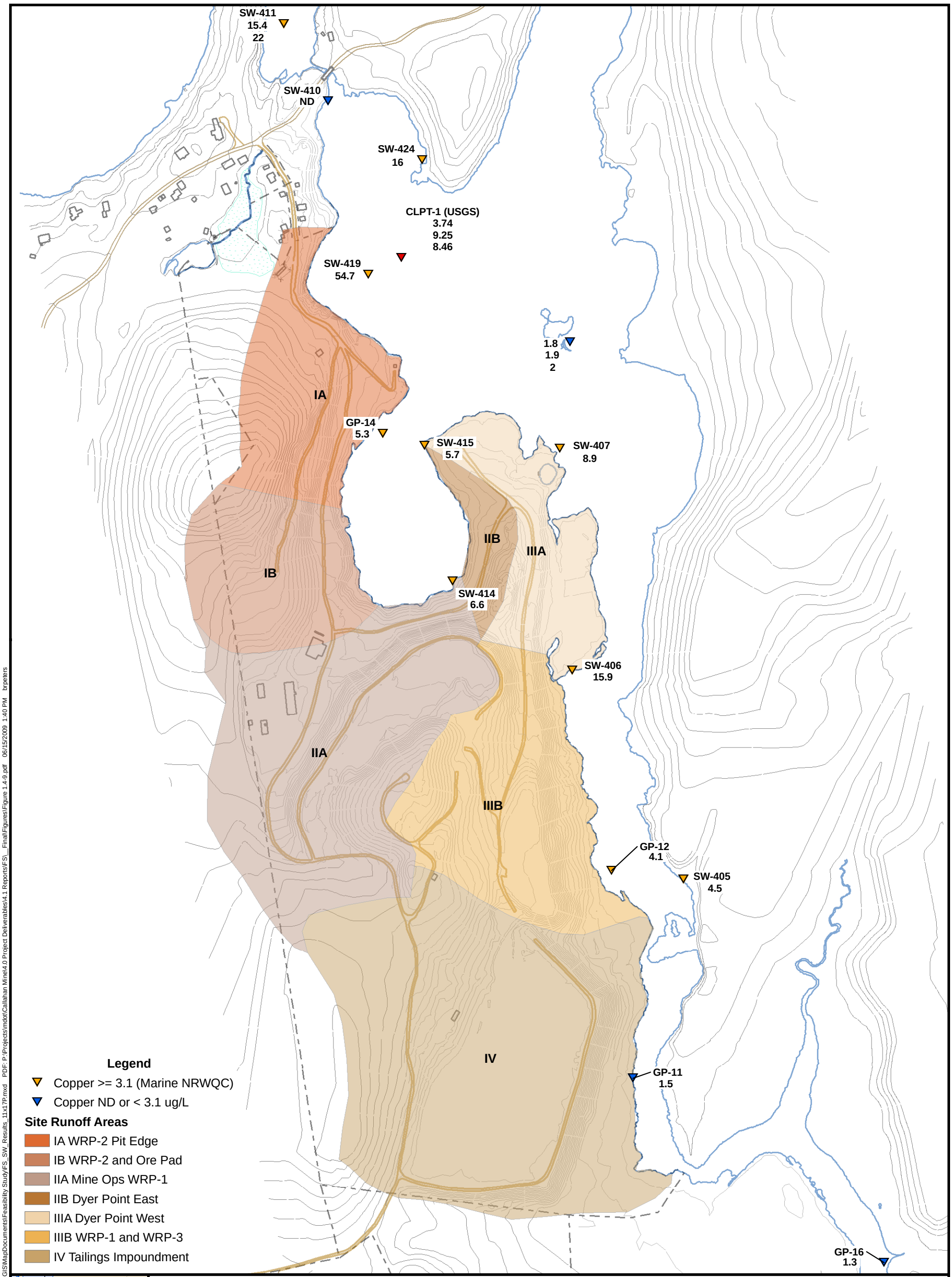

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Figure 1.4-9
Copper Detected in Marine Surface Water
in Excess of NRWQC

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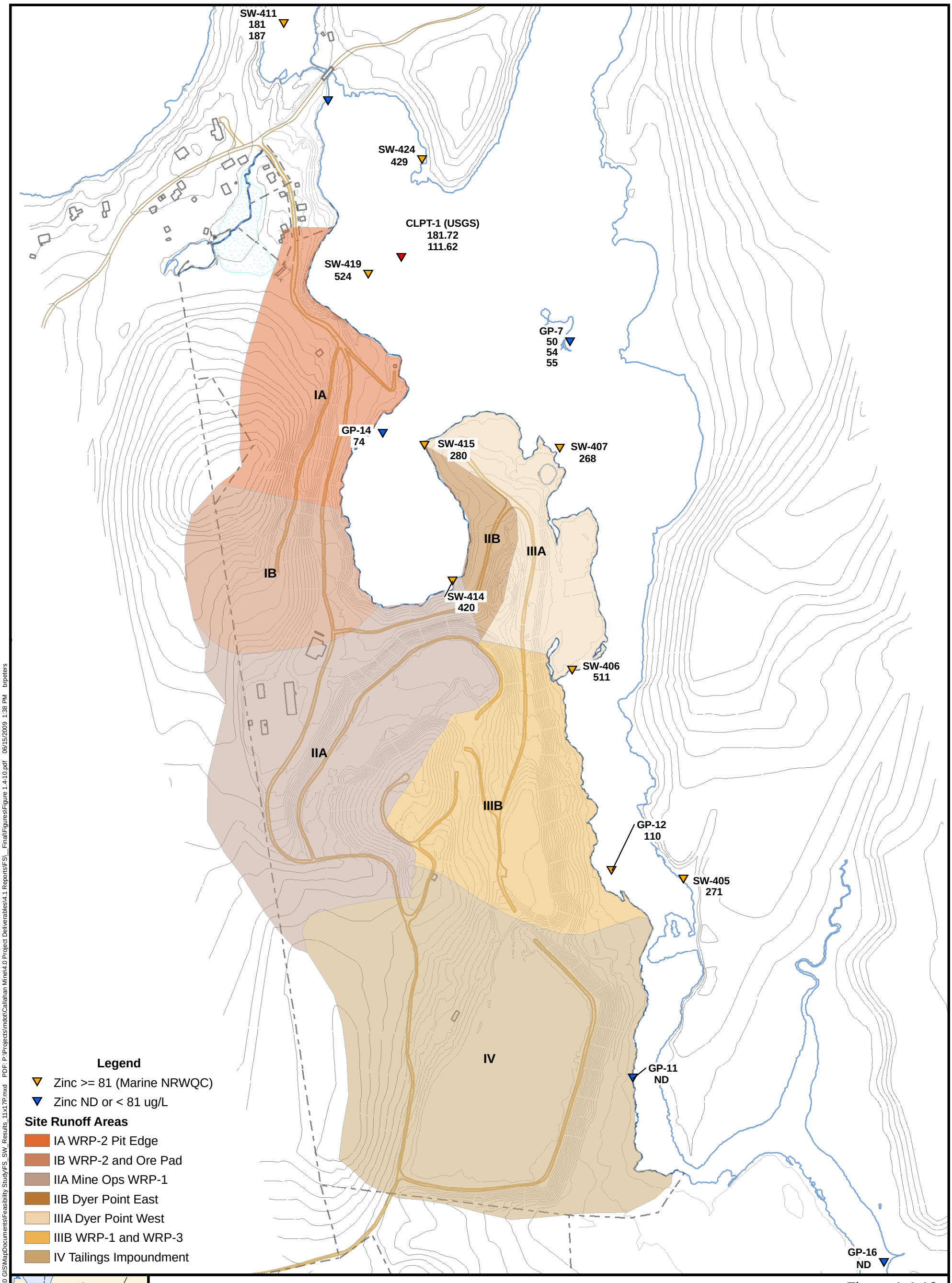

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Figure 1.4-10
Zinc Detected in Marine Surface Water
in Excess of NRWQC

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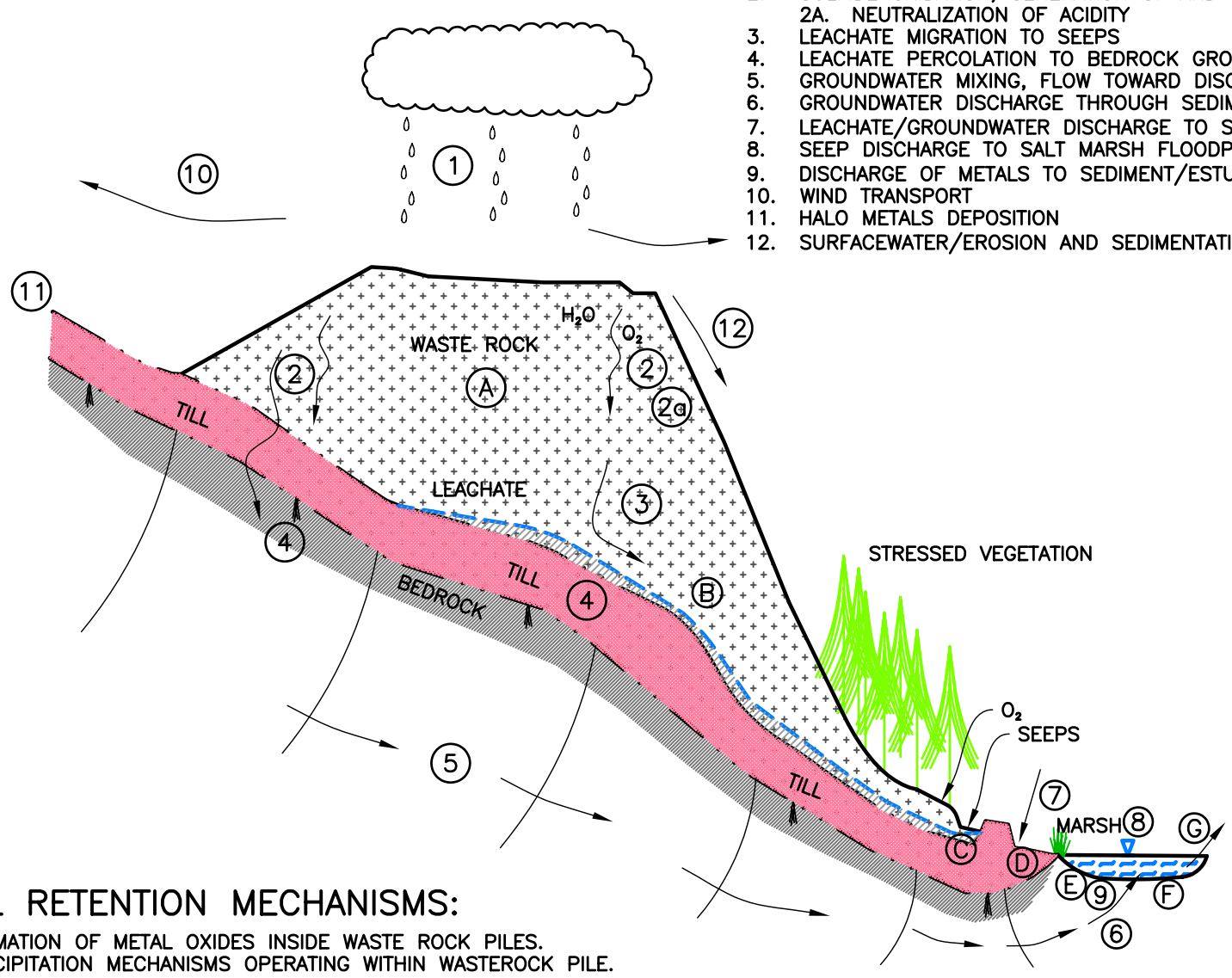
WASTE ROCK PILES AND ORE PAD

TRANSPORT PROCESSES:

1. PRECIPITATION
2. SULFIDE OXIDATION, GENERATION OF ARD
   2A. NEUTRALIZATION OF ACIDITY
3. LEACHATE MIGRATION TO SEEPS
4. LEACHATE PERCOLATION TO BEDROCK GROUNDWATER
5. GROUNDWATER MIXING, FLOW TOWARD DISCHARGE
6. GROUNDWATER DISCHARGE THROUGH SEDIMENT TO SURFACE WATER
7. LEACHATE/GROUNDWATER DISCHARGE TO SEEPS AND SURFACE WATER
8. SEEP DISCHARGE TO SALT MARSH FLOODPLAIN SOILS
9. DISCHARGE OF METALS TO SEDIMENT/ESTUARY COLUMN
10. WIND TRANSPORT
11. HALO METALS DEPOSITION
12. SURFACEWATER/EROSION AND SEDIMENTATION



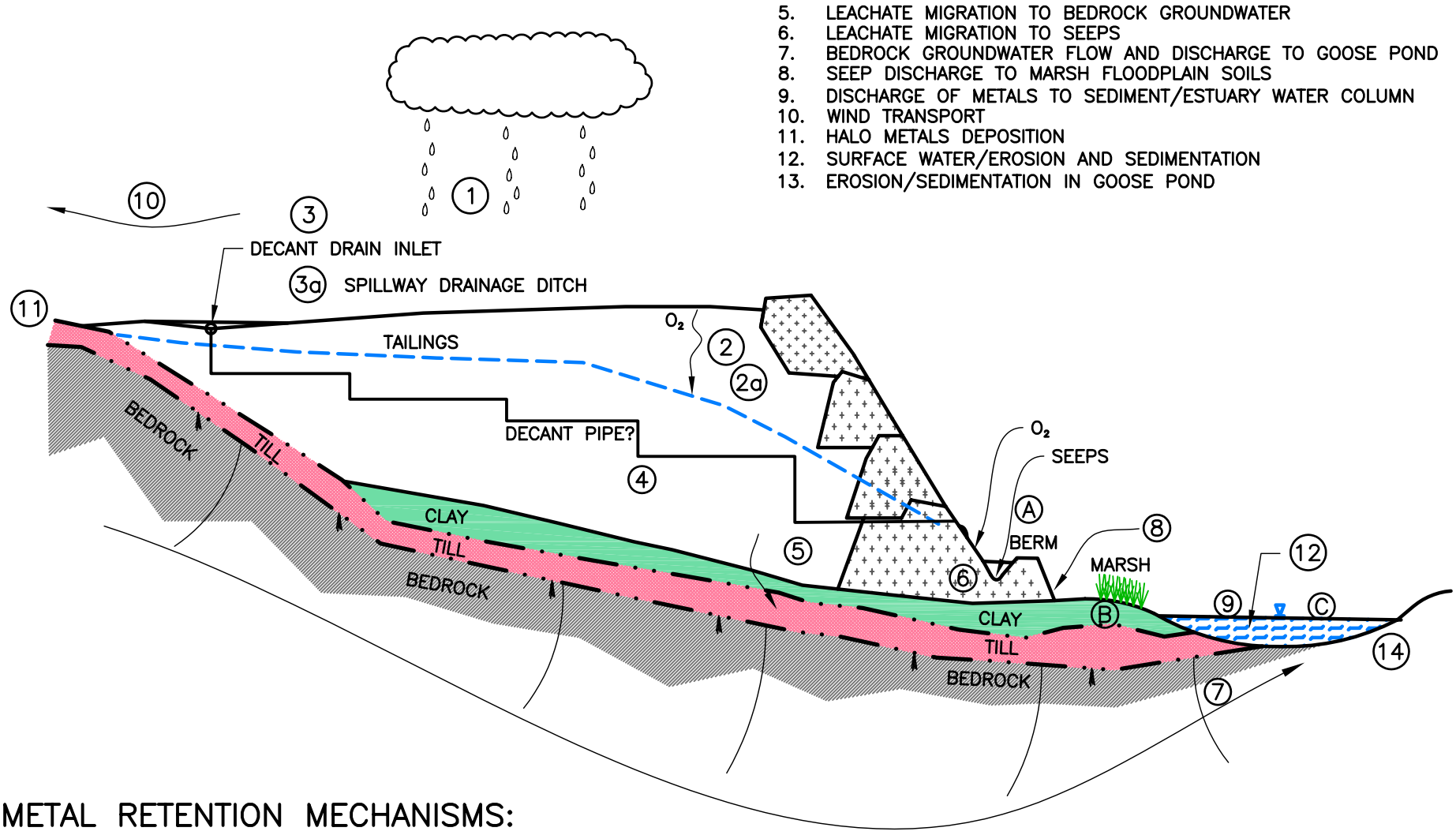
METAL RETENTION MECHANISMS:

A. FORMATION OF METAL OXIDES INSIDE WASTE ROCK PILES.
B. PRECIPITATION MECHANISMS OPERATING WITHIN WASTEROCK PILE.
C. MINERAL PRECIPITATES IN SURFACEWATERS/SEEP DISCHARGE AREAS.
D. SORPTION/RETENTION OF METALS IN SALT MARSH SEDIMENTS.
E. METALS IN GROUNDWATER; DISCHARGED TO AND RETAINED BY SEDIMENTS.
F. METALS RETAINED IN "MINE WASTE" LAYER IN SEDIMENT.
G. AREAS OF EROSION AND SEDIMENTATION IN GOOSE POND.

TAILINGS IMPOUNDMENT

TRANSPORT PROCESSES:

1. PRECIPITATION
2. SULFIDE OXIDATION, GENERATION OF ARD ABOVE WATERTABLE
   2A. NEUTRALIZATION OF ACIDITY
3. SURFACE WATER RUN–OFF TO VERTICAL CAST IRON DRAIN PIPE
   3A. SURFACE WATER RUN–OFF TO DRAINAGE DITCH
4. NO PYRITE OXIDATION IN SATURATED TAILINGS
5. LEACHATE MIGRATION TO BEDROCK GROUNDWATER
6. LEACHATE MIGRATION TO SEEPS
7. BEDROCK GROUNDWATER FLOW AND DISCHARGE TO GOOSE POND
8. SEEP DISCHARGE TO MARSH FLOODPLAIN SOILS
9. DISCHARGE OF METALS TO SEDIMENT/ESTUARY WATER COLUMN
10. WIND TRANSPORT
11. HALO METALS DEPOSITION
12. SURFACE WATER/EROSION AND SEDIMENTATION
13. EROSION/SEDIMENTATION IN GOOSE POND



METAL RETENTION MECHANISMS:

A. SEDIMENTATION IN DITCH BETWEEN TAILINGS IMPOUNDMENT AND SMALL BERM.
B. SORPTION AND EXTENT OF METALS IN MARSH FLOOD PLAIN SOILS.
C. METALS RETAINED IN "MINE WASTE" LAYER IN SEDIMENT.

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Checked/Date: SR 03/25/09

CALLAHAN MINE SUPERFUND SITE
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Figure 1.4-11
CONCEPTUAL SITE MODEL
OU1 FEASIBILITY STUDY REPORT
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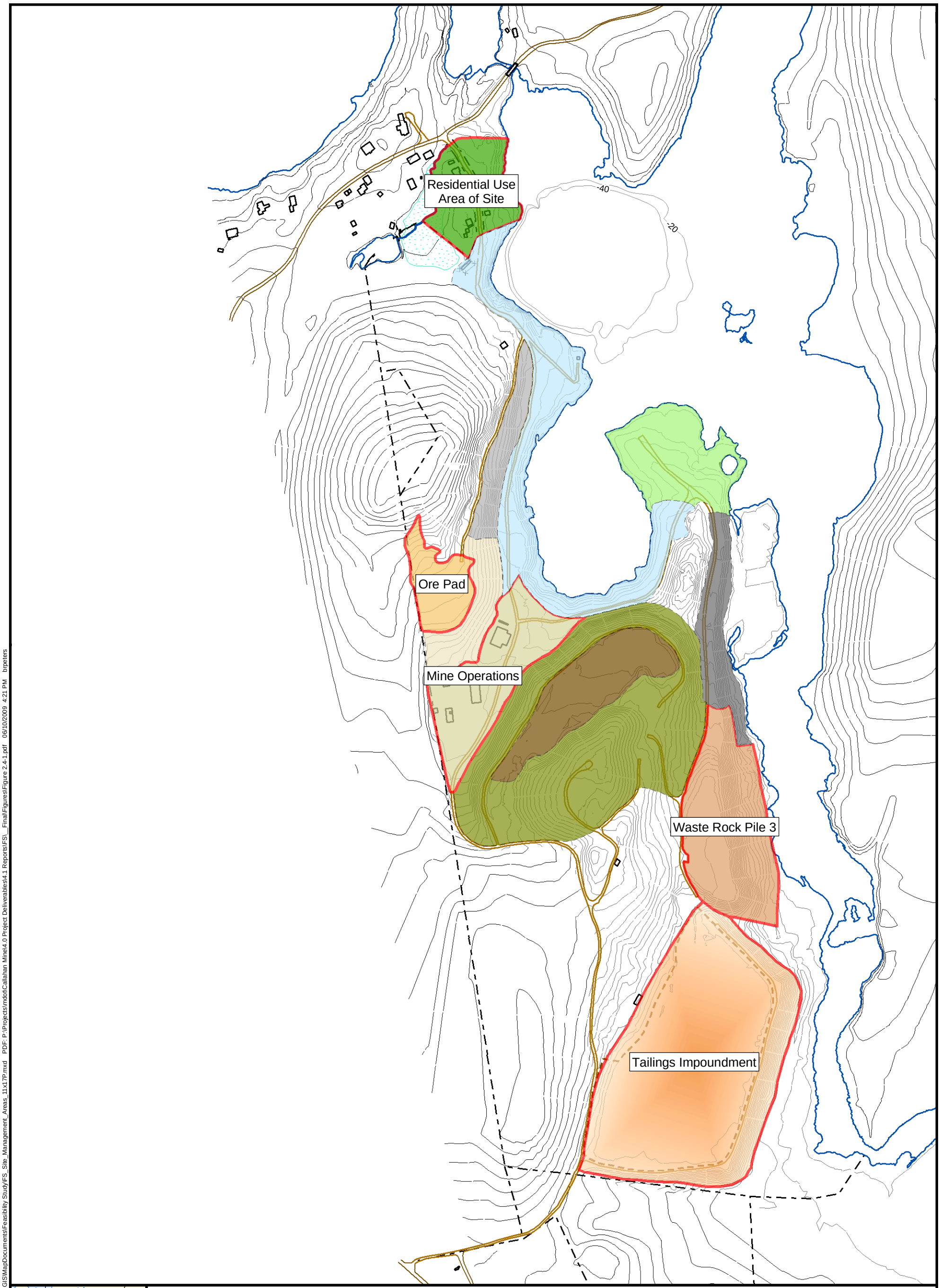

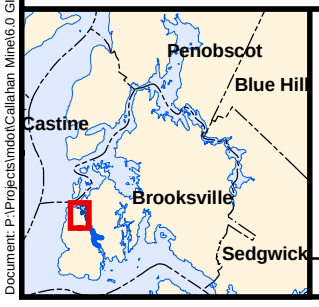

Legend

Areas included in OU1

0 200 400 Feet

N

Figure 2.4-1
Residential Use and Source Areas Addressed in OU1

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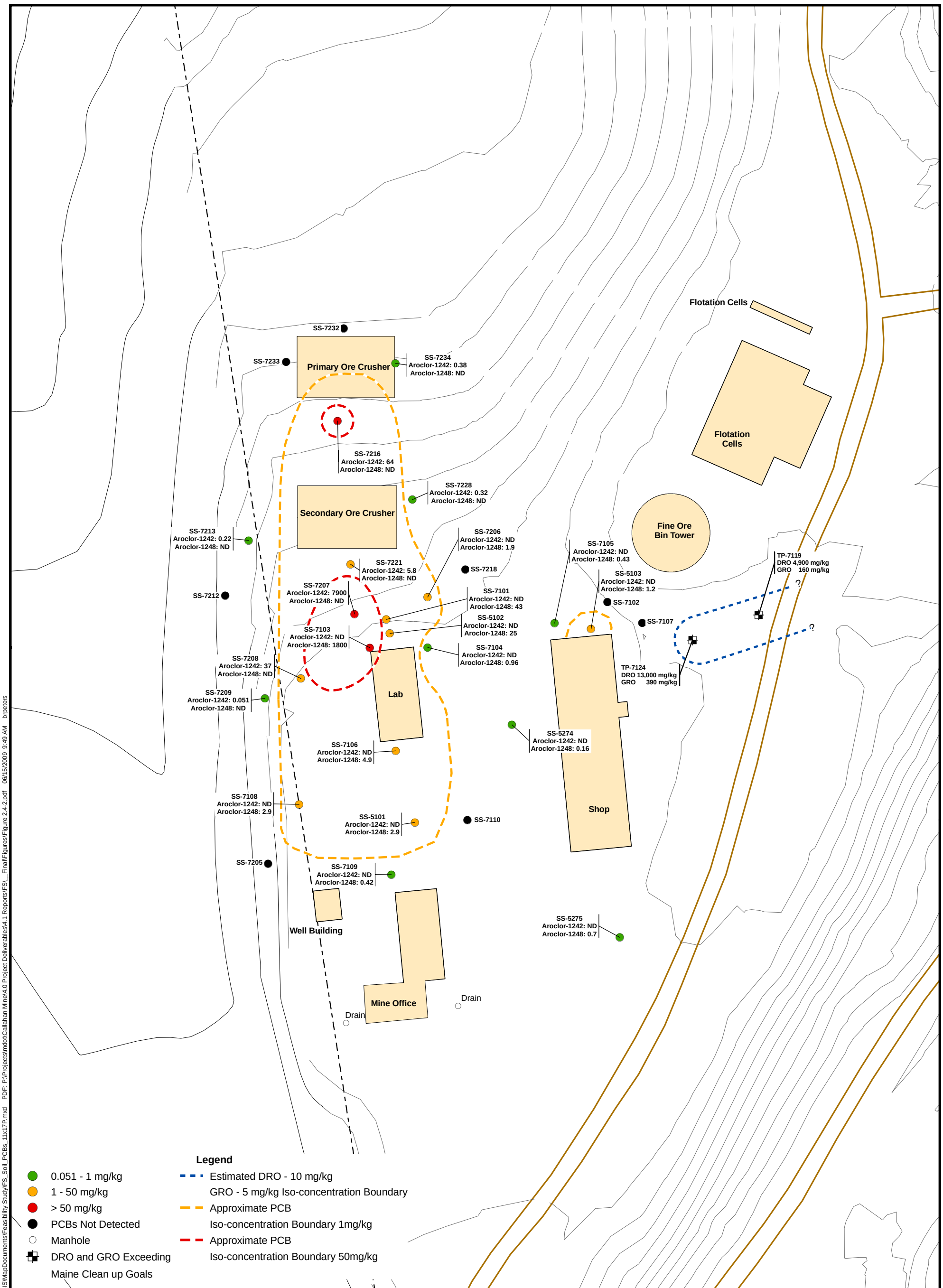

Figure 2.4-2
Areas Exceeding PCB PRGs and DRO/GRO Cleanup Goals

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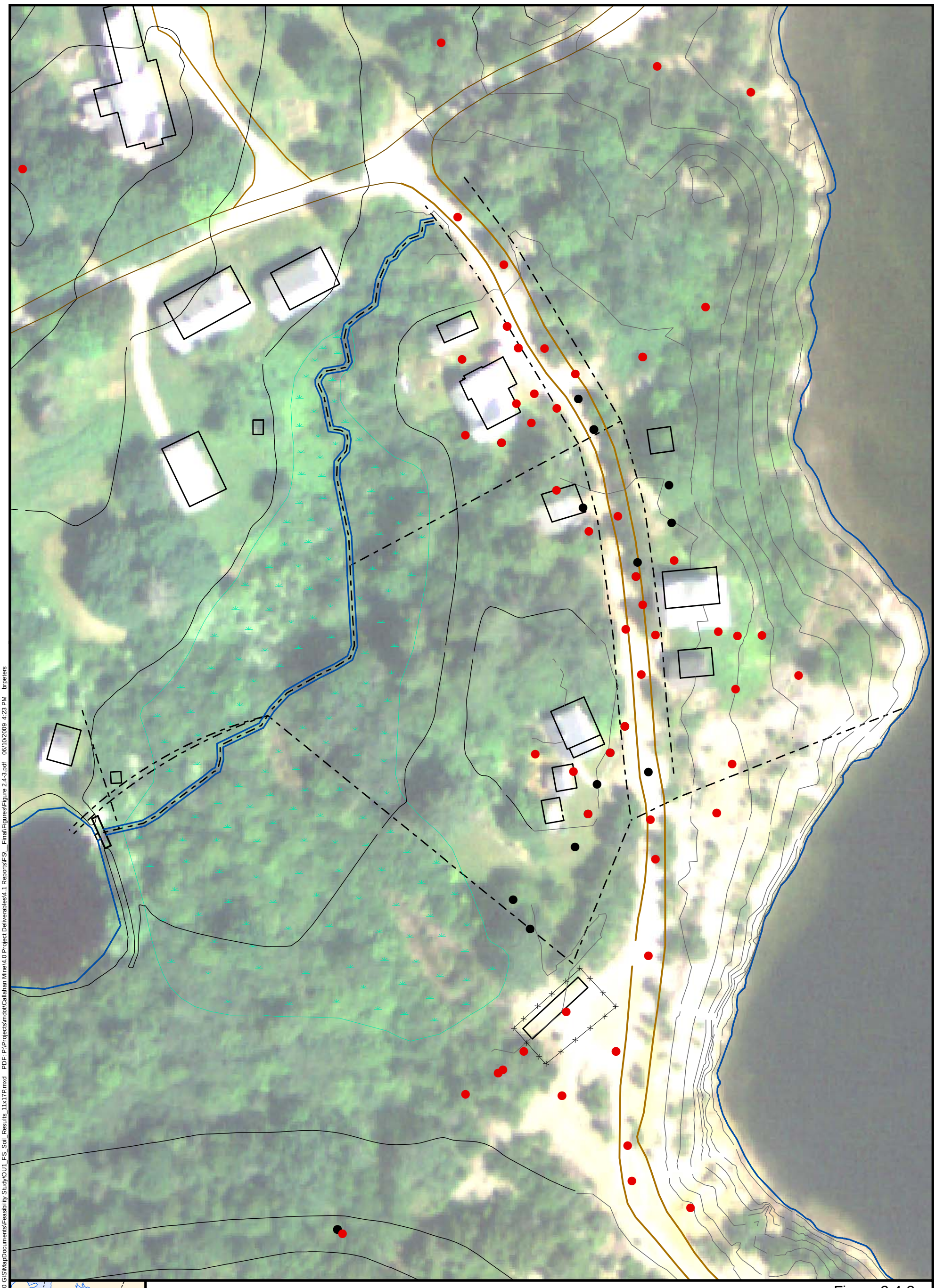

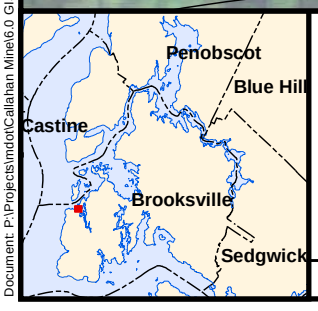

Legend

Arsenic in Surface Soil:

- Arsenic <= 14 mg/kg
- Arsenic > 14 mg/kg

0 30 60 Feet

N

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Figure 2.4-3
Residential Use Area Soil Exceeding Arsenic PRG

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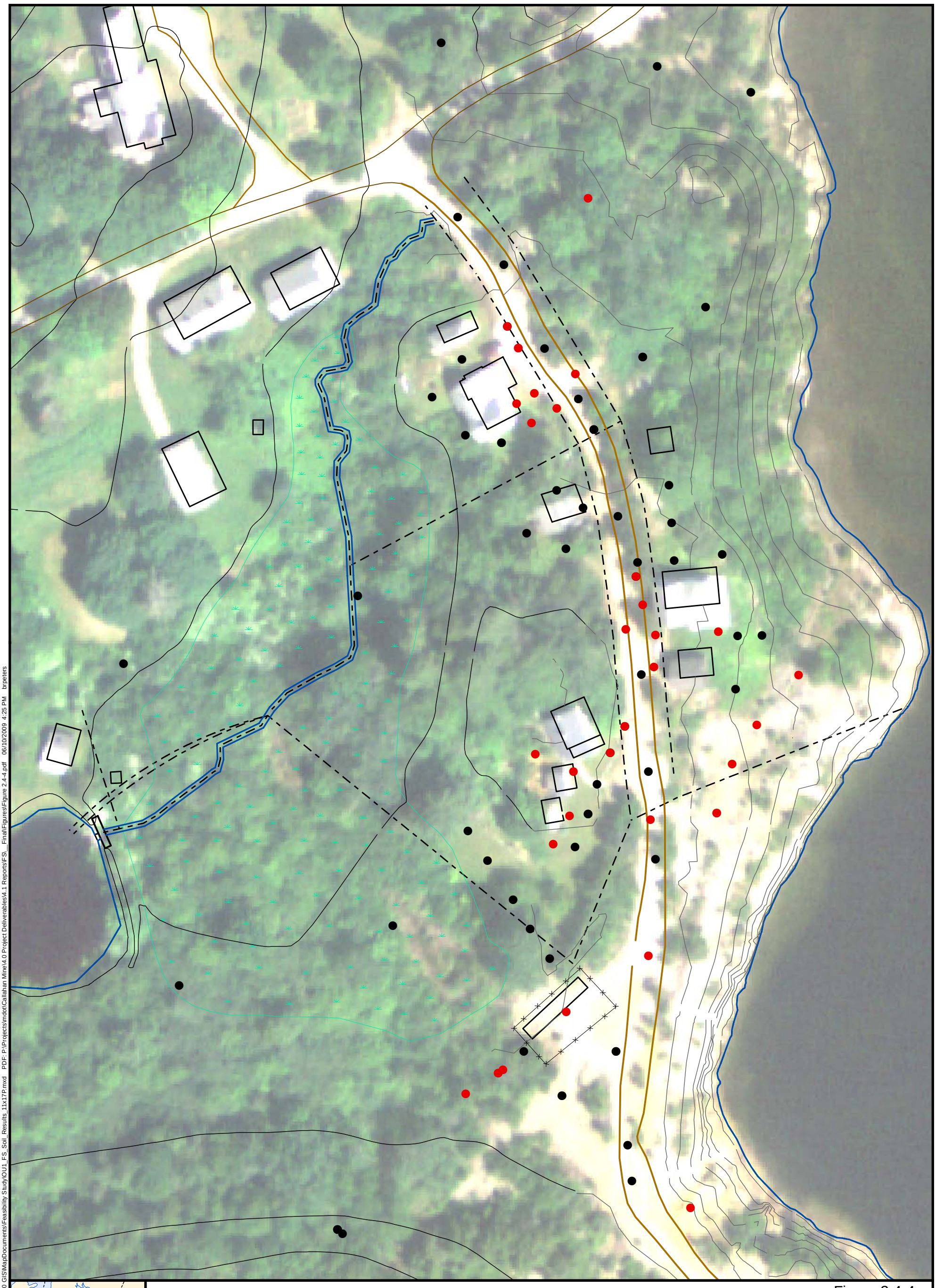

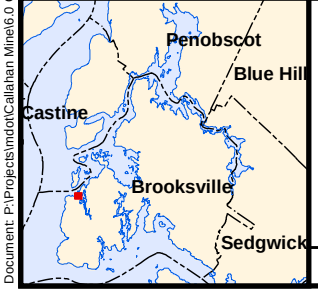

Legend

Lead in Surface Soil:

- Lead <= 375 mg/kg
- Lead > 375 mg/kg

0 30 60 Feet

N

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Figure 2.4-4
Residential Use Area Soil Exceeding Lead PRG

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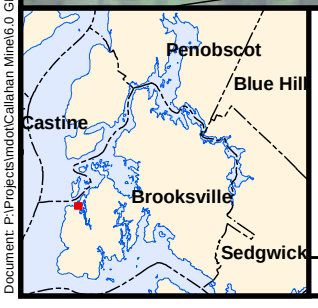

Legend

Thallium in Surface Soil:

- Thallium <= 15 mg/kg
- Thallium > 15 mg/kg

0 30 60 Feet

N

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Figure 2.4-5
Residential Use Area Soil Exceeding Thallium PRG

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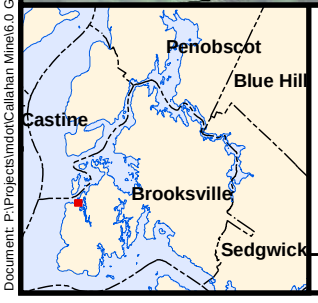

Legend

- Arsenic <= 14, Lead <= 375, and Thallium <= 15 mg/kg
- Arsenic > 14, Lead > 375, and Thallium > 15 mg/kg
- Bedrock Outcrops
- Risk Assessment Data Groups
- Area to be excavated - 41060 Sq. Feet
- Property Line

0 30 60 Feet

N

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Figure 2.4-6
Residential Use Area Remediation

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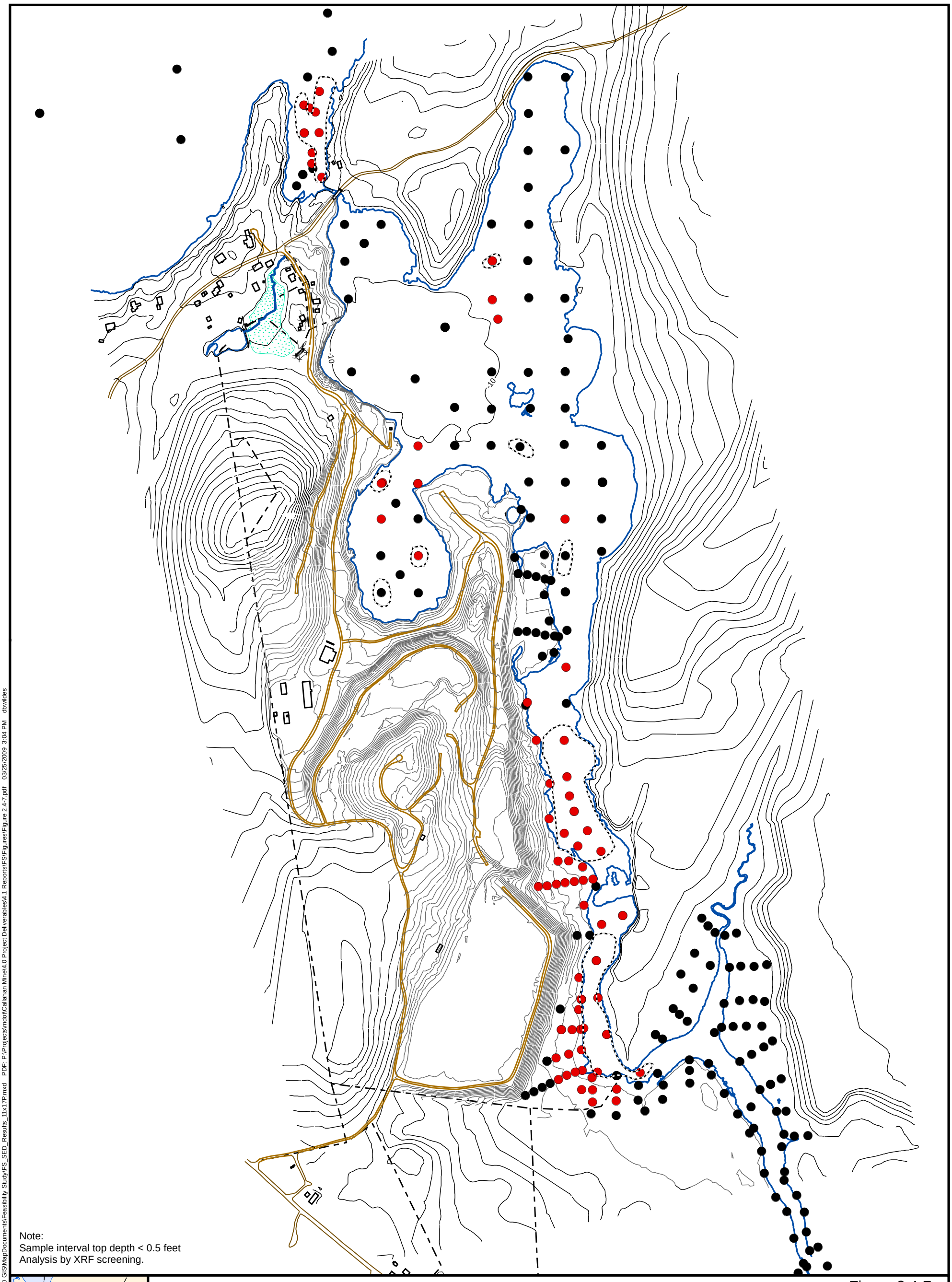

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Figure 2.4-7
Exceedance of Copper
PRGs in Sediment and Salt Marsh

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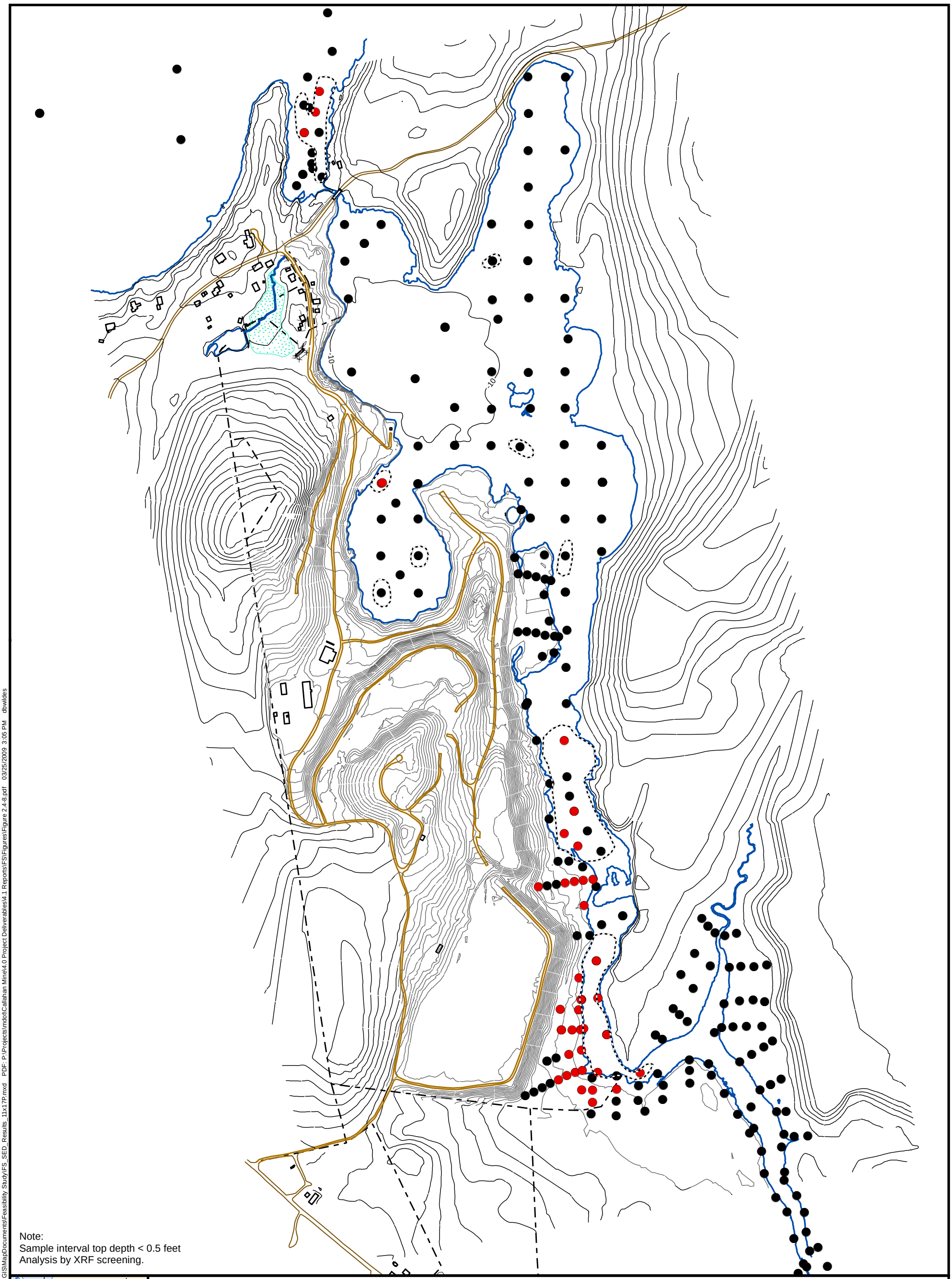

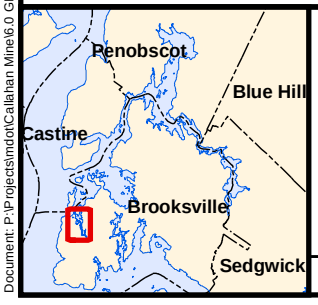

Legend

- Lead > 710 mg/kg
- Lead ND or <= 710 mg/kg
- Mine Waste in Sediment

0 250 500 Feet

N

Prepared/Date: DBW 03/25/09 | Checked/Date: SWR 03/25/09

Figure 2.4-8
Exceedance of Lead
PRGs in Sediment and Salt Marsh

OU1 Feasibility Study Report
Callahan Mine Superfund Site
Brooksville, Maine
MACTEC, Inc.

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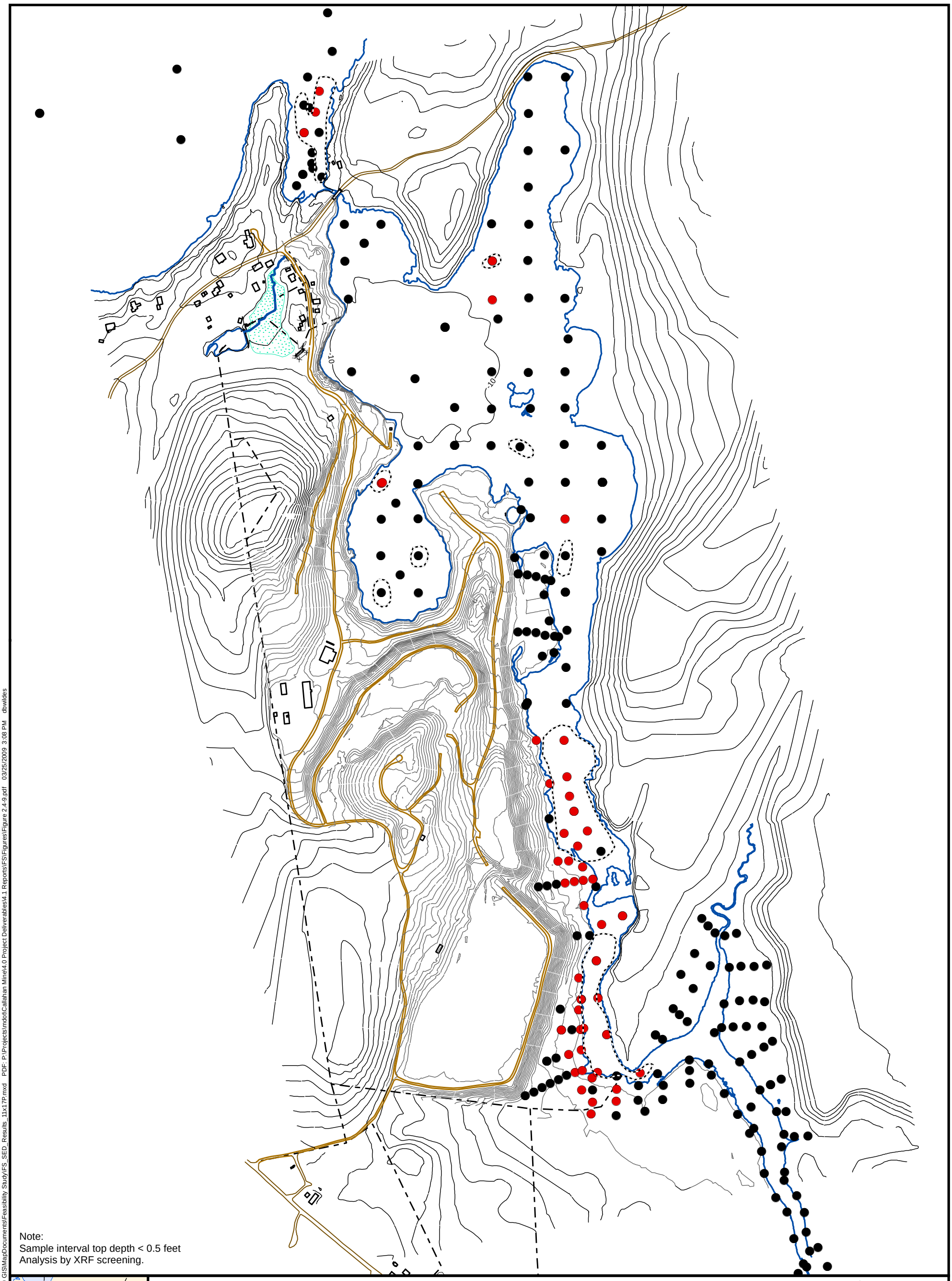

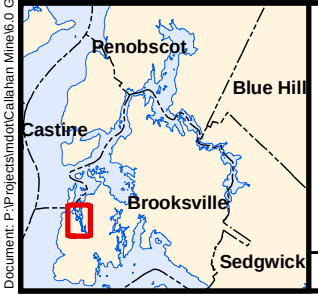

Legend

- Zinc > 5100 mg/kg
- Zinc ND or <= 5100 mg/kg
- Mine Waste in Sediment

0 250 500 Feet

N

Prepared/Date: DBW 03/25/09 | Checked/Date: SWR 03/25/09

Figure 2.4-9
Exceedance of Zinc
PRGs in Sediment and Salt Marsh

OU1 Feasibility Study Report
Callahan Mine Superfund Site
Brooksville, Maine
MACTEC, Inc.

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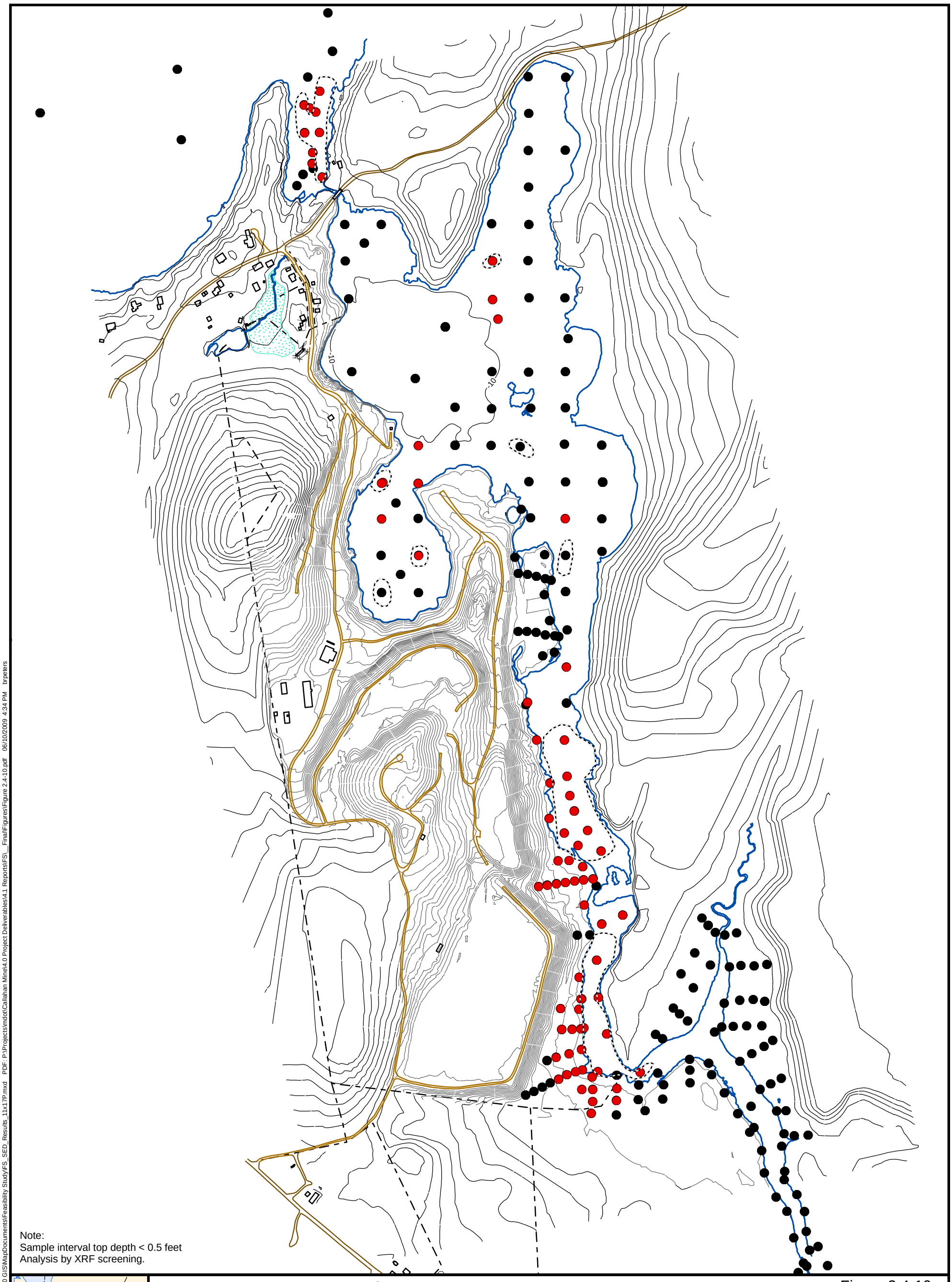

Prepared/Date: BRP 06/10/09 | Checked/Date: SWR 06/10/09

Figure 2.4-10
Exceedance of Cd, Cu, Pb, and Zn PRGs in Sediment and Salt Marsh

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Callahan Mine Superfund Site
Brooksville, Maine
MACTEC, Inc.

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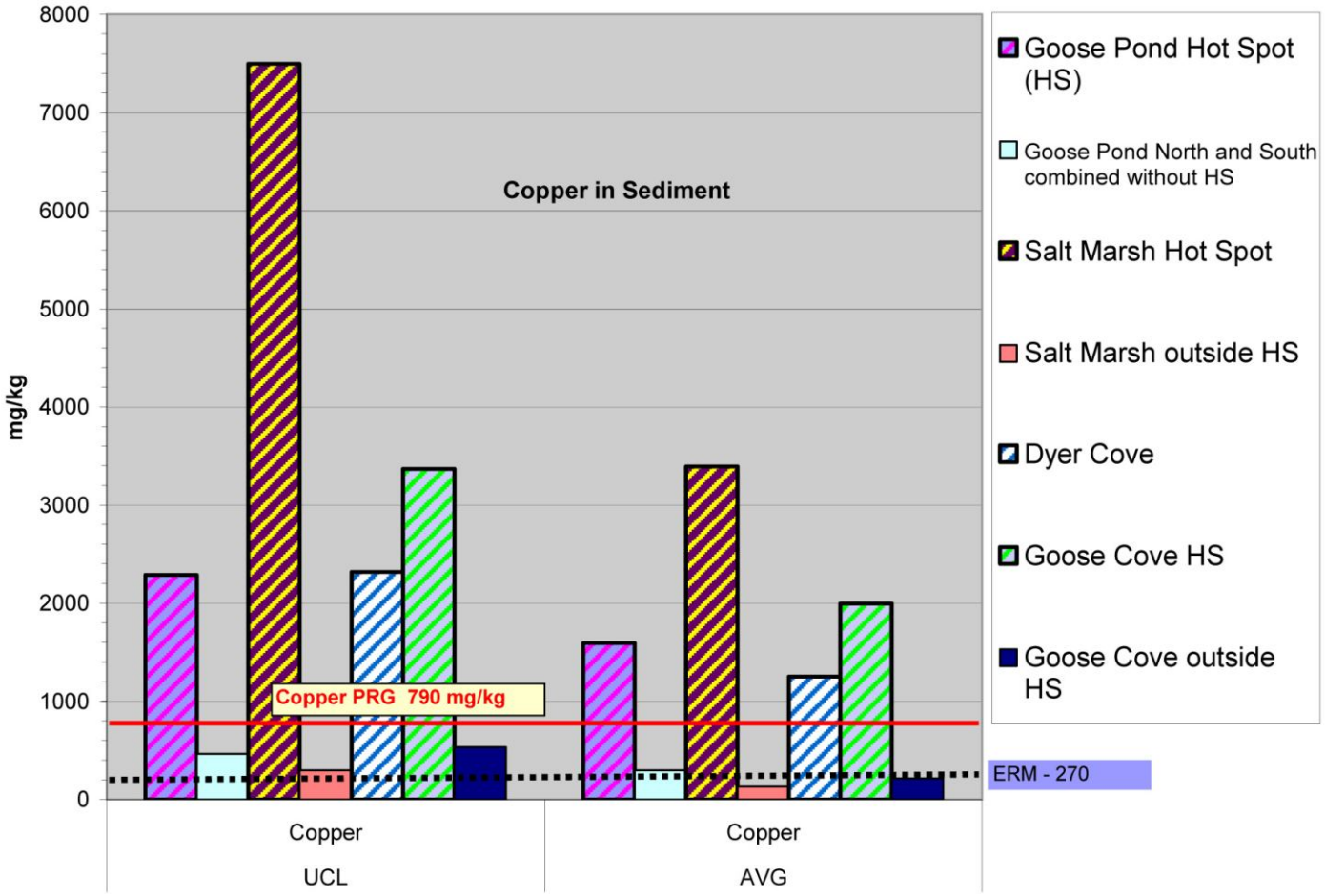


Prepared/Date: JPH 6/8/09
Checked/Date: SWR 6/8/09

CALLAHAN MINE SUPERFUND SITE

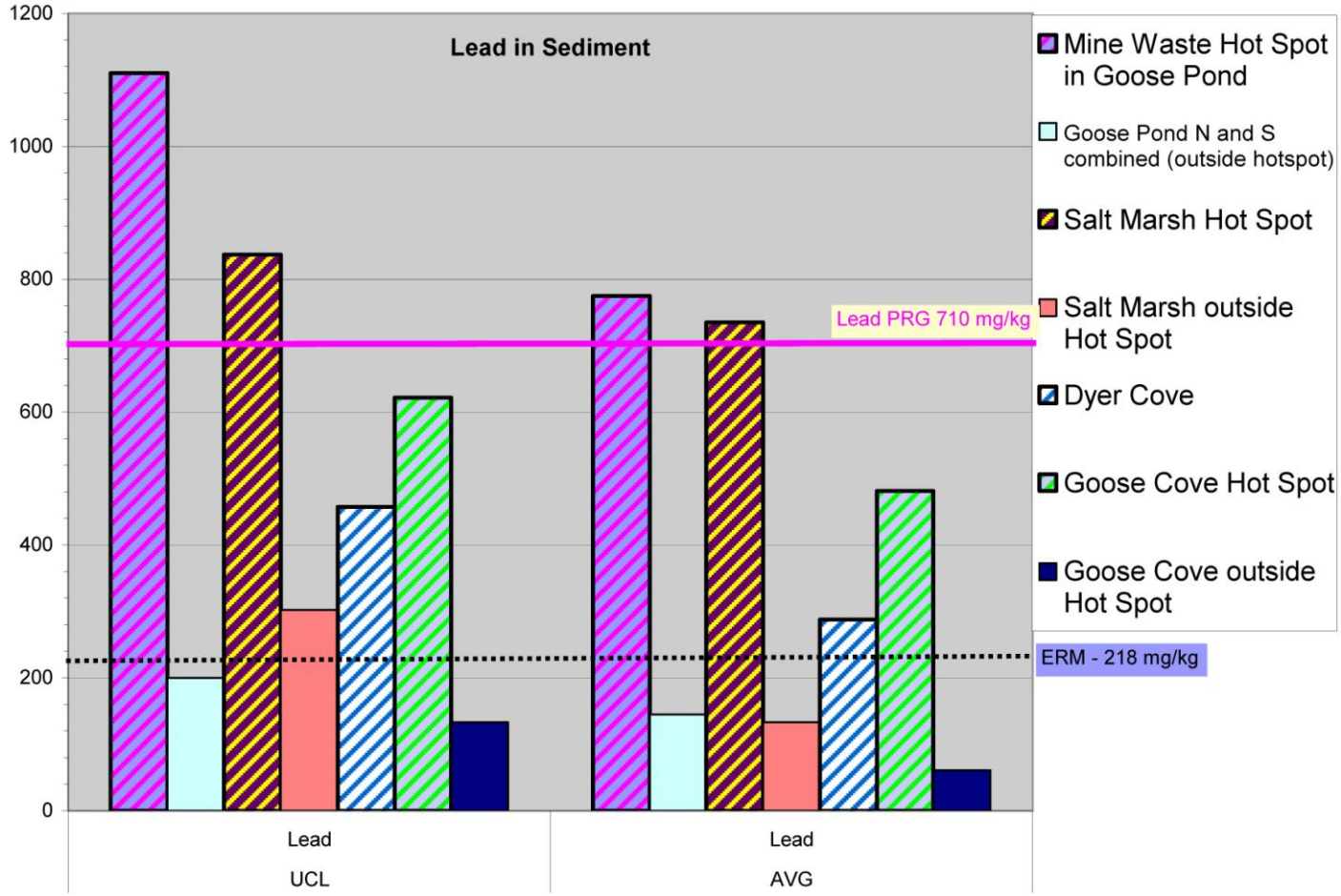
MACTEC

Comparison of Sediment Hot Spot and Non-Hot-Spot Concentrations for Copper
OU1 Feasibility Study Report
Callahan Mine Superfund Site
Brooksville, Maine

3612062047-30

Figure 2.4-11

PORT2009013b-pg1.cdr



Prepared/Date: JPH 6/8/09
Checked/Date: SWR 6/8/09

CALLAHAN MINE SUPERFUND SITE

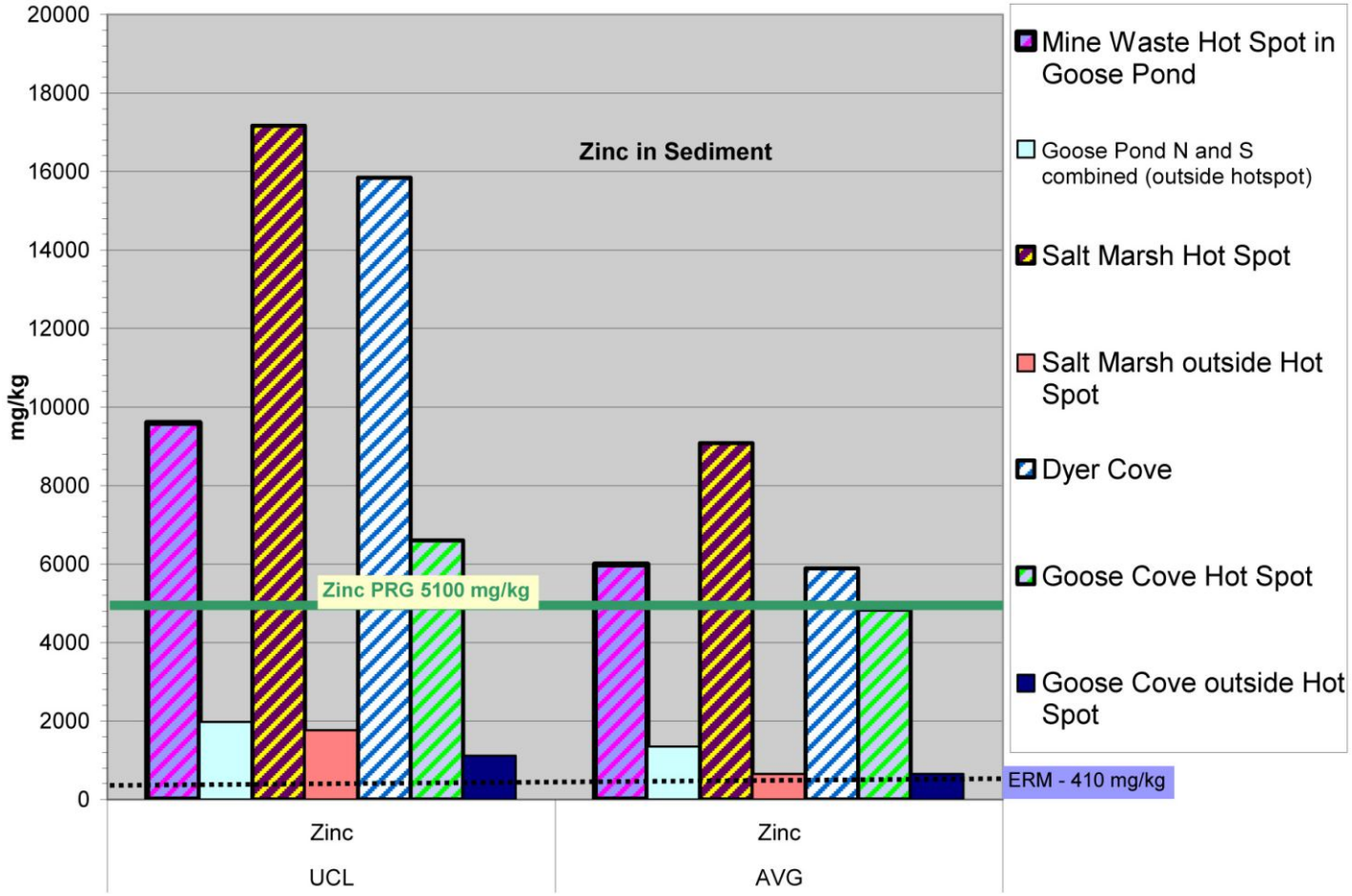
MACTEC

Comparison of Sediment Hot Spot and Non-Hot-Spot Concentrations for Lead
OU1 Feasibility Study Report
Callahan Mine Superfund Site
Brooksville, Maine

3612062047-30

Figure 2.4-12

PORT2009013b-pg2.cdr



Prepared/Date: JPH 6/8/09
Checked/Date: SWR 6/8/09

CALLAHAN MINE SUPERFUND SITE

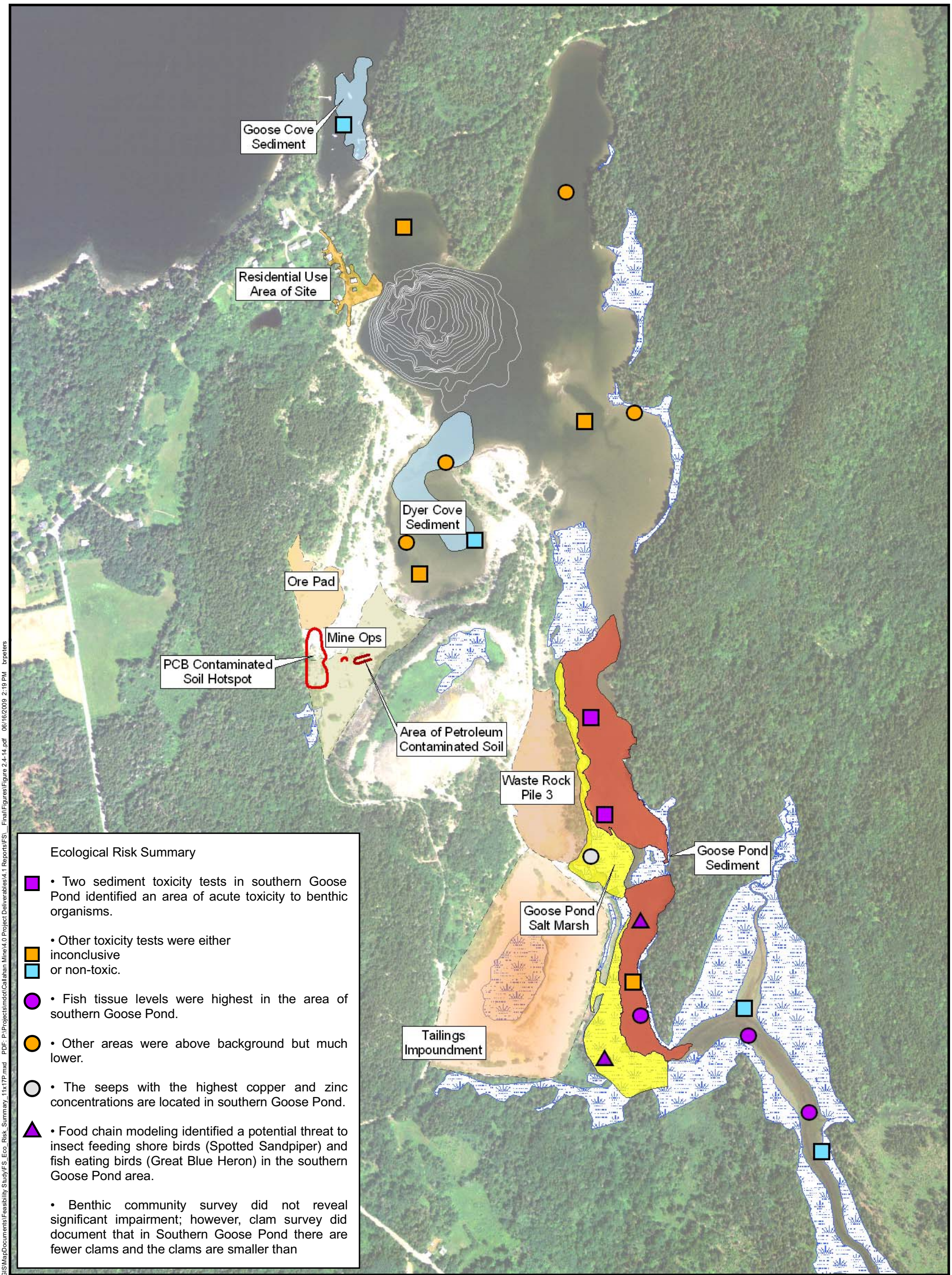
MACTEC

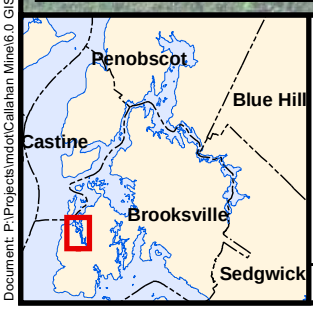
Comparison of Sediment Hot Spot and Non-Hot-Spot Concentrations for Zinc
OU1 Feasibility Study Report
Callahan Mine Superfund Site
Brooksville, Maine

3612062047-30

Figure 2.4-13

PORT2009013b-pg3.cdr





Legend

Bathymetric Contour

Delineated Wetlands

N

0 250 500 Feet

Prepared/Date: BRP 06/16/09 | Checked/Date: SWR 06/16/09

Figure 2.4-14
Highlights of Tier II Evaluation

OU1 Feasibility Study Report
Callahan Mine Superfund Site
Brooksville, Maine
MACTEC, Inc.

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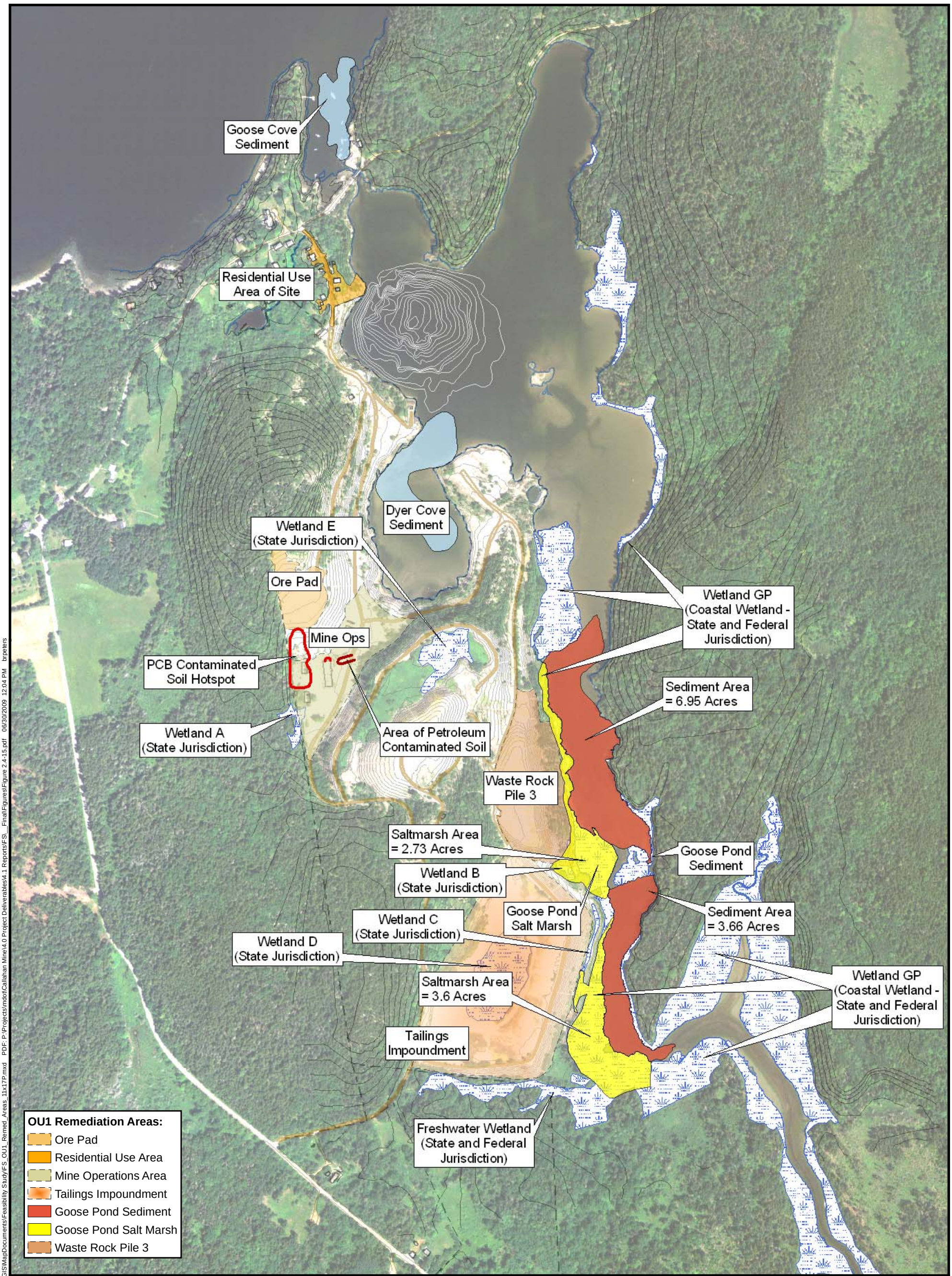

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Figure 2.4-15
OU1 Remediation Areas

OU1 Feasibility Study Report
Callahan Mine Superfund Site
Brooksville, Maine
MACTEC, Inc.

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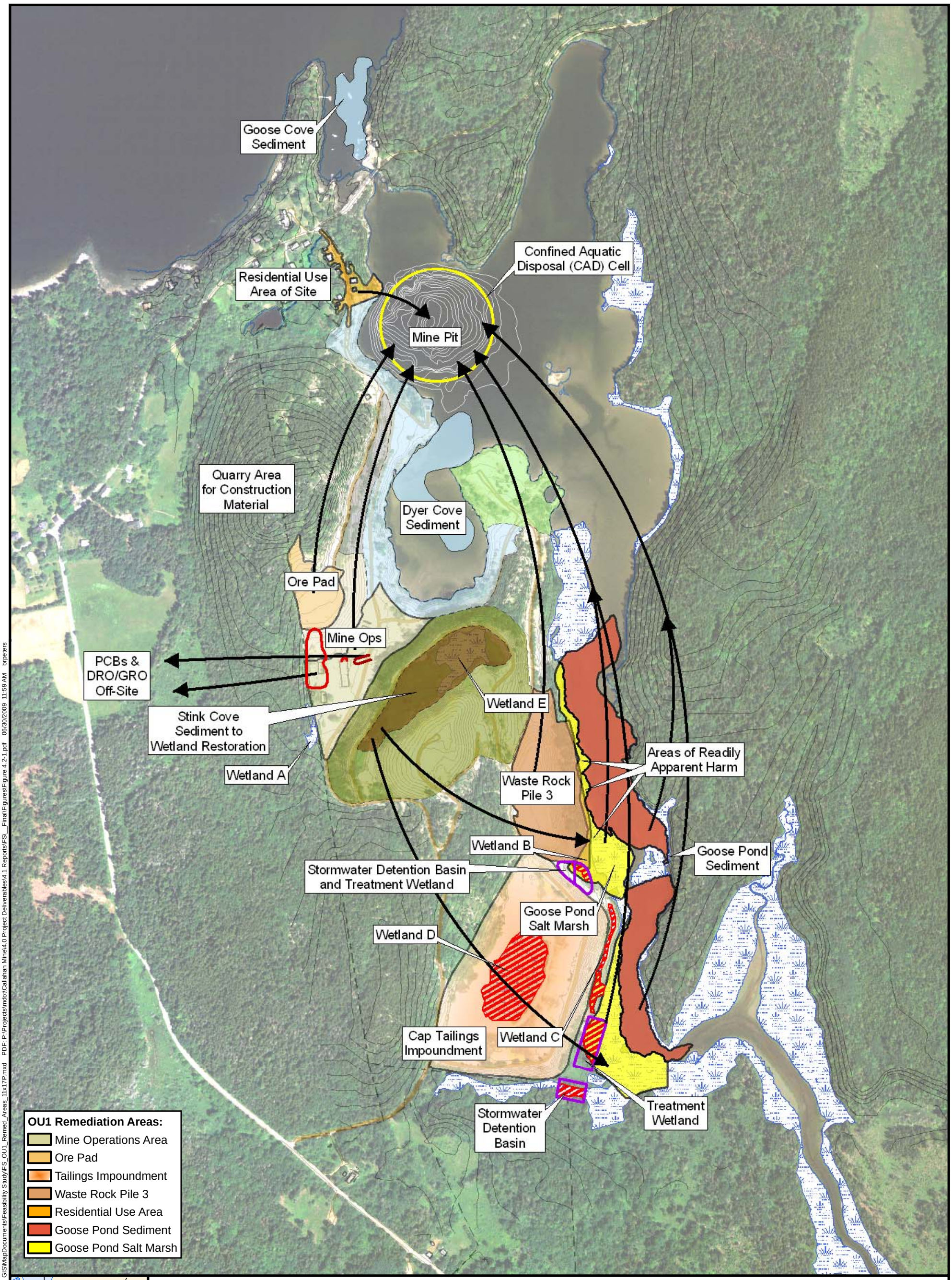

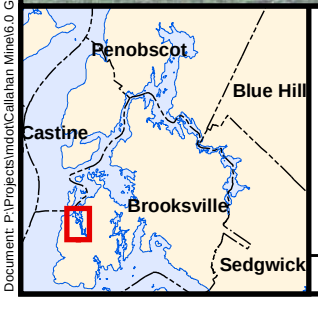

Legend

- Bathymetric Contour
- Delineated Wetlands
- Area of Permanent Wetland Loss

N

0 250 500 Feet

Prepared/Date: BRP 06/30/09 | Checked/Date: SWR 06/30/09

Figure 4.2-1
Alternative CMS2
Proposed Remedy Map

OU1 Feasibility Study Report
Callahan Mine Superfund Site
Brooksville, Maine
MACTEC, Inc.

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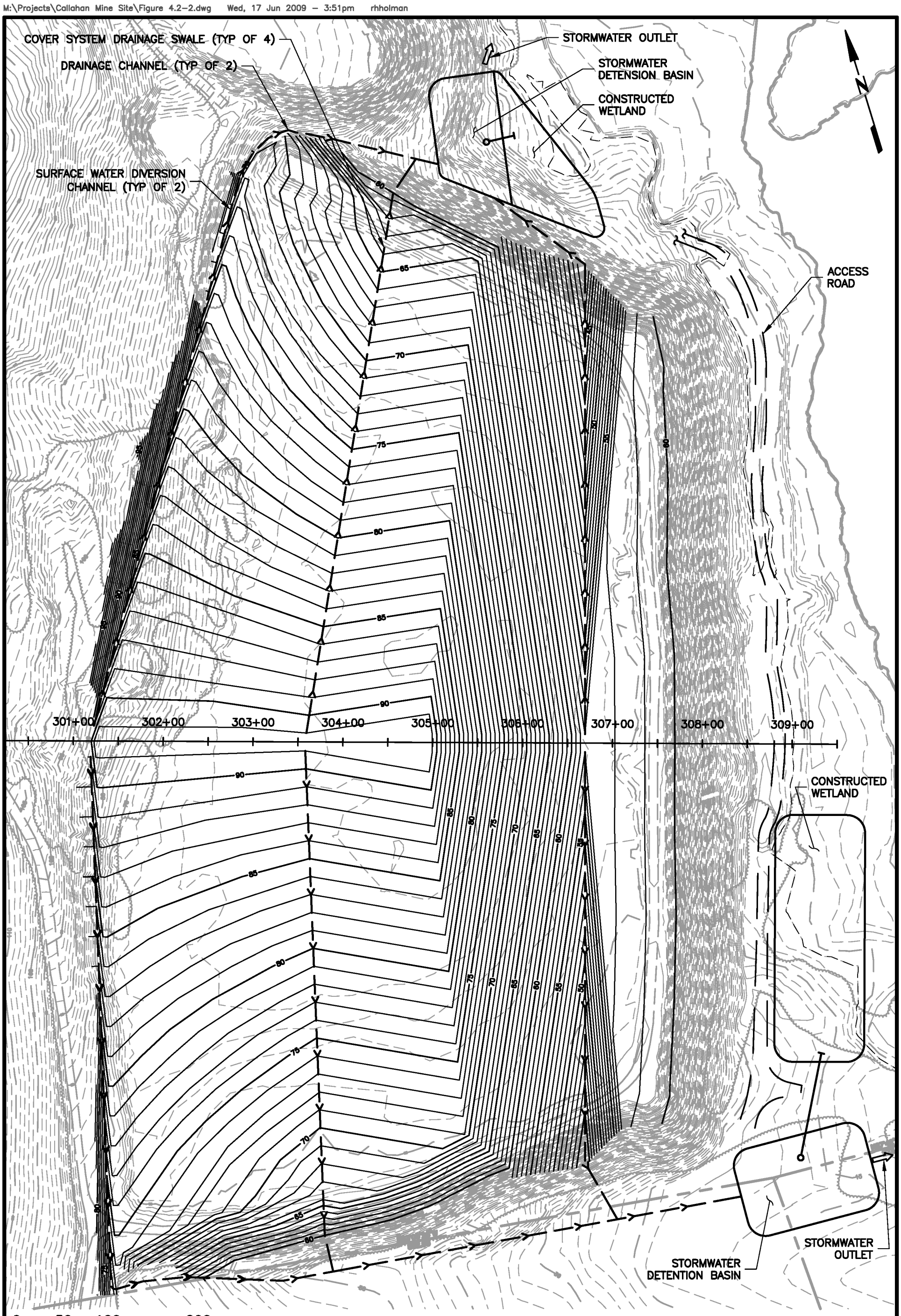


NOTE: FOR CROSS-SECTION, SEE FIGURE 4.2-3

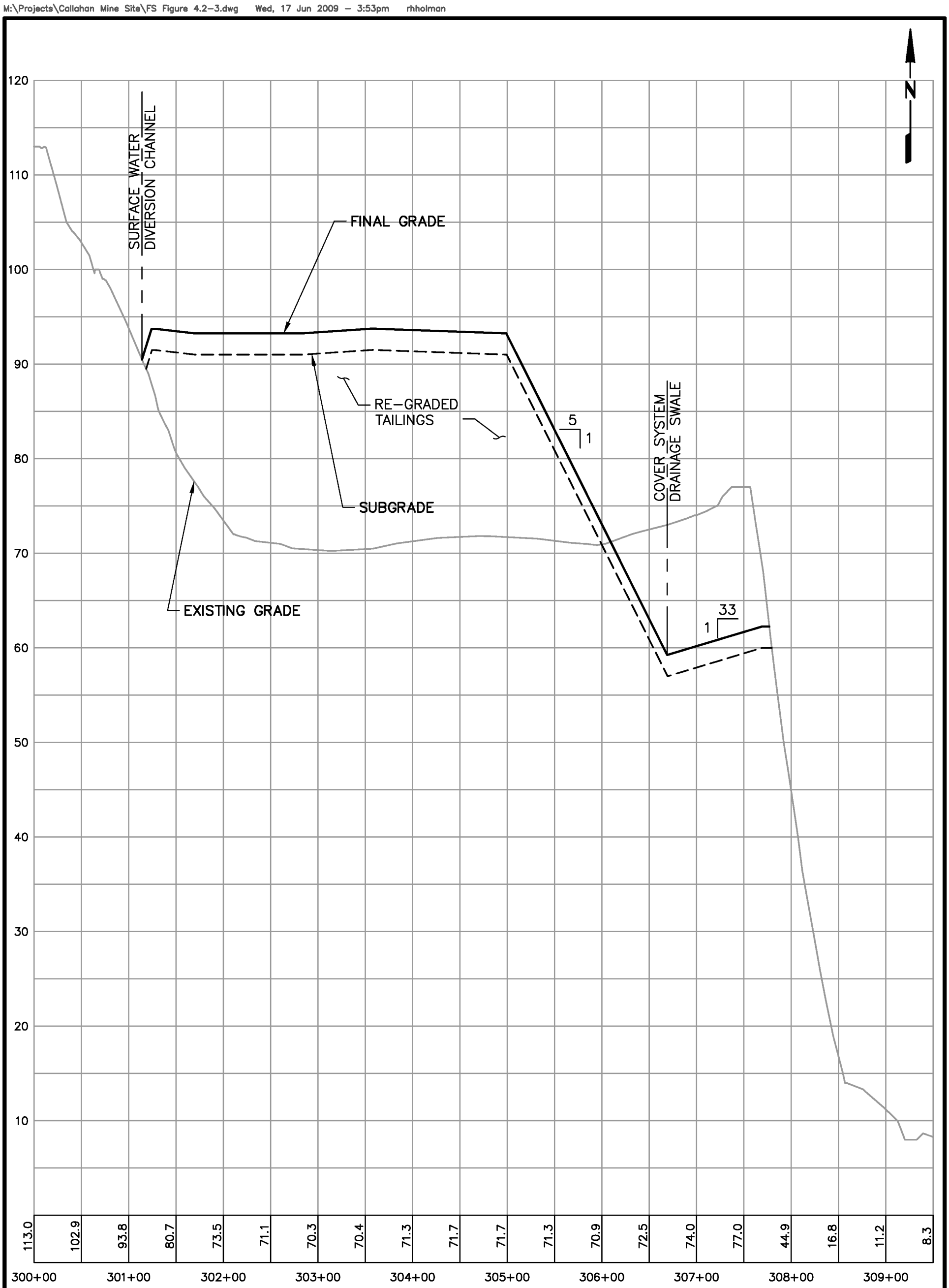
Prepared/Date: DEL 03/27/09
Checked/Date: JPM 03/27/09

CALLAHAN MINE SUPERFUND SITE
BROOKSVILLE, MAINE

MACTEC

ALTERNATIVE CMS2 TAILINGS IMPOUNDMENT IMPROVEMENTS
OU1 FEASIBILITY STUDY REPORT
Project 3612-06-2047.30
Figure 4.2-2

M:\Projects\Callahan Mine Site\FS Figure 4.2-3.dwg Wed, 17 Jun 2009 - 3:53pm rhholman



0 5 10 20 VERTICAL
SCALE IN FEET

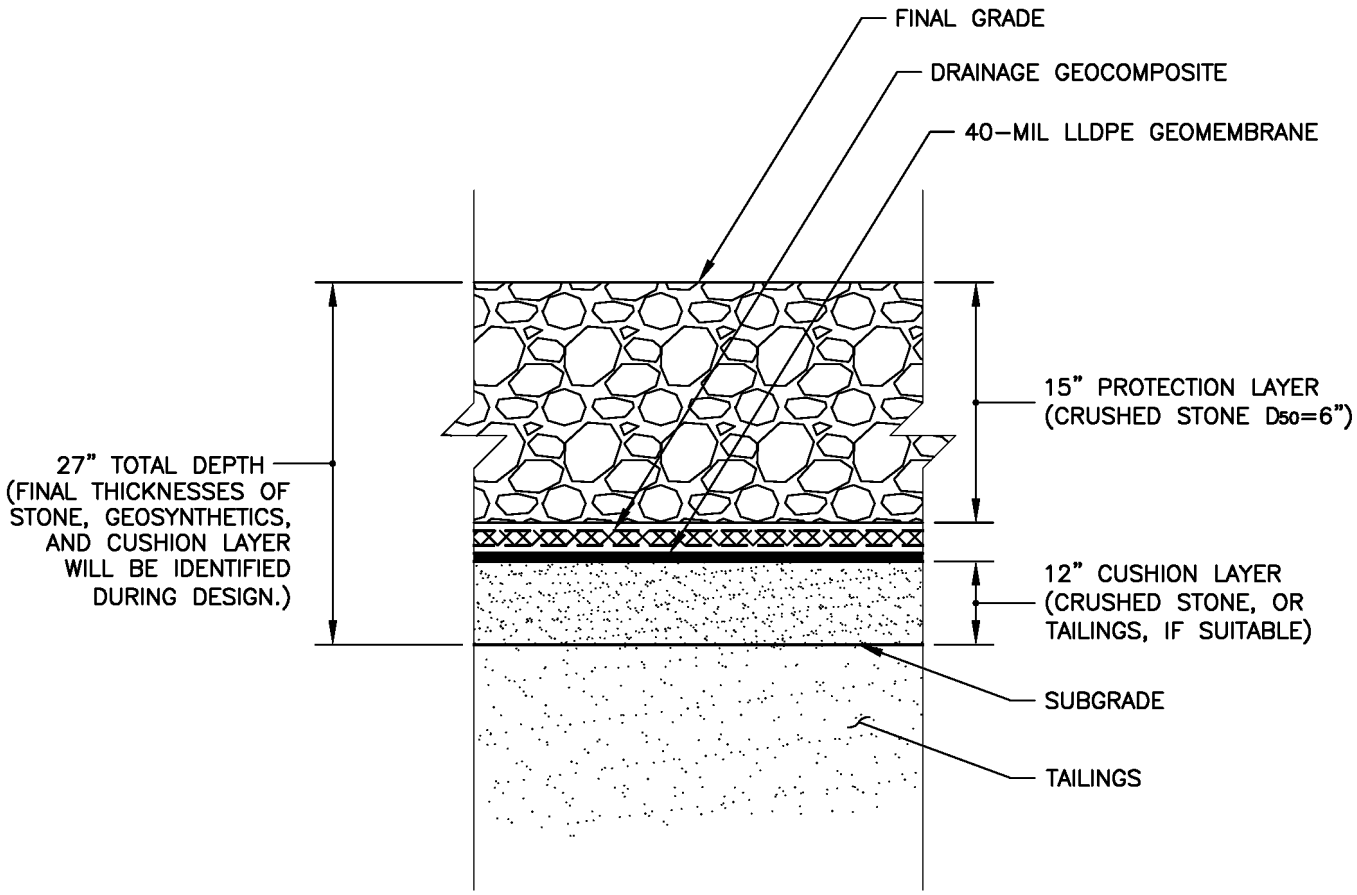
0 50 100 200 HORIZONTAL
SCALE IN FEET

Prepared/Date: MRS 06/12/09
Checked/Date: SRW 06/12/09

CALLAHAN MINE SUPERFUND SITE
BROOKSVILLE, MAINE

MACTEC

ALTERNATIVE CMS2 TAILINGS IMPOUNDMENT CROSS-SECTION
OU1 FEASIBILITY STUDY REPORT
Project 3612-06-2047.30
Figure 4.2-3



INFILTRATION BARRIER CAP

NTS

Prepared/Date: DEL 06/15/09
Checked/Date: SWR 06/15/09

CALLAHAN MINE SUPERFUND SITE BROOKSVILLE, MAINE	MACTEC	Detailed Cross-Section of Tailings Impoundment Cap - Alternates CMS2 and CMS3 Project 3612-06-2047.30 Figure 4.2-4

M:\Projects\Callahan Mine Site\FS Figure 4.2-4.dwg Wed, 17 Jun 2009 - 3:35pm rhholman

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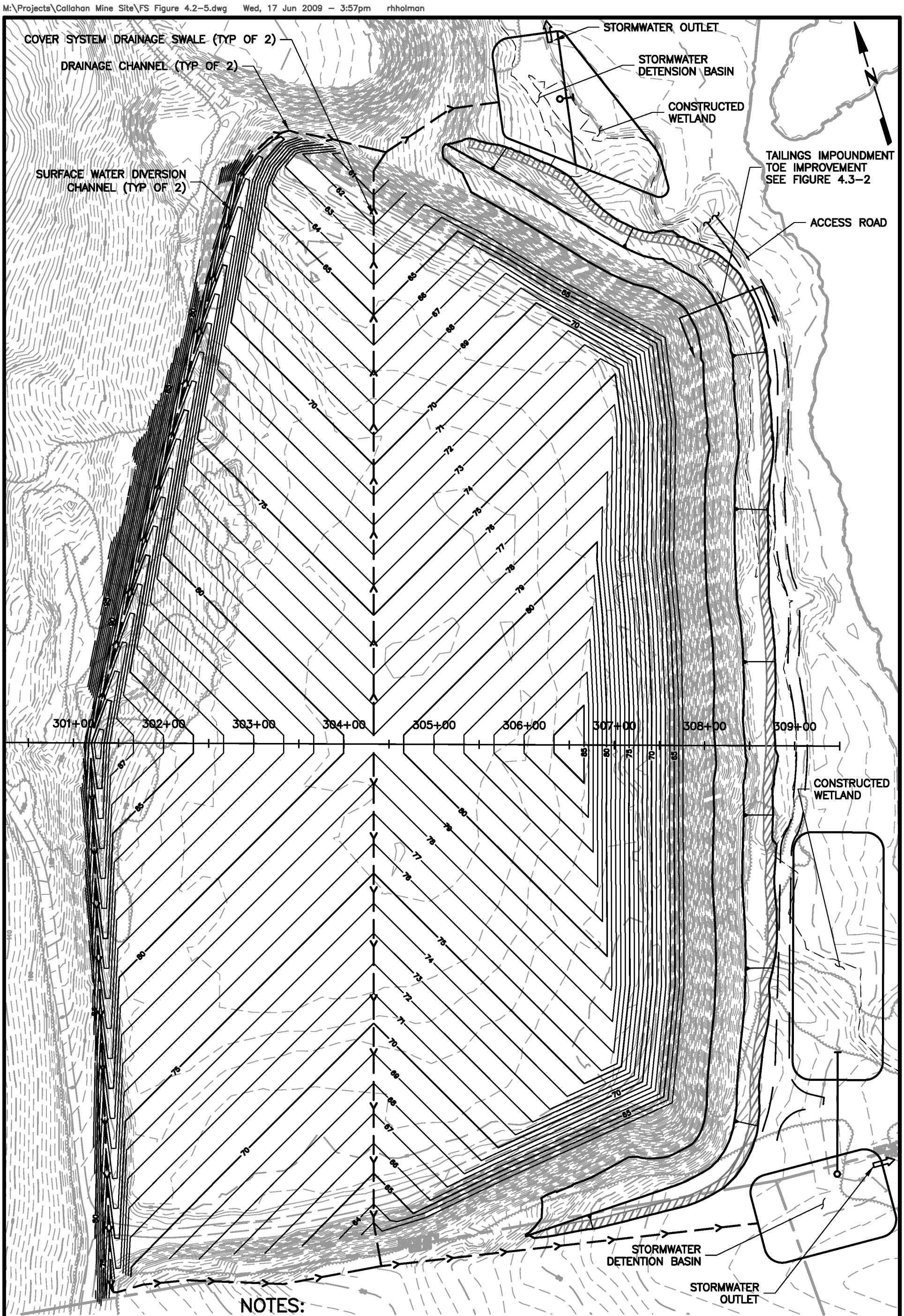

NOTES:

1. FOR CROSS-SECTION, SEE FIGURE 4.2-6
2. THIS CONCEPTUAL GRADING PLAN AND TOE IMPROVEMENTS WOULD BE IMPLEMENTED ONLY IF IDENTIFIED AS NECESSARY DURING DESIGN.

0 50 100 200
SCALE IN FEET

Prepared/Date: MRS 06/12/09
Checked/Date: JPM 06/12/09

CALLAHAN MINE SUPERFUND SITE
BROOKSVILLE, MAINE

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CONCEPTUAL ALTERNATIVE TAILINGS IMPOUNDMENT
GRADING AND TOE IMPROVEMENTS
OU1 FEASIBILITY STUDY REPORT
Project 3612-06-2047.30
Figure 4.2-5

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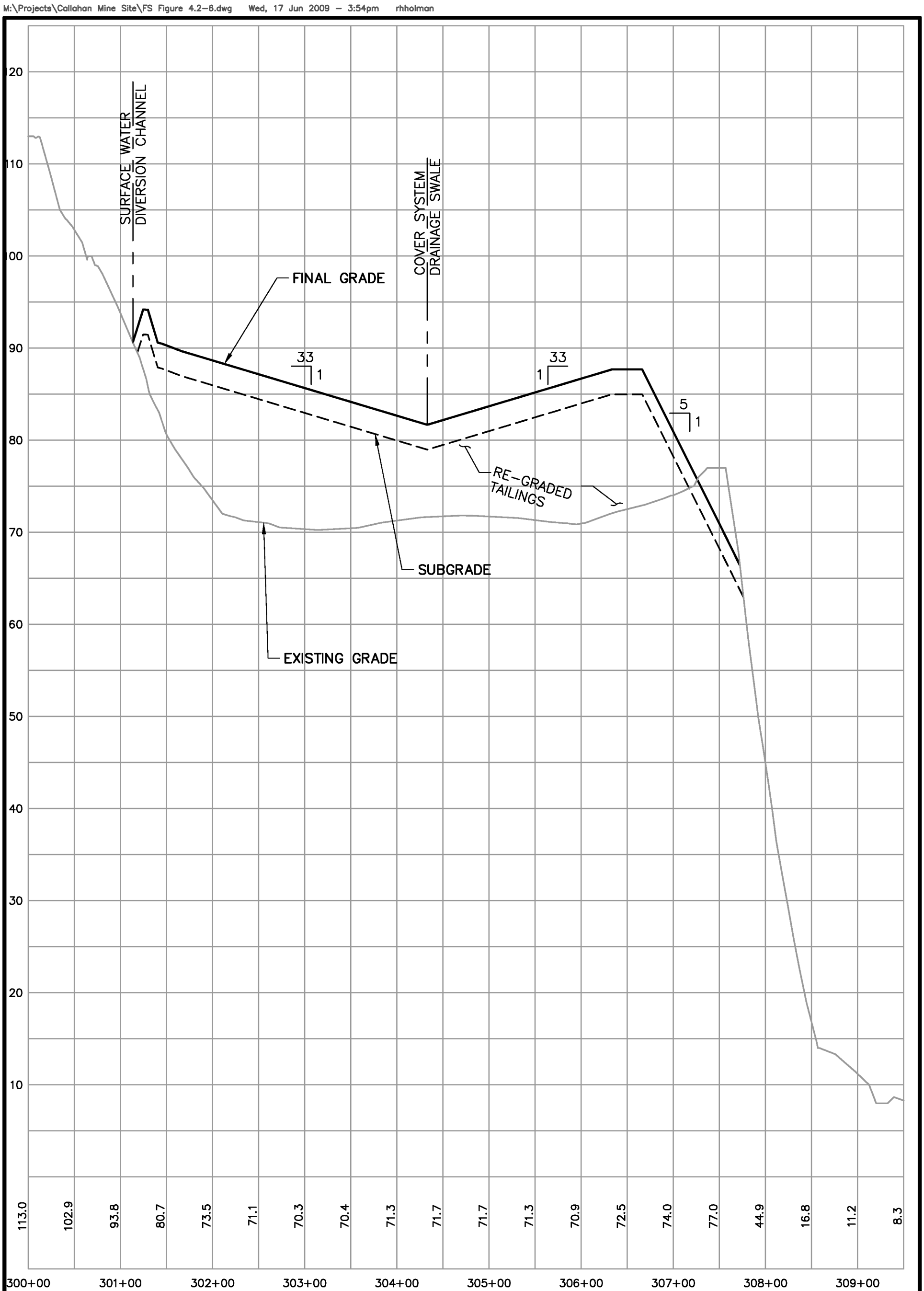

0 5 10 20 VERTICAL
SCALE IN FEET

0 50 100 200 HORIZONTAL
SCALE IN FEET

NOTES:

THIS CONCEPTUAL GRADING PLAN WOULD BE IMPLEMENTED ONLY IF IDENTIFIED AS NECESSARY DURING DESIGN.

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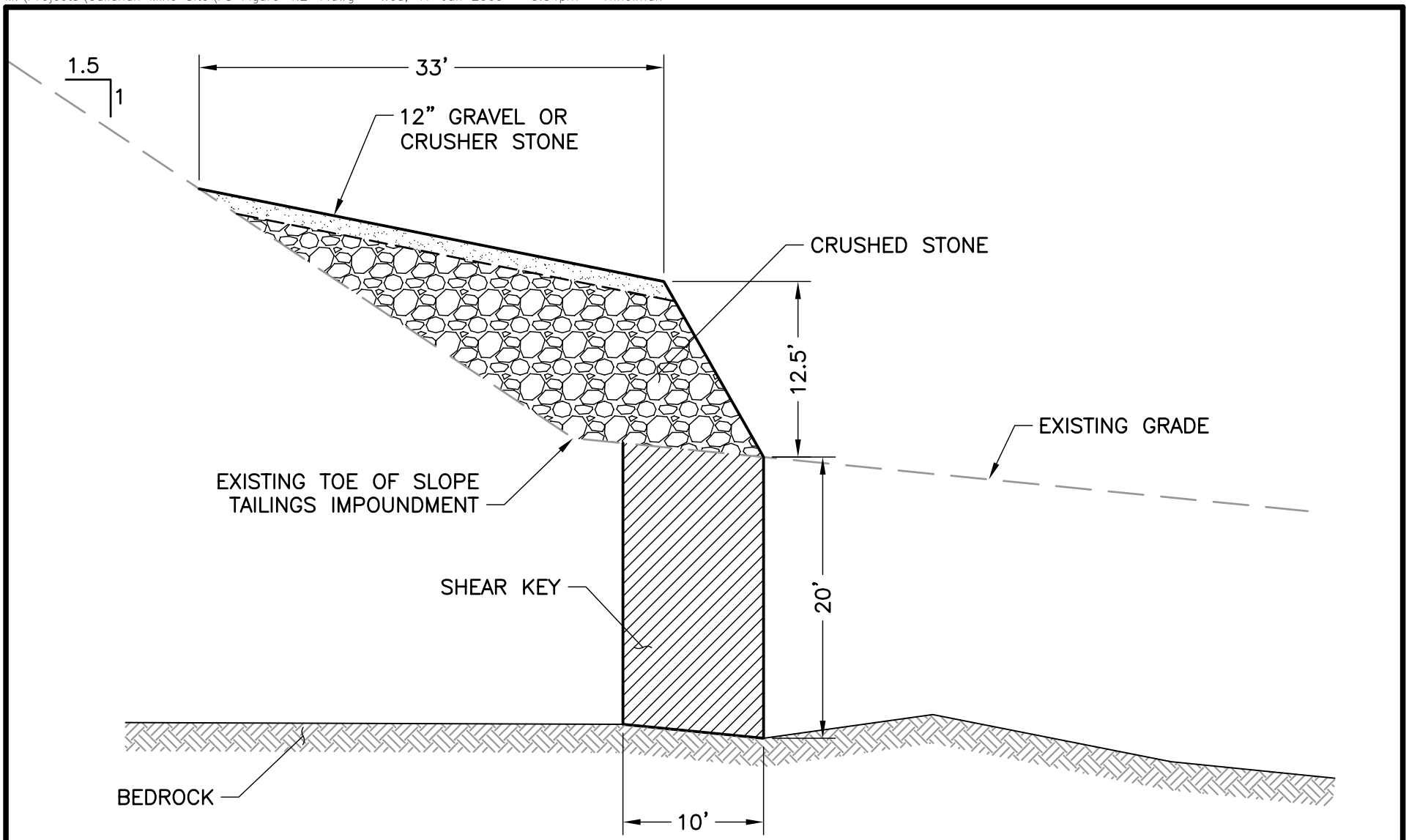
CALLAHAN MINE SUPERFUND SITE
BROOKSVILLE, MAINE

MACTEC

CROSS-SECTION OF ALTERNATIVE TAILINGS IMPOUNDMENT CAP
OU1 FEASIBILITY STUDY REPORT
Project 3612-06-2047.30
Figure 4.2-6



NOTE:

IMPROVEMENTS TO BE IMPLEMENTED ONLY IF IDENTIFIED AS NECESSARY DURING DESIGN.

TAILINGS IMPOUNDMENT TOE IMPROVEMENTS

NTS

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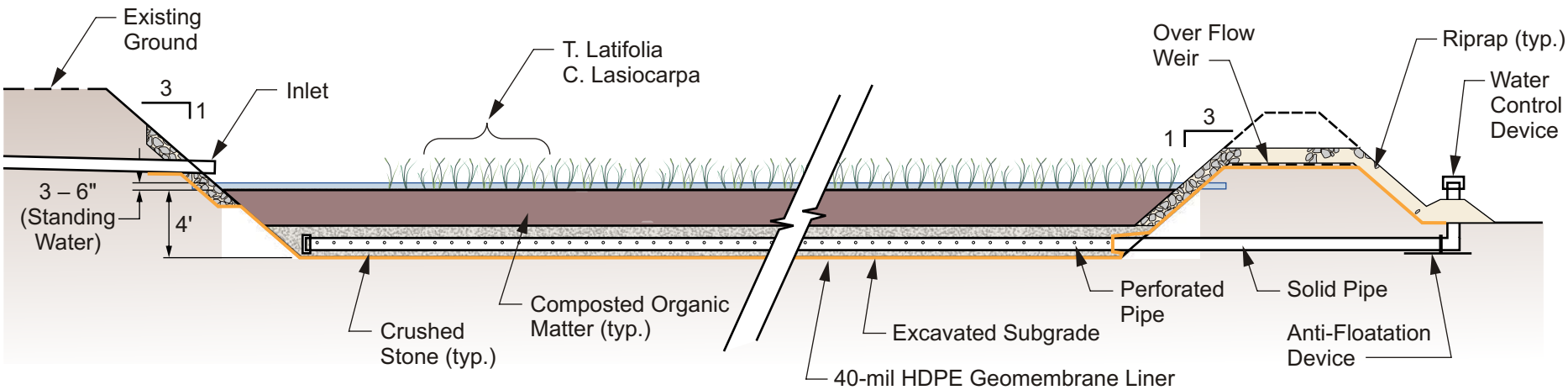
CALLAHAN MINE SUPERFUND SITE
BROOKSVILLE, MAINE

MACTEC

CROSS-SECTION OF CONCEPTUAL
TAILINGS IMPOUNDMENT TOE IMPROVEMENTS
Project 3612-06-2047.30
Figure 4.2-7



Note:
Surface of organic matter shall have micro topo relief (i.e., mounds and pools).

Not to Scale

Prepared/Date: JPH 3/23/09
Checked/Date: JPM 3/23/09

CALLAHAN MINE SUPERFUND SITE

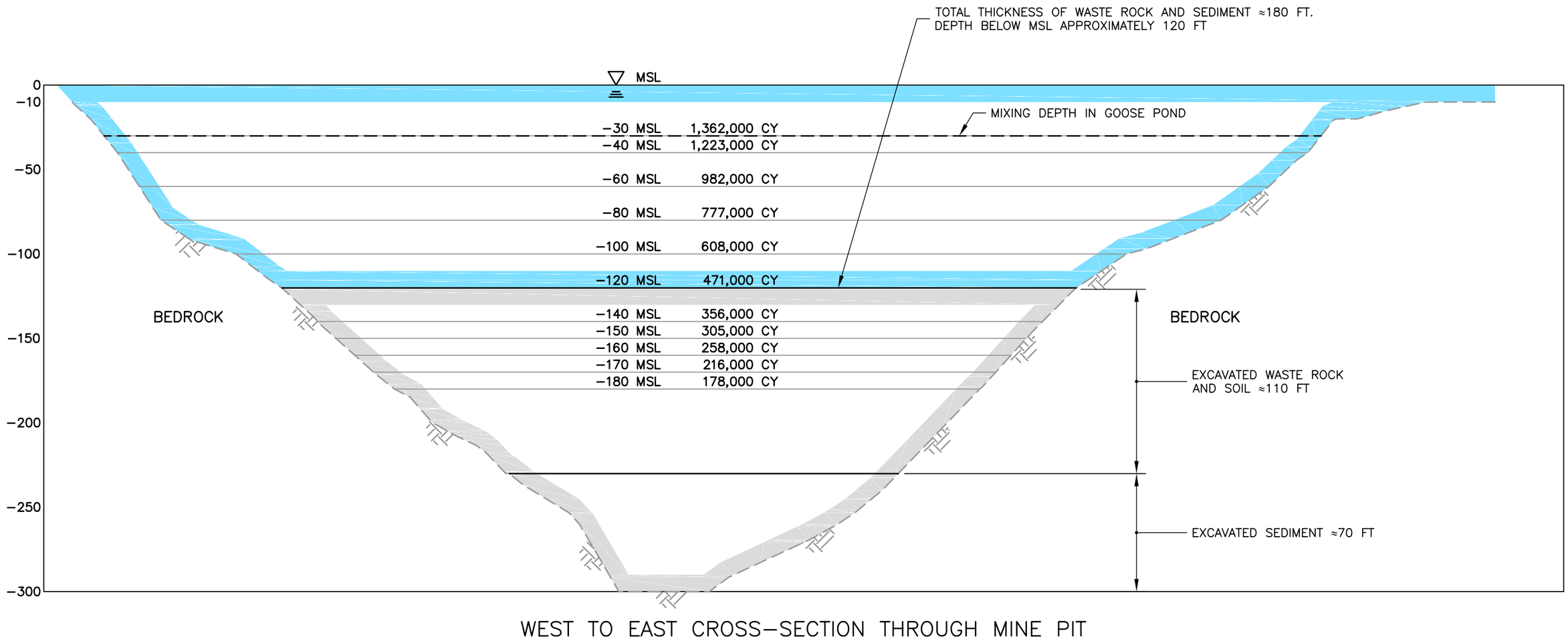
MACTEC

Wetland Construction Cross-Section
OU1 Feasibility Study Report
Callahan Mine Superfund Site
Brooksville, Maine

3612062047-30

Figure 4.2-8

PORT2009013a.cdr



WEST TO EAST CROSS–SECTION THROUGH MINE PIT

0 30 60 120
SCALE IN FEET

Prepared/Date: DEL 06/17/09
Checked/Date: SWR 06/17/09

CALLAHAN MINE SUPERFUND SITE
BROOKSVILLE, MAINE

MACTEC

ALTERNATIVE CMS2
DEPTH OF FILL IN MINE PIT
OU1 FEASIBILITY STUDY REPORT
Project 3612-06-2047.30
Figure 4.2-9

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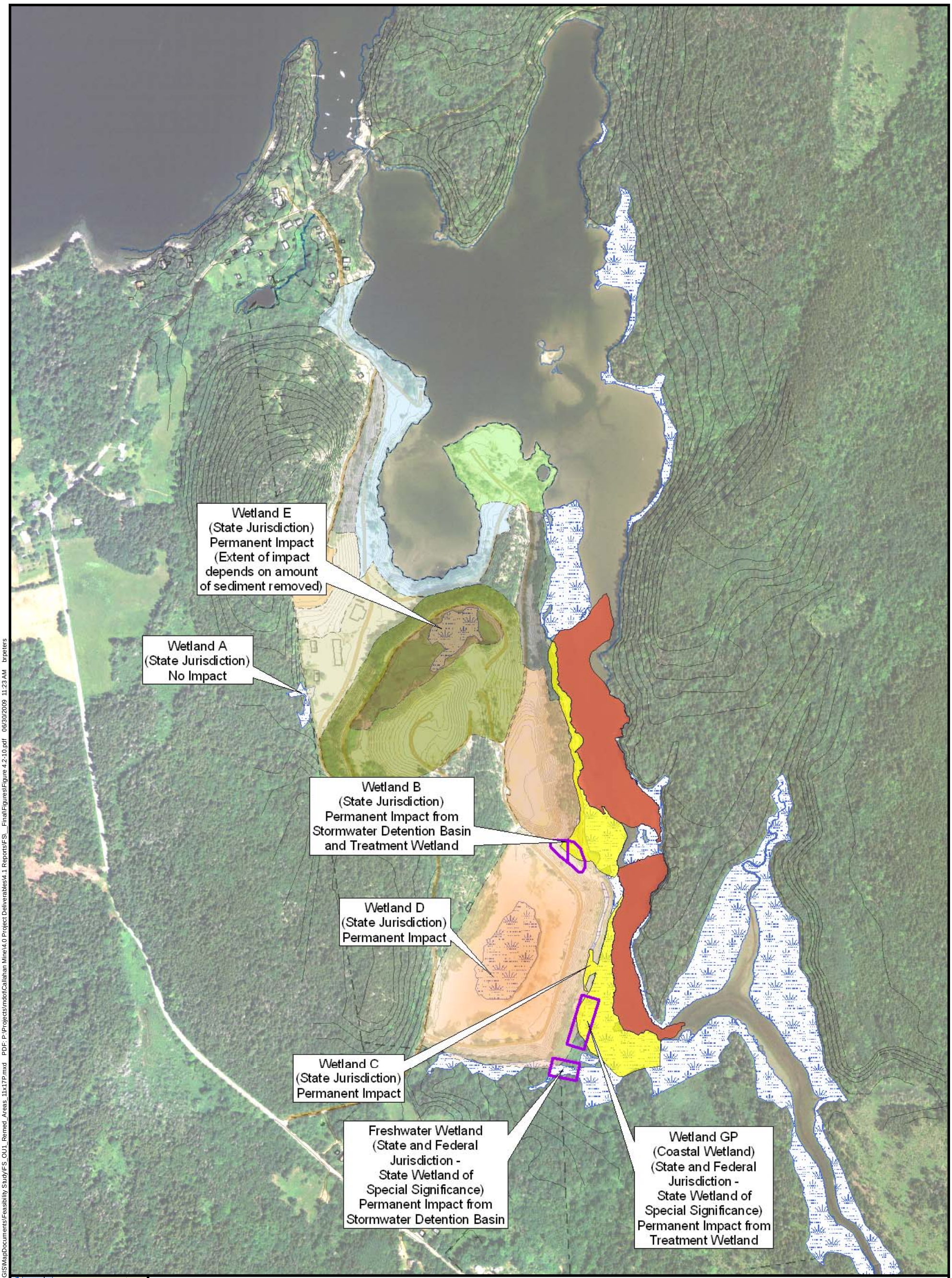

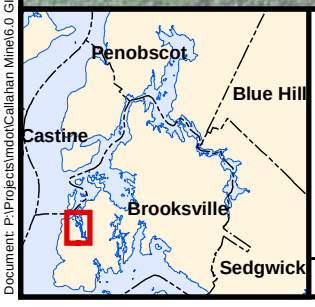

Note:
Final jurisdictional status to be determined by Maine DEP and USACE.

N

0 250 500 Feet

Legend

- Goose Pond Remediation Area
- Salt Marsh Remediation Area
- Delineated Wetlands

Prepared/Date: BRP 06/30/09 | Checked/Date: SWR 06/30/09

Figure 4.2-10
Alternative CMS2
Wetland Impacts

OU1 Feasibility Study Report
Callahan Mine Superfund Site
Brooksville, Maine
MACTEC, Inc.

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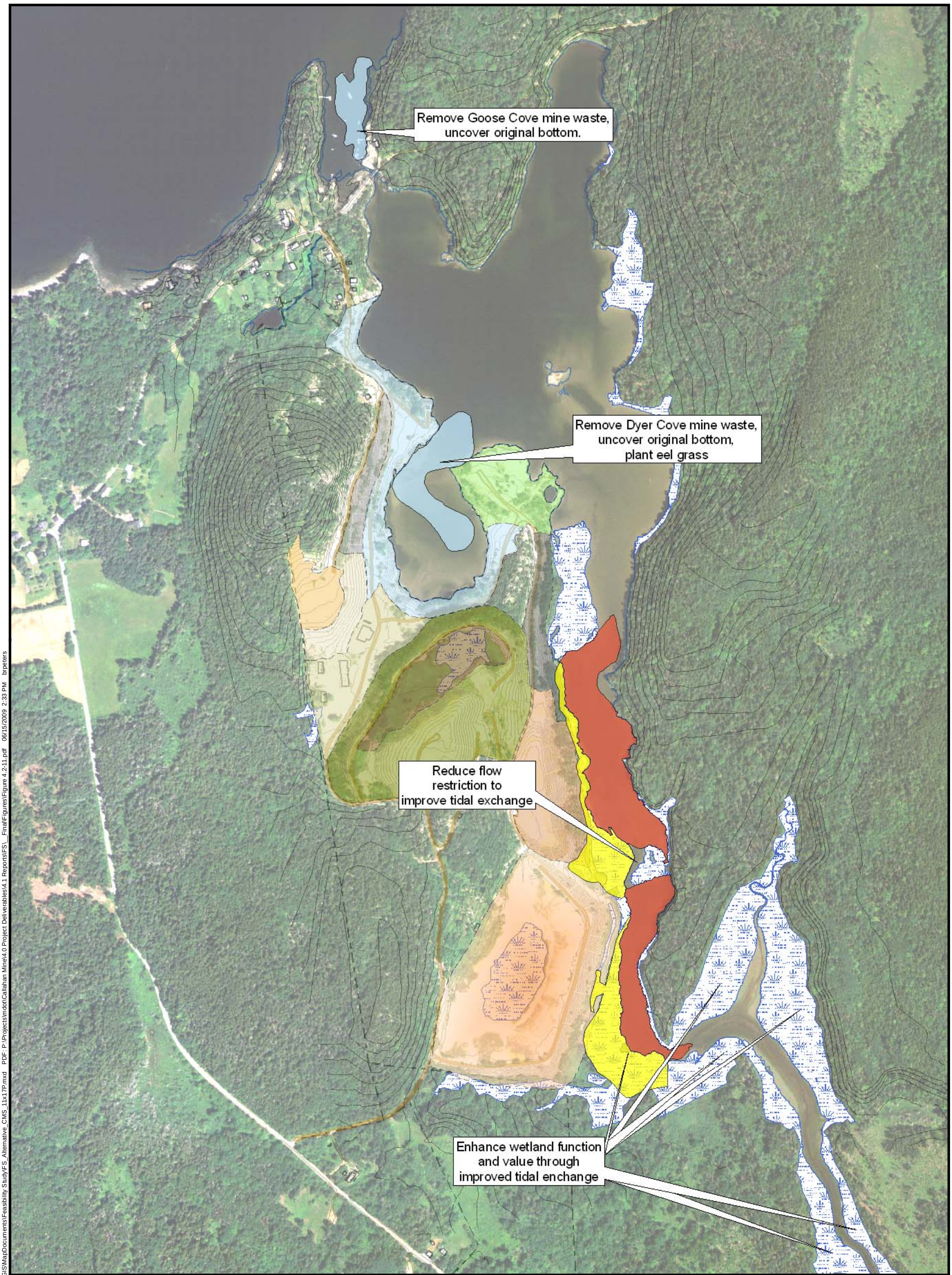

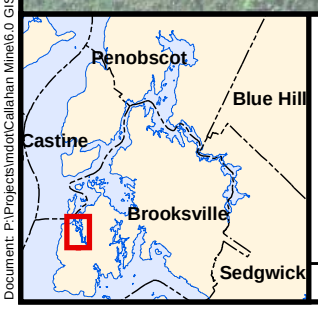

Legend

- Exceeds PRGs in Sediment
- Exceeds PRGs in Salt Marsh
- Delineated Wetlands

N

0 250 500 Feet

Prepared/Date: BRP 06/15/09 | Checked/Date: SWR 06/15/09

Figure 4.2-11
Alternatives CMS2 and CMS3
Potential Wetland Mitigation Measures

OU1 Feasibility Study Report
Callahan Mine Superfund Site
Brooksville, Maine
MACTEC, Inc.

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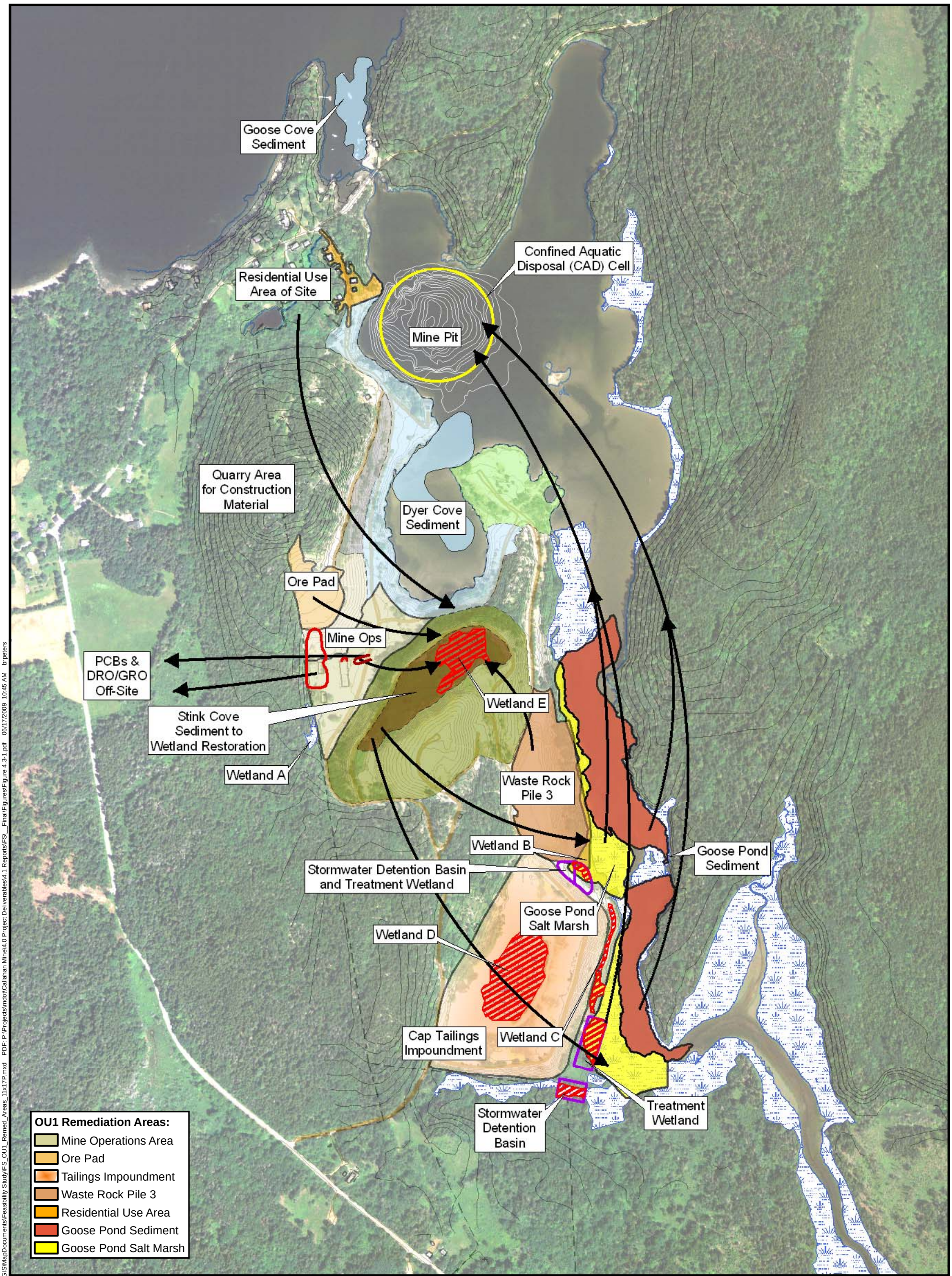

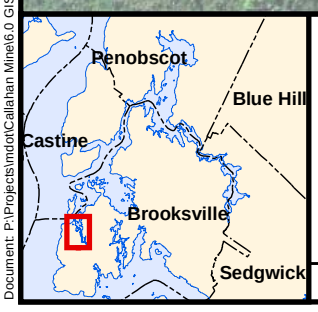

Legend

- Bathymetric Contour
- Delineated Wetlands
- Area of permanent Wetland Loss

N

0 250 500 Feet

Prepared/Date: BRP 06/17/09 | Checked/Date: SWR 06/17/09

Figure 4.3-1
Alternative CMS3
Proposed Remedy Map

OU1 Feasibility Study Report
Callahan Mine Superfund Site
Brooksville, Maine
MACTEC, Inc.

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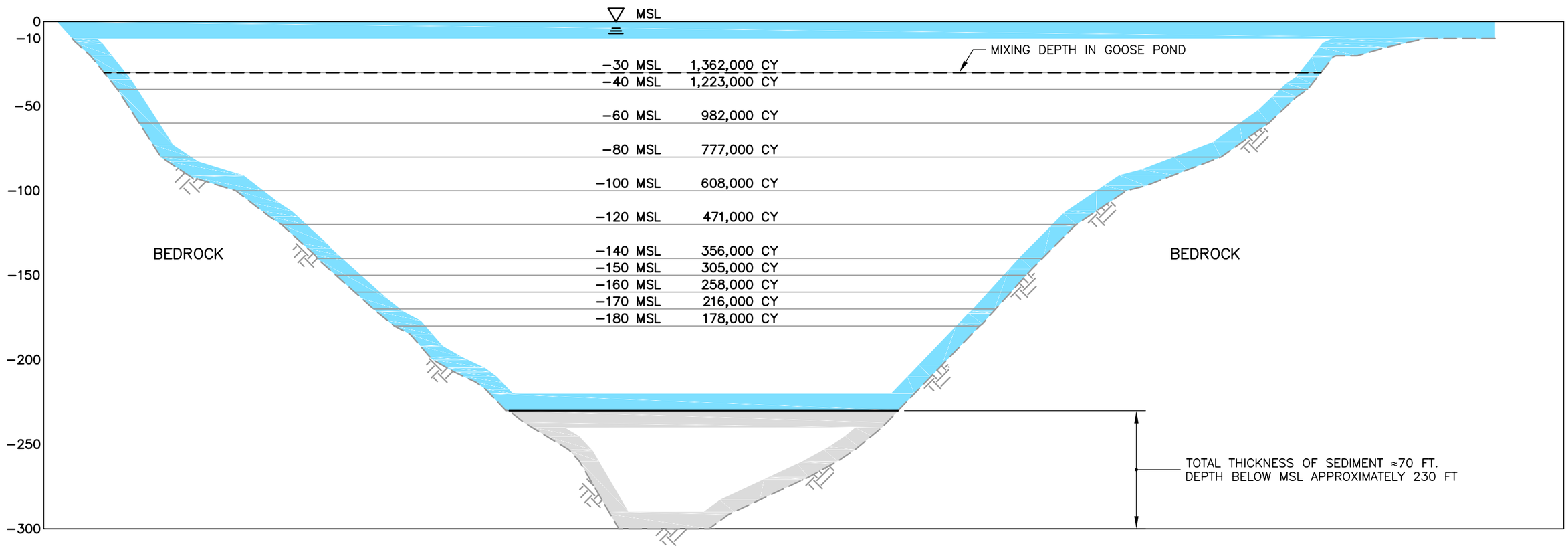

WEST TO EAST CROSS−SECTION THROUGH MINE PIT

0 30 60 120
SCALE IN FEET

Prepared/Date: DEL 06/17/09
Checked/Date: SWR 06/17/09

CALLAHAN MINE SUPERFUND SITE
BROOKSVILLE, MAINE

MACTEC

ALTERNATIVE CMS3
DEPTH OF FILL IN MINE PIT
OU1 FEASIBILITY STUDY REPORT
Project 3612-06-2047.30
Figure 4.3-2

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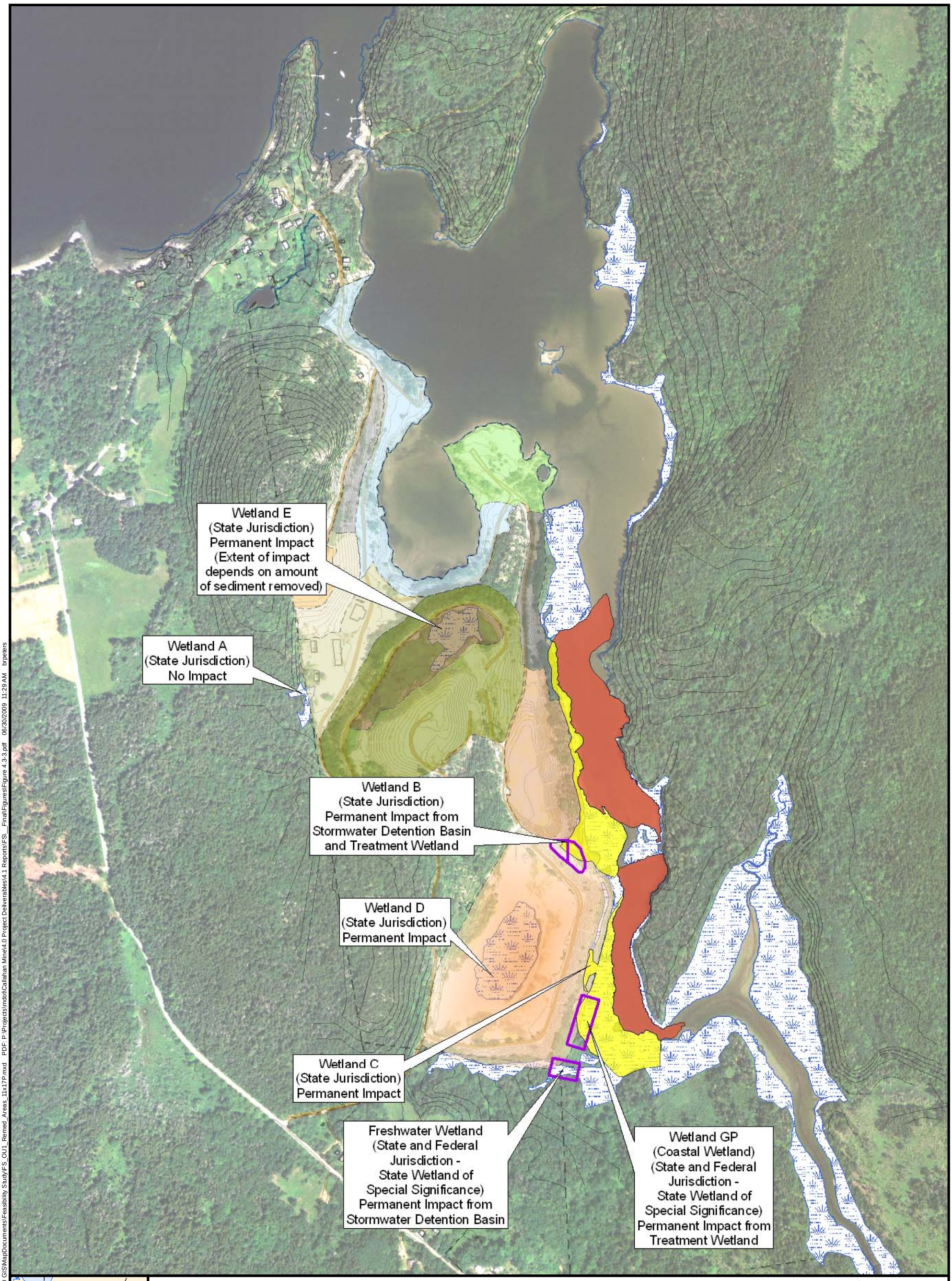

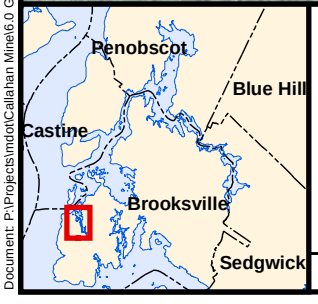

Note:
Final jurisdictional status to be determined by Maine DEP and USACE.

N

0 250 500 Feet

Legend

- Goose Pond Remediation Area
- Salt Marsh Remediation Area
- Delineated Wetlands

Prepared/Date: BRP 06/30/09 | Checked/Date: SWR 06/30/09

Figure 4.3-3
Alternative CMS3
Wetland Impacts

OU1 Feasibility Study Report
Callahan Mine Superfund Site
Brooksville, Maine
MACTEC, Inc.

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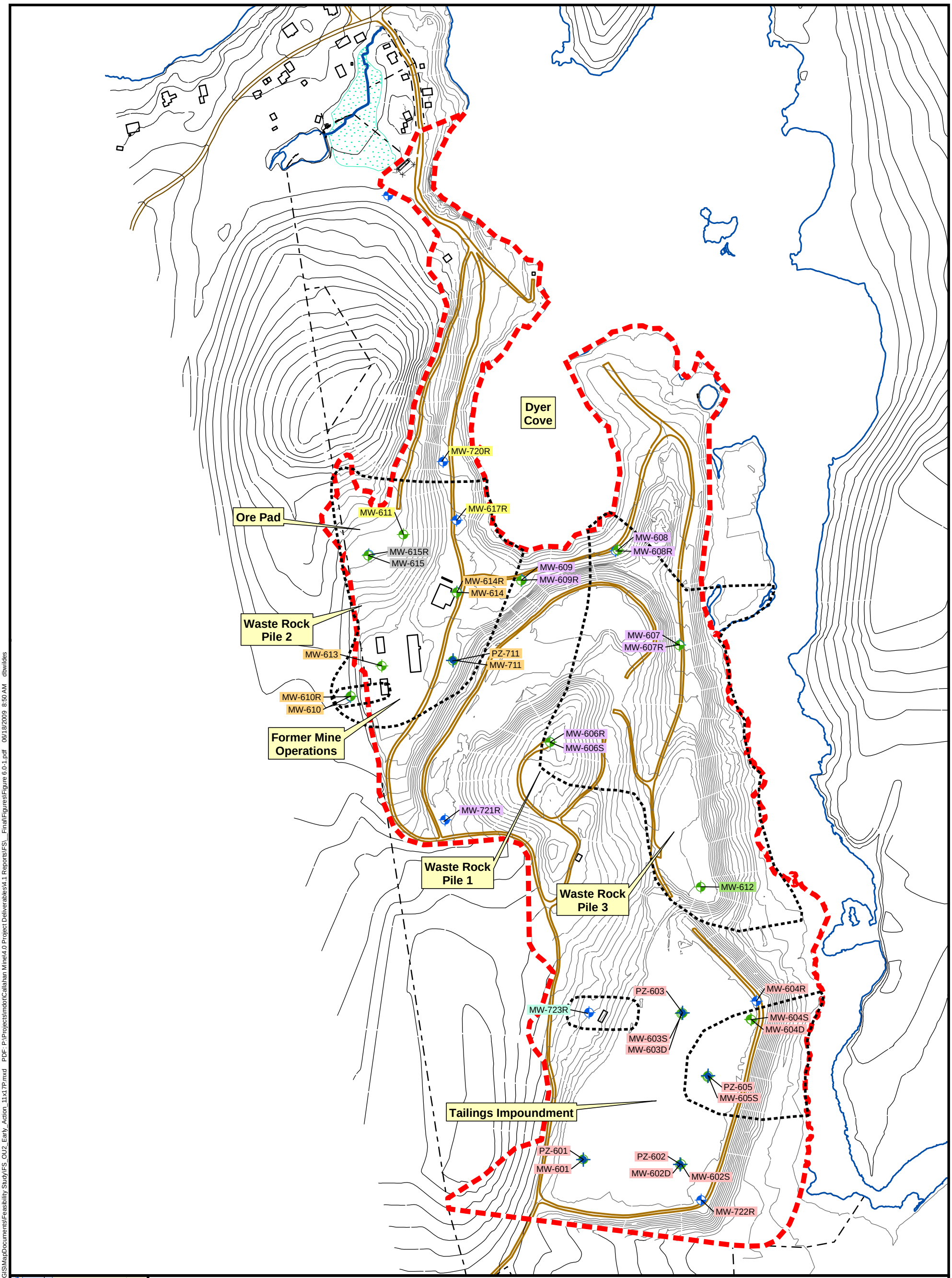

Prepared/Date: BRP 06/18/09 | Checked/Date: SWR 06/18/09

Figure 6.0-1
OU2 Early Action IC Areas

OU1 Feasibility Study Report
Callahan Mine Superfund Site
Brooksville, Maine
MACTEC, Inc.

Document: P:\Projects\mdot\Callahan Mine\6.0 GIS\MapDocuments\Feasibility Study\FS_OU2_Early_Action_11x17P.mxd PDF: P:\Projects\mdot\Callahan Mine\4.0 Project Deliverables\4.1 Reports\FS_Final\Figures\Figure 6.0-1.pdf 06/18/2009 8:50 AM dbwildes

TABLES

Table ES-1
Summary of Site Investigations

Year of Investigation	Principal Investigator	Investigation Description	Sampling Summary
1968- 1972	Callahan Mine Period of Operations	-	-
1975	Maine Dept. of Marine Resources	Bioaccumulation Survey	Marine organism tissue - Goose Cove
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1985	FM Beck, Inc.	Site Review Data	5 sediment cores
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Summary of Site Investigations

Year of Investigation	Principal Investigator	Investigation Description	Sampling Summary
2006	MaineDOT - MACTEC	Phase 1A 2006 Remedial Investigation	22 soil borings 16 piezocone penetrations 5 piezometers 14 overburden monitoring wells 10 bedrock monitoring wells 1 round residential drinking water sampling 2 rounds groundwater sampling 2 synoptic groundwater level surveys 4 air monitoring stations Electromagnetic surveys 15 seep samples 7 surface water samples
2007	MaineDOT - MACTEC	Phase 1B 2007 Remedial Investigation	12 soil borings 10 piezometers 9 overburden monitoring wells 4 bedrock monitoring wells 44 test pit excavations 1 round residential drinking water sampling 1 round groundwater sampling 1 synoptic groundwater level survey 9-month water elevation monitoring 5 seep samples 325 surface soil samples 55 subsurface soil samples 6 surface water samples
2008	Maine DOT - MACTEC	Clam Tissue/Sediment Bioavailability Study	22 clam tissue samples 22 sediment samples

Prepared/Date: SFC 06/25/07
Checked/Date: SWR 06/15/09

Table ES-2
Human Health Preliminary Remediation Goals for Soil

	Back-ground	Maine Remedial Action Guideline [1]	Site-Specific Risk Calculation ELCR = $1x10^{-6}$	Site-Specific Risk Calculation HQ = 1 or IEUBK for Lead	Selected as PRG	Basis	Risk at PRG HQ / ELCR
Residential Use Areas							
Arsenic	14	10	1	56	14	Background	HQ = 0.2 ELCR = $5.8x10^{-6}$
Lead [2,4]	37	375	Not applicable	340	375	Maine State Safe Lead level and site-specific IEUBK model output	95% of exposed population should have a blood lead level that does not exceed 10 µg/dl based on this PRG
Polychlorinated biphenyls	Not detected	2.2	0.52	2.6	1	TSCA[3] and site-specific risk basis to allow for unrestricted future use	HQ = 0.4 ELCR = $1.9x10^{-6}$
Thallium	0.12	Not applicable	Not applicable	15	15	Site-specific risk basis for noncancer exposure	HQ = 1 ELCR = n.a. HI = 1.6 Cumulative ELCR = $7.7x10^{-6}$
Recreational Use Areas							
Arsenic	14	30	2.4	146	30	Risk-management decision to accept $1x10^{-5}$ ELCR for arsenic	HQ = 0.2 ELCR = $1.2x10^{-5}$
Lead [4]	37	700	Not applicable	2,385	700	Maine Remedial Action Guideline and site-specific IEUBK model output	95% of exposed population should have a blood lead level that does not exceed 10 µg/dl based on this PRG
Polychlorinated biphenyls	Not detected	8.1	1.2	7.7	1	TSCA and site-specific risk basis to allow for unrestricted future use	HQ = 0.1 ELCR = $0.8x10^{-6}$ HI = 0.3 Cumulative ELCR = $1.2x10^{-5}$

Notes:
All concentrations = mg/kg
HI = hazard index, HQ = hazard quotient; ELCR = excess lifetime cancer risk
[1] Maine DEP, Implementation of Remedial Action Guidelines, Table 4 – Remedial Action Guidelines for Contaminated Soils
[2]USEPA Memorandum: Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities" (August 1994) EPA/540/F-94/043, OSWER 9355.4-12 recommends a residential lead cleanup level of 400 mg/kg.
[3] Toxic Substances Control Act, 40 CFR Part 761 – Polychlorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution in Commerce, and Use Prohibitions.
[4] Maine Solid Waste Management Rules, Lead Management Regulations [06-096 CMR 424] establish lead safe standards for soil containing lead – if lead in bare soil in play areas exceeds 375 ppm or 1,000 ppm in other than play areas, the soil in those areas shall be considered a lead hazard.

Prepared by: SWR 02/18/2009
Checked by: JHP 06/15/2009

Table ES-3
Preliminary Remediation Goals for Sediment

Chemical of Concern	Goose Pond Background	Salt Marsh Background	Selected as PRG	Basis	Derivation [1]
Cadmium	1	1	210	Ecological effects	Lower of LOAELs for G.B. heron or S. sandpiper
Copper	21	18	790	Ecological effects	Lower of LOAELs for G.B. heron or S. sandpiper
Lead	27	26	710	Ecological effects	Lower of LOAELs for G.B. heron or S. sandpiper
Zinc	98	91	5100	Ecological effects	Benthic Macroinvertebrate Dose-Response Value – High

Notes:
All concentrations are in units of mg/kg.
[1] see Table 2.2-8 in FS report for additional information.

Prepared by: AMR 03/03//2009
Checked by: SWR 03/03/2009

Table ES-4
Summary of Tier I Evaluation of Sediment and Salt Marsh Hot Spots

Analyte	PRG	Goose Pond Mine Waste Hot Spot	Salt Marsh Mine Waste Hot Spot	Salt Marsh Not Mine Waste	Dyer Cove	Goose Pond North & South	Goose Cove Not Hot Spot	Goose Cove Mine Waste
Cadmium	210	29.0	45.1	17.9	18.6	8.8	4.7	19.6
Copper	790	2288	7498	296	2316	464	524	3370
Lead	710	1110	837	303	457	200	133	622
Zinc	5100	9601	17161	1773	15835	1979	1111	6607

Note:
All values in miligrams per killogram (mg/kg)
Shade indcates UCL concentration exceeds PRG.

Prepared by SWR 03/12/2009
Checked by: JHP 04/02/2009
Checked by: SWR 06/15/2009

Table ES-5
Summary of Tier II Evaluation of Sediment and Salt Marsh Hot Spots

Area	Do 95% UCL Concentrations Exceed the PRGs?	Did Sediment Toxicity Tests Reveal Acute Toxicity?	Do Fish Tissue Concentrations Exceed Background?	Are Plant Tissue Concentrations Above Background?	Are Clam Tissue Concentrations Above Background?	Was Pore Water Above NRWQC?	Was There Clear Evidence of Benthic Community Impairment?	Was There Qualitative Evidence of Benthic Community Impairment?	Does Food Chain Modeling Indicate a Threat to Insect and Fish Eating Birds?	Post BERA Eco Risk Refinement Conclusion Based on Hot Spot Evaluations
Goose Pond Mine Waste Hot Spot	y +	y	*y+	n.a.	y*	y	n	y	y	Southern Goose Pond mine waste hot spot represents an unacceptable threat to ecological receptors
Dyer Cove	y+	n	y+	n.a.	y*	n	n	n	n	While concentrations of contaminants are above the PRGs and clam tissue was elevated above background, the overall assessment does not support an unacceptable threat to ecological receptors in Dyer Cove
Goose Cove Mine Waste Hot Spot	y+	n	n	n.a.	n.a.	n	n	n	n	While concentrations of contaminants are above the PRGs, the overall assessment does not support an unacceptable threat to ecological receptors in Goose Cove
Remainder Goose Pond	n	n	y	n.a.	n	n	n	n	n	Remainder of Goose Pond does not represent an unacceptable threat to ecological receptors
Remainder Goose Cove	n	n	n	n.a.	n	n	n	n	n	Remainder of Goose Cove does not represent an unacceptable threat to ecological receptors
Salt Marsh Mine Waste Hot Spot	y+	n.a.	n.a.	y	n.a.	n.a.	n.a.	n.a.	y	Salt Marsh mine waste hot spot represents an unacceptable threat to ecological receptors
Remainder Salt Marsh	n	n.a.	n.a.	n	n.a.	n.a.	n.a.	n.a.	n	Remainder of Salt Marsh does not represent an unacceptable threat to ecological receptors

Notes:

Prepared by: LJ 06/30/09

Checked by: SWR 06/30/09

+ means more that 10x background
*includes areas adjacent to mine waste hot spot that could be part of foraging area for the fish
n.a. = not applicable
NRWQC = National Recommended Water Quality Criteria

Table ES-6
Estimated Volumes and Areas Identified for Remediation

Site Management Area	Average Thickness, ft [1]	Area, sq feet	Area, acres	Volume, cy [2]
Waste Rock and Soil				
Residential Area *	2.0	41,060	0.9	3,041
Mine Operations Area (includes subareas below)	5.2	227,480	5.2	43,920
PCB Area > 1mg/kg boundary*	2.0	29,666	0.7	2,197
PCB Area > 50 mg/kg boundary*	2.0	2,958	0.1	219
Oil-Contaminated Area **	3.0	2,615	0.1	600
Ore Pad	4.8	90,161	2.1	15,948
Waste Rock Pile 3	20.5	285,561	6.6	216,396
Road to Waste Rock Pile 3	14.6	111,128	2.6	60,238
Tailings Impoundment (footprint and volume including berm)	21.1	915,551	21.0	716,490
Tailings Impoundment Surface Inside of Berm	-	576,300	13.2	-
Waste Rock Pile 2 (200x200 ft strip at western edge)	5.0	40,000	0.9	7,410
Sediment				
Goose Pond (Hot spot east of WRP-3 and T. Impoundment) *	3.0	462,172	10.6	51,352
Salt Marsh (Hot spot east of WRP-3 and T. Impoundment) *	2.0	299,257	6.9	22,167
Areas of Salt Marsh Readily Apparent Harm (three areas)	2.0	4,790	0.11	355
Dyer Cove (as potential mitigation, CMS2-CMS5)*	3.0	155,074	3.6	17,230
Goose Cove (as potential mitigation, CMS2-CMS5)*	4.0	66,211	1.5	9,809

Notes: Prepared by: MRS 10/09/08
1 Average depth in upland areas backcalculated from volume and area Checked by: SWR 06/30/09
2 All volume are in-place volumes. Unless noted, volume in upland areas calculated with AutoCAD by comparing TRC survey (2004) to premine topography (Callahan Mine Corp map by Sewall, 1965).
* Values based on analytical data and field observation
** Because of uncertainty in the delineation of oil-contaminated soil, volume asumed to be twice that based on listed area and depth.

Table 1.4-1
Summary of Site Investigations

Year of Investigation	Principal Investigator	Investigation Description	Sampling Summary
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Prepared/Date: SFC 06/25/07
Checked/Date: SWR 06/15/09

Table 1.4-2
Estimated Volumes of Waste Rock and Tailings

Site Management Area	Average Thickness, ft[1]	Area, sq feet	Area, acres	Volume, cu. yards[2]
Dyer Cove Perimeter	10.0	340,204	7.8	125,908
Dyer Point	5.7	181,320	4.2	38,071
Mine Operations	5.2	227,480	5.2	43,920
PCB Area > 1mg/kg *	2.0	29,666	0.7	2,197
Petroleum-contaminated soil exceeding State criteria [3]	3.0	2,615	0.1	600
Ore Pad	4.8	90,161	2.1	15,948
Ore Pad Haul Road	2.8	80,184	1.8	8,322
Residential Area *	2.0	72,492	1.7	5,370
Road to Waste Rock Pile 3	14.6	111,128	2.6	60,238
Tailings Impoundment (footprint and volume including berm)	21.1	915,551	21.0	716,490
Tailings Impoundment Surface Inside of Berm	-	576,300	13.2	-
Stink Cove Sediment at Waste Rock Pile 1	41.7	187,585	4.3	289,900
Waste Rock Pile 1 (includes berm, excludes Stink Cove sediment)	42.7	613,106	14.1	968,763
Waste Rock Pile 2	6.5	94,340	2.2	22,781
Waste Rock Pile 3	20.5	285,561	6.6	216,396

Prepared by: MRS 10/09/2008
Checked by: SWR 03/27/2009

Notes:

1 average depth backcalculated from volume and area

2 Unless noted, volume calculated with AutoCAD by comparing TRC survey (2004) to premine topography (Callahan Mine Corp map by Sewall, 1965).

3 Because of uncertainty in the the delineation of oil-contaminated soil, volume asumed to be twice the volume based on listed area and depth.

* values based on analytical data and field observation

Table 1.4-3
Maximum Detected Dissolved Phase Concentrations in Leachate, Overburden, and Bedrock Groundwater

Site Area	Arsenic (µg/L)	Cadmium (µg/L)	Copper (µg/L)	Lead (µg/L)	Manganese (µg/L)	Zinc (µg/L)
Leachate and Overburden Groundwater						
Federal Drinking Water Standard	10	5	1,300	15	300 [1]	2,000
State Maximum Exposure Guidelines	10	3.5	1,300	10	500	2,000
Water Quality Standard (NRWQC) [3]	36	9	3	8	na	81
OU1 Source Areas						
Tailings Impoundment	25	0.2	10	4	7,500	2410
WRP-3	nd	10	82	48	668	1420
Ore Pad	nd	1,180	13	8	1,820	83,600
Mine Operations Area[2]	16	58	132	nd	2,710	7,460
OU2 Source Areas						
WRP-2	na	na	na	na	na	na
WRP-1, Dyer Point Perimeter, Dyer point	17	32	171	405	776	2,710
Bedrock Groundwater						
OU1 Source Areas						
Tailings Impoundment	nd	nd	nd	nd	1,000	9
WRP-3	na	na	na	Na	na	na
Ore Pad	nd	160	13,800	3	817	42,600
Mine Operations Area	3	30	68	nd	2,740	12,500
OU2 Source Areas						
WRP-2 (downgradient of Ore Pad)	nd	14	nd	nd	1,470	906
WRP-1, WRP-2, Dyer Point Perimeter, Dyer point	nd	16	6	13	9,510	4,120
Background (Bedrock)	nd	3	84	nd	74	717

Notes:
[1] USEPA health advisory.
[2] Mine Operations exhibits true overburden groundwater conditions
[3] Saltwater chronic concentration
na = not available
nd = not detected
Shading indicates concentration exceeds drinking water / groundwater standard by more than five times.

Prepared by: SFC 06/16/09
Checked by: SWR 06/16/09

Table 1.4-4
Maximum Detected Dissolved Phase Concentrations in Seeps

Site Area	Cadmium (µg/L)	Copper (µg/L)	Lead (µg/L)	Zinc (µg/L)
National Recommended Water Quality Criteria [1]	9	3	8	81
OU1 Source Areas [2]				
Tailings Impoundment	65	154	22	16,200
WRP-3	770	11,100	172	172,000
Mine Operations Area	79	90	3.4	14,500
OU2 Source Areas [2]				
WRP-1, WRP-2, Dyer Point Perimeter, Dyer point	34	982	nd	7,860
Estimated Loading [3]				
Dyer Cove (Mine Ops and Ore Pad)	0.001 kg/d	0.002 kg/d	0.0001 kg/d	0.25 kg/d
WRP-1	0.00005 kg/d	0.001 kg/d	0.00002 kg/d	0.015 kg/d
WRP-3	0.0009 kg/d	0.03 kg/d	0.0002 kg/d	0.20 kg/d
Tailings Impoundment	0.001 kg/d	0.007 kg/d	0.002 kg/d	0.49 kg/d

Notes:
[1] Saltwater chronic concentration
2 Concentration data from RI Table 4.4-1
3 Estimated loadings for April 2005 data, RI Table 4.4-3a
nd = not detected
kg/day = kilograms per day
Shading indicates concentration in excess of Water Quality Criteria by at least five times.

Prepared by SFC 6/08/2009
Checked by SWR 06/08/2009

Table 1.4-5
Human Health Risk Assessment Summary

Exposure Point	Current Resident			Future Resident			Current/Future Recreational Visitor			Future Recreational Angler			Future Commercial Angler		
	ELCR	HI	Pb_{BLD}	ELCR	HI	Pb_{BLD}	ELCR	HI	Pb_{BLD}	ELCR	HI	Pb_{BLD}	ELCR	HI	Pb_{BLD}
Residential Risk Assessment Area A Surface Soil	5E-05	1 [a]	> 10												
Residential Risk Assessment Area B Surface Soil	4E-05	0.7	< 10												
Residential Risk Assessment Area C Surface Soil	3E-05	1	> 10												
Residential Risk Assessment Area D Surface Soil	4E-05	2	> 10												
Source Area Surface Soil				3E-03	58	> 10	1E-03	167	< 10						
Source Area Subsurface Soil				3E-07	0.07										
Halo Area Surface Soil				2E-05	1	< 10	7E-06	0.2	< 10						
Freshwater Seeps							1E-08	0.1							
Overburden Groundwater				1E-03	235	> 10									
Bedrock Groundwater				1E-04	86	< 10									
Goose Cove Surface Water							5E-09	0.001		9E-09	0.002		6E-08	0.01	
Goose Cove Crustaceans (Crabs) [b]										3E-04	4	< 10	3E-04	4	
Goose Cove Crustaceans (Lobster) [b,c]										2E-04	2	< 10	2E-04	3	
Goose Cove Bivalves (Clams) [c]										9E-05	3	< 10	7E-05	2	
Goose Cove Bivalves (Mussels)										1E-04	1 [a]	< 10	1E-04	1 [a]	
Goose Pond Surface Water							5E-09	0.001		9E-09	0.002		6E-08	0.01	
Goose Pond Sediment							3E-07	0.003		2E-06	0.03	< 10			
Goose Pond (Irregularly Flooded) Sediment							2E-05	0.6	< 10	3E-06	0.03	< 10			
Goose Pond Crustaceans (Crabs) [c]										1E-04	3	< 10	1E-04	4	
Goose Pond Bivalves (Clams)										2E-05	0.6	< 10			
Salt Marsh Sediment							1E-05	1	< 10						
Marsh Creek Surface Water							1E-07	0.003							
Marsh Creek Sediment							1E-07	0.001							
Weir Cove Bivalves (Clams) [b]										2E-04	1 [a]	< 10	1E-04	1 [a]	

Green shading indicates ELCR less than 1E-06, HI less than 1, or Pb_{BLD} 10 µg/dL or less for 95% or more of the population.
Blue shading indicates ELCR between 1E-06 and 1E-04.
Red shading indicates ELCR greater than 1E-04, HI greater than 1, or Pb_{BLD} greater than 10 µg/dL for more than 5% of the population.
Yellow shading indicates incremental risks are below a cancer risk of 1E-04 and a HI of 1.

[a] Based on target organ hazard index.
[b] Risks are due to arsenic; arsenic in biota tissue does not appear to be related to the Site. Incremental risks are below a cancer risk of 1E-04 and a hazard index of 1.
[c] Target organ hazard index does not exceed 1.

ELCR - Excess Lifetime Cancer Risk
HI - Hazard Index
Pb_{BLD} - Geometric mean blood lead level

Prepared by / Date: KJC 03/10/08
Checked by / Date: JHP 03/10/08
Revised by / Date: KJC 10/23/08

Table 1.4-6
Ecological Risk Summary Matrix - Aquatic Exposure Areas

	Receptor Group	Assessment Endpoint	Measurement Endpoints	Inference Weight*	Uncertainty	Goose Cove	Goose Pond Permanently Flooded	Goose Pond Irregularly Flooded	Salt Marsh	Marsh Creek	Weir Cove
			AQUATIC HABITAT								
1	Salt Marsh Plants	Maintenance of plant communities in the Salt Marsh exposure area that were potentially affected by past mining activities at the Site similar to those communities found at the reference site.	1A: Compare Site salt marsh sediment metal concentrations to published sediment benchmarks protective of vascular plants (*Spartina*) and to reference sediment concentrations.	L	Bulk sediment concentrations may overestimate bioavailable fraction.	Not evaluated	Not evaluated	Not evaluated	Adverse population level effects possible from cadmium and copper. HQs are low (1.1 to 2.8 based on RME/CTE and NOAEL/LOAEL combinations).	Not evaluated	Not evaluated
			1B: Compare concentrations in Salt Marsh plant tissue (*Spartina*) to literature-based effects thresholds and to reference locations.	L/M	Assumes tissue concentrations greater than reference result in adverse effects and therefore overestimates risk.	Not evaluated	Not evaluated	Not evaluated	Adverse population level effects possible for cadmium, copper, and zinc. HQs are low (1.7 to 5.3) based on RME/CTE combinations).	Not evaluated	Not evaluated
			1C: Perform field surveys to determine if the Salt Marsh *Spartina* population is significantly different from reference populations.	M/H	Assumes that physical parameters (flooding regime, salinity range natural sulfuric acid production, etc.) are consistent between study and reference areas.	Not evaluated	Not evaluated	Not evaluated	Salt marsh plants in location of readily apparent harm (RAH) located at the upland fringe of the salt marsh are significantly different from reference salt marsh. There is likely a high risk of harm to the salt marsh plant community in areas of RAH.	Not evaluated	Not evaluated
			Assessment Endpoint 1 Weight of Evidence Conclusion	-	-	Not evaluated	Not evaluated	Not evaluated	There is a high risk to salt marsh plants in areas of RAH. The cause of the RAH is not known; it could be due to an episodic event from a seep discharge, chronic exposure to Site seeps or sediment, or other natural non-chemical stressors. In other areas of the salt marsh, risk of harm is unlikely. Areas of RAH affects less than 0.5% of Salt Marsh habitat. Benchmark comparisons may overestimate risk.	Not evaluated	Not evaluated
2	Benthic Invertebrates	Maintenance of benthic invertebrate communities at the Site similar to those found at the reference site.	2A: Compare Site sediment AVS SEM concentrations to toxicity thresholds and reference locations.	M	AVS SEM data are better at predicting lack of toxicity than predicting toxicity. Less than 5% of AVS SEM data are above the uncertainty thresholds (>130 uMols/g) for lack of toxicity.	Divalent metals not likely to be toxic and are not bioavailable. Risk to the benthic macroinvertebrate community unlikely.	Divalent metals not likely to be toxic and are not bioavailable. Risk to the benthic macroinvertebrate community unlikely.	Divalent metals not likely to be toxic. Risk to the benthic macroinvertebrate community unlikely.	Not evaluated	Divalent metals not likely to be toxic and are not bioavailable. Risk to the benthic macroinvertebrate community unlikely.	Divalent metals not likely to be toxic. Risk to the benthic macroinvertebrate community unlikely.
			2B: Perform laboratory toxicity tests to measure survival and growth of two marine/estuarine benthic invertebrates (the amphipod *Leptocherius plumulosus* and the polycheate *Neanthes arenaceodentata*) exposed to sediments collected from Site exposure areas and reference locations. Compare toxicity test results to sediment and pore water chemistry data to try to identify a dose-response relationship in exposure areas demonstrating ecologically significant effects.	M/H	Predators found in some replicates; tests performed at salinity concentrations of 27 parts per thousand (ppt) while field conditions in some exposure areas may be lower; only one reference sample was collected for each exposure area; lab conditions not truly representative of field conditions where biota have had the opportunity to acclimate to ambient conditions.	Ecologically significant effects to *Neanthes arenaceodentata* growth at GC-05. Analysis of dose-response scatter plots for copper, lead, and zinc did not identify a potential effects driver. No effect on *Neanthes* growth, or *Leptocheirus* growth and survival. Sediment COPC concentrations at GC-05 were lower than GC-04 and GC-06 which did not exhibit ecologically significant effects.	Ecologically significant effects to survival and growth. Integrating results of statistical analyses of sediment and pore water concentration data with dose-response scatter plots suggests that arsenic, cadmium, and copper may occur in hotspots at GP-22 and GP-12. Ecologically significant effects were observed for *Leptocheirus* survival at GP-07 and *Leptocheirus* growth at GP-13; sediment COPC concentrations at GP-07 and GP-13 were lower than other locations which did not exhibit adverse ecological effects.	No ecologically significant effects to the benthic community from sediment COPCs. Risk to benthic macroinvertebrate community unlikely. No ecologically significant effects on *Leptocheirus plumulosus* or *Neanthes arenaceodentata* survival or growth.	Not evaluated	Not evaluated	Not evaluated
			2C: Compare tissue residue levels in benthic invertebrates collected from Site exposure areas and reference exposure areas to published tissue benchmarks.	L/M	Benchmark comparisons may overestimate risk; benchmarks not available for between 4 and 5 COPCs (cadmium, copper, plead, nickel, zinc), depending on tissue type.	Adverse population level effects to the benthic macroinvertebrate community are unlikely.	Adverse population level risks to benthic macroinvertebrate community unlikely. Possible adverse population level risks to clams from lead does not signify a community level risk considering other tissue types evaluated in this measurement endpoint.	Adverse population level effects to the benthic macroinvertebrate community possible from lead and zinc based on two clam tissue samples.	Not evaluated	Not evaluated	Adverse population level effects are not expected. Risk to benthic macroinvertebrate community unlikely.
			2D: Compare the diversity and community structure of benthic invertebrates in sediments from Site exposure areas to reference locations.	M	Assumes that study area conditions worse than reference exhibit adverse effects even though they may actually fall within natural variability.	Based on CSI, diversity and structure of benthic macroinvertebrate community is consistent with reference. Risk to the benthic macroinvertebrate community unlikely.	Based on CSI, diversity and structure of benthic macroinvertebrate community is consistent with reference. Risk to the benthic macroinvertebrate community unlikely.	Based on CSI, diversity and structure of benthic macroinvertebrate community is consistent with reference. Risk to the benthic macroinvertebrate community unlikely.	Not evaluated	Not evaluated	Not evaluated
			Assessment Endpoint 2 Weight of Evidence Conclusion	-	-	Overall unlikely risk to the Goose Cove benthic macroinvertebrate community. Effects to *Neanthes* growth did not correlate with sediment COPC concentrations.	Overall, there is negligible risk to the benthic macroinvertebrate community in the Goose Pond Permanently Flooded exposure area, though toxicity tests suggest that hotspots may occur at GP-22 and GP-12 for arsenic, cadmium, and copper. However, large areas of the Site do not show impairment to the benthic macroinvertebrate community.	Risk to the Goose Pond Irregularly Flooded exposure area benthic macroinvertebrate community unlikely.	Not evaluated	Risk to the Marsh Creek benthic macroinvertebrate community unlikely.	Risk to the Weir Cove benthic macroinvertebrate community unlikely.
3	Water Column Invertebrates	Maintenance of water column invertebrate (zooplankton) communities in Site surface waters similar to those found in the reference site.	3A: Compare total and dissolved metal concentrations in Site surface water to published surface water benchmarks and reference locations.	M	Benchmark comparisons may overestimate risk; total concentrations not available in reference samples; benchmarks available for only cadmium, copper, lead, nickel, and zinc.	Possible adverse population level effects from copper and zinc. Low confidence in conclusions. Only 1 surface water sample evaluated.	Possible adverse population level effects from copper and zinc. Low confidence in conclusions.	Possible adverse population level effects from cadmium, copper, nickel, and zinc. Low confidence in conclusions. Only 1 surface water sample evaluated.	Not evaluated	Risk to the water column invertebrate community unlikely. HQs<1.	Not evaluated
			Assessment Endpoint 3 Weight of Evidence Conclusion	-	-	High uncertainty and low confidence that adverse population level effects are possible in Goose Cove.	High uncertainty and low confidence that adverse population level effects are possible in the Goose Pond Permanently Flooded exposure area.	High uncertainty and low confidence that adverse population level effects are possible in the Goose Pond Irregularly Flooded exposure area.	Not evaluated	Risk to the Marsh Creek water column invertebrate community unlikely.	Not evaluated
4	Fish	Maintenance of fish communities in aquatic Site exposure areas similar to those found in reference locations.	4A: Compare total and dissolved metal concentrations in Site surface water to published surface water benchmarks and reference locations.	M	Benchmark comparisons may overestimate risk; total concentrations not available in reference samples; benchmarks not available for all COPCs.	Possible adverse population level effects possible from copper and zinc. Low confidence in conclusions. Only 1 surface water sample evaluated.	Possible adverse population level effects from copper and zinc. Low confidence in conclusions.	Possible adverse population level effects from cadmium, copper, nickel, and zinc. Low confidence in conclusions. Only 1 surface water sample evaluated.	Not evaluated	Risk to fish unlikely. HQs <1.	Not evaluated
			4B: Compare tissue residue levels measured in whole fish collected from the Site exposure areas to published benchmarks and reference locations.	L/M	Benchmark comparisons may overestimate risk; benchmarks available for cadmium, copper, and zinc.	Risk unlikely. HQs<1.	Risk unlikely. HQs<1.	Possible adverse population level effects from copper.	Not evaluated	Risk to fish unlikely. HQs<1.	Not evaluated
			4C: Calculate fish condition factors and compare to reference locations.	L	Fish data biased to largest specimens to meet tissue sample requirements, however bias applied equally across all exposure areas and reference locations.	Fish condition consistent with reference. Risk unlikely.	Fish condition consistent with reference. Risk unlikely.	Fish condition consistent with reference. Unlikely risk.	Not evaluated	Fish condition consistent with reference. Unlikely risk.	Not evaluated
			Assessment Endpoint 4 Weight of Evidence Conclusion	-	-	Risk to fish in Goose Cove unlikely.	Risk to fish in the Goose Pond Permanently Flooded exposure area unlikely.	Risk to fish in the Goose Pond Irregularly Flooded exposure area unlikely.	Not evaluated	Risk to fish in Marsh Creek unlikely.	Not evaluated
5	Insectivorous Birds (estuarine)	Maintenance of insectivorous populations at the Site similar to those found in the reference site.	5A: Compare estimated daily dose for insectivorous bird species (spotted sandpiper) based on ingestion of prey in Site exposure areas to published avian Toxicity Reference Values (TRVs) and to reference locations.	M	TRVs assume 100% of COPCs are bioavailable, likely resulting in an overestimate of risk. Forage habitat would normally be limited to sediment under two inches of standing water due to their leg length; food chain model overestimates ingestion from locations deeper than a few inches which would not be accessible.	Adverse population level effects unlikely.	Adverse population level effects unlikely.	Possible adverse population level effects from copper (high confidence) and lead (low confidence).	Possible adverse population level effects from copper.	Adverse population level effectsunlikely.	Adverse population level effects unlikely.
			Assessment Endpoint 5 Weight of Evidence Conclusion	-	-	Risk to insectivorous birds in Goose Cove unlikely.	Risk to insectivorous birds in the Goose Pond Permanently Flooded exposure area unlikely.	Low to high confidence of possible adverse population level effects from copper and lead to insectivorous birds in the Goose Pond Irregularly Flooded exposure area.	High confidence of possible adverse population level effects from copper to insectivorous birds in the Salt Marsh.	Risk to insectivorous birds in Marsh Creek unlikely.	Risk to insectivorous birds in Weir Cove unlikely.

Table 1.4-6
Ecological Risk Summary Matrix - Aquatic Exposure Areas

	Receptor Group	Assessment Endpoint	Measurement Endpoints	Inference Weight*	Uncertainty	Goose Cove	Goose Pond Permanently Flooded	Goose Pond Irregularly Flooded	Salt Marsh	Marsh Creek	Weir Cove
			AQUATIC HABITAT								
6	Semi-Aquatic Piscivorous Birds	Maintenance of piscivorous populations at the Site similar to those found in the reference site.	6A: Compare estimated daily dose for piscivorous bird species (great blue heron) based on ingestion of prey in Site exposure areas to published avian Toxicity Reference Values (TRVs) and to reference locations.	M	TRVs assume 100% of COPCs are bioavailable, likely resulting in an overestimate of risk. Forage habitat would normally be limited to sediment under two inches of standing water do to their leg length; food chain model overestimates ingestion from locations deeper than a few inches which would not be accessible.	Adverse population level effects unlikely.	Adverse population level effects unlikely.	Possible adverse population level effects from zinc (low confidence).	Possible adverse population level effects from copper (high confidence) and zinc (low confidence).	Adverse population level effectsunlikely.	Possible adverse population level effects from chromium (moderate confidence) and zinc (low confidence).
			Assessment Endpoint 6 Weight of Evidence Conclusion	-	-	Risk to piscivorous birds in Goose Cove unlikely.	Risk to piscivorous birds in the Goose Pond Permanently Flooded exposure area unlikely.	Low possibility of adverse population level effects from zinc to piscivorous birds in the Goose Pond Irregularly Flooded exposure area.	High to moderate possibility of adverse population level effects from copper and zinc to piscivorous birds in the Salt Marsh.	Negligible risk to piscivorous birds in Marsh Creek	Low to moderate possibility of adverse population level effects to piscivorous birds in Weir Cove.
7	Semi-Aquatic Predatory Birds	Maintenance of predatory bird populations at the Site similar to those found in the reference site.	7A: Compare estimated daily dose for predatory bird species (osprey) based on ingestion of prey in Site exposure areas to published avian Toxicity Reference Values (TRVs) and to reference locations. Use exposure and risk estimates for bald eagle (Assessment Endpoint #9) as surrogate for predatory birds, with emphasis on population-level effects rather than effects on individuals.	M	TRVs assume 100% of COPCs are bioavailable, likely resulting in an overestimate of risk.	Adverse population level effects unlikely.	Adverse population level effects unlikely.	Adverse population level effects unlikely.	Adverse population level effects unlikely.	Adverse population level effects unlikely.	Adverse population level effects unlikely.
			Assessment Endpoint 7 Weight of Evidence Conclusion	-	-	Risk to predatory birds in Goose Cove unlikely.	Negligible Risk to predatory birds in the Goose Pond Permanently Flooded exposure area unlikely.	Risk to predatory birds in the Goose Pond Irregularly Flooded exposure area unlikely.	Risk to predatory birds in the Salt Marsh exposure area unlikely.	Risk to predatory birds in the Marsh Creek exposure area unlikely.	Risk to predatory birds in the Weir Cove exposure area unlikely..
8	Semi-Aquatic Mammals	Maintenance of semi-aquatic mammal populations at the Site similar to those found in the reference site.	8A: Compare estimated daily dose for semi-aquatic mammal (river otter) based on ingestion of prey in Site exposure areas to published mammalian Toxicity Reference Values (TRVs) and to reference locations.	M	TRVs assume 100% of COPCs are bioavailable, likely resulting in an overestimate of risk.	Adverse population level effects unlikely.	Adverse population level effects unlikely.	Adverse population level effects unlikely.	Adverse population level effects unlikely.	Adverse population level effects unlikely.	Adverse population level effects unlikely.
			Assessment Endpoint 8 Weight of Evidence Conclusion	-	-	Risk to semi-aquatic mammals in Goose Cove unlikely.	Risk to semi-aquatic mammals in the Goose Pond Permanently Flooded exposure area unlikely.	Risk to semi-aquatic mammals in the Goose Pond Irregularly Flooded exposure area unlikely.	Risk to semi-aquatic mammals in the Salt Marsh exposure area unlikely.	Risk to semi-aquatic mammals in the Marsh Creek exposure area unlikely.	Risk to semi-aquatic mammals in the Weir Cove exposure area unlikely.
9	Rare, Threatened, and Endangered species	Protection of individual bald eagles foraging in aquatic habitats at the Site similar to those found in the reference site.	9A: Compare estimated daily dose for predatory bird species (bald eagle) based on ingestion of prey in Site exposure areas to published avian Toxicity Reference Values (TRVs) and to reference locations.	L/M	TRVs assume 100% of COPCs are bioavailable, likely resulting in an overestimate of risk.	Adverse population level effects unlikely.	Adverse population level effects unlikely.	Adverse population level effects unlikely.	Adverse population level effects unlikely.	Adverse population level effects unlikely.	Adverse population level effects unlikely.
			Assessment Endpoint 9 Weight of Evidence Conclusion	-	-	Risk to bald eagles in Goose Cove unlikely.	Risk to bald eagles in the Goose Pond Permanently Flooded exposure area unlikely.	Risk to bald eagles in the Goose Pond Irregularly Flooded exposure area unlikely.	Risk to bald eagles in the Salt Marsh exposure area unlikely.	Risk to bald eagles in the Marsh Creek exposure area unlikely.	Risk to bald eagles in the Weir Cove exposure area unlikely.

NOTES:
* Measurement endpoints are assigned an inference weight for each of the attributes that account for strength of association between the assessment and measurement endpoints,
AVS/SEM - acid volatile sulfide/simultaneously extracted metals
COPC- chemical of potential concern
EPC- exposure point concentration
LOAEL- lowest observed adverse effects level
TOC - total organic carbon
TRV-toxicological reference value
CSI - community site index

Prepared by: AMR, 3/25/08
Checked by: BJR, 3/25/08

Table 1.4-7
Ecological Risk Summary Matrix - Terrestrial Exposure Areas

	Receptor Group	Assessment Endpoint	Measurement Endpoints	Inference Weight*	Uncertainty	Source	Halo
			TERRESTRIAL HABITAT				
10	Terrestrial Plants	Maintenance of plant communities in terrestrial habitats at the Site similar to those found in a reference site.	10A: Compare Site soil concentrations to benchmarks protective of terrestrial plants and to reference locations.	L	Benchmark comparisons may overestimate risk; benchmarks not available for the 3 VOC and SVOC COPCs.	High confidence of possible adverse population level effects from aluminum, arsenic, cadmium, copper, lead, mercury, selenium, silver, thallium, zinc, and PCBs.	Possible adverse population level effects from cadmium, copper, lead, and zinc. Benchmark comparisons likely overestimate risk.
			10B: Perform field surveys to determine if terrestrial plant communities on-Site are significantly different from terrestrial plant communities at reference locations.	M	Assumes that study area conditions that are worse than reference conditions are indicative of adverse effects, even though they may actually fall within natural variability therefore overestimating risk.	High risk though most of the Source area lacks a suitable growth medium to support plant growth.	Terrestrial plant communities are consistent with reference.
			Assessment Endpoint 10 Weight of Evidence Conclusion	-	-	High risk of harm to the plant community at the Source area from several metal and PCB COPCs.	Risk to Halo area plant community unlikely based on field surveys which were given a higher weight than benchmark comparisons.
11	Soil Invertebrates	Maintenance of a soil invertebrate community in the terrestrial habitats at the Site similar to those found nearby in a reference site.	11A: Compare Site soil concentrations to benchmarks protective of soil invertebrates and ~~in~~ to reference.	L	Benchmark comparisons may overestimate risk; benchmarks not available for the 5 VOC, SVOC, and PCB COPCs.	Possible adverse population level effects from copper, lead, mercury, and zinc (high confidence).	High confidence of possible adverse population level effects from copper, mercury, and zinc. Benchmark comparisons likely overestimate risk
			11B: Compare tissue residue levels in terrestrial invertebrates from the Site to published tissue benchmarks and to reference locations.	L/M	Effects benchmarks not available.	Not evaluated	Not evaluated
			11C: Compare forest litter community data from the Site to reference locations.	M	Assumes that study area conditions that are worse than reference conditions are indicative of adverse effects, even though they may actually fall within natural variability therefore overestimating risk.	Not evaluated	Soil invertebrate communities are consistent with reference.
			Assessment Endpoint 11 Weight of Evidence Conclusion	-	-	Adverse population level effects are possible from copper, lead, mercury, and zinc (high confidence).	Risk to Halo area soil invertebrates unlikely based on field surveys which were given a higher weight than benchmark comparisons.
12	Terrestrial Insectivorous Birds	Maintenance of omnivorous populations of songbirds at the Site similar to those found at a reference site.	12A: Compare estimated daily dose for omnivorous song bird species (robin) based on ingestion of prey in Site exposure areas to published avian Toxicity Reference Values (TRVs) and to reference locations.	M	TRVs assume 100% of COPCs are bioavailable, likely resulting in an overestimate of risk.	Possible adverse population level effects from copper, zinc, and PCBs (high confidence), cadmium and lead (moderate confidence), and antimony and selenium (low confidence).	Possible adverse population level effects from chromium, copper, lead, selenium, and zinc (low to moderate confidence). Confidence decrease with decreasing HQ values, which are low, ranging from 1.1 to 4.0 in the CTE/LOAEL scenario.
			Assessment Endpoint 12 Weight of Evidence Conclusion	-	-	Adverse population level effects possible. Omnivorous songbirds not likely to forage in the Source area due to poor habitat for prey species.	Possibility of adverse population level effects to omnivorous songbirds in the Halo area is uncertain given that all CTE/LOAEL HQs <1. Food chain models likely overestimate risk since TRVs assume 100% of COPCs are bioavailable.
13	Terrestrial Predatory Birds	Maintenance of predatory bird populations at the Site similar to those found at a reference site	13A: Compare estimated daily dose for predatory bird species (red-tailed hawk) based on ingestion of prey in Site exposure areas to published avian Toxicity Reference Values (TRVs) and to reference locations.	M	TRVs assume 100% of COPCs are bioavailable, likely resulting in an overestimate of risk.	Possible adverse population level effects from zinc and PCBs (moderate to high certainty).	Adverse population level effects unlikely.
			Assessment Endpoint 13 Weight of Evidence Conclusion	-	-	Moderate to high certainty of adverse population level effects possible from zinc and PCBs. Predatory birds not likely to forage in the Source area due to poor habitat for prey species.	Risk to predatory birds in the Halo area unlikely.
14	Terrestrial Small Omnivorous Mammals	Maintenance of terrestrial mammal populations at the Site similar to those found in a reference area.	14A: Compare estimated daily dose for small omnivorous mammal species (white-footed mouse) based on ingestion of prey in Site exposure areas to published mammalian Toxicity Reference Values (TRVs) and to reference locations.	M	TRVs assume 100% of COPCs are bioavailable, likely resulting in an overestimate of risk.	Possible adverse population level effects from arsenic, copper, selenium, vanadium, zinc, and PCBs (high certainty), and antimony, cadmium, lead, manganese, and thallium (moderate certainty).	Possible adverse population level effects from arsenic, chromium, and copper (low confidence). Confidence decreases with decreasing HQ values, which are all <8 in the CTE/NOAEL scenario and are all <1 in the CTE/LOAEL scenario.
			Assessment Endpoint14 Weight of Evidence Conclusion	-	-	Adverse population level effects possible. Omnivorous mammals not likely to forage at the site due to poor habitat and sparse vegetation.	Possibility of adverse population level effects to omnivorous mammal in the Halo area from arsenic, chromium, and copper is uncertain given low CTE/LOAEL HQs. Food chain models likely overestimate risk since TRVs assume 100% of COPCs are bioavailable. Food chain models likely overestimate risk since TRVs assume 100% of COPCs are bioavailable.
15	Terrestrial Small Worm-Eating Mammals	Maintenance of terrestrial mammal populations at the Site similar to those found in a reference area.	15A: Compare estimated daily dose for small worm-eating mammal species (short-tailed shrew) based on ingestion of prey in Site exposure areas to published mammalian Toxicity Reference Values (TRVs) and to reference locations.	M	TRVs assume 100% of COPCs are bioavailable, likely resulting in an overestimate of risk.	Possible adverse population level effects from arsenic, cadmium, copper, lead, manganese, selenium, thallium, vanadium, zinc, and PCBs (high certainty), and antimony and mercury (moderate uncertainty).	Low confidence in adverse population level effects form arsenic, chromium, and copper to small worm-eating mammals in the Halo area.
			Assessment Endpoint 15 Weight of Evidence Conclusion	-	-	Adverse population level effects possible. Worm-eating mammals not likely to forage at the site due to poor habitat and sparse vegetation.	Moderate to high confidence that adverse population level effects to small worm-eating mammals are unlikely.

NOTES:
* Measurement endpoints are assigned an inference weight for each of the attributes that account for strength of association between the assessment and measurement endpoints, data quality, and study design and execution. The relative importance is indicated by an attribute weighting factor following guidance provided by Menzie et al. (1996).

COPC- chemical of potential concern
LOAEL- lowest observed adverse effects level
NOAEL- no observed adverse effects level
TRV-toxicological reference value

Prepared by: AMR 3/25/08
Checked by: BJR 3/25/08

Table 2.2-1
Human Health Risk Summary for Exposure to Residential Lot and On-Site Soil

	Current Exposure		Future Exposure	
Exposure Scenario and COC	**ELCR**	**HI**	**ELCR**	**HI**
Soil				
Lot A Residential Exposure				
Child				
Arsenic	3.5E-05	0.9	*	*
Lead	**	**	*	*
Total	**3E-05**	**9E-01**	*	*
Adult				
Arsenic	1.5E-05	0.1	*	*
Total	**2E-05**	**1E-01**	*	*
Lot C Residential Exposure				
Child				
Arsenic	2.1E-05	0.6	*	*
Lead	**	**	*	*
Total	**2E-05**	**6E-01**	*	*
Adult				
Arsenic	9.5E-06	0.06	*	*
Total	**9E-06**	**6E-02**	*	*
Lot D Residential Exposure				
Child				
Arsenic	2.7E-05	0.7	*	*
Lead	**	**	*	*
Thallium	--	1.4	*	*
Total	**3E-05**	**2E+00**	*	*
Adult				
Arsenic	1.2E-05	0.08	*	*
Total	**1E-05**	**8E-02**	*	*
Source Area Residential Exposure				
Child				
Aroclor-1242	NA	NA	8.6E-04	250
Aroclor-1248	NA	NA	7.8E-04	230
Arsenic	NA	NA	6.9E-05	1.8
Lead			**	**
Total			**2E-03**	**4.8E+02**

Table 2.2-1
Human Health Risk Summary for Exposure to Residential Lot and On-Site Soil

	Current Exposure		Future Exposure	
Exposure Scenario and COC	**ELCR**	**HI**	**ELCR**	**HI**
Source Area Residential Exposure (cont.)				
Adult				
Aroclor-1242	NA	NA	4.1E-04	30
Aroclor-1248	NA	NA	3.7E-04	27
Arsenic	NA	NA	3.1E-05	0.2
Total			**8E-04**	**5.7E+01**
Soruce Area Recreational Exposure				
Child				
Aroclor-1242	3.0E-04	87	*	*
Aroclor-1248	2.7E-04	79	*	*
Arsenic	2.4E-05	0.7	*	*
Total	**6E-04**	**1.7E+02**	*	*
Older Child				
Aroclor-1242	1.6E-04	23	*	*
Aroclor-1248	1.4E-04	21	*	*
Arsenic	9.1E-06	0.1	*	*
Total	**3E-04**	**4.4E+01**	*	*
Adult				
Aroclor-1242	7.1E-05	10	*	*
Aroclor-1248	6.5E-05	9	*	*
Arsenic	5.3E-06	0.07	*	*
Total	**1E-04**	**2E+01**	*	*

Notes:

Table based on Appendix G, Tables G-1, G-2, G-5 through G-10, G-16 through G-19, and G-40 through G-42 of Draft Human Health Risk Assessment.

COC = Chemical of concern. ELCR >/= 1E-06 and/or HI >/= 1

ELCR = Exces lifetime cancer risk

HI = Hazard index

* Future exposure risk same as current risk for this scenario

** IEUBK modeling shows blood lead above 10 µg/dl in greater than 5 percent of the exposed population.

NA = Not applicable, exposure scenario/pathway not applicable

Prepared by: SWR 09/05/08
Checked by: JHP 09/09/08

Table 2.2-2
Summary of Media Requiring Human Health PRGs and COCs

Medium Requiring PRGs	Land Use Scenario Triggering Need for PRGs	COCs (based on risks >1E-04, >HI = 1, or IEUBK Model Output for Lead)	COCs (based on risks > 1E-06)	Approach to Derive PRGs
Source Area surface soil	Residential	PCBs, As, Pb	--	Derive risk-based PRG: consider, background, Maine RAG [1], risk-based PRG, USEPA Soil Lead Guidance [2], TSCA [3], and Maine Safe Lead Rule [4]
	Recreational	PCBs	As	Derive risk-based PRG: consider background, Maine RAG [1],risk-based PRG, TSCA [3]
Residential Risk Assessment Area A Surface Soil	Residential	Pb	As	Derive risk-based PRG: consider background, Maine RAG [1], risk-based PRG, USEPA Soil Lead Guidance [2], and Maine Safe Lead Rule [4]
Residential Risk Assessment Area C Surface Soil	Residential	Pb	As	Derive risk-based PRG: consider background, Maine RAG [1], risk-based PRG, USEPA Soil Lead Guidance [2], and Maine Safe Lead Rule [4]
Residential Risk Assessment Area D Surface Soil	Residential	Pb, Tl	As	Derive risk-based PRG: consider background, Maine RAG [1], risk-based PRG, USEPA Soil Lead Guidance [2], and Maine Safe Lead Rule [4]

Notes:
[1] Maine DEP, Implementation of Remedial Action Guidelines, Table 4 – Remedial Action Guidelines for Contaminated Soils
[2]USEPA Memorandum: Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities" (August 1994) EPA/540/F-94/043, OSWER 9355.4-12
[3] Toxic Substances Control Act, 40 CFR Part 761 – Polychlorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution in Commerce, and Use Prohibitions.
[4] Maine Solid Waste Management Rules, Lead Management Regulations [06-096 CMR 424]

Prepared by: JHP 03/02/2009
Checked by: SWR 06/15/2009

Table 2.2-3
Human Health Preliminary Remediation Goals for Soil

	Back-ground	Maine Remedial Action Guideline [1]	Site-Specific Risk Calculation ELCR = $1x10^{-6}$	Site-Specific Risk Calculation HQ = 1 or IEUBK for Lead	Selected as PRG	Basis	Risk at PRG HQ / ELCR
Residential Use Areas							
Arsenic	14	10	1	56	14	Background	HQ = 0.2 ELCR = $5.8x10^{-6}$
Lead [2,4]	37	375	Not applicable	340	375	Maine State Safe Lead level and site-specific IEUBK model output	95% of exposed population should have a blood lead level that does not exceed 10 µg/dl based on this PRG
Polychlorinated biphenyls	Not detected	2.2	0.52	2.6	1	TSCA[3] and site-specific risk basis to allow for unrestricted future use	HQ = 0.4 ELCR = $1.9x10^{-6}$
Thallium	0.12	Not applicable	Not applicable	15	15	Site-specific risk basis for noncancer exposure	HQ = 1 ELCR = n.a. HI = 1.6 Cumulative ELCR = $7.7x10^{-6}$
Recreational Use Areas							
Arsenic	14	30	2.4	146	30	Risk-management decision to accept $1x10^{-5}$ ELCR for arsenic	HQ = 0.2 ELCR = $1.2x10^{-5}$
Lead [4]	37	700	Not applicable	2,385	700	Maine Remedial Action Guideline and site-specific IEUBK model output	95% of exposed population should have a blood lead level that does not exceed 10 µg/dl based on this PRG
Polychlorinated biphenyls	Not detected	8.1	1.2	7.7	1	TSCA and site-specific risk basis to allow for unrestricted future use	HQ = 0.1 ELCR = $0.8x10^{-6}$ HI = 0.3 Cumulative ELCR = $1.2x10^{-5}$

Notes:
All concentrations = mg/kg
HI = hazard index, HQ = hazard quotient; ELCR = excess lifetime cancer risk
[1] Maine DEP, Implementation of Remedial Action Guidelines, Table 4 – Remedial Action Guidelines for Contaminated Soils
[2]USEPA Memorandum: Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities" (August 1994) EPA/540/F-94/043, OSWER 9355.4-12 recommends a residential lead cleanup level of 400 mg/kg.
[3] Toxic Substances Control Act, 40 CFR Part 761 – Polychlorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution in Commerce, and Use Prohibitions.
[4] Maine Solid Waste Management Rules, Lead Management Regulations [06-096 CMR 424] establish lead safe standards for soil containing lead – if lead in bare soil in play areas exceeds 375 ppm or 1,000 ppm in other than play areas, the soil in those areas shall be considered a lead hazard.

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Table 2.2-4
Non-Incremental and Incremental Risk HQs for
Semi-Aquatic Wildlife Receptors

Goose Cove		
Eagle	**Non-Incremental Risk**	**Incremental Risk**
Analyte	RME-LOAEL HQ	RME-LOAEL HQ
No COCs		
Great Blue Heron	**Non-Incremental Risk**	**Incremental Risk**
Analyte	RME-LOAEL HQ	RME-LOAEL HQ
No COCs		
River Otter	**Non-Incremental Risk**	**Incremental Risk**
Analyte	RME-LOAEL HQ	RME-LOAEL HQ
No COCs		
Spotted Sandpiper	**Non-Incremental Risk**	**Incremental Risk**
Analyte	RME-LOAEL HQ	RME-LOAEL HQ
No COCs		
Goose Pond Permanently Flooded		
Eagle	**Non-Incremental Risk**	**Incremental Risk**
Analyte	RME-LOAEL HQ	RME-LOAEL HQ
No COCs		
Great Blue Heron	**Non-Incremental Risk**	**Incremental Risk**
Analyte	RME-LOAEL HQ	RME-LOAEL HQ
No COCs		
River Otter	**Non-Incremental Risk**	**Incremental Risk**
Analyte	RME-LOAEL HQ	RME-LOAEL HQ
No COCs		
Spotted Sandpiper	**Non-Incremental Risk**	**Incremental Risk**
Analyte	RME-LOAEL HQ	RME-LOAEL HQ
Copper	**1.2E+00**	**1.1E+00**

Table 2.2-4
Non-Incremental and Incremental Risk HQs for
Semi-Aquatic Wildlife Receptors

Goose Pond Irregularly Flooded		
Eagle	**Non-Incremental Risk**	**Incremental Risk**
Analyte	RME-LOAEL HQ	RME-LOAEL HQ
No COCs		
Great Blue Heron	**Non-Incremental Risk**	**Incremental Risk**
Analyte	RME-LOAEL HQ	RME-LOAEL HQ
Copper	**5.2E+00**	**5.1E+00**
River Otter	**Non-Incremental Risk**	**Incremental Risk**
Analyte	RME-LOAEL HQ	RME-LOAEL HQ
No COCs		
Spotted Sandpiper	**Non-Incremental Risk**	**Incremental Risk**
Analyte	RME-LOAEL HQ	RME-LOAEL HQ
Copper	**1.4E+01**	**1.3E+01**
Zinc	**1.7E+00**	LB
Lead	**1.4E+00**	**1.3E+00**
Salt Marsh		
Eagle	**Non-Incremental Risk**	**Incremental Risk**
Analyte	RME-LOAEL HQ	RME-LOAEL HQ
No COCs		
Great Blue Heron	**Non-Incremental Risk**	**Incremental Risk**
Analyte	RME-LOAEL HQ	RME-LOAEL HQ
Copper	**3.5E+00**	**3.4E+00**
River Otter	**Non-Incremental Risk**	**Incremental Risk**
Analyte	RME-LOAEL HQ	RME-LOAEL HQ
No COCs		
Spotted Sandpiper	**Non-Incremental Risk**	**Incremental Risk**
Analyte	RME-LOAEL HQ	RME-LOAEL HQ
Copper	**9.4E+00**	**8.2E+00**
Zinc	**1.2E+00**	LB
Lead	**1.3E+00**	**1.3E+00**

Table 2.2-4
Non-Incremental and Incremental Risk HQs for
Semi-Aquatic Wildlife Receptors

Marsh Creek		
Eagle	**Non-Incremental Risk**	**Incremental Risk**
Analyte	RME-LOAEL HQ	RME-LOAEL HQ
No COCs		
Great Blue Heron	**Non-Incremental Risk**	**Incremental Risk**
Analyte	RME-LOAEL HQ	RME-LOAEL HQ
No COCs		
River Otter	**Non-Incremental Risk**	**Incremental Risk**
Analyte	RME-LOAEL HQ	RME-LOAEL HQ
No COCs		
Spotted Sandpiper	**Non-Incremental Risk**	**Incremental Risk**
Analyte	RME-LOAEL HQ	RME-LOAEL HQ
No COCs		
Weir Cove		
Eagle	**Non-Incremental Risk**	**Incremental Risk**
Analyte	RME-LOAEL HQ	RME-LOAEL HQ
No COCs		
Great Blue Heron	**Non-Incremental Risk**	**Incremental Risk**
Analyte	RME-LOAEL HQ	RME-LOAEL HQ
Chromium	**2.3E+00**	**2.2E+00**
River Otter	**Non-Incremental Risk**	**Incremental Risk**
Analyte	RME-LOAEL HQ	RME-LOAEL HQ
No COCs		
Spotted Sandpiper	**Non-Incremental Risk**	**Incremental Risk**
Analyte	RME-LOAEL HQ	RME-LOAEL HQ
No COCs		

Prepared by: SEB 09/03/08
Checked by: AMR 09/04/08

NOTES:
HQs summarized from Table 3-48 in the 2008 Draft Final Baseline Ecological Risk Assessment for the Callahan Mine site. Only COCs with HQs > 1 in the RME-LOAEL exposure case are shown.

LOAEL - Lowest Observed Adverse Effects Level
HQ - Hazard Quotient
COC - Contaminant of Concern

Table 2.2-5
Calculation of Sediment PRG - Great Blue Heron

$$PRG_{sed} \quad \frac{THQ \times TRV \times BW}{SFF \times EF \times ((BAF_{inv} \times IR_{food} \times P_{inv}) + (BAF_{fish} \times IR_{food} \times P_{fish}) + (IR_{sed}))}$$

Parameter Symbol	Parameter Definition	Units	Value
PRG_{sed}	Sediment PRG protective of the Heron	mg/kg	calculated
THQ	Target Hazard Quotient	unitless	1
TRV	Toxicity Reference Value	mg/kg-d	chemical specific
BAF_{inv}	Site Specific or Literature Based Invertebrate Bioaccumulation Factor	mg/kg	chemical specific
BAF_{fish}	Site Specific or Literature Based Fish Bioaccumulation Factor	mg (ww tissue) / kg (dw soil)	chemical specific
IR_{food}	Ingestion Rate of food	kg/day	0.39
IR_{sed}	Ingestion Rate of sediment	kg/day	0.019
P_{inv}	Percent Invertebrates in diet	unitless	0.05
P_{fish}	Percent Fish in diet	unitless	0.95
SFF	Site Foraging Frequency	unitless	area specific
EF	Exposure Frequency	unitless	0.58
BW	Body Weight	kg	2.2

Exposure Area	Chemical	SFF	NOAEL	LOAEL	BAF_{inv}	BAF_{fish}	NOAEL PRG_{sed}	LOAEL PRG_{sed}
Goose Cove	Zinc	1	14.5	131	0.043	0.035	1,645	14,858
Goose Pond Perm Fld	Zinc	1	14.5	131	0.031	0.036	1,641	14,829
	Lead	1	1.6	8.3	0.050	0.0027	288	1,462
Goose Pond Irreg Fld	Zinc	1	14.5	131	0.031	0.053	1,387	12,527
	Copper	1	9.4	12.3	0.083	0.052	879	1,155
	Lead	1	1.6	8.3	0.050	0.036	182	926
	Beryllium	1	0.0037	0.037	0.035	0.026	0.47	4.7
Salt Marsh	Zinc	1	14.5	131	0.031	0.053	1,387	12,527
	Copper	1	9.4	12.3	0.083	0.052	879	1,155
	Lead	1	1.6	8.3	0.050	0.036	182	926
	Beryllium	1	0.0037	0.037	0.035	0.026	0.47	4.7
	Aluminum	1	110	1097	0.017	0.017	15,855	158,550

Prepared by: BJR 09/03/2008
Checked by: AMR 03/03/2009

Shaded BAFs are literature based values. All other BAFs are based on site specific information.

Table 2.2-6
Calculation of Sediment PRG - Sandpiper

$$PRG_{sed} = \frac{THQ \times TRV \times BW}{SFF \times EF \times ((BAF_{inv} \times IR_{food} \times P_{inv}) + (IR_{sed}))}$$

Parameter Symbol	Parameter Definition	Units	Value
PRG_{sed}	Sediment PRG protective of the Heron	mg/kg	calculated
THQ	Target Hazard Quotient	unitless	1
TRV	Toxicity Reference Value	mg/kg-d	chemical specific
BAF_{inv}	Site Specific or Literature Based Invertebrate Bioaccumulation Factor	mg/kg	chemical specific
IR_{food}	Ingestion Rate of food	kg/day	0.0095
IR_{sed}	Ingestion Rate of sediment	kg/day	0.00047
P_{inv}	Percent Invertebrates in diet	unitless	1.00
SFF	Site Foraging Frequency	unitless	area specific
EF	Exposure Frequency	unitless	0.58
BW	Body Weight	kg	0.047

Exposure Area	Chemical	SFF	NOAEL	LOAEL	BAF_{inv}	NOAEL PRG_{sed}	LOAEL PRG_{sed}
Goose Cove	Zinc	1	14.5	131	0.043	1,328	11,997
	Copper	1	9.394	12.344	0.030	996	1,309
	Lead	1	1.6	8.3	0.0065	246	1,250
Goose Pond Perm Fld	Lead	1	1.63	8.28	0.050	139	706
	Zinc	1	14.5	131.0	0.031	1,527	13,796
	Copper	1	9.4	12.3	0.083	603	792
Goose Pond Irreg Fld	Copper	1	9.394	12.344	0.083	603	792
	Lead	1	1.63	8.28	0.05	139	706
	Beryllium	1	0.0	0.0	0.035	0.37	3.7
	Cadmium	1	1.5	5.5	0.17	57	211
	Aluminum	1	109.7	1097	0.017	13,967	139,668
Salt Marsh	Copper	1	9	12.344	0.083	603	792
	Lead	1	1.63	8.28	0.05	139	706
	Beryllium	1	0.0037	0.037	0.035	0.37	3.7
	Cadmium	1	1.5	5	0.17	57	211
	Aluminum	1	109.7	1097	0.017	13,967	139,668

Prepared by: BJR 09/03/2008
Checked by: AMR 03/03/2009

Shaded BAFs are literature based values. All other BAFs are based on site specific information.

Table 2.2-7
Calculation of BASFs for Goose Pond
Permanently Flooded Based on Invertabrate Tissue

	Green Crab			**Green Crab**			**Green Crab**		
	GP-04			GP-05			GP-06		
Parameter	MT-GC-GP045010001XX 9/20/2005	SD-EC-GP045030001XX 9/22/2005 0-0_5 ft	BSAF (1)	MT-GC-GP055010001XX 9/20/2005	SD-EC-GP055030001XX 9/22/2005 0-0_5 ft	BSAF (1)	MT-GC-GP065010001XX 9/20/2005	SD-EC-GP065030001XX 9/23/2005 0-0_5 ft	BSAF (1)
Inorganics (mg/kg)									
Aluminum	31	9610	0.0032	28	25200	0.0011	40	18300	0.0022
Antimony	0.0027 UJ	R	NC	0.0027 UJ	R	NC	0.0085	R	NC
Arsenic	2.1	9.6	0.22	2.2	15.6	0.14	2.8	12	0.23
Barium	2.4	15.5	0.15	2.5	45.6	0.055	2.8	31.5	0.089
Beryllium	0.0047 U	0.4 U	NC	0.0046 U	1	ND	0.0078	0.65	0.012
Cadmium	0.19	13.1	0.015	0.31	6.6	0.047	0.47	4.5	0.10
Calcium	50000	3990	13	50000	3980	13	56000	3160	18
Chromium	3.3	20.8	0.16	3.8	52.7	0.072	2.4	34.8	0.069
Cobalt	0.38	7.2	0.053	0.38	11.4	0.033	0.47	9.9	0.047
Copper	15	129	0.12	16	183	0.087	16	278	0.058
Iron	1100	14100	0.078	1100	29100	0.038	1300	24600	0.053
Lead	0.57	108	0.0053	0.97	152	0.0064	1.6	115	0.014
Magnesium	2500	6600	0.38	2600	13500	0.19	2400	11500	0.21
Manganese	4.3	137	0.031	5.4	302	0.018	12	321	0.037
Mercury	0.0078	0.13	0.060	0.0077	0.26	0.030	0.012	0.18	0.067
Nickel	5.8	15.2	0.38	6.1	35.3	0.17	5.7	28.1	0.20
Potassium	1900	2300	0.83	2600	5970	0.44	2300	3340	0.69
Selenium	3.5	1.4 U	ND	3	1.9 U	ND	3.7	1.5 U	ND
Silver	0.086	1.1	0.078	0.15	1.3	0.12	0.18	0.65	0.28
Sodium	6100	12300	0.50	5000	20700	0.24	4600	7260	0.63
Thallium	0.0039 U	0.34 U	NC	0.0038 U	0.54 U	NC	0.013	0.3 U	ND
Vanadium	0.41	20.5	0.020	0.36	52.2	0.0069	0.52	33.9	0.015
Zinc	26	1100	0.024	34	1100	0.031	40	967	0.041

Table 2.2-7
Calculation of BASFs for Goose Pond
Permanently Flooded Based on Invertabrate Tissue

	Green Crab			**Marine Worm**			**Soft Shell Clam**			**Soft Shell Clam**		
	GP-07			GP-08			GP-09			GP-10		
Parameter	MT-GC-GP075010001XX 10/3/2005	SD-EC-GP075030001XX 10/3/2005 0-0_3281 ft	BSAF (1)	MT-MW-GP085010001XX 10/13/2005	SD-EC-GP085030001XX 10/13/2005 0-0_3281 ft	BSAF (1)	MT-SC-GP095010001XX 10/18/2005	SD-EC-GP095030001XX 10/18/2005 0-0_3281 ft	BSAF (1)	MT-SC-GP105010001XX 10/13/2005	SD-EC-GP105030001XX 10/13/2005 0-0_3281 ft	BSAF (1)
Inorganics (mg/kg)												
Aluminum	140	18500	0.0076	250	22400	0.011	420	11900	0.035	440	23300	0.019
Antimony	0.0029 UJ	1.04 UJ	NC	0.016 UJ	0.77 UJ	NC	0.014 UJ	R	NC	0.0055 UJ	0.71 UJ	NC
Arsenic	2.1	10.3	0.20	1.3	18.4	0.071	2.6	5.9	0.44	2	11.4	0.18
Barium	3.5	27.6	0.13	0.71	48.2	0.015	1.3	17.3	0.075	1.5	40.8	0.037
Beryllium	0.0048 U	0.32	ND	0.0096	0.71	0.014	0.021	0.16	0.13	0.019	0.85	0.022
Cadmium	0.38	3.2	0.12	0.27	9	0.030	0.67	1.3	0.52	0.86	3.9	0.22
Calcium	74000	2710	27	300	3240	0.093	860	1720	0.50	430	2960	0.15
Chromium	25	39.4	0.63	30	45	0.67	6	22.8	0.26	1.7	48.5	0.035
Cobalt	0.66	7.2	0.092	0.32	9.5	0.034	0.22	4.3	0.051	0.23	7.8	0.029
Copper	20	276	0.072	12	557	0.022	10	202	0.050	13	280	0.046
Iron	1900	24700	0.077	680	29700	0.023	890	13700	0.065	600	26500	0.023
Lead	1.8	125	0.014	4.2	288	0.015	5.6	78.9	0.071	3.3	160	0.021
Magnesium	4200	13300	0.32	390	14800	0.026	780	9280	0.084	710	14000	0.051
Manganese	8.6	267	0.032	7.6	339	0.022	6	178	0.034	5.6	290	0.019
Mercury	0.0065	0.21	0.031	0.0025	0.33	0.0076	0.01	0.12	0.083	0.009	0.17	0.053
Nickel	20	26.2	0.76	16	34.7	0.46	3.9	13.8	0.28	1	30.9	0.032
Potassium	2300	3860	0.60	790	5190	0.15	1800	2130	0.85	1900	5120	0.37
Selenium	3.7	1.71 U	ND	0.86	1.26 U	ND	1.4	0.98 U	ND	1.2	1.17 U	ND
Silver	0.11	0.81	0.14	0.11	2.8 U	ND	0.027	0.47	0.057	0.057	0.88 U	ND
Sodium	5200	18400	0.28	1400	17400	0.08	3400	7240	0.47	2900	16000	0.18
Thallium	0.004 U	0.28 U	ND	0.01	0.46 U	ND	0.0071	0.27 U	ND	0.008	0.34 U	ND
Vanadium	0.6	34.2	0.018	1.5	53.7	0.028	1.3	21.8	0.060	1.2	41.5	0.029
Zinc	33	1110	0.030	43	1610	0.027	29	533	0.054	32	1160	0.028

Table 2.2-7
Calculation of BASFs for Goose Pond
Permanently Flooded Based on Invertabrate Tissue

	Soft Shell Clam			**Soft Shell Clam**			**Soft Shell Clam**			**Soft Shell Clam**			**Soft Shell Clam**		
	GP-12			GP-13			GP-14			GP-15			GP-22		
Parameter	MT-SC-GP125010 001XX 10/18/2005	SD-EC-GP125030 001XX 10/18/2005 0-0_3281 ft	BSAF (1)	MT-SC-GP135010 001XX 10/13/2005	SD-EC-GP135030 001XX 10/13/2005 0-0_3281 ft	BSAF (1)	MT-SC-GP145010 001XX 10/12/2005	SD-EC-GP145030 001XX 10/13/2005 0-0_3281 ft	BSAF (1)	MT-SC-GP155010 001XX 10/19/2005	SD-EC-GP155030 001XX 10/18/2005 0-0_3281 ft	BSAF (1)	MT-SC-GP225010 001XX 10/18/2005	SD-EC-GP225030 001XX 10/19/2005 0-0_3281 ft	BSAF (1)
Inorganics (mg/kg)															
Aluminum	470	38000	0.012	800	40800	0.020	180	67900	0.0027	300	21400	0.014	620	38900	0.016
Antimony	0.11 UJ	R	NC	0.01 UJ	R	NC	0.019 UJ	2.12 UJ	NC	0.0026 UJ	R	NC	0.056 UJ	R	NC
Arsenic	3	53.2	0.056	1.6	14.6	0.11	1	25.7	0.039	1.2	7.8	0.15	1.4	30.8	0.045
Barium	0.81	27.9	0.029	2.2	42.9	0.051	0.7	97	0.0072	1.3	34.1	0.038	0.9	25.6	0.035
Beryllium	0.013	0.6	0.022	0.017	0.84	0.020	0.0062	2.5	0.0025	0.011	0.69	0.016	0.012	0.38	0.032
Cadmium	0.77	19.8	0.039	1.2	9	0.13	0.87	16.9	0.051	1.1	6.1	0.18	1.2	23.4	0.051
Calcium	800	5070	0.16	2000	3020	0.66	610	12400	0.049	390	3690	0.11	1100	5010	0.220
Chromium	2.1	36.4	0.058	1.4	49.3	0.028	0.56	143	0.0039	1	41	0.024	2	38.7	0.052
Cobalt	0.16	5.7	0.028	0.19	8.4	0.023	0.13	29.4	0.0044	0.13	8.1	0.016	0.14	3.6	0.039
Copper	30	1540	0.019	35	1400	0.025	18	722	0.025	17	252	0.067	61	2340	0.026
Iron	1400	43000	0.033	700	34100	0.021	290	92600	0.0031	320	25600	0.013	640	35300	0.018
Lead	43	524	0.082	22	351	0.063	9.4	301	0.031	4	112	0.036	23	469	0.049
Magnesium	1200	62500	0.019	1500	53100	0.028	430	41200	0.010	730	13000	0.056	1400	67900	0.021
Manganese	26	872	0.030	15	819	0.018	8	957	0.0084	3.2	255	0.013	22	1010	0.022
Mercury	0.013	0.73	0.018	0.013	0.37	0.035	0.0046	0.02	0.23	0.0074	0.21	0.035	0.014	0.65	0.022
Nickel	1.2	16.6	0.072	0.9	35.4	0.025	0.37	109	0.0034	0.65	31.7	0.021	0.78	13	0.060
Potassium	1400	4300	0.33	1800	6390	0.28	1300	15100	0.086	1600	4920	0.33	1600	4210	0.38
Selenium	1.2	4.2	0.29	1.8	2.4	0.75	0.99	6.6	0.15	1.2	0.94 U	ND	1.4	5.9	0.24
Silver	0.079	3.5	0.023	0.24	2.6	0.09	0.095	1.7 U	ND	0.097	0.6	0.16	0.17	3.6	0.047
Sodium	3500	7680	0.46	4600	22000	0.21	1500	47000	0.032	4000	16900	0.24	2900	9940	0.29
Thallium	0.021	1.6	0.013	0.016	0.83 U	ND	0.005	1.1 U	ND	0.0073	0.39 U	ND	0.021	1.3	0.016
Vanadium	1.2	37.3	0.032	1.2	43.5	0.028	0.49	133	0.0037	0.63	36.2	0.017	0.79	29.4	0.027
Zinc	100	5260	0.019	51	2860	0.018	50	3540	0.014	44	1320	0.033	110	6000	0.018

Table 2.2-7
Calculation of BASFs for Goose Pond
Permanently Flooded Based on Invertabrate Tissue

Parameter	Green Crab Average BSAF	Marine Worm Average BSAF	Soft Shell Clam Average BSAF	Max BSAF (2)
Inorganics (mg/kg)				
Aluminum	0.004	0.011	0.017	0.017
Antimony	NC	NC	NC	0.00
Arsenic	0.199	0.071	0.15	0.20
Barium	0.106	0.015	0.039	0.106
Beryllium	0.012	0.014	0.035	0.035
Cadmium	0.071	0.030	0.17	0.17
Calcium	17.530	0.093	0.3	17.5
Chromium	0.234	0.667	0.07	0.67
Cobalt	0.056	0.034	0.027	0.056
Copper	0.083	0.022	0.037	0.083
Iron	0.061	0.023	0.025	0.061
Lead	0.010	0.015	0.050	0.050
Magnesium	0.274	0.026	0.04	0.27
Manganese	0.030	0.022	0.021	0.030
Mercury	0.047	0.008	0.068	0.068
Nickel	0.380	0.461	0.07	0.46
Potassium	0.64	0.15	0.37	0.64
Selenium	NC	NC	0.36	0.36
Silver	0.152	NC	0.08	0.15
Sodium	0.41	0.08	0.27	0.41
Thallium	NC	NC	0.015	0.015
Vanadium	0.015	0.028	0.028	0.028
Zinc	0.031	0.027	0.026	0.031

Prepared by: BJR 09/03/2008
Checked by: AMR 03/03/2009

Notes:
(1) BSAFs were calculated for each earthworm/sediment pair by taking the quotient of the earthworm concentrations and the sediment concentrations.
(2) Max of the averages of green crab, soft shell clam and marine worm.

Table 2.2-8
Goose Pond and Salt Marsh Sediment Ecological Effects Matrix

Chemical of Concern	UTL/ Background[1]	Benthic Macroinv. EC20[2]	Benthic Macroinv. Dose-Response Value - Low (Survival)	Benthic Macroinv. Dose-Response Value - High (Survival)	Food Chain Modeling Great Blue Heron NOAEL[3]	Food Chain Modeling Great Blue Heron LOAEL[4]	Food Chain Modeling S. Sandpiper NOAEL[3]	Food Chain Modeling S. Sandpiper LOAEL[4]
Irregularly Flooded Area								
Cadmium	1	-	-	-	-	-	57	211
Copper	21	-	-	-	879	1,155	603	792
Lead	27	-	-	-	182	926	139	706
Zinc	98	-	-	-	1,387	12,527	-	-
Permanently Flooded Area								
Cadmium	1	-	7	18	-	-	-	-
Copper	21	500	1,200	1,750	-	-	603	792
Lead	27	220	300	380	288	1,462	139	706
Zinc	98	1,200	2,100	5,100	1,641	14,829	1,527	13,796
Salt Marsh Area								
Cadmium	1	-	-	-	-	-	57	211
Copper	18	-	-	-	879	1,155	603	792
Lead	26	-	-	-	182	926	139	706
Zinc	91	-	-	-	1,387	12,527	-	-

Prepared by: AMR 03/03/2009
Checked by: SWR 03/03/2009

Notes:

1 = lesser of UTL or maximum value in off-site background data.

2 = effects concentration

3 = no observed adverse effects level

4 = lowest observed adverse effects level

- = Not Applicable

All concentrations are in units of mg/kg.

Table 2.2-9
Preliminary Remediation Goals for Sediment

Chemical of Concern	Goose Pond Background	Salt Marsh Background	Selected as PRG	Basis	Derivation [1]
Cadmium	1	1	210	Ecological effects	Lower of LOAELs for G.B. heron or S. sandpiper
Copper	21	18	790	Ecological effects	Lower of LOAELs for G.B. heron or S. sandpiper
Lead	27	26	710	Ecological effects	Lower of LOAELs for G.B. heron or S. sandpiper
Zinc	98	91	5100	Ecological effects	Benthic Macroinvertebrate Dose-Response Value – High

Notes:
All concentrations are in units of mg/kg.
[1] see Table 2.2-8 for additional information.

Prepared by: AMR 03/03//2009
Checked by: SWR 03/03/2009

Table 2.4-1
Summary of Tier I Evaluation of Sediment and Salt Marsh Hot Spots

Analyte	PRG	Goose Pond Mine Waste Hot Spot	Salt Marsh Mine Waste Hot Spot	Salt Marsh Not Mine Waste	Dyer Cove	Goose Pond North	Goose Cove Not Hot Spot	Goose Cove Mine Waste
Cadmium	210	29.0	45.1	17.9	18.6	10.2	4.7	19.6
Copper	790	2288	7498	296	2316	577	524	3370
Lead	710	1110	837	303	457	236	133	622
Zinc	5100	9601	17161	1773	15835	2372	1111	6607

Note:
All values in miligrams per killogram (mg/kg)
Shade indcates UCL concentration exceeds PRG.

Prepared by SWR 03/12/2009
Checked by: JHP 04/02/2009
Checked by: SWR 06/15/2009

Table 2.4-2
Summary of Tier II Evaluation of Sediment and Salt Marsh Hot Spots

Area	Do 95% UCL Concentrations Exceed the PRGs?	Did Sediment Toxicity Tests Reveal Acute Toxicity?	Do Fish Tissue Concentrations Exceed Background?	Are Plant Tissue Concentrations Above Background?	Are Clam Tissue Concentrations Above Background?	Was Pore Water Above NRWQC?	Was There Clear Evidence of Benthic Community Impairment?	Was There Qualitative Evidence of Benthic Community Impairment?	Does Food Chain Modeling Indicate a Threat to Insect and Fish Eating Birds?	Post BERA Eco Risk Refinement Conclusion Based on Hot Spot Evaluations
Goose Pond Mine Waste Hot Spot	y +	y	*y+	n.a.	y*	y	n	y	y	Southern Goose Pond mine waste hot spot represents an unacceptable threat to ecological receptors
Dyer Cove	y+	n	y+	n.a.	y*	n	n	n	n	While concentrations of contaminants are above the PRGs and clam tissue was elevated above background, the overall assessment does not support an unacceptable threat to ecological receptors in Dyer Cove
Goose Cove Mine Waste Hot Spot	y+	n	n	n.a.	n.a.	n	n	n	n	While concentrations of contaminants are above the PRGs, the overall assessment does not support an unacceptable threat to ecological receptors in Goose Cove
Remainder Goose Pond	n	n	y	n.a.	n	n	n	n	n	Remainder of Goose Pond does not represent an unacceptable threat to ecological receptors
Remainder Goose Cove	n	n	n	n.a.	n	n	n	n	n	Remainder of Goose Cove does not represent an unacceptable threat to ecological receptors
Salt Marsh Mine Waste Hot Spot	y+	n.a.	n.a.	y	n.a.	n.a.	n.a.	n.a.	y	Salt Marsh mine waste hot spot represents an unacceptable threat to ecological receptors
Remainder Salt Marsh	n	n.a.	n.a.	n	n.a.	n.a.	n.a.	n.a.	n	Remainder of Salt Marsh does not represent an unacceptable threat to ecological receptors

Notes:

Prepared by: LJ 06/30/09

Checked by: SWR 06/30/09

+ means more that 10x background
*includes areas adjacent to mine waste hot spot that could be part of foraging area for the fish
n.a. = not applicable
NRWQC = National Recommended Water Quality Criteria

Table 2.4-3
Estimated Volumes and Areas Identified for Remediation

Site Management Area	Average Thickness, ft [1]	Area, sq feet	Area, acres	Volume, cy [2]
Waste Rock and Soil				
Residential Area *	2.0	41,060	0.9	3,041
Mine Operations Area (includes subareas below)	5.2	227,480	5.2	43,920
PCB Area > 1mg/kg boundary*	2.0	29,666	0.7	2,197
PCB Area > 50 mg/kg boundary*	2.0	2,958	0.1	219
Oil-Contaminated Area **	3.0	2,615	0.1	600
Ore Pad	4.8	90,161	2.1	15,948
Waste Rock Pile 3	20.5	285,561	6.6	216,396
Road to Waste Rock Pile 3	14.6	111,128	2.6	60,238
Tailings Impoundment (footprint and volume including berm)	21.1	915,551	21.0	716,490
Tailings Impoundment Surface Inside of Berm	-	576,300	13.2	-
Waste Rock Pile 2 (200x200 ft strip at western edge)	5.0	40,000	0.9	7,410
Sediment				
Goose Pond (Hot spot east of WRP-3 and T. Impoundment) *	3.0	462,172	10.6	51,352
Salt Marsh (Hot spot east of WRP-3 and T. Impoundment) *	2.0	299,257	6.9	22,167
Areas of Salt Marsh Readily Apparent Harm (three areas)	2.0	4,790	0.11	355
Dyer Cove (as potential mitigation, CMS2-CMS5)*	3.0	155,074	3.6	17,230
Goose Cove (as potential mitigation, CMS2-CMS5)*	4.0	66,211	1.5	9,809

Notes: Prepared by: MRS 10/09/08
1 Average depth in upland areas backcalculated from volume and area Checked by: SWR 06/30/09

2 All volume are in-place volumes. Unless noted, volume in upland areas calculated with AutoCAD by comparing TRC survey (2004) to premine topography (Callahan Mine Corp map by Sewall, 1965).

* Values based on analytical data and field observation

** Because of uncertainty in the delineation of oil-contaminated soil, volume asumed to be twice that based on listed area and depth.

Table 2.5-1
Screening of Soil Remedial Technologies

General Response Action	Remediation Technology and Process Option	Description of Process Option	Effectiveness	Implementability	Cost	Retained	Screening Comments
No Action	None	No action taken	Not effective	Implementable	No Cost	Yes	Required for baseline comparison
Institutional Controls	Access and Use Restrictions						
	Deed covenants	Prohibit residential use and development of site through restrictive language in deeds and other instruments of property transfer.	Effective	Implementable	Low	Yes	
	Signs	Restrict access to site areas or provide health advisories.	Effective	Implementable	Very Low	Yes	
	Fencing	Restrict access to site areas with construction and maintenance of fences.	Effective	Implementable	Low	Yes	
	Environmental Monitoring						
	Groundwater sampling	Collection and analysis of soil samples.	Effective	Implementable	Medium-Low	Yes	Applicable. Used to assess effectiveness of source controls
	Soil sampling	Collection and analysis of groundwater samples.	Effective	Implementable	Medium-Low	Yes	Applicable. Used to assess remedy effectiveness
Containment	Capping						
	Reclamation cap	Install a cover system to prevent direct contact exposure to contaminated site materials and reduce weathering and erosion. Provides limited reduction in infiltration.	Not effective for controlling acid mine drainage.	Implementable	High	No	
	Low-permeability cap	Install a cover system to prevent direct contact exposure to contaminated site materials, reduce weathering and erosion, and provide a significant reduction in infiltration.	Effective	Implementable	High	Yes	May be used in conjunction with other technologies
In-Situ Treatment	Monitored natural attenuation						
		Relies on natural attenuation processes of decay/degradation, dilution, dispersion, adsorption, and volatilization to reduce contaminant concentrations and reduce site exposure risks.	Not effective for metals in mine waste. Time frame for natural attenuation of PCB and DRO/GRO contaminated soil expected to be long.	Implementable	Medium-Low	No	
	Enhanced bioremediation	Relies on biological processes to reduce the toxicity, mobility, and volume of contaminants. Amendments and nutrients are added to soil to enhance/accelerate natural degradation processes.	Not effective for metals in mine waste. Potentially applicable for DRO/GRO contaminated soil, but could interfere with remedial approach for metals.	Implementable	Medium-Low	No	

Table 2.5-1
Screening of Soil Remedial Technologies

General Response Action	Remediation Technology and Process Option	Description of Process Option	Effectiveness	Implementability	Cost	Retained	Screening Comments
Excavation	Mechanical excavation						
		Excavation using conventional earthmoving equipment.	Effective. Interrupts direct exposure pathway and reduces erosion and leaching if combined with protective disposal option.	Implementable. Need to protect workers with HASP. Need to identify suitable disposal method.	Medium	Yes	Used in conjunction with treatment/disposal technologies
Disposal	On-site Disposal						
	Consolidate in former mine pit	Excavated material would be disposed of in the former mine pit.	Effective. Placement in mine pit below stagnation depth interrupts direct exposure pathway. Anaerobic conditions below stagnation depth interrupt acid rock drainage and prevent leaching and migration of contaminants. Could require subaqueous cap if consolidation depth less than stagnation depth.	Implementable	Medium -low	Yes	
	Consolidate on-site and cap	Excavated material would be consolidated on site under a capping system.	Effective. Will require appropriate design to ensure cap stability on steep slopes. Capping interrupts direct exposure pathway and can be designed to prevents leaching and migration of contaminants.	Implementable, but requires administrative controls and deed restrictions on future land use at site. Alternative capping design needed to utilize in-site materials and minimize need to import cap materials. Requires long-term monitoring and maintenance.	Medium-High	Yes	
	Off-Site Disposal	Permitted landfill	Effective.	Difficult to implement. Volume of materials requiring off-site disposal would result in very large volume of site traffic and be very costly.	Very High	No	Not implementable for mine waste at site. Retained for disposal of small volumes of soil contaminated with materials that are not mine waste (e.g., PCB and petroleum contaminated soil).

Prepared by: SWR 03/18/2009
Checked by: JEB 03/24/2009

Table 2.5-2
Screening of Sediment Remedial Technologies

General Response Action	Remediation Technology and Process Option	Description of Process Option	Effectiveness	Implementability	Cost	Retained	Screening Comments
No Action	None	No action taken	Not effective	Implementable	No Cost	Yes	Required for baseline comparison
Institutional Controls	Access and Use Restrictions						
	Deed covenants	Restricts land use thought restrictive language in deeds and other instruments of property transfer.	Not effective for reducing ecological risks.	Implementable	Low	No	
	Signs	Restrict access to site areas with signs.	Not effective for reducing ecological risks. A useful tool for restricting clam digging by local residents.	Implementable	Low	Yes	May be used in conjunction with other technologies
	Fencing	Restrict access to site areas with construction and maintenance of fences.	Not effective for reducing ecological risks.	Implementable	Low	No	
	Shellfish harvesting prohibitions	Maine Department of Marine Resources prohibits harvesting of shellfish in areas where adverse health effects are possible.	Effective as a useful tool for restricting clam digging by local residents.	Implementable	Low	Yes	May be used in conjunction with other technologies
	Environmental Monitoring						
	Sediment sampling	Collection and analysis of sediment samples to aid in assessing potential exposure risks.	Effective	Implementable	Medium-Low	Yes	May be used in conjunction with other technologies
	Surface water sampling	Collection and analysis of surface water samples to aid in assessing potential exposure risks.	Effective	Implementable	Medium-Low	Yes	May be used in conjunction with other technologies
Containment	Soil/sediment cap						
		Cover contaminated sediments with a layer of clean material to prevent ecological direct contact exposure to contaminated material.	Limited effectiveness. Approximately one foot of material needed to prevent significant remixing with contaminated material by bioturbation. Shallow depth of Goose Pond adjacent to tailing impoundment and WRP 3 would subject cap to erosion and ice scour, compromising cap integrity. Poorly consolidated nature of existing sediments in area to be capped unlikely to support weight of capping material.	Installation of cap would adversely affect existing biological community and substantially decrease water column depth, thereby affecting long-term habitat and recolonization.	High	No	

Table 2.5-2
Screening of Sediment Remedial Technologies

General Response Action	Remediation Technology and Process Option	Description of Process Option	Effectiveness	Implementability	Cost	Retained	Screening Comments
In-Situ Treatment	Monitored natural recovery						
		Relies on natural sediment deposition processes to cover contaminated sediment, thereby reducing site exposure risks.	Ineffective. Sediment deposition rate in Goose Pond is low (i.e., 0.5 to 1 millimeter per year), and decades would be required to isolate contaminated sediments. Bioturbation and ice scour would be expected to prolong the time needed to achieve isolation.	Implementable	Medium-Low	No	
Excavation	Dredging						
	Mechanical dredging	Excavate/dredge using conventional dredging equipment.	Effective. Interrupts direct exposure pathway. Resuspension of material during dredging may result in suspension and redeposition of contaminated material in vicinity of dredge, thereby reducing effectiveness. Poorly consolidated nature of Goose Pond sediment may cause extensive resuspension of sediment during dredging and result in migration of contaminants if not controlled.	Implementable. Results in major alteration of existing habitat and biological community which must re-establish. Identification and development of an upland confined disposal area for dredged material expected to be difficult because of space requirements. As alternative, spoil could be disposed of in mine pit.	High	Yes	May be used alone or in conjunction with hydraulic dredging. May be suitable for Salt Marsh sediment.
	Hydraulic dredging	Excavate/dredge using hydraulic dredging equipment.	Effective. Interrupts direct exposure pathway. Resuspension of material during dredging may result in suspension and redeposition of contaminated material in vicinity of dredge, thereby reducing effectiveness and result in migration of contaminants if not controlled. With careful operation of dredge, resuspension can be minimized.	Implementable. Results in major alteration of existing habitat and biological community which must re-establish. Identification and development of an upland confined disposal area for dredged material expected to be difficult because of space requirements. As alternative, spoil could be disposed of in mine pit.	High	Yes	May be used alone of in conjunction with mechanical dredging.

Table 2.5-2
Screening of Sediment Remedial Technologies

General Response Action	Remediation Technology and Process Option	Description of Process Option	Effectiveness	Implementability	Cost	Retained	Screening Comments
Disposal	On-site Disposal						
	Upland confined disposal facility	An earthen basin is constructed to receive dredged material for dewatering and long-term disposal.	Effective. Would require extensive measures to capture/treat/dispose of excess water. Also, would require capping to prevent infiltration of precipitation and leaching of contaminants.	Limited implementability. Available site space is not conducive to development of an upland confined disposal facility.	High	Yes	
	Consolidate in former mine pit	Excavated material would be disposed of in the former mine pit.	Effective. Placement in mine pit below stagnation depth interrupts direct exposure pathway. Anaerobic conditions below stagnation depth interrupt acid rock drainage and prevent leaching and migration of contaminants. Could require subaqueous cap if consolidation depth less than stagnation depth. Would require controls to limit the resuspension and migration of contaminants during placement of spoil in pit.	Implementable. Would require coordination with several regulatory agencies including U.S. Army Corps of Engineers, U.S. Fish and Wildlife Service, Maine Department of Marine Resources, and Maine Department of Environmental Protection.	Medium	Yes	
	Off-site Disposal						
	Landfill disposal	Permitted landfill	Effective.	Difficult to implement. Dredged material would need extensive dewatering to make suitable for off-site disposal. Volume of materials requiring off-site disposal would result in large volume of site traffic and be costly. Poor roads in area could be damaged by extensive truck traffic.	Very High	No	

Prepared by: SWR 03/18/2009
Checked by: JEB 03/24/2009

Table 2.5-3
Screening of Seep Passive Treatment Technologies

General Response Action	Remediation Technology and Process Option	Description of Process Option	Effectiveness	Implementability	Cost	Retained	Screening Comments
No Action	None	No action taken	Not effective	Implementable	No Cost	Yes	Required for baseline comparison
Institutional Controls	Access and Use Restrictions						
	Deed covenants	Restricts land use thought restrictive language in deeds and other instruments of property transfer.	Not effective for reducing ecological risks or controlling contaminant migration via seeps.	Implementable	Low	No	
	Signs	Restrict access to site areas with signs.	Not effective for reducing ecological risks or controlling contaminant migration via seeps.	Implementable	Low	No	
	Fencing	Restrict access to site areas with construction and maintenance of fences.	Not effective for reducing ecological risks or controlling contaminant migration via seeps.	Implementable	Low	No	
	Environmental Monitoring						
	Sediment sampling	Collection and analysis of sediment samples to aid in assessing effectiveness of seep controls.	Effective	Implementable	Medium-Low	Yes	May be used in conjunction with other technologies
	Surface water sampling	Collection and analysis of sediment samples to aid in assessing effectiveness of seep controls.	Effective	Implementable	Medium-Low	Yes	May be used in conjunction with other technologies
In-Situ Treatment	Aerobic wetlands	Aerobic wetlands are shallow, surface flow wetlands with emergent vegetation. They are useful for aluminum, iron, and manganese oxidation and precipitation. Other metals may co-precipitate with iron and manganese or sorb to biomass.	Most effective for precipitation of iron and manganese which are not the primary problem in seeps at Site. May need to be preceded by cascades and other methods of oxygenating acid rock drainage. Increases acidity (reduces pH of seep water) when the available alkalinity is used up.	Implementable	Medium	No	Does not focus on site contaminants as well as anaerobic wetlands. Long-term increase in acidity undesirable. May result in formation of visible, rust-like precipitate.
	Open limestone channels	Acidic water flows over limestone, or other alkaline agent in open channel. Increases alkalinity and promotes precipitation of aluminum, iron, and manganese as metal oxides. Other metals may co-precipitate with iron and manganese	Primary function is to increase pH and alkalinity. May be successful only for limited periods before dissolved and atmospheric oxygen produces precipitates that partially "armour" the limestone particles, forming hard surface layers that inhibit more reactions.	Implementable. Requires long-term replacement of limestone media.	Medium	No	Does not focus on site contaminants as well as anaerobic wetlands. Long-term increase in acidity undesirable.

Table 2.5-3
Screening of Seep Passive Treatment Technologies

General Response Action	Remediation Technology and Process Option	Description of Process Option	Effectiveness	Implementability	Cost	Retained	Screening Comments
	Anoxic limestone drains	Water flows through a buried or capped limestone channel under anoxic conditions. Results in alkalinity addition, but prevents/reduces limestone armoring. When exposed to aerobic conditions in downstream basin, metal hydroxide sludges precipitate and settle.	Primary function is to increase pH and alkalinity. Designed to overcome limestone armoring problems of open limestone channels.	Implementable. Requires long-term replacement of limestone media.	Medium	No	Does not focus on site contaminants as well as anaerobic wetlands. Long-term increase in acidity undesirable.
	Anaerobic wetlands	Subsurface flow wetland, isolated from atmosphere by standing water or overlying material. Primary function is sulfate reduction and precipitation of metal sulfides; sorption or uptake of metals by vegetation.	Effective for reduction of sulfate and production of sulfide which quickly reacts with divalent metals to form relatively insoluble metal-sulfide precipitates. Also, adds alkalinity which raises pH.	Implementable.	Medium	Yes	Focuses on control of divalent metals that are a site concern. Does not contribute to increase in acidity. Minimal operation and maintenance requirements.
	Successive Alkalinity Producing Systems	Vertical flow systems that drain through layers of limestone and anaerobic organic matter. Results in alkalinity addition; sulfate reduction, and metal precipitation.	Primary function is to increase pH and alkalinity.	Implementable.	Medium	No	Control of acidity/alkalinity is not the major concern at site.
	Sulfate-Reducing Bioreactors	Collected water drains into anoxic chamber containing organic matter (compost) and sulfate reducing bacteria. Conceptually similar to anaerobic wetlands, but more controlled, less passive.	Effective for reduction of sulfate and production of sulfide which quickly reacts with divalent metals to form relatively insoluble metal-sulfide precipitates. Also, adds alkalinity which raises pH.	Implementable. It may be necessary to replace the compost layer because compost may become compacted or clogged, reducing its permeability.	Medium	No	Function similar to anaerobic wetland, but higher maintenance. No advantage over anaerobic wetland.
	Permeable Reactive Barriers	Intercepted groundwater flows through permeable barrier containing reactive material. Could be constructed with organic matter (compost). results in alkalinity addition; sulfate reduction, and metal precipitation/sorption.	Effective for reduction of sulfate and production of sulfide which quickly reacts with divalent metals to form relatively insoluble metal-sulfide precipitates. Also, adds alkalinity which raises pH.	Permeable reactive barrier would need to be installed at toe of tailings impoundment berm; however, observations in this area suggest that subsurface hydraulic characteristics (i.e., low permeability) are not suitable.	Medium	No	In addition to low-permeability concern, permeable reactive barrier is intended to intercept groundwater. Primary intent, however, is to intercept seep flow.

Prepared by: SWR 03/18/2009
Checked by: JEB 03/24/2009

Table 3.3-1
Screening of Alternative SC2

This alternative includes in-place closure of the tailings impoundment with treatment of horizontal drain discharge in a passive wetland; excavation and subaqueous disposal of WRP-3, Ore Pad, and Mine Ops Area source material along with lead and arsenic contaminated waste from the residential use area of the site in a CAD cell in the former mine pit; and off-site disposal of PCB- and petroleum-contaminated soil.

Effectiveness	
Advantages	Disadvantages
• Capping of tailings will isolate waste and reduce the mobility of contaminants by reducing leaching and erosion. • Improves the stability of the tailings impoundment and tailings impoundment berm. • Excavation and subaqueous disposal of material from WRP-3, Ore Pad, and Mine Ops Area will remove these areas as sources of groundwater and surface water contamination of concern. • Subaqueous disposal and isolation is one of the most effective means of preventing acid generation associated with disposal of mine wastes. • Excavation, consolidation, and capping residential lot soil will reduce human-health risks to acceptable levels. • Will comply with TSCA regulations for PCBs and State of Maine regulations for mining waste, PCBs, and petroleum contamination. • Cleanup levels within excavation areas will be protective of human receptors based on recreational direct contact exposure.	• Will not reduce the volume or toxicity of tailings or mine waste material. • Will not reduce the volume or toxicity of residential lot soil. • Institutional control needed to prevent potable use of Site groundwater. • Subaqueous disposal will require use of silt curtains and other measures to minimize migration of suspended solids and contaminants. • Long-term effectiveness requires monitoring and maintenance of capping systems and institutional controls.
Implementability	
Advantages	Disadvantages
• Technical resources are readily available for design and implementation of remedy. • Will be designed and implemented to comply with action-specific ARARs. • Significant adverse short-term effects to community are not expected. • Treatment, storage, and disposal facilities are available for the volume of PCB and petroleum contaminated soil requiring off-site disposal. • Does not require sophisticated or intensive operation and maintenance. • Will not interfere with the ability to perform additional upland remedial actions, if needed.	• On-site and regional materials (e.g., common borrow, topsoil) for cap construction are limited. As an alternative, it may be possible to quarry and crush non-ore-bearing / non-pyritic site rock to create cover materials. • Once materials are placed in former mine pit, future removal would be expensive and difficult.
Cost	
Advantages	Disadvantages
• Disposal of excavated material in former mine pit is expected to be less expensive than consolidating and capping in an upland waste cell.	
Screening Decision: This alternative is **retained** for detailed evaluation.	

Prepared by: SWR 2/11/2009
Checked by: JEB 03/24/2009

Table 3.3-2
Screening of Alternative SC3

This alternative includes in-place closure of the Tailings Impoundment with treatment of horizontal drain discharge in a passive wetland; excavation of WRP-3, Ore Pad, and Mine Ops Area source material along with lead and arsenic contaminated waste from the residential use area of the Site and disposal in a separate upland waste cell with a low permeability cover system; and off-site disposal of PCB- and petroleum-contaminated soil.

Effectiveness	
Advantages	Disadvantages
• Capping of tailings will isolate waste and reduce the mobility of contaminants by reducing leaching and erosion. • Improves the stability of the tailings impoundment and tailings impoundment berm.. • Excavation, onsite consolidation, and capping of WRP-3, Ore Pad, and Mine Ops Area source material will remove these areas as sources of groundwater and surface water contamination of concern. • Will comply with TSCA regulations for PCBs and State of Maine regulations for mining waste, PCBs, and petroleum contamination. • Cleanup levels within excavation areas will be protective of human receptors based on recreational direct contact exposure.	• Will not reduce the volume or toxicity of tailings or source material. • Will not reduce the volume or toxicity of residential lot soil. • Institutional controls needed to prevent potable use of Site groundwater. • Long-term effectiveness requires monitoring and maintenance of capping systems and institutional controls.
Implementability	
Advantages	Disadvantages
• Technical resources are readily available for design and implementation of remedy. • Will be designed and implemented to comply with action-specific ARARs. • Significant adverse short-term effects to community are not expected. • Treatment, storage, and disposal facilities are available for the volume of PCB and petroleum contaminated soil requiring off-site disposal. • Does not require sophisticated or intensive operation and maintenance. • Will not interfere with the ability to perform additional remedial actions, if needed.	• On-site and regional materials (e.g., common borrow, topsoil) for cap construction are limited. As an alternative, it may be possible to quarry and crush non-ore-bearing / non-pyritic site-rock to create cover materials.
Cost	
Advantages	Disadvantages
	• Upland consolidation and capping expected to be more expensive than disposal in pit.
Screening Decision: This alternative is **retained** for detailed evaluation.	

Prepared by: SWR 2/11/2009
Checked by: JEB 03/24/2009

Table 3.3-3
Screening of Alternative SC4

This alternative includes collection and treatment of Tailings Impoundment and WRP-3 seeps using a passive wetland; excavation and disposal of Ore Pad and Mine Ops Area source material, along with the lead and arsenic contaminated waste from the residential use area of the Site in a CAD cell in the former Mine Pit; and off-site disposal of PCB- and petroleum-contaminated soil.

Effectiveness	
Advantages	Disadvantages
• Diversion of upslope surface water will reduce the amount of runoff flowing onto the tailings impoundment. • Capture of tailings impoundment and WRP-3 seeps and subsequent treatment in anaerobic wetland will reduce the loading of metals to Goose Pond. • Excavation and subaqueous disposal of material from Ore Pad and Mine Ops Area will remove these areas as sources of groundwater and surface water contamination of concern. • Subaqueous disposal and isolation is one of the most effective means of preventing acid generation associated with disposal of mine wastes. • Excavation and disposal of residential lot soil in mine pit will reduce human-health risks to acceptable levels at residential lots. • Will comply with TSCA regulations for PCBs and State of Maine regulations for PCBs and petroleum contamination. • Cleanup levels within excavation areas will be protective of human receptors based on recreational direct contact exposure.	• Simple regrading of tailings surface will not address Tailings Impoundment stability concerns. • Will not address stability issues at WRP-3 or minimize acid rock drainage at Tailings Impoundment or WRP-3. • Will not control or reduce sources resulting in exceedances of groundwater contamination at Tailings Impoundment or WRP-3. • Without a low-permeability capping system, there will still be infiltration of precipitation into the tailings impoundment resulting in long-term leaching and seep generation. • Will not reduce the volume or toxicity of tailings, mine waste material, or residential lot soil. • Storm water flows and winter conditions may limit effectiveness of treatment wetland. • Institutional controls needed to prevent potable use of Site groundwater. • Subaqueous disposal will require use of silt curtains and other measures to minimize migration of suspended solids and contaminants. • Long-term effectiveness requires monitoring and maintenance of capping systems and institutional controls.
Implementability	
Advantages	Disadvantages
• Technical resources are readily available for design and implementation of remedy. • Significant adverse short-term effects to community are not expected. • Treatment, storage, and disposal facilities are available for the volume of PCB and petroleum contaminated soil requiring off-site disposal. • Does not require sophisticated or intensive operation and maintenance. • Will not interfere with the ability to perform additional upland remedial actions, if needed.	• Once materials are placed in former mine pit, future removal would be expensive and difficult. • Would not comply with Maine Mining Regulations performance standards to minimize acid rock drainage and provide structural stability. • Available space for construction of treatment wetland is limited. Existing wetland areas would need to be excavated to create treatment wetland.
Cost	
Advantages	Disadvantages
• Surface water diversions and seep control relatively inexpensive. • Disposal of excavated material in former mine pit is expected to be less expensive than upland consolidation and capping or offsite disposal.	Treatment wetland will require long-term (but relatively low-level) monitoring and maintenance.
Screening Decision: This alternative is **not retained** for detailed evaluation.	

Prepared by: SWR 2/11/2009
Checked by: JEB 03/24/2009

Table 3.3-4
Screening of Alternative SED2

This alternative includes excavation of Salt Marsh and Goose Pond sediment and subaqueous disposal in a CAD cell in the former mine pit.

Effectiveness	
Advantages	Disadvantages
• Excavation/dredging of sediments and disposal/isolation in an on-shore confined disposal facility interrupts human and ecological sediment exposure pathways. • Sediment excavation/dredging is one of three typical remedies for contaminated sediment.	• Results in major disturbance of existing habitat and biological community. • Does not reduce the toxicity, mobility, or volume of contaminants through treatment. • Care must be taken during dredging to limit suspension of fine-grained material and subsequent settling that can result in recontamination of site. • Cart must be taken during placement in pit to limit suspension of fine-grained material and subsequent migration and settling that could result in recontamination of site.
Implementability	
Advantages	Disadvantages
• Technical resources are readily available for design and implementation of remedy. • Will be designed and implemented to comply with action-specific ARARs. • Significant adverse short-term effects to community are not expected. • Does not require locating, constructing, and long term-maintenance of confined disposal facility. • Does not require use of off-site treatment, storage, and disposal facilities. • Does not require sophisticated or intensive operation and maintenance. • Will not interfere with the ability to perform additional remedial actions, if needed.	• If for some reason a problem developed with material placed in pit, removal of material could be difficult.
Cost	
Advantages	Disadvantages
• Costs are expected to be lower than for Alternative SED4 • Relatively low long-term monitoring cost • Costs are proportional to benefits.	
Screening Decision: This alternative **is retained** for detailed evaluation.	

Prepared by: SWR 02/11/2009
Checked by: JEB 03/24/2009

Table 3.3-5
Screening of Alternative SED3

This alternative includes excavation of Salt Marsh and Goose Pond Sediment and disposal in an upland confined disposal facility.

Effectiveness	
Advantages	Disadvantages
• Excavation/dredging of sediments and disposal/isolation in an on-shore confined disposal facility interrupts human and ecological sediment exposure pathways. • Sediment excavation/dredging is one of three typical remedies for contaminated sediment.	• Results in major disturbance of existing habitat and biological community. • Does not reduce the toxicity, mobility, or volume of contaminants through treatment. • Care must be taken during dredging to limit suspension of fine-grained material and subsequent settling that can result in recontamination of site.
Implementability	
Advantages	Disadvantages
• Technical resources are readily available for design and implementation of remedy. • Will be designed and implemented to comply with action-specific ARARs. • Significant adverse short-term effects to community are not expected. • Does not require use of off-site treatment, storage, and disposal facilities. • Does not require sophisticated or intensive operation and maintenance. • Will not interfere with the ability to perform additional remedial actions, if needed.	• Requires locating, constructing, and long term-maintenance of confined disposal facility. • Materials and space for a confined disposal facility are not readily available.
Cost	
Advantages	Disadvantages
• Relatively low long-term monitoring cost	Relatively high cost alternative.
Screening Decision: This alternative **is not retained** for detailed evaluation.	

Prepared by: SWR 02/11/2009
Checked by: JEB 03/24/2009

Table 4.1-1
Chemical-Specific ARARs and TBCs for Alternative CMS1

No Action

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.	This alternative would not prevent exposure to non-carcinogenic hazards caused by exposure to contaminants and would not met this standard.
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.	This alternative would not prevent exposure to carcinogenic hazards caused by exposure to contaminants and would not met this standard.
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 of assessing cancer risks to children.	This alternative would not prevent exposure to carcinogenic hazards to children caused by exposure to contaminants and would not meet this standard.
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.	This alternative would not prevent exposure to carcinogenic hazards caused by exposure to contaminants and would not met this standard.
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.	This alternative would not address lead-impacted soil exceeding adult risk levels and would not meet this standard.

Table 4.1-1
Chemical-Specific ARARs and TBCs for Alternative CMS1

No Action

Regulatory Authority	Chemical Medium	Requirement	Status	Requirement Synopsis	Action to be Taken to Attain Requirement
State	Soil	Maine Solid Waste Rules, Lead Management Regulations [06-096 CMR Chapter 424]	Relevant and Appropriate	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 that exceeds 375 ppm would not be addressed 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 Maine Department of Environmental Protection (Maine 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, and the Guidelines include standards for zinc that are not included in federal standards.	Exceedances of State standards would not be addressed under this No Action alternative.

Notes:

Prepared by: LJ 03/18/2009
Checked by: SWR 06/17/2009

ARAR = Applicable or Relevant and Appropriate Requirement
CFR = Code of Federal Regulations
CMR = Code of Maine Regulations
CSF = Cancer Slope Factor
Maine DEP = Maine Department of Environmental Protection
ppm = parts per million
RfD = Risk Reference Dose
USEPA = U.S. Environmental Protection Agency

Table 4.1-2
Cost Summary for Alternative CMS1

ITEM	COST
CAPITAL COSTS	
Direct Cost Subtotal	$0
Contingency Cost (@30 Percent)	$0
Direct and Contingency Cost Subtotal	$0
TOTAL CAPITAL COSTS	**$0**
LONG-TERM OPERATION, MAINTENANCE, AND MONITORING COST	
Five Year Review (every 5 years)	$7,400
TOTAL LONG-TERM OPERATION, MAINTENANCE, AND MONITORING PW COSTS, 30-YEARS, 7% (See Note 2)	**$19,000**
TOTAL LONG-TERM OPERATION, MAINTENANCE, AND MONITORING PW COSTS, 100-YEARS, 2.7% (See Note 2)	**$56,000**
TOTAL LONG-TERM OPERATION, MAINTENANCE, AND MONITORING NOMINAL COSTS, 100-YEARS (See Note 2)	**$171,000**
TOTAL PV COST (CAPITAL + LONG TERM PV, 30-YR, 7%)	**$19,000**
TOTAL PV COST (CAPITAL + LONG TERM PV, 100-YR, 2.7%)	**$56,000**
TOTAL COST (CAPITAL + LONG TERM NOMINAL, 100-YR)	**$171,000**

Prepared by: SWReed, 6/16/2009
Checked by: JPMcCrady, 6/16/2009

Notes:

1. PV = Present Value
2. Includes project management and technical support as a percentage of operation, maintenance, and monitoring costs. See PV Cost sheet.

Table 4.2-1
Location-Specific ARARs for 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 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 United States Code (USC) 403 *et seq.*; 33 CFR 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 will be restored.
Federal	Surface Waters including Wetlands	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. Part 230, 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 if necessary to comply with this ARAR. 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 alternation of any freshwater federal jurisdictional wetlands will also be addressed under these standards. A final determination of federal jurisdiction and wetland mitigation will be made during the predesign phase.

Table 4.2-1
Location-Specific ARARs for 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 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 USC 661 *et seq.*]	Applicable	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 the U.S. Fish and Wildlife Service and the appropriate state agency to ascertain the means and measures necessary to mitigate, prevent, and compensate for project-related losses of 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 U.S. Fish and Wildlife Service and the appropriate state agency will be consulted.
Federal	Coastal Zone	Coastal Zone Management Act [16 U.S.C. 1451 *et seq.*]	Applicable	Require 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	Historic Sites Act of 1935 (16 U.S.C. § 469 *et seq.*); National historic landmarks (36 C.F.R. Part 65)	Applicable	The purpose of the National Historic Landmarks program is to identify and designate National Historic Landmarks, and encourage the long range preservation of nationally significant properties that illustrate or commemorate the history and prehistory of the United States.	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 Department of the Interior.

Table 4.2-1
Location-Specific ARARs for 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 Former Mine Pit

Regulatory Authority	Location Characteristic	Requirement	Status	Requirement Synopsis	Action to be Taken to Attain Requirement
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) [Title 38, Chapter 3, §§ 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. 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 4.2-1
Location-Specific ARARs for 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 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 Code of Maine Regulations (CMR), 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; (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." Restoration activities will be performed so that post-remediation on-site wetlands are at least comparable to existing on-site wetlands. 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 if necessary. A final determination of state jurisdiction and wetland mitigation will be made during the predesign phase.

Table 4.2-1
Location-Specific ARARs for 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 Former Mine Pit

Regulatory Authority	Location Characteristic	Requirement	Status	Requirement Synopsis	Action to be Taken to Attain Requirement
State	Wetlands Surface Waters	Maine NRPA, Permit-by-Rule Standards [06-096 CMR, 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.
State	Shoreland areas	Maine Mandatory Shoreland Zoning Act [Title 38, M.R.S.A., Sections 435-449; 06 096 CMR Chapter 1000]	Applicable	To protect and conserve 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 [Title 12 M.R.S.A. Sections 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 MRSA §§ 1801 *et seq.*]	Applicable	Provide 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 MRSA § 481-490. Also 06-096 CMR Chapters 374 and 375]	Applicable	Regulations apply to control activities at certain developments so that there are minimal adverse impacts to natural resources, to include specifically erosion and sedimentation control, noise control, and air quality control. Metallic mineral mining is designated as development of state or regional significance that may substantially affect the environment.	Remedial alternatives 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.

Table 4.2-1
Location-Specific ARARs for Alternative CMS2

Prepared by: LJ 03/18/2009
Checked by: SWR 06/17/2009

Notes:

ARAR	=	Applicable or Relevant and Appropriate Requirement
CFR	=	Code of Federal Regulations
CMR	=	Code of Maine Regulations
MEDEP	=	Maine Department of Environmental Protection
MNA	=	Monitored Natural Attenuation
M.R.S.A	=	Maine Revised Statutes Annotated
USC	=	United States Code
USEPA	=	U.S. Environmental Protection Agency
UST	=	Underground Storage Tank

Table 4.2-2
Chemical-Specific ARARs and TBCs for Alternative CMS2

Capping of Tailings Impoundment; Off-Site Disposal of PCB and Petroleum Contaminated Soil; Capping of Source Area Material (from the Ore Pad, Mine Operations Area, WRP-3), and Residential Use Area Soil; and subaqueous disposal of Sediment in a Confined Aquatic Disposal (CAD) cell in Former 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.	This alternative will meet these standards by removing contaminants that pose non-carcinogen risks in the residential properties and disposing of them in the CAD and achieving recreational risk levels elsewhere in OU 1.
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.	This alternative will meet these standards by removing contaminants that pose carcinogen risks in the residential properties and disposing of them in the CAD and achieving recreational risk levels elsewhere in OU 1.
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 of assessing cancer risks to children.	This alternative will meet these standards by removing contaminants that pose carcinogen risks to children in the residential properties and disposing of them in the CAD and achieving child recreational risk levels elsewhere in OU 1.
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.	This alternative will meet these standards by removing contaminants that pose carcinogen risks in the residential areas and disposing of them in the CAD and achieving recreational risk levels elsewhere in OU 1.

Table 4.2-2
Chemical-Specific ARARs and TBCs for Alternative CMS2

Capping of Tailings Impoundment; Off-Site Disposal of PCB and Petroleum Contaminated Soil; Capping of Source Area Material (from the Ore Pad, Mine Operations Area, WRP-3), and Residential Use Area Soil; and subaqueous disposal of Sediment in a Confined Aquatic Disposal (CAD) cell in Former 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.	This alternative will meet this standard by excavating lead-impacted soil exceeding adult risk levels in the residential properties and disposing of the soil in the CAD.
State	Soil	Maine Solid Waste Rules, Lead Management Regulations [06-096 CMR Chapter 424]	Relevant and Appropriate	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 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 Maine Department of Environmental Protection (Maine 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. Includes standards for copper and zinc that do not have federal standards.	This alternative will meet these standards by capping wastes that exceed these standards in the Tailing 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 into the CAD cell.

Notes:

Prepared by: LJ 03/18/2009
Checked by: SWR 06/17/2009

ARAR = Applicable or Relevant and Appropriate Requirement
CFR = Code of Federal Regulations
CMR = Code of Maine Regulations
ppm = parts per million
Maine DEP = Maine Department of Environmental Protection
CSF = Cancer Slope Factor
RfD = Risk Reference Dose
USEPA = U.S. Environmental Protection Agency

Table 4.2-3
Action-Specific ARARs and TBCs for Alternative CMS2

Capping of Tailings Impoundment; Off-Site Disposal of PCB and Petroleum Contaminated Soil; Confined Aquatic Disposal of WRP-3, Ore Pad, and Mine Ops Area Source Material; and Sediment in 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 CFR 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) [40 CFR761.61(a) and (c)] PCB Remediation Waste	Applicable	This section of TSCA 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. The Proposed Plan will include a finding by the Director, Office of Site Remediation and Restoration, that the cleanup level selected meets these standards for protectiveness.
Federal	Off-site 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 stored, transported, and disposed of in accordance with these standards.

Table 4.2-3
Action-Specific ARARs and TBCs for Alternative CMS2

Capping of Tailings Impoundment; Off-Site Disposal of PCB and Petroleum Contaminated Soil; Confined Aquatic Disposal of WRP-3, Ore Pad, and Mine Ops Area Source Material; and Sediment in Former Mine Pit

Regulatory Authority	Action	Requirement	Status	Requirement Synopsis	Actions to be Taken to Attain Requirement
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	Used to establish water quality standards for the protection of aquatic life.	Standards to 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, and other remedial activities.
Federal	Groundwater	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	Establishes maximum contaminant levels (MCLs) for common organic and inorganic contaminants applicable to public drinking water supplies. Used as relevant and appropriate cleanup standards for aquifers and surface water bodies that are potential drinking water sources.	Establish standards for groundwater monitoring for the capped Tailings Impoundment area to assess the protectiveness of the cap.
Federal	Groundwater	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	Establishes 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.	Establish standards for groundwater monitoring for the capped Tailings Impoundment area to assess the protectiveness of the cap.

Table 4.2-3
Action-Specific ARARs and TBCs for Alternative CMS2

Capping of Tailings Impoundment; Off-Site Disposal of PCB and Petroleum Contaminated Soil; Confined Aquatic Disposal of WRP-3, Ore Pad, and Mine Ops Area Source Material; and Sediment in Former Mine Pit

Regulatory Authority	Action	Requirement	Status	Requirement Synopsis	Actions to be Taken to Attain Requirement
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. 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.	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	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 CFR Part 761.	The cleanup and off-site disposal of PCB contaminated soil will be performed in a manner to comply with TSCA.
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 CMR 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 woodwaste, 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.	This alternative would meet the substantive portions of these regulations for reclamation, closure, and post-closure activities by capping waste in the Tailing Impoundment area, use of a treatment wetland for runoff, and disposing of all other contaminated soil/sediment in OU1 in the CAD cell.

Table 4.2-3
Action-Specific ARARs and TBCs for Alternative CMS2

Capping of Tailings Impoundment; Off-Site Disposal of PCB and Petroleum Contaminated Soil; Confined Aquatic Disposal of WRP-3, Ore Pad, and Mine Ops Area Source Material; and Sediment in Former Mine Pit

Regulatory Authority	Action	Requirement	Status	Requirement Synopsis	Actions to be Taken to Attain Requirement
State	Off-site 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 CMR 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	Off-site disposal of hazardous waste	Maine Hazardous Waste Management Rules - Requirements for Generators (38 M.R.S.A. §§ 1301 *et seq.*; 06-096 CMR 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 stored, transported, and disposed of in accordance with these standards.
State	Management of land clearing debris and wood waste	Maine Solid Waste Management Rules [06-096 CMR Chapter 400-409]	Applicable if encountered	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.
State	Surface water discharge	Maine Waste Discharge Licenses [38 Maine Revised Statutes Annotated (M.R.S.A.) Section 413 *et seq.*] and Waste Discharge Permitting Program [06-096 CMR Chapter 520-529]	Applicable	This rule requires permits issued by Maine Department of Environmental Protection for the discharge of pollutants from point sources.	All substantive requirements of this regulation 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.

Table 4.2-3
Action-Specific ARARs and TBCs for Alternative CMS2

Capping of Tailings Impoundment; Off-Site Disposal of PCB and Petroleum Contaminated Soil; Confined Aquatic Disposal of WRP-3, Ore Pad, and Mine Ops Area Source Material; and Sediment in 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 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 they do 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. Sec. 420; 06-096 CMR Chapter 530]	Applicable	These rules set forth the National Recommended 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 they do 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 4.2-3
Action-Specific ARARs and TBCs for Alternative CMS2

Capping of Tailings Impoundment; Off-Site Disposal of PCB and Petroleum Contaminated Soil; Confined Aquatic Disposal of WRP-3, Ore Pad, and Mine Ops Area Source Material; and Sediment in 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 CMR Chapter 584]	Applicable	Except as naturally occur, levels of toxic pollutants in surface waters must not exceed federal water quality criteria as established by the U.S. environmental Protection Agency (USEPA), pursuant to Section 304(a) of the Clean Water Act, or alternative criteria.	Site activities will be designed and implemented in a manner that they do 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	Shellfishing ban	Closed Area No. 36, Bagaduce River and Harborside (Castine, Penobscot, Brooksville) [DMR Chapter 95.04(C)]	Applicable	State ban, because of pollution, on digging, taking, or possessing any clams, quahogs, oysters, or mussels taken from the flats and waters of Goose Cove or Goose Pond.	State shellfishing ban has been established due to site contamination. Such ban will need to remain in effect for site contamination until cleanup levels are achieved.
State	Quarrying of rock	Performance Standards For Quarries [38 M.R.S.A. Section 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 a reclamation cover, these standards will be complied with.

Table 4.2-3
Action-Specific ARARs and TBCs for Alternative CMS2

Capping of Tailings Impoundment; Off-Site Disposal of PCB and Petroleum Contaminated Soil; Confined Aquatic Disposal of WRP-3, Ore Pad, and Mine Ops Area Source Material; and Sediment in 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 Erosion and Sedimentation Control [38 M.R.S.A. Section 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.
State	Activities that expose soil with potential for erosion	Maine Storm Water Management [38 M.R.S.A. Section 420-D], Maine Storm Water Management Rules [06 096 CMR Chapter 500], and Direct Watershed of Waterbodies Most at Risk from New Development [06-096 CMR 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 4.2-3
Action-Specific ARARs and TBCs for Alternative CMS2

Capping of Tailings Impoundment; Off-Site Disposal of PCB and Petroleum Contaminated Soil; Confined Aquatic Disposal of WRP-3, Ore Pad, and Mine Ops Area Source Material; and Sediment in 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:

Prepared by: LJ 03/18/2009
Checked by: SWR 06/17/2009

ARAR = Applicable or Relevant and Appropriate Requirement
CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act
CFR = Code of Federal Regulations
CMR = Code of Maine Regulations
IDW = Investigation-Derived Waste
Maine 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
USC = United States Code
USEPA = U.S. Environmental Protection Agency

Table 4.2-4
Equivalent Truck Traffic Reduction for Alternative CMS2

Activity		Volume (cy) [2]	Truck Loads [3]
On-Site Disposal of Material			
Mine Ops Area / Ore Pad		87,200	6,229
WRP-2 (partial)		9,900	707
WRP-3 (including WRP-3 Haul Road)		347,894	24,850
Residential Lot Soil		3,350	239
Goose Pond/Goose Cove Sediment, Salt Marsh		100,800	7,200
	Subtotal	**549,144**	**39,225**
On-Site Quarrying/Crushing			
Cap Rock (Tailings Area)		53,400	3,814
WRP-3 Reclamation [4]		16,300	1,164
Ore Pad /Mine Ops/WRP-2 Reclamation [4]		16,800	1,200
PCB Area Reclamation [4]		2,430	174
Residential Lot Access Road		520	37
Misc./Drainage Rip-Rap/etc		1,000	71
	Subtotal	**90,450**	**6,461**
Beneficial Use of On-Site Materials			
Stink Cove Sediment to Salt Marsh		8,700	621
	Subtotal	**8,700**	**621**
	TOTAL		**46,307**

Notes:
1 = Number of truckloads not transported over local roads.
2 = "loose cubic yards"= bank cubic yards plus swell.
Goose Pond/ Goose Cove and Salt Marsh sediment in-place (bank) volume.
3 = Assumes 14 cy dump trucks.
4 = If excavation to an irregular bedrock surface is required and material exceeding PRGs remains exposed at the bottom of the excavation, a one foot layer of crushed stone would be placed as backfill.

Prepared by SWR 04/07/2009
Checked by JPM 04/13/2009

Table 4.2-5
Estimated Heavy Truck Traffic for Alternative CMS2 [1]

Activity	Volume or Quantity of Material [2]		Number of Trucks	Number of Trips per Truck	Total Number of Trips
Tandem-Axle Dump Trucks [3]					
Off-Site Disposal of Petroleum Contaminated Soils	800	lcy	58	2	116
Residential Lot Restoration, Common Borrow import	2,365	lcy	169	2	338
Residential Lot Restoration, Topsoil import	575	lcy	42	2	84
Mine Ops, Off-Site Disposal of PCB Contaminated Material	2,406	lcy	172	2	344
Tandem-Axle Dump Truck Trip Subtotal					**882**
Tractors and Haul Trailers [4]					
General Equipment Mobilization, dozers	2	ea	2	4	8
General Equipment Mobilization, excavators	3	ea	3	4	12
General Equipment Mobilization, compactors	2	ea	2	4	8
General Equipment Mobilization, tandem axle dump trucks for on-site hauling	8	ea	8	2	16
Tailings Impoundment, geomembrane delivery	30	rolls	1	2	2
Tailings Impoundment, geocomposite delivery	290	rolls	3	2	6
Tailings Impoundment, treatment wetland composted organic matter	9,036	lcy	452	2	904
Tractors and Haul Trailers Trip Subtotal					**956**
Miscellaneous Construction Equipment [5]					
General Mobilization, equipment maintenance, and misc. equipment and supply delivery	-	-	52	2	104
General Mobilization, Quarry Rock Crushers (assume 2)			2	2	4
Tailings Impoundment, horizontal directional drilling	-	-	1	2	2
Waste Rock Pile 3 Excavation, floating conveyor system	-	-	16	2	32
Residential Lot Restoration, Hydroseed tanker	-	-	3	2	6
Residential Lot Restoration, misc. structure repair/replacement	-	-	5	2	10
Mobilization of hydraulic dredging equipment	-	-	4	2	8
Wetland Mitigation, General Restoration, hydroseeder tanker	-	-	4	2	8
Miscellaneous Equipment Trip Subtotal					**174**
TOTAL CONSTRUCTION TRUCK TRIPS					**2,012**

Notes:
Prepared by JPM 04/30/2009
Checked by SWR 04/30/2009
1 = Number and type of trucks traveling over local public roads during execution of the work.
2 = "loose cubic yards"
3 = Assumes 14 cy dump trucks.
4 = Assumes heavy haul trailers for equipment delivery and 20 cy semi dump trailers for material delivery
5 = Does not include delivery of daily supplies, FedEx, Fuel, etc.

Table 4.2-6
Cost Summary for Alternative CMS2

	ITEM	COST
CAPITAL COSTS		
2.1	Pre-Design Studies	$310,000
2.2	General Construction Costs Common to all Components of Work	$827,000
2.3	Tailings Impoundment Improvements	$4,331,000
2.4	Waste Rock Pile No. 3 (WRP3)	$3,002,000
2.5	Ore Pad and Mine Operations Area (Mine Ops, Etc.)	$694,000
2.6	Residential Lots	$314,000
2.7	PCB Soils	$587,000
2.8	Sediment Dredging of Goose Pond and Salt Marsh	$2,124,000
2.9	Wetland Mitigation	$1,245,000
2.10	Institutional Controls	$31,000
2.11	Monitoring Well Installation	$66,000
2.12	Long-term Monitoring Plan	$35,000
	Direct Cost Subtotal	$13,566,000
	Contingency Cost (@30 Percent)	$4,069,800
	Direct and Contingency Cost Subtotal	$17,635,800
2.13	Indirect Capital Costs (Engineering, Design, Construction Mgmt, and PMgmt)	$3,880,000
	TOTAL CAPITAL COSTS	**$21,515,800**
LONG-TERM OPERATION, MAINTENANCE, AND MONITORING COST		
2.14	Long-Term Operation and Maintenance	
	Annual Inspection and Site Summary Report, Per Event, Nominal	$10,700
	Constructed Wetland (5-yr event)	$87,600
	Salt Marsh (years 1, 3 , 5, 10)	$7,300
	Tailings Impoundment Cap and Stormwater System (5-yr event)	$70,900
	Tailings Impoundment Cap (25-yr event)	$210,700
2.15	Long-Term Environmental Monitoring, Per Event, Nominal	
	Semi-Annual Constructed Wetland Inf/Eff (year 1)	$24,800
	Annual Constructed Wetland Inf/Eff (years 2-100)	$12,400
	Annual Groundwater (years 1-2)	$18,800
	Annual Groundwater (years 3-10)	$18,800
	Annual Groundwater (years 15, 20, 25, …, 100)	$18,800
	Semi-Annual Surface Water (years 1-2)	$36,600
	Annual Surface Water (years 3 -10, 15, 20, 25, …, 100)	$18,300
	Sediment Monitoring (every 5 years)	$13,500
	Periodic Clam Tissue (years 3, 4, 5, 10, 15, 20, 25, …, 100)	$9,100
	Five Year Review (every 5 years)	$27,000

Table 4.2-6
Cost Summary for Alternative CMS2

ITEM	COST
TOTAL LONG-TERM OPERATION, MAINTENANCE, AND MONITORING PW COSTS, 30-YEARS, 7% (See Note 3)	$1,324,000
TOTAL LONG-TERM OPERATION, MAINTENANCE, AND MONITORING PW COSTS, 100-YEARS, 2.7% (See Note 3)	$3,398,000
TOTAL LONG-TERM OPERATION, MAINTENANCE, AND MONITORING NOMINAL COSTS, 100-YEARS (See Note 3)	$9,718,000
TOTAL COST (CAPITAL + LONG TERM PV, 30-YR, 7%)	$22,839,800
TOTAL COST (CAPITAL + LONG TERM PV, 100-YR, 2.7%)	$24,913,800
TOTAL COST (CAPITAL + LONG TERM NOMINAL, 100-YR)	$31,233,800

Prepared by: JPMcCrady, 6/16/2009
Checked by: SWReed, RSEgan, 6/16/2009

Notes:

1. PV = Present Value
2. Compensatory wetland mitigation requirements have not been established and may not be necessary. If mitigation is not required, capital and long-term costs will be reduced.
3. Includes project management and technical support as a percentage of operation, maintenance, and monitoring costs. See PV Cost sheet.

Table 4.3-1
Location-Specific ARARs for Alternative CMS3

Capping of Tailings Impoundment; Off-Site Disposal of PCB- and Petroleum-Contaminated Soil; Capping of Source Area Material (from the Ore Pad, Mine Operations Area, and WRP-3), and Residential Area Soil; and Subaqueous Disposal of 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 United States Code (USC) 403 *et seq*.; 33 CFR 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 deposition into the CAD cell. Disturbed areas will be restored.

Table 4.3-1
Location-Specific ARARs for Alternative CMS3

Capping of Tailings Impoundment; Off-Site Disposal of PCB- and Petroleum-Contaminated Soil; Capping of Source Area Material (from the Ore Pad, Mine Operations Area, and WRP-3), and Residential Area Soil; and Subaqueous Disposal of 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 including Wetlands	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. Part 230, 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 construction of Tailings Impoundment improvements and dredging/excavation of sediments and salt marsh will result in the 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. Deposition of material into the CAD cell will also comply with these standards, regarding the filling of aquatic habitats. The alternation of any freshwater federal jurisdictional wetlands will also be addressed under these standards. Compensatory habitat mitigation will be performed if necessary to comply with this ARAR. A final determination of federal jurisdiction and wetland mitigation will be made during the predesign phase.

Table 4.3-1
Location-Specific ARARs for Alternative CMS3

Capping of Tailings Impoundment; Off-Site Disposal of PCB- and Petroleum-Contaminated Soil; Capping of Source Area Material (from the Ore Pad, Mine Operations Area, and WRP-3), and Residential Area Soil; and Subaqueous Disposal of 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 USC 661 *et seq.*]	Applicable	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 the U.S. Fish and Wildlife Service and the appropriate state agency to ascertain the means and measures necessary to mitigate, prevent, and compensate for project-related losses of 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 U.S. Fish and Wildlife Service and the appropriate state agency will be consulted.
Federal	Coastal Zone	Coastal Zone Management Act [16 U.S.C. 1451 *et seq.*]	Applicable	Require 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	Historic Sites Act of 1935 (16 U.S.C. § 469 *et seq.*); National historic landmarks (36 C.F.R. Part 65)	Applicable	The purpose of the National Historic Landmarks program is to identify and designate National Historic Landmarks, and encourage the long range preservation of nationally significant properties that illustrate or commemorate the history and prehistory of the United States.	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 Department of the Interior.

Table 4.3-1
Location-Specific ARARs for Alternative CMS3

Capping of Tailings Impoundment; Off-Site Disposal of PCB- and Petroleum-Contaminated Soil; Capping of Source Area Material (from the Ore Pad, Mine Operations Area, and WRP-3), and Residential Area Soil; and Subaqueous Disposal of 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	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) [Title 38, Chapter 3, §§ 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. 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 4.3-1
Location-Specific ARARs for Alternative CMS3

Capping of Tailings Impoundment; Off-Site Disposal of PCB- and Petroleum-Contaminated Soil; Capping of Source Area Material (from the Ore Pad, Mine Operations Area, and WRP-3), and Residential Area Soil; and Subaqueous Disposal of 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	Wetland s	Maine NRPA; Wetlands Protection Rule [06-096 Code of Maine Regulations (CMR), 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; (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 for existing coastal and freshwater wetland/habitat, particularly any "Wetlands of Special Significance." If necessary, restoration activities will be performed so that post-remediation on-site wetlands are at least comparable to existing on-site wetlands. 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, if necessary. A final determination of state jurisdiction and wetland mitigation will be made during the predesign phase.

Table 4.3-1
Location-Specific ARARs for Alternative CMS3

Capping of Tailings Impoundment; Off-Site Disposal of PCB- and Petroleum-Contaminated Soil; Capping of Source Area Material (from the Ore Pad, Mine Operations Area, and WRP-3), and Residential Area Soil; and Subaqueous Disposal of 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 Surface Waters	Maine NRPA, Permit-by-Rule Standards [06-096 CMR, 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.
State	Shoreland areas	Maine Mandatory Shoreland Zoning Act [Title 38, M.R.S.A., Sections 435-449; 06 096 CMR Chapter 1000]	Applicable	To protect and conserve 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 [Title 12 M.R.S.A. Sections 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 MRSA §§ 1801 *et seq.*]	Applicable	Provide 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 MRSA § 481-490. Also 06-096 CMR Chapters 374 and 375]	Applicable	Regulations apply to control activities at certain developments so that there are minimal adverse impacts to natural resources, to include specifically erosion and sedimentation control, noise control, and air quality control. Metallic mineral mining is designated as development of state or regional significance that may substantially affect the environment.	Remedial alternatives 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.

Table 4.3-1
Location-Specific ARARs for Alternative CMS3

Prepared by: LJ 03/18/2009
Checked by: SWR 06/17/2009

Notes:

ARAR	=	Applicable or Relevant and Appropriate Requirement
CFR	=	Code of Federal Regulations
CMR	=	Code of Maine Regulations
MEDEP	=	Maine Department of Environmental Protection
MNA	=	Monitored Natural Attenuation
M.R.S.A	=	Maine Revised Statutes Annotated
USC	=	United States Code
USEPA	=	U.S. Environmental Protection Agency
UST	=	Underground Storage Tank

Table 4.3-2
Chemical-Specific ARARs and TBCs for Alternative CMS3

In-place closure of the Tailings Impoundment with treatment of the horizontal drain discharge in a passive wetland; Excavation of WRP-3, Ore Pad, and Mine Ops Area Source Material along with the lead and arsenic contaminated waste from the residential use area of the Site and consolidation and capping of this material in a separate waste cell with a low permeability cover system; and Off-Site Disposal of PCBs and Petroleum-Contaminated Soil and Dredging and disposal of Sediment in a CAD cell in the former 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.	This alternative will meet these standards by removing contaminants that pose non-carcinogen risks in the residential properties and disposing of them under an on-site cap and achieving recreational risk levels elsewhere in OU 1.
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.	This alternative will meet these standards by removing contaminants that pose carcinogen risks in the residential properties and disposing of them under an on-site cap and achieving recreational risk levels elsewhere in OU 1.
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 of assessing cancer risks to children.	This alternative will meet these standards by removing contaminants that pose carcinogen risks to children in the residential properties and disposing of them under an on-site cap and achieving recreational risk levels elsewhere in OU 1.
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.	This alternative will meet these standards by removing contaminants that pose carcinogen risks in the residential properties and disposing of them under an on-site cap and achieving recreational risk levels elsewhere in OU 1.

Table 4.3-2
Chemical-Specific ARARs and TBCs for Alternative CMS3

In-place closure of the Tailings Impoundment with treatment of the horizontal drain discharge in a passive wetland; Excavation of WRP-3, Ore Pad, and Mine Ops Area Source Material along with the lead and arsenic contaminated waste from the residential use area of the Site and consolidation and capping of this material in a separate waste cell with a low permeability cover system; and Off-Site Disposal of PCBs and Petroleum-Contaminated Soil and Dredging and disposal of Sediment in a CAD cell in the former 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.	This alternative will meet this standard by excavating lead-impacted soil exceeding adult risk levels in the residential properties and disposing of the soil on-site under a cap.
State	Soil	Maine Solid Waste Rules, Lead Management Regulations [06-096 CMR Chapter 424]	Relevant and Appropriate	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 areas that exceeds 375 ppm will be will be excavated and capped on-site so that the residential area soil 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 Maine Department of Environmental Protection (Maine 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. Includes standards for copper and zinc that do not have federal standards.	This alternative will meet these standards by capping wastes that exceed these standards in the Tailing Impoundment area, treating runoff from the capped area in a treatment wetland, disposing of all contaminated sediments in the CAD cell, and consolidating all other contaminated soils within OU1 under an on-site cap.

Table 4.3-2
Chemical-Specific ARARs and TBCs for Alternative CMS3

Prepared by: LJ 03/18/2009
Checked by: SWR 06/17/2009

Notes:

ARAR	=	Applicable or Relevant and Appropriate Requirement
CFR	=	Code of Federal Regulations
CMR	=	Code of Maine Regulations
CSF	=	Cancer Slope Factor
Maine DEP	=	Maine Department of Environmental Protection
ppm	=	parts per million
RfD	=	Risk Reference Dose
USEPA	=	U.S. Environmental Protection Agency

Table 4.3-3
Action-Specific ARARs and TBCs for Alternative CMS3

In-place closure of the Tailings Impoundment with treatment of the horizontal drain discharge in a passive wetland; Excavation of WRP-3, Ore Pad, and Mine Ops Area Source Material along with the lead and arsenic contaminated waste from the residential use area of the Site and consolidation and capping of this material in a separate waste cell with a low permeability cover system; and Off-Site Disposal of PCBs and Petroleum-Contaminated Soil and Dredging and disposal of Sediment in a 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 CFR 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, particularly from the treatment wetland, shall meet these substantive discharge standards. 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) [40 CFR761.61(c)] PCB Remediation Waste	Applicable	This section of TSCA 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. The Proposed Plan will include a finding by the Director, Office of Site Remediation and Restoration, that the cleanup level selected meets these standards for protectiveness.
Federal	Off-site 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 stored, transported, and disposed of in accordance with these standards.

Table 4.3-3
Action-Specific ARARs and TBCs for Alternative CMS3

In-place closure of the Tailings Impoundment with treatment of the horizontal drain discharge in a passive wetland; Excavation of WRP-3, Ore Pad, and Mine Ops Area Source Material along with the lead and arsenic contaminated waste from the residential use area of the Site and consolidation and capping of this material in a separate waste cell with a low permeability cover system; and Off-Site Disposal of PCBs and Petroleum-Contaminated Soil and Dredging and disposal of Sediment in a CAD cell in the former mine pit

Regulatory Authority	Action	Requirement	Status	Requirement Synopsis	Actions to be Taken to Attain Requirement
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	Used to establish water quality standards for the protection of aquatic life.	Standards to 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, and other remedial activities.
Federal	Groundwater	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	Establishes maximum contaminant levels (MCLs) for common organic and inorganic contaminants applicable to public drinking water supplies. Used as relevant and appropriate cleanup standards for aquifers and surface water bodies that are potential drinking water sources.	Establish standards for groundwater monitoring for the on-site capped areas to make sure the capping remedy remains protective of groundwater.
Federal	Groundwater	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	Establishes 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.	Establish standards for groundwater monitoring for the on-site capped areas to make sure the capping remedy remains protective of groundwater.

Table 4.3-3
Action-Specific ARARs and TBCs for Alternative CMS3

In-place closure of the Tailings Impoundment with treatment of the horizontal drain discharge in a passive wetland; Excavation of WRP-3, Ore Pad, and Mine Ops Area Source Material along with the lead and arsenic contaminated waste from the residential use area of the Site and consolidation and capping of this material in a separate waste cell with a low permeability cover system; and Off-Site Disposal of PCBs and Petroleum-Contaminated Soil and Dredging and disposal of Sediment in a CAD cell in the former mine pit

Regulatory Authority	Action	Requirement	Status	Requirement Synopsis	Actions to be Taken to Attain Requirement
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. 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.	Establish standards for groundwater monitoring for the capped areas on site to assess the protectiveness of the caps.
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	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 CFR Part 761.	The cleanup and off-site disposal of PCB contaminated soil will be performed in a manner to comply with TSCA.
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.

Table 4.3-3
Action-Specific ARARs and TBCs for Alternative CMS3

In-place closure of the Tailings Impoundment with treatment of the horizontal drain discharge in a passive wetland; Excavation of WRP-3, Ore Pad, and Mine Ops Area Source Material along with the lead and arsenic contaminated waste from the residential use area of the Site and consolidation and capping of this material in a separate waste cell with a low permeability cover system; and Off-Site Disposal of PCBs and Petroleum-Contaminated Soil and Dredging and disposal of Sediment in a CAD cell in the former mine pit

Regulatory Authority	Action	Requirement	Status	Requirement Synopsis	Actions to be Taken to Attain Requirement
State	Remediation of metallic mining sites	Maine Metallic Mineral Exploration, Advanced Explorations, and Mining [06-096 CMR 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 woodwaste, 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.	This alternative would meet the substantive portions of these regulations for reclamation, closure, and post-closure activities by capping waste in the Tailing Impoundment area, use of a treatment wetland for runoff, and disposing contaminated sediment into the CAD cell and consolidating all other contaminated soil in OU1 under an on-site cap.
State	Off-site 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 CMR 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	Off-site disposal of hazardous waste	Maine Hazardous Waste Management Rules - Requirements for Generators (38 M.R.S.A. §§ 1301 *et seq.*; 06-096 CMR 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 stored, transported, and disposed of in accordance with these standards.
State	Management of land clearing debris and woodwaste	Maine Solid Waste Management Rules [06-096 CMR Chapter 400-409]	Applicable if encountered	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 4.3-3
Action-Specific ARARs and TBCs for Alternative CMS3

In-place closure of the Tailings Impoundment with treatment of the horizontal drain discharge in a passive wetland; Excavation of WRP-3, Ore Pad, and Mine Ops Area Source Material along with the lead and arsenic contaminated waste from the residential use area of the Site and consolidation and capping of this material in a separate waste cell with a low permeability cover system; and Off-Site Disposal of PCBs and Petroleum-Contaminated Soil and Dredging and disposal of Sediment in a 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 Maine Revised Statutes Annotated (M.R.S.A.) Section 413 *et seq.*] and Waste Discharge Permitting Program [06-096 CMR Chapter 520-529]	Applicable	This rule requires permits issued by Maine Department of Environmental Protection for the discharge of pollutants from point sources.	All substantive requirements of this regulation 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 they do 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 on-site cap, treatment wetland, and CAD cell will also be conducted.

Table 4.3-3
Action-Specific ARARs and TBCs for Alternative CMS3

In-place closure of the Tailings Impoundment with treatment of the horizontal drain discharge in a passive wetland; Excavation of WRP-3, Ore Pad, and Mine Ops Area Source Material along with the lead and arsenic contaminated waste from the residential use area of the Site and consolidation and capping of this material in a separate waste cell with a low permeability cover system; and Off-Site Disposal of PCBs and Petroleum-Contaminated Soil and Dredging and disposal of Sediment in a 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 Toxics Program [38 M.R.S.A. Sec. 420; 06-096 CMR Chapter 530]	Applicable	These rules set forth the National Recommended 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 they do 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 on-site cap, treatment wetland, and CAD cell will also be conducted.
State	Actions that may degrade surface water quality	Maine Surface Water Quality Criteria for Toxic Pollutants [06-096 CMR Chapter 584]	Applicable	Except as naturally occur, levels of toxic pollutants in surface waters must not exceed federal water quality criteria as established by the U.S. environmental Protection Agency (USEPA), pursuant to Section 304(a) of the Clean Water Act, or alternative criteria.	Site activities will be designed and implemented in a manner that they do 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 on-site cap, treatment wetland, and CAD cell will also be conducted.
State	Shellfishing ban	Closed Area No. 36, Bagaduce River and Harborside (Castine, Penobscot, Brooksville) [DMR Chapter 95.04(C)]	Applicable	State ban, because of pollution, on digging, taking, or possessing any clams, quahogs, oysters, or mussels taken from the flats and waters of Goose Cove or Goose Pond.	State shellfishing ban has been established due to site contamination. Such ban will need to remain in effect for site contamination until cleanup levels are achieved.

Table 4.3-3
Action-Specific ARARs and TBCs for Alternative CMS3

In-place closure of the Tailings Impoundment with treatment of the horizontal drain discharge in a passive wetland; Excavation of WRP-3, Ore Pad, and Mine Ops Area Source Material along with the lead and arsenic contaminated waste from the residential use area of the Site and consolidation and capping of this material in a separate waste cell with a low permeability cover system; and Off-Site Disposal of PCBs and Petroleum-Contaminated Soil and Dredging and disposal of Sediment in a CAD cell in the former mine pit

Regulatory Authority	Action	Requirement	Status	Requirement Synopsis	Actions to be Taken to Attain Requirement
State	Quarrying of rock	Performance Standards For Quarries [38 M.R.S.A. Section 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 a reclamation cover, these standards will be complied with.
State	Activities that expose soil with potential for erosion	Maine Erosion and Sedimentation Control [38 M.R.S.A. Section 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 4.3-3
Action-Specific ARARs and TBCs for Alternative CMS3

In-place closure of the Tailings Impoundment with treatment of the horizontal drain discharge in a passive wetland; Excavation of WRP-3, Ore Pad, and Mine Ops Area Source Material along with the lead and arsenic contaminated waste from the residential use area of the Site and consolidation and capping of this material in a separate waste cell with a low permeability cover system; and Off-Site Disposal of PCBs and Petroleum-Contaminated Soil and Dredging and disposal of Sediment in a 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. Section 420-D], Maine Storm Water Management Rules [06 096 CMR Chapter 500], and Direct Watershed of Waterbodies Most at Risk from New Development [06-096 CMR 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 excavation of all upland OU1 contaminated material to be disposed of under the on-site caps and construction of the caps and treatment wetland.
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.
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.

Table 4.3-3
Action-Specific ARARs and TBCs for Alternative CMS3

Prepared by: LJ 03/18/2009
Checked by: SWR 06/17/2009

Notes:

ARAR	=	Applicable or Relevant and Appropriate Requirement
CERCLA	=	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	=	Code of Federal Regulations
CMR	=	Code of Maine Regulations
IDW	=	Investigation-Derived Waste
Maine 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
USC	=	United States Code
USEPA	=	U.S. Environmental Protection Agency

Table 4.3-4
Estimated Heavy Truck Traffic for Alternative CMS3 [1]

Activity	Volume or Quantity of Material [2]		Number of Trucks	Number of Trips per Truck	Total Number of Trips
Tandem-Axle Dump Trucks [3]					
Off-Site Disposal of Petroleum Contaminated Soils	800	lcy	58	2	116
Residential Lot Restoration, Common Borrow import	2,365	lcy	169	2	338
Residential Lot Restoration, Topsoil import	575	lcy	42	2	84
Mine Ops, Off-Site Disposal of PCB Contaminated Material	2,406	lcy	172	2	344
Tandem-Axle Dump Truck Trip Subtotal					**882**
Tractors and Haul Trailers [4]					
General Equipment Mobilization, dozers	2	ea	2	4	8
General Equipment Mobilization, excavators	3	ea	3	4	12
General Equipment Mobilization, compactors	2	ea	2	4	8
General Equipment Mobilization, tandem axle dump trucks for on-site hauling	8	ea	8	2	16
Tailings Impoundment, geomembrane delivery	30	rolls	1	2	2
Tailings Impoundment, geocomposite delivery	290	rolls	3	2	6
Tailings Impoundment, treatment wetland composted organic matter	9,036	lcy	452	2	904
WRP1, geomembrane delivery	16	rolls	1	2	2
WRP1, geocomposite delivery	154	rolls	2	2	4
Tractors and Haul Trailers Trip Subtotal					**962**
Miscellaneous Construction Equipment [5]					
General Mobilization, equipment maintenance, and misc. equipment and supply delivery	-	-	52	2	104
General Mobilization, Quarry Rock Crushers (assume 2)	-	-	2	2	4
Tailings Impoundment, horizontal directional drilling	-	-	1	2	2
Residential Lot Restoration, Hydroseed tanker	-	-	3	2	6
Residential Lot Restoration, misc. structure repair/replacement	-	-	5	2	10
Mobilization of hydraulic dredging equipment	-	-	4	2	8
Wetland Mitigation, General Restoration, hydroseeder tanker	-	-	4	2	8
Miscellaneous Equipment Trip Subtotal					**142**
TOTAL CONSTRUCTION TRUCK TRIPS					**1,986**

Notes:

1 = Number and type of trucks traveling over local public roads during execution of the work.

2 = "loose cubic yards"

3 = Assumes 14 cy dump trucks.

4 = Assumes heavy haul trailers for equipment delivery and 20 cy semi dump trailers for material delivery

5 = Does not include delivery of daily supplies, FedEx, Fuel, etc.

Prepared by: JPMcCrady, 6/16/2009
Checked by: SWReed, 6/16/2009

Table 4.3-5
Cost Summary for Alternative CMS3

	ITEM	COST
CAPITAL COSTS		
4.1	Pre-Design Studies	$330,000
4.2	General Construction Costs Common to all Components of Work	$845,000
4.3	Tailings Impoundment Improvements	$4,331,000
4.4	Waste Rock Pile No. 3 (WRP3)	$1,652,000
4.5	Ore Pad and Mine Operations Area (Mine Ops, Etc.)	$3,655,000
4.6	Residential Lots	$314,000
4.7	PCB Soils	$587,000
4.8	Sediment Dredging of Goose Pond and Salt Marsh	$2,124,000
4.9	Wetland Mitigation	$1,245,000
4.10	Institutional Controls	$31,000
4.11	Monitoring Well Installation	$31,000
4.12	Long-term Monitoring Plan	$66,000
	Direct Cost Subtotal	$15,215,000
	Contingency Cost (@30 Percent)	$4,564,500
	Direct and Contingency Cost Subtotal	$19,779,500
4.13	Indirect Capital Costs (Engineering, Design, Construction Mgmt, and PMgmt)	$4,352,000
	TOTAL CAPITAL COSTS	**$24,131,500**
LONG-TERM OPERATION, MAINTENANCE, AND MONITORING COST		
4.14	Long-Term Operation and Maintenance	
	Annual Inspection and Site Summary Report, Per Event, Nominal	$10,700
	Constructed Wetland (5-yr event)	$87,600
	Salt Marsh (years 1, 3 , 5, 10)	$7,300
	Tailings Impoundment Cap and Stormwater System (5-yr event)	$70,900
	Tailings Impoundment Cap (25-yr event)	$210,700
4.15	Long-Term Environmental Monitoring, Per Event, Nominal	
	Semi-Annual Constructed Wetland Inf/Eff (year 1)	$24,800
	Annual Constructed Wetland Inf/Eff (years 2-100)	$12,400
	Annual Groundwater (years 1-2)	$18,800
	Annual Groundwater (years 3-10)	$18,800
	Annual Groundwater (years 15, 20, 25, …, 100)	$18,800
	Semi-Annual Surface Water (years 1-2)	$36,600
	Annual Surface Water (years 3 -10, 15, 20, 25, …, 100)	$18,300
	Sediment Monitoring (every 5 years)	$13,500
	Periodic Clam Tissue (years 3, 4, 5, 10, 15, 20, 25, …, 100)	$9,100
	Five Year Review (every 5 years)	$27,000

Table 4.3-5
Cost Summary for Alternative CMS3

ITEM	COST
TOTAL LONG-TERM OPERATION, MAINTENANCE, AND MONITORING PW COSTS, 30-YEARS, 7% (See Note 3)	$1,324,000
TOTAL LONG-TERM OPERATION, MAINTENANCE, AND MONITORING PW COSTS, 100-YEARS, 2.7% (See Note 3)	$3,398,000
TOTAL LONG-TERM OPERATION, MAINTENANCE, AND MONITORING NOMINAL COSTS, 100-YEARS (See Note 3)	$9,718,000
TOTAL COST (CAPITAL + LONG TERM PV, 30-YR, 7%)	$25,455,500
TOTAL COST (CAPITAL + LONG TERM PV, 100-YR, 2.7%)	$27,529,500
TOTAL COST (CAPITAL + LONG TERM NOMINAL, 100-YR)	$33,849,500

Prepared by: JPMcCrady, 6/16/2009
Checked by: SWReed, RSEgan, 6/16/2009

Notes:

1. PV = Present Value
2. Compensatory wetland mitigation requirements have not been established and may not be necessary. If mitigation is not required, capital and long-term costs will be reduced.
3. Includes project management and technical support as a percentage of operation, maintenance, and monitoring costs. See PV Cost sheet.

Table 5.2-1
Comparative Analysis of Alternatives

Evaluation Criteria	Alternative CMS1	Alternative CMS2	Alternative CMS3
Overall Protection of Human Health and the Environment	Poor. Would not be protective of human health and environment. Would not: reduce, control, or eliminate human exposure to contaminants exceeding PRGs at residential use areas; address contaminant source areas; or prevent, reduce, or control ecological exposure to contaminants exceeding PRGs in sediment and salt marsh areas.	Good. Would be protective of human health and environment. Would prevent human exposure to contaminants exceeding PRGs at residential use areas; address contaminant source areas; and control ecological exposure to contaminants exceeding PRGs in sediment and salt marsh areas. No significant difference among CMS2 and CMS3.	Good. Would be protective of human health and environment. Would prevent human exposure to contaminants exceeding PRGs at residential use areas; address contaminant source areas; and control ecological exposure to contaminants exceeding PRGs in sediment and salt marsh areas. No significant difference among CMS2 and CMS3.
Attainment of ARARs	Would not attain ARARs pertaining to management of mine waste or PCBs, or protection of water quality.	Would be designed to attain ARARs pertaining to management of mine waste and PCBs and protection of wetlands. Source control actions would be designed to protect groundwater and surface water quality. No significant difference among CMS2 and CMS3.	Would be designed to attain ARARs pertaining to management of mine waste and PCBs and protection of wetlands. Source control actions would be designed to protect groundwater and surface water quality. No significant difference among CMS2 and CMS3.

Table 5.2-1
Comparative Analysis of Alternatives

Evaluation Criteria	Alternative CMS1	Alternative CMS2	Alternative CMS3
Long-term Effectiveness and Permanence	Poor. No actions would be taken to provide long-term effectiveness or permanence in protecting human health and the environment. No action would be taken to enhance the long-term stability of the Tailings Impoundment.	Good. Capping of Tailings Impoundment and disposal of source material and sediments in mine pit would provide reliable, long-term effectiveness in protecting human health and the environment. The mine pit would provide maintenance-free long-term containment. The Tailings Impoundment cover would be designed to improve the long-term stability FOS of the Tailings Impoundment. Excavation of WRP-3 would improve its FOS.	Good. Capping of Tailings Impoundment and disposal of sediments in mine pit would provide reliable, long-term effectiveness in protecting human health and the environment. The mine pit would provide maintenance-free long-term containment of sediment. The Tailings Impoundment cover would be designed to improve the long-term stability FOS of the Tailings Impoundment. Excavation of WRP-3 would improve its FOS. Consolidation of large volumes of source material at WRP-1 would raise concerns about the long-term stability of the WRP-1 berm that would need to be addressed in the design phase. Consolidation at WRP-1 is considered to have less long-term effectiveness and permanence than disposal in mine pit.
Reduction of Toxicity, Mobility, and Volume Through Treatment	Would not satisfy CERCLA's statutory preference for reduction of toxicity, mobility, and volume of waste through treatment.	Would reduce the mobility of contaminants in Tailings Impoundment seeps in a treatment wetland; however, this alternative relies primarily on removal, containment, and isolation to control source areas and reduce exposure. This alternative would not satisfy CERCLA's statutory preference for treatment as a principal component of remedial action.	Would reduce the mobility of contaminants in Tailings Impoundment seeps in a treatment wetland; however, this alternative relies primarily on removal, containment, and isolation to control source areas and reduce exposure. This alternative would not satisfy CERCLA's statutory preference for treatment as a principal component of remedial action.

Table 5.2-1
Comparative Analysis of Alternatives

Evaluation Criteria	Alternative CMS1	Alternative CMS2	Alternative CMS3
Short-term Effectiveness	Poor. No actions would be taken that would present short-term risks to community or environment; however, no actions would be taken to reduce, control, or eliminate existing risks.	Short-term risks include continued exposure of seasonal residents to residential lot soil and continued exposure of ecological receptors to contaminated sediment and salt marsh during remedy implementation, and risks to construction workers during implementation. Construction of Tailings Impoundment cover and treatment wetland would create truck traffic to deliver construction materials (e.g., geomembrane, geocomposite, and treatment media) that cannot be obtained on-site. Dredging would result in adverse short-term effects to salt marsh and Goose Pond. Construction of treatment wetland would result in adverse effects to existing salt marsh.	Short-term risks include continued exposure of seasonal residents to residential lot soil and continued exposure of ecological receptors to contaminated sediment and salt marsh during remedy implementation, and risks to construction workers during implementation. Construction of Tailings Impoundment cover and treatment wetland would create truck traffic to deliver construction materials (e.g., geomembrane, geocomposite, and treatment media) that cannot be obtained on-site. Increased quarrying and construction activities, compared to Alternative CMS2, for cap at WRP-1 would pose greater risks to construction workers during implementation. Increased quarrying would also adversely affect greater area of habitat than Alternative CMS-2. Dredging would result in adverse short-term effects to salt marsh and Goose Pond. Construction of treatment wetland would result in adverse effects to existing salt marsh.

Table 5.2-1
Comparative Analysis of Alternatives

Evaluation Criteria	Alternative CMS1	Alternative CMS2	Alternative CMS3
Implementability	Technical: good. No action to implement. Administrative: very poor. No action would be taken to protect human health or the environment, attain ARARs, or manage migration of contaminants. Approach would be unacceptable to regulatory agencies.	Technical: good. Proposed actions, although large-scale, would be technically easy to implement. Services and equipment readily available. Construction of Tailings Impoundment cap would require large volume of soil/crushed stone not currently available on or near Site. On-site quarrying would be performed to obtain material. Administrative: good. Alternative would protect human health and environment and improve long-term stability of Tailings Impoundment. Implementation of alternative would require regulatory approval of an innovative cover system design and of detailed plans for mitigation of altered wetlands.	Technical: good. Proposed actions, although large-scale, would be technically easy to implement. Services and equipment readily available. Construction of Tailings Impoundment and WRP-1 caps would require a greater volume of soil/crushed stone than Alternative CMS2 and which is not currently available on or near Site. On-site quarrying would be performed to obtain material. It is possible that available space at WRP-1 would not hold all material proposed for consolidation; remainder would go to Tailings Impoundment or to mine pit. Geotechnical evaluation would be required to confirm the ability to safely consolidate material at WRP-1. Administrative: good. Alternative would protect human health and environment and improve long-term stability of Tailings Impoundment. Implementation of alternative would require regulatory approval of an innovative cover system design and of detailed plans for mitigation of altered wetlands.
Cost	Capital cost: $0 Total PW (30 yrs @ 7%): $19,000 Total PW (100 yrs @ 2.7%): $56,000 Total long-term cost (100 yrs): $171,000	Capital cost: $21,515,800 Total PW (30 yrs @ 7%): $22,839,800 Total PW (100 yrs @ 2.7%): $24,913,800 Total long-term cost (100 yrs): $31,233,800	Capital cost: $24,131,500 Total PW (30 yrs @ 7%): $25,455,500 Total PW (100 yrs @ 2.7%): $27,529,500 Total long-term cost (100 yrs): $33,849,500

Prepared by/ Date: SWR 03/19/09
Checked by/ Date: JEB 03/23/09
Checked by/ Date: SWR 06/17/09

APPENDIX A

Hydrodynamic Modeling Technical Memorandum

81 Technology Park Dr., E. Falmouth, MA 02536
www.woodsholegroup.com

TECHNICAL MEMORANDUM

Date: October 24, 2008
To: MACTEC, Inc.
From: Woods Hole Group, Inc.
Re: Callahan Mining Site Additional Tasks 2 and 3
Modeling of Potential Future Hydrodynamic Scenarios and
Analytical Sediment Transport Modeling of Goose Cove

The purpose of this technical memorandum is to present results of additional modeling tasks at the Callahan Mining Site. These additional modeling results were simulated to evaluate potential future hydrodynamic scenarios in the Goose Pond estuarine system, as well as assess the potential transport of contaminated sediments within Goose Cove.

Modeled scenarios presented herein represent potential future scenarios that may occur at the Goose Pond estuary. After performing the model simulations, the resulting impacts on the hydrodynamics and sediment transport potential within the Goose Pond system is subsequently evaluated. The following scenarios were evaluated using the calibrated/verified hydrodynamic model for Goose Pond:

- Removal of anthropogenic features at Goose Falls, the connection of Goose Pond and Goose Cove
- Complete erosion of the earthen dam in Marsh Creek
- Evaluation of the potential turnover of anoxic waters within Goose Pond

Woods Hole Group employed the 3-D hydrodynamic EFDC model developed for the Goose Pond Estuary (Woods Hole Group, 2008) to evaluate these potential future scenarios under the extreme storm conditions (e.g., 100-year rainfall and 100-year storm surge). The extreme storm condition cases had shown the most potential for sediment mobility near the earthen dam and the areas surrounding Goose Falls Dam (Woods Hole Group, 2008). In order to simulate the potential scenarios, the EFDC model domain was modified to remove the relevant flow obstructions, extreme storm forcing conditions were applied (both 100-year storm surge and precipitation events), and areas of the potential mobility of sediments were identified. The areas of potential sediment mobility/deposition were then compared with existing conditions to identify any increased potential for sediment transport caused by these future scenarios.

In addition, Woods Hole Group also developed of an analytical sediment transport model to further assess the movement of sediments within Goose Cove and to provide estimates of the potential extent of erosion/deposition. The sediment transport model incorporated known characteristics of the natural bed sediments within Goose Cove and hydrodynamic results

obtained from the 3-D numerical model, and represents an analytical step towards a fully numerical sediment transport model. Estimates of sediment erosion/deposition rates were calculated for normal (spring) tidal conditions as well as for the 100-year return period storm surge event. This allowed for average scour depths to be computed for a range of forcing conditions. As such, the model provided a first-order assessment of the exposure of contaminated sediments at different depth layers within Goose Cove.

MODIFICATIONS TO EFDC MODEL DOMAIN

In order to simulate the removal of the Goose Falls Dam and the earthen dam in Marsh Creek, two separate EFDC model domains were created. For both scenarios, the spatial extent of the model domain was modified. In addition, the model bathymetry was adjusted in these areas to create a channel bed that would most likely naturally occur, if these flow control structures were eroded (earthen dam) or removed (Goose Falls Dam).

Figure 1 shows the northern portion of the first adjusted EFDC model grid for the scenario where the Goose Falls Dam is eroded and Goose Cove connects with Goose Pond. This figure also shows color contours of bathymetry for water depths less than 3 meters, relative to MSL. For this scenario, the Goose Falls Dam restriction was completely removed, as well as a portion of the road and land that extended to the southwest from the structure. Although it is unlikely that a complete removal of both anthropogenic and natural features would occur, this scenario does represent the worst case scenario in terms of tidal exchange, velocities, and volumetric flux in the Goose Cove area (and subsequently sediment exposure in Goose Cove). Additional model simulations were conducted for cases with removal of only the anthropogenic features of the Goose Falls Dam (e.g., bridge abutments); however, velocity and sediment transport results within Goose Cove were similar to the worst-case scenario for the 100-year extreme events presented herein. Therefore, the worst-case scenario is a conservative, yet reasonable, representation of the velocity, scour, and erosion potential that could occur in Goose Cove under storm conditions with the anthropogenic features at Goose Falls Dam removed.

Figure 2 shows the southern portion of the second EFDC model grid, adjusted for the scenario where the earthen dam in Marsh Creek is eroded. Color contours of bathymetry are also shown in Figure 2 for water depths less than 3 meters, relative to MSL. For this potential future scenario, water cells were added to the grid domain in the area of the remaining earthen dam restriction. The newly added water cells were given an elevation of approximately 0 meters relative to MSL to allow for a transition from the higher elevations lying south of the removed restriction.

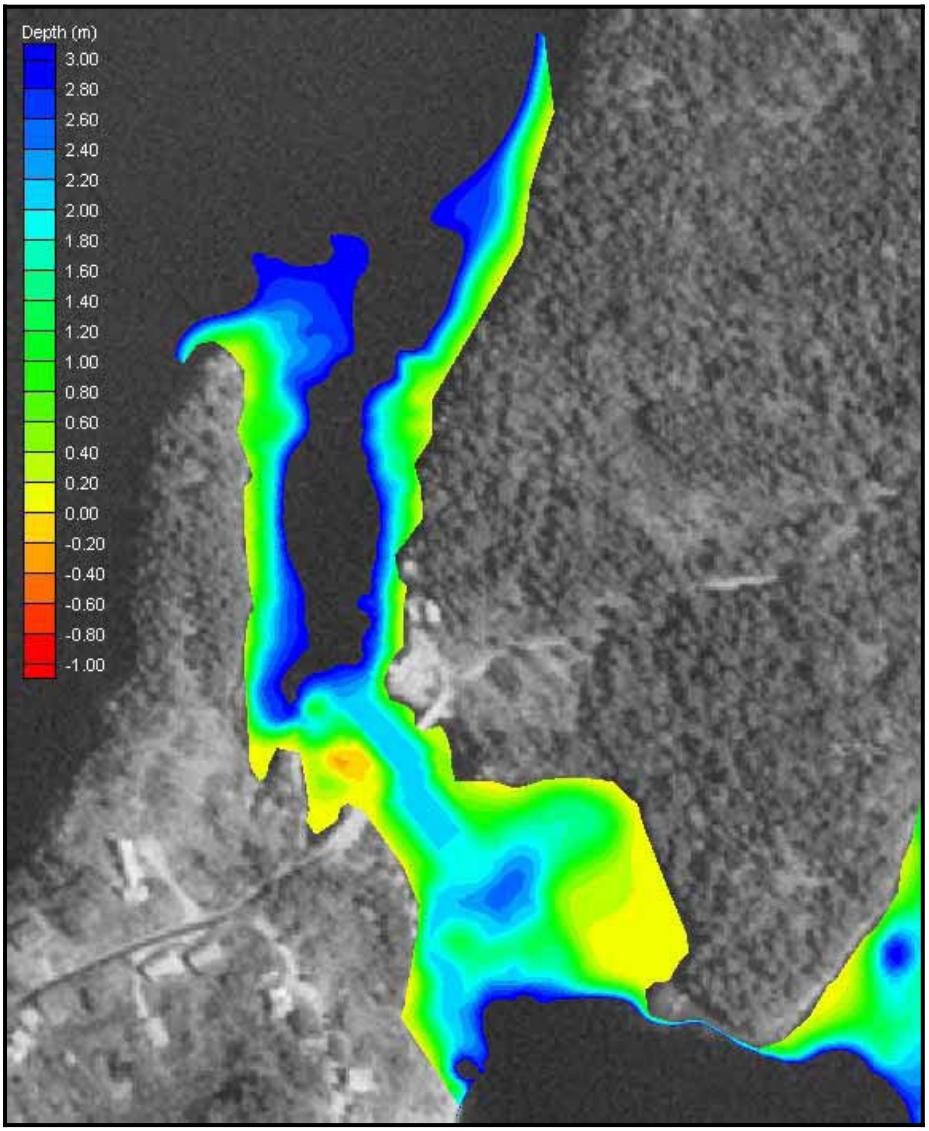

Figure 1. **Adjusted EFDC model grid (upper portion) showing bathymetry contours for scenario where the Goose Falls Dam is eroded and Goose Cove connects to Goose Pond.**

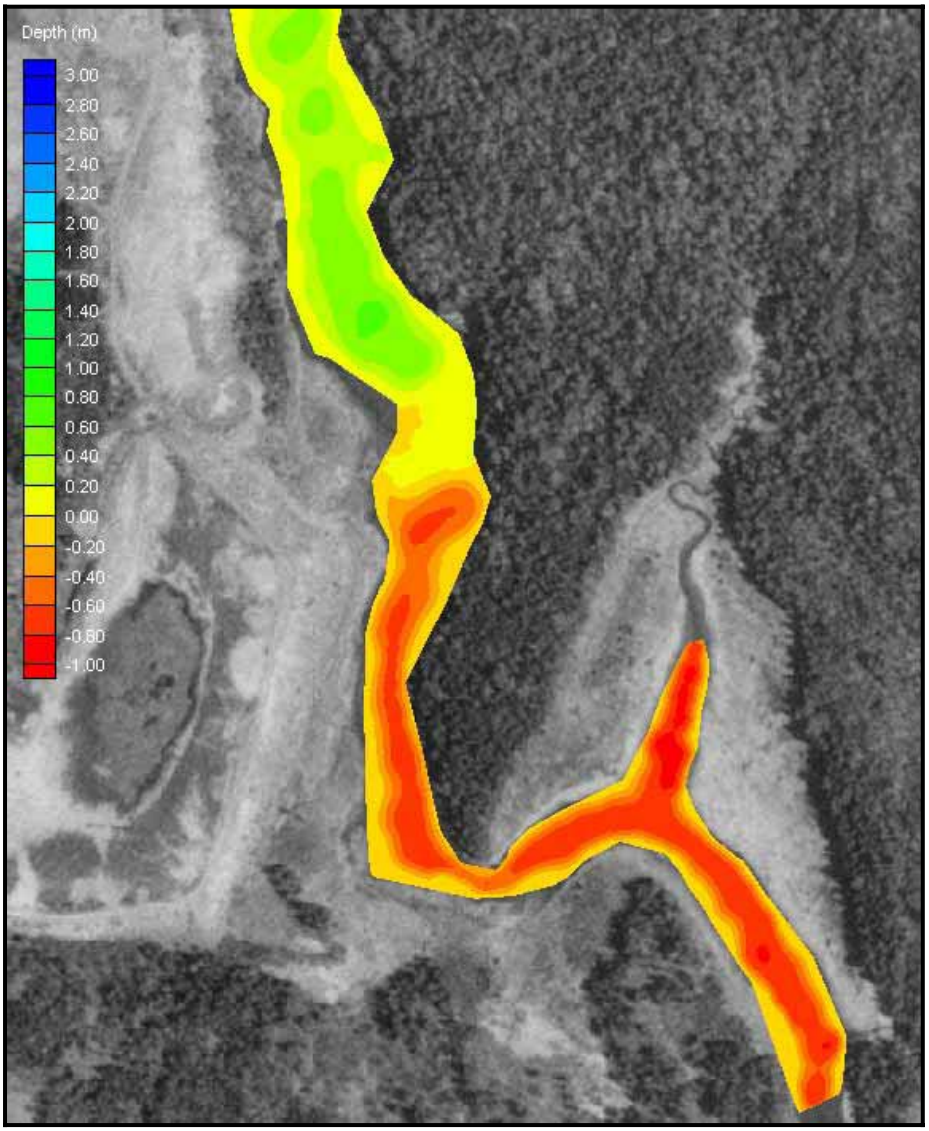

Figure 2. Adjusted EFDC model grid (lower portion) showing bathymetry contours for scenario where the remaining portion of the earthen dam in Marsh Creek is eroded.

MODELING OF POTENTIAL FUTURE SCENARIOS

The potential future scenarios were evaluated using the modified EFDC model domains. For the first two scenarios, the intent was to determine the "worst-case scenario" or the maximum potential for the mobility of sediments within the Goose Pond Estuary. Therefore, these potential future scenarios were simulated under extreme storm conditions. The extreme storms induce the most significant current velocities within the system and showed the most potential for the initiation of sediment transport (Woods Hole Group, 2008). The potential for sediment transport was then quantified for the extreme flow conditions using a first level assessment based on Shield's criterion for the initiation of sediment mobility, as was complete in the existing conditions calculations (Woods Hole Group, 2008). More information regarding the model input conditions for the extreme storms and the methodology used to determine the initiation of sediment mobility can be found in the Woods Hole Group 2008 Report.

Removal of Goose Falls Dam

The first future scenario evaluated was the complete removal of Goose Falls Dam. Although the relative likelihood of the complete removal of the dam is unlikely, this scenario was evaluated to determine the potential impacts on the system by introducing a much greater tidal signal into the estuary and evaluate the potential exposure of contaminated sediments. As discussed, this worst-case scenario is a conservative, yet reasonable, representation of the velocity, scour, and erosion potential that could occur in Goose Cove under storm conditions with the anthropogenic features at Goose Falls Dam removed. Ultimately, in order to increase scour in the Goose Cove region, the ebb tidal jet (Woods Hole Group, 2008) must spatially increase through expansion of the Goose Falls Dam constriction. Therefore, this scenario evaluated a larger connection from Goose Cove to Goose Pond (through removal of the anthropogenic features), and was specifically evaluated for a 100-year storm surge event. In the previous simulations of existing conditions, the 100-year storm surge event was shown to have the greatest influence on current velocities in the areas surrounding the Goose Falls Dam.

After simulation of the 100-year storm surge on the refined model domain, the maximum flood and ebb bottom currents that were encountered during the tidal cycle were determined. Additionally, the maximum bottom stresses were compared to the critical stress required for the initiation of sediment mobility throughout the Goose Pond Estuary model domain. The hydrodynamic and sediment transport potential results are presented in Figures 3 and 4, representing a simulation of the worst-case storm surge scenario.

The color contours of the maximum bottom current magnitude encountered during a 100-year storm surge event is depicted for the northern portion (left panel) and southern portion (right panel) of the Goose Pond Estuary in Figures 3 and 4. Flood and ebb tide conditions are presented in Figures 3 and 4, respectively. In these figures the scale was capped at 30 cm/s to better depict areas with increased velocities (the maximum current magnitudes encountered during the simulation exceed 125 cm/s).

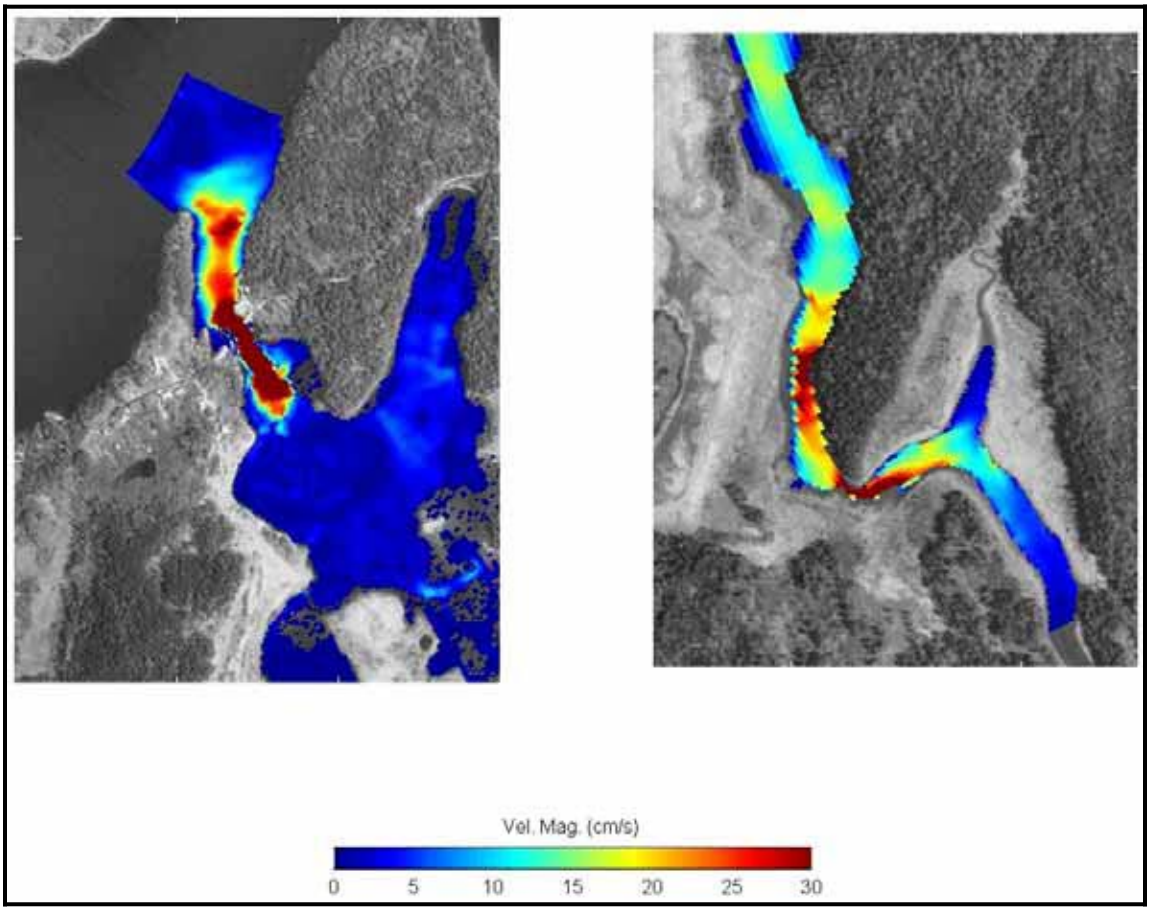

Figure 3. Maximum bottom current magnitudes simulated for the removal of Goose Falls Dam scenario, within the northern portion (left panel) and southern portion (right panel) of Goose Pond Estuary during flood conditions of a 100-year storm surge event.

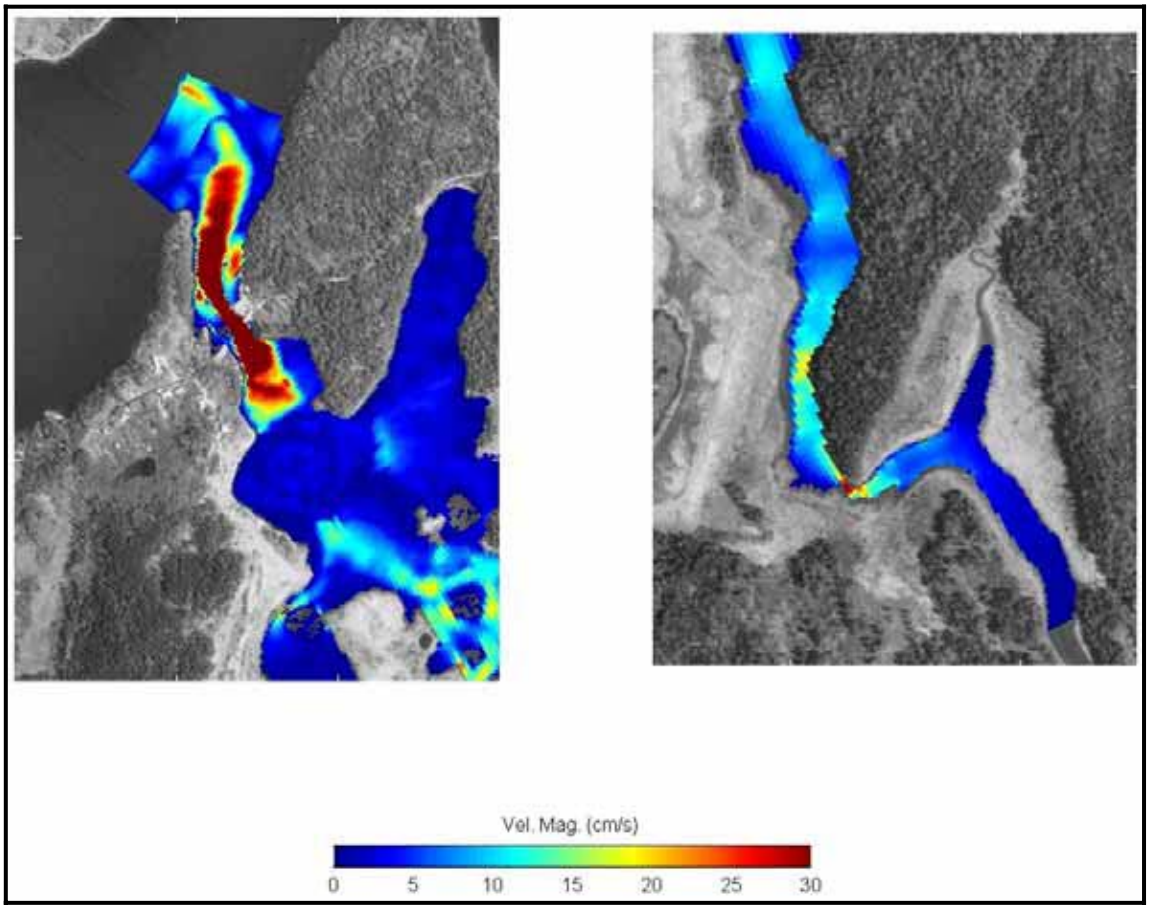

Figure 4. Maximum bottom current magnitudes simulated for the removal of Goose Falls Dam scenario, within the northern portion (left panel) and southern portion (right panel) of Goose Pond Estuary during ebb conditions of a 100-year storm surge event.

The results from the worst-case, simulated 100-year return period tidal surge event indicate that the removal of the Goose Falls Dam restriction, as expected, allows for the conveyance of more flow into Goose Pond and the estuarine system. The spatial extent of current velocities exceeding 30 cm/s is significant and covers a large portion of Goose Cove, as well as the channel connecting Goose Cove with Goose Pond, during both flood and ebb conditions. Velocities exceeding 30 cm/s also exist in the lower portion of the system, upstream of the former earthen dam, during flood conditions (Figure 3, right panel). Current velocities within the interior of the system, downstream of the earthen dam and upstream of the former mine pit, reach 20 cm/s in some areas during ebb conditions (Figure 4, left panel). Therefore, if a removal of the Goose Falls Dam were ever to occur, either by anthropogenic influence or natural causes, there would be a significant change in the velocities in the Goose Falls area, especially in the Goose Cove region.

The sediment mobility model results for the simulated 100-year storm surge event are presented in Figure 5 and Figure 6, for flood and ebb conditions, respectively. As was seen for existing conditions, the majority of the estuary is depositional (blue color). There are areas of erosion potential which are consistent with the areas showing higher current magnitudes. There is potential for erosion within the channel connecting Goose Cove with Goose Pond and into Goose Pond under flood conditions (Figure 5, left panel), and the highest potential for erosion within Goose Cove under ebb conditions (Figure 6, left panel). Potential areas of erosion in the southern portion of the estuary for the simulated 100-year storm surge exist under flood conditions (right panel of Figure 5) when the higher current velocities were shown to occur.

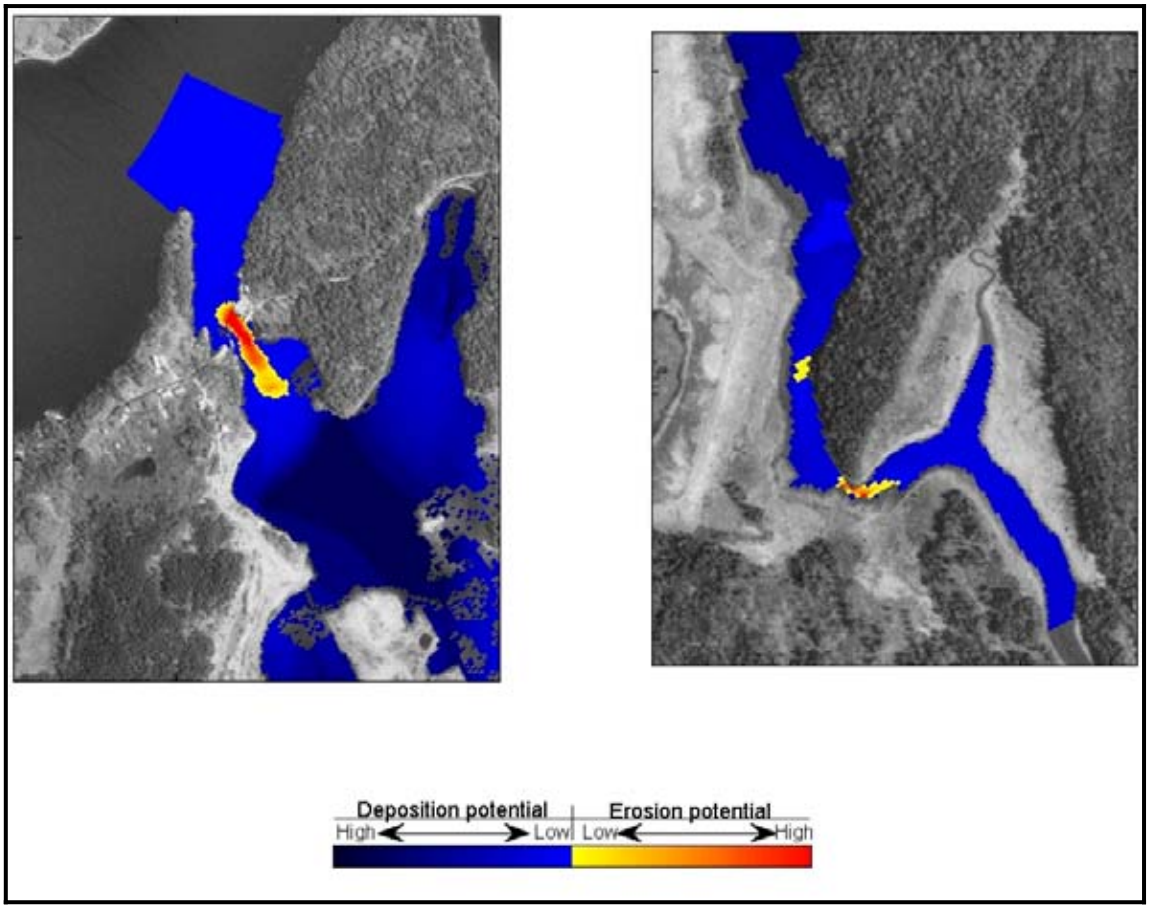

Figure 5. Sediment transport potential for the removal of Goose Falls Dam scenario, within the northern portion (left panel) and southern portion (right panel) of Goose Pond Estuary during flood conditions of a 100-year storm surge event.

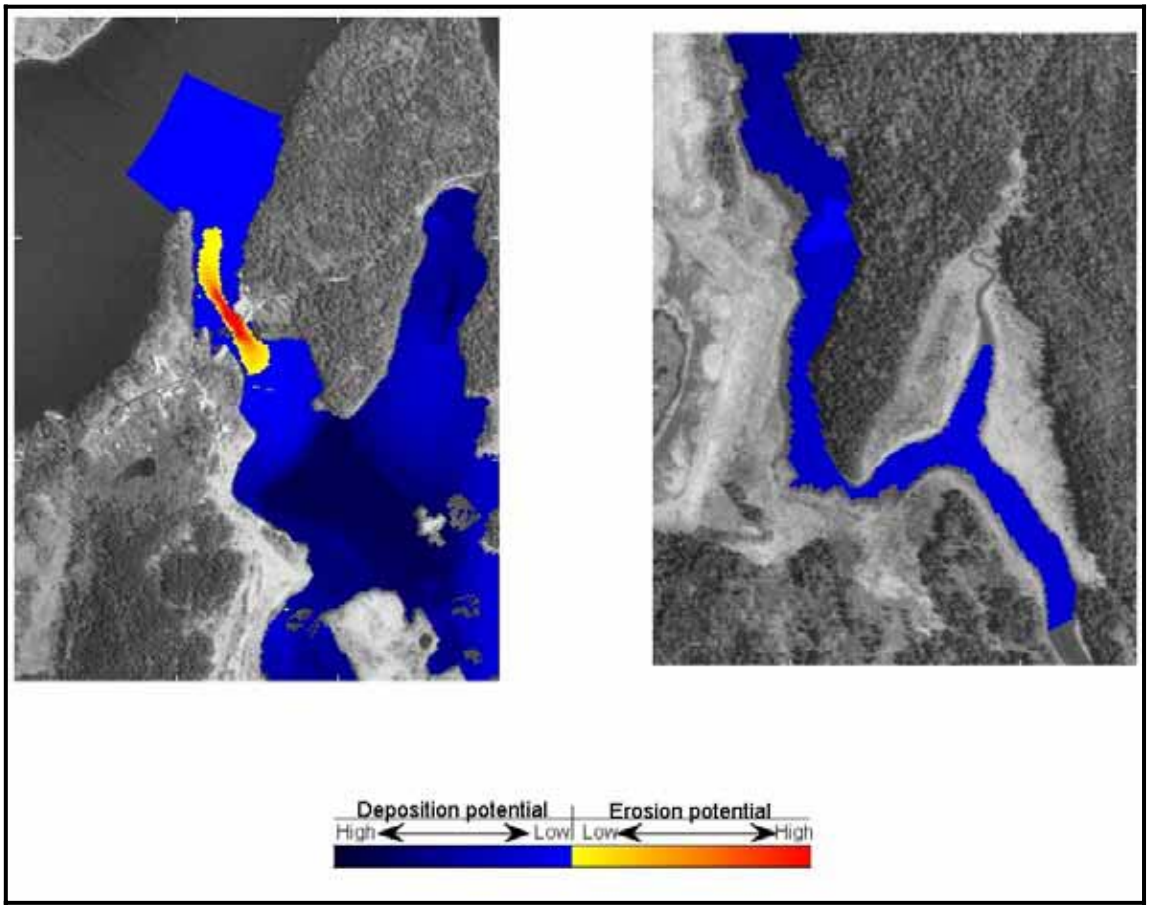

Figure 6. Sediment transport potential for the removal of Goose Falls Dam scenario, within the northern portion (left panel) and southern portion (right panel) of Goose Pond Estuary during ebb conditions of a 100-year storm surge event.

Erosion of Earthen Dam in Marsh Creek

The second future scenario evaluated was the complete erosion of the earthen dam in Marsh Creek. The relative likelihood of the complete erosion of this dam is feasible, considering impacts of rainfall events and spring freshet freshwater discharge events that will likely continue to erode the earthen dam. This potential scenario was evaluated under a 100-year precipitation event. Previous simulations of existing conditions showed the 100-year precipitation event induced the largest current velocities in the southern portion of the estuarine system, near the former earthen dam (Woods Hole Group, 2008).

Again, the maximum flood and ebb bottom currents that were encountered during the simulation with increased freshwater discharge were determined for the 100-year storm and the maximum bottom stresses were compared to the critical stress required for the initiation of sediment mobility throughout the Goose Pond Estuary model domain. The color contours of the maximum bottom current magnitude encountered during a 100-year precipitation event are depicted for the northern portion (left panel) and southern portion (right panel) of the Goose Pond Estuary in Figures 7 and 8. Figure 7 shows flood tide conditions while Figure 8 presents conditions during an ebb tide. Also, in these figures the upper limit of the scale was capped at 30 cm/s (the maximum current magnitudes encountered during the simulation exceed 170 cm/s).

The results from the simulated 100-year return period precipitation event indicate that for the scenario where the remaining portion of the earthen dam in Marsh Creek is removed, there are larger current magnitudes in Goose Cove, within the entrance to Goose Pond, as well as upstream of the eroded earthen dam. Similar to what was seen for existing conditions, a jet, having velocities exceeding 30 cm/s, forms both upstream and downstream of the Goose Falls restriction. A larger jet formation exists in Goose Cove on an ebb tide (Figure 8, left panel) due to the increased freshwater discharge. Velocities exceeding 30 cm/s exist in the smaller channels of the lower portion of the system (upstream of the eroded earthen dam), during both flood and ebb conditions (right panel of Figures 7 and 8).

The sediment mobility model results for the simulated 100-year precipitation event are presented in Figure 9 and Figure 10, for flood and ebb conditions, respectively. Again, as was seen for existing conditions, the majority of the estuary is depositional. There is increased potential for erosion within Goose Cove where the jet extending from Goose Falls was shown to occur. The largest area within Goose Cove having a potential for erosion exists under ebb conditions (Figure 10, left panel). A potential area of erosion exists in the southern portion of the estuary at the narrowest portion of the channel for the simulated 100-year precipitation event under both flood and ebb conditions (right panel of Figures 9 and 10). Ultimately, the erosion of the earthen dam in Marsh Creek does not significantly change the hydrodynamics and/or sediment transport potential within the Goose Pond estuary system.

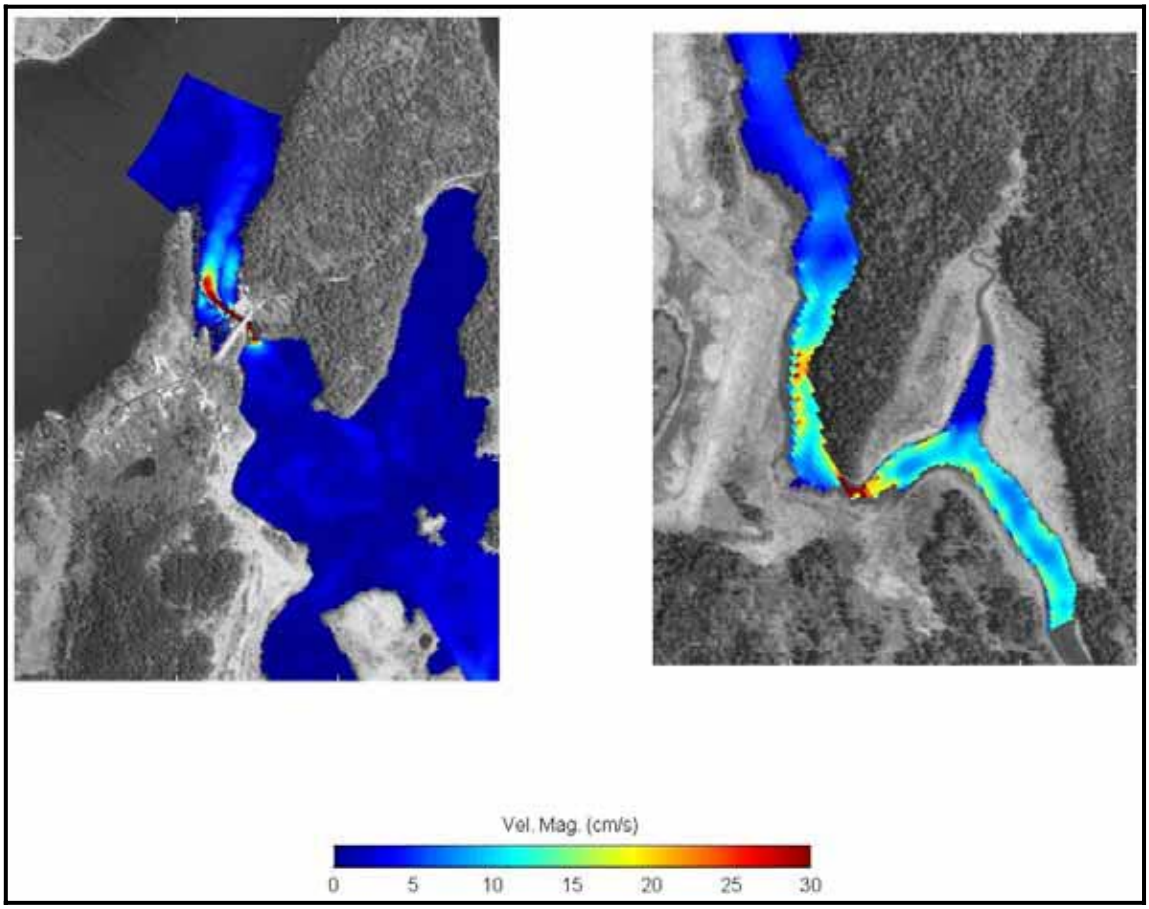

Figure 7. Maximum bottom current magnitudes simulated for the erosion of the earthen dam in Marsh Creek scenario, within the northern portion (left panel) and southern portion (right panel) of Goose Pond Estuary during flood conditions of a 100-year precipitation event.

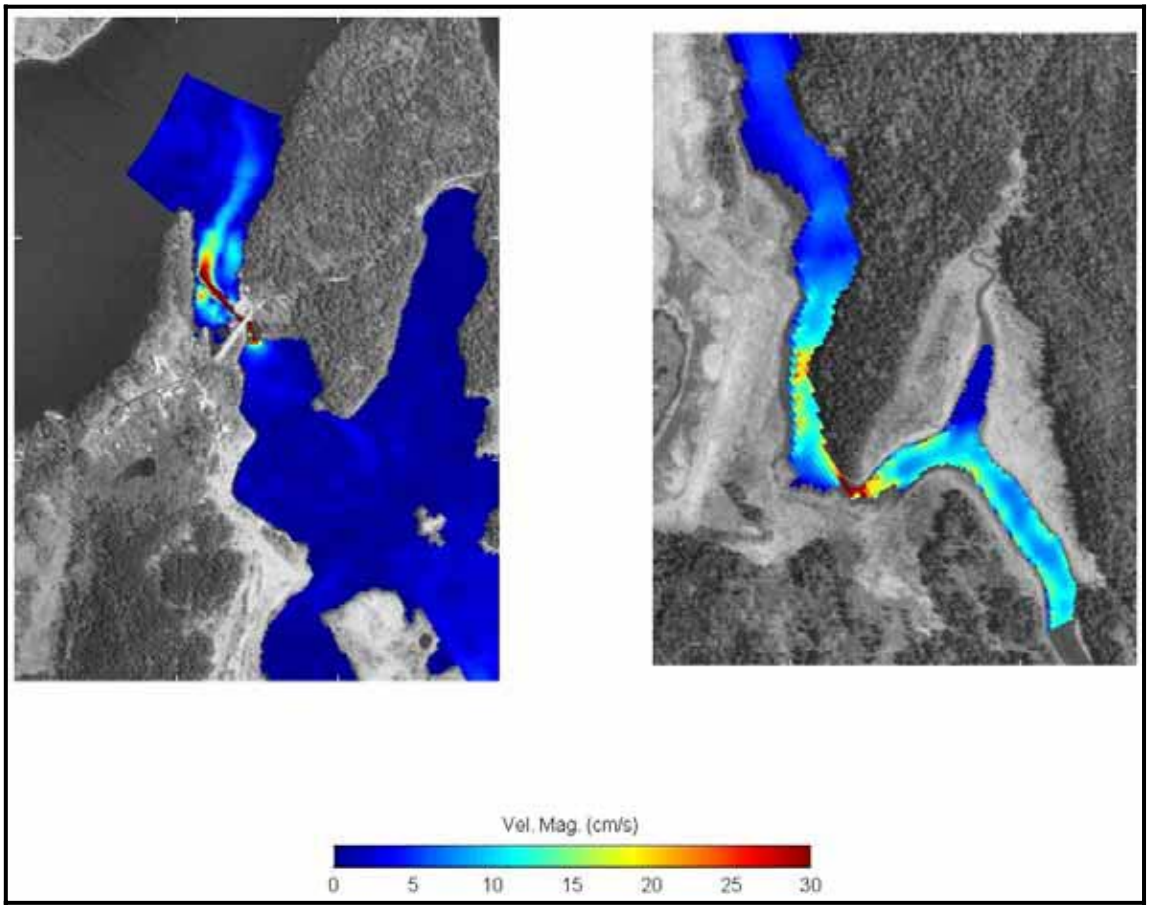

Figure 8. **Maximum bottom current magnitudes simulated for the erosion of the earthen dam in Marsh Creek scenario, within the northern portion (left panel) and southern portion (right panel) of Goose Pond Estuary during ebb conditions of a 100-year precipitation event.**

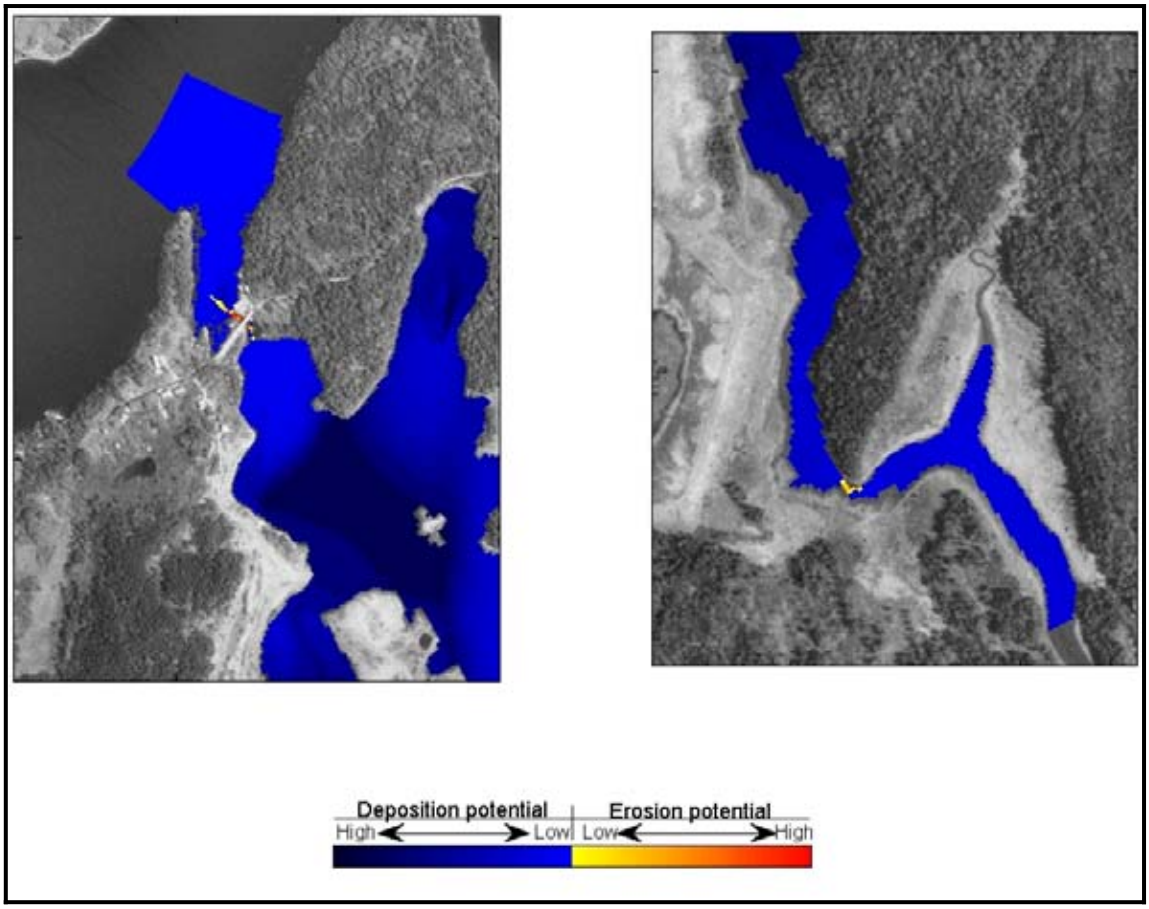

Figure 9. Sediment transport potential for the erosion of the earthen dam in Marsh Creek scenario, within the northern portion (left panel) and southern portion (right panel) of Goose Pond Estuary during flood conditions of a 100-year precipitation event.

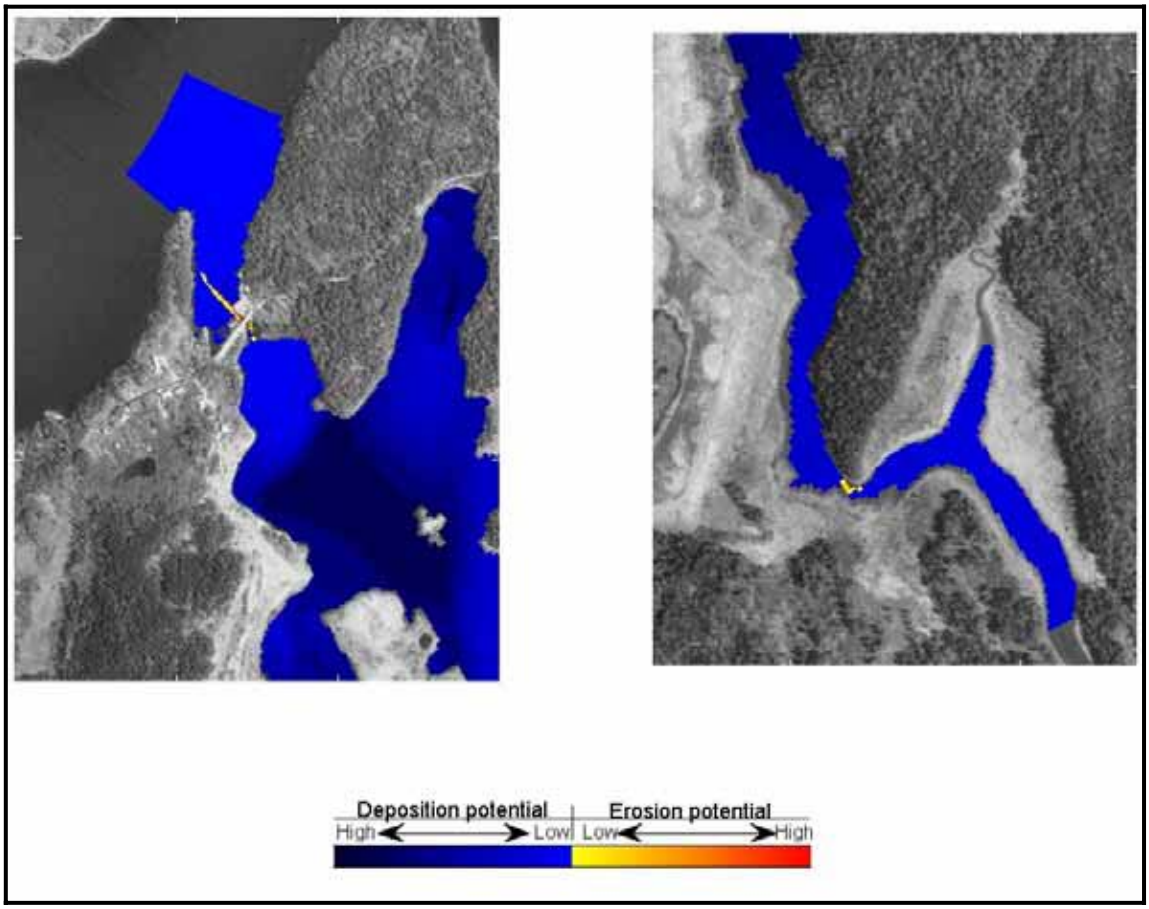

Figure 10. Sediment transport potential for the erosion of the earthen dam in Marsh Creek scenario, within the northern portion (left panel) and southern portion (right panel) of Goose Pond Estuary during ebb conditions of a 100-year precipitation event.

Potential Turnover of Anoxic Waters within Goose Pond

Another hydrodynamic process that may be critical in identification of a potential remedial strategy is the potential turnover of water in the former mining pit that is now the dominant subtidal feature within the Goose Pond estuary. As such, the potential feasibility of turnover of the anoxic waters in the deeper portions of the pit was assessed.

In general, freshwater lakes can turnover twice within a year. The driving mechanism between the turnover and complete mixing of a lake is in response to thermal stratification (Horne, A.J. and C.R. Goldman, 1994). In a freshwater setting, the density is solely dependant upon water temperature. Freshwater is densest at 4º C with both cooler and warmer water being less dense. During the spring, solar radiation warms the surface waters to 4º C, making the surface water denser than underlying water. Therefore, the surface water downwells bringing the deeper water to the surface. A similar turnover can occur in the autumn as well. During autumn, with the reduction of solar radiation, surface waters begin to cool. As the surface water cools to 4º C, and subsequently becomes heavier, downwells, and repeats the mixing process.

Wind energy also can play a role in the mixing of a lake. The rate of change of potential energy (dP/dt) above a critical wind speed ($U_{a,crit}$) can supply sufficient surface turbulence to entrain deeper water layers (Horne, A.J. and C.R. Goldman, 1994). The potential energy of a lake is determined by the following equation:

$$\frac{dP}{dt} \quad \gamma_w U_{a,crit}^3 + \gamma_{\bar{h}} g \frac{\alpha_{vs}}{C_p} q_s D$$

Where the first term on the left hand side is wind stirring and the second term is heat loss or heat gain.

Wind can also mix the water within Goose Pond; however, the turbulence would not be able to achieve the depth of the anoxic layer within the pit. Goose Cove has a relatively short fetch length over which winds can impart turbulent energy and is relatively shallow everywhere except above the pit. These factors limit the ability of wind imparted turbulent energy to fully mix the deepwater column and cause turnover of the system.

The same density-driven mixing processes do not occur in coastal estuarine systems. Stratification within a coastal estuarine system is not solely a function of water temperature, but also of salinity and pressure (Pond, S. and G.L. Pickard, 1983). The thermal mechanism that drives the downwelling in a freshwater lake is not typically a dominant process in a coastal estuarine system. For example, in the Goose Pond estuary, freshwater entering the system would not be dense enough to replace the anoxic waters in the bottom of the pit. The maximum density of freshwater is 1000 kg/m^3 (at 4ºC), whereas water at the bottom of the pit in Goose Pond (2º C, 30 psu) has a density of 1024 kg/m^3. Therefore, freshwater alone cannot result in a turnover of the anoxic pit water.

On a daily basis, water is flushed in and out of an estuarine system, exposing the estuary to more dense salt water, and mixing the system through a completely different process. As such, the potential turnover of water in an estuarine system may occur when more dense saltwater enters the system and replaces the bottom layers. Under current conditions, the tidal exchange is not significant enough to allow for significant salinity, and thus density changes, to develop in the system. Additionally, all of the vertical profile data currently observed in the vicinity of the former mining pit indicates that, under existing conditions, the mixing of water does not occur below approximately 30 feet (Woods Hole Group, 2006; USGS, 2007). Therefore, the potential turnover of water within the pit is not expected under exiting conditions.

However, if an increased tidal range and volumetric exchange were introduced to the system, the increased saltwater may cause the release of some of the anoxic water. As such, the hydrodynamic model was used to simulate a scenario that allowed the maximum tidal exchange into Goose Pond from Penobscot Bay. Although this scenario is somewhat unrealistic since there will likely always be some tidal dampening as water enters Goose Pond, the model results will indicate the maximum possible extent of mixing in the former mine region.

The potential turnover of anoxic waters within Goose Pond was evaluated using the same model domain used to study the removal of the Goose Falls Dam and by adjusting the entrance to allow for maximum tidal exchange. In evaluating the feasibility of this potential scenario, the most extreme hydrodynamic conditions model simulation was used to determine if the stagnant anoxic waters in the bottom layers of former mine pit could be mobilized. Stratification and mixing data were output from the model to analyze vertical mixing of the bottom layers in the deepest portion of the estuary.

Figure 11 shows the time series of water surface elevation (eta) and temperature output from the 100-year storm surge simulation at locations within Goose Cove (blue line) and the former mine pit (black line). The top panel of Figure 11 shows the peaks of the modeled water surface reach the same elevation both within Goose Cove and in the Goose Pond pit. The low water tidal elevations appear to be muted in the former mine pit (when compared to Goose Cove) due to areas in the connection between Goose Cove and Goose Pond that run dry. The lower panel of Figure 11 shows the modeled temperature in the bottom layer within Goose Cove and at a location within Goose Pond having a depth of approximately 77 meters. As a conservative approach, the initial water temperature at both locations was set to 14 degrees Celsius. The water temperature in the bottom layer of the Goose Pond former mine pit (black line) is not affected by the incoming tides and increased salinity in the simulation. The bottom panel of Figure 11 also shows the modeled temperature within the former mine pit for the 4 model layers. The results show the development of a stratified water column, with the top two layers showing significant water exchange, and the bottom two layers showing no variation in temperature. These results indicate vertical mixing is occurring within the top two (2) layers, or approximately the upper 40 meters of the water column. This is significantly more mixing than occurs during existing conditions, where water exchange is evident in only the upper 10 meters of the water column above the pit. This level of mixing was shown both in data (Woods Hole Group 2006; USGS, 2007) and the existing conditions model results (Woods Hole Group, 2008). Therefore, the maximum penetration or mixing of water that is expected to occur is approximately 40

meters, even under a worst-case, unlikely scenario. Under existing conditions, the possibility of a turnover is highly unlikely due to the dense nature of the water in the pit compared to the range of possible densities in the surface waters. Even with increased tidal exchange of salt laden water, the possible turnover of the entire pit is unlikely. The model showed a maximum exchange to a depth of approximately 40 meters.

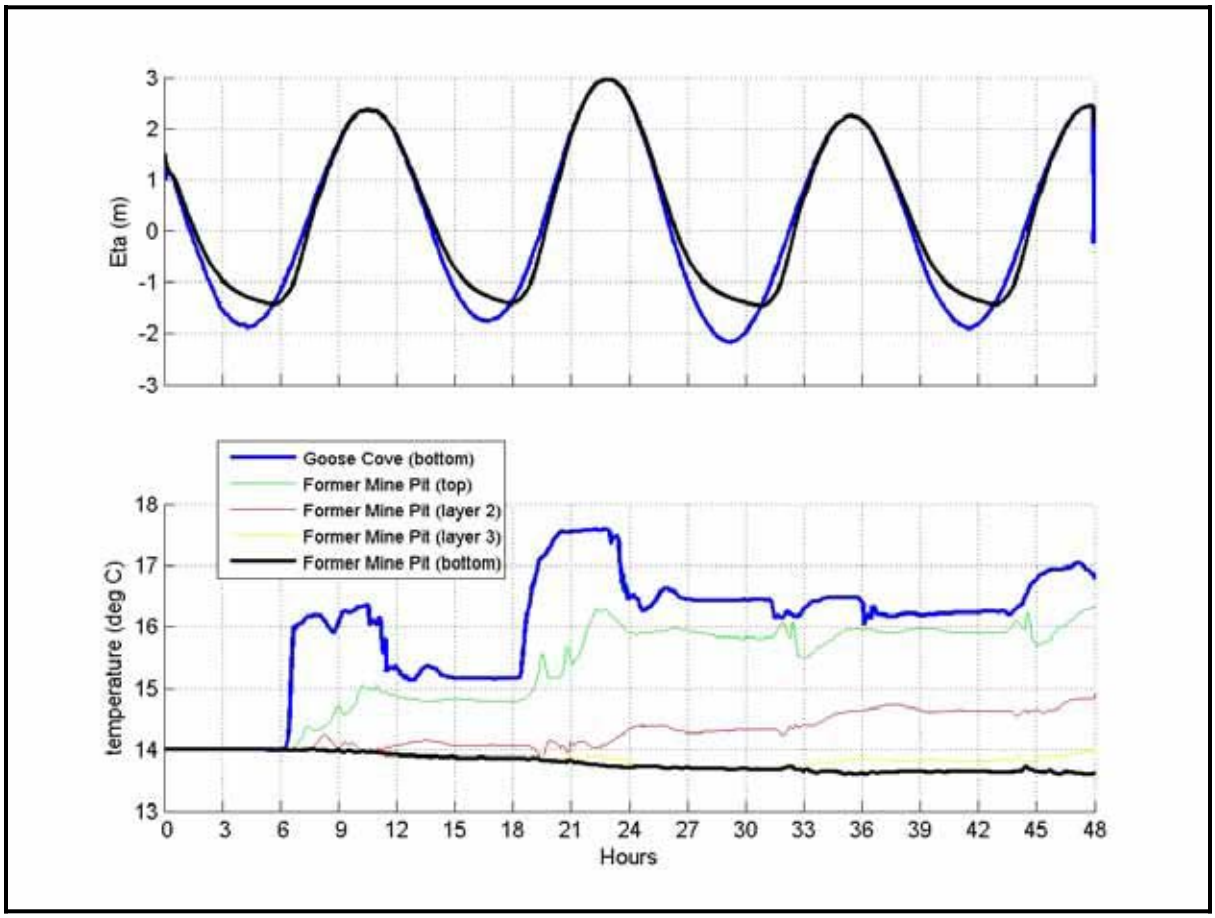

Figure 11. Time series of water surface elevation (eta, upper panel) and temperature (lower panel) within the Goose Pond Estuary during a 100-year storm surge event. The model where the Goose Falls Dam was removed was utilized in this simulation to study the potential turnover of anoxic waters in Goose Pond.

Comparison of Potential Future Scenarios to Existing Conditions

For the first two potential future scenarios (where hydraulic changes were made to the Goose Pond Estuary), potential sediment mobility was compared with that computed for existing conditions (Woods Hole Group, 2008). An important goal of this task was to determine if the removal of the Goose Falls Dam or the erosion of the earthen dam in Marsh Creek could affect

the hydrodynamics of the system such that there would be increased potential for sediment transport.

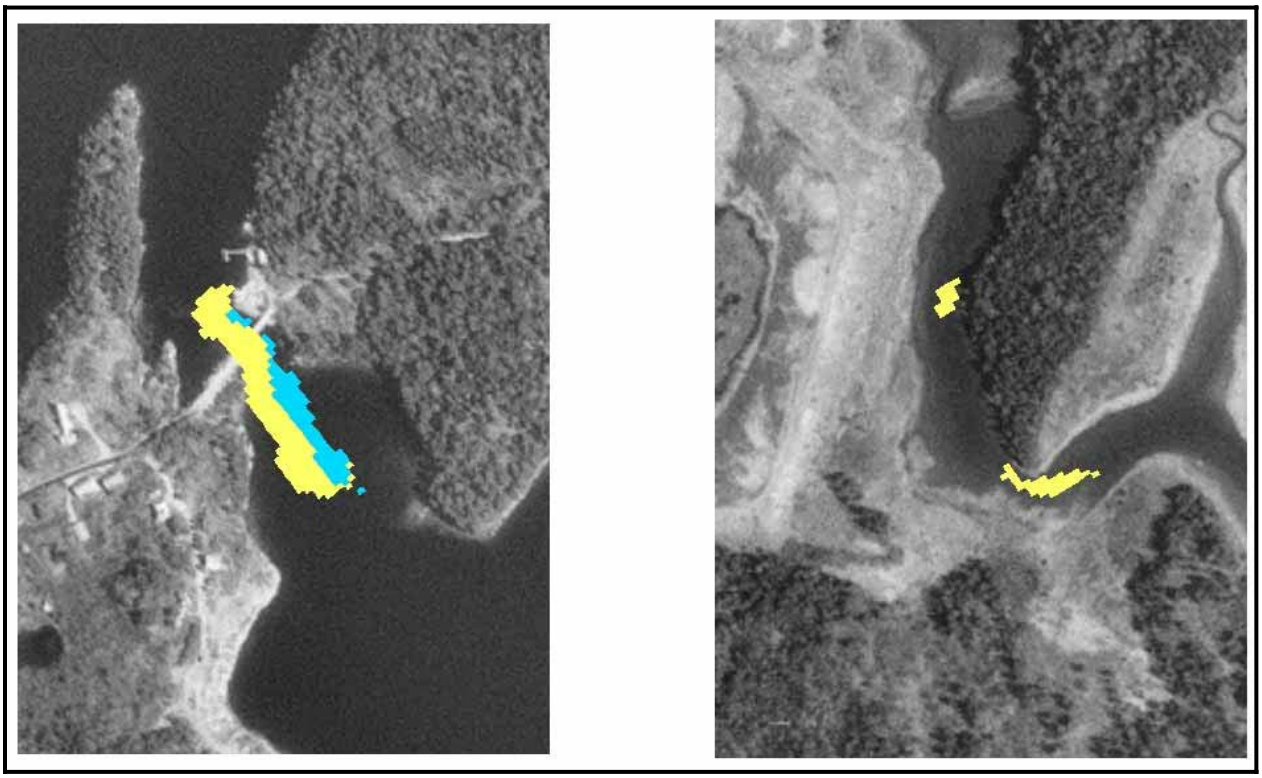

Figure 12. Areas of potential sediment transport shown for the removal of the Goose Falls Dam scenario (yellow) and existing conditions (blue) within the northern portion (left panel) and southern portion (right panel) of Goose Pond Estuary during flood conditions of a 100-year storm surge event.

The results from these comparisons are shown in Figures 12 through 15. In each of these figures, the area of potential erosion is shown for both the future scenario (yellow) and existing conditions (blue) for the upper (left panel) and lower (right panel) portions of the Goose Pond Estuary. Figures 12 and 13 show the results for the potential scenario where the Goose Falls Dam is removed during a 100-year storm surge event, respectively, for both flood and ebb conditions. As was shown earlier, the removal of the Goose Falls Dam allows for a larger volume of water to flow into Goose Pond. During flood conditions of a 100-year storm surge event, there is an increased area of potential erosion at the southern end of Goose Cove/entrance to Goose Pond (left panel of Figure 12). When compared to existing conditions, there are new areas of potential erosion upstream of the former earthen dam when the 100-year storm surge floods the system (right panel of Figure 12). Removal of the Goose Falls Dam also shows increased potential for erosion when waters recede in a 100-year storm surge event. There is a larger area of potential erosion in Goose Cove and the channel connecting Goose Pond with Goose Cove when comparing to the potential erosional areas for existing conditions (left panel of Figure 13).

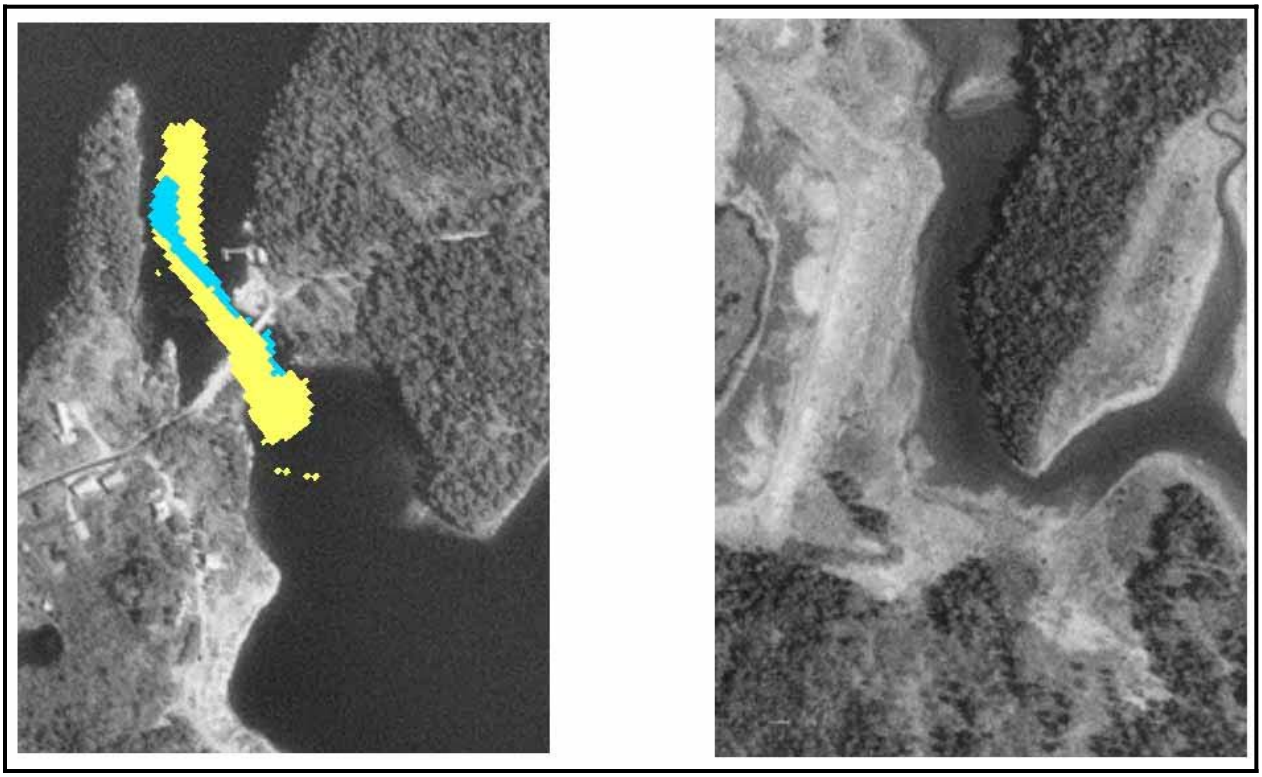

Figure 13. Areas of potential sediment transport shown for the removal of the Goose Falls Dam scenario (yellow) and existing conditions (blue) within the northern portion (left panel) and southern portion (right panel) of Goose Pond Estuary during ebb conditions of a 100-year storm surge event.

The areas of potential sediment transport computed for a 100-year precipitation event are shown in Figures 14 and 15 for the scenario where the earthen dam in Marsh Creek is eroded (yellow) and for existing conditions (blue). Figure 14 shows the results for flood conditions while Figure 15 depicts ebb conditions. When compared to existing conditions, the erosion of the former earthen dam does not greatly affect the potential mobility of sediments. The locations of potential erosion are the basically the same between existing conditions and the potential future scenario. There are only slight increases in the areas of sediment mobility when the earthen dam is eroded, under both flood and ebb tidal conditions.

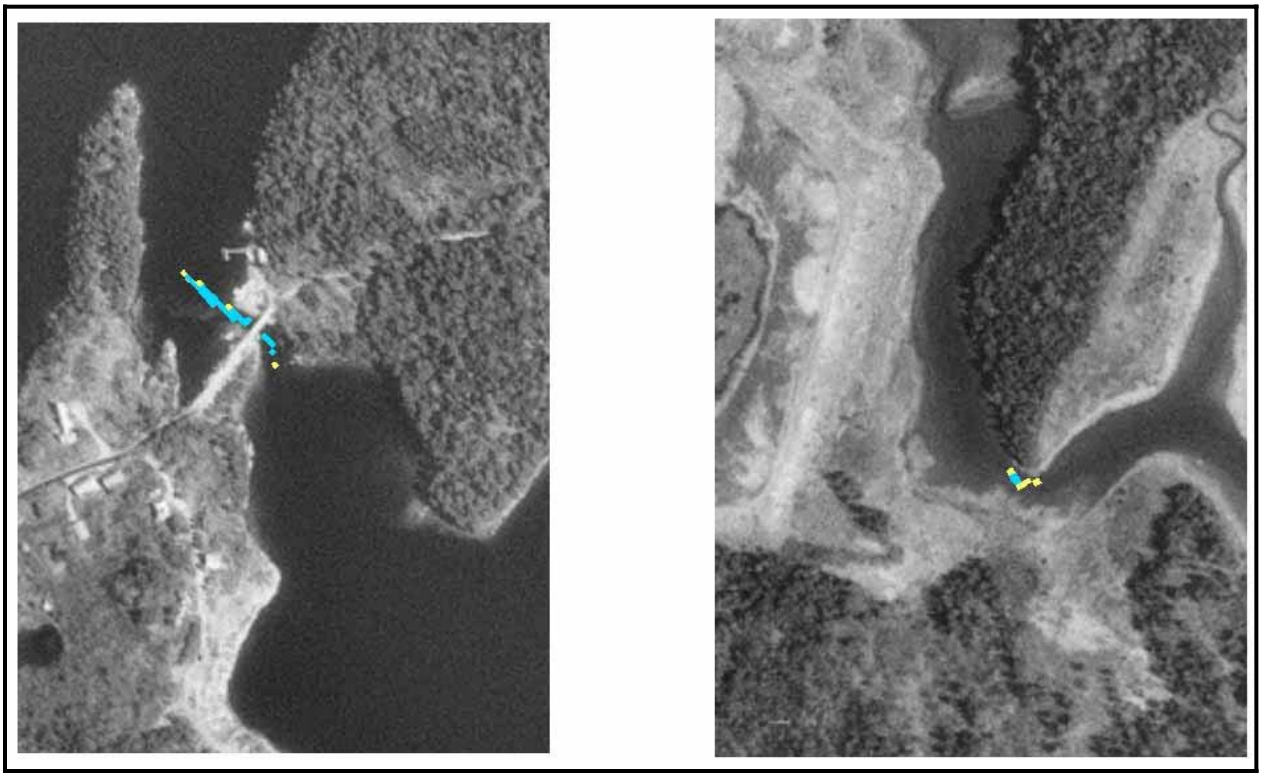

Figure 14. Areas of potential sediment transport shown for the erosion of the earthen dam in Marsh Creek scenario (yellow) and existing conditions (blue) within the northern portion (left panel) and southern portion (right panel) of Goose Pond Estuary during flood conditions of a 100-year precipitation event.

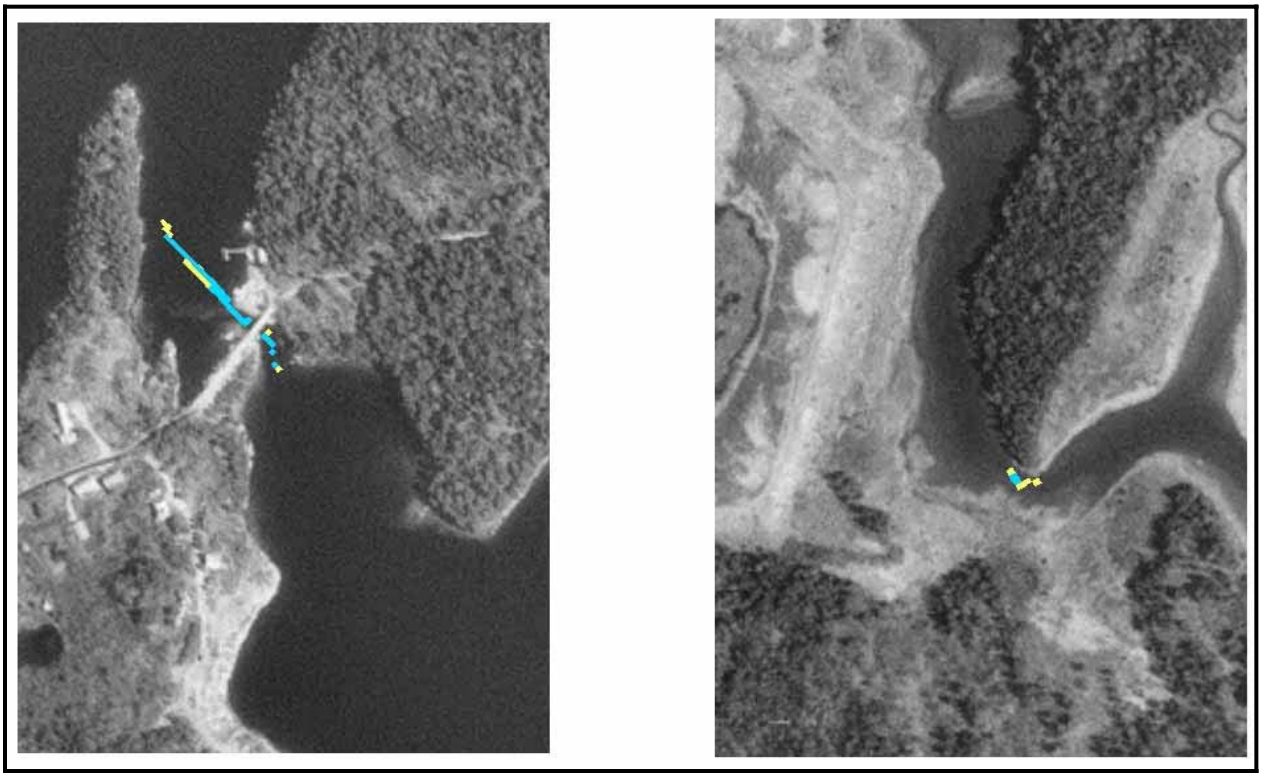

Figure 15. Areas of potential sediment transport shown for the erosion of the earthen dam in Marsh Creek scenario (yellow) and existing conditions (blue) within the northern portion (left panel) and southern portion (right panel) of Goose Pond Estuary during ebb conditions of a 100-year precipitation event.

SEDIMENT TRANSPORT/SCOUR IN GOOSE COVE

An analytical sediment transport model was developed to further assess the potential mobility and transport of sediments, specifically within Goose Cove. Previous modeling efforts, completed using the 3-D hydrodynamic model developed for the Goose Pond Estuary, have shown that the greatest potential for exposure of contaminated sediments is likely in the Goose Cove region. The larger velocities in this region create a jet of high current velocities on an ebb tide when Goose Pond is draining into Goose Cove. In addition, testing of the subaqueous sediments has shown the presence of contamination and evidence of mine waste within Goose Cove. The analytical sediment transport model was developed to determine the type and rate of sediment transport that would occur in Goose Cove in order to obtain first-order estimates of erosion depths for both normal tidal conditions (spring tide) and storm conditions. The areas of erosion and depths of erosion were then correlated with information on the areas/depths of contaminated sediments in order to give an approximation of potential exposure of these sediments.

There are two common classifications of sediment movement within a body of water: bed load and suspended load. Bed load is defined as the part of the load moving on or near the bed by rolling, saltation or sliding. Suspended load is load that moves while in suspension in the water column. The analytical sediment transport model that was developed for Goose Cove includes computations of both bed load and suspended sediment transport. The model first determines if the bottom sediments are mobile by comparing the bed shear stress with the critical shear stress required for mobility. The sediment median grain size (d_{50}) and the bottom current velocities are used to determine the bed shear stress. The bed load sediment transport is then computed using the Meyer-Peter and Muller equation (1948) while suspended sediment transport is computed based on a log profile for velocity and a Rouse profile for sediment (Soulsby, 1997).

In evaluating the potential sediment transport within Goose Cove, the analytical sediment transport was applied using sediment grain size results obtained from subaqueous samples provided by MACTEC. The median grain size for the entirety of Goose Cove was interpolated/extrapolated from the results of several samples. The sediment transport model also used results obtained from the numerical hydrodynamic EFDC model developed for the Goose Pond Estuary. Maximum bottom currents simulated during both spring tide and 100-year storm surge events were used as input to the sediment transport model. An erosion rate was computed using the total sediment flux (bed load and suspended load). Scour depths were then determined assuming the maximum forcing occurred for a 12-hour duration, which represents a relatively normal length of a Nor'easter storm event.

Figures 16 and 17 show the computed scour depths within Goose Cove obtained from the sediment transport model for both a spring tide and a 100-year storm surge event, respectively. Also shown in these figures is the area of mine waste (provided by MACTEC) shown by a bold black line. The color contours shown in the figures for the computed scour depths range from 0 to 3 meters, however, computed scour depths did exceed 3 meters in some areas for the events simulated. The maximum scour depth in the figures was limited to 3 meters in order to better show areas having less predicted scour.

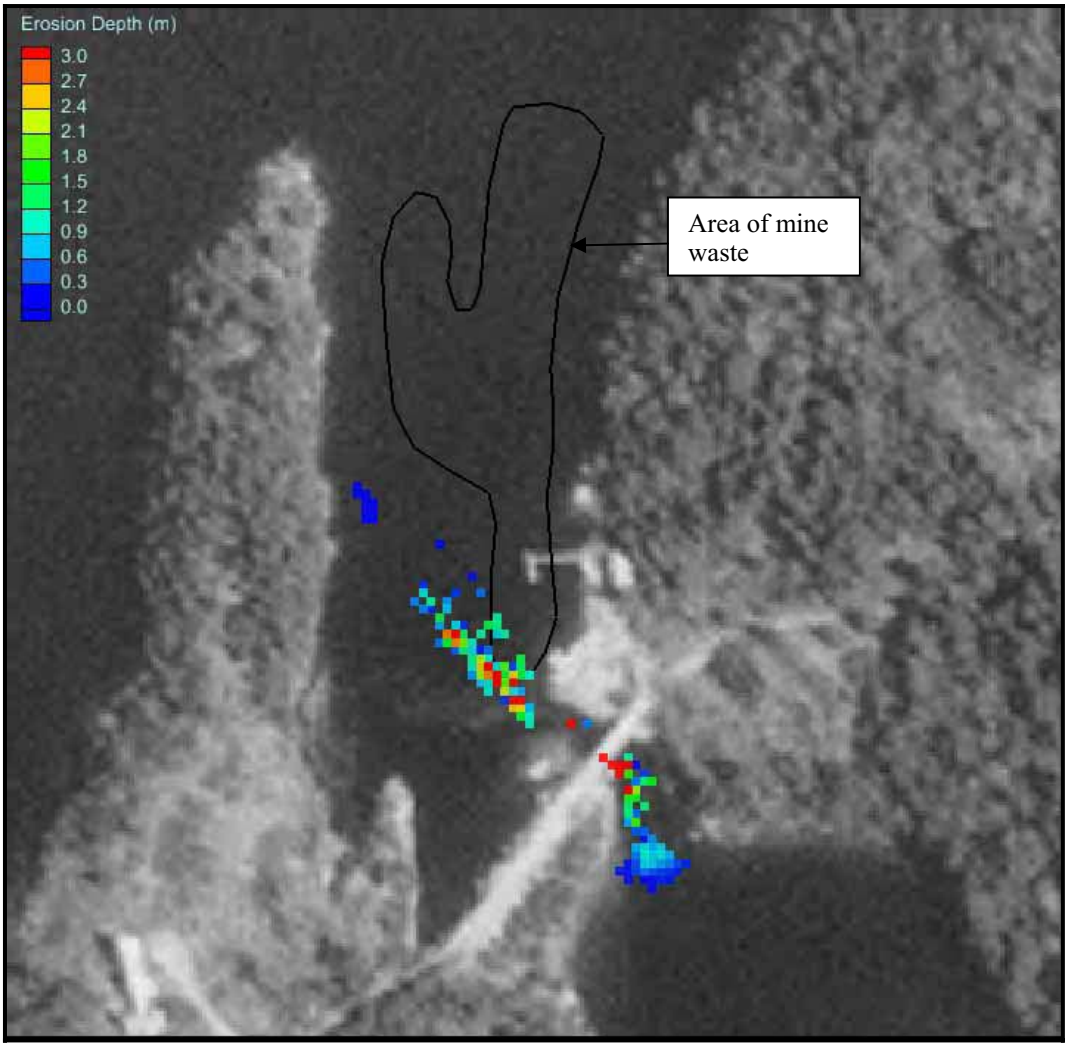

Figure 16. Computed scour depths within Goose Cove during ebb conditions of a spring tide (scour depths in some areas may actually be greater than 3 meters).

As shown in Figure 16, under spring tidal conditions significant erosion is predicted to occur at the extreme landward (southern) end of the mine waste deposit, where there are large current velocities. These large current velocities are associated with the narrow jet that extends from the Goose Falls Dam on an ebb tide. In this zone where these rather large computed scour depths are predicted, the sediments will erode until the fine material is gone and the bed is armored with coarser sediments. It is presumed that this type of erosion has already occurred under normal tidal conditions, within the narrow area band underlying the ebb-tide current jet. Most likely bedrock or coarser sediments currently exist where large scour depths have been predicted.

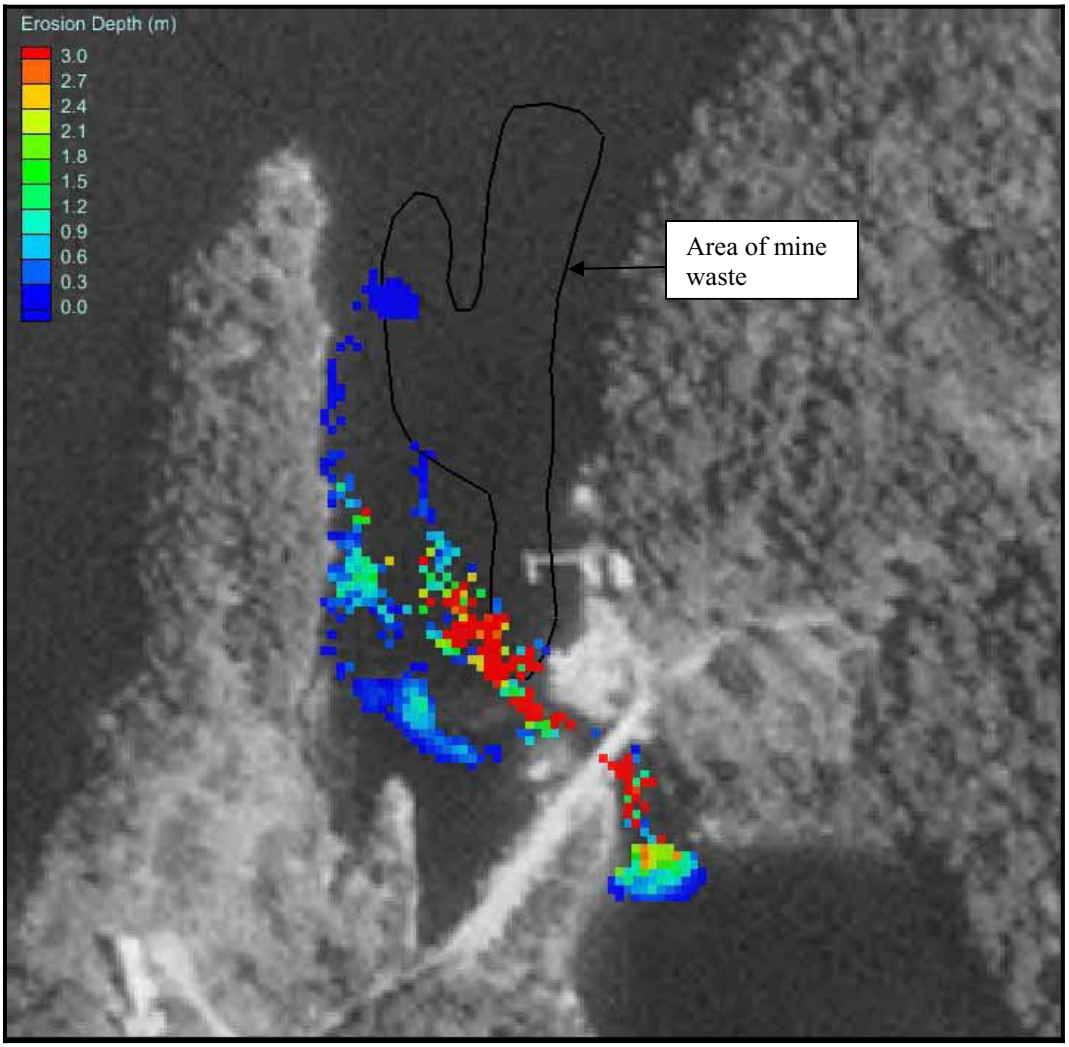

Figure 17. Computed scour depths within Goose Cove during ebb conditions of a 100-year storm surge event (scour depths in some areas may actually be greater than 3 meters).

Figure 17 shows the computed scour within Goose Cove for a 100-year storm surge event. In this case, significant erosion occurs again at the landward/southern end of the mine waste deposit, although the area of erosion is larger for the 100-year storm when compared to normal tidal conditions. Again, the large scour depths are associated with the current jet that extends from the Goose Falls Dam when the waters are receding. As was shown in previous modeling efforts, the current jet that is created in a 100-year storm surge has more of a northwest heading than the current jet that exists under normal tidal conditions, which has a heading of west-northwest (Woods Hole Group, 2008). This shift in direction allows for the area of scour to extend over a greater portion of the mine waste area. Erosion of a lesser extent (less than about 1 cm) is predicted in other areas of the mine waste deposit. These areas of erosion are caused by a return flow that enters Goose Cove from the seaward boundary.

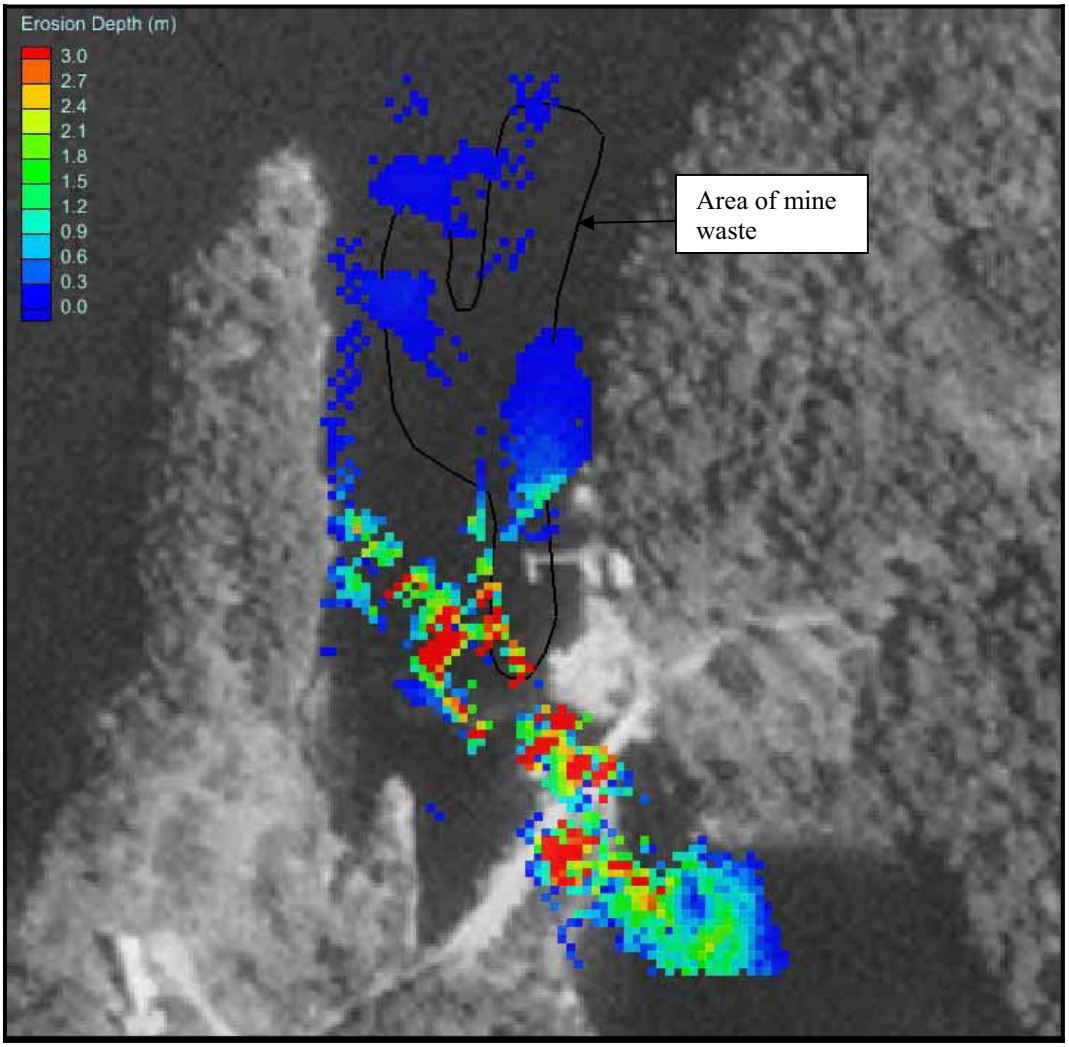

Figure 18. Computed scour depths within Goose Cove shown for the removal of the Goose Falls Dam scenario during ebb conditions of a 100-year storm surge event (scour depths in some areas may actually be greater than 3 meters).

To further evaluate a potential future scenario and the impact that it might have on Goose Cove, the sediment transport model was applied to the case where the Goose Falls Dam is removed. The computed scour depths during ebb conditions of a 100-year storm surge are shown in Figure 18 for the removal of Goose Falls Dam scenario. In this scenario where the restriction between Goose Cove and Goose Pond is removed, erosion occurs over a larger area of the mine waste deposit. Significant scour (exceeding 3 meters) is predicted again at the most southern portion of the mine waste deposit. There is also an area of erosion along the eastern shoreline of Goose Cove where the mine waste exists. The computed scour depths in this area range up to approximately one (1) meter. In the northwestern portion of the mine waste area, simulated scour is in the range of 1 to 10 cm. The modified geometry of the system has shown to lessen the current velocities of the jet but at the same time the jet widens, thus affecting a larger region of the mine waste deposit.

CONCLUSION/DISCUSSION

This report presented the results from modeling completed to evaluate three potential future scenarios within the Goose Pond Estuary. The modeling helped to determine if there was potential for increased mobility of sediments and turnover of anoxic waters within the system. Additionally, the scour depths expected within Goose Pond were estimated based on an analytical scour model. Based on the model results the following observations can be made:

- The removal of the anthropogenic features at Goose Falls Dam would allow for larger tidal ranges to enter Goose Pond and more flow would be conveyed into the estuarine system. During a 100-year storm surge event, current velocities greater than 20 cm/s were shown to occur in the interior of the system, while velocities exceeding 30 cm/s exist in Goose Cove, the channel connecting Goose Cove with Goose Pond, as well as upstream of the former earthen dam.

- The removal of the anthropogenic features at Goose Falls Dam would increase the potential for erosion of the sediments within Goose Cove and upstream of the former earthen dam. The contaminated sediments that exist in Goose Cove could be exposed and mobilized under these conditions.

- Complete erosion of the remaining earthen dam in Marsh Creek did not greatly affect the hydrodynamics of the system. The potential future scenario was simulated in a 100-year precipitation event and similar trends were seen in current velocities and areas of potential erosion when compared to existing conditions. Therefore, the complete erosion of the earthen dam will not significantly impact the overall hydrodynamics or sediment transport within the system.

- The potential turnover of anoxic waters in the deeper portions of the estuary was analyzed using the model allowing the full tidal range to enter Goose Pond. A 100-year storm surge was simulated to determine if extreme hydrodynamic conditions would induce mixing and or release the anoxic waters in the bottommost layers of the former mine pit. Model results showed an increase of water exchange in the water column above the pit (from approximately 10 meters under normal conditions to 40 meters under the full tidal exchange conditions).

- The turnover of anoxic waters within the deep former mine pit is unlikely. Under normal conditions, the dense waters in the pit are confined and mixing only occurs in the upper 10 meters of the water column. During the simulation of 100-year extreme storm conditions coupled with the removal of the restriction at the Goose Falls, vertical mixing increased to the upper 40 meters, but did not entrain the bottom layers within the mine pit.

- The analytical sediment scour/transport model, which includes both bed load and suspended load, is a useful tool in predicting scour for various conditions. The model was applied to Goose Cove in order to evaluate potential exposure of contaminated sediments.

- The analytical scour/transport model showed that Goose Cove, as it exists today, has the potential for erosion and transport of subaqueous mine waste sediments under extreme 100-year return period storm conditions. However, under normal conditions, the contaminated waste material was not exposed.

- The removal anthropogenic features at Goose Falls Dam would allow for a larger portion of the mine waste deposit in Goose Cove to be exposed in a 100-year storm event, based on the analytical sediment transport calculations.

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APPENDIX B

Wetland Delineation and Functional Assessment Report

WETLAND DELINEATION AND FUNCTIONAL ASSESSMENT REPORT

Callahan Mine Superfund Site

Brooksville, Maine

Prepared for:

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

Prepared by:

MACTEC Engineering and Consulting, Inc.
511 Congress Street
Portland, Maine 04101

MACTEC Project 3612062047

April 2009

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April 2009

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LIST OF ACRONYMS AND ABBREVIATIONS

GPS	Global Positioning System
MACTEC	MACTEC Engineering and Consulting, Inc.
MEDEP	Maine Department of Environmental Protection
MEDLF&W	
NPL	National Priority List
Site	Callahan Mine Superfund Site
USACE	U.S. Army Corps of Engineers
WOSS	Wetlands of Special Significance
WRP	waste rock pile

1.0 INTRODUCTION

MACTEC Engineering and Consulting, Inc. (MACTEC) conducted a wetland delineation survey at the Callahan Mine Superfund Site (Site) in support of environmental permits relating to potential remediation activities at the Site. The purpose of the survey was to identify and delineate Maine Department of Environmental Protection (MEDEP) Protected Natural Resources at the Site. The wetland delineation survey included salt marsh/tidal wetlands, freshwater wetlands, and streams and a review of potential vernal pools.

The area of investigation included Goose Pond from the outlet to Goose Cove to the upper marsh where the pond transitions to a tidal creek (Marsh Creek). The area of investigation associated with Goose Pond ended at the point where an old beaver dam bisects Marsh Creek. The area of investigation also included the portion of the property within 250 feet of areas on Site where remediation activities may occur. The wetland delineation included flagging the upland-wetland boundary and locating wetland flags using a differentially corrected global positioning system (GPS). The wetland delineation also included a survey of the property for potential vernal pools.

The Protected Natural Resources at the Site were identified and delineated on June 17, 18, and 19, 2008. Six wetland features were delineated and labeled Wetlands A, B, C, D, E, and GP. An area of ponded water in a closed depression was observed within Wetland A, which was identified as a potential vernal pool. Due to the time of year when the field work was conducted (i.e., outside the spring amphibian breeding season) we were unable to document any breeding amphibian use. Delineated wetlands and the potential vernal pool are shown on Figure 1.

2.0 METHODOLOGY

Wetlands were delineated using methods described in the 1987 U.S. Army Corps of Engineers (USACE) Wetland Delineation Manual. The methodology presented in this manual is generally accepted by both state and federal regulatory agencies. The wetland delineation was based on the definition of wetlands as recognized by both the MEDEP and USACE (i.e., presence of hydric soils, dominance of hydrophytic vegetation, and presence of wetland hydrology). Wetlands, streams, and potential vernal pools on the property were delineated and marked in the field using numbered flagging. The delineated wetland resources were located using a Trimble Pro-XR submeter GPS. Delineated wetlands were classified based on current MEDEP wetland regulations, and on the U.S. Fish and Wildlife Service wetland classification system, *Classification of Wetlands and Deepwater Habitats of the United States* (Cowardin et al., 1979). The hydric soils observed in wetlands delineated at the Site were classified based on the *Field Indicators for Identifying Hydric Soils in New England ("Field Indicators")*, Version 3 (NEHSTC, 1998).

3.0 FINDINGS

The following subsections present the findings of the wetland delineation and include a brief description and classification of the protected natural resources identified at the Site.

3.1 WETLAND A

Wetland A is classified as a PFO4 or a palustrine, forested, needle-leaved evergreen wetland, based on the U. S. Fish and Wildlife wetland classification system. This wetland is located off the property to the west of the Mine Operations Area. The wetland delineation included the portions of wetland within approximately 125 feet of the western property boundary. Wetland A is dominated by needle-leaved evergreen trees including Northern white cedar (*Thuja occidentalis*), black spruce (*Picea mariana*), and balsam fir (*Abies balsamea*). Subordinate tree, shrub, and herbaceous species included yellow birch (*Betula alleghaniensis*), white pine (*Pinus strobus*), alder (*Alnus incana*), meadow horsetail (*Equisetum pretense*), meadow sweet (*Spirea latifolia*), sensitive fern (*Onoclea sensibilis*), sedges (*Cares* spp.) and moss (*Sphagnum* sp.). Mound and pool micro-topography was present throughout Wetland A, which also included small upland islands. The poorly drained silt to clay textured soils in Wetland A formed in glaciomarine deposits and are hydric soils. The soils are classified as type XI.A. hydric soils.

3.2 WETLAND B

Wetland B is classified as a PEM1 or palustrine, emergent, persistent wetland. This wetland is located at the toe of the southern end of Waste Rock Pile #3 (WRP-3). The wetland formed in an area where an access road was installed between the salt marsh and WRP-3. Seeps discharging from below WRP-3 provide the wetland hydrology. Wetland B is dominated by black grass (*Juncus gerardi*i) and horsetail (*Equisetum* sp.) and also included the following subordinate species alder, meadow sweet and sensitive fern. The poorly drained silt to clay textured soils in Wetland B formed in glaciomarine deposits and are hydric soils. The soils are classified as type XI.A. hydric soils.

3.3 WETLAND C

Wetland C is classified as a PEM1 or palustrine, emergent, persistent wetland. This wetland is located along the toe of the Tailings Pile between the berm that exists between the salt marsh and the Tailings Pile. The wetland hydrology is derived from seeps, discharging to the ground surface, from the Tailings Pile and a decant pipe that drains the surface water from the top of the Tailings Pile. Wetland C is dominated by common reed (*Phragmites australis*), and also included sedges (*Carex* spp.), broad-leaved cattail (*Typha latifolia*) and wetland grasses. The soils in Wetland C are composed of an organic surface layer overlying silty glacial till deposits. The soils are classified as type V. hydric soils.

3.4 WETLAND D

Wetland D is classified as a PEM1 or palustrine, emergent, persistent wetland. This wetland is located on the top of the Tailings Pile, in an area that was used to pond and settle aqueous mine wastes. The substrate in the area delineated as Wetland D is composed of very fine angular sand and silt particles and slimes settled from the mine wastes. These materials are characterized as fill material. The hydrology in the area is derived from surface water runoff from the uplands to the west of the Tailings Pile. There is an existing decant structure (6-inch diameter open pipe) that regulates the level of water in the area. The fine particle size of the substrate creates a perched water table in the mine wastes. Wetland D is dominated by broad-leaved cattails, and also included beaked spike rush (*Eleocharis rostellata*). The soils are classified as type VI. hydric soils.

3.5 WETLAND E

Wetland E is classified as a PEM1 or palustrine, emergent, persistent wetland. This wetland is located at the north end of Waste Rock Pile #1 (WRP-1). While the mine was in operation, sediment from Stink Cove slumped into the mine pit during a single mass wasting event. This sediment was excavated from the mine pit and placed on top of WRP-1, where Wetland E has formed. Seeps discharging from below the upper tier of WRP-1 provide the wetland hydrology. Wetland E is dominated hydrophitic vegetation including broad-leaved cattails, subordinate vegetation included golden rod (*Solidago* sp.), blackberry and raspberry (*Rubus* spp.). The northern boundary of the wetland is delineated by an existing berm and the southern boundary follows the toe of slope of the upper tier of the Waste Rock Pile. The sediment deposited on the

top of the waste rock pile is composed of fine grained silty esturarine sediments, which have developed hydric soil characteristics. The soils are classified as type XI.A. hydric soils.

3.6 WETLAND GP

Wetlands delineated in the field as Wetland GP include the salt marsh habitat bordering the eastern and western shores of Goose Pond and where present the contiguous freshwater wetlands that exist up gradient of the salt marsh. Wetlands were delineated within 250 feet of the salt marsh bordering Goose Pond. The upland wetland boundary along the west side (i.e., Site side) and east side (Holbrook Island Sanctuary side) of Goose Pond included areas that transition abruptly from the pond to upland in areas where mining occurred and where bedrock outcrops exist along the pond edge. The upland wetland boundary in these areas is delineated by the highest tide level for the year (i.e., MEDEP Highest Annual Tide). The salt marsh and freshwater wetlands delineated in the vicinity of Goose Pond are discussed in the following sections. Goose Pond is classified as an E1UB3, or estuarine, subtidal, unconsolidated bottom (mud) wetland.

3.6.1 Salt Marsh

The fringe salt marsh along Goose Pond is classified as E2EM1 or estuarine, intertidal, emergent, persistent wetland. These wetlands occur in a relatively narrow band along the edge of Goose Pond. There are several areas where freshwater wetlands bordered the inland edge of fringe salt marsh, which are noted on the wetland delineation plan (Figure 1). There were also several named and unnamed streams observed flowing into Goose Pond. The freshwater wetlands are described in Subsection 3.6.2. The fringe salt marsh wetlands are dominated by smooth cordgrass (*Spartina alterniflora*), and also included saltmeadow cordgrass (*Spartina patens*), narrow-leaved cattail (*Typha angustifolia*) and common reed (Phragmites australis). The salt marsh soils are composed of silty textured material that formed in glaciomarine deposits. Wetlands data forms are included in Attachment A. Also included in Attachment A is a data form documenting typical undisturbed bordering upland conditions. The marsh soils are classified as type II. hydric soils.

3.6.2 Freshwater Wetland and Streams

A large freshwater wetland complex was delineated, south of Tailings Pile, which is contiguous with the fringe salt marsh bordering Goose Pond. This area of wetland includes the following

wetland classes PFO4 (palustrine, forested, needle-leaved evergreen wetland), PSS1 (palustrine, scrub/shrub, broad-leaved deciduous wetland) and PEM1 (palustrine, emergent, persistent wetland). Two stream features were also observed within the delineated portions of the wetland complex. One of the stream channels observed becomes broad and diffuse where it transitions into the salt marsh. The other stream channel exists in an entrenched channel to Goose Pond. The PFO4 portion of the wetland is dominated by northern white cedar, black spruce and balsam fir trees. The PSS1 wetland is dominated by alder and high bush blueberry (*Vaccinium corymbosum*). The PEM1 wetland is codominated by horse tail (*Equisetum palustre*), tussock sedge (*Carex stricta*), and sensitive fern (*Onoclea sensibilis*). The wetland hydrology is derived from seeps discharging from below the Tailings Pile and surface water runoff from the surrounding uplands. The soils within the PFO1 wetlands are composed of silty textured hydric soil formed in glacial till deposits. The soils within the PSS1 and PEM1 wetlands are composed of muck and silt textured soils that formed in glaciomarine sediments. Wetland data forms are included in Attachment A. The soils are classified as type XI.A. hydric soils.

4.0 CONCLUSION

Wetland A exists off property to the west of the mine operations area. It appears that this wetland may have continued across the property prior to development of the mine. A small closed depression was observed along the property boundary within Wetland A that may be functioning as a vernal pool. Ponded water was observed in the closed depression at the time of our wetland delineation, which would suggest that ponded water would be found in the depression during the spring amphibian breeding season. However, because our wetland delineation work was done outside the amphibian breeding season, a survey during the spring of 2009 would be required to determine if this area is a "Significant Vernal Pool".

Four of the wetlands delineated on Site, including Wetlands B, C, D and E, appear to have developed in areas that have been impacted by mine activities and are a direct result mine operations (i.e., man-made). Wetland B developed in an area where seeps discharging from below WRP-3 and the Tailings Pile were cut off from direct discharge to the Goose Pond salt marsh by an access road. Wetland C exists in a low lying area between the toe of the Tailings Pile and an access road running along the edge of the salt marsh. Wetland D formed on the top of the Tailings Pile, in an area that was used to pond and settle aqueous mine wastes. Wetland E formed on the top of WRP-1 in an area where sediments excavated from the mine pit were placed during mine operations. All of these wetlands were created as a direct result of mine operations or the cessation of mine operations.

The protected natural resources delineated on the Site include Coastal Wetlands (Goose Pond and bordering salt marsh) and Freshwater Wetlands and Streams. All of the wetlands delineated in association with Goose Pond, including the pond, fringe salt marsh, and freshwater wetlands within 250 feet of the pond are considered "Wetlands of Special Significance" (WOSS). In addition, wetlands within 25' of mapped streams are also considered WOSS. Alteration of a WOSS would require a Tier 3 Wetland Permit from the MEDEP and an individual permit from the Army Corps of Engineers. Based the area of proposed impacts (i.e., alteration of greater than 500 square feet of WOSS including coastal wetlands and freshwater wetlands) additional submittals may be required including a wetland mitigation and compensation plan. A wetland functions and values assessment was completed as a part of our wetland delineation services, the results of which are presented in the following subsections.

5.0 WETLAND FUNCTIONS AND VALUES ASSESSMENT

The USACE guidance document The Highway Methodology Workbook (USACE, 1993) was used to evaluate the wetland functions and values of the wetland habitats delineated at the Site. The Highway Methodology Workbook Supplement (USACE, 1999) outlined the specific methodology followed when conducting the wetland functions and values assessment. A total of six wetland types were identified and delineated on the Site; they include Goose Pond, a estuarine subtidal unconsolidated bottom wetland (E1UB3), estuarine intertidal emergent marsh wetland (E2EM1), palustrine unconsolidated bottom wetlands (PUB), palustrine forested wetland (PFO4), palustrine scrub shrub wetland (PSS1), and palustrine emergent wetland (PEM1). Results of the functions and values assessment, for each of the wetland types identified were documented on evaluation forms which are included in Attachment A. In accordance with The Highway Methodology, wetland functions and values have been qualitatively evaluated for each of the wetlands identified at the Site. The functions and values are discussed below. A summary of the suitable and principal functions-values for each wetland type is presented in the Wetland Functions and Values Summary Table (presented in Section 5.14).

5.1 GROUNDWATER RECHARGE/DISCHARGE

This function considers the potential for the wetland to serve as a groundwater recharge and /or discharge area. It refers to the fundamental interaction between wetlands and aquifers, where there is potential for the wetland to contribute water to an aquifer (recharge) or to function as a groundwater discharge area.

The estuarine wetlands delineated on Site (i.e., E1UB3 and E2EM1 wetlands) are functioning as groundwater discharge areas. Groundwater in the form of seeps was observed at multiple locations discharging to the intertidal emergent marsh and Goose Pond (i.e., E1UB3 wetland). The seeps observed discharging to the marsh and Pond appear to originate in the mine tailings piles and waste rock piles on the Site.

The freshwater wetlands (i.e., PFO4, PSS1 and PEM1) delineated on site also appear to be deriving all or part of their hydrology from groundwater discharges, as seeps were observed in these wetland features. In addition, these wetland features are associated with a perennial stream feature, as shown on the wetland delineation plan (Figure 1). Based on our observations and data collected

during remedial investigations at the Site groundwater discharge is a suitable function of the wetlands delineated on Site.

5.2 FLOODFLOW ALTERATION (STORAGE AND DE-SYNCHRONIZATION)

This function considers the effectiveness of the wetland in reducing flood damage by attenuating floodwaters for prolonged periods following precipitation and snow melt events.

Goose Pond (i.e., E1UB3) does not provide significant floodflow alteration. There are areas where tributary streams discharge to the estuary, in these areas floodflow alteration may be a suitable function of bordering emergent marsh (i.e., E2EM1). However, the watersheds of these tributary streams are small and the surrounding soils are well drained; therefore, floodflow alteration would not be a principal function of these wetlands.

Similarly the freshwater wetlands delineated on Site would likely buffer increased runoff due to episodic precipitation events and spring runoff, primarily the PEM1 wetlands. As these wetlands are characterized by thick organic soils which are known to have a high water holding capacity. As noted above however, the watershed of the tributary streams delineated on site are relatively small and would not generate significant runoff therefore this function would not be considered a principal function of these wetlands.

5.3 FISH AND SHELLFISH HABITAT

This function considers the effectiveness or importance of seasonal or permanent waterbodies associated with the wetlands in question for fish and shellfish habitat.

The estuarine wetlands delineated on Site are providing fish and shellfish habitat based on direct of observations of fish and shellfish in these habitats. Estuarine habitats are known to provide breeding and nursery habitat for fish and shellfish. Fish and shellfish habitat would be a principal function of these wetlands.

The stream features delineated within the freshwater wetland to the south of the Tailings Pile may be providing suitable fish and shellfish habitat, although no direct observations of fish and shellfish use were documented. The streams delineated on Site do not connect via a defined channel to the

estuarine marsh and Goose pond, but becomes dendritic and defuse in the emergent freshwater wetland adjacent to the estuarine marsh (as shown on Figure 1). Fish passage from the estuary to the freshwater stream is unlikely. In addition, the upper reaches of the streams delineated on site originate from drainages which collect runoff from the surrounding uplands. This function is considered suitable, but not a primary function of the freshwater wetlands and steam delineated on site.

5.4 SEDIMENT/TOXICANT RETENTION

This function reduces or prevents degradation of water quality. It relates to the effectiveness of the wetland to act as a trap for sediments, toxicants, or pathogens that may be contained in river or runoff water.

The estuarine emergent marsh (i.e., E2EM1) bordering Goose Pond is providing sediment/toxicant retention, based on the high density of herbaceous species growing in this habitat. In addition, sediment sampling done in support of remedial activities at the Site has shown that these habitats are trapping sediment and toxicants. The primary source of sediment and toxicants is storm water runoff from the Site. Sediment/toxicant retention would be a principal function of these wetlands.

Sediment/toxicant retention is a suitable function for the freshwater wetlands delineated along the southern end of the Tailings Pile. The PFO and PSS wetlands to a lesser extent however, the PEM wetlands are providing sediment/toxicant retention, based on the density and species composition of emergent vegetation observed in these areas. Sediment/toxicant retention is a principal function of the PEM wetlands delineated on site, the PFO and PSS wetland would also function to slow/intercept storm water runoff, which would provide sediment/toxicant reduction.

5.5 NUTRIENT REMOVAL/RETENTION/TRANSFORMATION

This wetland function considers the effectiveness of the wetland to prevent adverse effects of excess nutrients entering aquifers or surface water. The effectiveness is related to the ability of the wetland to trap and process these nutrients into other forms or tropic levels.

As noted in the previous section, retention of sediments is occurring in the estuarine and freshwater emergent marsh wetlands on Site. The high density and plant species (i.e., smooth cordgrass and

cattails) growing in the wetlands, and the presence of organic and silt sediment, are likely functioning to remove excess nutrients through plant uptake and or attenuation in sediment. Based on observations of sediment trapping, vegetative growth and presence of organic/silt deposits the wetlands on site are providing nutrient removal, retention and transformation. Nutrient uptake is also a suitable function of the forested and scrub shrub wetlands on site, as they are also likely providing some nutrient uptake, based on their vigorous growth and density in the wetlands.

5.6 PRODUCTION EXPORT (NUTRIENT)

This function evaluates the effectiveness of the wetland to produce food or usable products for humans or other living organisms.

The estuarine and freshwater wetlands on site provide wildlife food sources including flowering and fruiting plants and seed producing herbaceous plants. These wetlands also provide habitat for fish, invertebrates, and amphibian populations which would provided a forage base for secondary and tertiary consumers. Piscivorous birds including kingfishers, greater yellow legs, green herons, and great blue herons were observed foraging in and along Goose Pond and bordering emergent marsh. Migratory waterfowl including mallard ducks, black ducks and wood ducks were also observed using the wetlands on site.

5.7 SEDIMENT/SHORELINE STABILIZATION

This function considers the effectiveness of a wetland to stabilize stream banks and shorelines against erosion.

The estuarine emergent marsh bordering Goose Pond is providing sediment and shoreline stabilization. The dense herbaceous growth observed in the marsh habitat provides protection to the underlying sediments from wind derived wave action. In addition, the freshwater wetlands (PFO4, PSS1, and PEM1 wetlands) are also providing sediment and stream bank stabilization. The dense herbaceous vegetation growing in the wetlands and the scrub shrub vegetation and trees growing along the edge of wetlands are functioning to stabilize the banks of the stream that bisect these wetlands. Sediment and shoreline stabilization is a principal function of the wetlands delineated on the Site.

5.8 WILDLIFE HABITAT

This function considers the effectiveness of the wetland to provide habitat for various types and populations of animals typically associated with wetlands and the wetland edge. Both resident and/or migrating species are considered.

The wetlands on site provide wildlife habitat for a variety of resident and migratory species. In particular, as noted above Goose Pond has a significant population of polychaete worms, bivalves and other aquatic invertebrates, fish, and amphibians which provide a forage base for higher trophic level consumers. Wildlife observed foraging in the estuarine habitats on site included kingfishers, cormorants, bald eagles, ducks and wading birds including great blue herons and greater yellow legs. The wetlands and adjacent forested upland to the south of the Tailings Pile also support small mammals such as voles, shrews and field mice as well as larger mammals including deer, raccoons, red fox, otters, and skunks, all of which have been observed at the Site. In addition, black bear tracks have been observed on the Tailings Pile. Wildlife habitat is considered a primary function of the wetlands delineated on site.

5.9 RECREATION (CONSUMPTIVE AND NON-CONSUMPTIVE)

This value considers the suitability of the wetland and associated watercourses to provide recreational opportunities such as hiking, canoeing, boating, fishing, hunting, and other active or passive recreational activities. Both "consumptive" and "non-consumptive" types of recreation are considered.

The Site is a listed National Priority List (NPL) Superfund Site, however public access is not currently controlled; therefore there is opportunity for recreational activities to occur on the Site. Recreational boaters have been observed using Goose Pond in the recent past. Duck hunting blinds have been observed in the marsh, in the southern end of Goose Pond. In addition, all-terrain vehicle use has been observed on portions of the Site. Goose Pond is closed to shell fishing. The land area to the east of Goose Pond is a wildlife sanctuary managed by the State of Maine, which provides hiking trails and ocean access to the public. Based on the current status as a NPL Site, and the availability of public recreational area to the east of Goose Pond, this is not considered a value of the wetlands on site.

5.10 EDUCATIONAL/SCIENTIFIC VALUE

This function considers the suitability of the wetland as a site for an "outdoor classroom" or as a location for scientific study or research.

The Site is a listed NPL Superfund Site, therefore utilizing the wetlands as an "outdoor classroom" would not be feasible due to potential for exposure to known contamination at the Site. There may be some value in the study of the Site for research purposes however due to the levels of contamination at the Site this would be limited to trained qualified personnel. Therefore educational/scientific value is not considered a value of these wetlands.

5.11 UNIQUENESS/HERITAGE

This value relates to the effectiveness of the wetland or its associated watersheds to provide certain special values such as archeological sites, unusual aesthetic qualities, historical events, unique plants, animals, geologic features, etc.

The wetland complex including Goose Pond, estuarine salt marsh, and bordering freshwater wetlands are somewhat unique to the coast of Maine. However, the historic mining operation has significantly altered some of the uniqueness of the area (i.e., waste rock piles and tailings pile). Therefore, uniqueness and heritage are not considered a value for these wetlands.

5.12 VISUAL QUALITY/AESTHETICS

This value relates to the visual and aesthetic qualities of the wetland.

As noted above the historic mining operation has significantly impacted the uplands adjacent to the wetland complex, through the construction of the tailings pile and waste rock piles, as well as other mining operations. Therefore, based on the current conditions at the Site visual quality/aesthetics is not considered a value for the wetlands on site.

5.13 ENDANGERED SPECIES HABITAT

This function considers the suitability of the wetland or associated watersheds to support rare, threatened, or endangered species.

The estuarine and freshwater wetlands on Site are likely providing forage and nesting habitat for rare, threatened and endangered species. Bald eagles have been observed on site on multiple occasions. Requests have been sent to the Maine Natural Areas Program, Maine Department of Inland Fisheries and Wildlife, and U.S. Fish and Wildlife Service requesting information on Rare, Threatened, and Endangered Species and Significant Wildlife Habitat known to occur on or in the vicinity of the Site. Endangered species habitat is considered a suitable function of the wetlands on site.

Response letters did not identify any rare threatened and/or endangered plant or animal species occurrences on the property. However, the Maine Department of Inland Fisheries and Wildlife have mapped all grass beds in Dyer Cove and Goose Pond as inland waterfowl/wading bird habitat. The letters sent to regulators and their responses are included in Attachment B.

5.14 CONCLUSION

The following table provides a summary of the suitable and principal functions of the wetlands delineated on the Site.

WETLAND FUNCTIONS AND VALUES SUMMARY TABLE

Functions and Values	**E1UB3**	**E2EM1**	**PFO4**	**PSS1**	**PEM1**
Groundwater Recharge/Discharge	S	S	S	S	S
Floodflow Alteration		S	S	S	S
Fish and Shell Fish Habitat	S,P	S,P			
Sediment/Toxicant Retention		S,P	S	S	S,P
Nutrient Removal		S	S	S	S
Production Export	S	S		S	S
Sediment/Shoreline Stabilization		S,P	S,P	S,P	S,P
Wildlife Habitat	S,P	S,P	S,P	S,P	S,P
Recreation					
Education/Scientific Value					
Uniqueness/Heritage					
Visual Quality/Aesthetics					
Endangered Species Habitat	S	S	S	S	S

Notes:

S = Suitable Function/Value

P = Principal Function/Value

As shown in the summary table the wetlands delineated on Site are providing functions and values. The estuarine wetlands (i.e., Goose Pond and adjacent salt marsh) principal functions are fish and shell fish habitat and wildlife habitat. In addition the estuarine salt marsh is providing sediment/toxicant retention and sediment/shore line stabilization. The freshwater wetlands delineated on Site principal functions included sediment/shoreline stabilization and wildlife habitat.

The following values; recreation, education/scientific value, uniqueness/heritage, and visual quality aesthetics were not considered suitable and or principal values due to the fact that the Site is a

listed NPL Superfund Site and residual impacts to the Site from historic mining operations, including the Mine Operations Area, Tailings Pile, and Waste Rock Piles.

6.0 REFERENCES:

Cowardin, 1979. Classification of Wetlands and Deepwater Habitats of the United States. U.S. Fish and Wildlife Service Publication Number FWS/OBS-79/31; Cowardin, L.M., Carter, V., Golet, F.C., and LaRoe, E.T., 1979.

NEHSTC, 1998. "Field Indicators for Identifying Hydric Soils in New England (2nd version)", New England Hydric Soils Technical Committee; New England Interstate Water Pollution Control Commission. Wilmington, MA; 1998.

USACE, 1993. The Highway Methodology Workbook; U.S. Army Corps of Engineers, New England Division. 28pp (NAEEP-360-1-30). 1993.

USACE, 1999. The Highway Methodology Workbook Supplement; U.S. Army Corps of Engineers, New England Division. 32pp (NAEEP-360-1-30a). September 1999.

FIGURES

Wetland GP
E2EM1

NWI Wetland
PUBHh

Wetland Delineated
By Others.

PVP

Wetland E
PEM1

Wetland A
PFO4

Wetland GP
E2EM1

Wetland B
PEM1

Wetland D
PEM1

Wetland C
PEM1

tp 6

tp 8

tp 9

Approximate location
of stream

tp 7

TP- 7A

Wetland GP
PFO4, PSS1, PEM1

Wetland GP
E2EM1

Legend

- Test_Points_09_09_2008
- Stream Channel
- Delineated Wetlands
- MACTEC Delineated Wetland
- Maine DEP Highest Annual Tide

N

0 125 250 Feet

Prepared/Date: DBW 10/27/08 | Checked/Date: CHL 10/27/08

Wetland Classification (Gowardin etal, 1979)

PFO4 - Palustrine, Forested, Needle-Leaved Evergreen wetland
PEM1 - Palustrine, Emergent, Persistant wetland
PSS1 - Palustrine, Scrub-Shrub, Broad-Leaved Deciduous wetland
E2EM1 - Estuarine, Intertidal, Emergent, Persistant wetland
E1UB3 - Estuarine, Subtidal, Uncosolidated Bottom, Mud wetland
PUBHh - Palustrine, Uncosolidated Bottom, Permanently Flooded, Diked / Impounded

PVP - Potential Vernal Pool
NWI - National Wetlands Inventory

Figure 1
Wetland Delineation Plan

Callahan Mine Superfund Site
Brooksville, Maine
MACTEC, Inc.

ATTACHMENT A

WETLAND AND FUNCTIONAL ASSESSMENT DATA FORMS

Wetland Function-Value Evaluation Form

Total area of wetland _____ Human made? ___no___ Is wetland part of a wildlife corridor?__yes___ or a "habitat island"? ___no___

Adjacent land use:_____forested/open marsh(estuarine)/historic mine_____ Distance to nearest roadway or other development_____

Dominant wetland systems present _____open water, muck bottom_____ Contiguous undeveloped buffer zone present_____

Is the wetland a separate hydraulic system? _____no_____ If not, where does the wetland lie in the drainage basin?_____lower_____

How many tributaries contribute to the wetland? ___multiple___ Wildlife & Vegetation diversity/abundance (see attached list)

Wetland I.D. _____E1UB3_____
Latitude_____ Longitude_____
Prepared by:__CHL____ Date__09/08/08
Wetland Impact:
Type_____ Area_____

Evaluation based on:
Office___X___ Field__X__

Corps manual wetland delineation completed? Y__X___ N_____

Function/Value	Suitability Y	Suitability N	Rationale (Reference #)*	Principal Functions(s)/Value(s)	Comments
Groundwater Recharge/Discharge	X				local hydrology affected by mine operations
Floodflow Alteration		X			open water
Fish and Shellfish Habitat	X			X	Goose Pond & Tidal Creeks are providing significant fish and shell fish habitat
Sediment/Toxicant Retention		X			sediment are deposited in this tidal estuary
Nutrient Removal		X			no significant nutrient removal, although sediments in pond area likely contaminant sink
Production Export	X				shellfish, marine invertebrates
Sediment/Shoreline Stabilization		X			NA
Wildlife Habitat	X			X	shellfish, marine invertebrates, fish
Recreation		X			Goose Pond sediments are known to contain elevated levels of inorganic constituents related to historic mining operations.
Educational/Scientific Value		X			Goose Pond sediments are known to contain elevated levels of inorganic constituents related to historic mining operations.
Uniqueness/Heritage		X			Goose Pond sediments are known to contain elevated levels of inorganic constituents related to historic mining operations.
Visual Quality Aesthetics		X			Goose Pond sediments are known to contain elevated levels of inorganic constituents related to historic mining operations.
ES Endangered Species Habitat	X				no known sediment inhabiting organisms present
Other					

Notes: Estuarine subtidal wetland; muck bottom also includes eel grass beds and other emergent and floating leaf plants

* Refer to backup list of numbered considerations.

Wetland Function-Value Evaluation Form

Total area of wetland _____ Human made? no Is wetland part of a wildlife corridor? yes or a "habitat island"? no

Adjacent land use: forested upland & wetland/historic mine Distance to nearest roadway or other development _____

Dominant wetland systems present salt marsh Contiguous undeveloped buffer zone present _____

Is the wetland a separate hydraulic system? no If not, where does the wetland lie in the drainage basin? lower

How many tributaries contribute to the wetland? multiple Wildlife & Vegetation diversity/abundance (see attached list)

Wetland I.D. E2EM1
Latitude _____ Longitude _____
Prepared by: CHL Date 09/08/08
Wetland Impact:
Type _____ Area _____

Evaluation based on:
Office X Field X

Corps manual wetland delineation completed? Y X N _____

Function/Value	Suitability Y	Suitability N	Rationale (Reference #)*	Principal Functions(s)/Value(s)	Comments
Groundwater Recharge/Discharge	X		1,6,7,13		local hydrology affected by mine operations, area shallow to bedrock seeps observed along Tailings Pile and Waste Rock piles.
Floodflow Alteration	X		3,5,6,7,8,9,13,18		wetland borders tidal estuary, Goose Pond does not receive significant inputs/discharges from tributaries
Fish and Shellfish Habitat	X		1,3,4,5,7,9,10,11,12, 14,15,16, (1,2,3,4,5)	X	marsh & Goose Pond "Tidal Creeks" provide nursery habitat from fish & shellfish
Sediment/Toxicant Retention	X		6	X	marsh is likely providing sed/tox retention
Nutrient Removal	X		2,3,4,5,6,7,8,9,10,12,13,14		marsh likely providing nutrient removal
Production Export		X	1,2,4,5,6,7,10,12		wildlife food sources limited to grass/verb seeds. No shrubs/trees
Sediment/Shoreline Stabilization	X		1,3,4,6,7,10,12,13,15	X	primay erosional force is wind derived wave action as well as some tidally influenced erosion
Wildlife Habitat	X		3,4,5,6,7,8,9,11,12, 13,16,17, 18,19,21	X	marsh likely providing significant wildlife habitat
Recreation		X			relatively uncommon wetland type however historic mine operations have significantly impacted adjacent uplands. Similar habitats are located in the vicinity of the site.
Educational/Scientific Value		X			relatively uncommon wetland type however historic mine operations have significantly impacted adjacent uplands. Similar habitats are located in the vicinity of the site.
Uniqueness/Heritage		X			relatively uncommon wetland type however historic mine operations have significantly impacted adjacent uplands. Similar habitats are located in the vicinity of the site.
Visual Quality Aesthetics		X			relatively uncommon wetland type however historic mine operations have significantly impacted adjacent uplands. Similar habitats are located in the vicinity of the site.
ES Endangered Species Habitat	X				area known to support bald eagles
Other					

Notes: Estuarine intertidal weltand (see PF04, PEM1, and PSS1 for descriptions/evaluations of freshwater wetlands which border the Goose Pond marsh habitat)

* Refer to backup list of numbered considerations.

Wetland Function-Value Evaluation Form

Total area of wetland _____ Human made? no Is wetland part of a wildlife corridor? yes or a "habitat island"? no

Adjacent land use: forested/historic mine Distance to nearest roadway or other development _____

Dominant wetland systems present needle leaved evergreen forest Contiguous undeveloped buffer zone present no, mine wastes

Is the wetland a separate hydraulic system? no If not, where does the wetland lie in the drainage basin? upper

How many tributaries contribute to the wetland? _____ Wildlife & Vegetation diversity/abundance (see attached list)

Wetland I.D. PF04
Latitude _____ Longitude _____
Prepared by: CHL Date 09/08/08
Wetland Impact:
Type _____ Area _____

Evaluation based on:
Office X Field X

Corps manual wetland delineation completed? Y X N _____

Function/Value	Suitability Y	Suitability N	Rationale (Reference #)*	Principal Functions(s)/Value(s)	Comments
Groundwater Recharge/Discharge	X		1,6,7,13		local hydrology affected by mine operations, area shallow to bedrock. Seeps observed along mine tailings & Waste Rock piles.
Floodflow Alteration	X		2,3,5,8,9,14,18		forested wetlands may buffer increase runoff due to episodic precipitation events & spring runoff
Fish and Shellfish Habitat		X			forested wetlands do not provide fish and shellfish habitat; no ponded or permanently flowing streams
Sediment/Toxicant Retention	X		1,2,4,7,8,9,10		forested wetlands borders scrub/shrub & emergent wetlands and may be providing some sediment/toxicant retention & nutrient removal.
Nutrient Removal		X	2,3,6,7,11		appear to be providing some sediment & bank stabilization
Production Export		X	1,2,4,8,10,11,12		some fruit producing trees present
Sediment/Shoreline Stabilization	X		1,2,3,4,6,7,9,14,15	X	uplands contain highly erodible silty soils
Wildlife Habitat	X		3,5,6,7,8,9, 10,11,15,16,17, 18,19,20,21	X	forested wetlands on site are providing habitat for avian mammalian and inverts, reptiles & amphibians; some human impact due to past mining operation
Recreation		X			common wetland type; similar habitats located close by in state run sanctuary; historic mine operations have significantly impacted uplands (tailings and Waste Rock piles)
Educational/Scientific Value		X			common wetland type; similar habitats located close by in state run sanctuary; historic mine operations have significantly impacted uplands (tailings and Waste Rock piles)
Uniqueness/Heritage		X			common wetland type; similar habitats located close by in state run sanctuary; historic mine operations have significantly impacted uplands (tailings and Waste Rock piles)
Visual Quality Aesthetics		X			historic mine operations have significantly impacted adjacent uplands
ES Endangered Species Habitat	X				area known to support bald eagles (have been observed at site)(observed potential vernal pool in PF04-wetland)
Other					

Notes: includes wetland A & portions of wetland GP south of Tailings Pile

* Refer to backup list of numbered considerations.

Wetland Function-Value Evaluation Form

Total area of wetland _____ Human made? no Is wetland part of a wildlife corridor? yes or a "habitat island"? no

Adjacent land use: forested/open marsh(estuarine)/historic mine Distance to nearest roadway or other development _____

Dominant wetland systems present scrub/shrub Contiguous undeveloped buffer zone present no, mine wastes

Is the wetland a separate hydraulic system? no If not, where does the wetland lie in the drainage basin? lower

How many tributaries contribute to the wetland? _____ Wildlife & Vegetation diversity/abundance (see attached list)

Wetland I.D. PSS1
Latitude_____ Longitude_____
Prepared by: CHL Date 09/08/08
Wetland Impact:
Type_____ Area_____

Evaluation based on:
Office X Field X

Corps manual wetland delineation completed? Y X N_____

Function/Value	Suitability Y	Suitability N	Rationale (Reference #)*	Principal Functions(s)/Value(s)	Comments
Groundwater Recharge/Discharge	X		1,6,7,13		local hydrology affected by mine operations, area shallow to bedrock seeps observed along mine tailings & Waste Rock piles
Floodflow Alteration	X		3,5,6,8,9,10,13,14,16,18		scrub shrub wetlands border emergent wetlands throughout site; likely provide some flood flow alteration
Fish and Shellfish Habitat		X			scrub shrub wetlands do not provide fish & shellfish habitat (i.e. open water)
Sediment/Toxicant Retention	X		1,2,3,4,7,9,10,11,14,16		scrub shrub wetlands occur between forested & emergent wetlands in several locations on site. Appear to be providing some sediment & toxicant retention & nutrient removal
Nutrient Removal	X		3,4,5,6,7,8,9,11,12,14		
Production Export	X		1,2,4,5,7,8,10,12,13		fruit producing shrubs present
Sediment/Shoreline Stabilization	X		1,2,3,4,5,7,9,14,15	X	scrub shrub vegetation is providing sed/shoreline stabilization
Wildlife Habitat	X		1,3,4,5,6,7,8,9,10,13,14,15 ,16,17,18, 19,20,21	X	wildlife have been observed using all wetlands on site
Recreation		X			common wetland type; similar wetlands located close by in state run sanctuary (Holbrook Sanctuary) Past mine operations have significantly impacted bordering uplands (Tailings Pile & Waste Rock piles)
Educational/Scientific Value		X			common wetland type; similar wetlands located close by in state run sanctuary (Holbrook Sanctuary) Past mine operations have significantly impacted bordering uplands (Tailings Pile & Waste Rock piles)
Uniqueness/Heritage		X			common wetland type; similar wetlands located close by in state run sanctuary (Holbrook Sanctuary) Past mine operations have significantly impacted bordering uplands (Tailings Pile & Waste Rock piles)
Visual Quality Aesthetics		X			common wetland type; similar wetlands located close by in state run sanctuary (Holbrook Sanctuary) Past mine operations have significantly impacted bordering uplands (Tailings Pile & Waste Rock piles)
ES Endangered Species Habitat	X				area known to support bald eagles (observed on site)
Other					

Notes:

* Refer to backup list of numbered considerations.

Wetland Function-Value Evaluation Form

Total area of wetland _____ Human made? no Is wetland part of a wildlife corridor? yes or a "habitat island"? no

Adjacent land use: forested/historic mine Distance to nearest roadway or other development _____

Dominant wetland systems present persistent emergent Contiguous undeveloped buffer zone present _____

Is the wetland a separate hydraulic system? no If not, where does the wetland lie in the drainage basin? mid to lower

How many tributaries contribute to the wetland? multiple Wildlife & Vegetation diversity/abundance (see attached list)

Wetland I.D. PEM1
Latitude _____ Longitude _____
Prepared by: CHL Date 09/08/08
Wetland Impact:
Type _____ Area _____

Evaluation based on:
Office X Field X

Corps manual wetland delineation completed? Y X N _____

Function/Value	Suitability Y	Suitability N	Rationale (Reference #)*	Principal Functions(s)/Value(s)	Comments
Groundwater Recharge/Discharge	X		1,6,7,13		local hydrology affected by mine operations, area shallow to bedrock seeps observed along mine tailing and Waste Rock piles
Floodflow Alteration	X		3,5,6,7,8,9,13,14,16,18		emergent wetlands, with organic soils have a high potential to provide significant flood flow alteration
Fish and Shellfish Habitat		X			emergent wetlands (fresh water) don't provide fish & shellfish habitat
Sediment/Toxicant Retention	X		1,2,3,4,5,6,7,9,10,11,13, 14,16	X	channelized flow observed flowing into PEM 1 become diffuse and un-discernable
Nutrient Removal	X		3,4,5,6,7,8,9,10,11,12,13 ,14		
Production Export	X		1,2,4,5,7,9,10,12,13		
Sediment/Shoreline Stabilization	X		3,4,5,7,12,13,15	X	
Wildlife Habitat	X		3,4,5,6,7,8,11,12,13,16, 17,18,19,20,21	X	
Recreation		X			common wetland type; similar wetlands located close by in state run sanctuary (Holbrook Sanctuary); past mine operations have significantly impacted bordering uplands (Tailings Pile & Waste Rock piles)
Educational/Scientific Value		X			common wetland type; similar wetlands located close by in state run sanctuary (Holbrook Sanctuary); past mine operations have significantly impacted bordering uplands (Tailings Pile & Waste Rock piles)
Uniqueness/Heritage		X			common wetland type; similar wetlands located close by in state run sanctuary (Holbrook Sanctuary); past mine operations have significantly impacted bordering uplands (Tailings Pile & Waste Rock piles)
Visual Quality Aesthetics		X			common wetland type; similar wetlands located close by in state run sanctuary (Holbrook Sanctuary); past mine operations have significantly impacted bordering uplands (Tailings Pile & Waste Rock piles)
ES Endangered Species Habitat	X				area known to support bald eagles (observed on the site)
Other					

Notes: PEM = freshwater emergent marsh; areas bordering the Goose Pond salt marsh and several isolated man-made wetlands

* Refer to backup list of numbered considerations.

PROJECT TITLE: Callahan Mine Superfund Site TRANSECT: ~~WETLAND~~ PLOT: TP-6

DELINEATOR(S): CLYMAN DATE: 9/5/08

VEGETATION

Stratum and Species	Dominance Ratio	Percent Dominance	DOM	NWI Status
~~TREES: None~~				
~~SHRUBS: None~~				
Herbs:				
Common Reed (Phragmites australis)	20.5/144	14%		
Smooth Cordgrass (Spartina alterniflora)	85.5/144	60%	X	OBL
Saltmeadow Cordgrass (Spartina patens)	38/144	26%	X	FACW+
~~Narrow leaved cattail (Typha angustifolia)~~				
SHRUBS: None				
TREES: None				
Vines: None				

HYDROPHYTES

OBL	FACW	FAC	*OTHER
1	1		

NON-HYDROPHYTES

FAC-	FACU	UPL

Hydrophytes Subtotal (A): 2 Non-hydrophytes Subtotal (B): 0

PERCENT HYDROPHYTES (100A/A+B): 100%

HYDROLOGY

☐ RECORDED DATA
Stream, lake, or tidal gage Identification: _____
Aerial photography Identification: _____
Other Identification: _____

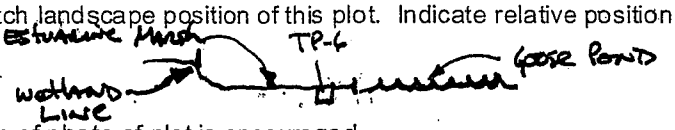
☑ NO RECORDED DATA

☑ OBSERVATIONS:
Depth to Free Water: SURFACE
Depth to Saturation (including capillary fringe): SURFACE
Altered Hydrology (explain): _____

☐ Inundated ☑ Saturated in upper 12" ☑ Water Marks ☑ Drift Lines ☐ Sediment Deposits ☐ Drainage Patterns within Wetland

☑ OTHER (explain): SALT MARSH TIDALLY INFLUENCED

SOIL Sketch landscape position of this plot. Indicate relative position of other plot(s) and the wetland flag if not on plan.



Submission of photo of plot is encouraged.

DEPTH	HORIZON	MATRIX COLOR	REDOXIMORPHIC FEATURES (color, abundance, size, contrast)	COMMENTS (USDA texture, nodules, concretions, masses, pore linings, restrictive layers, root distribution, soil water, etc.)
0-8"	Oi	DARK BROWN	—	MANY fine Roots, MUCK, Friable
8-12"	Oa	gray (Gley 2 4/10g)	gleyed	Silty CLAY, No Roots, friable
12"-48"	C	5y 3/1	↓	Silt, No Roots, friable/loose.
48" = Limit of observations				Note/ Sulfidic ODOR throughout. - Free water to top of Pit.

HYDRIC SOIL INDICATOR(S): II

REFERENCE(S): Field Indicators for Identifying Hydric Soils in New England V.3 April 2004

OPTIONAL SOIL DATA

Taxonomic subgroup:
Soil drainage class:
Depth to active water table:
NTCHS hydric soil criterion:

REFERENCE(S): Upland adjacent to wetland is composed of fill material (Berm surrounding the tailings Pile.

CONCLUSIONS

	YES	NO	REMARKS:
Hydrophytic vegetation criterion met?	☑	☐	
Hydric soils criterion met?	☑	☐	
Wetland hydrology criterion met?	☑	☐	
IS THIS DATAPOINT IN A WETLAND?	☑	☐	

PROJECT TITLE: Callahan Mine superfund site TRANSECT: Wetland PLOT: TP-6

PROJECT TITLE: Callahan Mine Superfund Site TRANSECT: Wetland PLOT: TP-7A

DELINEATOR(S): CLymon DATE: 9/5/08

VEGETATION

Stratum and Species	Dominance Ratio	Percent Dominance	DOM	NWI Status
Herbaceous:				
Tussock sedge (Carex stricta)	63/173	39%	X	OBL
Cinnamon fern (Osmunda cinnamomea)	38/173	22%	X	FACW
Sensitive fern (Onoclea sensibilis)	38/173	22%	X	FACW
Grass (Poa palustris)	20.5/173	12%		
Equisetum (Equisetum palustre)	10.5/173	6%		
Golden Rod (Solidago sp.)	3/173	2%		
Shrubs:				
Alder (Alnus serrulata)	85.5/96	89%	X	OBL
Black spruce (Picea mariana)	10.5/96	11%		
Trees:				
Black spruce (Picea mariana)	282/358	78%	X	FACW
Gray Birch (Betula populifolia)	76/358	22%	X	FAC

HYDROPHYTES

OBL	FACW	FAC	*OTHER
2	3	1	

NON-HYDROPHYTES

FAC-	FACU	UPL

Hydrophytes Subtotal (A): 6 Non-hydrophytes Subtotal (B): 0

PERCENT HYDROPHYTES (100A/A+B): 100%

HYDROLOGY

☐ RECORDED DATA
- Stream, lake, or tidal gage Identification: _____
- Aerial photography Identification: _____
- Other Identification: _____

☑ NO RECORDED DATA

☐ OBSERVATIONS:

Depth to Free Water: _____

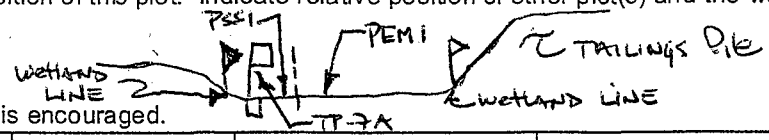
Depth to Saturation (including capillary fringe): _____

Altered Hydrology (explain): _____

☐ Inundated ☑ Saturated in upper 12" ☑ Water Marks ☑ Drift Lines ☐ Sediment Deposits ☐ Drainage Patterns within Wetland

☐ OTHER (explain):

SOIL Sketch landscape position of this plot. Indicate relative position of other plot(s) and the wetland flag if not on plan.



Submission of photo of plot is encouraged.

DEPTH	HORIZON	MATRIX COLOR	REDOXIMORPHIC FEATURES (color, abundance, size, contrast)	COMMENTS (USDA texture, nodules, concretions, masses, pore linings, restrictive layers, root distribution, soil water, etc.)
4-0"	Oi	DARK BROWN	—	Many fine, few Med Roots, friable
0-7"	A	5y 5/1	Many fine & Many Med depletions	Loamy fine SAND, friable, few fine Roots.
7-14"	Bw	5y 5/1	↓	Loamy SAND, firm, No Roots w/channels
14"-24"	B/C	5y 5/3	few fine & many Med. depletions	Silt LOAM, firm, No Roots
24" = Limit of observations				

HYDRIC SOIL INDICATOR(S): V

REFERENCE(S): Field Indicators for Identifying Hydric Soils in New England V.3 April 2004

OPTIONAL SOIL DATA

REFERENCE(S):

Taxonomic subgroup:
Soil drainage class:
Depth to active water table:
NTCHS hydric soil criterion:

CONCLUSIONS

	YES	NO
Hydrophytic vegetation criterion met?	☑	☐
Hydric soils criterion met?	☑	☐
Wetland hydrology criterion met?	☑	☐
IS THIS DATAPOINT IN A WETLAND?	☑	☐

REMARKS: PSS1 - WETLAND (FRESHWATER)

PROJECT TITLE: Callahan Mine Superfund site TRANSECT: Wetland PLOT: TP-7A

PROJECT TITLE: Calhoun Mine Superfund site TRANSECT: Wetland PLOT: TP-7

DELINEATOR(S): CLymon DATE: 9/5/08

VEGETATION

Stratum and Species	Dominance Ratio	Percent Dominance	DOM	NWI Status
HERBACEOUS:				
Cattails (Typha latifolia)	85.5/190	44%	X	OBL
Sensitive fern (Onoclea sensibilis)	20.5/190	11%		
Sedge (Carex crinita)	63/190	33%	X	OBL
~~Grass~~ (Reed Canary (Phalaris arundinacea)	10.5/190	6%		
Jewel weed (Impatiens capensis)	10.5/190	6%		
SHRUBS:				
Gooseberry (Ribes hirtellum)	3/6	50%	X	FAC
Raspberry (Rubus sp.)	3/6	50%	X	FAC-
TREES: NONE				

HYDROPHYTES

OBL	FACW	FAC	*OTHER
2		1	

Hydrophytes Subtotal (A): 3

NON-HYDROPHYTES

FAC-	FACU	UPL
1		

Non-hydrophytes Subtotal (B): 1

PERCENT HYDROPHYTES (100A/A+B): 75%

HYDROLOGY

☐ RECORDED DATA
Stream, lake, or tidal gage Identification: _____
Aerial photography Identification: _____
Other Identification: _____

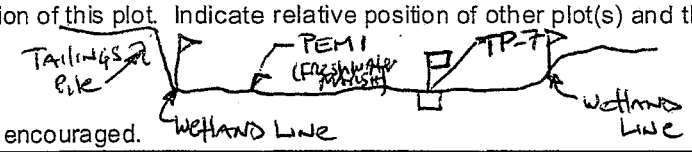
☑ NO RECORDED DATA

☐ OBSERVATIONS:
Depth to Free Water: surface
Depth to Saturation (including capillary fringe): surface
Altered Hydrology (explain): _____

☐ Inundated ☑ Saturated in upper 12" ☐ Water Marks ☐ Drift Lines ☑ Sediment Deposits ☐ Drainage Patterns within Wetland

☐ OTHER (explain):

SOIL Sketch landscape position of this plot. Indicate relative position of other plot(s) and the wetland flag if not on plan.



Submission of photo of plot is encouraged.

DEPTH	HORIZON	MATRIX COLOR	REDOXIMORPHIC FEATURES (color, abundance, size, contrast)	COMMENTS (USDA texture, nodules, concretions, masses, pore linings, restrictive layers, root distribution, soil water, etc.)
7-0"	Oi	DARK BROWN	—	Many fine Roots
0-7"	A	5y 5/1	Many fine & Many Med. Depletions	Loamy fine SAND, friable, few fine roots.
7-14"	Bw	5y 5/1	↓	Loamy fine SAND, firm, No Roots
14"-48"	2C	5y 3/1	depleted	Silt Loam, firm, No Roots

HYDRIC SOIL INDICATOR(S): V

REFERENCE(S): Field Indicators for Identifying Hydric Soils in New England V.3 April 2004

OPTIONAL SOIL DATA

REFERENCE(S):

Taxonomic subgroup:
Soil drainage class:
Depth to active water table:
NTCHS hydric soil criterion:

CONCLUSIONS

	YES	NO
Hydrophytic vegetation criterion met?	☑	☐
Hydric soils criterion met?	☑	☐
Wetland hydrology criterion met?	☑	☐
IS THIS DATAPOINT IN A WETLAND?	☑	☐

REMARKS: PEM1-WETLAND (FRESHWATER)

PROJECT TITLE: Callahan Mine Superfund site TRANSECT: Wetland PLOT: TP-7

PROJECT TITLE: Callahan Mine Superfund Site TRANSECT: Wetland PLOT: TP-8

DELINEATOR(S): Clymer DATE: 9/5/08

VEGETATION

Stratum and Species	Dominance Ratio	Percent Dominance	DOM	NWI Status
Herbaceous:				
Smooth cordgrass (Spartina alterniflora)	38/89.5	42%	X	OBL
Saltmeadow cordgrass (Spartina patens)	38/89.5	42%	X	FACW+
Seaside goldenrod (Solidago sempervirens)	10.5/89.5	12%		
Black grass (Juncus gerardii)	3/89.5	3%		
Shrubs/saplings: None				
Trees: None				

HYDROPHYTES

OBL	FACW	FAC	*OTHER
	1	1	

Hydrophytes Subtotal (A): 2

NON-HYDROPHYTES

FAC-	FACU	UPL

Non-hydrophytes Subtotal (B): 0

PERCENT HYDROPHYTES (100A/A+B): 100%

HYDROLOGY

☐ RECORDED DATA
Stream, lake, or tidal gage Identification: _____
Aerial photography Identification: _____
Other Identification: _____

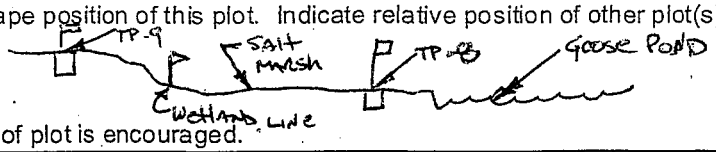
☑ NO RECORDED DATA

☐ OBSERVATIONS:
Depth to Free Water: Surface
Depth to Saturation (including capillary fringe): _____
Altered Hydrology (explain): _____

☐ Inundated ☑ Saturated in upper 12" ☑ Water Marks ☑ Drift Lines ☐ Sediment Deposits ☐ Drainage Patterns within Wetland

☑ OTHER (explain): Salt marsh tidally influenced

SOIL Sketch landscape position of this plot. Indicate relative position of other plot(s) and the wetland flag if not on plan.



Submission of photo of plot is encouraged.

DEPTH	HORIZON	MATRIX COLOR	REDOXIMORPHIC FEATURES (color, abundance, size, contrast)	COMMENTS (USDA texture, nodules, concretions, masses, pore linings, restrictive layers, root distribution, soil water, etc.)
0-8"	Oi to Oa	DARK BROWN	—	MANY fine Roots, silty MUCK,
8-12"	C_1	5y 4/1	Depleted	~~Silt Loam~~ ~~Mucky Silt~~, silt, few fine Roots friable/loose
12-48"	C_2	2.5y 4/1	↓	silt., No Roots., friable/loose
48" = Limit of observations				

HYDRIC SOIL INDICATOR(S): II/III

REFERENCE(S): Field Indicators for Identifying Hydric Soils in New England V.3 April 2004

OPTIONAL SOIL DATA

REFERENCE(S):

Taxonomic subgroup:
Soil drainage class:
Depth to active water table:
NTCHS hydric soil criterion:

CONCLUSIONS

	YES	NO	REMARKS:
Hydrophytic vegetation criterion met?	☑	☐	
Hydric soils criterion met?	☑	☐	
Wetland hydrology criterion met?	☑	☐	
IS THIS DATAPOINT IN A WETLAND?	☑	☐	

PROJECT TITLE: Callahan Mine Superfund Site TRANSECT: Wetland PLOT: TP-8

PROJECT TITLE: Callahan Mine Superfund Site TRANSECT: UPLAND (Typical un-impacted) PLOT: TP-9

DELINEATOR(S): Clyman DATE: 9/5/08

VEGETATION Stratum and Species	Dominance Ratio	Percent Dominance	DOM	NWI Status
HERBACEOUS:				
Star flower (Trientalis borealis)	3/9	33%	X	FAC
Lilly (Lilium canadensis)	3/9	33%	X	FAC+
Bracken Fern (Pteridium aquilinum)	3/9	33%	X	FACU
SHRUBS/SAPLINGS:				
Low Bush Blueberry (Vaccinium angustifolium)	20.5/31	66%	X	FACU-
Balsam fir (Abies balsamea)	10.5/31	34%	X	FAC
TREES:				
Red spruce (Picea rubens)	1,041/1812	57%	X	FACU
White Pine (Pinus strobus)	570/1812	32%	X	FACU
~~White~~ Gray Birch (Betula populifolia)	201/1812	11%		

HYDROPHYTES

OBL	FACW	FAC	*OTHER
		3	

Hydrophytes Subtotal (A): 3

NON-HYDROPHYTES

FAC-	FACU	UPL
	4	

Non-hydrophytes Subtotal (B): 4

PERCENT HYDROPHYTES (100A/A+B): 43%

HYDROLOGY

☐ RECORDED DATA
Stream, lake, or tidal gage Identification: _____
Aerial photography Identification: _____
Other Identification: _____

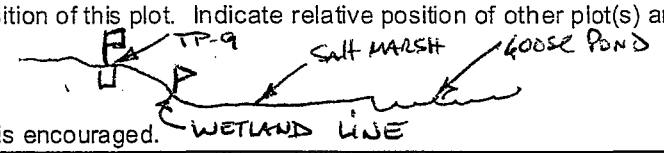
☑ NO RECORDED DATA

☐ OBSERVATIONS:
Depth to Free Water: _____
Depth to Saturation (including capillary fringe): _____
Altered Hydrology (explain): _____

☐ Inundated ☐ Saturated in upper 12" ☐ Water Marks ☐ Drift Lines ☐ Sediment Deposits ☐ Drainage Patterns within Wetland

☐ OTHER (explain):

SOIL Sketch landscape position of this plot. Indicate relative position of other plot(s) and the wetland flag if not on plan.



Submission of photo of plot is encouraged.

DEPTH	HORIZON	MATRIX COLOR	REDOXIMORPHIC FEATURES (color, abundance, size, contrast)	COMMENTS (USDA texture, nodules, concretions, masses, pore linings, restrictive layers, root distribution, soil water, etc.)
3-0	Oi	—	—	Pine Needles, Partially Decomposed with depth
0-2"	E	10YR 4/1	—	Silt Loam, friable, many fine Roots
2-6"	Bw1	10YR 3/3	—	Silt Loam, friable, many fine Roots
6-12"	Bw2	10YR 4/4	—	Silt Loam, friable, few fine Roots
12-14"	B/C	10YR 4/4	—	Silt Loam-Channery, firm, no Roots.
14" Limit of observations				

HYDRIC SOIL INDICATOR(S): Non-Hydric Soil

REFERENCE(S):

OPTIONAL SOIL DATA

REFERENCE(S):

Taxonomic subgroup:
Soil drainage class:
Depth to active water table:
NTCHS hydric soil criterion:

CONCLUSIONS

	YES	NO
Hydrophytic vegetation criterion met?	☐	☑
Hydric soils criterion met?	☐	☑
Wetland hydrology criterion met?	☐	☑
IS THIS DATAPOINT IN A WETLAND?	☐	☑

REMARKS: Typical upland outside of Area impacted by Historic Mine Operations.

PROJECT TITLE: Callahan MINE Superfund Site TRANSECT: Upland (Unimpacted) PLOT: TP-9

ATTACHMENT B

CORRESPONDANCE LETTERS AND RESPONSES FROM REGULATORS

Correspondence Letters to Regulators

MACTEC

engineering and constructing a better tomorrow

October 15, 2008

Project No. 3612062047/29

U.S. Fish and Wildlife Service
Maine Field Office
1168 Main Street
Old Town, Maine 04468

Subject: Rare, Threatened or Endangered Species Review
Callahan Mine Superfund Site
Brooksville, Maine

Dear Sir/Madam,

I am sending you this letter to request a review for known occurrences of Rare, Threatened, or Endangered species known to occur in the vicinity of the subject property, located in Brooksville, Maine. This information is to be used in support of remediation activities being conducted at the site. Please find a Site Location Map showing the approximate site boundary, attached to this letter. Please feel free to contact me at (207) 828-3280, if you have any questions regarding this request.

Sincerely,
MACTEC ENGINEERING AND CONSULTING, INC.

Charles H. Lyman

Charles H. Lyman
Project Scientist

MACTEC Engineering and Consulting, Inc.
511 Congress Street, P.O. Box 7050 • Portland, ME 04112-7050 • Phone: 207.775.5401 • Fax: 207.772.4762

MACTEC

engineering and constructing a better tomorrow

October 15, 2008

Project No. 3612062047/29

Department of Inland Fisheries and Wildlife
41 State House Station
Augusta, Maine 04333

Subject: Significant Wildlife Habitats and Rare, Threatened or Endangered Species Review
Callahan Mine Superfund Site
Brooksville, Maine

Dear Sir/Madam,

I am sending you this letter to request a review for known occurrences of Significant Wildlife Habitat and Rare, Threatened, or Endangered species known to occur in the vicinity of the subject property, located in Brooksville, Maine. This information is to be used in support of remediation activities being conducted at the site. Please find a Site Location Map showing the approximate site boundary, attached to this letter. Please feel free to contact me at (207) 828-3280, if you have any questions regarding this request.

Sincerely,
MACTEC ENGINEERING AND CONSULTING, INC.

Charles H. Lyman

Charles H. Lyman
Project Scientist

MACTEC Engineering and Consulting, Inc.
511 Congress Street, P.O. Box 7050 • Portland, ME 04112-7050 • Phone: 207.775.5401 • Fax: 207.772.4762
www.mactec.com

MACTEC

engineering and constructing a better tomorrow

October 15, 2008

Project No. 3612062047/29

Maine Natural Areas Program
Department of Conservation
93 State House Station
Augusta, Maine 04333

Subject: Rare, Threatened and Endangered Species
Environmental Site Review
Callahan Mine Superfund Site
Brooksville, Maine

Dear Sir/Madam,

I am sending you this letter to request an environmental site review for the subject property, located in Brooksville, Maine. This information is to be used in support of remediation activities being conducted at the site. Please find a Site Location Map showing the approximate site boundary, attached to this letter. Please feel free to contact me at (207) 828-3280, if you have any questions regarding this request.

Sincerely,
MACTEC ENGINEERING AND CONSULTING, INC.

Charles H. Lyman

Charles H. Lyman
Project Scientist

MACTEC Engineering and Consulting, Inc.
511 Congress Street, P.O. Box 7050 • Portland, ME 04112-7050 • Phone: 207.775.5401 • Fax: 207.772.4762 www.mactec.com

Response from Regulators

United States Department of the Interior

FISH AND WILDLIFE SERVICE

Maine Field Office – Ecological Services
1168 Main Street
Old Town, ME 04468
(207) 827-5938 Fax: (207) 827-6099

In Reply Refer To: 53411-2009-SL-0013
FWS/Region5/ES/MEFO

October 16, 2008

Charles Lyman
MACTEC Engineering and Consulting Inc.
511 Congress St
PO Box 7050
Portland, ME 04112-7050

Dear Mr. Lyman,

Thank you for your letter dated October 15, 2008 requesting information or recommendations from the U.S. Fish and Wildlife Service. This letter provides the Service's response pursuant to Section 7 of the Endangered Species Act (ESA), as amended (16 U.S.C. 1531-1543), Bald and Golden Eagle Protection Act (16 U.S.C. 668-668d, 54 Stat. 250) and the Fish and Wildlife Coordination Act, as amended (16 U.S.C. 661-667d).

Project Name/Location: Callahan Mine Superfund Site, Brooksville

Federally listed species

Based on the information currently available to us, no federally threatened or endangered species under the jurisdiction of the Service are known to occur in the project area. Accordingly, no further action is required under Section 7 of the ESA, unless: (1) new information reveals impacts of this identified action that may affect listed species or critical habitat in a manner not previously considered; (2) this action is subsequently modified in a manner that was not considered in this review; or (3) a new species is listed or critical habitat determined that may be affected by the identified action.

Other protected species

We have not reviewed this project for state-threatened and endangered wildlife, wildlife species of special concern, and significant wildlife habitats protected under the Maine Natural Resources Protection Act. I recommend that you contact the Maine Department of Inland Fisheries and Wildlife:

TAKE PRIDE® IN AMERICA

Steve Timpano
Maine Department of Inland Fisheries and Wildlife
284 State St.
State House Station 41
Augusta, ME 04333-0041
Phone: 207 287-5258

Atlantic salmon may occur in the project area. I recommend that you contact the Department of Marine Resources for additional information:

Norm Dube
Maine Department of Marine Resources
650 State St.
Bangor, ME 04401

I recommend that you contact the Maine Natural Areas Program for additional information on state-threatened and endangered plant species, plant species of special concern, and rare natural communities:

Lisa St. Hilaire
Maine Natural Areas Program
Department of Conservation
93 State House Station
Augusta, ME 04333
Phone: 207 287-8046

Bald eagles

Occasional, transient bald eagles (*Haliaeetus leucocephalus*) may occur in the area. Based on the information currently available to use, there are no bald eagle nests near your project. The bald eagle was removed from the federal threatened list on August 9, 2007 and is now protected from take under the Bald and Golden Eagle Protection Act and the Migratory Bird Treaty Act. "Take" means to pursue, shoot, shoot at, poison, wound, kill, capture, trap, collect, molest or disturb. The term "disturb" under the Bald and Golden Eagle Protection Act was recently defined within a final rule published in the Federal Register on June 5, 2007 (72 Fed. Reg. 31332). "Disturb" means to agitate or bother a bald or golden eagle to a degree that causes, or is likely to cause, based on the best scientific information available, 1) injury to an eagle; 2) a decrease in its productivity, by substantially interfering with normal breeding, feeding, or sheltering behavior; or 3) nest abandonment, by substantially interfering with normal breeding, feeding, or sheltering behavior.

Further information on bald eagle delisting and their protection can be found at http://www.fws.gov/migratorybirds/baldeagle.htm.

Please consult with our new national bald eagle guidelines, which can found at http://www.fws.gov/migratorybirds/issues/BaldEagle/NationalBaldEagleManagementGuidelines.pdf.

These Guidelines are voluntary and were prepared to help landowners, land managers and others meet the intent of the Eagle Act and avoid disturbing bald eagles. If you believe your project will result in taking or disturbing bald or golden eagles, please contact our office for further guidance. We encourage early and frequent consultations to avoid take of eagles.

If you have any questions, please call Mark McCollough, endangered species biologist, at (207) 827-5938 ext.12.

Sincerely,

Lori Nordstrom, Project Leader
Maine Field Office

From: Jordan, Richard [mailto:Richard.Jordan@maine.gov]
Sent: Wednesday, October 22, 2008 3:18 PM
To: Lyman, Charles
Cc: Timpano, Steve
Subject: Review of Callahan Mine Superfund Site for significant freshwater fisheries, Project No. 3612062047/29

Charles,

After review of your site location map that you sent us from MACTEC Engineering and Consulting, with further review using our mapping software, I do not find any significant inland freshwater fisheries habitat or fish population concerns at the Callahan Mine Superfund Site.

Rick Jordan

><< <*))))))>{ ><< <*))))))>{ ><< <*))))))>{
Rick Jordan, Regional Fisheries Biologist
Maine Dept. of Inland Fisheries & Wildlife
P.O. Box 220
Jonesboro, ME 04648-0220

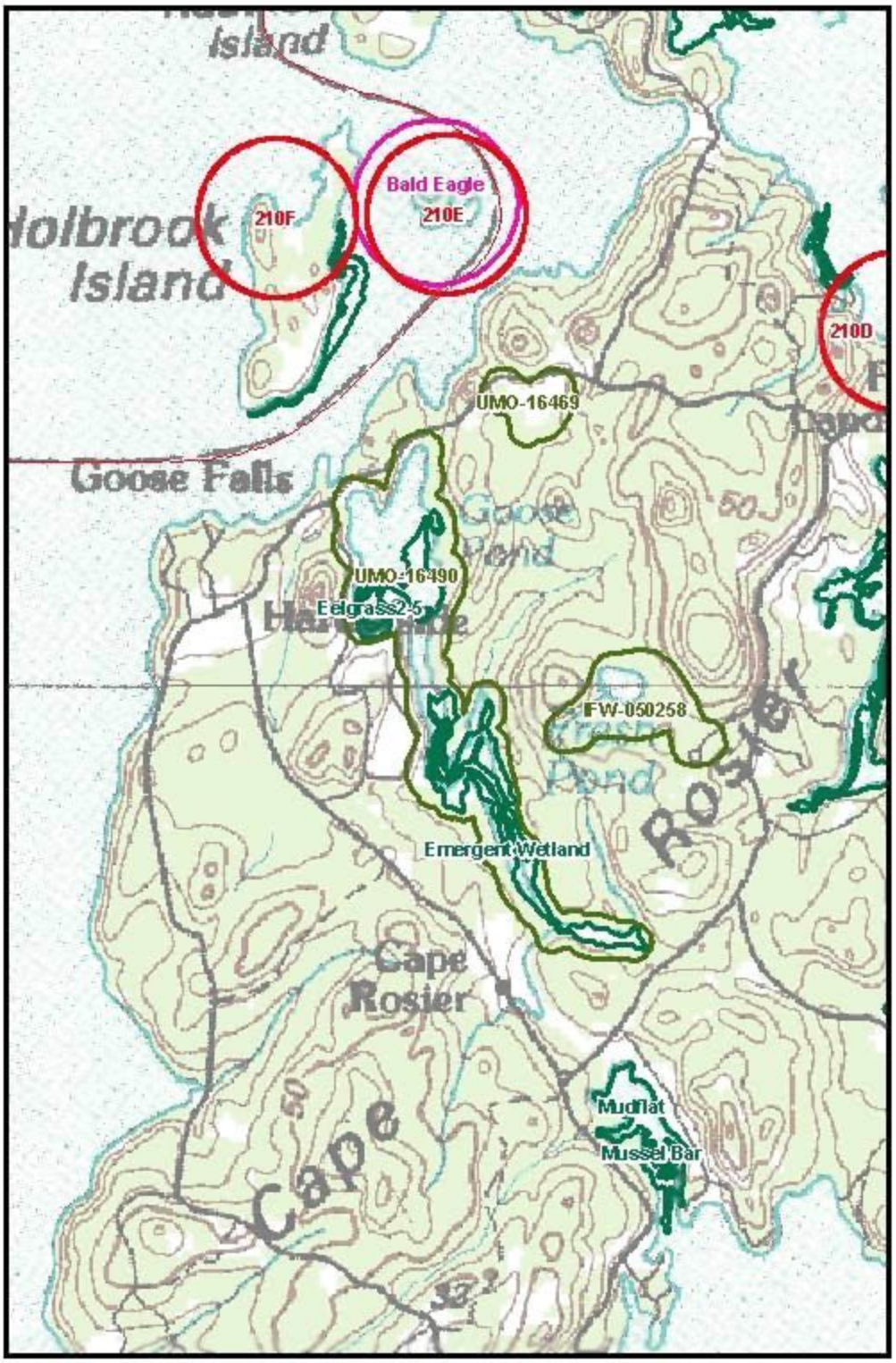
Phone: (207)-434-5925
Fax: (207)-434-5923
Email: richard.jordan@maine.gov

From: Hall, James [mailto:James.Hall@maine.gov]
Sent: Wednesday, October 22, 2008 2:59 PM
To: Lyman, Charles
Subject: Brooksville Wildlife Habitat Map

Please find attached map, if any questions call or email. Tel. 434-5927 <<MactecBroks.jpg>>

James Hall, Wildlife Biologist

Search for Wildlife Observations & Habitat



- Bald Eagle Nest Site
- Piping Plover / Least Tern Nesting, Feeding, & Brood-rearing Area
- Roseate Tern Nesting Area
- Deer Winter Area
- Inland Waterfowl / Wading Bird Habitat
- Tidal Waterfowl / Wading Bird Habitat
- Seabird Nesting Island
- Shorebird Area
- Biological Conservation Database Rare Species or Habitat Observation
- Township Boundary
- County

0 0.3 0.6 0.9 1.2 Miles

1:34,126

UTM Projection, Zone 19N, NAD83

N

P.O. Box 220
Jonesboro, ME 04648
Voice: (207) 434-5927
Fax: (207) 434-5923
October 22, 2008

APPENDIX C

Dewatering Rate Estimates

To: Stan Reed
From: Ron Lewis
Date: March 4, 2009
Subject: Dewatering rate estimates for the tailings impoundment, Callahan Mine Site

Objective: The construction of the tailings impoundment at the Callahan Mine Site presents potential stability problems in the case of a seismic event. The containment berm could be insufficient to prevent collapse with the height and weight of saturated tailings behind it. Approaches to reducing the potential for failure include capping or other means to reduce or eliminate run-on or direct recharge of precipitation as a source of water to the tailings impoundment with gravity drainage and some form of accelerated groundwater removal such as vertical wells or horizontal well/drains. This memorandum summarizes a groundwater modeling approach to estimating dewatering of the tailings impoundment under idealized conditions of eliminating all recharge to the impoundment area, and comparing natural gravity drainage over time with an augmented removal of groundwater via a horizontal well/drain.

Conceptual Model: Due to limited data, the modeling approach taken is that of a vertical section through the tailings impoundment. Such a geologic section is presented as Figure 3.1.4 in the Remedial Investigation Report (MACTEC, 2008), and is included as Attachment A. Tailings were deposited behind a waste rock berm that was partially sealed with clay on the inner face. As the height of tailings increased over the years, the waste rock berm height was also increased in lifts. The principal function of the berm was to contain the tailings, but imperfections in the sealing allowed seeps and/or underflow to release accumulated water from precipitation and run-on. The result is a relatively stable groundwater table throughout the year. Continuous water level data at two locations on the cross section show about a three foot variation in water level at MW-603S and about 1.5 feet at MW-604S, closer to the rock berm over a period of about nine months of monitoring.

The cross section shows a thin layer of till overlying fairly competent bedrock. A thin layer of clay overlays the till across much of the section extent. The length of the section is approximately 600 feet. The height of the berm is about 70 feet. The base of the tailings impoundment slopes upward away from the berm. The water table is about 15 feet below the crest of the berm. Seeps have been noted toward the base of the berm, but vary in location along the entire length of the berm.

Some slug testing of wells within the tailings impoundment has been performed, and indicates relatively low hydraulic conductivity (K) materials. Slug test analyses of the sandy tailings indicate a K of from 0.1 to 0.4 feet per day (ft/d). Similarly, K estimates for the till (very fine tailings) were 0.01 to 0.17 ft/d, for the clay was 0.19 ft/d, and for fractured rock were from 0.21 to 0.25 ft/d. No data are available for the effective K of the rock berm. The results for the tailings appear low, given descriptions of the materials and apparent ease of accepting recharge, while those for the clay and fractured rock would appear to be on the high side of expected values.

Observations of high seep flow rates attending precipitation events, coupled with the relatively low K values for the tailings, suggests there may be preferential pathways through the tailings impoundment that relieve the setting of some of the influx of precipitation. Vegetation over the tailings impoundment area is sparse, so transpiration is expected to be minimal. Some evaporation is expected, but infiltration of precipitation and run-on from upslope appears to be rapid and extensive across the tailings impoundment area. However, some run-on and direct precipitation does flow across the tailings impoundment and exits through an overflow pipe or low spots along the berm. The modeling estimates deal with the residual water content not subject to the preferential pathway movement or overflow, but which depends more on the flow through the less permeable units.

Modeling approach: Based on limited hydrogeological data, probable unidentified preferential pathways for groundwater flow, and the limited objectives of the modeling estimates, a full three-dimensional model of the tailings impoundment is not in order. A vertical section model is adequate for the purpose. The section included as Attachment A was used to determine model layer top and bottom elevations. The model has three layers. Layer 1 represents the sandy tailings, layer 2 is the clay, or where clay is absent the till, and layer 3 represents the till overlaying the bedrock. The underlying bedrock is assumed to be competent and not to significantly contribute to the overall flow of groundwater in the model, hence is not represented in the model. The vertical section consists of 1 row, a nominal 10 feet wide, 49 columns each 12 feet long, and three layers of varying thickness. Figure 1 shows the model setup in vertical section.

Based on the low hydraulic conductivity of the tailings impoundment sandy soils, a probably thinning aquifer over time, and the requisite expansion of the model areally, vertical well dewatering schemes were not considered in this modeling.

Model input parameters and boundary conditions: Initial assumed horizontal K values for the hydrogeologic units were 0.4 ft/d for the sandy tailings, 0.2 ft/d for the clay, 0.1 ft/d for the till, and 0.1 ft/d for the effective K of the waste rock berm. Vertical K values were taken as one-tenth of the horizontal Ks.

To represent the seep at the face of the waste rock berm, a drain node was placed interior to the simulated berm to simulate a preferential flow path through the waste rock, possibly at the first lift elevation. The elevation of the seep was initially set at 30 feet (relative to the lowest point of the section), but this was adjusted during calibration. The width of the seep was taken as the nominal width of the model (10 feet).

The section shows the rock berm placed above the clay and till layers. To provide a pathway for flow to exit the model at this location (underflow), constant head nodes were assigned to layers 2 (clay) and 3 (till) at the last column of the model, and set to values of 3 feet.

An initial 36 inches per year recharge was assigned over the length of the model section, and this was adjusted during calibration.

The model was initially run in steady-state mode, and storage coefficient values are not needed for this mode. However, for simulating dewatering conditions, the model is run in transient mode, and storage coefficient and porosity values need to be input. The values assigned as confined storage, specific yield, and porosity to the three units were, respectively: 0.0001, 0.2, and 0.35 for the sandy tailings; 0.0001, 0.1 and 0.35 for the till; and 0.0001, 0.05 and 0.45 for the clay.

The specific yield deserves additional comment. This is the drainable portion of the total saturated porosity value, and the difference represents residual water content after gravity drainage is complete. This residual moisture has an impact on the slope stability calculations. Without site-specific values of specific yield, this factor cannot be fully accounted for in the modeling. A reasonable range for the specific yield of the sandy tailings is from 0.1 to 0.2, and the effects of this parameter, at least on the estimated time for drainage to occur in the tailings impoundment following elimination of recharge, is explored through a sensitivity analysis, using both 0.1 and 0.2 as input values.

Figure 1 shows the location of the seep/drain and underflow nodes along the model section length.

Model calibration: Calibration was limited to adjusting recharge, drain node elevation, and K values to obtain a reasonable representation of the approximate steady-state water table profile and remain within reasonable ranges for K and recharge. In achieving an approximation of the water table elevation as represented by water levels taken at MW-603S and MW-604S, the following input parameters were adjusted to final values: K of the sandy tailings was increased to 1.0 ft/d; recharge was lowered to 18 inches per year; and the elevation of the seep through the berm was set at 40 feet (relative to the lowest point in the model). The steady-state water table elevation is shown in Figure 1, and is only about a foot lower than midrange values of heads at the two monitoring well locations during the nine-month recording of water levels there.

Model simulations and results: Four simulations were run in transient mode for 10 years each. First, recharge was eliminated over the section, and water allowed to naturally drain out of the impoundment through the simulated seep and the underflow pathway. Second, a horizontal well was simulated as a drain node near the location of MW-604S, and set at an elevation (23 feet relative to the lowest point on the section) of 5 feet above the clay layer (see Figure 2). These two runs were repeated with the specific yield lowered from 0.2 to 0.1.

In the first simulation (recharge eliminated, specific yield of 0.2 for the sandy tailings, and no groundwater withdrawal enhancements), the water table had fallen to within or near the surface of the clay in about 9 to 10 years. The model pre- and post-processing software (Groundwater Vistas, version 5.33) allows the user to place hypothetical wells anywhere within the model to help track head or concentration profiles at selected locations throughout the simulation, and then to create hydrographs of head or concentration versus simulation time. Hydrographs of hypothetical wells placed in the

model at locations along the section corresponding to MW-603S and MW-604S of the water level in these two model nodes are shown as Figures 3 and 4. A graphical summary of model inflows and outflows is presented on Figure 5. On Figure 5, the seep removes the majority of the water until the water table drops below the apparent seep elevation, then underflow must account for the remainder of the water table decline.

In the second simulation (recharge eliminated, specific yield of 0.2 for the sandy tailings, and a horizontal well added), the water table had fallen to within or near the clay layer surface in about 6 to 7 years. Hydrographs of the hypothetical wells at MW-603S and MW-604S are presented as Figures 6 and 7. Since the hypothetical well is located in the same node as the drain representing the horizontal well, the apparent response is somewhat exaggerated until the water table locally reaches the specified elevation of the well invert. Figure 8 presents a graphical summary of the model inflows and outflows over the simulation period. Figure 8 shows the majority of the water removed by the existing seep and the horizontal well. Little outflow occurs through underflow.

In the third simulation, the first simulation was repeated with the specific yield of the sandy tailings reduced from 0.2 to 0.1. The simulation time to reach near top of clay layer levels in this simulation was about 6 years. The principal difference in this scenario is that less water escapes the tailing impoundment area, at a lower rate, but the remaining soil within the tailings impoundment retains a higher degree of moisture. Figures 9 and 10 show the hydrographs of the hypothetical wells over the simulation period. Figure 11 shows the inflow and outflow rates over the simulation period. These can be compared to those on matching Figures 5, 8, 11 and 14 for the other simulations.

In the fourth simulation, the second simulation was repeated with the specific yield of the sandy tailings reduced from 0.2 to 0.1. The simulation time for the water table to reach near top of clay layer levels was about 3 to 4 years. Due to the reduced specific yield, more water remains in the tailings soil. Figures 12 and 13 show the hydrographs at the two monitoring well locations. Figure 14 shows the hydrograph of inflows and outflows for the simulation period. Here the added horizontal well/drain provides for the principal portion of the outflow.

Limitations of the modeling: The modeling conducted here is intended to provide order of magnitude estimates of groundwater flows under specific conditions, and to compare possible natural and enhanced drainage rates and times to reach dewatering goals. The model, as noted above, is a simplification of the actual hydrogeologic system, and details of certain features (including seep locations and elevations, spatial variation and amplitude of K, specific yield, and effective K of the waste rock berm among them), are either unknown or poorly understood. Further, the cross section used as a basis for the model may not be typical of the behavior of groundwater flow in the tailings impoundment at other section locations.

Summary:

Modeling conducted here has been performed to aid in understanding the potential effectiveness of drainage scenarios for the tailings impoundment. The model was based on a simplified cross section and input parameters were adjusted within reasonable ranges to produce an approximation of the observed water table elevation. The model looked primarily at capping to eliminate recharge and natural and enhanced drainage. Since specific yield is an important parameter in dewatering calculations, specific yield was varied from 0.1 to 0.2 in the simulations. The model is a very rough approximation of the real system, and actual dewatering rates will depend on several factors for which actual data are not available. These results should be considered order-of-magnitude only and used only for comparison among remedial alternatives.

FIGURES

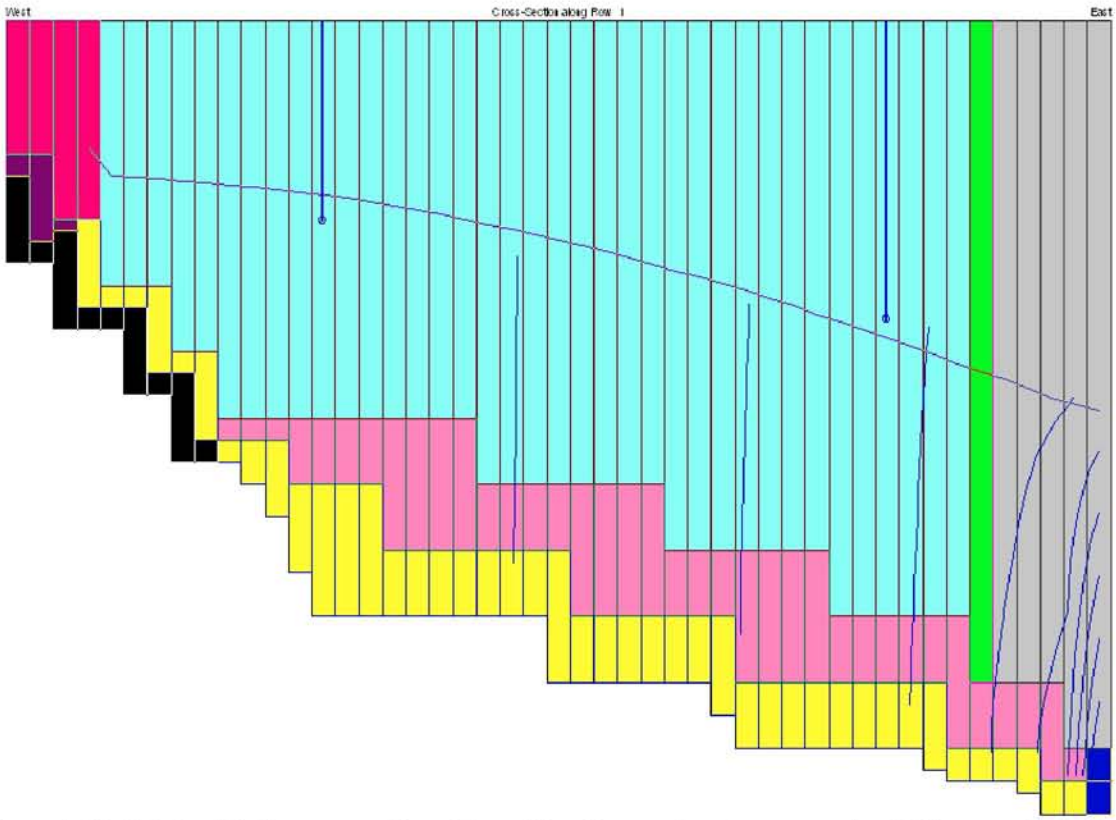


Figure 1: Model simplified representation of the tailings impoundment cross section. Units are color coded: sandy tailings (light blue); clay (magenta); till (yellow); and waste rock (grey). Black nodes to left are no-flow corresponding to lack of clay unit. Red nodes to upper left are dry as the water table (blue line across section) falls below layer bottom. Green node to right represents seep through waste rock. Blue nodes at lower right are constant heads permitting underflow. Vertical blue lines extending from model top are hypothetical wells used to track heads in transient mode. Model spans 0 to 72 feet vertically; vertical exaggeration about 5.5:1.

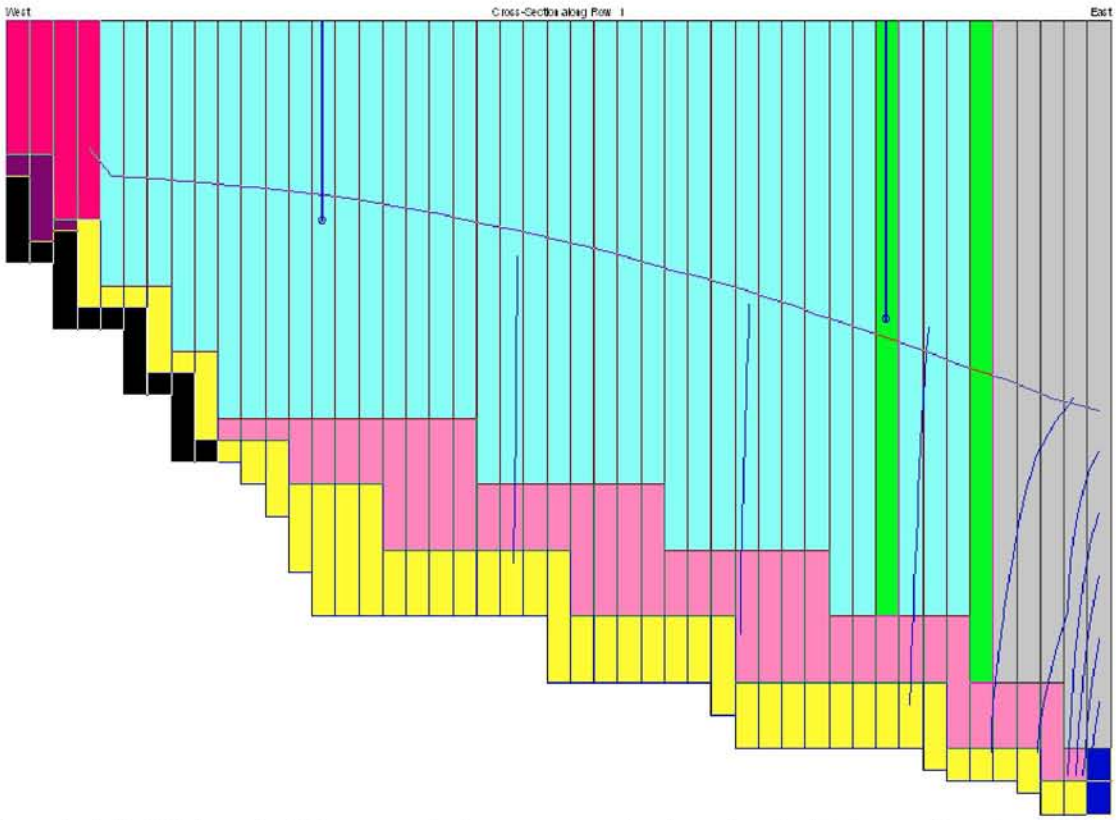


Figure 2: Added drain node (left green stripe) to represent a horizontal well with invert 5 feet above top of clay. Water table shown as initial position taken from steady-state model.

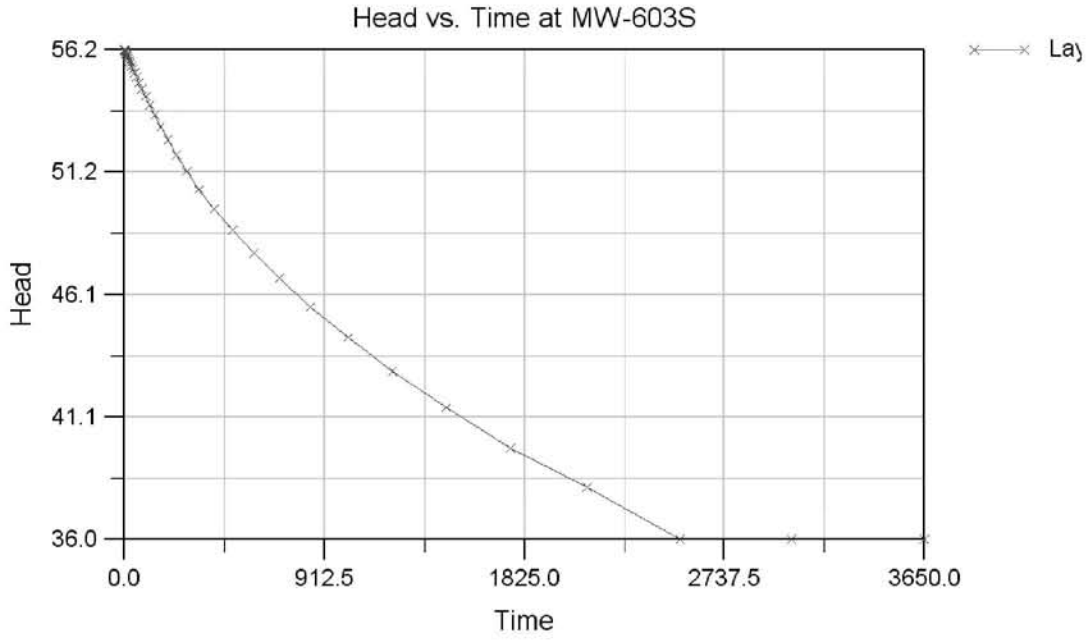


Figure 3: Hydrograph of hypothetical well at location of MW-603S, natural drainage after recharge reduced to zero. Specific yield of tailings set at 0.2.

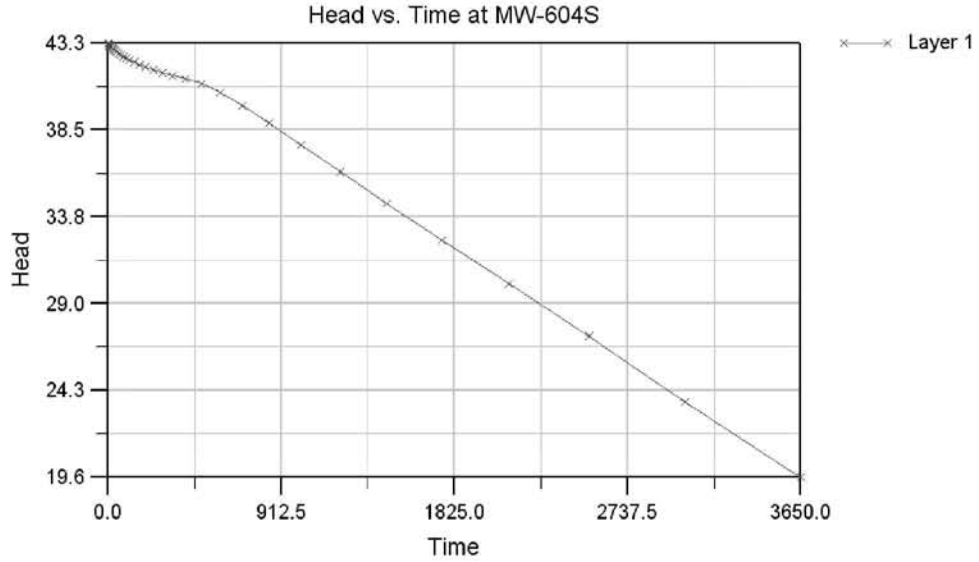


Figure 4: Hydrograph of hypothetical well at location of MW-604S, natural drainage after recharge reduced to zero. Specific yield of tailings set at 0.2.

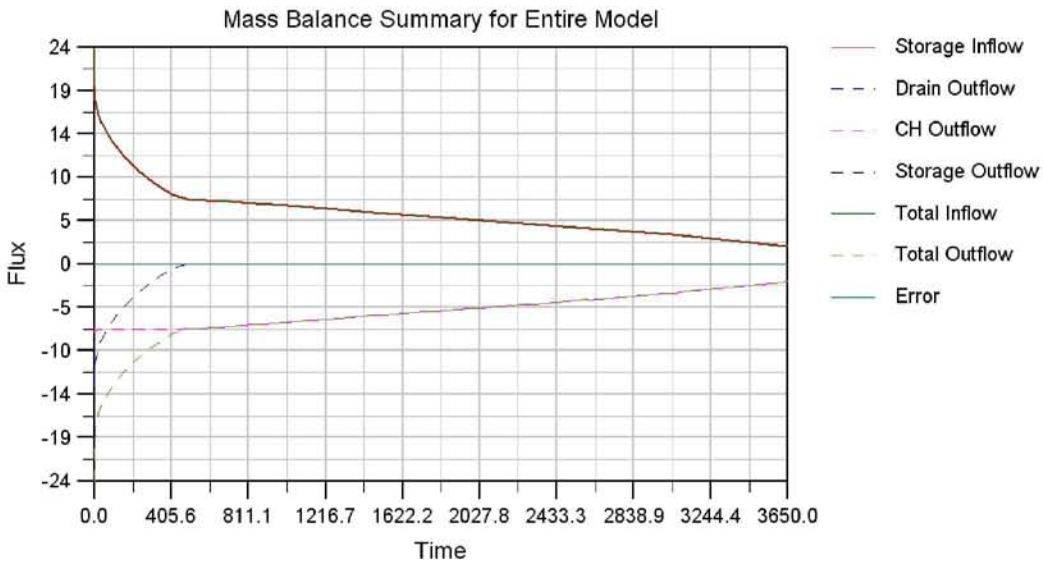


Figure 5: Mass balance fluxes – natural drainage after recharge reduced to zero. Specific yield of tailings set at 0.2.

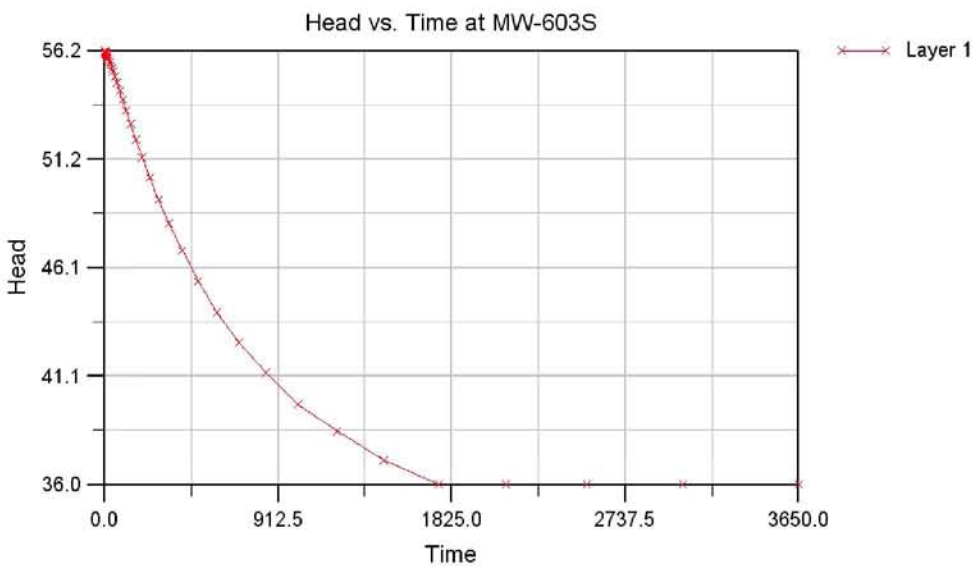


Figure 6: Hydrograph of hypothetical well at location of MW-603S, horizontal well operating after recharge reduced to zero. Specific yield of tailings set at 0.2.

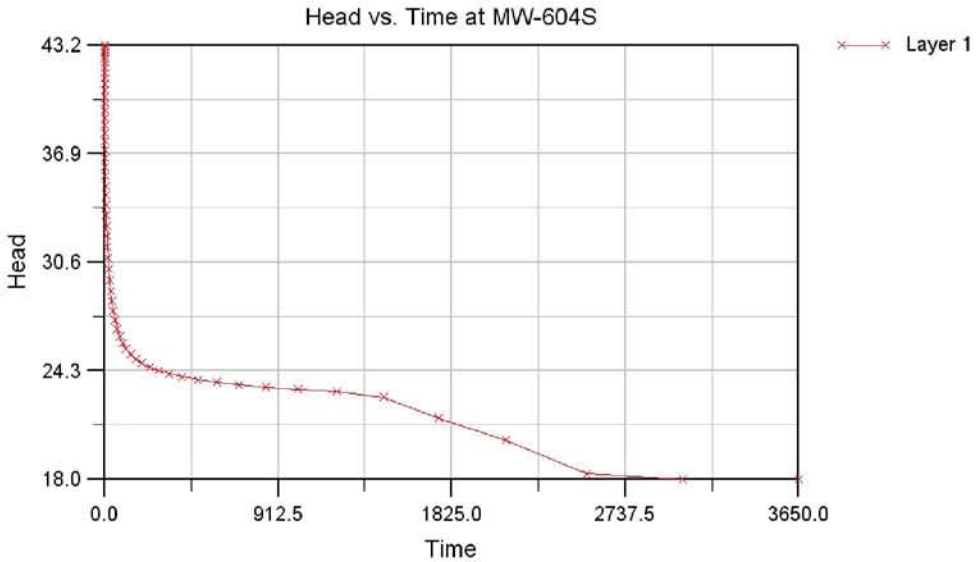


Figure 7: Hydrograph of hypothetical well at location of MW-604S, horizontal well operating after recharge reduced to zero. Specific yield of tailings set at 0.2.

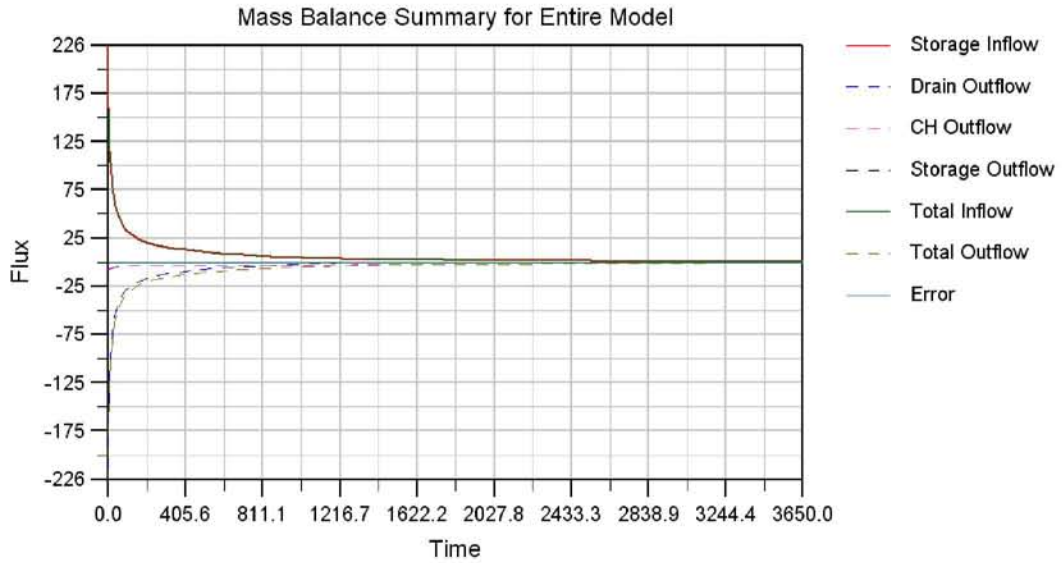


Figure 8: Mass balance fluxes – horizontal well operating after recharge reduced to zero. Specific yield of tailings set at 0.2.

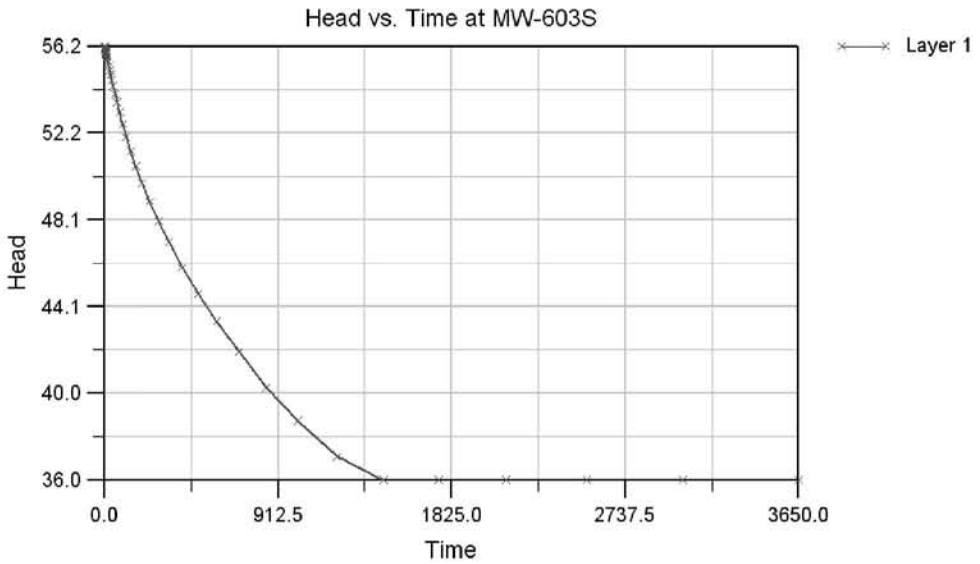


Figure 9: Hydrograph of hypothetical well at location of MW-603S, natural drainage after recharge reduced to zero. Specific yield of tailings set at 0.1.

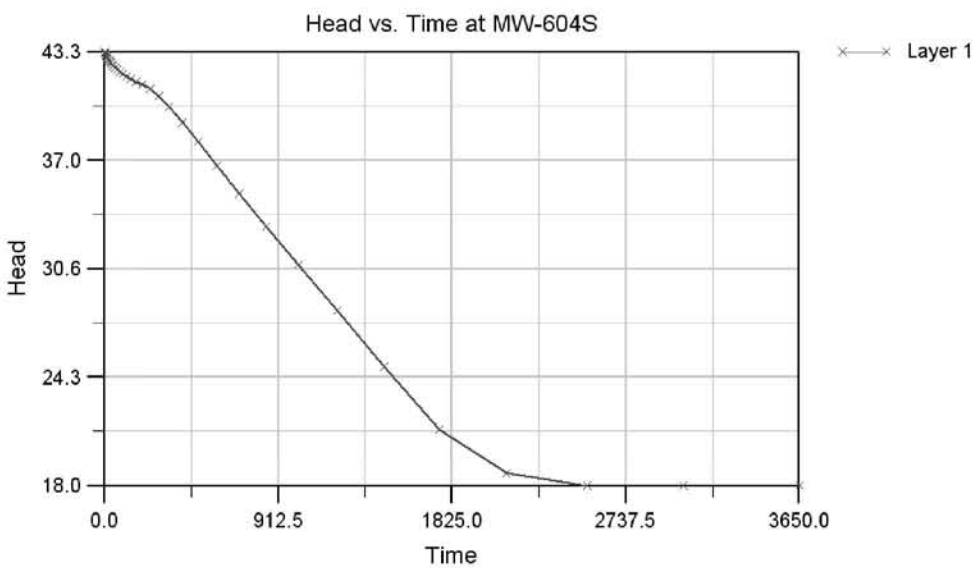


Figure 10: Hydrograph of hypothetical well at location of MW-604S, natural drainage after recharge reduced to zero. Specific yield of tailings set at 0.1.

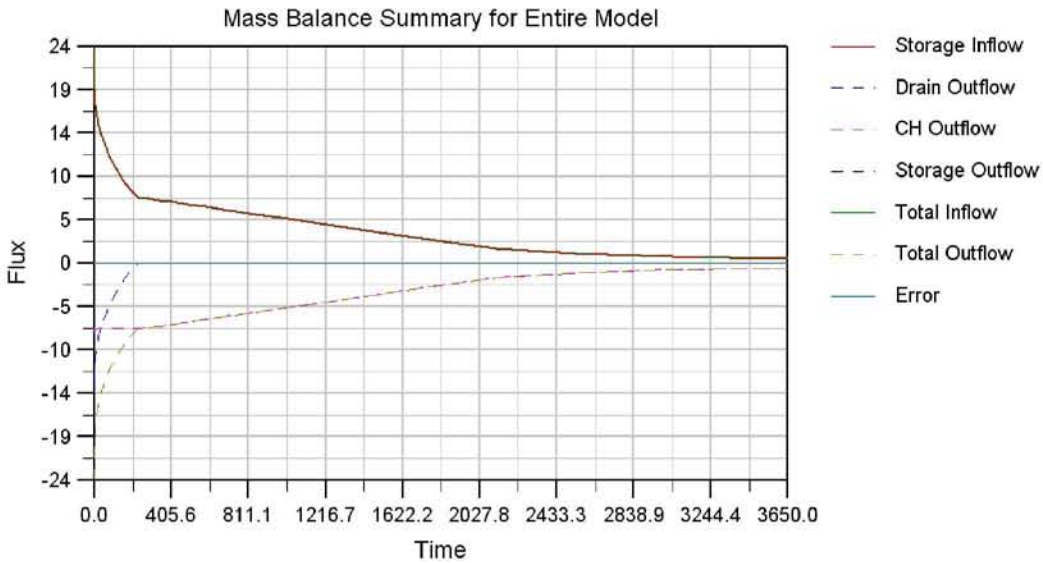


Figure 11: Mass balance fluxes – natural drainage after recharge reduced to zero. Specific yield of tailings set at 0.1.

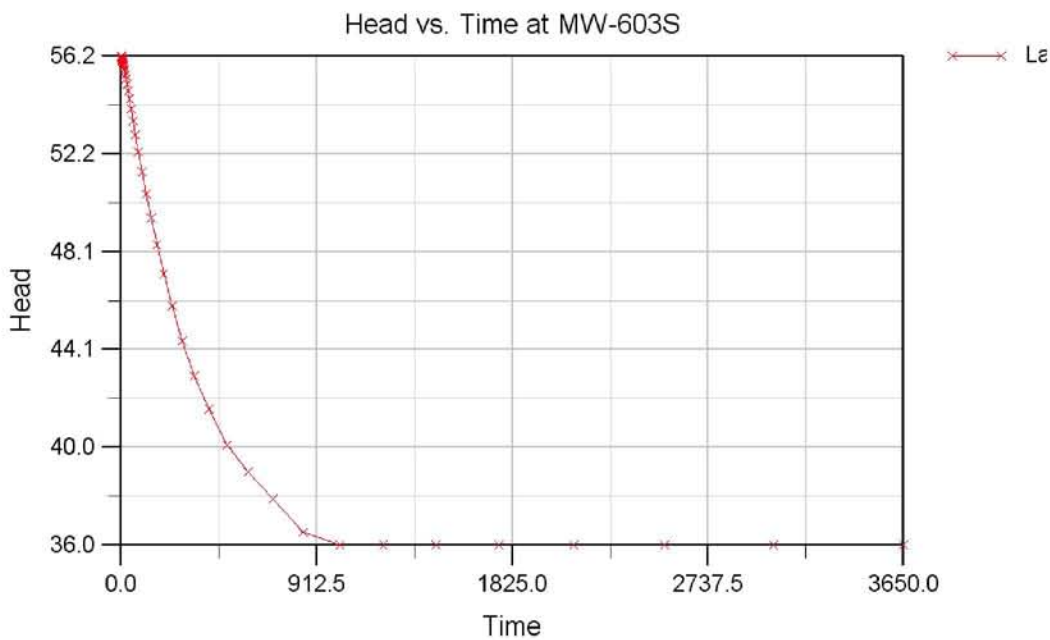


Figure 12: Hydrograph of hypothetical well at location of MW-603S, horizontal well operating after recharge reduced to zero. Specific yield of tailings set at 0.1.

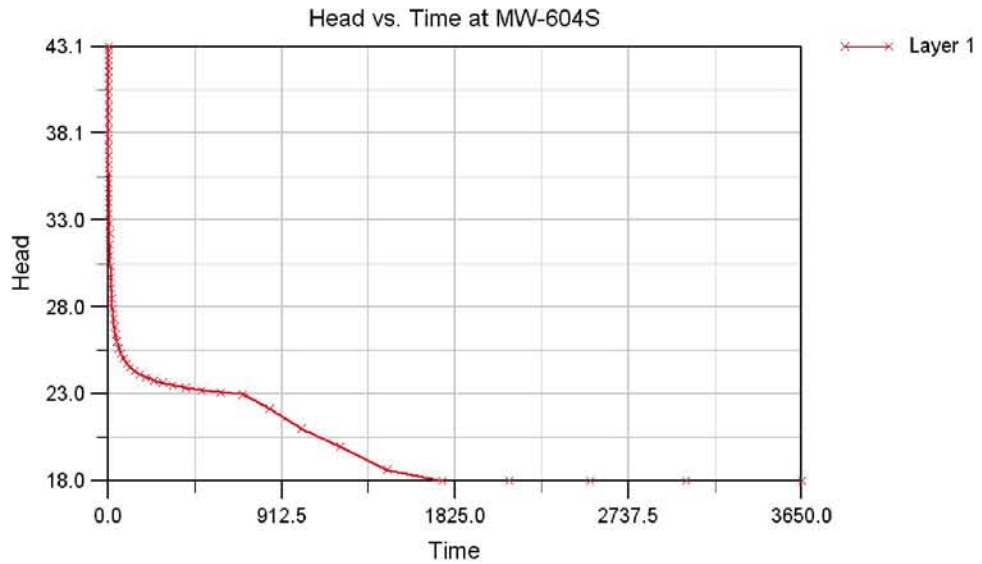


Figure 13: Hydrograph of hypothetical well at location of MW-604S, horizontal well operating after recharge reduced to zero. Specific yield of tailings set at 0.1.

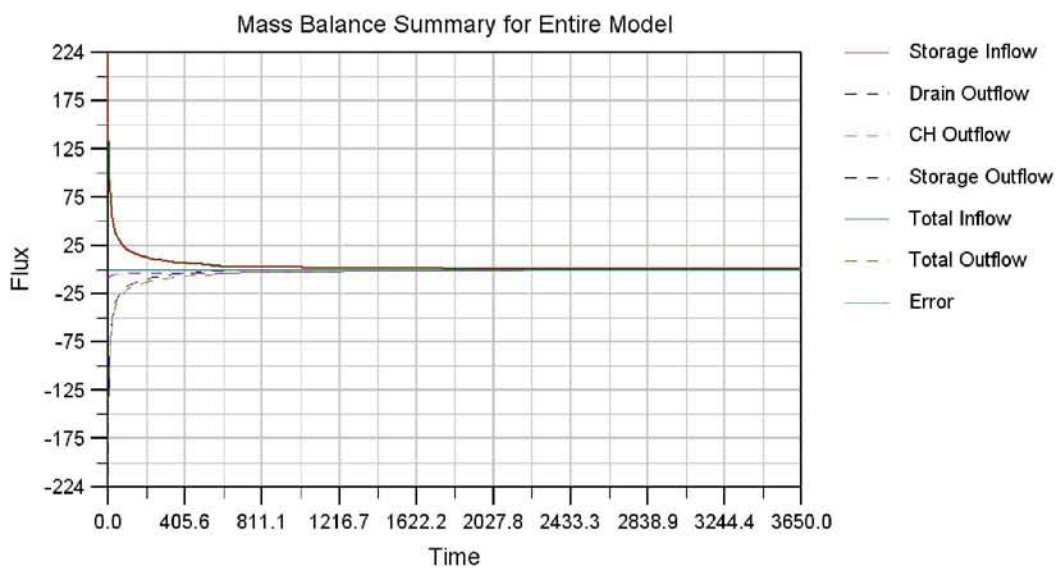
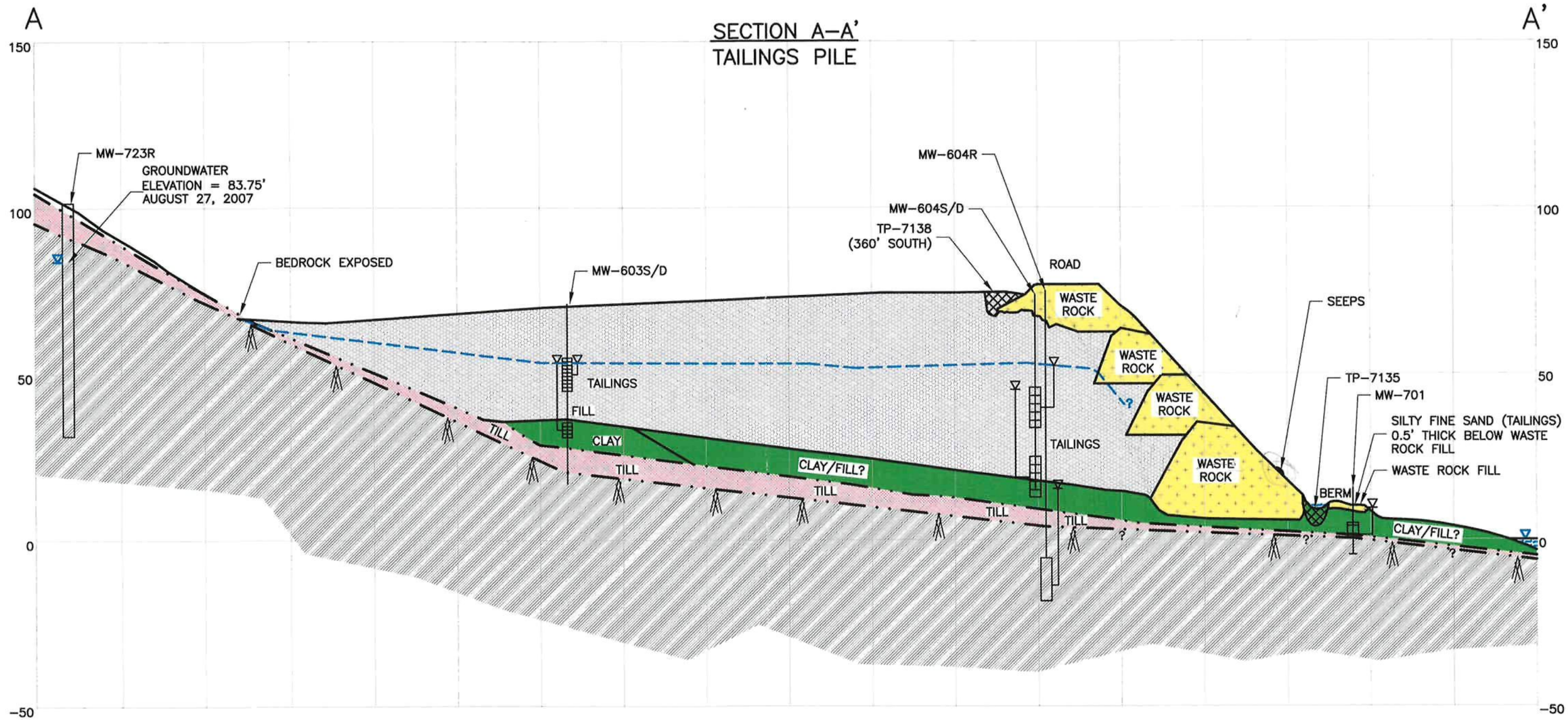


Figure 14: Mass balance fluxes – horizontal well operating after recharge reduced to zero. Specific yield of tailings set at 0.1.

ATTACHMENT A

Model Basis Cross Section



LEGEND

- TAILINGS
- WASTE ROCK
- CLAY
- TILL
- BEDROCK

SCREENED MONITORING WELL

WATER LEVEL IN MONITORING WELL
OPEN HOLE BEDROCK WELL

WATER ELEVATION DATA FROM 08/27/07

SURFACE WATER LEVEL

0 30 60 120
HORIZONTAL SCALE IN FEET

0 15 30 60
VERTICAL SCALE IN FEET

Prepared/Date: MRS 11/07/08
Checked/Date: SFC 11/07/08

Project 3612-06-2047.27

MACTEC

Figure 3.1-4
CROSS SECTION A-A'
REMEDIAL INVESTIGATION REPORT
CALLAHAN MINE SUPERFUND SITE
BROOKSVILLE, MAINE

M:\Projects\Callahan Mine Site\Figure 3.1-4.dwg Fri, 07 Nov 2008 - 2:14pm MRSTACEY

APPENDIX E

Closed Area No. 36

NOTICE OF EMERGENCY RULE-MAKING

AGENCY: Department of Marine Resources
STATUTORY AUTHORITY: 12 M.R.S.A. §§6172, 6192, 6193 & 6194
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BASIS STATEMENT

The Commissioner of the Maine Department of Marine Resources promulgates the emergency DMR Chapter 95.04(C), Area No. 36 Bagaduce River and Harborside (Castine, Penobscot, Brooksville) and repeals Regulation 95.04 D Closed Area No. 36-C, Harborside, Town of Brooksville amended on March 25, 2004; and repeals Regulation 95.04 QQ, Closed Area No. 36-D, Penobscot River, Lower Bagaduce River and Grindles Eddy, Towns of Castine, Penobscot and Brooksville amended on February 26, 2006. This rulemaking combines pollution Area No. 36-D Penobscot River, Lower Bagaduce River and Grindles Eddy (Castine, Penobscot, Brooksville) and Area No. 36-C Harborside (Brooksville) into a single regulation, Area No. 36. It also defines the Conditionally Approved areas in Smith Cove (Brooksville) and Grindles Eddy (Penobscot). A portion of the previous Area No. 36-D is also currently included in Area No. 35, Penobscot River (Stockton Springs, Prospect, Bucksport, Orland, Penobscot, Castine). This is a duplication of the rule making effective January 13, 2009 to correct the title of Chapter 95.04 QQ which was not correctly sited as being repealed. As authorized by 12 M.R.S.A. §§6172, 6192, 6193 & 6194 the Commissioner of Marine Resources adopts emergency amendments to Chapter 95.04(C).

RULE TITLE AND SUBJECT: DMR Regulation 95.04 QQ, Closed Area No. 36-D, Penobscot River, Lower Bagaduce River and Grindles Eddy, Towns of Castine, Penobscot and Brooksville, amended on February 28, 2006, and DMR Regulation 95.04 D Closed Area No. 36-C, Harborside, Town of Brooksville, amended on March 25, 2004, are repealed. DMR Chapter 95.04(C), Area No. 36, Bagaduce River and Harborside (Castine, Penobscot, Brooksville) is promulgated as follows:

TEXT OF RULE: ~~DMR Regulation 95.04 D, Closed Area No. 36-C, Harborside, Town of Brooksville.~~

~~Effective immediately, because of pollution, it shall be unlawful to dig, take or possess any clams, quahogs, oysters or mussels taken from the shores, flats and waters of:~~

~~The area at Harborside, Brooksville, lying south (inshore) of a line beginning at a red post located on the most western tip of land in Tom Cod Cove and running southwesterly to the most northwestern prominence (about 0.9 mile) at Harborside, then following the lowest tide mark southerly (about 0.6 mile) to a red post located on a stone pier.~~

TEXT OF RULE: ~~DMR Regulation 95.04 QQ, Closed Area No. 36-D, Penobscot River, Lower Bagaduce River and Grindles Eddy, Towns of Castine, Penobscot, and Brooksville~~

~~A. Effective immediately, because of pollution, it shall be unlawful to dig, take or possess any clams, quahogs, oysters or mussels taken from the flats and waters of the Castine Peninsula that lie shoreward (east) of a line beginning at a red painted post located about 0.2 mile west of the junctions of Routes 166 and 175 (at West Penobscot) and running southwest to the western tip of Turner Point, Castine, then running south to the western tip of Perkins Point, then running south to the western tip of Blockhouse Point; then following the lowest tide mark to the southern tip of Dice Head; AND the shores, flats and waters of the Bagaduce River inshore (north and west) of a line beginning at the southern tip of Dice Head, Castine, and running east to the northern tip of High Tide Island, then northeast to the southern tip of Lower Negro Island, then running north to the eastern point on Upper Negro Island, then running northwest (about 0.2 miles) to a red painted post on the western shore of the Bagaduce River.~~

~~B. Effective May 1 through October 31, the Bagaduce River will be closed **between** a line running north from the northern point of Jones Point, Brooksville to the nearest opposite shore of the so called "Grindle Eddy Narrows", Penobscot and a line from the west point of Jones Point, Brooksville west to the nearest opposite shore.~~

TITLE & TEXT OF RULE: DMR Chapter 95.04(C), Area No. 36, Bagaduce River and Harborside (Castine, Penobscot, Brooksville)

A. Effective immediately, because of pollution, it shall be unlawful to dig, take or possess any clams, quahogs, oysters or mussels taken from the flats and waters of:

   1. Harborside, Brooksville: lying south (inshore) of a line beginning at a red post located on the most western tip of land in Tom Cod Cove and running southwesterly to the most northwestern prominence (about 0.9 mile) at Harborside, then following the lowest tide mark southerly (about 0.6 mile) to a red post located on a stone pier.

   2. Bagaduce River: inshore (north and west) of a line beginning at the southern tip of Dice Head, Castine, and running east to the northern tip of High Tide Island, then northeast to the southern tip of Lower Negro Island, then running north to the eastern point on Upper Negro Island, then running northwest (about 0.2 miles) to a red painted post on the western shore of the Bagaduce River.

B. Effective May 1 through October 31, the Bagaduce River will be closed **between** a line running north from the northern point of Jones Point, Brooksville to the nearest opposite shore of the so called "Grindle Eddy Narrows", Penobscot and a line from the west point of Jones Point, Brooksville west to the nearest opposite shore.

C. Effective immediately, because of pollution, it shall be unlawful to dig, take or possess any clams, quahogs, oysters or mussels taken from the shores, flats and waters of the Bagaduce River: east of a line from the southern tip of Dice Head, Castine running south to the northwest point of Harborside, Brooksville; then north of a line extending from the northwest point of Harborside, Brooksville northeast to the western tip of land in Tom Cod Cove, Brooksville; then follows the shoreline northeast to the northwest end of Indian Bar, Brooksville: then running across the bar to the northeast end: then running northeast to the Coast Guard navigational aid Nun "2"; then north to the southern tip of Henry Point, Brooksville; then follows the shoreline north to Jones Point, Brooksville; then south of a line from Jones Point, Brooksville west to the nearest opposite shore in Castine; then follows the shoreline approximately .9 miles to a red painted post on the western shore of the Bagaduce River, Castine; then south and east of a line extending from the red painted post southeast about .2 miles to the eastern point on Upper Negro Island, Castine; then south and east of a line running south to Lower Negro Island, Castine; then south and east of a line running southwest to the northern tip of High Tide Island; then south of a line extending west to the southern tip of Dice Head, Castine.

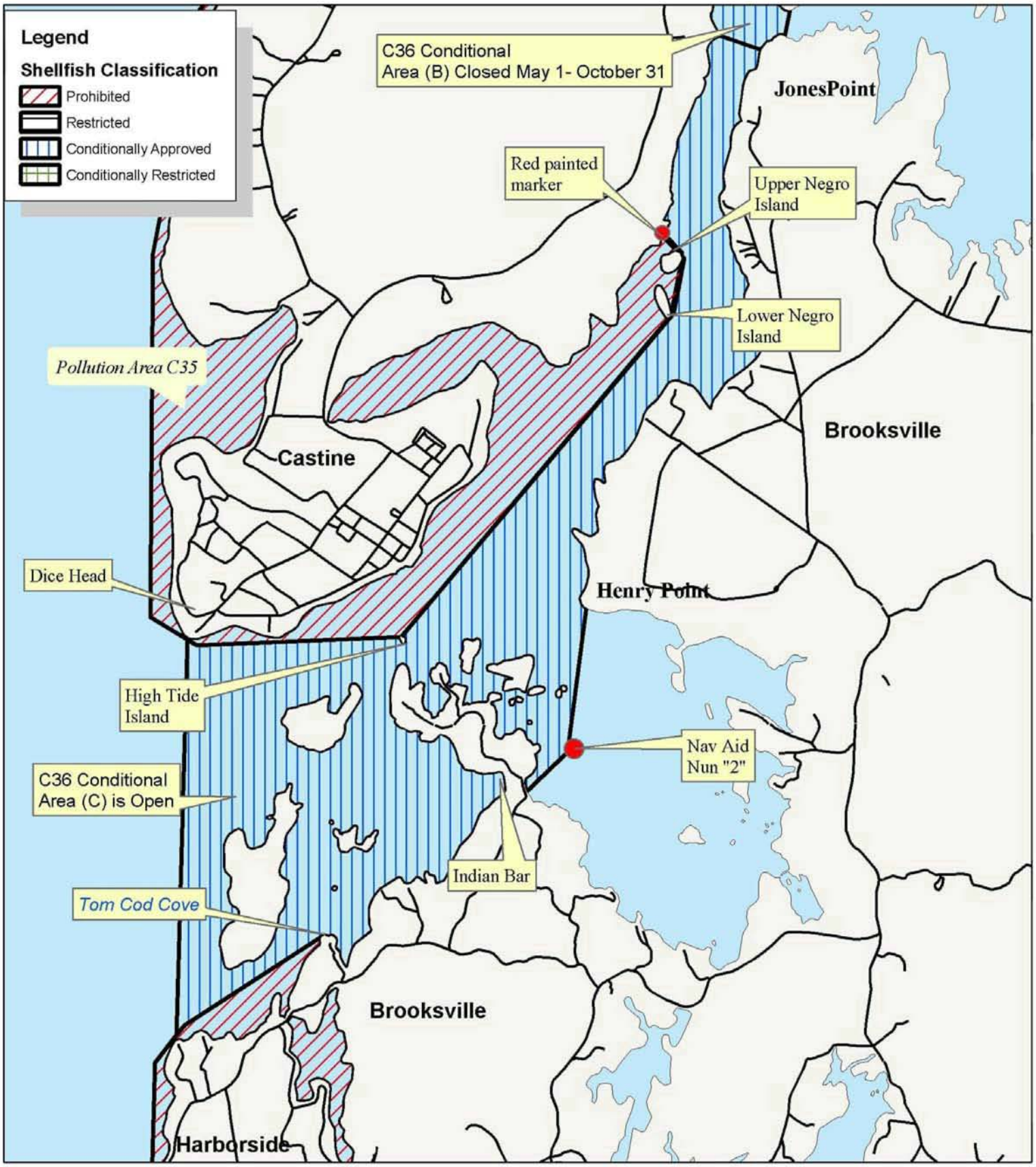
EFFECTIVE DATE: January 22, 2009 EFFECTIVE TIME: 1:30 PM

AGENCY CONTACT PERSON: Amy M. Fitzpatrick, Department of Marine Resources,
194 McKown Point Road, W. Boothbay Harbor, Maine 04575
http://www.maine.gov/dmr/rm/public_health/closures/closedarea.htm
EMAIL: Amy.Fitzpatrick@maine.gov

Maine Department of Marine Resources

Pollution Area No. 36

Bagaduce River and Harborside (Castine, Penobscot, Brooksville) 1/13/09



APPENDIX F

Sediment Risk Management Memorandum

RISK MANAGEMENT MEMO

Data from the Salt Marsh and Goose Pond Mine Waste hot spots, defined as the areas of mine waste adjacent to WRP-3 and Tailings Pile, were separated from the rest of the sediment areas to determine if the other areas at the Callahan Mine Site require remediation. Sediment data were grouped into the following data sets areas:

a) Goose Pond Mine Waste Hot Spot
b) Salt Marsh Outside Hot Spot Area
c) Salt Marsh Hot Spot Area
d) Dyer Cove (all data)
e) Goose Pond North of Mine Waste Hot Spot (excluding Dyer Cove & Salt Marsh)
f) Goose Pond South of Mine Waste Hot Spot (excluding Dyer Cove & Salt Marsh)
g) Goose Pond Non Hot Spot (e and f combined)
h) Goose Cove Non Hot Spot
i) Goose Cove Mine Waste
j) Goose Cove All Data

The "Hot Spot" in reference to the Salt Marsh refers to brown shaded area on Figure 1 and "brown" areas in tables.

The evaluation was conducted in two tiers. For each data set, 95% Upper Concentration Limits (UCLs) and average (mean) sediment concentrations for Cd, Cu, Pb, and Zn were calculated and compared to Preliminary Remediation Goals (PRGs) to eliminate areas which did not exceed PRGs and to identify areas with marginal PRG exceedences (Tier I). Data sets with 95% UCLs and average concentrations that did not exceed PRGs were eliminated from further evaluation. Data sets with 95% ULCs and/or average concentrations which exceeded PRGs were further evaluated using other ecological data including Habitat Analysis, Toxicity Tests, and Tissue Concentration data (Tier II). Each of these evaluations are described below and summarized in Table 1.

1.0 Comparison of 95% UCL and Average Concentrations to PRGs

95% UCL and average (mean) concentrations of Cd, Cu, Pb, and Zn were below respective PRGs for the following data sets (Table 2 through Table 11), and so do not appear to require remediation:

- **Salt Marsh Outside Hot Spot Area**
- **Goose Pond North of Mine Waste Hot Spot**
- **Goose Pond South of Mine Waste Hot Spot**
- **Goose Pond Non Hot Spot**
- **Goose Cove Non Hot Spot**

In the **Dyer Cove** data set, 95% UCL and average (mean) concentrations of Cd and Pb are all below their respective PRGs. 95% UCL and average concentrations of Cu and Zn are above respective PRGs and clearly are more than just marginal exceedences.

In the **Salt Marsh Hot Spot Area** and **Goose Pond Mine Waste Hot Spot** data sets, 95% UCLs and average concentrations of Cd are below the PRG. 95% UCL and average concentrations of Cu, Pb, and Zn are above respective PRGs and clearly are more than just marginal exceedences so will continue to from the basis for the remedial footprint.

In the **Goose Cove All Data** and **Goose Cove Mine Waste** data sets, 95% UCLs and average concentrations of Cd and Pb are below respective PRGs, and 95% UCLs and average concentrations of Cu are above the PRG and thus are more than just marginal exceedences. Zn in both exposure areas is a marginal exceedence because the 95% UCL is above the PRG but the average concentrations are below the PRG and should be further investigated.

Exposure point concentrations based on Zn 95% UCLs and average concentrations were subsequently run through food chain models for spotted sandpiper and great blue heron. Assuming receptors spend <u>all</u> their time feeding in the **Goose Cove Mine Waste** or **Goose Cove All Data** data set areas (i.e. SFF=1), adverse population-level effects are unlikely.

2. Ecological Data Evaluation

<u>Habitat Analysis</u>
Habitat condition at Dyer Cove, Salt Marsh Hot Spot Area, Goose Pond Mine Waste Hot Spot, Goose Cove Mine Waste, and Goose Cove Sediment data sets were reviewed to determine which were accessible to great blue heron and spotted sandpiper (i.e., the two receptors that form the basis of the Pb and Cu PRGs). If conditions were such that these species would be unable to forage, it was concluded that there was an incomplete exposure pathway with respect to these receptors.

- The **Dyer Cove** data set area abuts the shoreline and so is accessible to spotted sandpiper and great blue heron.

- The **Salt Marsh Hot Spot Area** data set area abuts and includes the shoreline and so is accessible to spotted sandpiper and great blue heron.

- The **Goose Pond Mine Waste Hot Spot** data set includes areas accessible to both the spotted sandpiper and the great blue heron.

- The **Goose Cove Mine Waste data are**a is not accessible to spotted sandpiper or great blue heron because the shore is steep and ledgey.

- **The Goose Cove All Data** data set abuts the shoreline and so is accessible to spotted sandpiper and great blue heron.

Toxicity Tests

Sediment toxicity tests conducted as part of the baseline ecological risk assessment (BERA) were re-evaluated according to the new data set areas. The Zn PRG (5,100 mg/kg) is based on the benthic endpoint.

Two sediment toxicity test samples (GP-13 and GP-15) were located in the **Dyer Cove** data set area**.** GP-15 did not exhibit any sediment toxicity. Ecologically significant risk to *Leptocheirus* growth at GP-13 was overestimated because concentrations exhibiting adverse effects were higher than concentrations in other samples the exhibited no effect (c.f. BERA). Therefore, toxicity tests suggest adverse population level effects to the benthic invertebrate community in Dyer Cove are unlikely.

Three sediment toxicity test samples (GP-11, GP-12, and GP-22) were located in the **Goose Pond Mine Waste Hot Spot** data area**.** GP-12 and GP-22 sediment samples were among the most toxic sediment samples, exhibiting ecologically significant effects to at least one receptor-effects combination. The GP-11 sediment sample did not exhibit any statistically or ecologically significant effects in any of the tests. Toxicity tests suggest population level effects to the benthic invertebrate community in the Mine Waste Hot Spot are likely.

One sediment toxicity test sample (GC-4) was located in the **Goose Cove Non Hot Spot** data set area. Statistically or ecologically significant effects were not observed at GC-4. Two sediment toxicity test samples (GC-5 and GC-6) were located in the **Goose Cove Mine Waste** data set area. The only statistically and ecologically adverse ecological effects was observed in *Neanthes* growth at GC-06, but this risk was overestimated because concentrations at GC-5 were lower than concentrations than other Goose Cove locations that did not exhibit any ecologically significant adverse effects (c.f. BERA). Therefore, toxicity test suggest adverse population level effects to the benthic invertebrate community in Goose Cove are unlikely.

Tissue Concentrations

Fish and clam tissue concentration data were evaluated by first identifying exposure areas where COPCs were present at concentrations that resulted in incremental risk HQs (based on effects benchmarks) greater than 1 in fish tissue (BERA Tables 3-44, 3-45, and 3-46) and benthic invertebrate tissue (BERA Tables 3-30, 3-31, 3-32, 3-33, 3-34, and 3-35). HQs greater than 1 were identified for fish tissue Cu and clam tissue Cu, Pb, and Zn. Individual sample locations were then arranged into data set areas. If the majority of incremental risk HQs for a given COC in a data set were below or very close to 1, it was concluded that adverse effects to the benthic community were unlikely (Table 12 through Table 15). Results of the tissue concentration analysis are summarized below:

- There were no tissue samples from the **Goose Cove Mine Waste** or **Goose Cove Non Hot Spot** (and therefore the **Goose Cove All Data**) data set areas so these areas were not evaluated.

- *Spartina* tissue collected from the **Salt Marsh Hot Spot Area** data set was not used to select PRGs so it was not evaluated in this exercise.

- The majority of incremental risk HQs for fish and clam tissue at the **Goose Pond Mine Waste Hot Spot** were above 1, suggesting that effects to the benthic invertebrate community in the Mine Waste Hot Spot are likely.

- In **Dyer Cove,** the majority of incremental risk HQs for clam Cu and clam Zn were close to or below 1. The majority of fish Cu and clam Pb were above 1. Therefore, effects to the benthic macroinvertebrate community in Dyer Cove data set area are likely from fish Cu and Clam Pb. It should be noted that the BERA give this measurement endpoint a lower weight (low/medium) than toxicity tests (medium/high).

3.0 Conclusions

Salt Marsh Outside Hot Spot Area, Goose Pond North of Mine Waste Hot Spot, Goose Pond South of Mine Waste Hot Spot, Goose Pond Non Hot Spot, and Goose Cove Non Hot Spot data set areas do not appear to require remediation.

Salt Marsh Hot Spot Area, Goose Pond Mine Waste Hot Spot, Dyer Cove, and Goose Cove Mine Waste areas require remediation. Existing PRGs apply to each of these data set areas.

FIGURES

Sediment area
= 1.52 Acres

Sediment area
= 3.56 Acres

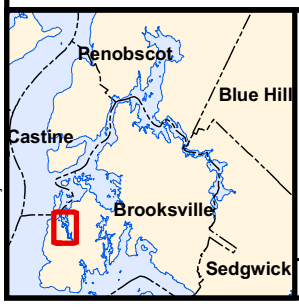
Sediment Area
= 6.95 Acres

Saltmarsh Area
= 2.73 Acres

Sediment Area
= 3.66 Acres

Saltmarsh Area
= 3.6 Acres

Note:
Sample interval top depth < 0.5 feet
Analysis by XRF screening.



Legend

One or more of the following applies:
- Cadmium > 210 mg/kg
- Copper > 790 mg/kg
- Lead > 710 mg/kg
- Zinc > 5100 mg/kg

- Cadmium, Copper, Lead and Zinc do not exceed listed concentrations
- Mine Waste in Sediment
- Exceeds PRGs in Sediment
- Exceeds PRGs in Salt Marsh

0 250 500 Feet

N

Prepared/Date: DBW 04/09/09 | Checked/Date: SWR 04/09/09

Figure E-1
Exceedance of Cd, Cu, Pb, and Zn
PRGs in Sediment and Salt Marsh

OU1 Feasibility Study Report
Callahan Mine Superfund Site
Brooksville, Maine
MACTEC, Inc.

Document: P:\Projects\mdot\Callahan Mine\6.0 GIS\MapDocuments\Feasibility Study\FS_SED_Results_11x17P.mxd PDF: P:\Projects\mdot\Callahan Mine\6.0 GIS\Figures\FS - April 2009\Figure E-1.pdf 04/09/2009 3:54 PM dbwilde

TABLES

Table 1
Review of Lines of Evidence Based

Risk Management Appendix - Feasibility Study
Callahan Mine Superfund Site
Brooksville, Maine

Data Set Area	95 % UCL/Mean PRG Comparison	Habitat Analysis	Benthic Toxicity Tests	Tissue
Salt Marsh Outside Brown Area	-	NA	NA	NA
Goose Pond North of Mine Waste Hot Spot	-	NA	NA	NA
Goose Pond South of Mine Waste Hot Spot	-	NA	NA	NA
Goose Pond Non Hot Spot	-	NA	NA	NA
Goose Cove Non Hot Spot	-	NA	NA	
Dyer Cove [1]	- Cd Pb + Cu Zn	+	-	-Clam Cu, Clam Zn + Fish Cu, Clam Pb
Salt Marsh Inside Brown Area	- Cd + Cu Pb Zn	+	NA	NA
Mine Waste Hot Spot [2]	- Cd + Cu Pb Zn	-SP + GBH	+	+
Goose Cove Mine Waste [3]	- Cd Pb Zn + Cu	-	-	NA
Goose All Data Set [3]	- Cd Pb Zn + Cu	+	-	NA

Prepared by / Date: AMR 03/19/09
Checked by / Date: JHP 03/19/09

+ = Adverse ecological impact possible
- = Adverse ecological impact unlikely

SP = Spotted Sandpiper
GBH = Great Blue Heron
NA = Not Applicable
? = Unknown if water at the Mine Waste Hot Spot is too deep for GBH to forage.

1. Comparison of 95% UCL and average concentrations of Zn exceed the PRG. The Zn PRG is based on a benthic endpoint. However, toxicity tests and tissue cooncentration comparisons do not demonstrate risk.
2. Habitat is inaccessible to SP consider revising Cu and Pb PRG to be based on GBH.
3. Risk conclusions for Zn 95% UCLs/Mean based on food chain models.

Table 2
Exposure Point Concentrations
Mine Waste Hot Spot - Sediment

Risk Management Appendix - Feasibility Study
Callahan Mine Superfund Site
Brooksville, Maine

Analyte	Frequency of Detection			Range of Reporting Limits for Non Detects			Range of Detected Concentrations			Average of All Samples	PRG (mg/Kg)	Percent of Samples Exceeding PRG	Average Exceeds PRG?	95% UCL		Exposure Point Concentration (EPC)		EPC Exceeds PRG?
Select Metals (mg/Kg)																		
Cadmium	25	/	69	40	:	40	2.6	-	82	24.8	210	0%	No	29.0	NP [a]	29.0	95% UCL - NP [a]	No
Copper	62	/	69	20	:	20	25	-	5700	1593	790	72%	Yes	2288	NP [b]	2288	95% UCL - NP [b]	Yes
Lead	74	/	78	16	:	16	17	-	2700	775	710	37%	Yes	1110	NP [b]	1110	95% UCL - NP [b]	Yes
Zinc	68	/	69	30	:	30	76	-	19000	5992	5100	64%	Yes	9601	NP [c]	9601	95% UCL - NP [c]	Yes

NP - Nonparametric Distribution
[a] 95% KM (t) UCL
[b] 95% KM (Chebyshev) UCL
[c] 97.5% KM (Chebyshev) UCL

Prepared by / Date: KJC 03/12/09
Checked by / Date: BJR 03/12/09

Table 3
Exposure Point Concentrations
Salt Marsh outside Brown Area - Sediment

Risk Management Appendix - Feasibility Study
Callahan Mine Superfund Site
Brooksville, Maine

Analyte	Frequency of Detection			Range of Reporting Limits for Non Detects			Range of Detected Concentrations			Average of All Samples	PRG (mg/Kg)	Percent of Samples Exceeding PRG	Average Exceeds PRG?	95% UCL		Exposure Point Concentration (EPC)		EPC Exceeds PRG?
Select Metals (mg/Kg)																		
Cadmium	9	/	87	40	:	40	0.32	-	67	19.6	210	0%	No	17.9	NP [a]	17.9	95% UCL - NP [a]	No
Copper	70	/	89	20	:	20	20	-	2500	134	790	3%	No	296	NP [b]	296	95% UCL - NP [b]	No
Lead	65	/	89	16	:	16	16	-	2400	133	710	3%	No	303	NP [b]	303	95% UCL - NP [b]	No
Zinc	89	/	89				57	-	11000	656	5100	3%	No	1773	NP [c]	1773	95% UCL - NP [c]	No

NP - Nonparametric Distribution
[a] 95% KM (t) UCL
[b] 95% KM (Chebyshev) UCL
[c] 97.5% Chebyshev (Mean, Sd) UCL

Prepared by / Date: KJC 03/12/09
Checked by / Date: BJR 03/12/09

Table 4
Exposure Point Concentrations
Salt Marsh inside Brown Area - Sediment

Risk Management Appendix - Feasibility Study
Callahan Mine Superfund Site
Brooksville, Maine

Analyte	Frequency of Detection			Range of Reporting Limits for Non Detects			Range of Detected Concentrations			Average of All Samples	PRG (mg/Kg)	Percent of Samples Exceeding PRG	Average Exceeds PRG?	95% UCL		Exposure Point Concentration (EPC)		EPC Exceeds PRG?
Select Metals (mg/Kg)																		
Cadmium	34	/	66	40	:	40	0.37	-	216	36.1	210	2%	No	45.1	NP [a]	45.1	95% UCL - NP [a]	No
Copper	66	/	66				66	-	29800	3393	790	82%	Yes	7498	NP [b]	7498	95% UCL - NP [b]	Yes
Lead	66	/	66				64.6	-	2000	735	710	42%	Yes	837	N [c]	837	95% UCL - N [c]	Yes
Zinc	66	/	66				248	-	61900	9081	5100	59%	Yes	17161	NP [b]	17161	95% UCL - NP [b]	Yes

NP - Nonparametric Distribution
[a] 95% KM (BCA) UCL
[b] 97.5% Chebyshev (Mean, Sd) UCL
N - Normal Distribution
[c] 95% Student's-t UCL

Prepared by / Date: KJC 03/12/09
Checked by / Date: BJR 03/12/09

Table 5
Exposure Point Concentrations
Dyer Cove - Sediment

Risk Management Appendix - Feasibility Study
Callahan Mine Superfund Site
Brooksville, Maine

Analyte	Frequency of Detection			Range of Reporting Limits for Non Detects			Range of Detected Concentrations			Average of All Samples	PRG (mg/Kg)	Percent of Samples Exceeding PRG	Average Exceeds PRG?	95% UCL		Exposure Point Concentration (EPC)		EPC Exceeds PRG?
Select Metals (mg/Kg)																		
Cadmium	21	/	31	40	:	40	3.4	-	70	16.6	210	0%	No	18.6	NP [a]	18.6	95% UCL - NP [a]	No
Copper	29	/	31	420	:	740	163	-	4980	1251	790	45%	Yes	2316	NP [b]	2316	95% UCL - NP [b]	Yes
Lead	36	/	37	16	:	16	26.4	-	1000	288	710	8%	No	457	NP [b]	457	95% UCL - NP [b]	No
Zinc	31	/	31				609	-	40000	5888	5100	29%	Yes	15835	NP [c]	15835	95% UCL - NP [c]	Yes

NP - Nonparametric Distribution
[a] 95% KM (BCA) UCL
[b] 95% KM (Chebyshev) UCL
[c] 97.5% KM (Chebyshev) UCL

Prepared by / Date: KJC 03/12/09
Checked by / Date:

Table 6
Exposure Point Concentrations
Goose Pond North of Mine Waste Hot Spot - Sediment

Risk Management Appendix - Feasibility Study
Callahan Mine Superfund Site
Brooksville, Maine

Analyte	Frequency of Detection			Range of Reporting Limits for Non Detects			Range of Detected Concentrations			Average of All Samples	PRG (mg/Kg)	Percent of Samples Exceeding PRG	Average Exceeds PRG?	95% UCL		Exposure Point Concentration (EPC)		EPC Exceeds PRG?
Select Metals (mg/Kg)																		
Cadmium	41	/	97	40	:	40	0.5	-	46	15.7	210	0%	No	10.2	NP [a]	10.2	95% UCL - NP [a]	No
Copper	92	/	97	20	:	20	15.9	-	2400	364	790	9%	No	577	NP [b]	577	95% UCL - NP [b]	No
Lead	100	/	104	16	:	16	8	-	710	168	710	0%	No	236	NP [b]	236	95% UCL - NP [b]	No
Zinc	97	/	97				68	-	12000	1556	5100	5%	No	2372	NP [b]	2372	95% UCL - NP [b]	No

NP - Nonparametric Distribution
[a] 95% KM (BCA) UCL
[b] 95% KM (Chebyshev) UCL

Prepared by / Date: KJC 03/12/09
Checked by / Date:

Table 7
Exposure Point Concentrations
Goose Pond South of Mine Waste Hot Spot - Sediment

Risk Management Appendix - Feasibility Study
Callahan Mine Superfund Site
Brooksville, Maine

Analyte	Frequency of Detection			Range of Reporting Limits for Non Detects			Range of Detected Concentrations			Average of All Samples	PRG (mg/Kg)	Percent of Samples Exceeding PRG	Average Exceeds PRG?	95% UCL		Exposure Point Concentration (EPC)		EPC Exceeds PRG?
Select Metals (mg/Kg)																		
Cadmium	11	/	33	40	:	40	0.73	-	8.2	15.0	210	0%	No	6.4	NP [a]	6.4	95% UCL - NP [a]	No
Copper	31	/	33	20	:	20	19.1	-	240	106	790	0%	No	162	NP [b]	162	95% UCL - NP [b]	No
Lead	33	/	33				21	-	310	73	710	0%	No	89.6	G [c]	89.6	95% UCL - G [c]	No
Zinc	33	/	33				93	-	2200	728	5100	0%	No	936	G [c]	936	95% UCL - G [c]	No

NP - Nonparametric Distribution
[a] 95% KM (t) UCL
[b] 95% KM (Chebyshev) UCL
G - Gamma Distribution
[c] 95% Approximate Gamma UCL

Prepared by / Date: KJC 03/12/09
Checked by / Date: BJR 03/12/09

Table 8
Exposure Point Concentrations
Goose Pond Non Hot Spot - Sediment

Risk Management Appendix - Feasibility Study
Callahan Mine Superfund Site
Brooksville, Maine

Analyte	Frequency of Detection			Range of Reporting Limits for Non Detects			Range of Detected Concentrations			Average of All Samples	PRG (mg/Kg)	Percent of Samples Exceeding PRG	Average Exceeds PRG?	95% UCL		Exposure Point Concentration (EPC)		EPC Exceeds PRG?
Select Metals (mg/Kg)																		
Cadmium	52	/	130	40	:	40	0.5	-	46	15.5	210	0%	No	8.8	NP [a]	8.8	95% UCL - NP [a]	No
Copper	123	/	130	20	:	20	15.9	-	2400	299	790	7%	No	464	NP [b]	464	95% UCL - NP [b]	No
Lead	133	/	137	16	:	16	8	-	710	145	710	0%	No	200	NP [b]	200	95% UCL - NP [b]	No
Zinc	130	/	130				68	-	12000	1346	5100	4%	No	1979	NP [b]	1979	95% UCL - NP [b]	No

NP - Nonparametric Distribution
[a] 95% KM (BCA) UCL
[b] 95% KM (Chebyshev) UCL

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Table 9
Exposure Point Concentrations
Goose Cove Non Hot Spot - Sediment

Risk Management Appendix - Feasibility Study
Callahan Mine Superfund Site
Brooksville, Maine

Analyte	Frequency of Detection			Range of Reporting Limits for Non Detects			Range of Detected Concentrations			Average of All Samples	PRG (mg/Kg)	Percent of Samples Exceeding PRG	Average Exceeds PRG?	95% UCL		Exposure Point Concentration (EPC)		EPC Exceeds PRG?
Select Metals (mg/Kg)																		
Cadmium	8	/	13	40	:	40	0.55	-	10	9.0	210	0%	No	4.7	NP [a]	4.7	95% UCL - NP [a]	No
Copper	12	/	13	20	:	20	52	-	1000	214	790	8%	No	524	NP [b]	524	95% UCL - NP [b]	No
Lead	12	/	13	16	:	16	14.9	-	200	61	710	0%	No	133	NP [b]	133	95% UCL - NP [b]	No
Zinc	13	/	13				57	-	3100	651	5100	0%	No	1111	G [c]	1111	95% UCL - G [c]	No

NP - Nonparametric Distribution
[a] 95% KM (BCA) UCL
[b] 95% KM (Chebyshev) UCL
G - Gamma Distribution
[c] 95% Approximate Gamma UCL

Prepared by / Date: KJC 03/12/09
Checked by / Date: BJR 03/12/09

Table 10
Exposure Point Concentrations
Goose Cove Mine Waste Hot Spot - Sediment

Risk Management Appendix - Feasibility Study
Callahan Mine Superfund Site
Brooksville, Maine

Analyte	Frequency of Detection			Range of Reporting Limits for Non Detects			Range of Detected Concentrations			Average of All Samples	PRG (mg/Kg)	Percent of Samples Exceeding PRG	Average Exceeds PRG?	95% UCL		Exposure Point Concentration (EPC)		EPC Exceeds PRG?
Select Metals (mg/Kg)																		
Cadmium	15	/	42	40	:	40	1.7	-	58	19.8	210	0%	No	19.6	NP [a]	19.6	95% UCL - NP [a]	No
Copper	39	/	42	20	:	20	27	-	8700	1995	790	69%	Yes	3370	NP [b]	3370	95% UCL - NP [b]	Yes
Lead	42	/	42				20	-	2000	481	710	26%	No	622	G [c]	622	95% UCL - G [c]	No
Zinc	42	/	42				35	-	18000	4839	5100	33%	No	6607	G [c]	6607	95% UCL - G [c]	Yes

NP - Nonparametric Distribution
[a] 95% KM (% Bootstrap) UCL
[b] 95% KM (Chebyshev) UCL
G - Gamma Distribution
[c] 95% Approximate Gamma UCL

Prepared by / Date: KJC 03/12/09
Checked by / Date: BJR 03/12/09

Table 11
Exposure Point Concentrations
Goose Cove - Sediment

Risk Management Appendix - Feasibility Study
Callahan Mine Superfund Site
Brooksville, Maine

Analyte	Frequency of Detection			Range of Reporting Limits for Non Detects			Range of Detected Concentrations			Average of All Samples	PRG (mg/Kg)	Percent of Samples Exceeding PRG	Average Exceeds PRG?	95% UCL		Exposure Point Concentration (EPC)		EPC Exceeds PRG?
Select Metals (mg/Kg)																		
Cadmium	23	/	55	40	:	40	0.55	-	58	17.3	210	0%	No	14.1	NP [a]	14.1	95% UCL - NP [a]	No
Copper	51	/	55	20	:	20	27	-	8700	1573.9	790	55%	Yes	2716	NP [b]	2716	95% UCL - NP [b]	Yes
Lead	54	/	55	16	:	16	14.9	-	2000	382.0	710	20%	No	631	NP [b]	631.2	95% UCL - NP [b]	No
Zinc	55	/	55				35	-	18000	3849.0	5100	25%	No	5189	G [c]	5189	95% UCL - G [c]	Yes

NP - Nonparametric Distribution
[a] 95% KM (t) UCL
[b] 95% KM (Chebyshev) UCL
G - Gamma Distribution
[c] 95% Approximate Gamma UCL

Prepared by / Date: KJC 03/12/09
Checked by / Date: BJR 03/12/09

Table 12
Fish Tissue Copper

Risk Management Appendix - Feasibility Study
Callahan Mine Superfund Site
Brooksville, Maine

Location	Sample ID	Date Sampled	Copper (mg/Kg)	Effects Benchmark (mg/kg)	HQ	Old Exposure Area	Corresponding Reference Concentration (mg/kg)	Reference HQ	Incremental Risk HQ
Mine Waste Hot Spot (A)									
GP-11	FT-MM-GP115010001XX	9/22/2005	9	1.5	6.0	GPIF	2	1.3	4.7
Dyer Cove (D)									
GP-14	FT-MM-GP145010001XX	9/22/2005	5.3	1.5	3.5	GPPF	1.8	1.2	2.3
GP-15	FT-MM-GP155010001XX	9/30/2005	4	1.5	2.7	GPPF	1.8	1.2	1.5
Goose Pond North of Mine Waste Hot Spot (E)									
GP-05	FT-MM-GP055010001XX	9/30/2005	4.2	1.5	2.8	GPPF	1.8	1.2	1.6
GP-09	FT-MM-GP095010001XX	9/22/2005	4	1.5	2.7	GPPF	1.8	1.2	1.5
GP-10	FT-MM-GP105010001XX	9/22/2005	4	1.5	2.7	GPPF	1.8	1.2	1.5
Goose Pond South of Mine Waste Hot Spot (F)									
GP-16	FT-MM-GP165010001XX	9/22/2005	5.8	1.5	3.9	GPIF	2	1.3	2.5
GP-18	FT-MM-GP185010001XX	10/5/2005	18	1.5	12.0	GPIF	2	1.3	10.7

mg/kg - milligram per kilogram
HQ - Hazard Quotient
GPIF - Goose Pond irregularly Flooded
GPPF - Goose Pond Permanantly Flooded

Prepared by / Date: KJC 03/25/09
Checked by / Date: SEB 3/25/09

Table 13
Clam Tissue Copper

Risk Management Appendix - Feasibility Study
Callahan Mine Superfund Site
Brooksville, Maine

Location	Sample ID	Date Sampled	Copper (mg/Kg)	Effects Benchmark (mg/kg)	HQ	Old Exposure Area	Corresponding Reference Concentration (mg/kg)	Reference HQ	Incremental Risk HQ
Mine Waste Hot Spot (A)									
GP-12	MT-SC-GP125010001XX	10/18/2005	30	17	1.8	GPPF	8	0.5	1.3
GP-22	MT-SC-GP225010001XX	10/18/2005	61	17	3.6	GPPF	8	0.5	3.1
Dyer Cove (D)									
GP-13	MT-SC-GP135010001XX	10/13/2005	35	17	2.1	GPPF	8	0.5	1.6
GP-14	MT-SC-GP145010001XX	10/12/2005	18	17	1.1	GPPF	8	0.5	0.6
GP-15	MT-SC-GP155010001XX	10/19/2005	17	17	1.0	GPPF	8	0.5	0.5
Goose Pond North of Mine Waste Hot Spot (E)									
GP-09	MT-SC-GP095010001XX	10/18/2005	10	17	0.6	GPPF	8	0.5	0.1
GP-10	MT-SC-GP105010001XX	10/13/2005	13	17	0.8	GPPF	8	0.5	0.3

mg/Kg - milligram per kilogram
HQ - Hazard Quotient
GPIF - Goose Pond irregularly Flooded
GPPF - Goose Pond Permanantly Flooded

Prepared by / Date: KJC 03/25/09
Checked by / Date: SEB 3/25/09

Table 14
Clam Tissue Lead

Risk Management Appendix - Feasibility Study
Callahan Mine Superfund Site
Brooksville, Maine

Location	Sample ID	Date Sampled	Lead (mg/Kg)	Effects Benchmark (mg/kg)	HQ	Old Exposure Area	Corresponding Reference Concentration (mg/kg)	Reference HQ	Incremental Risk HQ
Mine Waste Hot Spot (A)									
GP-12	MT-SC-GP125010001XX	10/18/2005	43	2.3	18.7	GPPF	1	0.4	18.3
GP-22	MT-SC-GP225010001XX	10/18/2005	23	2.3	10.0	GPPF	1	0.4	9.6
GP-45	MT-SC-GP45-801CKDXX	7/30/2008	13.765	2.3	6.0	GPIR	0.75	0.3	5.7
GP-45	MT-SC-GP45-801RAWXX	7/30/2008	6.201	2.3	2.7	GPIR	0.75	0.3	2.4
GP-46	MT-SC-GP46-801CKDXX	7/30/2008	26.951	2.3	11.7	GPIR	0.75	0.3	11.4
GP-46	MT-SC-GP46-801RAWXX	7/30/2008	21.767	2.3	9.5	GPIR	0.75	0.3	9.1
Dyer Cove (D)									
GP-13	MT-SC-GP135010001XX	10/13/2005	22	2.3	9.6	GPPF	1	0.4	9.1
GP-14	MT-SC-GP145010001XX	10/12/2005	9.4	2.3	4.1	GPPF	1	0.4	3.7
GP-15	MT-SC-GP155010001XX	10/19/2005	4	2.3	1.7	GPPF	1	0.4	1.3
Goose Pond North of Mine Waste Hot Spot (E)									
GP-09	MT-SC-GP095010001XX	10/18/2005	5.6	2.3	2.4	GPPF	1	0.4	2.0
GP-10	MT-SC-GP105010001XX	10/13/2005	3.3	2.3	1.4	GPPF	1	0.4	1.0

mg/Kg - milligram per kilogram
HQ - Hazard Quotient
GPIF - Goose Pond irregularly Flooded
GPPF - Goose Pond Permanantly Flooded

Prepared by / Date: KJC 03/25/09
Checked by / Date: SEB 3/25/09

Table 15
Clam Tissue Zinc

Risk Management Appendix - Feasibility Study
Callahan Mine Superfund Site
Brooksville, Maine

Location	Sample ID	Date Sampled	Zinc (mg/Kg)	Effects Benchmark (mg/kg)	HQ	Old Exposure Area	Corresponding Reference Concentration (mg/kg)	Reference HQ	Incremental Risk HQ
Mine Waste Hot Spot									
GP-12	MT-SC-GP125010001XX	10/18/2005	100	25	4.0	GPPF	15	0.6	3.4
GP-22	MT-SC-GP225010001XX	10/18/2005	110	25	4.4	GPPF	15	0.6	3.8
GP-45	MT-SC-GP45-801CKDXX	7/30/2008	106.623	25	4.3	GPIR	0.75	0.03	4.2
GP-45	MT-SC-GP45-801RAWXX	7/30/2008	57.902	25	2.3	GPIR	0.75	0.03	2.3
GP-46	MT-SC-GP46-801CKDXX	7/30/2008	211.978	25	8.5	GPIR	0.75	0.03	8.4
GP-46	MT-SC-GP46-801RAWXX	7/30/2008	154.731	25	6.2	GPIR	0.75	0.03	6.2
Dyer Cove									
GP-13	MT-SC-GP135010001XX	10/13/2005	51	25	2.0	GPPF	15	0.6	1.4
GP-14	MT-SC-GP145010001XX	10/12/2005	50	25	2.0	GPPF	15	0.6	1.4
GP-15	MT-SC-GP155010001XX	10/19/2005	44	25	1.8	GPPF	15	0.6	1.2
Goose Pond North of Mine Waste Hot Spot (E)									
GP-09	MT-SC-GP095010001XX	10/18/2005	29	25	1.2	GPPF	15	0.6	0.6
GP-10	MT-SC-GP105010001XX	10/13/2005	32	25	1.3	GPPF	15	0.6	0.7

mg/Kg - milligram per kilogram
HQ - Hazard Quotient
GPIF - Goose Pond irregularly Flooded
GPPF - Goose Pond Permanantly Flooded

Prepared by / Date: KJC 03/25/09
Checked by / Date: SEB 3/25/09

APPENDIX G

Detailed Cost Estimates

FEASIBILITY COST SUMMARY OF OU1 ALTERNATIVES
Callahan Mine Superfund Site
Brooksville, Maine

Cost Description	Alternative		
	CMS1	CMS2	CMS3
Capital Cost	$0	$21,515,800	$24,131,500
Capital Cost + LTOMM, PV at 30-Yr, 7%	$19,000	$22,839,800	$25,455,500
Capital Cost + LTOMM, PV at 100-Yr, 2.7%	$56,000	$24,913,800	$27,529,500
Capital Cost + LTOMM, Nominal (Non-Discounted)	$171,000	$31,233,800	$33,849,500

Notes/Assumptions:

1. Abbreviations: LTOMM, Long-Term Operation, Maintenance, and Monitoring; PV, Present Value; Y1
2. Estimates subject to revision as remedial alternative components are developed and refined.
3. Capital costs do not include any long-term monitoring, maintenance, or reporting
4. Capital and Long Term Operation, Maintenance, and Monitoring costs include contingencies (30%) as a percentage of direct costs, and engineering and design, construction management, and project

1.0 FEASIBILITY STUDY COST ESTIMATE FOR OU1, ALTERNATIVE CMS1
Callahan Mine Superfund Site
Brooksville, Maine

Prepared by: JPMcCrady, 6/16/2009
Checked by: SWReed, RSEgan, 6/16/2009

Item Description	No.	Unit	Unit Cost	Total	Notes
1.1 Pre-Design Studies				**$ -**	
1.1.1 Geotechnical Investigation		ls	$ 150,000.00	$ -	
Subtotal w/o Contingency				$ -	Value = ROUNDUP(sum),-3)
1.1.2 Environmental Investigation		ls	$ 100,000.00	$ -	
Subtotal w/o Contingency				$ -	Value = ROUNDUP(sum),-3)
1.1.3 Survey		ls	$ 60,000.00	$ -	
Subtotal w/o Contingency				$ -	Value = ROUNDUP(sum),-3)
1.2 General Construction Costs Common to all Components of Work				**$ -**	
1.2.1 Mobilization/Demobilization		ls	$ 100,000.00	$ -	
Subtotal w/o Contingency				$ -	Value = ROUNDUP(sum),-3)
1.2.2 Temporary Facilities and Controls					
1.2.2.1 Construction facilities		ls	$ 50,000.00	$ -	Trailer, utilities, supplies, sanitary facilities
1.2.2.2 Barricades (concrete, temporary fencing)		ls	$ 25,000.00	$ -	
1.2.2.3 Erosion and sedimentation control maintenance		ls	$ 25,000.00	$ -	
1.2.2.4 Miscellaneous equipment		ls	$ 10,000.00	$ -	
1.2.2.5 Decontamination facilities		ls	$ 15,000.00	$ -	Includes liquid waste storage facilities
Subtotal w/o Contingency				$ -	Value = ROUNDUP(sum),-3)
1.2.3 Local Road Maintenance and Repair					
1.2.3.1 Tree trimming		ea	$ 217.00	$ -	Assume 260 trees
1.2.3.2 Drainage improvements and repairs		ea	$ 1,100.00	$ -	Assume 24-inch culvert replacements
1.2.3.3 Gravel filling, grading, and compacting		sf	$ 2.50	$ -	Assume 10% of total estimated 10-mile
1.2.3.4 Paving		sy	$ 9.94	$ -	road length requires maintenance/repair
Subtotal w/o Contingency				$ -	Value = ROUNDUP(sum),-3)
1.2.4 Site Road Maintenance and Repair					
1.2.4.1 Gravel filling, grading, and compacting		sf	$ 2.50	$ -	Assume 33% of total estimated 7,200 lf
Subtotal w/o Contingency				$ -	Value = ROUNDUP(sum),-3)
1.2.5 Construction Layout and Survey					
1.2.5.1 Construction layout and survey		days	$ 1,573.00	$ -	Assume 12-month construction period
1.2.5.2 As-Built survey		days	$ 1,573.00	$ -	

1.0 FEASIBILITY STUDY COST ESTIMATE FOR OU1, ALTERNATIVE CMS1
Callahan Mine Superfund Site
Brooksville, Maine

Prepared by: JPMcCrady, 6/16/2009
Checked by: SWReed, RSEgan, 6/16/2009

Item Description	No.	Unit	Unit Cost	Total	Notes
1.2.5.3 Record drawings		ls	$ 5,000.00	$ -	
Subtotal w/o Contingency				$ -	
1.1.6 Geotechnical Testing					
1.2.6.1 Laboratory testing of borrow material		ls	$ 40,000.00	$ -	
1.2.6.2 Field testing of installed materials		days	$ 500.00	$ -	Assume field testing once per week
Subtotal w/o Contingency				$ -	
1.3 <u>Tailings Impoundment Improvements</u>				**$ -**	
1.3.1 Tailings Impoundment Site Preparation				**$ -**	
1.3.1.1 Erosion and Sedimentation Controls		ls	$ 8,600.00	$ -	
1.3.1.2 Clearing and grubbing		ac	$ 5,125.00	$ -	
1.3.1.3 Dewatering of non-consolidated tailings		ls	$ 40,000.00	$ -	
1.3.1.4 Grading (excavating and filling) top of impoundment			$ 4.67	$ -	
Excavating and filling with dozer		bcy	$ 4.11	$ -	
Compaction		ecy	$ 0.56	$ -	
1.3.1.5 Underdrain installation (by horizontal directional drilling)		lf	$ 130.00	$ -	Assume 3-1,100 feet pipes
Subtotal w/o Contingency				$ -	Value = ROUNDUP(sum),-3)
1.3.2 Tailings Impoundment Infiltration Barrier Cover System				**$ -**	
1.3.2.1 Blasting		bcy	$ 7.00	$ -	bank cy (bcy)=fill cy - 33% swell
1.3.2.2 Crushing and loading		bcy	$ 6.00	$ -	
1.3.1.3 Hauling within the Site, 1 mile round trip		lcy	$ 2.48	$ -	Loose cy (lcy)=bank cy (bcy) + 67% swell
1.3.2.4 Place and grade at tailings impoundment		lcy	$ 1.62	$ -	
1.3.2.5 Compaction		ecy	$ 0.21	$ -	
1.3.2.6 Geocomposite, furnished and installed		sf	$ 0.68	$ -	
1.3.2.7 Geomembrane, furnished and installed		sf	$ 0.75	$ -	
Subtotal w/o Contingency				$ -	Value = ROUNDUP(sum),-3)
1.3.3 Tailings Impoundment Stormwater Controls				**$ -**	
1.3.3.1 Upslope surface water diversion channels		lf	$ 50.00	$ -	
1.3.3.2 Cover system drainage swales		lf	$ 100.00	$ -	designed for minimum 100-yr storm
1.3.3.3 Cover system downdrains		lf	$ 75.00	$ -	lined with geomembrane
1.3.3.4 Riprap drainage channels (outside limit of cover system)		lf	$ 50.00	$ -	designed for minimum 100-yr storm
1.3.3.5 Detention ponds		ea	$ 75,000.00	$ -	

1.0 FEASIBILITY STUDY COST ESTIMATE FOR OU1, ALTERNATIVE CMS1
Callahan Mine Superfund Site
Brooksville, Maine

Prepared by: JPMcCrady, 6/16/2009
Checked by: SWReed, RSEgan, 6/16/2009

Item Description	No.	Unit	Unit Cost	Total	Notes
1.3.3.6 Level spreaders		ea	$ 15,000.00	$ -	
Subtotal w/o Contingency				$ -	Value = ROUNDUP(sum),-3)
1.3.3 Tailings Impoundment Constructed/Treatment Wetland				**$ -**	
1.3.3.1 Excavating, lining, planting wetland areas		ac	$ 352,000.00	$ -	To treat impoundment leachate.
1.3.3.2 Piping from underdrains to constructed wetland		lf	$ 45.00	$ -	
Subtotal w/o Contingency				$ -	Value = ROUNDUP(sum),-3)
1.4 <u>Waste Rock Pile No. 3 (WRP3)</u>				**$ -**	
1.4.1 WRP3 Site Preparation					
1.4.1.1 Erosion and Sedimentation Controls		ls	$ 55,150.00	$ -	
1.4.1.2 Clearing and grubbing		ac	$ 5,125.00	$ -	
Subtotal w/o Contingency				$ -	Value = ROUNDUP(sum),-3)
1.4.2 WRP3 Excavation and Consolidation					
1.4.2.1 Impacted rock consolidation to Former Mine Pit				**$ -**	
Excavation and load		bcy	$ 2.06	$ -	WRP3 and 75% WRP3 Haul Road
Hauling within the Site, 1 mile round trip		lcy	$ 2.48	$ -	Assume 33% swell
Furnish conveyor system to transfer to Mine Pit		ea	$ 225,000.00	$ -	Assume 800 ft long or 6, 150 ft segments
1.4.2.2 Post-excavation field confirmation sampling				**$ -**	
XRF Technician		hrs	$ 90.00	$ -	44-days, 10-hr days
ODCs/Equipment Rental		wk	$ 1,700.00	$ -	1 wk min., assume 50 samples per day
Vehicle Rental (van / 4x4)		wk	$ 369.00	$ -	
Lodging and per diem		days	$ 150.00	$ -	
1.4.1.3 Confirmation analysis (off-site laboratory)		ea	**$ 150.00**	**$ -**	Assume RCRA metals 1/625 sf (25%)
Subtotal w/o Contingency				$ -	Value = ROUNDUP(sum),-3)
1.4.3 WRP3 Restoration					
1.4.3.1 Restoration cover (1ft crushed stone)				**$ -**	Assume 50% of excavated area
Blasting		bcy	$ 7.00	$ -	bank cy (bcy)=fill cy - 33% swell
Crushing and loading		bcy	$ 6.00	$ -	
Hauling within the Site, 1 mile round trip		lcy	$ 2.48	$ -	Loose cy (lcy)=bank cy (bcy) + 67% swell
Place and grade at WRP3 (sloped areas)		lcy	$ 1.62	$ -	
Compaction		ecy	$ 0.21	$ -	Fill cy
Subtotal w/o Contingency				$ -	Value = ROUNDUP(sum),-3)

1.0 FEASIBILITY STUDY COST ESTIMATE FOR OU1, ALTERNATIVE CMS1
Callahan Mine Superfund Site
Brooksville, Maine

Prepared by: JPMcCrady, 6/16/2009
Checked by: SWReed, RSEgan, 6/16/2009

Item Description	No.	Unit	Unit Cost	Total	Notes
1.5 Ore Pad and Mine Operations Area (Mine Ops, Etc.)				**$ -**	
1.5.1 Mine Ops, Etc. Site Preparation					
1.5.1.1 Erosion and Sedimentation Control		ls	$ 7,150.00	$ -	
1.5.1.2 Clearing and grubbing		ac	$ 5,125.00	$ -	
1.5.1.3 Select demolition (bldgs and foundations)		ls	$ 50,000.00	$ -	
Subtotal w/o Contingency				$ -	Value = ROUNDUP(sum),-3)
1.5.2 Mine Ops, Etc. Excavation and Consolidation					
1.5.2.1 Pre-excavation delineation (XRF)				**$ -**	
XRF technician		hrs	$ 90.00	$ -	5-days, 10-hr days
ODCs/Equipment rental		wk	$ 1,700.00	$ -	1 wk min., assume 50 samples per day
Vehicle rental (van / 4x4)		days	$ 115.00	$ -	
Lodging and per diem		days	$ 150.00	$ -	
1.5.2.2 Impacted soil consolidation to Former Mine Pit			**$ 4.92**	**$ -**	
Excavation and load		bcy	$ 2.44	$ -	Removal from Mine Ops, Ore Pad, Haul Rd
Hauling within the Site, 1 mile round trip		lcy	$ 2.48	$ -	Assume 33% swell
1.5.2.3 Petroleum contaminated soils (DRO/GRO)			**$ 30.00**	**$ -**	
Off-site transportation and disposal		tons	$ 30.00	$ -	V = 600 bcy
1.5.2.3 Post-excavation field confirmation sampling				**$ -**	
XRF Technician		hrs	$ 90.00	$ -	17-days, 10-hr days
ODCs/Equipment Rental		wk	$ 1,700.00	$ -	1 wk min., assume 50 samples per day
Vehicle Rental (van / 4x4)		wk	$ 369.00	$ -	
Lodging and per diem		days	$ 150.00	$ -	
1.5.2.4 Confirmation analysis (off-site laboratory)		ea	**$ 150.00**	**$ -**	Assume RCRA metals 1/625 sf (25%)
Subtotal w/o Contingency				$ -	Value = ROUNDUP(sum),-3)
1.5.3 Partial Waste Rock Pile 2 (WRP2) Excavation and Consolidation					
1.5.2.1 Pre-excavation delineation (XRF)				**$ -**	
XRF technician		hrs	$ 90.00	$ -	5-days, 10-hr days
ODCs/Equipment rental		wk	$ 1,700.00	$ -	1 wk min., assume 50 samples per day
Vehicle rental (van / 4x4)		days	$ 115.00	$ -	
Lodging and per diem		days	$ 150.00	$ -	
1.5.2.2 Impacted soil consolidation to Former Mine Pit			**$ 4.92**	**$ -**	
Excavation and load		bcy	$ 2.44	$ -	Removal from Mine Ops, Ore Pad, Haul Rd

1.0 FEASIBILITY STUDY COST ESTIMATE FOR OU1, ALTERNATIVE CMS1
Callahan Mine Superfund Site
Brooksville, Maine

Prepared by: JPMcCrady, 6/16/2009
Checked by: SWReed, RSEgan, 6/16/2009

Item Description	No.	Unit	Unit Cost	Total	Notes
Hauling within the Site, 1 mile round trip		lcy	$ 2.48	$ -	Assume 33% swell
1.5.2.3 Post-excavation field confirmation sampling				**$ -**	
XRF Technician		hrs	$ 90.00	$ -	2-days, 10-hr days
ODCs/Equipment Rental		wk	$ 1,700.00	$ -	1 wk min., assume 50 samples per day
Vehicle Rental (van / 4x4)		days	$ 115.00	$ -	
Lodging and per diem		days	$ 150.00	$ -	
1.5.2.4 Confirmation analysis (off-site laboratory)		ea	**$ 150.00**	**$ -**	Assume RCRA metals 1/625 sf (25%)
Subtotal w/o Contingency				$ -	Value = ROUNDUP(sum),-3)
1.5.3 Mine Ops, Etc. and Partial WRP2 Restoration					
1.5.3.1 Restoration cover system (1ft crushed stone)				**$ -**	Assume 50% of excavation area
Blasting		bcy	$ 7.00	$ -	bank cy (bcy)=fill cy - 33% swell
Crushing and loading		bcy	$ 6.00	$ -	Fill cy + 33% swell
Hauling within the Site, 1 mile round trip		lcy	$ 2.48	$ -	Loose cy (lcy)=bank cy (bcy) + 67% swell
Place and grade in Mine Ops Area, Etc.		lcy	$ 1.62	$ -	Loose cy (lcy)=bank cy (bcy) + 67% swell
Compaction		ecy	$ 0.21	$ -	
Subtotal w/o Contingency				$ -	Value = ROUNDUP(sum),-3)
1.6 <u>Residential Lots</u>				**$ -**	
1.6.1 Residential Lot Site Preparation					
1.6.1.1 Erosion and Sedimentation Controls		ls	$ 21,225.00	**$ -**	
1.6.1.2 Clearing and grubbing		ac	$ 5,125.00	**$ -**	
1.6.1.3 Select demolition		ls	$ 5,000.00	**$ -**	
Subtotal w/o Contingency				$ -	Value = ROUNDUP(sum),-3)
1.6.2 Residential Lot Excavation and Consolidation					
1.6.2.1 Pre-excavation delineation (XRF)				**$ -**	
XRF technician		hrs	$ 90.00	$ -	5-days, 10-hr days
ODCs/Equipment rental		wk	$ 1,700.00	$ -	1 wk min., assume 50 samples per day
Vehicle rental (van / 4x4)		days	$ 115.00	$ -	
Lodging and per diem		days	$ 150.00	$ -	
1.6.2.2 Impacted soil consolidation in Former Mine Pit			**$ 14.91**	**$ -**	
Excavation and load		bcy	$ 10.60	$ -	Excavation Unit Cost, Impacted Soil
Hauling within the Site, 1 mile round trip		lcy	$ 2.48	$ -	Assumes 10% material swell
Place and grade		lcy	$ 1.62	$ -	Material consolidated into WRP1

1.0 FEASIBILITY STUDY COST ESTIMATE FOR OU1, ALTERNATIVE CMS1
Callahan Mine Superfund Site
Brooksville, Maine

Prepared by: JPMcCrady, 6/16/2009
Checked by: SWReed, RSEgan, 6/16/2009

Item Description	No.	Unit	Unit Cost	Total	Notes
Compaction		ecy	$ 0.21	$ -	Material consolidated into WRP1
1.6.2.3 Post-excavation XRF sampling			**-**	**$ -**	
XRF technician		hrs	$ 90.00	$ -	11-days, 10-hr days
ODCs/Equipment rental		wk	$ 90.00	$ -	1 wk min., assume 50 samples per day
Vehicle rental (van / 4x4)		wk	$ 369.00	$ -	
Lodging and per diem		days	$ 150.00	$ -	
1.6.2.4 Confirmation analysis (off-site laboratory)		ea	**$ 150.00**	**$ -**	Assume RCRA metals 1/625 sf
Subtotal w/o Contingency				$ -	Value = ROUNDUP(sum),-3)
1.6.3 Residential Lot Restoration					
1.6.3.1 Common borrow backfill			**$ 35.13**	**$ -**	
Imported clean borrow loaded into truck		bcy	$ 10.80	$ -	20-inch
Hauling, 20 mile round trip		lcy	$ 22.50	$ -	Assume 10% swell
Place and grade		lcy	$ 1.62	$ -	Assume 10% swell
Compaction		ecy	$ 0.21	$ -	Assume 10% shrink
1.6.3.2 Topsoil/loam, installed		cy	$ 48.02	**$ -**	4-inch, assume 35% swell
1.6.3.3 Lawn preparation		msf	$ 41.00	**$ -**	
1.6.3.4 Seed/fertilize/mulch		msf	$ 47.00	**$ -**	Hydroseeding method
1.6.3.5 Road restoration				**$ -**	
Blasting		bcy	$ 7.00	$ -	bank cy (bcy)=fill cy - 33% swell
Crushing and loading		bcy	$ 6.00	$ -	Fill cy + 33% swell
Hauling within the Site, 1 mile round trip		lcy	$ 2.48	$ -	Loose cy (lcy)=bank cy (bcy) + 67% swell
Place and grade		lcy	$ 1.62	$ -	Loose cy (lcy)=bank cy (bcy) + 67% swell
Compaction		ecy	$ 1.00	$ -	
1.6.3.5 Misc. structure repair/replacement		ls	$ 100,000.00	**$ -**	Sheds, gardens, planters, walks, etc.
Subtotal w/o Contingency				$ -	Value = ROUNDUP(sum),-3)
1.7 <u>PCB Soils</u>				**$ -**	
1.7.1 <u>PCB Soil Excavation</u>					
1.7.1.1 Pre excavation delineation of excavation areas				**$ -**	
Technician		hrs	$ 90.00	$ -	
ODCs/Equipment Rental		wk	$ 1,700.00	$ -	
Vehicle Rental (van / 4x4)		days	$ 115.00	$ -	
Lodging and per diem		days	$ 150.00	$ -	
1.7.1.2 PCB soil excavation				**$ -**	

1.0 FEASIBILITY STUDY COST ESTIMATE FOR OU1, ALTERNATIVE CMS1
Callahan Mine Superfund Site
Brooksville, Maine

Prepared by: JPMcCrady, 6/16/2009
Checked by: SWReed, RSEgan, 6/16/2009

Item Description	No.	Unit	Unit Cost	Total	Notes
Excavate and stockpile		cy	$ 4.34	$ -	
Waste characterization		ea	$ 350.00	$ -	Assume 1 test/500ton
1.7.1.3 Post-excavation field confirmation sampling				**$ -**	
Technician		hrs	$ 90.00	$ -	2-days, 10-hr days
ODCs/Equipment Rental		wk	$ 1,700.00	$ -	
Vehicle Rental (van / 4x4)		days	$ 115.00	$ -	
Lodging and per diem		days	$ 150.00	$ -	
1.7.1.4 Confirmation analysis(off-site laboratory)		ea	$ 150.00	**$ -**	Assume RCRA metals 1/625 sf (25%)
Subtotal w/o Contingency				$ -	**Value = ROUNDUP(sum),-3)**
1.7.2 PCB Soil Transportation and Disposal					
1.7.2.1 TSCA waste load from stockpile to truck		lcy	$ 0.92	**$ -**	
1.7.2.2 TSCA waste transportation		load	$ 1,980.00	**$ -**	
1.7.2.3 TSCA waste disposal (Subtitle C)		ton	$ 80.00	**$ -**	
1.7.2.4 Waste disposal (Subtitle D)		ton	$ 80.00	**$ -**	
Subtotal w/o Contingency				$ -	**Value = ROUNDUP(sum),-3)**
1.7.3 PCB Soil Removal Area Restoration (1ft crushed stone)					
1.7.3.1 Blasting		bcy	$ 7.00	$ -	bank cy (bcy)=fill cy - 33% swell
1.7.3.2 Crushing and loading		bcy	$ 6.00	$ -	
1.7.3.3 Hauling within the Site, 1 mile round trip		lcy	$ 2.48	$ -	Loose cy (lcy)=bank cy (bcy) + 67% swell
1.7.3.4 Place and grade		lcy	$ 1.62	$ -	
1.7.3.5 Compaction		ecy	$ 0.21	$ -	
Subtotal w/o Contingency				$ -	**Value = ROUNDUP(sum),-3)**
1.8 <u>Sediment Dredging of Goose Pond and Salt Marsh</u>				**$ -**	
1.8.1 Goose Pond and Salt Marsh Site Preparation					
1.8.1.1 Erosion and Sedimentation Controls		ls	$ 22,055.00	**$ -**	
1.8.1.2 Clearing and grubbing		ac	$ 5,125.00	**$ -**	
Subtotal w/o Contingency				$ -	Value = ROUNDUP(sum),-3)
1.8.2 Goose Pond and Salt Marsh Dredging and Consolidation					
1.8.2.1 Dredging sediment (pump to Former Mine Pit)		bcy	**$ 27.00**	**$ -**	(51,304 + 22,264) bcy
1.8.2.2 Post-excavation field confirmation sampling				**$ -**	
XRF Technician		hrs	$ 90.00	$ -	20-days, 10-hr days

1.0 FEASIBILITY STUDY COST ESTIMATE FOR OU1, ALTERNATIVE CMS1
Callahan Mine Superfund Site
Brooksville, Maine

Prepared by: JPMcCrady, 6/16/2009
Checked by: SWReed, RSEgan, 6/16/2009

Item Description	No.	Unit	Unit Cost	Total	Notes
ODCs/Equipment Rental		wk	$ 90.00	$ -	1 wk min., assume 50 samples per day
Vehicle Rental (van / 4x4)		wk	$ 369.00	$ -	
Lodging and per diem		days	$ 150.00	$ -	
1.8.2.3 Confirmation analysis (off-site laboratory)		ea	**$ 150.00**	**$ -**	Assume RCRA metals 1/625 sf (25%)
Subtotal w/o Contingency				$ -	Value = ROUNDUP(sum),-3)
1.9 Wetland Mitigation				**$ -**	
1.9.1 Salt Marsh Wetland Restoration				$ -	
1.9.1.1 Excavation and load Stink Cove sediment (WRP1)		bcy	$ 5.79	$ -	Removal from WRP1
1.9.1.2 Hauling within the Site, 1 mile round trip		lcy	$ 2.48	$ -	Assumes 10% material swell
1.9.1.3 Place and grade in Salt Marsh		lcy	$ 1.62	$ -	Former Stink Cove sediment installed.
1.9.1.4 Compaction		ecy	$ 0.21	$ -	Former Stink Cove sediment installed.
1.9.1.5 Seed/fertilize/mulch		msf	$ 47.00	$ -	Hydroseeding method
1.9.1.6 Wetland plantings		ac	$ 50,000.00	$ -	Plantings, fine grading, etc.
Subtotal w/o Contingency				$ -	Value = ROUNDUP(sum),-3)
1.9.2 Goose Pond Restoration					
1.9.2.1 Eel grass planting along shoreline of Goose Pond		ac	$ 85,000.00	$ -	Assume can be done from water surface.
Subtotal w/o Contingency				$ -	Value = ROUNDUP(sum),-3)
1.9.3 Cove Restoration					
1.9.3.1 Dyer Cove sediment dredging (to Former Mine Pit)		bcy	$ 27.00	$ -	Assume wetland improvements
1.9.3.2 Goose Cove sediment dredging (to Former Mine Pit)		bcy	$ 27.00	$ -	Assume wetland improvements
Subtotal w/o Contingency				$ -	Value = ROUNDUP(sum),-3)
1.10 Institutional Controls				**$ -**	
1.10.1 Engineering Support	1	ls	$ -	$ -	
1.10.2 Legal Support	1	ls	$ -	$ -	
1.10.3 Administrative Support	1	ls	$ -	$ -	
Subtotal w/o Contingency				$ -	Value = ROUNDUP(sum),-3)
1.11 Monitoring Well Installation				**$ -**	
1.11.1 Install and develop 10 new/replaced monitoring wells		ls	$ 65,860.00	$ -	

1.0 FEASIBILITY STUDY COST ESTIMATE FOR OU1, ALTERNATIVE CMS1
Callahan Mine Superfund Site
Brooksville, Maine

Prepared by: JPMcCrady, 6/16/2009
Checked by: SWReed, RSEgan, 6/16/2009

	Item Description	No.	Unit	Unit Cost	Total	Notes
	Subtotal w/o Contingency				$ -	Value = ROUNDUP(sum),-3)
1.12	**Long-term Monitoring Plan (Institutional Controls Monitoring Plan)**				**$ -**	
1.11.1	**Preparation of Draft Plan**	1	ls	$ -	$ -	
1.11.2	**Stakeholder Meeting**	0	ea	$ -	$ -	
1.11.3	**Response to Review Comments**	0	ls	$ -	$ -	
1.11.4	**Preparation of Final Plan**	0	ls	$ -	$ -	
	Subtotal w/o Contingency				$ -	Value = ROUNDUP(sum),-3)
	Total Direct Capital Cost for OU1, CMS2				**$ -**	Value = ROUNDUP(sum),-3)
	Contingency			30.0%	**$ -**	
	Total Direct Capital Cost with Contingency for OU1, CMS2				**$ -**	
1.13	**Indirect Capital Costs (Engineering, Design, Construction Mgmt, and PMgmt)**				**$ -**	
1.13.1	**Engineering, Design, and Regulatory Coordination (@ 10 Percent)**			10.0%	**$ -**	
1.13.2	**Construction Management (@ 7 Percent)**			7.0%	**$ -**	
1.13.3	**Project Management (@ 5 Percent)**			5.0%	**$ -**	
	Subtotal w/ Contingency in Direct Capital Cost Value				$ -	Value = ROUNDUP(sum),-3)
1.14	**Long-Term Operation and Maintenance**					
1.14.1	**Annual Inspection and Site Summary Report, Per Event, Nominal**				**$ -**	
1.14.2	**Periodic Long-Term Maintenance , Per Event, Nominal**					
	1.14.2.1 Constructed Wetland (5-yr event)				$ -	
	1.14.2.2 Salt Marsh (years 1, 3 , 5, 10)				$ -	
	1.14.2.3 Tailings Impoundment Cap and Stormwater System (5-yr event)				$ -	
	1.14.2.4 Tailings Impoundment Cap (25-yr event)				$ -	
1.15	**Long-Term Environmental Monitoring, Per Event, Nominal**					
1.15.1	**Semi-Annual Constructed Wetland Inf/Eff (year 1)**				**$ -**	
1.15.2	**Annual Constructed Wetland Inf/Eff (years 2-100)**				**$ -**	
1.15.3	**Annual Groundwater (years 1-2)**				**$ -**	

1.0 FEASIBILITY STUDY COST ESTIMATE FOR OU1, ALTERNATIVE CMS1

Callahan Mine Superfund Site
Brooksville, Maine

Prepared by: JPMcCrady, 6/16/2009
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	Item Description	No.	Unit	Unit Cost	Total	Notes
1.15.4	Annual Groundwater (years 3-10)				$ -	
1.15.5	Annual Groundwater (years 15, 20, 25, …, 100)				$ -	
1.15.6	Semi-Annual Surface Water (years 1-2)				$ -	
1.15.7	Annual Surface Water (years 3 -10, 15, 20, 25, …, 100)				$ -	
1.15.8	Sediment Monitoring (every 5 years)				$ -	
1.15.9	Periodic Clam Tissue (years 3, 4, 5, 10, 15, 20, 25, …, 100)				$ -	
1.15.10	Five Year Review (every 5 years)				$ 7,400	

2.0 FEASIBILITY STUDY COST ESTIMATE FOR OU1, ALTERNATIVE CMS2
Callahan Mine Superfund Site
Brooksville, Maine

Prepared by: JPMcCrady, 6/16/2009
Checked by: SWReed, RSEgan, 6/16/2009

Item Description	No.	Unit	Unit Cost	Total	Notes
2.1 Pre-Design Studies				**$ 310,000**	
2.1.1 Geotechnical Investigation	1	ls	$ 150,000.00	$ 150,000	
Subtotal w/o Contingency				$ 150,000	Value = ROUNDUP(sum),-3)
2.1.2 Environmental Investigation	1	ls	$ 100,000.00	$ 100,000	
Subtotal w/o Contingency				$ 100,000	Value = ROUNDUP(sum),-3)
2.1.3 Survey	1	ls	$ 60,000.00	$ 60,000	
Subtotal w/o Contingency				$ 60,000	Value = ROUNDUP(sum),-3)
2.2 General Construction Costs Common to all Components of Work				**$ 827,000**	
2.2.1 Mobilization/Demobilization	1	ls	$ 100,000.00	$ 100,000	
Subtotal w/o Contingency				$ 100,000	Value = ROUNDUP(sum),-3)
2.2.2 Temporary Facilities and Controls					
2.2.2.1 Construction facilities	1	ls	$ 50,000.00	$ 50,000	Trailer, utilities, supplies, sanitary facilities
2.2.2.2 Barricades (concrete, temporary fencing)	1	ls	$ 25,000.00	$ 25,000	
2.2.2.3 Erosion and sedimentation control maintenance	1	ls	$ 25,000.00	$ 25,000	
2.2.2.4 Miscellaneous equipment	1	ls	$ 10,000.00	$ 10,000	
2.2.2.5 Decontamination facilities	1	ls	$ 15,000.00	$ 15,000	Includes liquid waste storage facilities
Subtotal w/o Contingency				$ 125,000	Value = ROUNDUP(sum),-3)
2.2.3 Local Road Maintenance and Repair					
2.2.3.1 Tree trimming	260	ea	$ 217.00	$ 56,420	Assume 260 trees
2.2.3.2 Drainage improvements and repairs	5	ea	$ 1,100.00	$ 5,500	Assume 24-inch culvert replacements
2.2.3.3 Gravel filling, grading, and compacting	79,200	sf	$ 2.50	$ 198,000	Assume 10% of total estimated 10-mile
2.2.3.4 Paving	8,800	sy	$ 9.94	$ 87,472	road length requires maintenance/repair
Subtotal w/o Contingency				$ 348,000	Value = ROUNDUP(sum),-3)
2.2.4 Site Road Maintenance and Repair					
2.2.4.1 Gravel filling, grading, and compacting	35,640	sf	$ 2.50	$ 89,100	Assume 33% of total estimated 7,200 lf
Subtotal w/o Contingency				$ 90,000	Value = ROUNDUP(sum),-3)

2.0 FEASIBILITY STUDY COST ESTIMATE FOR OU1, ALTERNATIVE CMS2
Callahan Mine Superfund Site
Brooksville, Maine

Prepared by: JPMcCrady, 6/16/2009
Checked by: SWReed, RSEgan, 6/16/2009

Item Description	No.	Unit	Unit Cost	Total	Notes
2.2.5 Construction Layout and Survey					
2.2.5.1 Construction layout and survey	52	days	$ 1,573.00	$ 81,796	Assume 12-month construction period
2.2.5.2 As-Built survey	7	days	$ 1,573.00	$ 11,011	
2.2.5.3 Record drawings	1	ls	$ 5,000.00	$ 5,000	
Subtotal w/o Contingency				$ 98,000	
2.2.6 Geotechnical Testing					
2.2.6.1 Laboratory testing of borrow material	1	ls	$ 40,000.00	$ 40,000	
2.2.6.2 Field testing of installed materials	52	days	$ 500.00	$ 26,000	Assume field testing once per week
Subtotal w/o Contingency				$ 66,000	
2.3 <u>Tailings Impoundment Improvements</u>				**$ 4,331,000**	
2.3.1 Tailings Impoundment Site Preparation				**$ 1,616,854**	
2.3.1.1 Erosion and Sedimentation Controls	1	ls	$ 8,600.00	$ 8,600	
2.3.1.2 Clearing and grubbing	5	ac	$ 5,125.00	$ 25,625	
2.3.1.3 Dewatering of non-consolidated tailings	1	ls	$ 40,000.00	$ 40,000	
2.3.1.4 Grading (excavating and filling) top of impoundment			$ 4.67	$ 1,113,629	
Excavating and filling with dozer	253,674	bcy	$ 4.11	$ 1,042,600	
Compaction	126,837	ecy	$ 0.56	$ 71,029	
2.3.1.5 Underdrain installation (by horizontal directional drilling)	3,300	lf	$ 130.00	$ 429,000	Assume 3-1,100 feet pipes
Subtotal w/o Contingency				$ 1,617,000	Value = ROUNDUP(sum),-3)
2.3.2 Tailings Impoundment Infiltration Barrier Cover System				**$ 1,675,227**	
2.3.2.1 Blasting	32,017	bcy	$ 7.00	$ 224,119	bank cy (bcy)=fill cy - 33% swell
2.3.2.2 Crushing and loading	32,017	bcy	$ 6.00	$ 192,102	
2.3.2.3 Hauling within the Site, 1 mile round trip	53,362	lcy	$ 2.48	$ 132,338	Loose cy (lcy)=bank cy (bcy) + 67% swell
2.3.2.4 Place and grade at tailings impoundment	53,362	lcy	$ 1.62	$ 86,446	
2.3.2.5 Compaction	48,025	ecy	$ 0.21	$ 10,085	
2.3.2.6 Geocomposite, furnished and installed	720,375	sf	$ 0.68	$ 489,855	
2.3.2.7 Geomembrane, furnished and installed	720,375	sf	$ 0.75	$ 540,281	

2.0 FEASIBILITY STUDY COST ESTIMATE FOR OU1, ALTERNATIVE CMS2
Callahan Mine Superfund Site
Brooksville, Maine

Prepared by: JPMcCrady, 6/16/2009
Checked by: SWReed, RSEgan, 6/16/2009

Item Description	No.	Unit	Unit Cost	Total	Notes
Subtotal w/o Contingency				$ 1,676,000	Value = ROUNDUP(sum),-3)
2.3.3 Tailings Impoundment Stormwater Controls				**$ 569,750**	
2.3.3.1 Upslope surface water diversion channels	1,200	lf	$ 50.00	$ 60,000	
2.3.3.2 Cover system drainage swales	2,600	lf	$ 100.00	$ 260,000	designed for minimum 100-yr storm
2.3.3.3 Cover system downdrains	200	lf	$ 75.00	$ 15,000	lined with geomembrane
2.3.3.4 Riprap drainage channels (outside limit of cover system)	1,095	lf	$ 50.00	$ 54,750	designed for minimum 100-yr storm
2.3.3.5 Detention ponds	2	ea	$ 75,000.00	$ 150,000	
2.3.3.6 Level spreaders	2	ea	$ 15,000.00	$ 30,000	
Subtotal w/o Contingency				$ 570,000	Value = ROUNDUP(sum),-3)
2.3.3 Tailings Impoundment Constructed/Treatment Wetland				**$ 467,400**	
2.3.3.1 Excavating, lining, planting wetland areas	1.2	ac	$ 352,000.00	$ 422,400	To treat impoundment leachate.
2.3.3.2 Piping from underdrains to constructed wetland	1,000	lf	$ 45.00	$ 45,000	
Subtotal w/o Contingency				$ 468,000	Value = ROUNDUP(sum),-3)
2.4 <u>Waste Rock Pile No. 3 (WRP3)</u>				**$ 3,002,000**	
2.4.1 WRP3 Site Preparation					
2.4.1.1 Erosion and Sedimentation Controls	1	ls	$ 55,150.00	$ 55,150	
2.4.1.2 Clearing and grubbing	2.6	ac	$ 5,125.00	$ 13,325	
Subtotal w/o Contingency				$ 69,000	Value = ROUNDUP(sum),-3)
2.4.2 WRP3 Excavation and Consolidation					
2.4.2.1 Impacted rock consolidation to Former Mine Pit				**$ 2,751,622**	
Excavation and load	261,574	bcy	$ 2.06	$ 538,842	WRP3 and 75% WRP3 Haul Road
Hauling within the Site, 1 mile round trip	347,895	lcy	$ 2.48	$ 862,780	Assume 33% swell
Furnish conveyor system to transfer to Mine Pit	6	ea	$ 225,000.00	$ 1,350,000	Assume 800 ft long or 6, 150 ft segments
2.4.2.2 Post-excavation field confirmation sampling				**$ 64,821**	
XRF Technician	440	hrs	$ 90.00	$ 39,600	44-days, 10-hr days
ODCs/Equipment Rental	9	wk	$ 1,700.00	$ 15,300	1 wk min., assume 50 samples per day
Vehicle Rental (van / 4x4)	9	wk	$ 369.00	$ 3,321	

2.0 FEASIBILITY STUDY COST ESTIMATE FOR OU1, ALTERNATIVE CMS2
Callahan Mine Superfund Site
Brooksville, Maine

Prepared by: JPMcCrady, 6/16/2009
Checked by: SWReed, RSEgan, 6/16/2009

Item Description	No.	Unit	Unit Cost	Total	Notes
Lodging and per diem	44	days	$ 150.00	$ 6,600	
2.4.2.3 Confirmation analysis (off-site laboratory)	159	ea	**$ 150.00**	**$ 23,850**	Assume RCRA metals 1/625 sf (25%)
Subtotal w/o Contingency				$ 2,841,000	Value = ROUNDUP(sum),-3)
2.4.3 WRP3 Restoration					
2.4.3.1 Restoration cover (1ft crushed stone)				**$ 91,838**	Assume 50% of excavated area
Blasting	4,555	bcy	$ 7.00	$ 31,885	bank cy (bcy)=fill cy - 33% swell
Crushing and loading	4,555	bcy	$ 6.00	$ 27,330	
Hauling within the Site, 1 mile round trip	7,607	lcy	$ 2.48	$ 18,865	Loose cy (lcy)=bank cy (bcy) + 67% swell
Place and grade at WRP3 (sloped areas)	7,607	lcy	$ 1.62	$ 12,323	
Compaction	6,832	ecy	$ 0.21	$ 1,435	Fill cy
Subtotal w/o Contingency				$ 92,000	Value = ROUNDUP(sum),-3)
2.5 <u>Ore Pad and Mine Operations Area (Mine Ops, Etc.)</u>				**$ 694,000**	
2.5.1 Mine Ops, Etc. Site Preparation					
2.5.1.1 Erosion and Sedimentation Control	1	ls	$ 7,150.00	$ 7,150	
2.5.1.2 Clearing and grubbing	1	ac	$ 5,125.00	$ 5,125	
2.5.1.3 Select demolition (bldgs and foundations)	1	ls	$ 50,000.00	$ 50,000	
Subtotal w/o Contingency				$ 63,000	Value = ROUNDUP(sum),-3)
2.5.2 Mine Ops, Etc. Excavation and Consolidation					
2.5.2.1 Pre-excavation delineation (XRF)				**$ 7,525**	
XRF technician	50	hrs	$ 90.00	$ 4,500	5-days, 10-hr days
ODCs/Equipment rental	1	wk	$ 1,700.00	$ 1,700	1 wk min., assume 50 samples per day
Vehicle rental (van / 4x4)	5	days	$ 115.00	$ 575	
Lodging and per diem	5	days	$ 150.00	$ 750	
2.5.2.2 Impacted soil consolidation to Former Mine Pit			**$ 4.92**	**$ 377,313**	
Excavation and load	66,003	bcy	$ 2.44	$ 161,047	Removal from Mine Ops, Ore Pad, Haul Rd
Hauling within the Site, 1 mile round trip	87,204	lcy	$ 2.48	$ 216,266	Assume 33% swell
2.5.2.3 Petroleum contaminated soils (DRO/GRO)			**$ 30.00**	**$ 38,400**	
Off-site transportation and disposal	1,280	tons	$ 30.00	$ 38,400	V = 600 bcy

2.0 FEASIBILITY STUDY COST ESTIMATE FOR OU1, ALTERNATIVE CMS2
Callahan Mine Superfund Site
Brooksville, Maine

Prepared by: JPMcCrady, 6/16/2009
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Item Description	No.	Unit	Unit Cost	Total	Notes
2.5.2.3 Post-excavation field confirmation sampling				**$ 26,126**	
XRF Technician	170	hrs	$ 90.00	$ 15,300	17-days, 10-hr days
ODCs/Equipment Rental	4	wk	$ 1,700.00	$ 6,800	1 wk min., assume 50 samples per day
Vehicle Rental (van / 4x4)	4	wk	$ 369.00	$ 1,476	
Lodging and per diem	17	days	$ 150.00	$ 2,550	
2.5.2.4 Confirmation analysis (off-site laboratory)	148	ea	**$ 150.00**	**$ 22,200**	Assume RCRA metals 1/625 sf (25%)
Subtotal w/o Contingency				$ 472,000	Value = ROUNDUP(sum),-3)
2.5.3 Partial Waste Rock Pile 2 (WRP2) Excavation and Consolidation					
2.5.2.1 Pre-excavation delineation (XRF)				**$ 7,525**	
XRF technician	50	hrs	$ 90.00	$ 4,500	5-days, 10-hr days
ODCs/Equipment rental	1	wk	$ 1,700.00	$ 1,700	1 wk min., assume 50 samples per day
Vehicle rental (van / 4x4)	5	days	$ 115.00	$ 575	
Lodging and per diem	5	days	$ 150.00	$ 750	
2.5.2.2 Impacted soil consolidation to Former Mine Pit			**$ 4.92**	**$ 42,583**	
Excavation and load	7,410	bcy	$ 2.44	$ 18,080	Removal from Mine Ops, Ore Pad, Haul Rd
Hauling within the Site, 1 mile round trip	9,880	lcy	$ 2.48	$ 24,502	Assume 33% swell
2.5.2.3 Post-excavation field confirmation sampling				**$ 4,375**	
XRF Technician	20	hrs	$ 90.00	$ 1,800	2-days, 10-hr days
ODCs/Equipment Rental	1	wk	$ 1,700.00	$ 1,700	1 wk min., assume 50 samples per day
Vehicle Rental (van / 4x4)	5	days	$ 115.00	$ 575	
Lodging and per diem	2	days	$ 150.00	$ 300	
2.5.2.4 Confirmation analysis (off-site laboratory)	16	ea	**$ 150.00**	**$ 2,400**	Assume RCRA metals 1/625 sf (25%)
Subtotal w/o Contingency				$ 57,000	Value = ROUNDUP(sum),-3)
2.5.3 Mine Ops, Etc. and Partial WRP2 Restoration					
2.5.3.1 Restoration cover system (1ft crushed stone)				**$ 101,496**	Assume 50% of excavation area
Blasting	5,034	bcy	$ 7.00	$ 35,238	bank cy (bcy)=fill cy - 33% swell
Crushing and loading	5,034	bcy	$ 6.00	$ 30,204	Fill cy + 33% swell
Hauling within the Site, 1 mile round trip	8,407	lcy	$ 2.48	$ 20,849	Loose cy (lcy)=bank cy (bcy) + 67% swell
Place and grade in Mine Ops Area, Etc.	8,407	lcy	$ 1.62	$ 13,619	Loose cy (lcy)=bank cy (bcy) + 67% swell
Compaction	7,550	ecy	$ 0.21	$ 1,586	

2.0 FEASIBILITY STUDY COST ESTIMATE FOR OU1, ALTERNATIVE CMS2
Callahan Mine Superfund Site
Brooksville, Maine

Prepared by: JPMcCrady, 6/16/2009
Checked by: SWReed, RSEgan, 6/16/2009

Item Description	No.	Unit	Unit Cost	Total	Notes
Subtotal w/o Contingency				$ 102,000	Value = ROUNDUP(sum),-3)
2.6 Residential Lots				**$ 314,000**	
2.6.1 Residential Lot Site Preparation					
2.6.1.1 Erosion and Sedimentation Controls	1	ls	$ 21,225.00	**$ 21,225**	
2.6.1.2 Clearing and grubbing	1	ac	$ 5,125.00	**$ 5,125**	
2.6.1.3 Select demolition	1	ls	$ 5,000.00	**$ 5,000**	
Subtotal w/o Contingency				$ 32,000	Value = ROUNDUP(sum),-3)
2.6.2 Residential Lot Excavation and Consolidation					
2.6.2.1 Pre-excavation delineation (XRF)				**$ 7,525**	
XRF technician	50	hrs	$ 90.00	$ 4,500	5-days, 10-hr days
ODCs/Equipment rental	1	wk	$ 1,700.00	$ 1,700	1 wk min., assume 50 samples per day
Vehicle rental (van / 4x4)	5	days	$ 115.00	$ 575	
Lodging and per diem	5	days	$ 150.00	$ 750	
2.6.2.2 Impacted soil consolidation in Former Mine Pit			**$ 14.91**	**$ 46,607**	
Excavation and load	3,042	bcy	$ 10.60	$ 32,245	Excavation Unit Cost, Impacted Soil
Hauling within the Site, 1 mile round trip	3,347	lcy	$ 2.48	$ 8,301	Assumes 10% material swell
Place and grade	3,347	lcy	$ 1.62	$ 5,422	Material consolidated into WRP1
Compaction	3,042	ecy	$ 0.21	$ 639	Material consolidated into WRP1
2.6.2.3 Post-excavation XRF sampling			**-**	**$ 12,927**	
XRF technician	110	hrs	$ 90.00	$ 9,900	11-days, 10-hr days
ODCs/Equipment rental	3	wk	$ 90.00	$ 270	1 wk min., assume 50 samples per day
Vehicle rental (van / 4x4)	3	wk	$ 369.00	$ 1,107	
Lodging and per diem	11	days	$ 150.00	$ 1,650	
2.6.2.4 Confirmation analysis (off-site laboratory)	17	ea	**$ 150.00**	**$ 2,550**	Assume RCRA metals 1/625 sf
Subtotal w/o Contingency				$ 70,000	Value = ROUNDUP(sum),-3)
2.6.3 Residential Lot Restoration					
2.6.3.1 Common borrow backfill			**$ 35.13**	**$ 80,715**	
Imported clean borrow loaded into truck	2,150	bcy	$ 10.80	$ 23,220	20-inch

2.0 FEASIBILITY STUDY COST ESTIMATE FOR OU1, ALTERNATIVE CMS2
Callahan Mine Superfund Site
Brooksville, Maine

Prepared by: JPMcCrady, 6/16/2009
Checked by: SWReed, RSEgan, 6/16/2009

Item Description	No.	Unit	Unit Cost	Total	Notes
Hauling, 20 mile round trip	2,365	lcy	$ 22.50	$ 53,213	Assume 10% swell
Place and grade	2,365	lcy	$ 1.62	$ 3,831	Assume 10% swell
Compaction	2,150	ecy	$ 0.21	$ 452	Assume 10% shrink
2.6.3.2 Topsoil/loam, installed	430	cy	$ 48.02	**$ 20,649**	4-inch, assume 35% swell
2.6.3.3 Lawn preparation	35	msf	$ 41.00	**$ 1,435**	
2.6.3.4 Seed/fertilize/mulch	35	msf	$ 47.00	**$ 1,645**	Hydroseeding method
2.6.3.5 Road restoration				**$ 6,592**	
Blasting	309	bcy	$ 7.00	$ 2,163	bank cy (bcy)=fill cy - 33% swell
Crushing and loading	309	bcy	$ 6.00	$ 1,854	Fill cy + 33% swell
Hauling within the Site, 1 mile round trip	515	lcy	$ 2.48	$ 1,277	Loose cy (lcy)=bank cy (bcy) + 67% swell
Place and grade	515	lcy	$ 1.62	$ 834	Loose cy (lcy)=bank cy (bcy) + 67% swell
Compaction	463	ecy	$ 1.00	$ 463	
2.6.3.5 Misc. structure repair/replacement	1	ls	$ 100,000.00	**$ 100,000**	Sheds, gardens, planters, walks, etc.
Subtotal w/o Contingency				$ 212,000	Value = ROUNDUP(sum),-3)
2.7 PCB Soils				**$ 587,000**	
2.7.1 PCB Soil Excavation					
2.7.1.1 Pre excavation delineation of excavation areas				**$ 7,525**	
Technician	50	hrs	$ 90.00	$ 4,500	
ODCs/Equipment Rental	1	wk	$ 1,700.00	$ 1,700	
Vehicle Rental (van / 4x4)	5	days	$ 115.00	$ 575	
Lodging and per diem	5	days	$ 150.00	$ 750	
2.7.1.2 PCB soil excavation				**$ 12,292**	
Excavate and stockpile	2,187	cy	$ 4.34	$ 9,492	
Waste characterization	8	ea	$ 350.00	$ 2,800	Assume 1 test/500ton
2.7.1.3 Post-excavation field confirmation sampling				**$ 4,030**	
Technician	20	hrs	$ 90.00	$ 1,800	2-days, 10-hr days
ODCs/Equipment Rental	1	wk	$ 1,700.00	$ 1,700	
Vehicle Rental (van / 4x4)	2	days	$ 115.00	$ 230	
Lodging and per diem	2	days	$ 150.00	$ 300	
2.7.1.4 Confirmation analysis(off-site laboratory)	13	ea	$ 150.00	**$ 1,950**	Assume RCRA metals 1/625 sf (25%)

2.0 FEASIBILITY STUDY COST ESTIMATE FOR OU1, ALTERNATIVE CMS2
Callahan Mine Superfund Site
Brooksville, Maine

Prepared by: JPMcCrady, 6/16/2009
Checked by: SWReed, RSEgan, 6/16/2009

Item Description	No.	Unit	Unit Cost	Total	Notes
Subtotal w/o Contingency				$ 26,000	**Value = ROUNDUP(sum),-3)**
2.7.2 PCB Soil Transportation and Disposal					
2.7.2.1 TSCA waste load from stockpile to truck	2,406	lcy	$ 0.92	**$ 2,214**	
2.7.2.2 TSCA waste transportation	110	load	$ 1,980.00	**$ 217,800**	
2.7.2.3 TSCA waste disposal (Subtitle C)	386	ton	$ 80.00	**$ 30,880**	
2.7.2.4 Waste disposal (Subtitle D)	3,494	ton	$ 80.00	**$ 279,520**	
Subtotal w/o Contingency				$ 531,000	**Value = ROUNDUP(sum),-3)**
2.7.3 PCB Soil Removal Area Restoration (1ft crushed stone)					
2.7.3.1 Blasting	1,458	bcy	$ 7.00	$ 10,206	bank cy (bcy)=fill cy - 33% swell
2.7.3.2 Crushing and loading	1,458	bcy	$ 6.00	$ 8,748	
2.7.3.3 Hauling within the Site, 1 mile round trip	2,430	lcy	$ 2.48	$ 6,026	Loose cy (lcy)=bank cy (bcy) + 67% swell
2.7.3.4 Place and grade	2,430	lcy	$ 1.62	$ 3,937	
2.7.3.5 Compaction	2,187	ecy	$ 0.21	$ 459	
Subtotal w/o Contingency				$ 30,000	**Value = ROUNDUP(sum),-3)**
2.8 <u>Sediment Dredging of Goose Pond and Salt Marsh</u>				**$ 2,124,000**	
2.8.1 Goose Pond and Salt Marsh Site Preparation					
2.8.1.1 Erosion and Sedimentation Controls	1	ls	$ 22,055.00	**$ 22,055**	
2.8.1.2 Clearing and grubbing	6.3	ac	$ 5,125.00	**$ 32,288**	
Subtotal w/o Contingency				$ 55,000	Value = ROUNDUP(sum),-3)
2.8.2 Goose Pond and Salt Marsh Dredging and Consolidation					
2.8.2.1 Dredging sediment (pump to Former Mine Pit)	73,568	bcy	**$ 27.00**	**$ 1,986,336**	(51,304 + 22,264) bcy
2.8.2.2 Post-excavation field confirmation sampling				**$ 22,836**	
XRF Technician	200	hrs	$ 90.00	$ 18,000	20-days, 10-hr days
ODCs/Equipment Rental	4	wk	$ 90.00	$ 360	1 wk min., assume 50 samples per day
Vehicle Rental (van / 4x4)	4	wk	$ 369.00	$ 1,476	
Lodging and per diem	20	days	$ 150.00	$ 3,000	
2.8.2.3 Confirmation analysis (off-site laboratory)	394	ea	**$ 150.00**	**$ 59,100**	Assume RCRA metals 1/625 sf (25%)

2.0 FEASIBILITY STUDY COST ESTIMATE FOR OU1, ALTERNATIVE CMS2
Callahan Mine Superfund Site Prepared by: JPMcCrady, 6/16/2009
Brooksville, Maine Checked by: SWReed, RSEgan, 6/16/2009

Item Description	No.	Unit	Unit Cost	Total	Notes
Subtotal w/o Contingency				$ 2,069,000	Value = ROUNDUP(sum),-3)
2.9 Wetland Mitigation				**$ 1,245,000**	
2.9.1 Salt Marsh Wetland Restoration				$ 338,152	
2.9.1.1 Excavation and load Stink Cove sediment (WRP1)	7,906	bcy	$ 5.79	$ 45,776	Removal from WRP1
2.9.1.2 Hauling within the Site, 1 mile round trip	8,697	lcy	$ 2.48	$ 21,569	Assumes 10% material swell
2.9.1.3 Place and grade in Salt Marsh	8,697	lcy	$ 1.62	$ 14,089	Former Stink Cove sediment installed.
2.9.1.4 Compaction	7,906	ecy	$ 0.21	$ 1,660	Former Stink Cove sediment installed.
2.9.1.5 Seed/fertilize/mulch	214	msf	$ 47.00	$ 10,058	Hydroseeding method
2.9.1.6 Wetland plantings	4.9	ac	$ 50,000.00	$ 245,000	Plantings, fine grading, etc.
Subtotal w/o Contingency				$ 339,000	Value = ROUNDUP(sum),-3)
2.9.2 Goose Pond Restoration					
2.9.2.1 Eel grass planting along shoreline of Goose Pond	2.0	ac	$ 85,000.00	$ 170,000	Assume can be done from water surface.
Subtotal w/o Contingency				$ 170,000	Value = ROUNDUP(sum),-3)
2.9.3 Cove Restoration					
2.9.3.1 Dyer Cove sediment dredging (to Former Mine Pit)	17,424	bcy	$ 27.00	$ 470,448	Assume wetland improvements
2.9.3.2 Goose Cove sediment dredging (to Former Mine Pit)	9,809	bcy	$ 27.00	$ 264,843	Assume wetland improvements
Subtotal w/o Contingency				$ 736,000	Value = ROUNDUP(sum),-3)
2.10 Institutional Controls				**$ 31,000**	
2.10.1 Engineering Support				**$ 10,000**	
2.10.2 Legal Support				**$ 20,000**	
2.10.3 Administrative Support				**$ 1,000**	
Subtotal w/o Contingency				$ 31,000	Value = ROUNDUP(sum),-3)
2.11 Monitoring Well Installation				**$ 66,000**	
2.11.1 Install and develop 10 new/replaced monitoring wells	1	ls	$ 65,860.00	$ 65,860	

2.0 FEASIBILITY STUDY COST ESTIMATE FOR OU1, ALTERNATIVE CMS2
Callahan Mine Superfund Site
Brooksville, Maine

Prepared by: JPMcCrady, 6/16/2009
Checked by: SWReed, RSEgan, 6/16/2009

	Item Description	No.	Unit	Unit Cost		Total	Notes
	Subtotal w/o Contingency				$	66,000	Value = ROUNDUP(sum),-3)
2.12	**Long-term Monitoring Plan**				**$**	**35,000**	
2.12.1	**Preparation of Draft Plan**	1	ls	$ 50,000.00	$	25,000	
2.12.2	**Stakeholder Meeting**	1	ea	$ 2,500.00	$	2,500	
2.12.3	**Response to Review Comments**	1	ls	$ 2,500.00	$	2,500	
2.12.4	**Preparation of Final Plan**	1	ls	$ 5,000.00	$	5,000	
	Subtotal w/o Contingency				$	35,000	Value = ROUNDUP(sum),-3)
	Total Direct Capital Cost for OU1, CMS2				**$**	**13,566,000**	Value = ROUNDUP(sum),-3)
	Contingency			30.0%	**$**	**4,069,800**	
	Total Direct Capital Cost with Contingency for OU1, CMS2				**$**	**17,635,800**	
2.13	**Indirect Capital Costs (Engineering, Design, Construction Mgmt, and PMgmt)**				**$**	**3,880,000**	
2.13.1	**Engineering, Design, and Regulatory Coordination (@ 10 Percent)**			10.0%	**$**	**1,763,580**	
2.13.2	**Construction Management (@ 7 Percent)**			7.0%	**$**	**1,234,506**	
2.13.3	**Project Management (@ 5 Percent)**			5.0%	**$**	**881,790**	
	Subtotal w/ Contingency in Direct Capital Cost Value				$	3,880,000	Value = ROUNDUP(sum),-3)
2.14	**Long-Term Operation and Maintenance**						
2.14.1	**Annual Inspection and Site Summary Report, Per Event, Nominal**				**$**	**10,700**	
2.14.2	**Periodic Long-Term Maintenance , Per Event, Nominal**						
2.14.2.1	Constructed Wetland (5-yr event)				$	87,600	
2.14.2.2	Salt Marsh (years 1, 3 , 5, 10)				$	7,300	
2.14.2.3	Tailings Impoundment Cap and Stormwater System (5-yr event)				$	70,900	
2.14.2.4	Tailings Impoundment Cap (25-yr event)				$	210,700	
2.15	**Long-Term Environmental Monitoring, Per Event, Nominal**						

2.0 FEASIBILITY STUDY COST ESTIMATE FOR OU1, ALTERNATIVE CMS2
Callahan Mine Superfund Site
Brooksville, Maine

Prepared by: JPMcCrady, 6/16/2009
Checked by: SWReed, RSEgan, 6/16/2009

	Item Description	No.	Unit	Unit Cost		Total	Notes
2.15.1	Semi-Annual Constructed Wetland Inf/Eff (year 1)				$	24,800	
2.15.2	Annual Constructed Wetland Inf/Eff (years 2-100)				$	12,400	
2.15.3	Annual Groundwater (years 1-2)				$	18,800	
2.15.4	Annual Groundwater (years 3-10)				$	18,800	
2.15.5	Annual Groundwater (years 15, 20, 25, …, 100)				$	18,800	
2.15.6	Semi-Annual Surface Water (years 1-2)				$	36,600	
2.15.7	Annual Surface Water (years 3 -10, 15, 20, 25, …, 100)				$	18,300	
2.15.8	Sediment Monitoring (every 5 years)				$	13,500	
2.15.9	Periodic Clam Tissue (years 3, 4, 5, 10, 15, 20, 25, …, 100)				$	9,100	
2.15.10	Five Year Review (every 5 years)				$	27,000	

4.0 FEASIBILITY STUDY COST ESTIMATE FOR OU1, ALTERNATIVE CMS3
Callahan Mine Superfund Site
Brooksville, Maine

Prepared by: JPMcCrady, 6/16/2009
Checked by: SWReed, RSEgan, 6/16/2009

Item Description	No.	Unit	Unit Cost	Total	Notes
4.1 Pre-Design Studies				**$ 330,000**	
4.1.1 Geotechnical Investigation	1	ls	$ 150,000.00	$ 150,000	
Subtotal w/o Contingency				$ 150,000	Value = ROUNDUP(sum),-3)
4.1.2 Environmental Investigation	1	ls	$ 100,000.00	$ 100,000	
Subtotal w/o Contingency				$ 100,000	Value = ROUNDUP(sum),-3)
4.1.3 Survey	1	ls	$ 80,000.00	$ 80,000	
Subtotal w/o Contingency				$ 80,000	Value = ROUNDUP(sum),-3)
4.2 General Construction Costs Common to all Components of Work				**$ 845,000**	
4.2.1 Mobilization/Demobilization	1	ls	$ 100,000.00	$ 100,000	
Subtotal w/o Contingency				$ 100,000	Value = ROUNDUP(sum),-3)
4.2.2 Temporary Facilities and Controls					
4.2.2.1 Construction facilities	1	ls	$ 50,000.00	$ 50,000	Trailer, utilities, supplies, sanitary facilities
4.2.2.2 Barricades (concrete, temporary fencing)	1	ls	$ 25,000.00	$ 25,000	
4.2.2.3 Erosion and sedimentation control maintenance	1	ls	$ 25,000.00	$ 25,000	
4.2.2.4 Miscellaneous equipment	1	ls	$ 10,000.00	$ 10,000	
4.2.2.5 Decontamination facilities	1	ls	$ 15,000.00	$ 15,000	Includes liquid waste storage facilities
Subtotal w/o Contingency				$ 125,000	Value = ROUNDUP(sum),-3)
4.2.3 Local Road Maintenance and Repair					
4.2.3.1 Tree trimming	260	ea	$ 217.00	$ 56,420	Assume 260 trees
4.2.3.2 Drainage improvements and repairs	5	ea	$ 1,100.00	$ 5,500	Assume 24-inch culvert replacements
4.2.3.3 Gravel filling, grading, and compacting	79,200	sf	$ 2.50	$ 198,000	Assume 10% of total estimated 10-mile
4.2.3.4 Paving	8,800	sy	$ 9.94	$ 87,472	road length requires maintenance/repair
Subtotal w/o Contingency				$ 348,000	Value = ROUNDUP(sum),-3)
4.2.4 Site Road Maintenance and Repair					
4.2.4.1 Gravel filling, grading, and compacting	35,640	sf	$ 2.50	$ 89,100	Assume 33% of total estimated 7,200 lf
Subtotal w/o Contingency				$ 90,000	Value = ROUNDUP(sum),-3)

4.0 FEASIBILITY STUDY COST ESTIMATE FOR OU1, ALTERNATIVE CMS3
Callahan Mine Superfund Site
Brooksville, Maine

Prepared by: JPMcCrady, 6/16/2009
Checked by: SWReed, RSEgan, 6/16/2009

Item Description	No.	Unit	Unit Cost	Total	Notes
4.2.5 Construction Layout and Survey					
4.2.5.1 Construction layout and survey	52	days	$ 1,573.00	$ 81,796	Assume 12-month construction period
4.2.5.2 As-Built survey	7	days	$ 1,573.00	$ 11,011	
4.2.5.3 Record drawings	1	ls	$ 5,000.00	$ 5,000	
Subtotal w/o Contingency				$ 98,000	
4.2.6 Geotechnical Testing					
4.2.6.1 Laboratory testing of borrow material	1	ls	$ 50,000.00	$ 50,000	
4.2.6.2 Field testing of installed materials	67	days	$ 500.00	$ 33,500	
Subtotal w/o Contingency				$ 84,000	
4.3 <u>Tailings Impoundment Improvements</u>				**$ 4,331,000**	
4.3.1 Tailings Impoundment Site Preparation				**$ 1,616,854**	
4.3.1.1 Erosion and Sedimentation Controls	1	ls	$ 8,600.00	$ 8,600	
4.3.1.2 Clearing and grubbing	5	ac	$ 5,125.00	$ 25,625	
4.3.1.3 Dewatering of non-consolidated tailings	1	ls	$ 40,000.00	$ 40,000	
4.3.1.4 Grading (excavating and filling) top of impoundment			$ 4.67	$ 1,113,629	
Excavating and filling with dozer	253,674	bcy	$ 4.11	$ 1,042,600	
Compaction	126,837	ecy	$ 0.56	$ 71,029	
4.13.1.5 Underdrain installation (by horizontal directional drilling)	3,300	lf	$ 130.00	$ 429,000	Assume 3-1,100 feet pipes
Subtotal w/o Contingency				$ 1,617,000	Value = ROUNDUP(sum),-3)
4.3.2 Tailings Impoundment Infiltration Barrier Cover System				**$ 1,675,227**	
4.3.2.1 Blasting	32,017	bcy	$ 7.00	$ 224,119	bank cy (bcy)=fill cy - 33% swell
4.3.2.2 Crushing and loading	32,017	bcy	$ 6.00	$ 192,102	
4.3.2.3 Hauling within the Site, 1 mile round trip	53,362	lcy	$ 2.48	$ 132,338	Loose cy (lcy)=bank cy (bcy) + 67% swell
4.3.2.4 Place and grade at tailings impoundment	53,362	lcy	$ 1.62	$ 86,446	
4.3.2.5 Compaction	48,025	ecy	$ 0.21	$ 10,085	
4.3.2.6 Geocomposite, furnished and installed	720,375	sf	$ 0.68	$ 489,855	
4.3.2.7 Geomembrane, furnished and installed	720,375	sf	$ 0.75	$ 540,281	

4.0 FEASIBILITY STUDY COST ESTIMATE FOR OU1, ALTERNATIVE CMS3
Callahan Mine Superfund Site
Brooksville, Maine

Prepared by: JPMcCrady, 6/16/2009
Checked by: SWReed, RSEgan, 6/16/2009

Item Description	No.	Unit	Unit Cost	Total	Notes
Subtotal w/o Contingency				$ 1,676,000	Value = ROUNDUP(sum),-3)
4.3.3 Tailings Impoundment Stormwater Controls				**$ 569,750**	
4.3.3.1 Upslope surface water diversion channels	1,200	lf	$ 50.00	$ 60,000	
4.3.3.2 Cover system drainage swales	2,600	lf	$ 100.00	$ 260,000	designed for minimum 100-yr storm
4.3.3.3 Cover system downdrains	200	lf	$ 75.00	$ 15,000	lined with geomembrane
4.3.3.4 Riprap drainage channels (outside limit of cover system)	1,095	lf	$ 50.00	$ 54,750	designed for minimum 100-yr storm
4.3.3.5 Detention ponds	2	ea	$ 75,000.00	$ 150,000	
4.3.3.6 Level spreaders	2	ea	$ 15,000.00	$ 30,000	
Subtotal w/o Contingency				$ 570,000	Value = ROUNDUP(sum),-3)
4.3.4 Tailings Impoundment Constructed/Treatment Wetland				**$ 467,400**	
4.3.4.1 Excavating, lining, planting wetland areas	1.2	ac	$ 352,000.00	$ 422,400	To treat impoundment leachate.
4.3.4.2 Piping from underdrains to constructed wetland	1,000	lf	$ 45.00	$ 45,000	
Subtotal w/o Contingency				$ 468,000	Value = ROUNDUP(sum),-3)
4.4 <u>Waste Rock Pile No. 3 (WRP3)</u>				**$ 1,652,000**	
4.4.1 WRP3 Site Preparation					
4.4.1.1 Erosion and Sedimentation Controls	1	ls	$ 55,150.00	$ 55,150	
4.4.1.2 Clearing and grubbing	2.6	ac	$ 5,125.00	$ 13,325	
Subtotal w/o Contingency				$ 69,000	Value = ROUNDUP(sum),-3)
4.4.2 WRP3 Excavation and Consolidation					
4.4.2.1 Impacted rock consolidation to WRP1				**$ 1,401,622**	
Excavation and load	261,574	bcy	$ 2.06	$ 538,842	WRP3 and 75% WRP3 Haul Road
Hauling within the Site, 1 mile round trip	347,895	lcy	$ 2.48	$ 862,780	Assume 33% swell
4.4.2.2 Post-excavation field confirmation sampling				**$ 64,821**	
XRF Technician	440	hrs	$ 90.00	$ 39,600	44-days, 10-hr days
ODCs/Equipment Rental	9	wk	$ 1,700.00	$ 15,300	1 wk min., assume 50 samples per day
Vehicle Rental (van / 4x4)	9	wk	$ 369.00	$ 3,321	
Lodging and per diem	44	days	$ 150.00	$ 6,600	

4.0 FEASIBILITY STUDY COST ESTIMATE FOR OU1, ALTERNATIVE CMS3
Callahan Mine Superfund Site
Brooksville, Maine

Prepared by: JPMcCrady, 6/16/2009
Checked by: SWReed, RSEgan, 6/16/2009

Item Description	No.	Unit	Unit Cost	Total	Notes
4.4.2.3 Confirmation analysis (off-site laboratory)	159	ea	**$ 150.00**	**$ 23,850**	Assume RCRA metals 1/625 sf (25%)
Subtotal w/o Contingency				$ 1,491,000	Value = ROUNDUP(sum),-3)
4.4.3 WRP3 Restoration					
4.4.3.1 Restoration cover (1ft crushed stone)				**$ 91,838**	Assume 50% of excavated area
Blasting	4,555	bcy	$ 7.00	$ 31,885	bank cy (bcy)=fill cy - 33% swell
Crushing and loading	4,555	bcy	$ 6.00	$ 27,330	
Hauling within the Site, 1 mile round trip	7,607	lcy	$ 2.48	$ 18,865	Loose cy (lcy)=bank cy (bcy) + 67% swell
Place and grade at WRP3 (sloped areas)	7,607	lcy	$ 1.62	$ 12,323	
Compaction	6,832	ecy	$ 0.21	$ 1,435	Fill cy
Subtotal w/o Contingency				$ 92,000	Value = ROUNDUP(sum),-3)
4.5 <u>Ore Pad and Mine Operations Area (Mine Ops, Etc.)</u>				**$ 3,655,000**	
4.5.1 Mine Ops, Etc. Site Preparation					
4.5.1.1 Erosion and Sedimentation Control	1	ls	$ 7,150.00	$ 7,150	
4.5.1.2 Clearing and grubbing	1	ac	$ 5,125.00	$ 5,125	
4.5.1.3 Select demolition (bldgs and foundations)	1	ls	$ 50,000.00	$ 50,000	
Subtotal w/o Contingency				$ 63,000	Value = ROUNDUP(sum),-3)
4.5.2 Mine Ops, Etc. Excavation and Consolidation					
4.5.2.1 Pre-excavation delineation (XRF)				**$ 7,525**	
XRF technician	50	hrs	$ 90.00	$ 4,500	5-days, 10-hr days
ODCs/Equipment rental	1	wk	$ 1,700.00	$ 1,700	1 wk min., assume 50 samples per day
Vehicle rental (van / 4x4)	5	days	$ 115.00	$ 575	
Lodging and per diem	5	days	$ 150.00	$ 750	
4.5.2.2 Impacted soil consolidation to WRP1			**$ 4.92**	**$ 377,313**	
Excavation and load	66,003	bcy	$ 2.44	$ 161,047	Removal from Mine Ops, Ore Pad, Haul Rd
Hauling within the Site, 1 mile round trip	87,204	lcy	$ 2.48	$ 216,266	Assume 33% swell
4.5.2.3 Petroleum contaminated soils (DRO/GRO)			**$ 30.00**	**$ 38,400**	
Off-site transportation and disposal	1,280	tons	$ 30.00	$ 38,400	V = 600 bcy
4.5.2.4 Post-excavation field confirmation sampling				**$ 26,126**	

Item Description	No.	Unit	Unit Cost	Total	Notes
XRF Technician	170	hrs	$ 90.00	$ 15,300	17-days, 10-hr days
ODCs/Equipment Rental	4	wk	$ 1,700.00	$ 6,800	1 wk min., assume 50 samples per day
Vehicle Rental (van / 4x4)	4	wk	$ 369.00	$ 1,476	
Lodging and per diem	17	days	$ 150.00	$ 2,550	
4.5.2.5 Confirmation analysis (off-site laboratory)	148	ea	**$ 150.00**	**$ 22,200**	Assume RCRA metals 1/625 sf (25%)
Subtotal w/o Contingency				$ 472,000	Value = ROUNDUP(sum),-3)
4.5.3 Partial Waste Rock Pile 2 (WRP2) Excavation and Consolidation					
4.5.3.1 Pre-excavation delineation (XRF)				**$ 7,525**	
XRF technician	50	hrs	$ 90.00	$ 4,500	5-days, 10-hr days
ODCs/Equipment rental	1	wk	$ 1,700.00	$ 1,700	1 wk min., assume 50 samples per day
Vehicle rental (van / 4x4)	5	days	$ 115.00	$ 575	
Lodging and per diem	5	days	$ 150.00	$ 750	
4.5.3.2 Impacted soil consolidation to WRP1			**$ 4.92**	**$ 42,583**	
Excavation and load	7,410	bcy	$ 2.44	$ 18,080	Removal from Mine Ops, Ore Pad, Haul Rd
Hauling within the Site, 1 mile round trip	9,880	lcy	$ 2.48	$ 24,502	Assume 33% swell
4.5.3.3 Post-excavation field confirmation sampling				**$ 4,375**	
XRF Technician	20	hrs	$ 90.00	$ 1,800	2-days, 10-hr days
ODCs/Equipment Rental	1	wk	$ 1,700.00	$ 1,700	1 wk min., assume 50 samples per day
Vehicle Rental (van / 4x4)	5	days	$ 115.00	$ 575	
Lodging and per diem	2	days	$ 150.00	$ 300	
4.5.3.4 Confirmation analysis (off-site laboratory)	16	ea	**$ 150.00**	**$ 2,400**	Assume RCRA metals 1/625 sf (25%)
Subtotal w/o Contingency				$ 57,000	Value = ROUNDUP(sum),-3)
4.5.4 Mine Ops, Etc. and Partial WRP2 Restoration					
4.5.4.1 Restoration cover system (1ft crushed stone)				**$ 101,496**	Assume 50% of excavation area
Blasting	5,034	bcy	$ 7.00	$ 35,238	bank cy (bcy)=fill cy - 33% swell
Crushing and loading	5,034	bcy	$ 6.00	$ 30,204	Fill cy + 33% swell
Hauling within the Site, 1 mile round trip	8,407	lcy	$ 2.48	$ 20,849	Loose cy (lcy)=bank cy (bcy) + 67% swell
Place and grade in Mine Ops Area, Etc.	8,407	lcy	$ 1.62	$ 13,619	Loose cy (lcy)=bank cy (bcy) + 67% swell
Compaction	7,550	ecy	$ 0.21	$ 1,586	
Subtotal w/o Contingency				$ 102,000	Value = ROUNDUP(sum),-3)

4.0 FEASIBILITY STUDY COST ESTIMATE FOR OU1, ALTERNATIVE CMS3
Callahan Mine Superfund Site
Brooksville, Maine

Prepared by: JPMcCrady, 6/16/2009
Checked by: SWReed, RSEgan, 6/16/2009

Item Description	No.	Unit	Unit Cost	Total	Notes
4.5.5 WRP1 Infiltration Barrier Cover System					
4.5.5.1 Erosion and Sedimentation Controls	1	ls	$ 7,000.00	$ 7,000	
4.5.5.2 Clearing and grubbing	2.5	ac	$ 5,125.00	$ 12,813	Assume total impoundment area
4.5.5.3 Dewatering ponded water and/or Stink Cove sediments	1	ls	$ 40,000.00	$ 40,000	
4.5.5.4 Grading (excavating and filling) top of WRP1			$ 4.67	**$ 1,634,719**	
Excavating and filling with dozer	350,047	bcy	$ 4.11	$ 1,438,693	
Compaction	350,047	ecy	$ 0.56	$ 196,026	
4.5.5.5 Blasting	17,032	bcy	$ 7.00	$ 119,224	bank cy (bcy)=fill cy - 33% swell
4.5.5.6 Crushing and loading	17,032	bcy	$ 6.00	$ 102,192	
4.5.5.7 Hauling within the Site, 1 mile round trip	28,387	lcy	$ 2.48	$ 70,400	Loose cy (lcy)=bank cy (bcy) + 67% swell
4.5.5.8 Place and grade at WRP1	28,387	lcy	$ 1.62	$ 45,987	
4.5.5.9 Compaction	25,547	ecy	$ 0.21	$ 5,365	
4.5.5.10 Geocomposite, furnished and installed	383,192	sf	$ 0.68	$ 260,571	
4.5.5.11 Geomembrane, furnished and installed	383,192	sf	$ 0.75	$ 287,394	
4.5.5.12 Cover system drainage swales	2,000	lf	$ 100.00	$ 200,000	designed for minimum 100-yr storm
4.5.5.13 Cover system downdrains	400	lf	$ 75.00	$ 30,000	lined with geomembrane
4.5.5.14 Riprap drainage channels (outside limit of cover system)	1,400	lf	$ 50.00	$ 70,000	designed for minimum 100-yr storm
4.5.5.15 Detention ponds	1	ea	$ 75,000.00	$ 75,000	
Subtotal w/o Contingency				$ 2,961,000	Value = ROUNDUP(sum),-3)
4.6 <u>Residential Lots</u>				**$ 314,000**	
4.6.1 Residential Lot Site Preparation					
4.6.1.1 Erosion and Sedimentation Controls	1	ls	$ 21,225.00	**$ 21,225**	
4.6.1.2 Clearing and grubbing	1	ac	$ 5,125.00	**$ 5,125**	
4.6.1.3 Select demolition	1	ls	$ 5,000.00	**$ 5,000**	
Subtotal w/o Contingency				$ 32,000	Value = ROUNDUP(sum),-3)
4.6.2 Residential Lot Excavation and Consolidation					
4.6.2.1 Pre-excavation delineation (XRF)				**$ 7,525**	
XRF technician	50	hrs	$ 90.00	$ 4,500	5-days, 10-hr days

Item Description	No.	Unit	Unit Cost	Total	Notes
ODCs/Equipment rental	1	wk	$ 1,700.00	$ 1,700	1 wk min., assume 50 samples per day
Vehicle rental (van / 4x4)	5	days	$ 115.00	$ 575	
Lodging and per diem	5	days	$ 150.00	$ 750	
4.6.2.2 Impacted soil consolidation in Former Mine Pit			**$ 14.91**	**$ 46,607**	
Excavation and load	3,042	bcy	$ 10.60	$ 32,245	Excavation Unit Cost, Impacted Soil
Hauling within the Site, 1 mile round trip	3,347	lcy	$ 2.48	$ 8,301	Assumes 10% material swell
Place and grade	3,347	lcy	$ 1.62	$ 5,422	Material consolidated into WRP1
Compaction	3,042	ecy	$ 0.21	$ 639	Material consolidated into WRP1
4.6.2.3 Post-excavation XRF sampling			**-**	**$ 12,927**	
XRF technician	110	hrs	$ 90.00	$ 9,900	11-days, 10-hr days
ODCs/Equipment rental	3	wk	$ 90.00	$ 270	1 wk min., assume 50 samples per day
Vehicle rental (van / 4x4)	3	wk	$ 369.00	$ 1,107	
Lodging and per diem	11	days	$ 150.00	$ 1,650	
4.6.2.4 Confirmation analysis (off-site laboratory)	17	ea	**$ 150.00**	**$ 2,550**	Assume RCRA metals 1/625 sf
Subtotal w/o Contingency				$ 70,000	Value = ROUNDUP(sum),-3)
4.6.3 Residential Lot Restoration					
4.6.3.1 Common borrow backfill			**$ 35.13**	**$ 80,715**	
Imported clean borrow loaded into truck	2,150	bcy	$ 10.80	$ 23,220	20-inch
Hauling, 20 mile round trip	2,365	lcy	$ 22.50	$ 53,213	Assume 10% swell
Place and grade	2,365	lcy	$ 1.62	$ 3,831	Assume 10% swell
Compaction	2,150	ecy	$ 0.21	$ 452	Assume 10% shrink
4.6.3.2 Topsoil/loam, installed	430	cy	$ 48.02	**$ 20,649**	4-inch, assume 35% swell
4.6.3.3 Lawn preparation	35	msf	$ 41.00	**$ 1,435**	
4.6.3.4 Seed/fertilize/mulch	35	msf	$ 47.00	**$ 1,645**	Hydroseeding method
4.6.3.5 Road restoration				**$ 6,592**	
Blasting	309	bcy	$ 7.00	$ 2,163	bank cy (bcy)=fill cy - 33% swell
Crushing and loading	309	bcy	$ 6.00	$ 1,854	Fill cy + 33% swell
Hauling within the Site, 1 mile round trip	515	lcy	$ 2.48	$ 1,277	Loose cy (lcy)=bank cy (bcy) + 67% swell
Place and grade	515	lcy	$ 1.62	$ 834	Loose cy (lcy)=bank cy (bcy) + 67% swell
Compaction	463	ecy	$ 1.00	$ 463	
4.6.3.6 Misc. structure repair/replacement	1	ls	$ 100,000.00	**$ 100,000**	Sheds, gardens, planters, walks, etc.

4.0 FEASIBILITY STUDY COST ESTIMATE FOR OU1, ALTERNATIVE CMS3
Callahan Mine Superfund Site
Brooksville, Maine

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Item Description	No.	Unit	Unit Cost	Total	Notes
Subtotal w/o Contingency				$ 212,000	Value = ROUNDUP(sum),-3)
4.7 PCB Soils				**$ 587,000**	
4.7.1 PCB Soil Excavation					
4.7.1.1 Pre excavation delineation of excavation areas				**$ 7,525**	
Technician	50	hrs	$ 90.00	$ 4,500	
ODCs/Equipment Rental	1	wk	$ 1,700.00	$ 1,700	
Vehicle Rental (van / 4x4)	5	days	$ 115.00	$ 575	
Lodging and per diem	5	days	$ 150.00	$ 750	
4.7.1.2 PCB soil excavation				**$ 12,292**	
Excavate and stockpile	2,187	cy	$ 4.34	$ 9,492	
Waste characterization	8	ea	$ 350.00	$ 2,800	Assume 1 test/500ton
4.7.1.3 Post-excavation field confirmation sampling				**$ 4,030**	
Technician	20	hrs	$ 90.00	$ 1,800	2-days, 10-hr days
ODCs/Equipment Rental	1	wk	$ 1,700.00	$ 1,700	
Vehicle Rental (van / 4x4)	2	days	$ 115.00	$ 230	
Lodging and per diem	2	days	$ 150.00	$ 300	
4.7.1.4 Confirmation analysis(off-site laboratory)	13	ea	$ 150.00	**$ 1,950**	Assume RCRA metals 1/625 sf (25%)
Subtotal w/o Contingency				$ 26,000	**Value = ROUNDUP(sum),-3)**
4.7.2 PCB Soil Transportation and Disposal					
4.7.2.1 TSCA waste load from stockpile to truck	2,406	lcy	$ 0.92	**$ 2,214**	
4.7.2.2 TSCA waste transportation	110	load	$ 1,980.00	**$ 217,800**	
4.7.2.3 TSCA waste disposal (Subtitle C)	386	ton	$ 80.00	**$ 30,880**	
4.7.2.4 Waste disposal (Subtitle D)	3,494	ton	$ 80.00	**$ 279,520**	
Subtotal w/o Contingency				$ 531,000	**Value = ROUNDUP(sum),-3)**
4.7.3 PCB Soil Removal Area Restoration (1ft crushed stone)					
4.7.3.1 Blasting	1,458	bcy	$ 7.00	$ 10,206	bank cy (bcy)=fill cy - 33% swell
4.7.3.2 Crushing and loading	1,458	bcy	$ 6.00	$ 8,748	
4.7.3.3 Hauling within the Site, 1 mile round trip	2,430	lcy	$ 2.48	$ 6,026	Loose cy (lcy)=bank cy (bcy) + 67% swell

4.0 FEASIBILITY STUDY COST ESTIMATE FOR OU1, ALTERNATIVE CMS3
Callahan Mine Superfund Site
Brooksville, Maine

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Item Description	No.	Unit	Unit Cost	Total	Notes
4.7.3.4 Place and grade	2,430	lcy	$ 1.62	$ 3,937	
4.7.3.5 Compaction	2,187	ecy	$ 0.21	$ 459	
Subtotal w/o Contingency				$ 30,000	**Value = ROUNDUP(sum),-3)**
4.8 Sediment Dredging of Goose Pond and Salt Marsh				**$ 2,124,000**	
4.8.1 Goose Pond and Salt Marsh Site Preparation					
4.8.1.1 Erosion and Sedimentation Controls	1	ls	$ 22,055.00	**$ 22,055**	
4.8.1.2 Clearing and grubbing	6.3	ac	$ 5,125.00	**$ 32,288**	
Subtotal w/o Contingency				$ 55,000	Value = ROUNDUP(sum),-3)
4.8.2 Goose Pond and Salt Marsh Dredging and Consolidation					
4.8.2.1 Dredging sediment (pump to Former Mine Pit)	73,568	bcy	**$ 27.00**	**$ 1,986,336**	(51,304 + 22,264) bcy
4.8.2.2 Post-excavation field confirmation sampling				**$ 22,836**	
XRF Technician	200	hrs	$ 90.00	$ 18,000	20-days, 10-hr days
ODCs/Equipment Rental	4	wk	$ 90.00	$ 360	1 wk min., assume 50 samples per day
Vehicle Rental (van / 4x4)	4	wk	$ 369.00	$ 1,476	
Lodging and per diem	20	days	$ 150.00	$ 3,000	
4.8.2.3 Confirmation analysis (off-site laboratory)	394	ea	**$ 150.00**	**$ 59,100**	Assume RCRA metals 1/625 sf (25%)
Subtotal w/o Contingency				$ 2,069,000	Value = ROUNDUP(sum),-3)
4.9 Wetland Mitigation				**$ 1,245,000**	
4.9.1 Salt Marsh Wetland Restoration				$ 338,152	
4.9.1.1 Excavation and load Stink Cove sediment (WRP1)	7,906	bcy	$ 5.79	$ 45,776	Removal from WRP1
4.9.1.2 Hauling within the Site, 1 mile round trip	8,697	lcy	$ 2.48	$ 21,569	Assumes 10% material swell
4.9.1.3 Place and grade in Salt Marsh	8,697	lcy	$ 1.62	$ 14,089	Former Stink Cove sediment installed.
4.9.1.4 Compaction	7,906	ecy	$ 0.21	$ 1,660	Former Stink Cove sediment installed.
4.9.1.5 Seed/fertilize/mulch	214	msf	$ 47.00	$ 10,058	Hydroseeding method
4.9.1.6 Wetland plantings	4.9	ac	$ 50,000.00	$ 245,000	Plantings, fine grading, etc.
Subtotal w/o Contingency				$ 339,000	Value = ROUNDUP(sum),-3)

4.0 FEASIBILITY STUDY COST ESTIMATE FOR OU1, ALTERNATIVE CMS3
Callahan Mine Superfund Site
Brooksville, Maine

Prepared by: JPMcCrady, 6/16/2009
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Item Description	No.	Unit	Unit Cost	Total	Notes
4.9.2 Goose Pond Restoration					
4.9.2.1 Eel grass planting along shoreline of Goose Pond	2.0	ac	$ 85,000.00	$ 170,000	Assume can be done from water surface.
Subtotal w/o Contingency				$ 170,000	Value = ROUNDUP(sum),-3)
4.9.3 Cove Restoration					
4.9.3.1 Dyer Cove sediment dredging (to Former Mine Pit)	17,424	bcy	$ 27.00	$ 470,448	Assume wetland improvements
4.9.3.2 Goose Cove sediment dredging (to Former Mine Pit)	9,809	bcy	$ 27.00	$ 264,843	Assume wetland improvements
Subtotal w/o Contingency				$ 736,000	Value = ROUNDUP(sum),-3)
4.10 Institutional Controls				**$ 31,000**	
4.10.1 Engineering Support				**$ 10,000**	
4.10.2 Legal Support				**$ 20,000**	
4.10.3 Administrative Support				**$ 1,000**	
Subtotal w/o Contingency				$ 31,000	Value = ROUNDUP(sum),-3)
4.11 Monitoring Well Installation				**$ 66,000**	
4.11.1 Install and develop 10 new/replaced monitoring wells	1	ls	$ 65,860.00	$ 65,860	
Subtotal w/o Contingency				$ 66,000	Value = ROUNDUP(sum),-3)
4.12 Long-term Monitoring Plan				**$ 35,000**	
4.12.1 Preparation of Draft Plan	1	ls	$ 50,000.00	$ 25,000	
4.12.2 Stakeholder Meeting	1	ea	$ 2,500.00	$ 2,500	
4.12.3 Response to Review Comments	1	ls	$ 2,500.00	$ 2,500	
4.12.4 Preparation of Final Plan	1	ls	$ 5,000.00	$ 5,000	
Subtotal w/o Contingency				$ 35,000	Value = ROUNDUP(sum),-3)
Total Direct Capital Cost for OU1, CMS2				**$ 15,215,000**	Value = ROUNDUP(sum),-3)
Contingency			30.0%	**$ 4,564,500**	
Total Direct Capital Cost with Contingency for OU1, CMS2				**$ 19,779,500**	

4.0 FEASIBILITY STUDY COST ESTIMATE FOR OU1, ALTERNATIVE CMS3
Callahan Mine Superfund Site
Brooksville, Maine

Prepared by: JPMcCrady, 6/16/2009
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Item Description	No.	Unit	Unit Cost		Total	Notes
4.13 Indirect Capital Costs (Engineering, Design, Construction Mgmt, and PMgmt)				**$**	**4,352,000**	
4.13.1 Engineering, Design, and Regulatory Coordination (@ 10 Percent)			10.0%	**$**	**1,977,950**	
4.13.2 Construction Management (@ 7 Percent)			7.0%	**$**	**1,384,565**	
4.13.3 Project Management (@ 5 Percent)			5.0%	**$**	**988,975**	
Subtotal w/ Contingency in Direct Capital Cost Value				$	4,352,000	Value = ROUNDUP(sum),-3)
4.14 Long-Term Operation and Maintenance						
4.14.1 Annual Inspection and Site Summary Report, Per Event, Nominal				**$**	**10,700**	
4.14.2 Periodic Long-Term Maintenance , Per Event, Nominal						
4.14.2.1 Constructed Wetland (5-yr event)				$	87,600	
4.14.2.2 Salt Marsh (5-yr event)				$	7,300	
4.14.2.3 Tailings Impoundment Cap and Stormwater System (5-yr event)				$	70,900	
4.14.2.4 Tailings Impoundment Cap (25-yr event)				$	210,700	
4.15 Long-Term Environmental Monitoring, Per Event, Nominal						
4.15.1 Semi-Annual Constructed Wetland Inf/Eff (year 1)				**$**	**24,800**	
4.15.2 Annual Constructed Wetland Inf/Eff (years 2-100)				**$**	**12,400**	
4.15.3 Quarterly Groundwater (years 1-2)				**$**	**18,800**	
4.15.4 Semi-Annual Groundwater (years 3-5)				**$**	**18,800**	
4.15.5 Annual Groundwater (years 6 -100)				**$**	**18,800**	
4.15.6 Semi-Annual Surface Water (years 1-5)				**$**	**36,600**	
4.15.7 Annual Surface Water (years 6-100)				**$**	**18,300**	
4.15.8 Periodic Sediment (every 5 years)				**$**	**13,500**	
4.15.9 Periodic Clam Tissue (years 3, 4, 5, 10, 15, 20, …, 100)				**$**	**9,100**	
4.15.10 Five Year Review (every 5 years)				**$**	**27,000**	

FEASIBILITY STUDY COST ESTIMATE FOR OU1 - PRESENT VALUE OF ESTIMATED LONG TERM OPERATION, MAINTENANCE, AND MONITORING COSTS FOR CMS1
Callahan Mine Superfund Site
Brooksville, Maine

Prepared by: JPMcCrady, 6/16/2009
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Year (t)	GW Monitoring - 1x per yr	GW Monitoring - 1x per yr	GW Monitoring - 1x per yr	Const WL Monitoring - 2x per yr	Const WL Monitoring - 1x per yr	SW Monitoring - 2x per yr	SW Monitoring - 1x per yr	Sediment Monitoring - 5-yr event	Clam Tissue periodic	Annual Inspection - 1 x per yr	Cap Maintenance 5-yr event	Cap Maintenance - 25-yr event	Const WL Maintenance - 5-yr event	S Marsh Maintenance - 5-yr event	Five-Year Reviews 5-yr event -	Project Mgmt at 5.0%	Technical Support at 10.0%	Total CMS2, CMS3 Non-Discounted Cost	Total CMS2, CMS3 Present Value, 2.7%	Total CMS2, CMS3 Present Value, 7%
0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
2	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
4	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
5	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 7,400	$ 370	$ 740	$ 8,510	$ 7,449	$ 6,068
6	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
7	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
8	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
9	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
10	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 7,400	$ 370	$ 740	$ 8,510	$ 6,520	$ 4,326
11	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
12	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
13	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
14	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
15	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 7,400	$ 370	$ 740	$ 8,510	$ 5,707	$ 3,084
16	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
17	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
18	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
19	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
20	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 7,400	$ 370	$ 740	$ 8,510	$ 4,995	$ 2,199
21	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
22	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
23	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
24	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
25	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 7,400	$ 370	$ 740	$ 8,510	$ 4,372	$ 1,568
26	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
27	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
28	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
29	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
30	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 7,400	$ 370	$ 740	$ 8,510	$ 3,827	$ 1,118
31	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
32	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
33	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
34	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
35	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 7,400	$ 370	$ 740	$ 8,510	$ 3,349	$ 797
36	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
37	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
38	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
39	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
40	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 7,400	$ 370	$ 740	$ 8,510	$ 2,932	$ 568
41	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
42	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
43	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
44	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
45	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 7,400	$ 370	$ 740	$ 8,510	$ 2,566	$ 405
46	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
47	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
48	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
49	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
50	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 7,400	$ 370	$ 740	$ 8,510	$ 2,246	$ 289
51	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
52	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
53	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
54	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
55	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 7,400	$ 370	$ 740	$ 8,510	$ 1,966	$ 206
56	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
57	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
58	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
59	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
60	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 7,400	$ 370	$ 740	$ 8,510	$ 1,721	$ 147
61	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
62	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
63	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -

FEASIBILITY STUDY COST ESTIMATE FOR OU1 - PRESENT VALUE OF ESTIMATED LONG TERM OPERATION, MAINTENANCE, AND MONITORING COSTS FOR CMS1
Callahan Mine Superfund Site
Brooksville, Maine

Prepared by: JPMcCrady, 6/16/2009
Checked by: SWReed, RSEgan, 6/16/2009

Year (t)	GW Monitoring - 1x per yr	GW Monitoring - 1x per yr	GW Monitoring - 1x per yr	Const WL Monitoring - 2x per yr	Const WL Monitoring - 1x per yr	SW Monitoring - 2x per yr	SW Monitoring - 1x per yr	Sediment Monitoring - 5-yr event	Clam Tissue periodic	Annual Inspection - 1 x per yr	Cap Maintenance 5-yr event	Cap Maintenance - 25-yr event	Const WL Maintenance - 5-yr event	S Marsh Maintenance - 5-yr event	Five-Year Reviews 5-yr event -	Project Mgmt at 5.0%	Technical Support at 10.0%	Total CMS2, CMS3 Non-Discounted Cost	Total CMS2, CMS3 Present Value, 2.7%	Total CMS2, CMS3 Present Value, 7%
64	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
65	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 7,400	$ 370	$ 740	$ 8,510	$ 1,506	$ 105
66	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
67	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
68	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
69	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
70	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 7,400	$ 370	$ 740	$ 8,510	$ 1,318	$ 75
71	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
72	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
73	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
74	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
75	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 7,400	$ 370	$ 740	$ 8,510	$ 1,154	$ 53
76	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
77	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
78	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
79	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
80	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 7,400	$ 370	$ 740	$ 8,510	$ 1,010	$ 38
81	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
82	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
83	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
84	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
85	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 7,400	$ 370	$ 740	$ 8,510	$ 884	$ 27
86	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
87	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
88	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
89	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
90	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 7,400	$ 370	$ 740	$ 8,510	$ 774	$ 19
91	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
92	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
93	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
94	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
95	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 7,400	$ 370	$ 740	$ 8,510	$ 677	$ 14
96	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
97	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
98	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
99	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
100	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 7,400	$ 370	$ 740	$ 8,510	$ 593	$ 10

																		Total, Nominal	2.7%	7.0%
30 years total	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$ -	$0	$0	$44,400	$2,220	$4,440	$52,000 rounded up	$33,000 rounded up	**$19,000** rounded up
100 years total	$0	$0	$0	$0	$0	$ -	$0	$0	$0	$0	$0	$ -	$0	$0	$148,000	$7,400	$14,800	**$171,000** rounded up	**$56,000** rounded up	$22,000 rounded up

PV Discount Rate (i)	**2.70%**	**7.00%**
PV = non-discounted cost x $1/((1+i)^t)$		

Discount rate based on EPA requirement

FEASIBILITY STUDY COST ESTIMATE FOR OU1 - PRESENT VALUE OF ESTIMATED LONG TERM OPERATION, MAINTENANCE, AND MONITORING COSTS FOR CMS
Callahan Mine Superfund Site
Brooksville, Maine

Prepared by: JPMcCrady, 6/16/2009
Checked by: SWReed, RSEgan, 6/16/2009

Year (t)	GW Monitoring - 1x per yr	GW Monitoring - 1x per yr	GW Monitoring - 1x per yr	Const WL Monitoring - 2x per yr	Const WL Monitoring - 1x per yr	SW Monitoring - 2x per yr	SW Monitoring - 1x per yr	Sediment Monitoring - 5-yr event	Clam Tissue periodic	Annual Inspection - 1 x per yr	Cap Maintenance 5-yr event	Cap Maintenance - 25-yr event	Const WL Maintenance - 5-yr event	S Marsh Maintenance - 5-yr event	Five-Year Reviews 5-yr event -	Project Mgmt at 5.0%	Technical Support at 10.0%	Total CMS2 Non-Discounted Cost	Total CMS2 Present Value, 2.7%	Total CMS2 Present Value, 7%
0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
1	$ 18,800	$ -	$ -	$ 24,800	$ -	$ 36,600	$ -	$ -	$ -	$ 10,700	$ -	$ -	$ -	$ 7,300	$ -	$ 4,910	$ 9,820	$ 112,930	$ 109,961	$ 105,542
2	$ 18,800	$ -	$ -	$ -	$ 12,400	$ 36,600	$ -	$ -	$ -	$ 10,700	$ -	$ -	$ -	$ -	$ -	$ 3,925	$ 7,850	$ 90,275	$ 85,591	$ 78,850
3	$ -	$ 18,800	$ -	$ -	$ 12,400		$ 18,300	$ -	$ 9,100	$ 10,700	$ -	$ -	$ -	$ 7,300	$ -	$ 3,830	$ 7,660	$ 88,090	$ 81,323	$ 71,908
4	$ -	$ 18,800	$ -	$ -	$ 12,400		$ 18,300	$ -	$ 9,100	$ 10,700	$ -	$ -	$ -	$ -	$ -	$ 3,465	$ 6,930	$ 79,695	$ 71,639	$ 60,799
5	$ -	$ 18,800	$ -	$ -	$ 12,400		$ 18,300	$ 13,500	$ 9,100	$ 10,700	$ 70,900	$ -	$ 87,600	$ 7,300	$ 27,000	$ 13,780	$ 27,560	$ 316,940	$ 277,412	$ 225,974
6	$ -	$ -	$ 18,800	$ -	$ 12,400	$ -	$ 18,300	$ -	$ -	$ 10,700	$ -	$ -	$ -	$ -	$ -	$ 3,010	$ 6,020	$ 69,230	$ 59,003	$ 46,131
7	$ -	$ -	$ 18,800	$ -	$ 12,400	$ -	$ 18,300	$ -	$ -	$ 10,700	$ -	$ -	$ -	$ -	$ -	$ 3,010	$ 6,020	$ 69,230	$ 57,451	$ 43,113
8	$ -	$ -	$ 18,800	$ -	$ 12,400	$ -	$ 18,300	$ -	$ -	$ 10,700	$ -	$ -	$ -	$ -	$ -	$ 3,010	$ 6,020	$ 69,230	$ 55,941	$ 40,292
9	$ -	$ -	$ 18,800	$ -	$ 12,400	$ -	$ 18,300	$ -	$ -	$ 10,700	$ -	$ -	$ -	$ -	$ -	$ 3,010	$ 6,020	$ 69,230	$ 54,470	$ 37,657
10	$ -	$ -	$ 18,800	$ -	$ 12,400	$ -	$ 18,300	$ 13,500	$ 9,100	$ 10,700	$ 70,900	$ -	$ 87,600	$ 7,300	$ 27,000	$ 13,780	$ 27,560	$ 316,940	$ 242,813	$ 161,116
11	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -	$ -	$ -	$ 1,155	$ 2,310	$ 26,565	$ 19,817	$ 12,621
12	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -	$ -	$ -	$ 1,155	$ 2,310	$ 26,565	$ 19,296	$ 11,795
13	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -	$ -	$ -	$ 1,155	$ 2,310	$ 26,565	$ 18,789	$ 11,024
14	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -	$ -	$ -	$ 1,155	$ 2,310	$ 26,565	$ 18,295	$ 10,302
15	$ -	$ -	$ 18,800	$ -	$ 12,400	$ -	$ 18,300	$ 13,500	$ 9,100	$ 10,700	$ 70,900	$ -	$ 87,600	$ -	$ 27,000	$ 13,415	$ 26,830	$ 308,545	$ 206,901	$ 111,831
16	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -	$ -	$ -	$ 1,155	$ 2,310	$ 26,565	$ 17,345	$ 8,998
17	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -	$ -	$ -	$ 1,155	$ 2,310	$ 26,565	$ 16,889	$ 8,410
18	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -	$ -	$ -	$ 1,155	$ 2,310	$ 26,565	$ 16,445	$ 7,860
19	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -	$ -	$ -	$ 1,155	$ 2,310	$ 26,565	$ 16,013	$ 7,345
20	$ -	$ -	$ 18,800	$ -	$ 12,400	$ -	$ 18,300	$ 13,500	$ 9,100	$ 10,700	$ 70,900	$ -	$ 87,600	$ -	$ 27,000	$ 13,415	$ 26,830	$ 308,545	$ 181,096	$ 79,734
21	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -	$ -	$ -	$ 1,155	$ 2,310	$ 26,565	$ 15,182	$ 6,416
22	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -	$ -	$ -	$ 1,155	$ 2,310	$ 26,565	$ 14,783	$ 5,996
23	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -	$ -	$ -	$ 1,155	$ 2,310	$ 26,565	$ 14,394	$ 5,604
24	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -	$ -	$ -	$ 1,155	$ 2,310	$ 26,565	$ 14,016	$ 5,237
25	$ -	$ -	$ 18,800	$ -	$ 12,400	$ -	$ 18,300	$ 13,500	$ 9,100	$ 10,700	$ 70,900	$ 210,700	$ 87,600	$ -	$ 27,000	$ 23,950	$ 47,900	$ 550,850	$ 282,991	$ 101,494
26	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -	$ -	$ -	$ 1,155	$ 2,310	$ 26,565	$ 13,289	$ 4,574
27	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -	$ -	$ -	$ 1,155	$ 2,310	$ 26,565	$ 12,939	$ 4,275
28	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -	$ -	$ -	$ 1,155	$ 2,310	$ 26,565	$ 12,599	$ 3,995
29	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -	$ -	$ -	$ 1,155	$ 2,310	$ 26,565	$ 12,268	$ 3,734
30	$ -	$ -	$ 18,800	$ -	$ 12,400	$ -	$ 18,300	$ 13,500	$ 9,100	$ 10,700	$ 70,900	$ -	$ 87,600	$ -	$ 27,000	$ 13,415	$ 26,830	$ 308,545	$ 138,741	$ 40,533
31	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -	$ -	$ -	$ 1,155	$ 2,310	$ 26,565	$ 11,631	$ 3,261
32	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -	$ -	$ -	$ 1,155	$ 2,310	$ 26,565	$ 11,325	$ 3,048
33	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -	$ -	$ -	$ 1,155	$ 2,310	$ 26,565	$ 11,028	$ 2,849
34	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -	$ -	$ -	$ 1,155	$ 2,310	$ 26,565	$ 10,738	$ 2,662
35	$ -	$ -	$ 18,800	$ -	$ 12,400	$ -	$ 18,300	$ 13,500	$ 9,100	$ 10,700	$ 70,900	$ -	$ 87,600	$ -	$ 27,000	$ 13,415	$ 26,830	$ 308,545	$ 121,438	$ 28,899
36	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -	$ -	$ -	$ 1,155	$ 2,310	$ 26,565	$ 10,181	$ 2,325
37	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -	$ -	$ -	$ 1,155	$ 2,310	$ 26,565	$ 9,913	$ 2,173
38	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -	$ -	$ -	$ 1,155	$ 2,310	$ 26,565	$ 9,652	$ 2,031
39	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -	$ -	$ -	$ 1,155	$ 2,310	$ 26,565	$ 9,399	$ 1,898
40	$ -	$ -	$ 18,800	$ -	$ 12,400	$ -	$ 18,300	$ 13,500	$ 9,100	$ 10,700	$ 70,900	$ -	$ 87,600	$ -	$ 27,000	$ 13,415	$ 26,830	$ 308,545	$ 106,292	$ 20,605
41	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -	$ -	$ -	$ 1,155	$ 2,310	$ 26,565	$ 8,911	$ 1,658
42	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -	$ -	$ -	$ 1,155	$ 2,310	$ 26,565	$ 8,677	$ 1,549
43	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -	$ -	$ -	$ 1,155	$ 2,310	$ 26,565	$ 8,449	$ 1,448
44	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -	$ -	$ -	$ 1,155	$ 2,310	$ 26,565	$ 8,226	$ 1,353
45	$ -	$ -	$ 18,800	$ -	$ 12,400	$ -	$ 18,300	$ 13,500	$ 9,100	$ 10,700	$ 70,900	$ -	$ 87,600	$ -	$ 27,000	$ 13,415	$ 26,830	$ 308,545	$ 93,035	$ 14,691
46	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -	$ -	$ -	$ 1,155	$ 2,310	$ 26,565	$ 7,800	$ 1,182
47	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -	$ -	$ -	$ 1,155	$ 2,310	$ 26,565	$ 7,594	$ 1,105
48	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -	$ -	$ -	$ 1,155	$ 2,310	$ 26,565	$ 7,395	$ 1,032
49	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -	$ -	$ -	$ 1,155	$ 2,310	$ 26,565	$ 7,200	$ 965
50	$ -	$ -	$ 18,800	$ -	$ 12,400	$ -	$ 18,300	$ 13,500	$ 9,100	$ 10,700	$ 70,900	$ 210,700	$ 87,600	$ -	$ 27,000	$ 23,950	$ 47,900	$ 550,850	$ 145,382	$ 18,700
51	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -	$ -	$ -	$ 1,155	$ 2,310	$ 26,565	$ 6,827	$ 843
52	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -	$ -	$ -	$ 1,155	$ 2,310	$ 26,565	$ 6,647	$ 788
53	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -	$ -	$ -	$ 1,155	$ 2,310	$ 26,565	$ 6,473	$ 736
54	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -	$ -	$ -	$ 1,155	$ 2,310	$ 26,565	$ 6,302	$ 688
55	$ -	$ -	$ 18,800	$ -	$ 12,400	$ -	$ 18,300	$ 13,500	$ 9,100	$ 10,700	$ 70,900	$ -	$ 87,600	$ -	$ 27,000	$ 13,415	$ 26,830	$ 308,545	$ 71,276	$ 7,468
56	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -	$ -	$ -	$ 1,155	$ 2,310	$ 26,565	$ 5,975	$ 601
57	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -	$ -	$ -	$ 1,155	$ 2,310	$ 26,565	$ 5,818	$ 562
58	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -	$ -	$ -	$ 1,155	$ 2,310	$ 26,565	$ 5,665	$ 525
59	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -	$ -	$ -	$ 1,155	$ 2,310	$ 26,565	$ 5,516	$ 491
60	$ -	$ -	$ 18,800	$ -	$ 12,400	$ -	$ 18,300	$ 13,500	$ 9,100	$ 10,700	$ 70,900	$ -	$ 87,600	$ -	$ 27,000	$ 13,415	$ 26,830	$ 308,545	$ 62,387	$ 5,325
61	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -	$ -	$ -	$ 1,155	$ 2,310	$ 26,565	$ 5,230	$ 428

FEASIBILITY STUDY COST ESTIMATE FOR OU1 - PRESENT VALUE OF ESTIMATED LONG TERM OPERATION, MAINTENANCE, AND MONITORING COSTS FOR CMS
Callahan Mine Superfund Site
Brooksville, Maine

Prepared by: JPMcCrady, 6/16/2009
Checked by: SWReed, RSEgan, 6/16/2009

Year (t)	GW Monitoring - 1x per yr	GW Monitoring - 1x per yr	GW Monitoring - 1x per yr	Const WL Monitoring - 2x per yr	Const WL Monitoring - 1x per yr	SW Monitoring - 2x per yr	SW Monitoring - 1x per yr	Sediment Monitoring - 5-yr event	Clam Tissue periodic	Annual Inspection - 1 x per yr	Cap Maintenance 5-yr event	Cap Maintenance - 25-yr event	Const WL Maintenance - 5-yr event	S Marsh Maintenance - 5-yr event	Five-Year Reviews 5-yr event -	Project Mgmt at 5.0%	Technical Support at 10.0%	Total CMS2 Non-Discounted Cost	Total CMS2 Present Value, 2.7%	Total CMS2 Present Value, 7%
62	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -	$ -	$ -	$ 1,155	$ 2,310	$ 26,565	$ 5,093	$ 400
63	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -	$ -	$ -	$ 1,155	$ 2,310	$ 26,565	$ 4,959	$ 374
64	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -	$ -	$ -	$ 1,155	$ 2,310	$ 26,565	$ 4,828	$ 350
65	$ -	$ -	$ 18,800	$ -	$ 12,400	$ -	$ 18,300	$ 13,500	$ 9,100	$ 10,700	$ 70,900	$ -	$ 87,600	$ -	$ 27,000	$ 13,415	$ 26,830	$ 308,545	$ 54,606	$ 3,796
66	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -	$ -	$ -	$ 1,155	$ 2,310	$ 26,565	$ 4,578	$ 305
67	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -	$ -	$ -	$ 1,155	$ 2,310	$ 26,565	$ 4,457	$ 285
68	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -	$ -	$ -	$ 1,155	$ 2,310	$ 26,565	$ 4,340	$ 267
69	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -	$ -	$ -	$ 1,155	$ 2,310	$ 26,565	$ 4,226	$ 249
70	$ -	$ -	$ 18,800	$ -	$ 12,400	$ -	$ 18,300	$ 13,500	$ 9,100	$ 10,700	$ 70,900	$ -	$ 87,600	$ -	$ 27,000	$ 13,415	$ 26,830	$ 308,545	$ 47,796	$ 2,707
71	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -	$ -	$ -	$ 1,155	$ 2,310	$ 26,565	$ 4,007	$ 218
72	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -	$ -	$ -	$ 1,155	$ 2,310	$ 26,565	$ 3,902	$ 204
73	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -	$ -	$ -	$ 1,155	$ 2,310	$ 26,565	$ 3,799	$ 190
74	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -	$ -	$ -	$ 1,155	$ 2,310	$ 26,565	$ 3,699	$ 178
75	$ -	$ -	$ 18,800	$ -	$ 12,400	$ -	$ 18,300	$ 13,500	$ 9,100	$ 10,700	$ 70,900	$ 210,700	$ 87,600	$ -	$ 27,000	$ 23,950	$ 47,900	$ 550,850	$ 74,688	$ 3,445
76	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -	$ -	$ -	$ 1,155	$ 2,310	$ 26,565	$ 3,507	$ 155
77	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -	$ -	$ -	$ 1,155	$ 2,310	$ 26,565	$ 3,415	$ 145
78	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -	$ -	$ -	$ 1,155	$ 2,310	$ 26,565	$ 3,325	$ 136
79	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -	$ -	$ -	$ 1,155	$ 2,310	$ 26,565	$ 3,238	$ 127
80	$ -	$ -	$ 18,800	$ -	$ 12,400	$ -	$ 18,300	$ 13,500	$ 9,100	$ 10,700	$ 70,900	$ -	$ 87,600	$ -	$ 27,000	$ 13,415	$ 26,830	$ 308,545	$ 36,617	$ 1,376
81	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -	$ -	$ -	$ 1,155	$ 2,310	$ 26,565	$ 3,070	$ 111
82	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -	$ -	$ -	$ 1,155	$ 2,310	$ 26,565	$ 2,989	$ 103
83	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -	$ -	$ -	$ 1,155	$ 2,310	$ 26,565	$ 2,910	$ 97
84	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -	$ -	$ -	$ 1,155	$ 2,310	$ 26,565	$ 2,834	$ 90
85	$ -	$ -	$ 18,800	$ -	$ 12,400	$ -	$ 18,300	$ 13,500	$ 9,100	$ 10,700	$ 70,900	$ -	$ 87,600	$ -	$ 27,000	$ 13,415	$ 26,830	$ 308,545	$ 32,050	$ 981
86	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -	$ -	$ -	$ 1,155	$ 2,310	$ 26,565	$ 2,687	$ 79
87	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -	$ -	$ -	$ 1,155	$ 2,310	$ 26,565	$ 2,616	$ 74
88	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -	$ -	$ -	$ 1,155	$ 2,310	$ 26,565	$ 2,547	$ 69
89	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -	$ -	$ -	$ 1,155	$ 2,310	$ 26,565	$ 2,481	$ 64
90	$ -	$ -	$ 18,800	$ -	$ 12,400	$ -	$ 18,300	$ 13,500	$ 9,100	$ 10,700	$ 70,900	$ -	$ 87,600	$ -	$ 27,000	$ 13,415	$ 26,830	$ 308,545	$ 28,053	$ 699
91	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -	$ -	$ -	$ 1,155	$ 2,310	$ 26,565	$ 2,352	$ 56
92	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -	$ -	$ -	$ 1,155	$ 2,310	$ 26,565	$ 2,290	$ 53
93	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -	$ -	$ -	$ 1,155	$ 2,310	$ 26,565	$ 2,230	$ 49
94	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -	$ -	$ -	$ 1,155	$ 2,310	$ 26,565	$ 2,171	$ 46
95	$ -	$ -	$ 18,800	$ -	$ 12,400	$ -	$ 18,300	$ 13,500	$ 9,100	$ 10,700	$ 70,900	$ -	$ 87,600	$ -	$ 27,000	$ 13,415	$ 26,830	$ 308,545	$ 24,554	$ 499
96	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -	$ -	$ -	$ 1,155	$ 2,310	$ 26,565	$ 2,058	$ 40
97	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -	$ -	$ -	$ 1,155	$ 2,310	$ 26,565	$ 2,004	$ 38
98	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -	$ -	$ -	$ 1,155	$ 2,310	$ 26,565	$ 1,952	$ 35
99	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -	$ -	$ -	$ 1,155	$ 2,310	$ 26,565	$ 1,900	$ 33
100	$ -	$ -	$ 18,800	$ -	$ 12,400	$ -	$ 18,300	$ 13,500	$ 9,100	$ 10,700	$ 70,900	$ 210,700	$ 87,600	$ -	$ 27,000	$ 23,950	$ 47,900	$ 550,850	$ 38,370	$ 635

																		Total, Nominal	2.7%	7.0%
30 years total	$37,600	$56,400	$169,200	$24,800	$359,600	$73,200	$219,600	$81,000	$72,800	$321,000	$425,400	$ 210,700	$525,600	$29,200	$162,000	$138,405	$276,810	$3,184,000 rounded up	$2,158,000 rounded up	**$1,324,000** rounded up
100 years total	$37,600	$56,400	$432,400	$24,800	$1,227,600	$ 73,200	$475,800	$270,000	$200,200	$1,070,000	$1,418,000	$ 842,800	$1,752,000	$29,200	$540,000	$422,500	$845,000	**$9,718,000** rounded up	**$3,398,000** rounded up	$1,474,000 rounded up

PV Discount Rate (i)	**2.70%**	**7.00%**
PV = non-discounted cost x $1/((1+i)^t)$		

Discount rate based on EPA requirement

FEASIBILITY STUDY COST ESTIMATE FOR OU1 - PRESENT VALUE OF ESTIMATED LONG TERM OPERATION, MAINTENANCE, AND MONITORING COSTS FOR CMS
Callahan Mine Superfund Site
Brooksville, Maine

Prepared by: JPMcCrady, 6/16/2009
Checked by: SWReed, RSEgan, 6/16/2009

Year (t)	GW Monitoring - 1x per yr	GW Monitoring - 1x per yr	GW Monitoring - 1x per yr	Const WL Monitoring - 2x per yr	Const WL Monitoring - 1x per yr	SW Monitoring - 2x per yr	SW Monitoring - 1x per yr	Sediment Monitoring - 5-yr event	Clam Tissue periodic	Annual Inspection - 1 x per yr	Cap Maintenance 5-yr event	Cap Maintenance - 25-yr event	Const WL Maintenance - 5-yr event	S Marsh Maintenance - 5-yr event	Five-Year Reviews 5-yr event -	Project Mgmt at 5.0%	Technical Support at 10.0%	Total CMS3 Non-Discounted Cost	Total CMS3 Present Value, 2.7%	Total CMS3 Present Value, 7%
0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
1	$ 18,800	$ -	$ -	$ 24,800	$ -	$ 36,600	$ -	$ -	$ -	$ 10,700	$ -	$ -	$ -	$ 7,300	$ -	$ 4,910	$ 9,820	$ 112,930	$ 109,961	$ 105,542
2	$ 18,800	$ -	$ -	$ -	$ 12,400	$ 36,600	$ -	$ -	$ -	$ 10,700	$ -	$ -	$ -	$ -	$ -	$ 3,925	$ 7,850	$ 90,275	$ 85,591	$ 78,850
3	$ -	$ 18,800	$ -	$ -	$ 12,400		$ 18,300	$ -	$ 9,100	$ 10,700	$ -	$ -	$ -	$ 7,300	$ -	$ 3,830	$ 7,660	$ 88,090	$ 81,323	$ 71,908
4	$ -	$ 18,800	$ -	$ -	$ 12,400		$ 18,300	$ -	$ 9,100	$ 10,700	$ -	$ -	$ -	$ -	$ -	$ 3,465	$ 6,930	$ 79,695	$ 71,639	$ 60,799
5	$ -	$ 18,800	$ -	$ -	$ 12,400		$ 18,300	$ 13,500	$ 9,100	$ 10,700	$ 70,900	$ -	$ 87,600	$ 7,300	$ 27,000	$ 13,780	$ 27,560	$ 316,940	$ 277,412	$ 225,974
6	$ -	$ -	$ 18,800	$ -	$ 12,400	$ -	$ 18,300	$ -	$ -	$ 10,700	$ -	$ -	$ -	$ -	$ -	$ 3,010	$ 6,020	$ 69,230	$ 59,003	$ 46,131
7	$ -	$ -	$ 18,800	$ -	$ 12,400	$ -	$ 18,300	$ -	$ -	$ 10,700	$ -	$ -	$ -	$ -	$ -	$ 3,010	$ 6,020	$ 69,230	$ 57,451	$ 43,113
8	$ -	$ -	$ 18,800	$ -	$ 12,400	$ -	$ 18,300	$ -	$ -	$ 10,700	$ -	$ -	$ -	$ -	$ -	$ 3,010	$ 6,020	$ 69,230	$ 55,941	$ 40,292
9	$ -	$ -	$ 18,800	$ -	$ 12,400	$ -	$ 18,300	$ -	$ -	$ 10,700	$ -	$ -	$ -	$ -	$ -	$ 3,010	$ 6,020	$ 69,230	$ 54,470	$ 37,657
10	$ -	$ -	$ 18,800	$ -	$ 12,400	$ -	$ 18,300	$ 13,500	$ 9,100	$ 10,700	$ 70,900	$ -	$ 87,600	$ 7,300	$ 27,000	$ 13,780	$ 27,560	$ 316,940	$ 242,813	$ 161,116
11	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -		$ -	$ 1,155	$ 2,310	$ 26,565	$ 19,817	$ 12,621
12	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -		$ -	$ 1,155	$ 2,310	$ 26,565	$ 19,296	$ 11,795
13	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -		$ -	$ 1,155	$ 2,310	$ 26,565	$ 18,789	$ 11,024
14	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -		$ -	$ 1,155	$ 2,310	$ 26,565	$ 18,295	$ 10,302
15	$ -	$ -	$ 18,800	$ -	$ 12,400	$ -	$ 18,300	$ 13,500	$ 9,100	$ 10,700	$ 70,900	$ -	$ 87,600		$ 27,000	$ 13,415	$ 26,830	$ 308,545	$ 206,901	$ 111,831
16	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -		$ -	$ 1,155	$ 2,310	$ 26,565	$ 17,345	$ 8,998
17	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -		$ -	$ 1,155	$ 2,310	$ 26,565	$ 16,889	$ 8,410
18	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -		$ -	$ 1,155	$ 2,310	$ 26,565	$ 16,445	$ 7,860
19	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -		$ -	$ 1,155	$ 2,310	$ 26,565	$ 16,013	$ 7,345
20	$ -	$ -	$ 18,800	$ -	$ 12,400	$ -	$ 18,300	$ 13,500	$ 9,100	$ 10,700	$ 70,900	$ -	$ 87,600		$ 27,000	$ 13,415	$ 26,830	$ 308,545	$ 181,096	$ 79,734
21	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -		$ -	$ 1,155	$ 2,310	$ 26,565	$ 15,182	$ 6,416
22	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -		$ -	$ 1,155	$ 2,310	$ 26,565	$ 14,783	$ 5,996
23	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -		$ -	$ 1,155	$ 2,310	$ 26,565	$ 14,394	$ 5,604
24	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -		$ -	$ 1,155	$ 2,310	$ 26,565	$ 14,016	$ 5,237
25	$ -	$ -	$ 18,800	$ -	$ 12,400	$ -	$ 18,300	$ 13,500	$ 9,100	$ 10,700	$ 70,900	$ 210,700	$ 87,600		$ 27,000	$ 23,950	$ 47,900	$ 550,850	$ 282,991	$ 101,494
26	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -		$ -	$ 1,155	$ 2,310	$ 26,565	$ 13,289	$ 4,574
27	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -		$ -	$ 1,155	$ 2,310	$ 26,565	$ 12,939	$ 4,275
28	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -		$ -	$ 1,155	$ 2,310	$ 26,565	$ 12,599	$ 3,995
29	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -		$ -	$ 1,155	$ 2,310	$ 26,565	$ 12,268	$ 3,734
30	$ -	$ -	$ 18,800	$ -	$ 12,400	$ -	$ 18,300	$ 13,500	$ 9,100	$ 10,700	$ 70,900	$ -	$ 87,600		$ 27,000	$ 13,415	$ 26,830	$ 308,545	$ 138,741	$ 40,533
31	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -		$ -	$ 1,155	$ 2,310	$ 26,565	$ 11,631	$ 3,261
32	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -		$ -	$ 1,155	$ 2,310	$ 26,565	$ 11,325	$ 3,048
33	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -		$ -	$ 1,155	$ 2,310	$ 26,565	$ 11,028	$ 2,849
34	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -		$ -	$ 1,155	$ 2,310	$ 26,565	$ 10,738	$ 2,662
35	$ -	$ -	$ 18,800	$ -	$ 12,400	$ -	$ 18,300	$ 13,500	$ 9,100	$ 10,700	$ 70,900	$ -	$ 87,600		$ 27,000	$ 13,415	$ 26,830	$ 308,545	$ 121,438	$ 28,899
36	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -		$ -	$ 1,155	$ 2,310	$ 26,565	$ 10,181	$ 2,325
37	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -		$ -	$ 1,155	$ 2,310	$ 26,565	$ 9,913	$ 2,173
38	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -		$ -	$ 1,155	$ 2,310	$ 26,565	$ 9,652	$ 2,031
39	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -		$ -	$ 1,155	$ 2,310	$ 26,565	$ 9,399	$ 1,898
40	$ -	$ -	$ 18,800	$ -	$ 12,400	$ -	$ 18,300	$ 13,500	$ 9,100	$ 10,700	$ 70,900	$ -	$ 87,600		$ 27,000	$ 13,415	$ 26,830	$ 308,545	$ 106,292	$ 20,605
41	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -		$ -	$ 1,155	$ 2,310	$ 26,565	$ 8,911	$ 1,658
42	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -		$ -	$ 1,155	$ 2,310	$ 26,565	$ 8,677	$ 1,549
43	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -		$ -	$ 1,155	$ 2,310	$ 26,565	$ 8,449	$ 1,448
44	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -		$ -	$ 1,155	$ 2,310	$ 26,565	$ 8,226	$ 1,353
45	$ -	$ -	$ 18,800	$ -	$ 12,400	$ -	$ 18,300	$ 13,500	$ 9,100	$ 10,700	$ 70,900	$ -	$ 87,600		$ 27,000	$ 13,415	$ 26,830	$ 308,545	$ 93,035	$ 14,691
46	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -		$ -	$ 1,155	$ 2,310	$ 26,565	$ 7,800	$ 1,182
47	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -		$ -	$ 1,155	$ 2,310	$ 26,565	$ 7,594	$ 1,105
48	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -		$ -	$ 1,155	$ 2,310	$ 26,565	$ 7,395	$ 1,032
49	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -		$ -	$ 1,155	$ 2,310	$ 26,565	$ 7,200	$ 965
50	$ -	$ -	$ 18,800	$ -	$ 12,400	$ -	$ 18,300	$ 13,500	$ 9,100	$ 10,700	$ 70,900	$ 210,700	$ 87,600		$ 27,000	$ 23,950	$ 47,900	$ 550,850	$ 145,382	$ 18,700
51	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -		$ -	$ 1,155	$ 2,310	$ 26,565	$ 6,827	$ 843
52	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -		$ -	$ 1,155	$ 2,310	$ 26,565	$ 6,647	$ 788
53	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -		$ -	$ 1,155	$ 2,310	$ 26,565	$ 6,473	$ 736
54	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -		$ -	$ 1,155	$ 2,310	$ 26,565	$ 6,302	$ 688
55	$ -	$ -	$ 18,800	$ -	$ 12,400	$ -	$ 18,300	$ 13,500	$ 9,100	$ 10,700	$ 70,900	$ -	$ 87,600		$ 27,000	$ 13,415	$ 26,830	$ 308,545	$ 71,276	$ 7,468
56	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -		$ -	$ 1,155	$ 2,310	$ 26,565	$ 5,975	$ 601
57	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -		$ -	$ 1,155	$ 2,310	$ 26,565	$ 5,818	$ 562
58	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -		$ -	$ 1,155	$ 2,310	$ 26,565	$ 5,665	$ 525
59	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -		$ -	$ 1,155	$ 2,310	$ 26,565	$ 5,516	$ 491
60	$ -	$ -	$ 18,800	$ -	$ 12,400	$ -	$ 18,300	$ 13,500	$ 9,100	$ 10,700	$ 70,900	$ -	$ 87,600		$ 27,000	$ 13,415	$ 26,830	$ 308,545	$ 62,387	$ 5,325
61	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -		$ -	$ 1,155	$ 2,310	$ 26,565	$ 5,230	$ 428

FEASIBILITY STUDY COST ESTIMATE FOR OU1 - PRESENT VALUE OF ESTIMATED LONG TERM OPERATION, MAINTENANCE, AND MONITORING COSTS FOR CMS
Callahan Mine Superfund Site
Brooksville, Maine

Prepared by: JPMcCrady, 6/16/2009
Checked by: SWReed, RSEgan, 6/16/2009

Year (t)	GW Monitoring - 1x per yr	GW Monitoring - 1x per yr	GW Monitoring - 1x per yr	Const WL Monitoring - 2x per yr	Const WL Monitoring - 1x per yr	SW Monitoring - 2x per yr	SW Monitoring - 1x per yr	Sediment Monitoring - 5-yr event	Clam Tissue periodic	Annual Inspection - 1 x per yr	Cap Maintenance 5-yr event	Cap Maintenance - 25-yr event	Const WL Maintenance - 5-yr event	S Marsh Maintenance - 5-yr event	Five-Year Reviews 5-yr event -	Project Mgmt at 5.0%	Technical Support at 10.0%	Total CMS3 Non-Discounted Cost	Total CMS3 Present Value, 2.7%	Total CMS3 Present Value, 7%
62	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -		$ -	$ 1,155	$ 2,310	$ 26,565	$ 5,093	$ 400
63	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -		$ -	$ 1,155	$ 2,310	$ 26,565	$ 4,959	$ 374
64	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -		$ -	$ 1,155	$ 2,310	$ 26,565	$ 4,828	$ 350
65	$ -	$ -	$ 18,800	$ -	$ 12,400	$ -	$ 18,300	$ 13,500	$ 9,100	$ 10,700	$ 70,900	$ -	$ 87,600		$ 27,000	$ 13,415	$ 26,830	$ 308,545	$ 54,606	$ 3,796
66	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -		$ -	$ 1,155	$ 2,310	$ 26,565	$ 4,578	$ 305
67	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -		$ -	$ 1,155	$ 2,310	$ 26,565	$ 4,457	$ 285
68	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -		$ -	$ 1,155	$ 2,310	$ 26,565	$ 4,340	$ 267
69	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -		$ -	$ 1,155	$ 2,310	$ 26,565	$ 4,226	$ 249
70	$ -	$ -	$ 18,800	$ -	$ 12,400	$ -	$ 18,300	$ 13,500	$ 9,100	$ 10,700	$ 70,900	$ -	$ 87,600		$ 27,000	$ 13,415	$ 26,830	$ 308,545	$ 47,796	$ 2,707
71	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -		$ -	$ 1,155	$ 2,310	$ 26,565	$ 4,007	$ 218
72	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -		$ -	$ 1,155	$ 2,310	$ 26,565	$ 3,902	$ 204
73	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -		$ -	$ 1,155	$ 2,310	$ 26,565	$ 3,799	$ 190
74	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -		$ -	$ 1,155	$ 2,310	$ 26,565	$ 3,699	$ 178
75	$ -	$ -	$ 18,800	$ -	$ 12,400	$ -	$ 18,300	$ 13,500	$ 9,100	$ 10,700	$ 70,900	$ 210,700	$ 87,600		$ 27,000	$ 23,950	$ 47,900	$ 550,850	$ 74,688	$ 3,445
76	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -		$ -	$ 1,155	$ 2,310	$ 26,565	$ 3,507	$ 155
77	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -		$ -	$ 1,155	$ 2,310	$ 26,565	$ 3,415	$ 145
78	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -		$ -	$ 1,155	$ 2,310	$ 26,565	$ 3,325	$ 136
79	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -		$ -	$ 1,155	$ 2,310	$ 26,565	$ 3,238	$ 127
80	$ -	$ -	$ 18,800	$ -	$ 12,400	$ -	$ 18,300	$ 13,500	$ 9,100	$ 10,700	$ 70,900	$ -	$ 87,600		$ 27,000	$ 13,415	$ 26,830	$ 308,545	$ 36,617	$ 1,376
81	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -		$ -	$ 1,155	$ 2,310	$ 26,565	$ 3,070	$ 111
82	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -		$ -	$ 1,155	$ 2,310	$ 26,565	$ 2,989	$ 103
83	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -		$ -	$ 1,155	$ 2,310	$ 26,565	$ 2,910	$ 97
84	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -		$ -	$ 1,155	$ 2,310	$ 26,565	$ 2,834	$ 90
85	$ -	$ -	$ 18,800	$ -	$ 12,400	$ -	$ 18,300	$ 13,500	$ 9,100	$ 10,700	$ 70,900	$ -	$ 87,600		$ 27,000	$ 13,415	$ 26,830	$ 308,545	$ 32,050	$ 981
86	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -		$ -	$ 1,155	$ 2,310	$ 26,565	$ 2,687	$ 79
87	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -		$ -	$ 1,155	$ 2,310	$ 26,565	$ 2,616	$ 74
88	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -		$ -	$ 1,155	$ 2,310	$ 26,565	$ 2,547	$ 69
89	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -		$ -	$ 1,155	$ 2,310	$ 26,565	$ 2,481	$ 64
90	$ -	$ -	$ 18,800	$ -	$ 12,400	$ -	$ 18,300	$ 13,500	$ 9,100	$ 10,700	$ 70,900	$ -	$ 87,600		$ 27,000	$ 13,415	$ 26,830	$ 308,545	$ 28,053	$ 699
91	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -		$ -	$ 1,155	$ 2,310	$ 26,565	$ 2,352	$ 56
92	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -		$ -	$ 1,155	$ 2,310	$ 26,565	$ 2,290	$ 53
93	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -		$ -	$ 1,155	$ 2,310	$ 26,565	$ 2,230	$ 49
94	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -		$ -	$ 1,155	$ 2,310	$ 26,565	$ 2,171	$ 46
95	$ -	$ -	$ 18,800	$ -	$ 12,400	$ -	$ 18,300	$ 13,500	$ 9,100	$ 10,700	$ 70,900	$ -	$ 87,600		$ 27,000	$ 13,415	$ 26,830	$ 308,545	$ 24,554	$ 499
96	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -		$ -	$ 1,155	$ 2,310	$ 26,565	$ 2,058	$ 40
97	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -		$ -	$ 1,155	$ 2,310	$ 26,565	$ 2,004	$ 38
98	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -		$ -	$ 1,155	$ 2,310	$ 26,565	$ 1,952	$ 35
99	$ -	$ -		$ -	$ 12,400	$ -		$ -	$ -	$ 10,700	$ -	$ -	$ -		$ -	$ 1,155	$ 2,310	$ 26,565	$ 1,900	$ 33
100	$ -	$ -	$ 18,800	$ -	$ 12,400	$ -	$ 18,300	$ 13,500	$ 9,100	$ 10,700	$ 70,900	$ 210,700	$ 87,600		$ 27,000	$ 23,950	$ 47,900	$ 550,850	$ 38,370	$ 635

																		Total, Nominal	2.7%	7.0%
30 years total	$37,600	$56,400	$169,200	$24,800	$359,600	$73,200	$219,600	$81,000	$72,800	$321,000	$425,400	$ 210,700	$525,600	$29,200	$162,000	$138,405	$276,810	$3,184,000 rounded up	$2,158,000 rounded up	**$1,324,000** rounded up
100 years total	$37,600	$56,400	$432,400	$24,800	$1,227,600	$ 73,200	$475,800	$270,000	$200,200	$1,070,000	$1,418,000	$ 842,800	$1,752,000	$29,200	$540,000	$422,500	$845,000	**$9,718,000** rounded up	**$3,398,000** rounded up	$1,474,000 rounded up

PV Discount Rate (i)	**2.70%**	**7.00%**
PV = non-discounted cost x $1/((1+i)^t)$		

Discount rate based on EPA requirement

FEASIBILITY STUDY COST ESTIMATE FOR OU1, LONG-TERM OPERATION, MAINTENANCE, AND MONITORING
Callahan Mine Superfund Site
Brooksville, Maine

Prepared by: JPMcCrady, 6/16/2009
Checked by: SWReed, RSEgan, 6/16/2009

Item Description	No.	Unit	Unit Cost	Total	Notes
1.0 Long-Term Operation and Maintenance					
1.1 Annual Inspection and Site Summary Report					
1.1.1 Inspections:					
Cover systems, stormwater controls, Institutional controls, etc.	40	hr	$ 90.00	$ 3,600	2 people x 2.5 days
Constructed wetland, salt marsh					
1.1.2 Vehicle Rental (van / 4x4)	3	day	$ 110.00	$ 330	
1.1.3 Lodging and per diem	4	day	$ 150.00	$ 600	CONUS per diem, Hancock County, wt avg
1.1.4 Summary Memo/report					
Labor	40	hr	$ 90.00	$ 3,600	
ODCs	1	ls	$ 100.00	$ 100	
Subtotal w/o Contingency (per event)				$ 8,230	
Contingency @			30.0%	$ 2,469	
Subtotal w/ Contingency				$ 10,700	
1.2 Periodic Long-Term Maintenance (CMS 2, and 3)					
1.2.1 Constructed/Treatment Wetland Maintenance (5-yr event)					
Mulch	3,015	lcy	$ 20.00	$ 60,300	Assume 33% of total mulch is replaced
Backhoe w/ operator and laborer	4	day	$ 700.00	$ 2,800	Assume rate of 1,500 cy/day
Oversight Labor	24	hr	$ 100.00	$ 2,400	3 days
Vehicle Rental (van / 4x4)	1	wk	$ 369.00	$ 369	
Lodging and per diem	4	day	$ 150.00	$ 600	CONUS per diem, Hancock County, wt avg
Documentation memo	10	hr	$ 90.00	$ 900	
Subtotal w/o Contingency (per event)				$ 67,369	
Contingency @			30.0%	$ 20,211	
Subtotal w/ Contingency				$ 87,600	
1.2.2 Salt Marsh Maintenance (5-yr event)					
Mulch	25	cy	$ 20.00	$ 500	

FEASIBILITY STUDY COST ESTIMATE FOR OU1, LONG-TERM OPERATION, MAINTENANCE, AND MONITORING
Callahan Mine Superfund Site
Brooksville, Maine

Prepared by: JPMcCrady, 6/16/2009
Checked by: SWReed, RSEgan, 6/16/2009

Item Description	No.	Unit	Unit Cost	Total	Notes
Backhoe w/ operator and laborer	2	day	$ 700.00	$ 1,400	
Oversight Labor	24	hr	$ 100.00	$ 2,400	
Vehicle Rental (van / 4x4)	2	day	$ 110.00	$ 220	
Lodging and per diem	2	day	$ 150.00	$ 300	CONUS per diem, Hancock County, wt avg
Documentation memo	8	hr	$ 90.00	$ 720	
Subtotal w/o Contingency				$ 5,600	
Contingency @			30.0%	$ 1,680	
Subtotal w/ Contingency				$ 7,300	
1.2.3 Tailings Impoundment Cap Maintenance (5-yr event)					
Cap Maintenance					
Stone	100	cy	$ 25.00	$ 2,500	
Backhoe w/ operator and laborer	5	day	$ 700.00	$ 3,500	
Ditch Maintenance					
Stone	100	cy	$ 40.00	$ 4,000	
Backhoe w/ operator and laborer	5	day	$ 700.00	$ 3,500	
Oversight Labor, Cap and Ditch	100	hr	$ 100.00	$ 10,000	
Vehicle Rental (van / 4x4)	10	day	$ 110.00	$ 1,100	
Lodging and per diem	8	day	$ 150.00	$ 1,200	CONUS per diem, Hancock County, wt avg
Vegetation Control					
Subcontracted labor	32	hr	$ 25.00	$ 800	2 people x 2 days
Oversight Labor (supervisory)	24	hr	$ 100.00	$ 2,400	includes travel
Vehicle Rental (van / 4x4)	3	day	$ 110.00	$ 330	
Lodging and per diem	2	day	$ 150.00	$ 300	CONUS per diem, Hancock County, wt avg
Muck Out Storm Water Detention Ponds					
Excavator w/ operator	5	day	$ 1,450.00	$ 7,250	
2 Dump trucks w/ operators	5	day	$ 1,960.00	$ 9,800	
Oversight Labor	50	hr	$ 100.00	$ 5,000	
Vehicle Rental (van / 4x4)	5	day	$ 110.00	$ 550	
Lodging and per diem	4	day	$ 150.00	$ 600	CONUS per diem, Hancock County, wt avg
Five year maintenance documentation memo	16	hr	$ 100.00	$ 1,600	

FEASIBILITY STUDY COST ESTIMATE FOR OU1, LONG-TERM OPERATION, MAINTENANCE, AND MONITORING
Callahan Mine Superfund Site
Brooksville, Maine

Prepared by: JPMcCrady, 6/16/2009
Checked by: SWReed, RSEgan, 6/16/2009

Item Description	No.	Unit	Unit Cost	Total	Notes
Subtotal w/o Contingency (per event)				$ 54,500	
Contingency @			30.0%	$ 16,350	
Subtotal w/ Contingency				$ 70,900	
1.2.4 Long-term Repairs to Cap (25-yr event)					
5-yr Maintenance	1	ls	$ 54,500.00	$ 54,500	
Specialty subcontractor mobilization	1	ls	$ 3,100.00	$ 3,100	
Geomembrane, 40-mil, LLDPE, smooth, installed	43,560	sf	$ 0.70	$ 30,492	Assume 1 ac of cap requires repair
Geocomposite, triplanar, Tenax, installed	43,560	sf	$ 0.72	$ 31,363	
Removal of stone, LGP dozer, oper & laborer	2	day	$ 2,080.00	$ 4,160	
Additional stone, 15 inch, 0.5 acre	1,010	cy	$ 25.00	$ 25,250	Assume reuse of 50% of the removed stone
Placement of stone, LGP dozer, oper & laborer	3	day	$ 2,080.00	$ 6,240	
Oversight Labor	50	hr	$ 100.00	$ 5,000	5 days
Vehicle Rental (van / 4x4)	5	day	$ 110.00	$ 550	
Lodging and per diem	4	day	$ 150.00	$ 600	CONUS per diem, Hancock County, wt avg
Documentation memo	8	hr	$ 100.00	$ 800	
Subtotal w/o Contingency (per event)				$ 162,055	
Contingency @			30.0%	$ 48,617	
Subtotal w/ Contingency				$ 210,700	
2.0 <u>Environmental Monitoring</u>					
2.1 Constructed Wetland Inf/Eff (per event)					
2.1.1 Sample collection ODCs/Equip	8	ea	$ 20.00	$ 160	
PP metals T/D; NO2/NO3; PO4; SO4; sulfide; alk	10	ea	$ 410.00	$ 4,100	includes 20% QA/QC
Field Parameters	1	ls	$ 300.00	$ 300	
2.1.2 Media monitoring					
5 locations, PP metals, Nit., PO4, SO4, S, alk	5	ea	$ 300.00	$ 1,500	includes 20% QA/QC
2.1.3 Technician Labor	24	hr	$ 80.00	$ 1,920	2 people x 2 day (inc travel, mob/demob)
2.1.4 Vehicle Rental (van / 4x4)	2	day	$ 110.00	$ 220	

FEASIBILITY STUDY COST ESTIMATE FOR OU1, LONG-TERM OPERATION, MAINTENANCE, AND MONITORING
Callahan Mine Superfund Site
Brooksville, Maine

Prepared by: JPMcCrady, 6/16/2009
Checked by: SWReed, RSEgan, 6/16/2009

Item Description	No.	Unit	Unit Cost	Total	Notes
2.1.5 Lodging and per diem	1		$ 150.00	$ 150	CONUS per diem, Hancock County, wt avg
2.1.6 Analytical Data Review and Memo	8	hr	$ 80.00	$ 640	
2.1.7 Database management	2	hr	$ 80.00	$ 160	
2.1.8 Documentation memo	4	hr	$ 90.00	$ 360	
Subtotal w/o Contingency (per event)				$ 9,510	
Contingency @			30.0%	$ 2,853	
Subtotal w/ Contingency				$ 12,400	
2.2 Groundwater Monitoring (per event - 10 wells)					
2.2.1 Sample collection ODCs/Equip (see backup sheet)	10	ea	$ 110.00	$ 1,100	
2.2.2 Sample analysis (water)				$ -	
TAL metals T/D; SO4; alk	12	ea	$ 319.00	$ 3,828	includes 20% QA/QC
Field Parameters	1	ls	$ 300.00	$ 300	
2.2.3 Technician Labor	80	hr	$ 80.00	$ 6,400	2 people x 4 day (inc travel, mob/demob)
2.2.4 Vehicle Rental (van / 4x4)	7	day	$ 110.00	$ 770	
2.2.5 Lodging and per diem	6	day	$ 150.00	$ 900	CONUS per diem, Hancock County, wt avg
2.2.6 Analytical Data Review and Memo	8	hr	$ 80.00	$ 640	
2.2.7 Database management	2	hr	$ 80.00	$ 160	
2.2.8 Documentation memo	4	hr	$ 90.00	$ 360	
Subtotal w/o Contingency (per event)				$ 14,458	
Contingency @			30.0%	$ 4,337	
Subtotal w/ Contingency				$ 18,800	
2.3 Surface Water Monitoring (8 locations - per event)					
2.3.1 Sample collection ODCs/Equip	18	ea	$ 100.00	$ 1,800	
2.3.2 Sample analysis (water)					2 x 6 locations, 3 x 2 locations
TAL metals T/D,	22	ea	$ 300.00	$ 6,600	includes 20% QA/QC
Field Parameters	1	ls	$ 300.00	$ 300	
2.3.3 Labor	40	hrs	$ 80.00	$ 3,200	2 people x 2 days (inc travel, mob/demob)
2.3.4 Vehicle Rental (van / 4x4)	3	day	$ 110.00	$ 330	
2.3.5 Lodging and per diem	2	day	$ 150.00	$ 300	2 people x 1 night, CONUS allowance

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Prepared by: JPMcCrady, 6/16/2009
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Item Description	No.	Unit	Unit Cost	Total	Notes
2.3.6 Analytical Data Review and Memo	8	hr	$ 80.00	$ 640	
2.3.7 Database management	2	hr	$ 80.00	$ 160	
2.3.8 Documentation memo	8	hr	$ 90.00	$ 720	
Subtotal w/o Contingency (per event)				$ 14,050	
Contingency @			30.0%	$ 4,215	
Subtotal w/ Contingency				$ 18,300	
2.4 Sediment Monitoring (8 locations - per event)					
2.4.1 Sample analysis					
PP metals	10	ea	$ 300.00	$ 3,000	includes 20% QA/QC
Field Parameters	1	ls	$ 300.00	$ 300	
2.4.2 Labor	60	hrs	$ 80.00	$ 4,800	2 people x 3 days (inc travel, mob/demob)
2.4.3 Vehicle Rental (van / 4x4)	4	day	$ 110.00	$ 440	
2.4.4 Lodging and per diem	2	day	$ 150.00	$ 300	2 people x 2 night, CONUS allowance
2.4.5 Analytical Data Review and Memo	8	hr	$ 80.00	$ 640	
2.4.6 Database management	2	hr	$ 80.00	$ 160	
2.4.7 Documentation memo	8	hr	$ 90.00	$ 720	
Subtotal w/o Contingency (per event)				$ 10,360	
Contingency @			30.0%	$ 3,108	
Subtotal w/ Contingency				$ 13,500	
2.5 Clam Tissue Sampling (4 locations)					
2.5.1 Sample collection ODCs/Equip (see backup sheet)	4	ea	$ 150.00	$ 600	
Sample analysis (clam tissue)					
Select metals	4	ea	$ 250.00	$ 1,000	includes 20% QA/QC
2.5.2 Labor	40	hr	$ 80.00	$ 3,200	2 people x 2 days (inc travel, mob/demob)
2.5.3 Vehicle Rental (van / 4x4)	3	day	$ 110.00	$ 330	
2.5.4 Lodging and per diem	2	day	$ 150.00	$ 300	2 people x 1 night, CONUS allowance
2.5.5 Analytical Data Review and Memo	8	hr	$ 80.00	$ 640	
2.5.6 Database management	2	hr	$ 80.00	$ 160	
2.5.7 Documentation memo	8	hr	$ 90.00	$ 720	

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	Item Description	No.	Unit	Unit Cost	Total	Notes
	Subtotal w/o Contingency (per event)				$ 6,950	
	Contingency @			30.0%	$ 2,085	
	Subtotal w/ Contingency				$ 9,100	
2.6	**Five Year Review**				**$ 20,714**	
2.6.1	Site Visit (including interviews)	16	hrs	$ 90.00	$ 1,440	
2.6.2	Meetings	16	hrs	$ 110.00	$ 1,760	
2.6.3	Labor to prepare (Draft and Final)	180	hrs	$ 90.00	$ 16,200	
2.6.4	ODCs/computer/copies/postage	1	ls	$ 750.00	$ 750	
2.6.5	Vehicle Rental	3	days	$ 88.00	$ 264	
2.6.6	Lodging and per diem	2	days	$ 150.00	$ 300	CONUS per diem, Hancock County, wt avg
	Subtotal w/o Contingency				$ 20,714	
	Contingency @			30.0%	$ 6,214	
	Subtotal w/ Contingency				$ 27,000	
2.7	**Five Year Review for CMS 1**				**$ 5,626**	
2.7.1	Site Visit (including interviews)	16	hrs	$ 90.00	$ 1,440	
2.7.2	Meetings	8	hrs	$ 110.00	$ 880	
2.7.3	Labor to prepare (Draft and Final)	32	hrs	$ 90.00	$ 2,880	
2.7.4	ODCs/computer/copies/postage	1	ls	$ 100.00	$ 100	
2.7.5	Vehicle Rental	2	days	$ 88.00	$ 176	
2.7.6	Lodging and per diem	1	days	$ 150.00	$ 150	CONUS per diem, Hancock County, wt avg
	Subtotal w/o Contingency				$ 5,626	
	Contingency @			30.0%	$ 1,688	
	Subtotal w/ Contingency				$ 7,400	