

**FINAL
OPERABLE UNIT 1 FEASIBILITY STUDY REPORT
EXECUTIVE SUMMARY**

**CALLAHAN MINE SUPERFUND SITE
BROOKSVILLE, MAINE**

Prepared for:

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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 [CuFeS₂]), 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 1×10^{-6} to 1×10^{-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 [$\mu\text{g}/\text{dl}$] 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 1×10^{-6} to 1×10^{-4} , HI of 1, and/or 5 percent or more of exposed population with a geometric mean blood lead level of 10 $\mu\text{g}/\text{dl}$ 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 1×10^{-6} to 1×10^{-4} , HI of 1, and/or 5 percent or more of exposed population with a geometric mean blood lead level of 10 $\mu\text{g}/\text{dl}$ 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 1×10^{-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

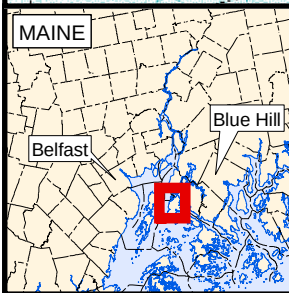
The design for the early cleanup action would identify the extent of the former Callahan Mine portion of the Site that exceeds the residential PRGs for arsenic and lead developed for the OU 1 cleanup and the extent of groundwater that exceeds MCLs, MCLGs, MEGs, or risk-based standards, whichever is more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

**EXECUTIVE SUMMARY
FIGURES**



1:24,000 scale digital topographic map
obtained from Maine Office of GIS at
<http://apollo.ogis.state.me.us/catalog>



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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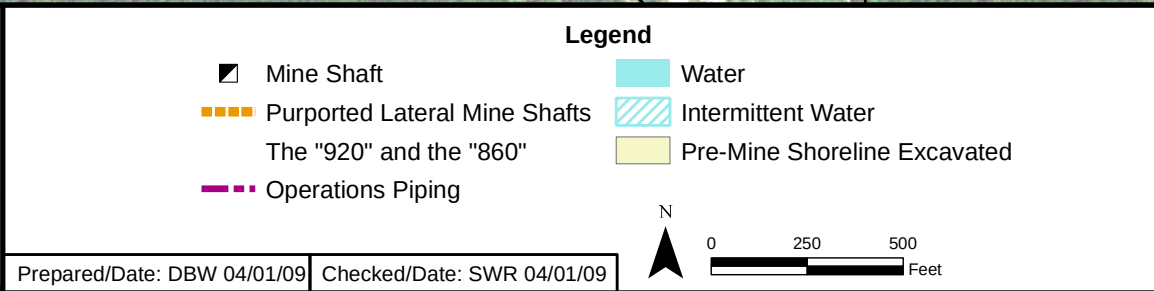
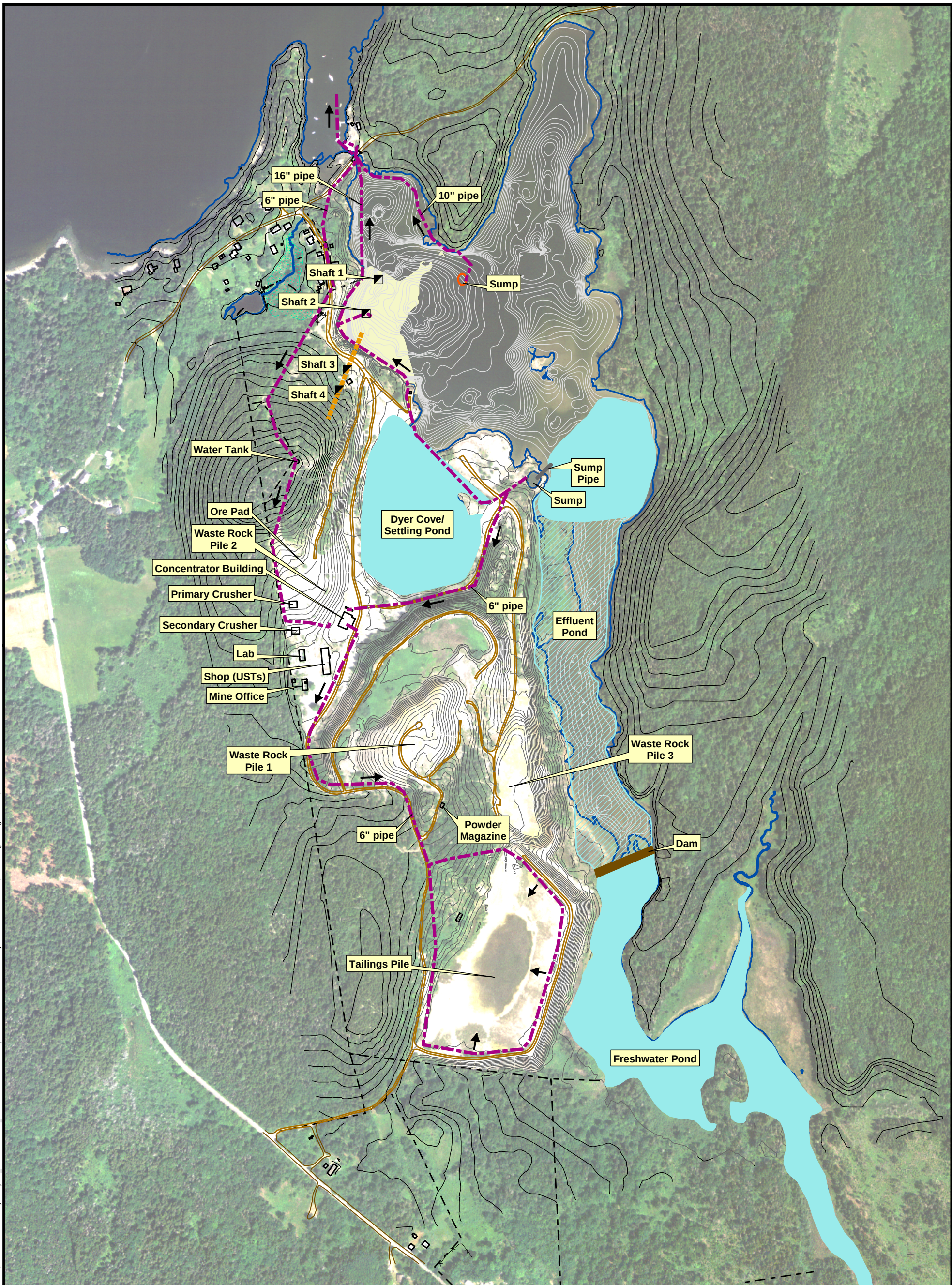


Figure ES-2
Historical Mine Features (1972)

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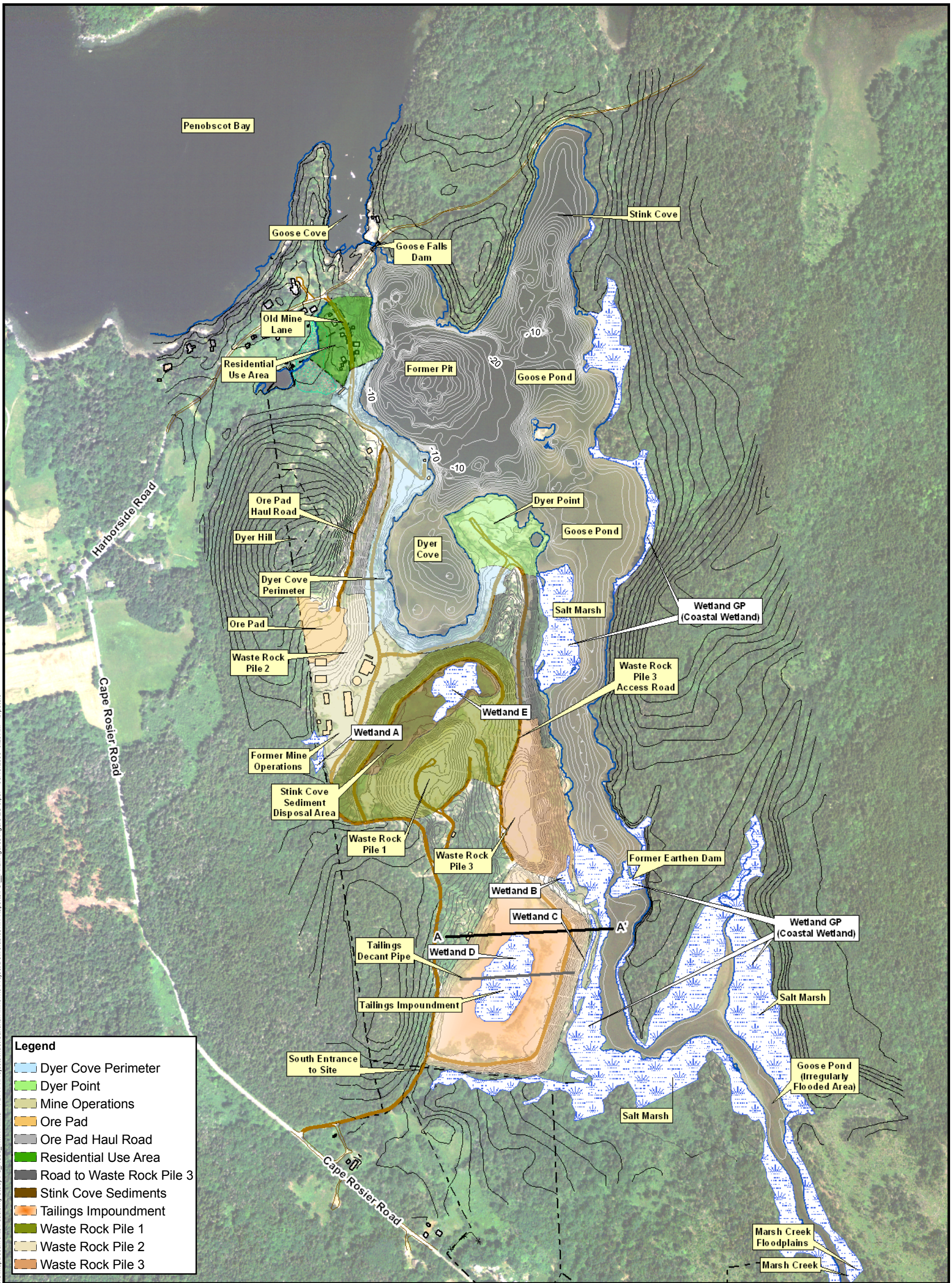


Figure ES-3
Site Features

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

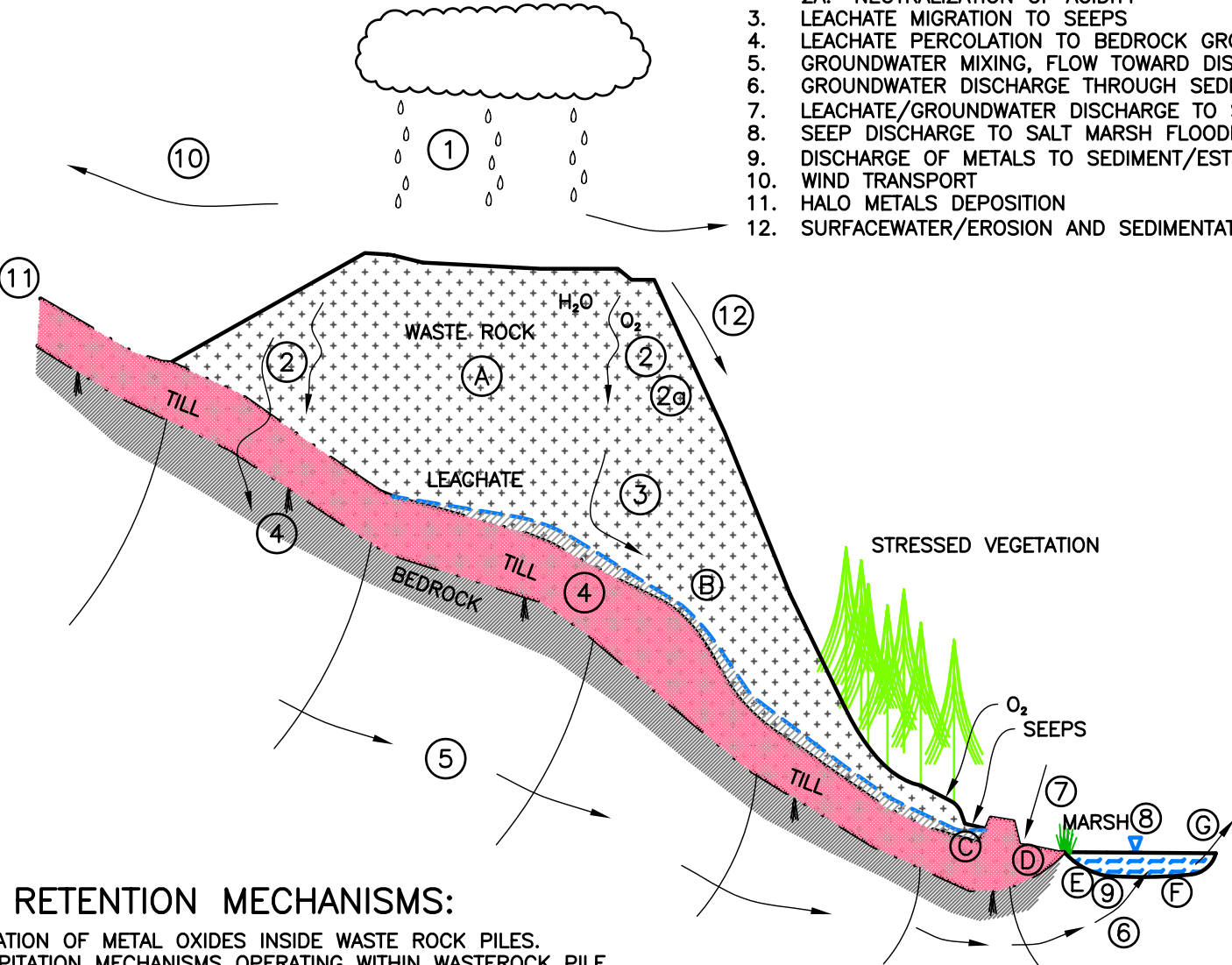
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WASTE ROCK PILES AND ORE PAD

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



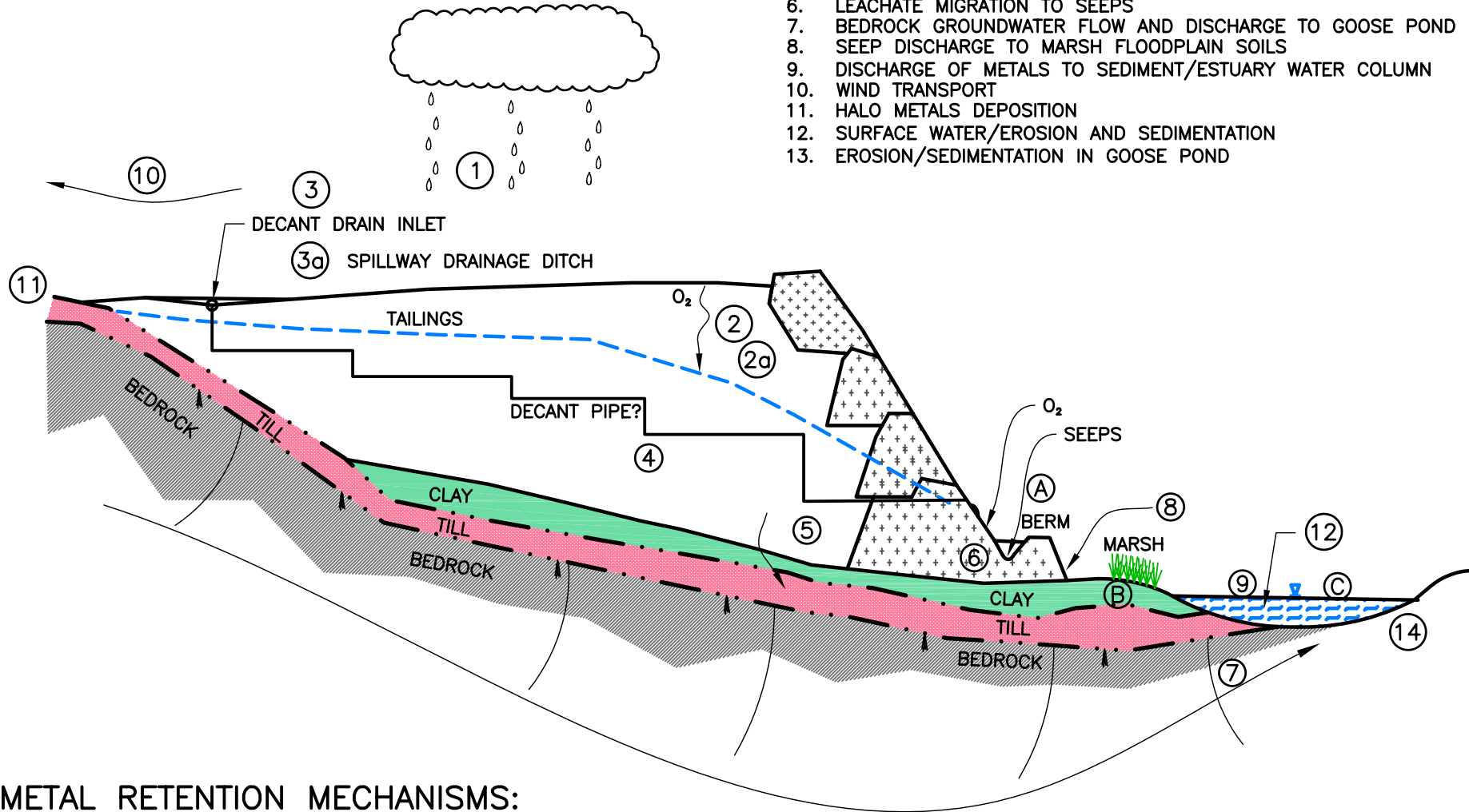
METAL RETENTION MECHANISMS:

- 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: SWR 06/11/09

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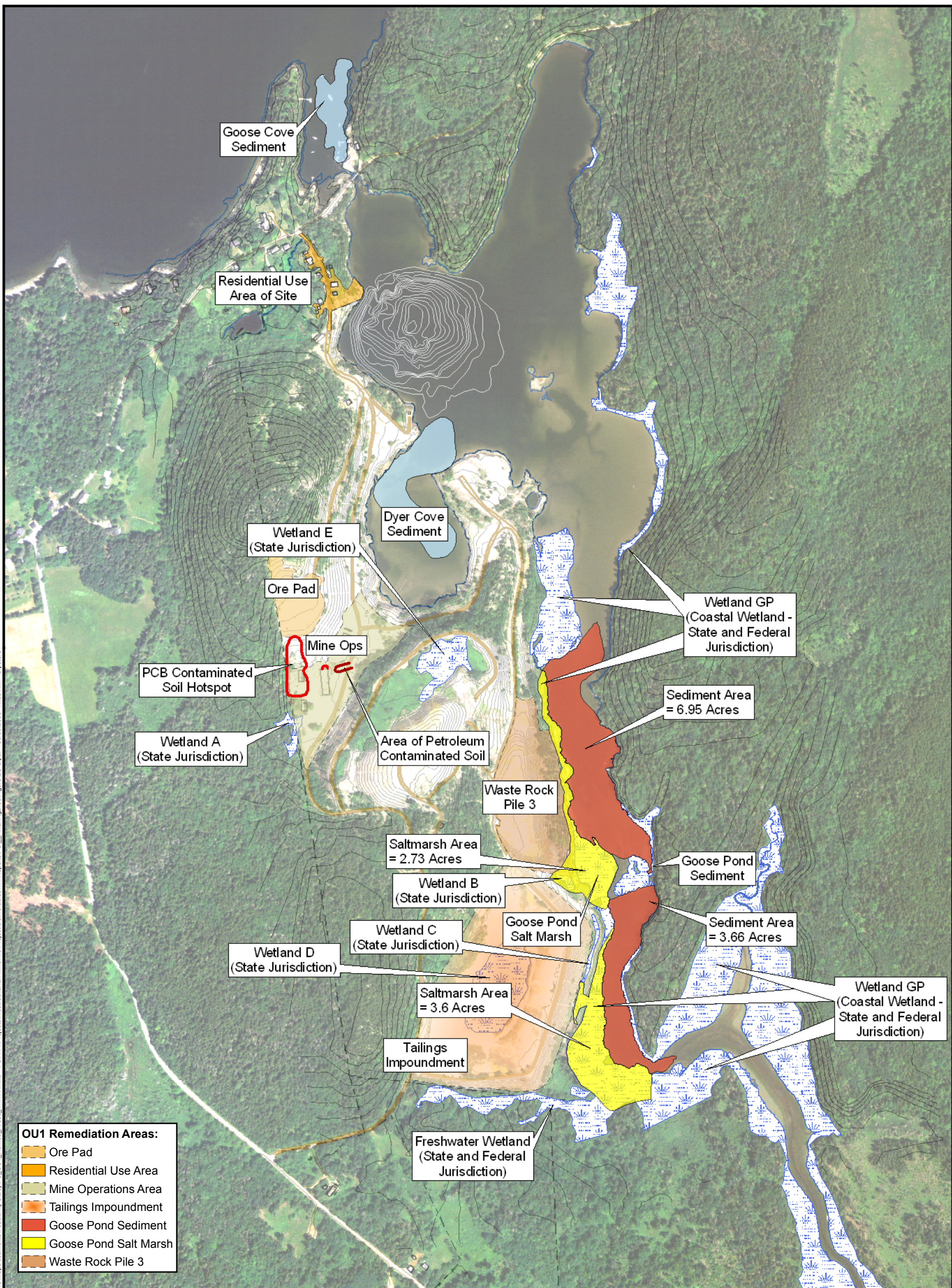
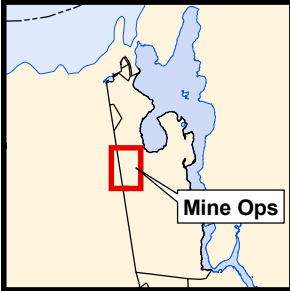
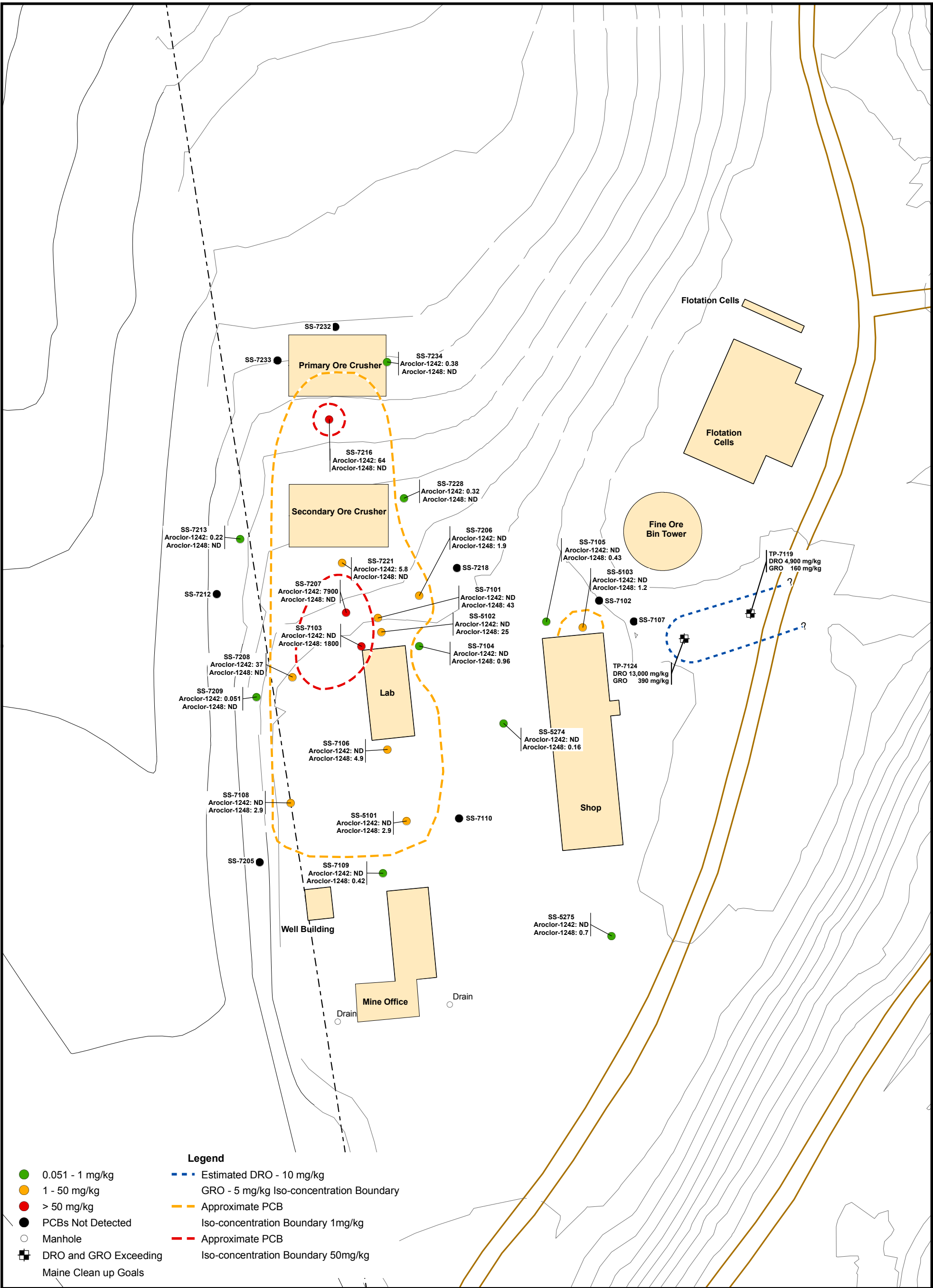


Figure ES-5
OU1 Remediation Areas

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Checked/Date: SWR 06/15/09

0 30 60 Feet

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Figure ES-6
Areas Exceeding PCB PRGs and DRO/GRO Cleanup Goals

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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

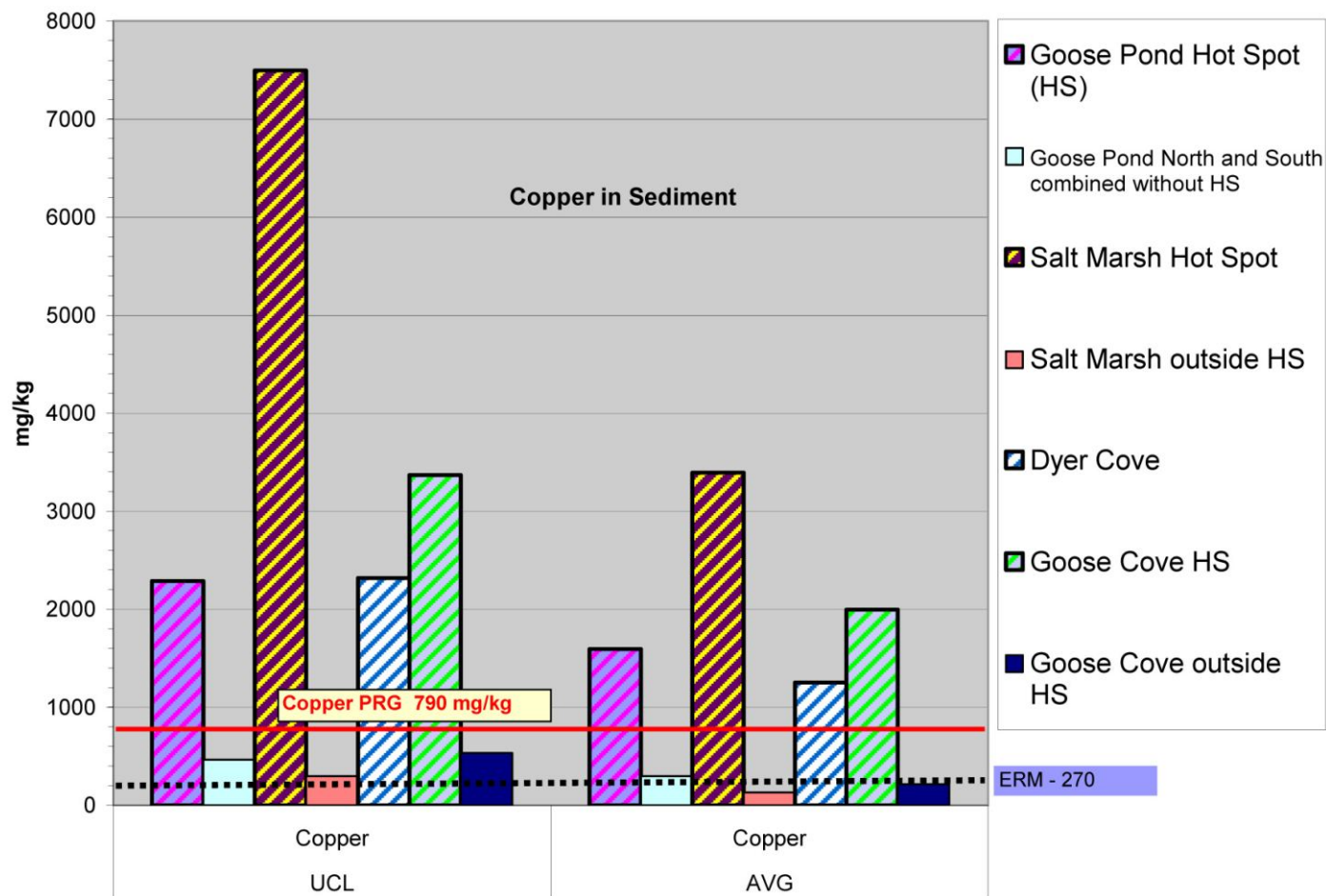
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Figure ES-7
Residential Use Area Remediation

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Brooksville, Maine
MACTEC, Inc.



Prepared/Date: JPH 6/8/09
 Checked/Date: SWR 6/8/09

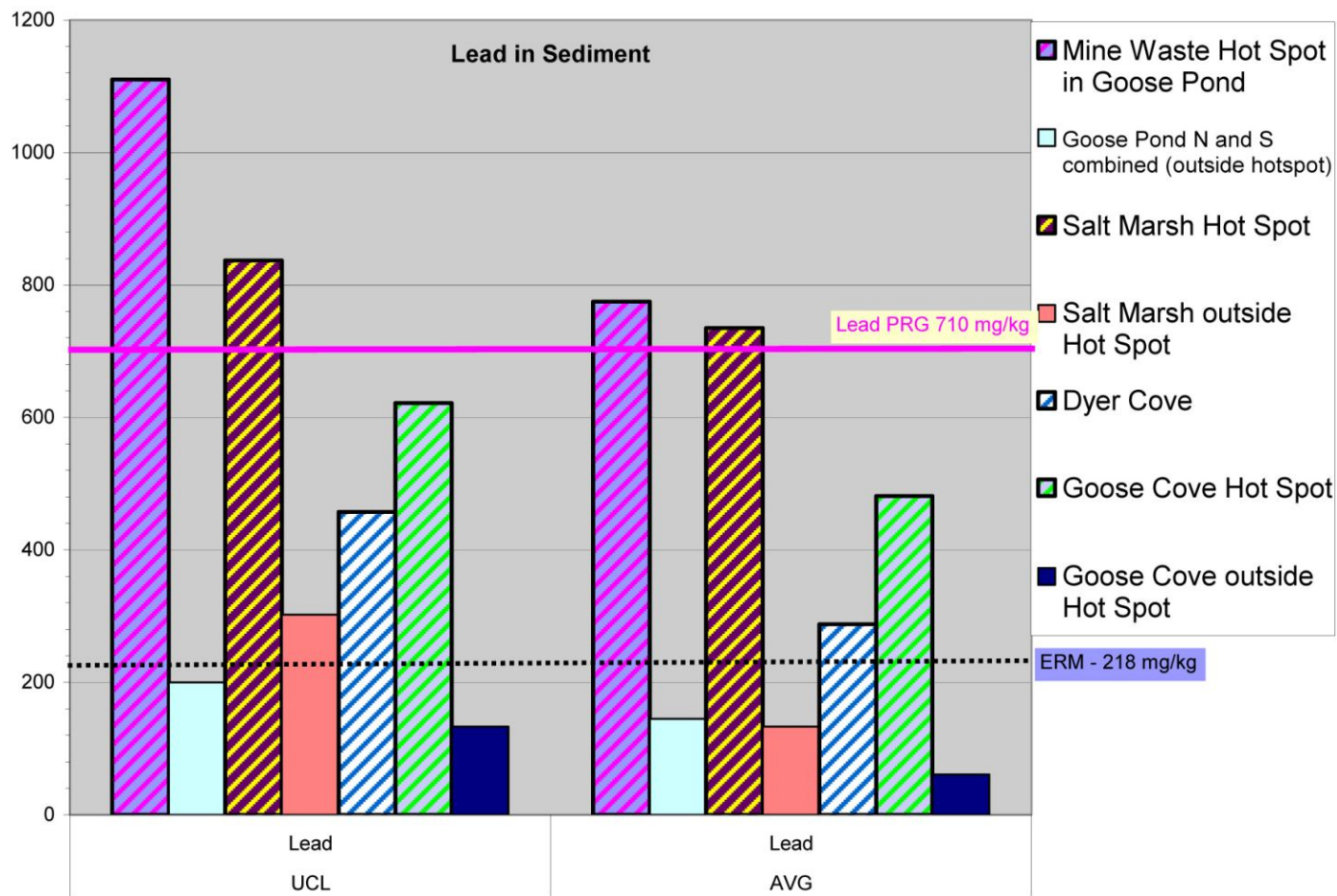
**CALLAHAN MINE
 SUPERFUND SITE**



Comparison of Sediment Hot Spot and
 Non-Hot-Spot Concentrations for Copper
 OU1 Feasibility Study Report
 Callahan Mine Superfund Site
 Brooksville, Maine

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Figure ES-8



Prepared/Date: JPH 6/8/09
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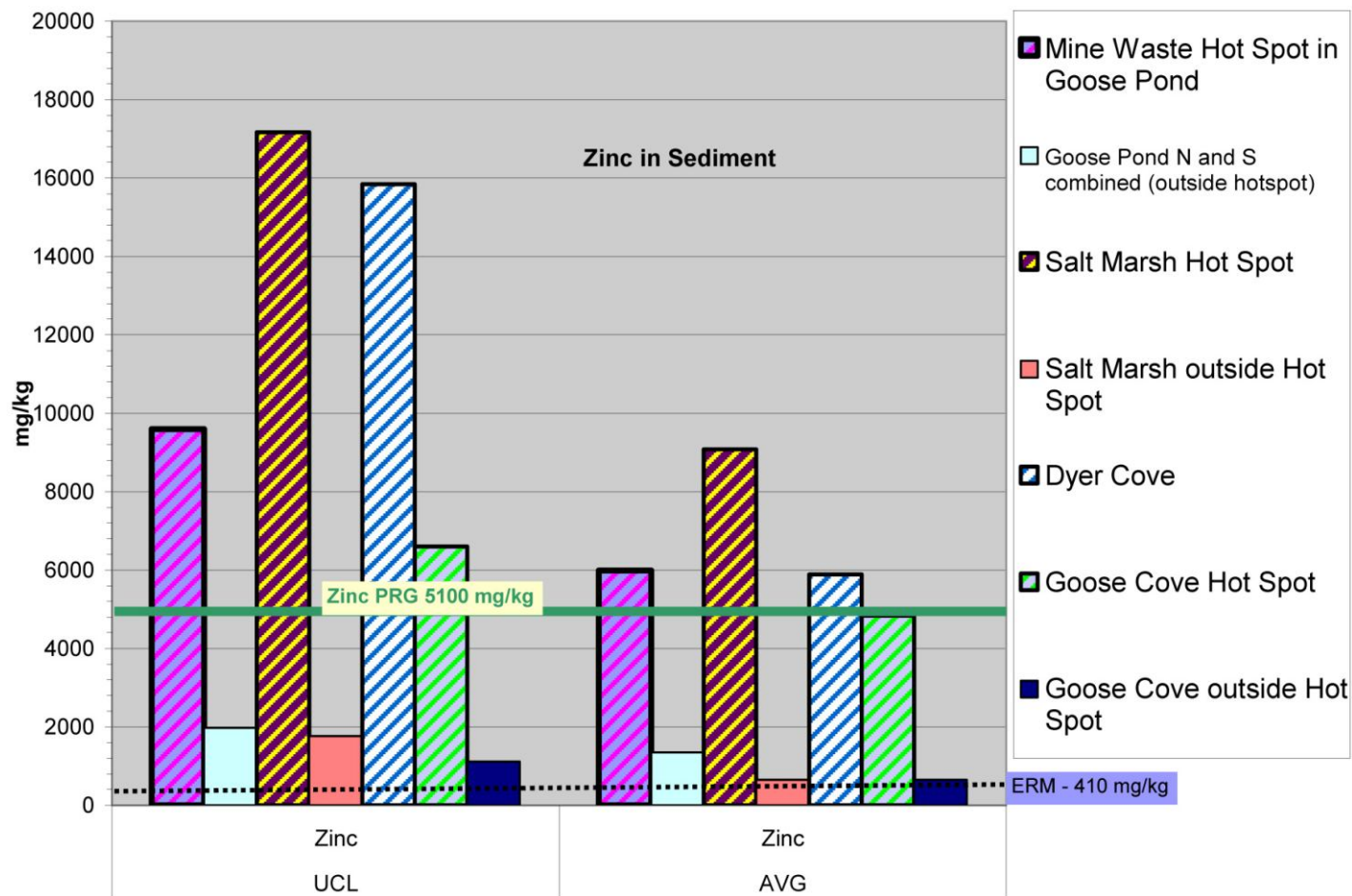
**CALLAHAN MINE
 SUPERFUND SITE**



Comparison of Sediment Hot Spot and
 Non-Hot-Spot Concentrations for Lead
 OU1 Feasibility Study Report
 Callahan Mine Superfund Site
 Brooksville, Maine

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Figure ES-9



Prepared/Date: JPH 6/8/09
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**CALLAHAN MINE
 SUPERFUND SITE**

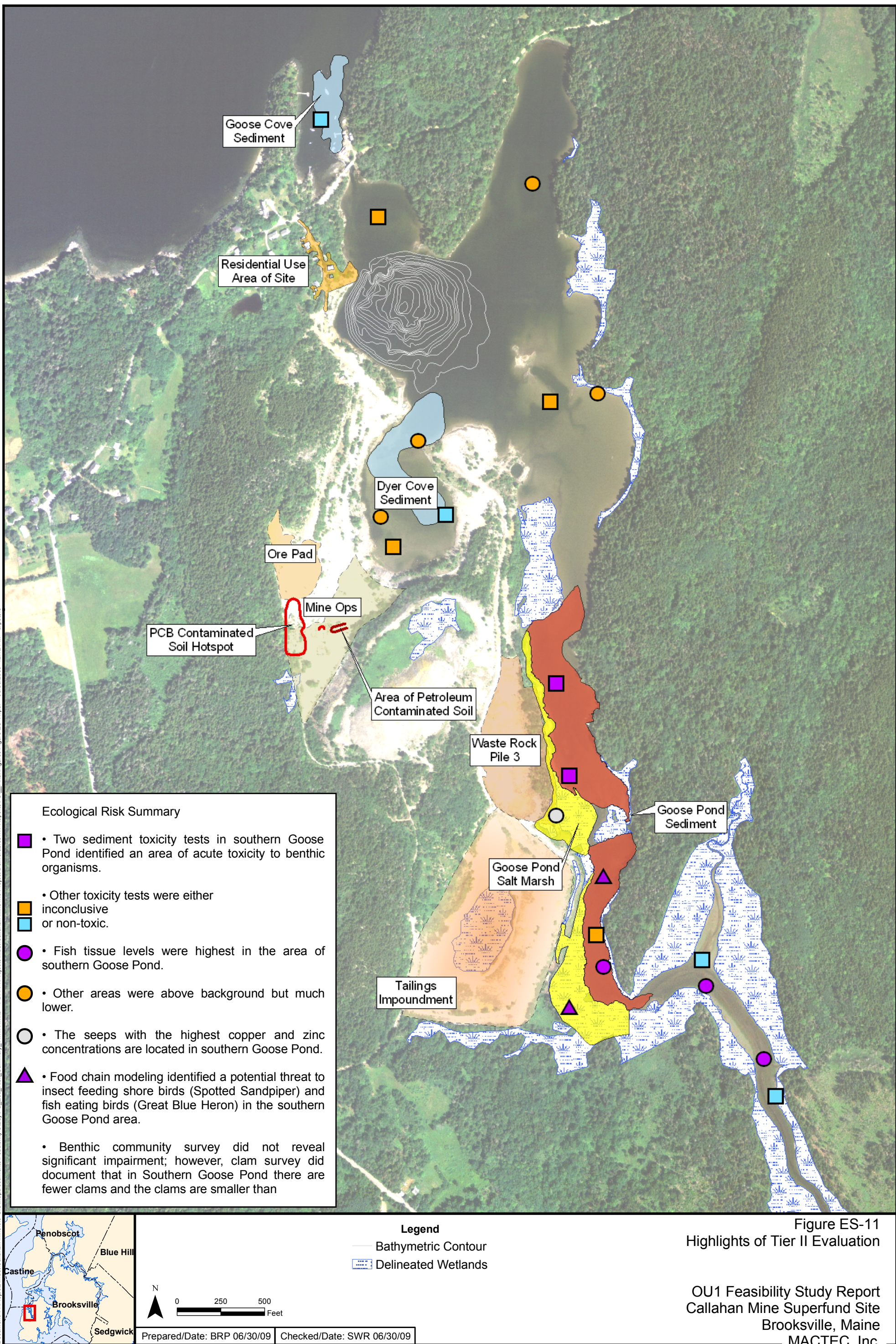


Comparison of Sediment Hot Spot and
 Non-Hot-Spot Concentrations for Zinc
 OU1 Feasibility Study Report
 Callahan Mine Superfund Site
 Brooksville, Maine

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Figure ES-10

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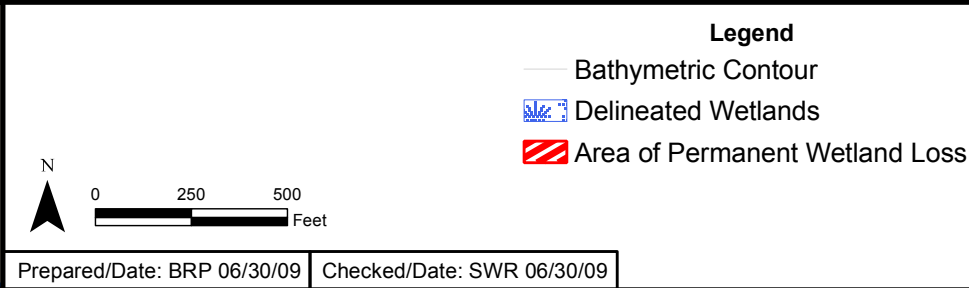
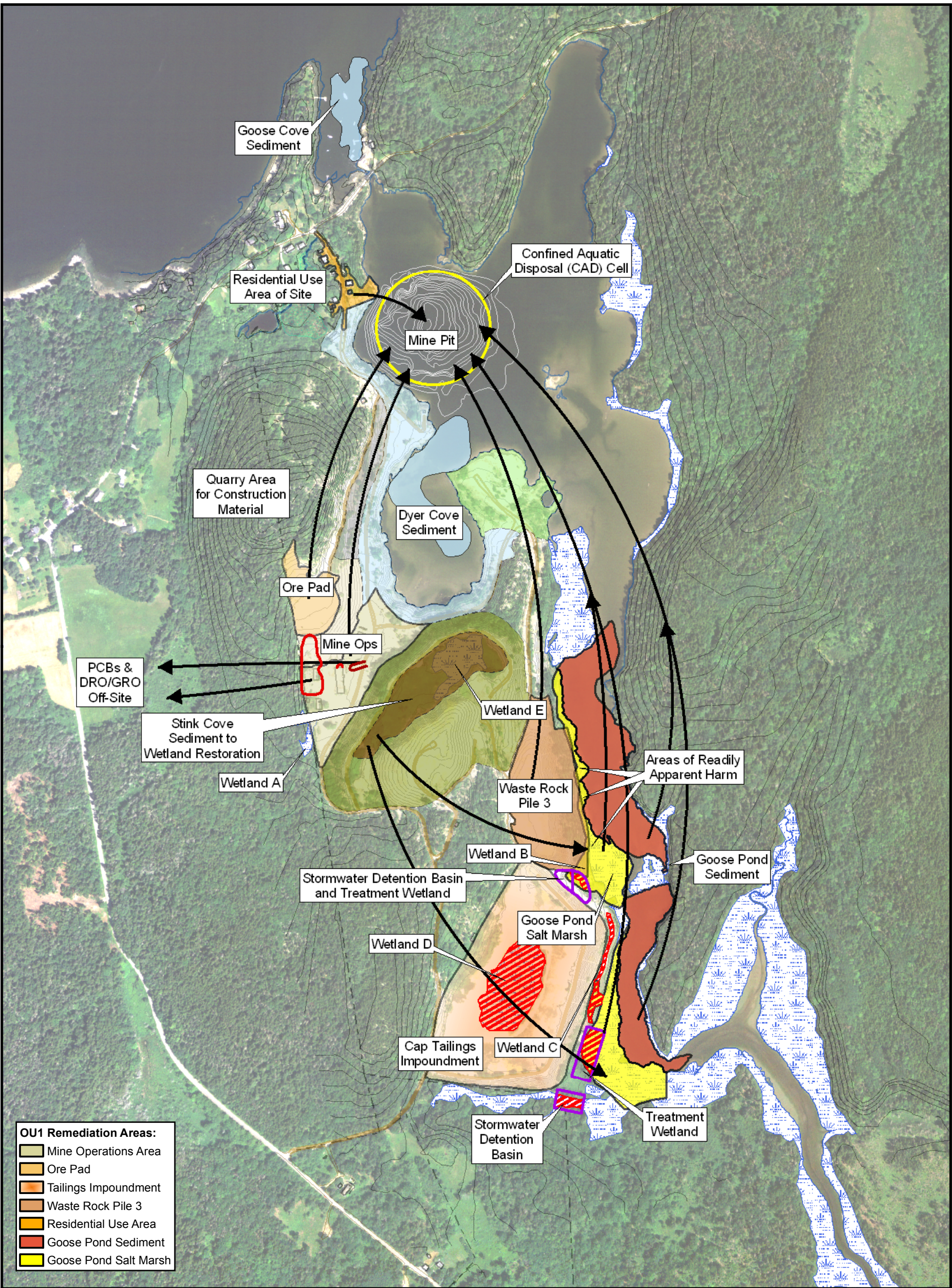
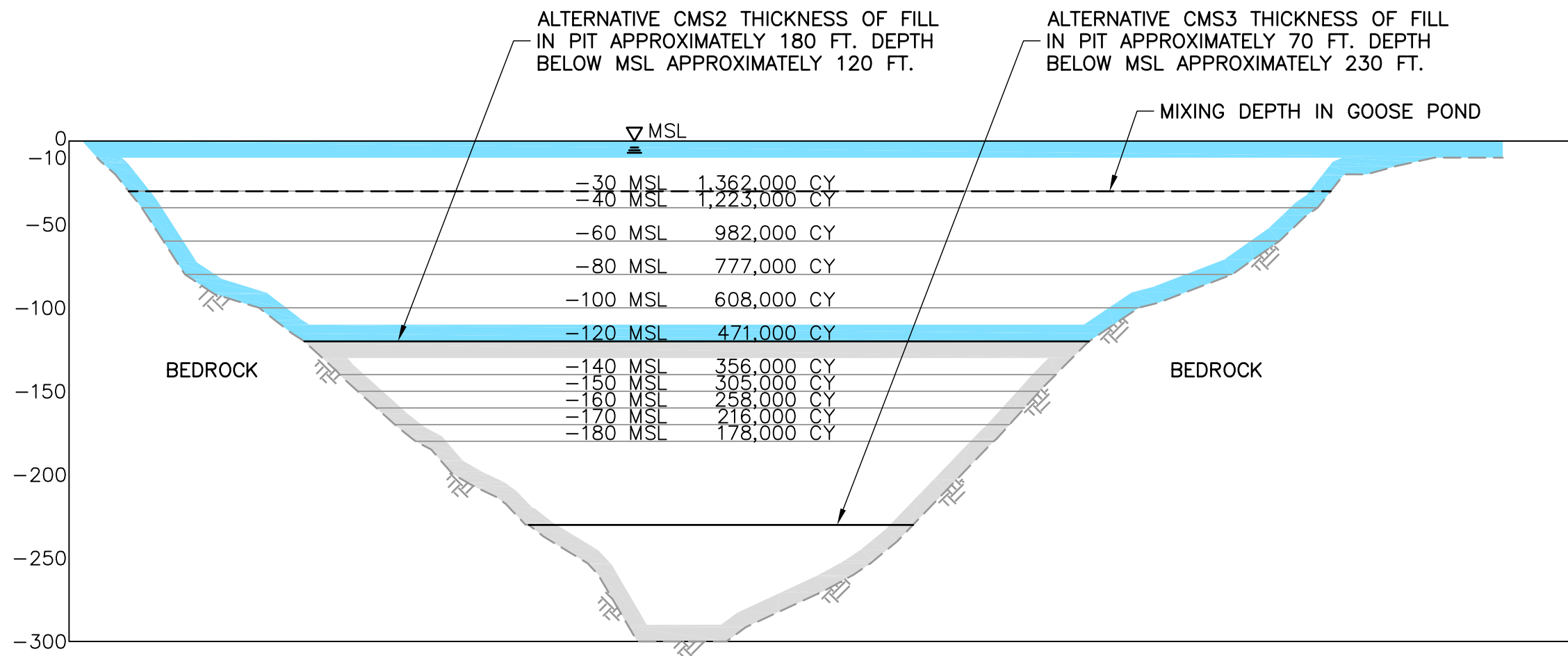


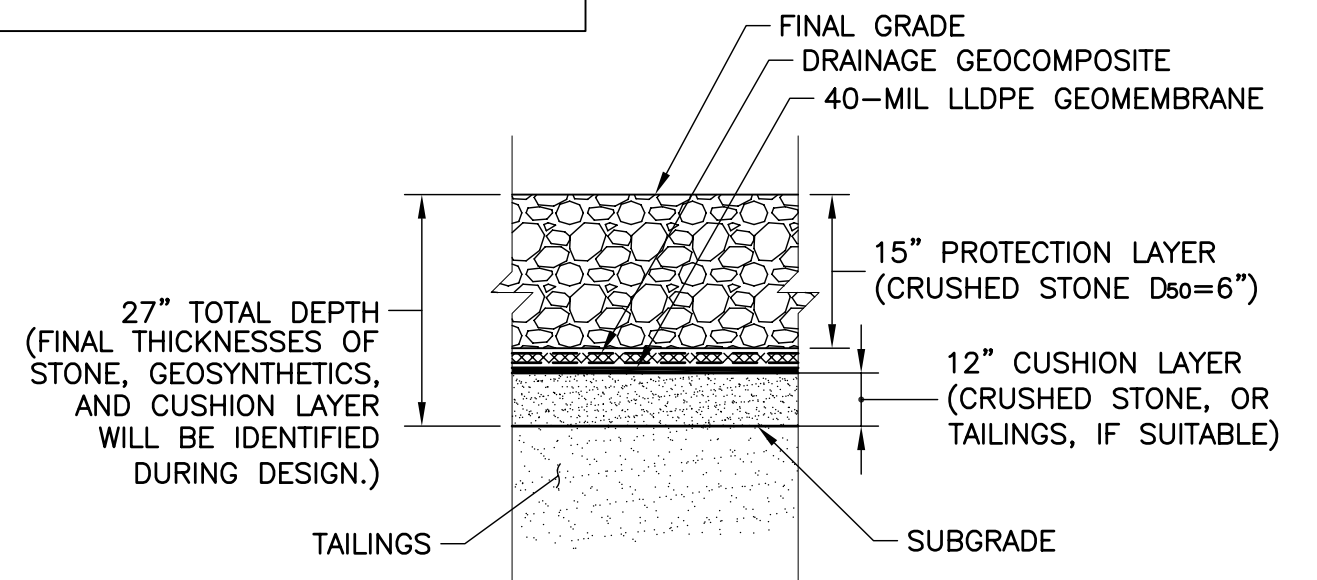
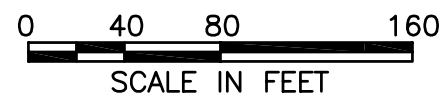
Figure ES-12
Alternative CMS2
Proposed Remedy Map

OU1 Feasibility Study Report
Callahan Mine Superfund Site
Brooksville, Maine
MACTEC, Inc.

M:\Projects\Callahan Mine Site\FS Figure ES-9 CADCELL.dwg Tue, 30 Jun 2009 - 4:11pm jymckenzie



WEST TO EAST CROSS-SECTION THROUGH MINE PIT



INFILTRATION BARRIER CAP
NTS

Prepared/Date: DEL 06/17/09
Checked/Date: SWR 06/17/09

CALLAHAN MINE SUPERFUND SITE
BROOKSVILLE, MAINE



CAD CELL AND TAILINGS IMPOUNDMENT
COVER SYSTEM
OU1 FEASIBILITY STUDY REPORT
Project 3612-06-2047.30
Figure ES-13

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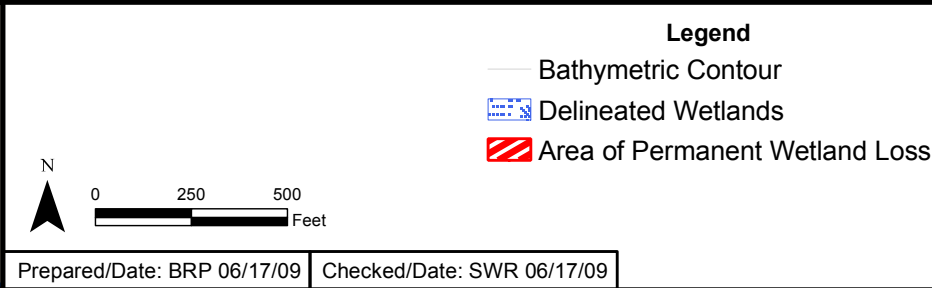
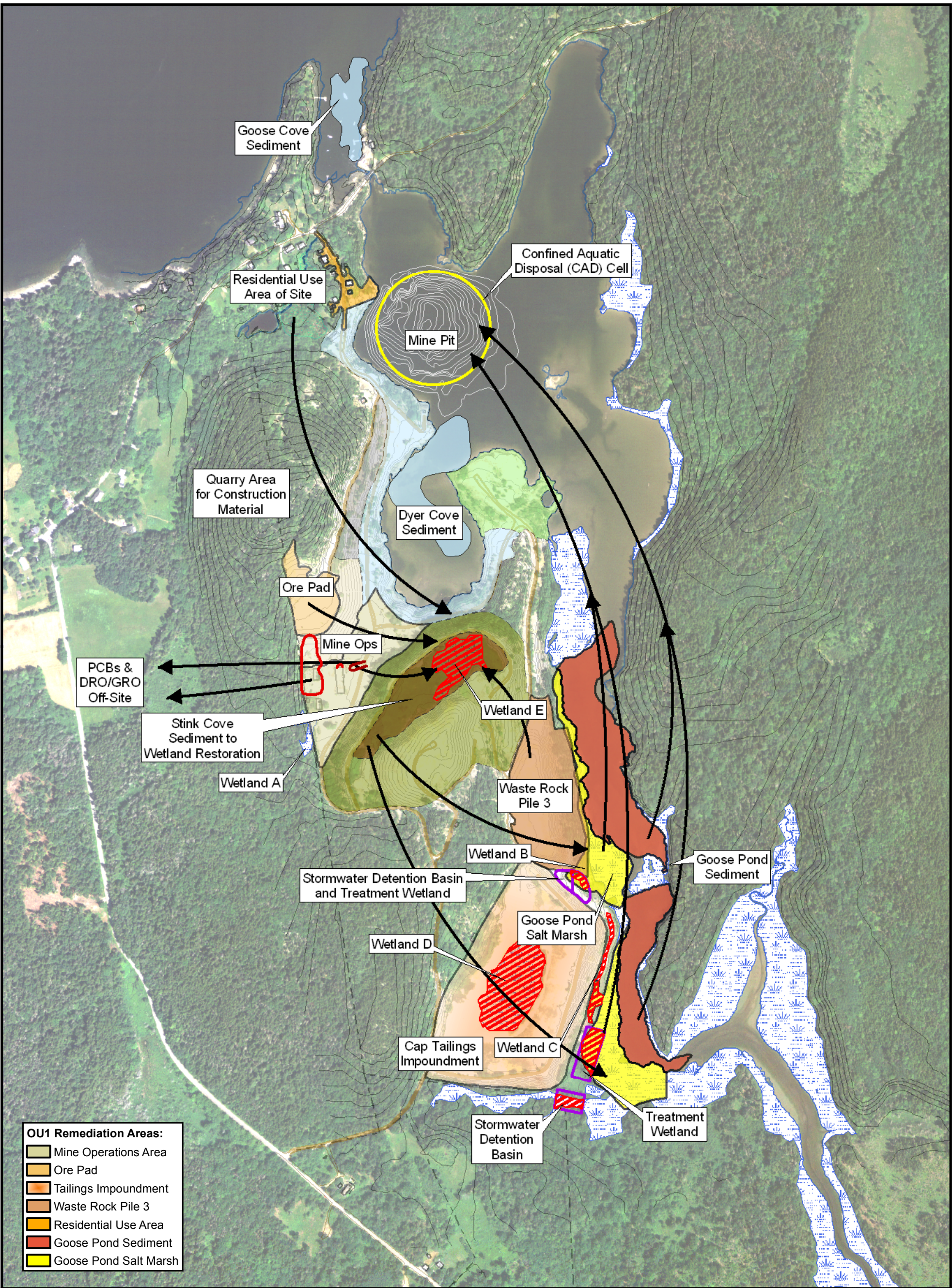


Figure ES-14
Alternative CMS3
Proposed Remedy Map

OU1 Feasibility Study Report
Callahan Mine Superfund Site
Brooksville, Maine
MACTEC, Inc.

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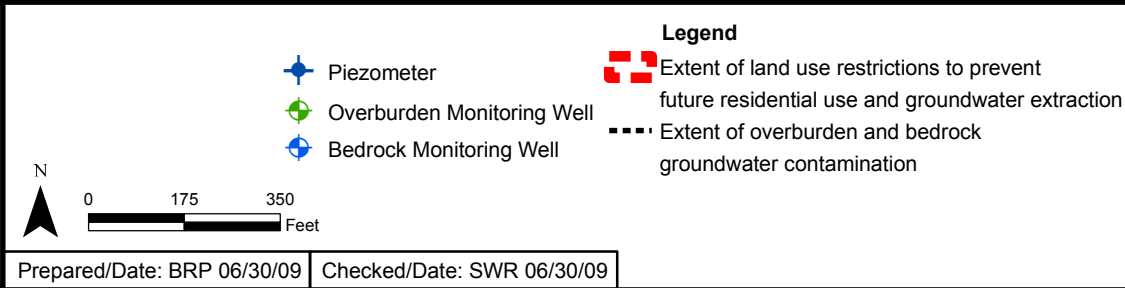
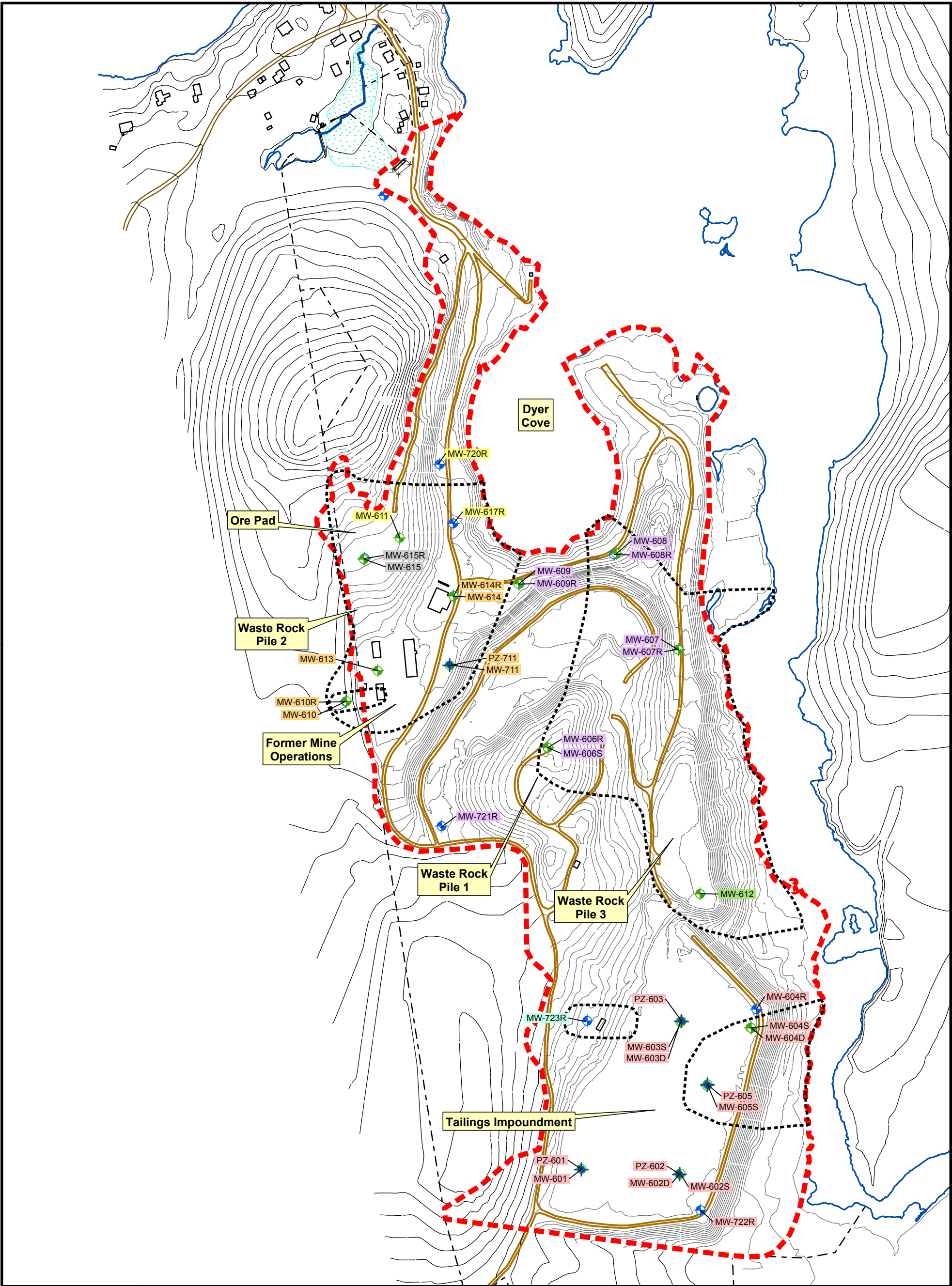


Figure ES-15
OU2 Early Action IC Areas

OU1 Feasibility Study Report
Callahan Mine Superfund Site
Brooksville, Maine
MACTEC, Inc.

**EXECUTIVE SUMMARY
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
1982	USEPA	Preliminary Assessment	Unknown
1985	FM Beck, Inc.	Site Review Data	5 sediment cores
1989	Maine DEP	UST Site Investigation	Four UST's removed
1999	Maine DEP	Site Inspection	22 surface soil samples 9 surface water samples 10 sediment samples
2004	USEPA - TRC	Initial Remedial Investigation	30 surface soil samples 12 surface water samples 1 seep sample 23 sediment samples Bathymetry survey of Goose Cove and Goose Pond Geophysical surveys to map bedrock
2005	MaineDOT - MACTEC	Phase 1A 2005 Remedial Investigation	189 surface soil samples 15 surface water samples 13 seep samples 564 sediment samples 41 ecological sample locations

Table ES-1
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 = 1×10^{-6}	Site-Specific Risk Calculation HQ = 1 or IEUBK for Lead	Selected as PRG	Basis	Risk at PRG HQ / ELCR
<u>Residential Use Areas</u>							
Arsenic	14	10	1	56	14	Background	HQ = 0.2 ELCR = 5.8×10^{-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 = 1.9×10^{-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 = 7.7×10^{-6}
<u>Recreational Use Areas</u>							
Arsenic	14	30	2.4	146	30	Risk-management decision to accept 1×10^{-5} ELCR for arsenic	HQ = 0.2 ELCR = 1.2×10^{-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 = 0.8×10^{-6} HI = 0.3 Cumulative ELCR = 1.2×10^{-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.

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 milligrams per killogram (mg/kg)
 Shade indicates 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:

+ 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

Prepared by: LJ 06/30/09
Checked by: SWR 06/30/09

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
<u>Waste Rock and Soil</u>				
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
<u>Sediment</u>				
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.