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EPA Project Officer: Diana King
EPA Remedial Project Manager: Leslie McVickar

CONCEPTUAL MODEL
AND
RI/FS SOW

Callahan Mining Superfund Site
Brookville, Maine

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Metcalf & Eddy, Inc.
30 Harvard Mill Square
Wakefield, MA 01880

Team Subcontractor
TRC Environmental Corporation
Boott Mills South
Foot of John Street
Lowell, MA 01852

TABLE OF CONTENTS

Section **Page**

1.0 INTRODUCTION 1-1

1.1 Objective 1-1
1.2 Organization 1-1
1.3 Limitations 1-1

2.0 BACKGROUND INFORMATION 2-1

2.1 Site Location 2-1
2.2 Site History 2-1
2.3 Site Operations 2-6
2.3.1 Site Reclamation 2-9
2.3.2 Post-Reclamation Site Development 2-9
2.4 Site Description 2-9
2.4.1 Pre-Mining Condition 2-9
2.4.2 Condition During Mining Operations 2-13
2.4.3 Current Condition 2-13
2.5 Pertinent Regulatory History 2-25
2.6 Previous Environmental Testing Results 2-31
2.6.1 Surface Water Quality 2-31
2.6.2 Sediment Quality 2-43
2.6.3 Soil Quality 2-57
2.6.4 Ground Water Quality 2-57
2.6.5 Marine Flora/Fauna Contaminant Concentrations 2-73

3.0 SITE PHYSICAL CHARACTERISTICS 3-1

3.1 Description of Waste Areas 3-1
3.1.1 Tailings Pile 3-1
3.1.2 Waste Rock Piles 3-7
3.1.3 Dyer Cove/Former Settling Pond 3-15
3.1.4 Open Pit Mine 3-15
3.1.5 Relict Facility Buildings and Structures 3-29
3.1.6 Ore Pad 3-35
3.1.7 Discharge Pipe 3-35
3.2 Site Geology 3-35
3.2.1 Surficial Geology 3-35
3.2.2 Bedrock Geology 3-35
3.3 Site Geochemistry 3-43
3.4 Site Hydrogeology and Hydrology 3-44
3.4.1 Climate 3-44
3.4.2 Surface Water Drainage/Tidal Effects 3-44
3.4.3 Ground Water Flow 3-46
3.5 Site Ecology 3-46
3.5.1 Unvegetated Areas 3-49

3.5.2 Open Water (Estuarine Unconsolidated Bottom) 3-49
3.5.3 Salt Marsh (Estuarine Emergent) 3-49
3.5.4 Shallow Marsh (Palustrine Emergent) 3-49
3.5.5 Grass 3-49
3.5.6 Shrub – Old Field 3-53
3.5.7 Birch – Aspen Woodland 3-53
3.5.8 Spruce – Birch Woodland 3-53
3.5.9 Organisms 3-53
3.5.10 Observed Impacts 3-59

4.0 CONCEPTUAL RISK ASSESSMENT 4-1

4.1 Potential Source Areas 4-1
4.1.1 Tailings Pile 4-1
4.1.2 Waste Rock Piles 4-1
4.1.3 Ore Pad 4-6
4.1.4 Mine Operations Area 4-6
4.1.5 Former Open Pit Mine 4-6
4.1.6 Dyer Cove/Former Settling Pond 4-6
4.1.7 Former Discharge Pipe/Goose Cove 4-7
4.2 Release Mechanisms 4-7
4.2.1 Acid Rock Drainage and Leaching of Metals into Ground Water 4-7
4.2.2 Erosion 4-8
4.2.3 Acid Rock Drainage to Surface Water 4-8
4.2.4 Windblown Dust 4-8
4.2.5 Catastrophic Slope Failure 4-8
4.3 Contaminant Transport Pathways 4-8
4.3.1 Wind 4-8
4.3.2 Soil Erosion 4-11
4.3.3 Sediment Transport 4-11
4.3.4 Surface Water Flow 4-11
4.3.5 Ground Water Flow 4-11
4.4 Potential Receptors 4-12
4.4.1 Ecological 4-12
4.4.2 Human 4-12

5.0 POTENTIAL/APPLICABLE REMEDIES 5-1

5.1 Waste Rock Piles/Ore Pad/Tailings Pile 5-1
5.1.1 Capping and Surface Reclamation 5-1
5.1.2 Excavation/Removal/Treatment of Waste 5-4
5.1.3 Soil Binding 5-4
5.2 Sediment 5-4
5.2.1 Dredging 5-4
5.2.2 Subaqueous Capping 5-5
5.3 Surface Water 5-5
5.3.1 Water Diversion 5-5
5.3.2 Water Collection 5-5
5.3.3 Water Neutralization 5-5

6.0 REMEDIAL INVESTIGATION DATA NEEDS 6-1
6.1 Data Needs 6-1
6.2 Remedial Investigation Scope of Work 6-1
7.0 REFERENCES 7-1

LIST OF TABLES

Table 2.6-1: Surface Water Analytical Results 2-35
Table 2.6-2: Sediment Analytical Results 2-45
Table 2.6-3: Soil Analytical Results 2-59
Table 2.6-4: Ground Water Analytical Results 2-65
Table 2.6-5: Flora/Fauna Analytical Results 2-75
Table 3.3-1: Composition of Ore Samples 3-44
Table 3.3-2: Analysis of Mine Tailings 3-45
Table 3.5-1: Potential Ecological Receptors 3-54
Table 5.0-1: Potential General Response Actions 5-2
Table 6.0-1: RI/FS Data Needs 6-1

LIST OF FIGURES

Figure 2.2-1: Site Location 2-3
Figure 2.3-1: Flow Chart of Mining Operations 2-7
Figure 2.4-1: Site Aerial Photo, 1960 2-11
Figure 2.4-2: Site Aerial Photo, 1972 2-15
Figure 2.4-3: 1972 Site Conditions 2-17
Figure 2.4-4: Aerial Photograph of Mining Operation, 1972 2-19
Figure 2.4-5: Photograph of Water Discharge Pipe 2-21
Figure 2.4-6: Aerial Photograph of Site, 2002 2-23
Figure 2.4-7: Map of 2002 Site Conditions 2-27
Figure 2.4-8: Photograph of Site from Waste Rock Pile 1 2-29
Figure 2.6-1: Previous Sampling Locations 2-33
Figure 2.6-2: Surface Water Analytical Results 2-41
Figure 2.6-3: Arsenic Concentrations in Soil and Sediment 2-49
Figure 2.6-4: Copper Concentrations in Soil and Sediment 2-51
Figure 2.6-5: Lead Concentrations in Soil and Sediment 2-53
Figure 2.6-6: Zinc Concentrations in Soil and Sediment 2-55
Figure 3.1-1: Photograph of Tailings Pile 3-3
Figure 3.1-2: Photograph of Tailings and Vegetation 3-5
Figure 3.1-3: Photograph of Site From Stink Cove, Showing WRP 1, WRP 3 and the Tailings Pile 3-9
Figure 3.1-4: Photograph of Waste Rock Pile 2 3-11
Figure 3.1-5: Photograph of Waste Rock Pile 3 3-13
Figure 3.1-6: Photograph of Dead Vegetation at WRP 3 3-17
Figure 3.1-7: Photograph of Slope Failure at WRP 3 3-19
Figure 3.1-8: Figure of Possible Future Failure Surface, WRP 3 3-21
Figure 3.1-9: Photograph of Dyer Cove 3-23

Figure 3.1-10: Historic Photograph of Open Pit Mine 3-25
Figure 3.1-11: Current Photograph of Open Pit Mine Area 3-27
Figure 3.1-12: Photograph of Mining Operations Buildings 3-31
Figure 3.1-13: Photograph of Mining Operations Building Area 3-33
Figure 3.1-14: Photograph of Ore Pad 3-37
Figure 3.1-15: Photograph of Acid Mine Drainage at Ore Pad 3-39
Figure 3.2-1: Bedrock Geology Map 3-41
Figure 3.4-1: Photograph of Goose Falls Dam 3-47
Figure 3.5-1: Map of Habitat/Vegetative Cover Types 3-51
Figure 4.0-1: Conceptual Model 4-3
Figure 4.3-1: Contaminant Transport Pathways 4-9

LIST OF APPENDICES

A Scope of Work for Remedial Investigation

1.0 INTRODUCTION

Metcalf & Eddy, Inc. (M&E) received Work Assignment No. 140-NGFN-017H under the United States Environmental Protection Agency's (EPA) Response Action Contract (RAC) No. 68-W6-0042 (RAC) to provide technical assistance at the Callahan Mining Superfund Site (the Site) in Brooksville, Maine. All technical work for this project was performed by Team Subcontractor TRC.

1.1 Objective

This report presents a detailed conceptual model of contaminant source areas, release mechanisms, transport pathways, and likely receptors based on a study of data that are currently available for the site. This report also presents a listing of likely remedial technologies that are applicable to site contaminants and that are typically used to remediate mining waste sites. In addition, this report includes a detailed scope of work for a Remedial Investigation to guide future remedial investigative efforts at the site that was developed based upon the Conceptual Model.

1.2 Organization

This report is organized as follows. Section 1 presents an overview of the site history to establish a foundation for the conceptual model source areas, release mechanisms and transport pathways. Section 2 presents additional information about the site related to the known physical characteristics such as geology, hydrogeology and ecology at and near the site. Section 3 presents a list of potential or known contaminant source areas at the site and provides an analysis of each area. Section 4 outlines the conceptual elements of a risk assessment that pertain to the site to guide data collection efforts and the ultimate risk assessment approach for both human and ecological receptors. Section 5 lists the applicable remedial technologies for the site together with the data that are needed to evaluate the feasibility, implementability, cost and effectiveness of each technology. The data needs identified in Sections 4 and 5 are combined and organized in Section 6 to lay out the data collection activities that will be necessary in the Remedial Investigation. A companion Remedial Investigation Scope of Work is presented in Appendix A.

1.3 Limitations

The information contained in this report is based on data collected and reported by others. In general, TRC did not have access to original laboratory data reports for data presented in this report. Therefore, TRC was not able to validate, verify or check most of the data presented. In some cases, data was utilized from published articles or reports or from brief technical memoranda that contained sparse and incomplete information about sample collection procedures, locations, analysis methods, detection limits, quality control, quality assurance, and other information about conditions at the time of sampling. Consequently, the conclusions and recommendations presented in this report are limited in that they are based, in part on these data.

As indicated above, this report will be used to guide planning and execution of a comprehensive environmental sampling effort (the Remedial Investigation) in accordance with the National

Contingency Plan. One of the goals of such an investigation is to obtain sufficient data of high quality, with appropriate documentation to provide for much of the information that is lacking from prior investigations. To the extent practicable, these prior data may be used in the Remedial Investigation.

2.0 BACKGROUND INFORMATION

2.1 Site Location

Figure 2.1-1 shows the location of the Callahan Mining site on the coast of Maine. The site is an elongate shaped, 150-acre property oriented north-south on Goose Falls Road in Brooksville, Maine, approximately 35 miles west of Bar Harbor, Maine. It is situated at 44° 21' 05.9" north latitude and 68° 48' 35.5" west longitude. The site is located on the northwestern coast of a peninsula known as Cape Rosier and is bordered by the Penobscot Bay to the west. East of the site is the Holbrook Island Sanctuary State Park and Goose Pond. A limited number of private residences are located adjacent to the site on Goose Falls Road and Cape Rosier Road.

2.2 Site History

1880 An outcrop of massive zinc and copper ore was discovered at low tide by a clam digger about ten miles west of the Blue Hill mining camp in a tidal estuary known as Goose Falls Pond. Subsequently, a shaft was sunk by William Veague on the nearby shore and mining of high grade zinc-copper ore commenced. The ore was taken from Goose Cove to Castine by barge and piled on a dock. Periodically, coastal schooners picked up the ore in Castine and delivered it to smelters located to the south.

1881 Beginning of two year period of mining. About 10,000 tons of ore were mined from four shafts at the mine, known at the time as the "Penobscot Mine." The ore was reported to contain 20 percent zinc 2.8 percent copper and some lead. The crude ore was hand sorted, and reportedly, 3,000 tons were shipped.

1887 Mine closes, apparently due to low metal prices.

1914 An attempt to reopen the mine proved unsuccessful.

1940 The St. Joseph Lead Company conducted an exploratory drilling program on the property advancing 13 boreholes totaling 5,501 feet.

1942 U.S. Bureau of Mines drills an additional nine boreholes, totaling 2,883 feet.

1950 U.S. Bureau of Mines conducts additional drilling. Although numerous occurrences of copper and zinc sulfides were encountered, apparently implementation of a mining operation was not considered economic.

1956 The 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.

1964 The property was brought to the attention of Callahan Mining Corporation. Re-evaluation of all past work indicated that sufficient values might exist to warrant an open

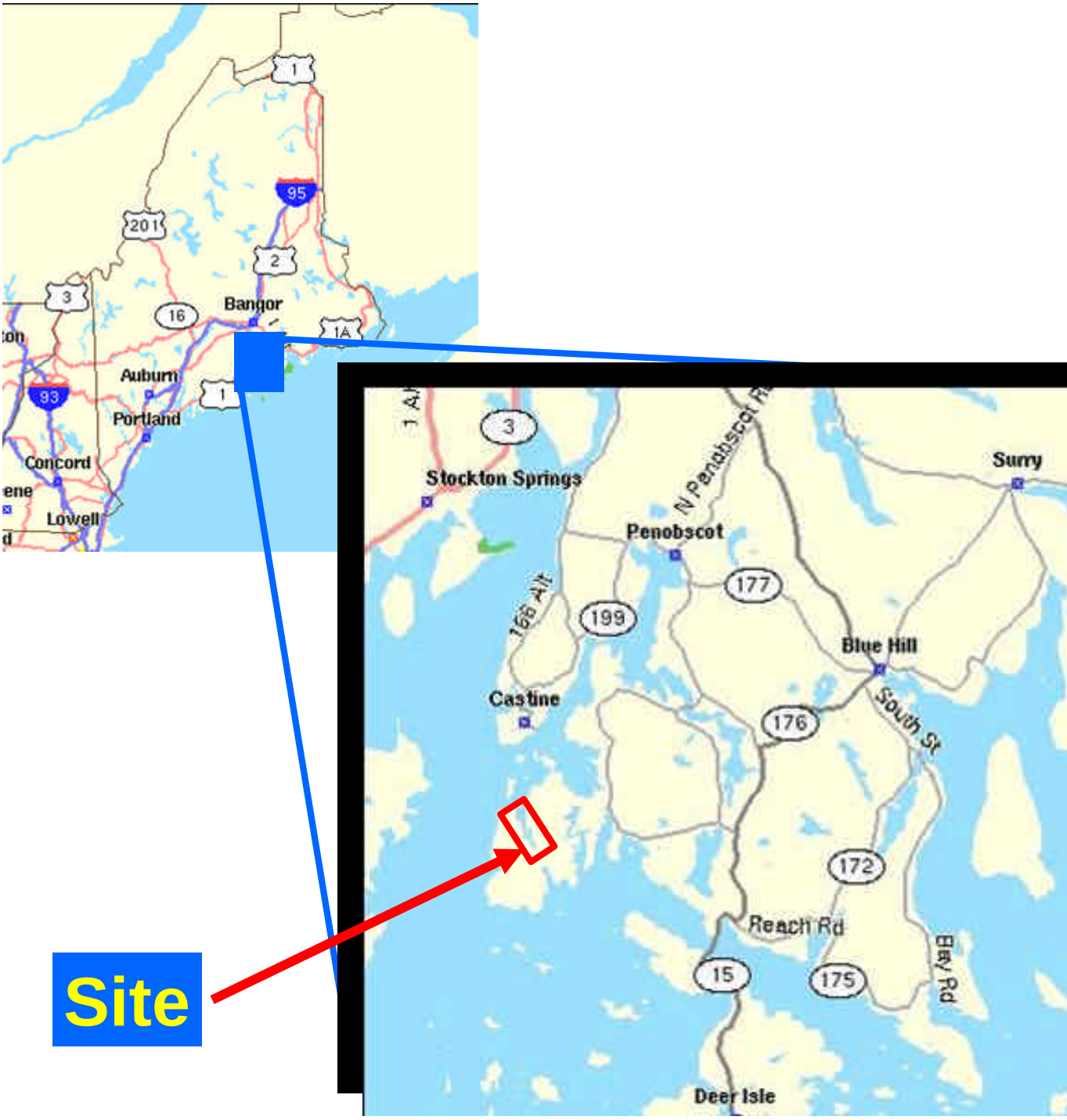

Figure 2.2-1: Site Location
Callahan Mining Superfund Site, Brooksville, Maine

pit mining operation. Based on this analysis a lease was negotiated by the Callahan Mining Corporation with the Penobscot Mining Company.

1966 Maine Legislature passes "An Act Relating to Mining Activity under Goose Falls Pond, Town of Brooksville, Hancock County" allowing Callahan Mining Corporation to construct and maintain dams to temporarily exclude and divert tidal and fresh water from Goose Pond.

Callahan Mining Corporation obtains permit from the U.S. Army Corps of Engineers to construct two dams, one at Goose Falls to prevent inflow of sea water and one upstream of the mine to prevent inflow of fresh water. The permit requires Callahan Mining Corporation to monitor effluent discharge and eliminate toxic effects on marine organisms.

Maine Water Improvement Commission issued a Waste Discharge License allowing discharge of effluent from the flotation operation to Goose Pond. The License was later modified to require discharge to Goose Cove.

1967 Dam construction completed.

1968 Open pit mining operations commenced on 2/17/68.

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.

1972 Mining operations ceased in June 1972 due to the depletion of the mineral reserve. At the time mining operations ceased, the mine consisted of a roughly circular open pit approximately 600 feet in diameter and 320 feet deep.

The Goose Pond Reclamation Society was formed and a Reclamation Plan was prepared.

1974 Aquaculture business established to raise oysters and coho salmon.

1979 Aquaculture business files for bankruptcy.

1980 Partial opening of Goose Falls Dam.

1982 EPA conducts Preliminary Assessment of Site.

1985 Goose Pond Reclamation Society obtains approval for dredging of sediment in Goose Cove but the Brooksville Planning Board refused to grant permission for the dredging.

Goose Pond Reclamation Society is dissolved.

1987 USTs removed from operations area. No evidence of contamination was observed.

Permission for removal of the remaining portion of the dam was issued by the Maine DEP to allow unrestricted tidal flow into the pond as occurred prior to the development of the mine. However, the dam was not removed.

1988 The site was acquired by Mr. James Benesen of White's Head, Maine. Mr. Benesen is the current owner of record for the site.

2.3 Site Operations

Figure 2.3-1 shows a flow chart of the ore processing operations performed at the Callahan Mine.

Approximately 5 million tons of waste rock and approximately 800,000 tons of ore-bearing rock were removed from the mine by Callahan Mining Corporation. The ore consisted primarily of sphalerite (ZnS), chalcopyrite ($CuFeS_2$) and minor occurrences of galena (PbS). Ore bearing rock was blasted from inside the pit and hauled out in trucks to an ore storage area (the Ore Pad).

An ore concentrate was produced from the ore. Approximately 18% of ore-bearing rock processed was recovered as copper/lead and zinc ore 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 a fine sand using two ball mills. The milling process produced a seawater slurry of the sand-sized ore particles which was subjected to a flotation separation process.

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 and forms a froth that is collected at 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. A series of flotation processes were used to concentrate the individual metals separately. The average ore grade was 1.30% copper, 4.91% zinc, 0.35% lead, and 0.50 ounces per ton of silver.

The non-metalliferous particles remaining in the slurry were discharged to the tailings pond. The approximately 11-acre tailings pond is located in the southern portion of the property, adjacent to Goose Pond. In the tailings pond solid tailings settle from the water, and the clarified water is decanted through a drain under the tailing pond for recycling into the flotation process. As more tailings storage was required, the rock embankment at the downstream side of the tailings pond was built up. The current height of the tailings embankment at the Callahan Mine is approximately 80 feet.

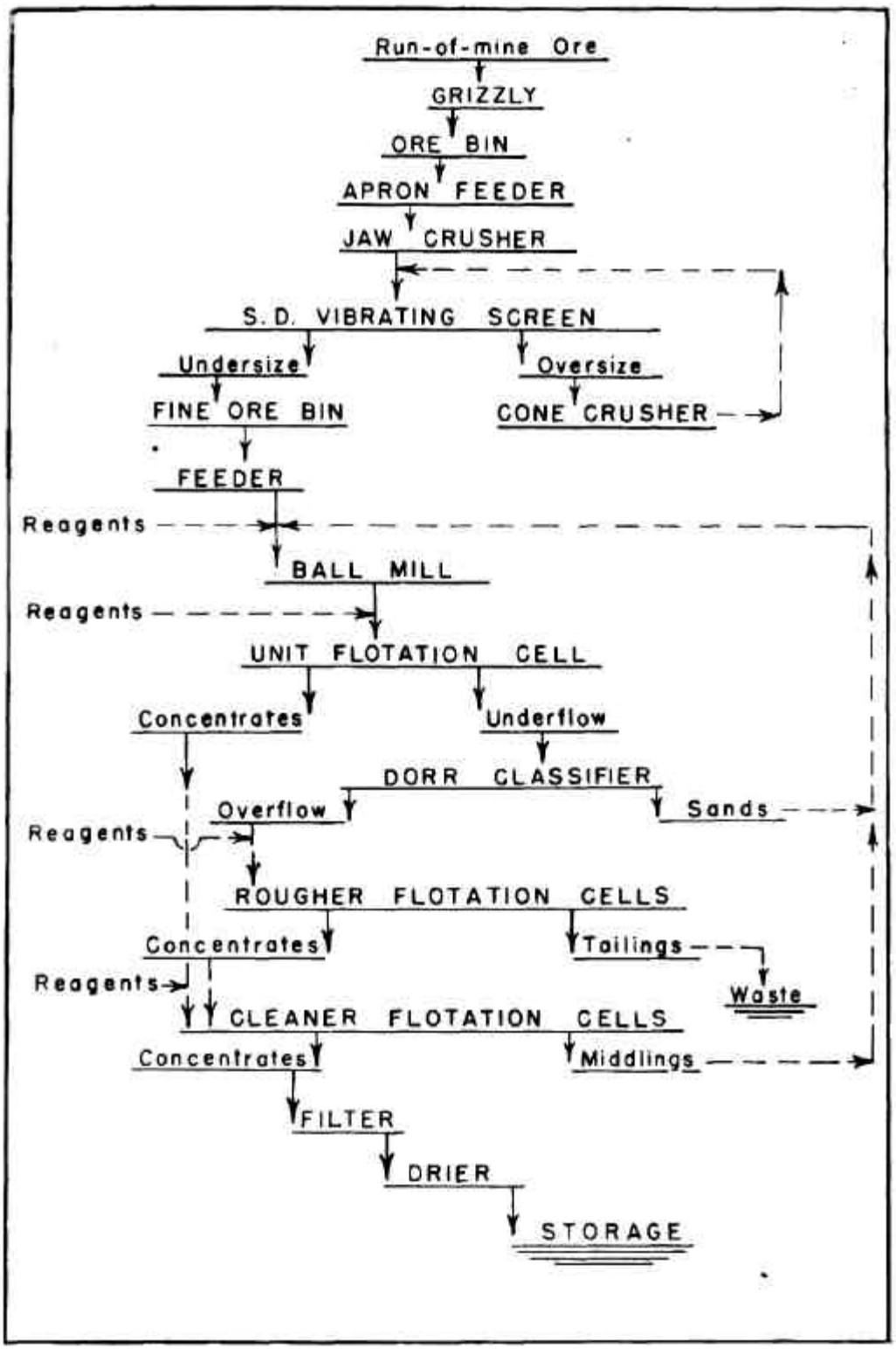

Figure 2.3-1: Flowchart of Mining Process
Callahan Mining Superfund Site, Brooksville, Maine

Due to the depth of the pit, water constantly seeped into the pit. This water was constantly pumped out and discharged through a pipe extending under Goose Falls, ending in Goose Cove. Due to excess siltation of Goose Cove, Dyer Cove was later used as a settling pond to remove a portion of the sediment (rock flour and silt) prior to discharging the mine water to Goose Cove.

2.3.1 Site Reclamation

A reclamation program was begun after cessation of mining in 1972. The reclamation program reportedly included the following activities.

- Draining of surface water from the tailings pond and seeding surface
- Grading, seeding and planting of the waste piles
- Removal of the upstream fresh water dam
- Flooding of pit by removing the sluice boards in the salt water (Goose Falls) dam
- Salvage and resale of mining and processing equipment
- Partial demolition of the buildings and equipment foundations

The seeding and plantings of the waste rock piles was not successful due to lack of any suitable soil in these areas.

2.3.2 Post-Reclamation Site Development

In the period between the mine closure and 1980, an aquaculture facility was operated at the Site for the cultivation and sale of Coho Salmon. Oyster cultivation was also conducted on an experimental basis. During this period, restricted tidal flow into Goose Pond was maintained by the Goose Falls dam. No other operations have been located at the site since 1980.

2.4 Site Description

The Callahan Mining Site is an abandoned zinc/copper/lead mine. The following sections describe the conditions of the site before, during and after the Callahan-era mining operations that took place at the site.

2.4.1 Pre-Mining Condition

Figure 2.4-1 is an aerial photograph of the site taken in 1960 prior to construction of the mine. The figure shows the approximate site boundary together with the eventual locations of the open pit mine and the tailings pond. The area that eventually became the open pit mine is located partially on land and partially underwater in Goose Pond.

Prior to the construction of the Callahan Mine, fresh water entered Goose Pond from the south, via a small stream. Salt water also entered the cove, from the north, at Goose Falls, during flood tides. At the time, a prominent feature of the site was the so-called “reversing” Goose Falls. During the incoming flood tide as the sea level rose, water flowed south across the rocks of

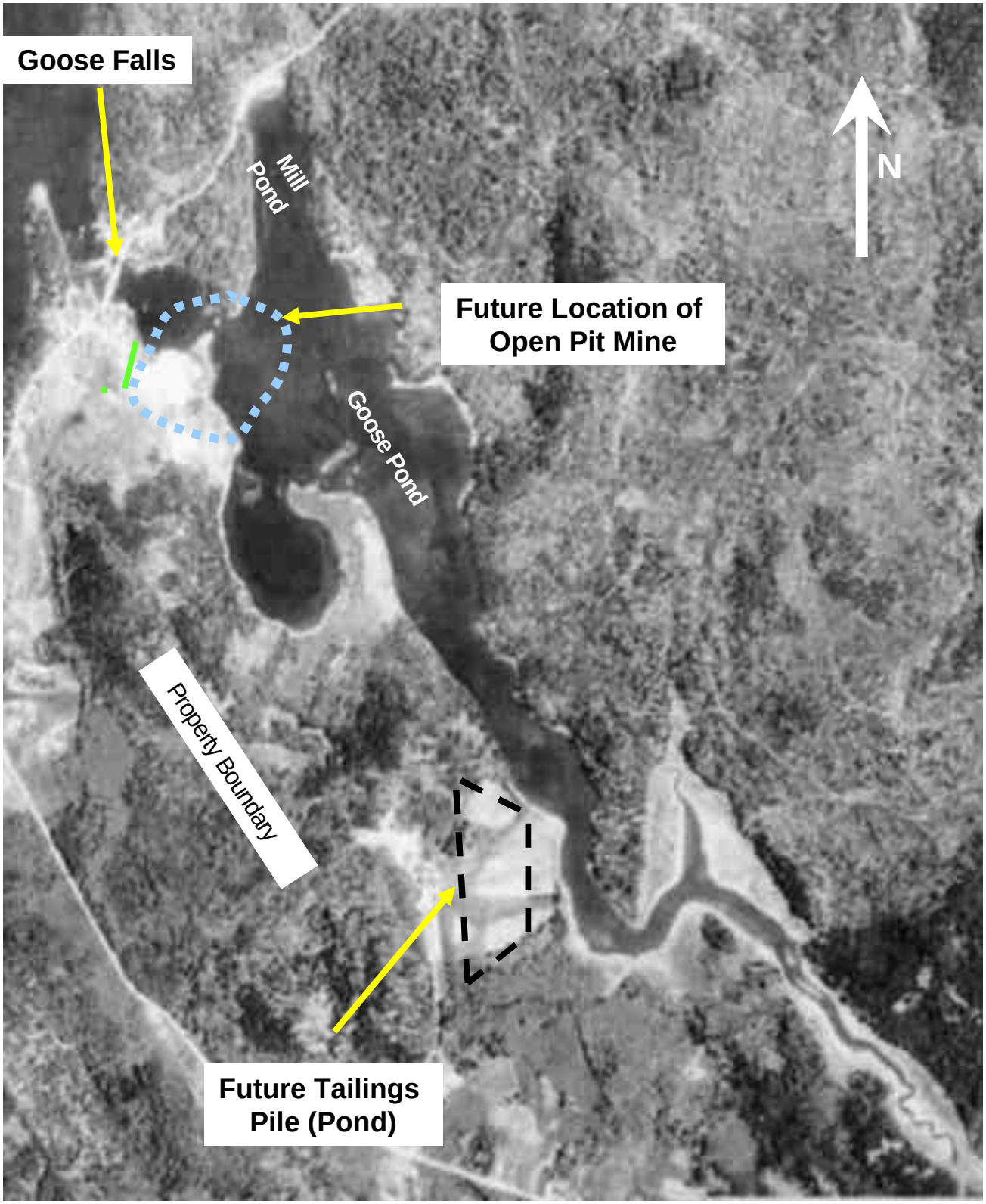

Figure 2.4-1: Site Photo, 1960
Callahan Mining Superfund Site, Brooksville, Maine

Goose Falls into Goose Pond. As the tide ebbed, flow reversed and the falls then reversed as well, cascading northward across Goose Falls into Goose Cove. The falls were well known as a picturesque and unique natural phenomenon visited by local residents and vacationing families. Reportedly, the foam caused by the falls was observed to glow at night due to phosphorescent algae in the water.

The site as it appears in 1960 is essentially undeveloped except for the area later to be occupied by the tailings pond where the land appears to have been cleared and possibly used for agricultural purposes (area currently referred to as the former "Redman Farm"). There are also several residences present adjacent to the site along the roadway.

2.4.2 Condition During Mining Operations

Figure 2.4-2 shows an aerial photograph of the site as it appeared when the mine was operating in 1972. Figure 2.4-3 shows a map of the site as it appeared during the time of active mining and Figure 2.4-4 is an aerial photograph from a newspaper article published in 1972 showing the condition of the site, including the open pit excavation.

To allow exploitation of the ore body, the Callahan Mining Corporation drained Goose Pond by constructing two dams, one upstream of the site and one at Goose Falls. Water that previously entered the site from upstream was diverted through a newly constructed channel to the south, allowing water to drain into Weir Cove. Figure 2.4-3 shows numerous facilities on the northern portion of the property, representing the various elements of the mining operation.

The mine pit was approximately 600 to 1,000 feet in diameter and 320 feet deep. Figure 2.4-2 shows that the pit extended east of the former eastern shoreline of Goose Pond, beyond the area that was formerly underwater.

Figure 2.4-3 shows the location of the former discharge pipe that was used to pump water out of the pond after the dam was constructed. Figure 2.4-5 shows a photograph of the discharge in the area of Goose Falls prior to later extension of the pipe into Goose Cove. The water appears to be laden with sediment. Due to concerns over the discharge of sediment, an embayment within Goose Pond (Dyer Cove) was later enclosed during mining and used as a settling pond for the mine. The water in the settling pond was pumped to the mine water sump, where it was then pumped through the pipe that was extended further out into Goose Cove.

2.4.3 Current Condition

Following the end of the mining operations, the mine pit was flooded with seawater by opening an eight foot section of the dam at Goose Falls. The mine is currently under water and is subject to daily tidal exchange in Goose Pond. The site is currently vacant, unfenced and access is not restricted in any way. Trespasser activity is evident from the presence of recreational vehicle tracks, food and beverage wastes, discharged firearms casings and campfire remnants.

Figure 2.4-6 shows an aerial photograph of the site in 2002. The area of the former open pit mine is highlighted as well as the pre-1968 shoreline in the area of the pit. In the area of Waste Rock Pile (WRP) 3, there is an apparent slope failure that is highlighted by a dashed white line.

drawn along the toe of the slope. The slope has failed at the location where the line bends out to the east. The site appears relatively bare of vegetation

Figure 2.4-7 shows a map of the Callahan Mining Site as it appeared in 2002. The site currently contains waste rock piles, a tailings pile, and some relic mine operations buildings and structures. The former open pit mine is now underwater in Goose Pond.

Figure 2.4-8 shows a panorama of the site looking north from the top of WRP 1 to provide a general depiction of site features from the ground. This view shows the layout of the Ore Pad uphill from WRP 2 on the left (west), Dyer Cove (the former settling pond), Goose Falls Dam and Stink Cove in the background, Holbrook Island Sanctuary on the far (east) side of Goose Pond, and WRP 3 are also observable in this photo. The orange staining that is observable on Waste Rock Pile 1 (foreground), the Ore Pad and WRP 3 is evidence of sulfide mineral oxidation, which can produce acid rock drainage (ARD).

In June 1967 when the open excavation reached a depth of approximately 100 feet, a large mass (estimated 225,000 tons) of black organic silt began to slide into the excavation from Stink Cove, a former cove located north of Goose Cove. The slide buried some mining equipment including trucks and a power shovel. Callahan Mining Corporation dredged the clay out of the excavation and reportedly placed it in then area at the base of WRP 1. The dredged clay area is now covered with wetland vegetation, and can be seen at the base of WRP 1 in Figure 2.4-9.

Goose Pond and Goose Cove are reportedly used for shellfish harvesting, although there are posted warning signs on the shore prohibiting this practice.

2.5 Pertinent Regulatory History

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 were observed during the tank removals.

1995 Maine Department of Environmental Protection (ME DEP) completes the Site Inspection Prioritization (SIP) Report.

1999 ME DEP issues Expanded Site Inspection Report.

2001 EPA 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.

9/5/02 Site added to National Priorities List.

2.6 Previous Environmental Testing Results

Figure 2.6-1 shows the location of all available sample locations at the site. Some of the sample locations are approximated based on reported descriptions of the sample location or figures and sketches presented in previous reports. Environmental samples of surface water, sediment, soil, ground water and organisms have been collected at the site periodically since at least 1967. Data from the following studies is summarized in the following sections.

- 1967 – 1968: Sampling of Well Water, unknown source
- 1974 – 1975: Testing for Trace Elements in Selected Marine Organisms by Maine Department of Marine Resources
- 1986: Minesite Environmental Review by F.M. Beck
- 1987: Site Investigation by Maine Department of Environmental Protection (ME DEP)
- 1995: Final Site Inspection by ME DEP
- 1999: Expanded Site Inspection by ME DEP

2.6.1 Surface Water Quality

Table 2.6-1 presents laboratory analytical results from previous surface water sampling. Blank results indicate parameters that were not tested. Analytical results for surface water are compared to three sets of screening criteria as a benchmark for evaluating the results.

(1) National Recommended Water Quality Criteria (NWQC) for surface water
(2) Ecological risk values for fresh water, and
(3) Ecological risk values for salt water

Highlighted values in Table 2.6-1 indicate exceedances of one or more screening criteria.

Figure 2.6-2 depicts the distribution of surface water quality for copper, lead and zinc. Metal concentrations that exceed one or more criteria are highlighted.

In general, surface water at all stations except Weir Cove contains cadmium, copper, lead, or zinc at concentrations that exceed one or more screening criteria. Surface water samples collected from standing water and seeps exhibit higher concentrations of metals than samples collected from within Goose Pond and Dyer Cove. The highest detected concentrations of cadmium, lead, nickel, and zinc are from samples collected from seeps that drain into Dyer Cove.

A limited number of surface water samples were analyzed for VOCs, SVOCs, pesticides and polychlorinated biphenyls (PCBs). VOCs detected surface water include 1,1,1-trichloroethane, toluene, ethylbenzene, xylenes and 1-butanethiol, which were detected in tailings pile seep water. Several SVOCs were detected in seep area surface water.

TABLE 2.6-1
SURFACE WATER ANALYTICAL RESULTS

				GOOSE POND										
Sample ID	*Screening Values*			GPWC1	GPWC2	SW-WCD	SW-GPE1	SW-GPE2	99-SW-30	99-SW-32	99-SW-34	99-SW-36	99-SW-42	99-SW-49
Location	*Recommended*	*Ecological Risk*		Weir Cove	Weir Cove	Weir Cove	Near Tailings	Near Tailings	Near Tailings	Near Tailings	Waste Rock	Waste Rock	Near Goose	Fmr. Mine
Date	*Water Quality*	*Fresh Wtr*	*Salt Wtr*	12/1967[5]	5/1968[5]	1986[5]	1986[5]	1987[5]	10/5/1999[6]	10/5/1999[6]	10/5/1999[6]	10/5/1999[6]	10/5/1999[6]	10/5/1999[6]
Validated (Y/N)				N	N	N	N		Y	Y	Y	Y	Y	Y
Metals (ug/L)									99E-DIN-10902	99E-DIN-10919	99E-DIN-10900	99E-DIN-10901	99E-DIN-10916	99E-DIN-10918
Cadmium	*NA*	*1.1*	*9.3*	0.0	**10 U**	1 U	2	9	1.2	2.9	2.7	1.0	0.5 U	1.2
Copper	*1,300*	*12*	*2.9*	20	40	**20 U**	40	--	26	46	50	14	2 J	3 J
Cyanide				--	--	--	--	--	--	--	--	--	--	--
Lead	*NA*	*3.2*	*8.5*	0.0	**10 U**	3 U	4	50 U	8 J	4 J	4 J	3 J	3 UJ	3 UJ
Mercury	*0.050*	*0.012*	*2.1*	--	--	--	--	--	**0.2 U**	**0.2 U**	**0.2 U**	**0.2 U**	**0.2 U**	**0.2 U**
Nickel	*610*	*160*	*8.3*	30	**10 U**	--	--	--	--	--	--	--	--	--
Selenium	*170*	*5.0*	*71*	--	--	--	--	--	**6 U**	**6 U**	**6 U**	**6 U**	**6 U**	**6 U**
Silver	*NA*	*0.92*	*0.12*	--	--	--	--	--	**0.5 U**	**0.5 U**	**0.5 U**	**0.5 U**	**0.5 U**	2.3
Zinc	*9,100*	*110*	*86*	30	10 U	20 U	380	--	420 J	850 J	790 J	270 J	87 J	110 J
VOCs (ug/L)														
1,1,1-Trichloroethane	*NA*	*NA*	*NA*	--	--	--	--	5 U	--	--	--	--	--	--
Toluene	*6,800*	*NA*	*5,000*	--	--	--	--	5 U	--	--	--	--	--	--
Ethylbenzene	*3,100*	*NA*	*NA*	--	--	--	--	5 U	--	--	--	--	--	--
Xylenes	*NA*	*NA*	*NA*	--	--	--	--	5 U	--	--	--	--	--	--
1-Butanethiol	*NA*	*NA*	*NA*	--	--	--	--	5 U	--	--	--	--	--	--
SVOCS (ug/L)														
Di-n-butylphthalate	*2,700*	*NA*	*NA*	--	--	--	--	10 U	--	--	--	--	--	--
o,o-diethyl-s-ethyl phosphorothioate	*NA*	*NA*	*NA*	--	--	--	--	10 U	--	--	--	--	--	--
o,o-diethyl-s-methyl phosphorothioate	*NA*	*NA*	*NA*	--	--	--	--	10 U	--	--	--	--	--	--
o,o-diethyl phophorodithioic acid	*NA*	*NA*	*NA*	--	--	--	--	10 U	--	--	--	--	--	--
o,o-s triethyl dithiophosphate	*NA*	*NA*	*NA*	--	--	--	--	10 U	--	--	--	--	--	--
Dioctyl adipate	*NA*	*NA*	*NA*	--	--	--	--	10 U	--	--	--	--	--	--
Dioctyl pthalate	*NA*	*NA*	*NA*	--	--	--	--	10 U	--	--	--	--	--	--
TPH (ug/L)														
Gasoline	*NA*	*NA*	*NA*	--	--	--	--	--	--	--	--	--	--	--
Fuel Oil	*NA*	*NA*	*NA*	--	--	--	--	--	--	--	--	--	--	--

Notes

1. National Recommended Water Quality Criteria, USEPA, Office of Water, April 1999
2. Ecological Risk Values - USEPA Water Quality Criteria Summary, Office of Science and Technology, Health & Ecological Criteria Division, 1994
3. Source: Final Hazard Ranking System Package (HRS), Reference 6.
4. Source: HRS, Reference 9.
5. Source: HRS, Reference 20.
6. "--" indicates no data for compound
7. Shaded values indicate exceedance of one or more screening criteria
8. Bold values indicate method detection limit above lowest screening value.

Data Qualifiers

U Result is below the sample detection limit.
J Quantitation is approximate due to limitations identifed in the quality control review.
UJ Value is non-detected and detection limit is estimated.

TABLE 2.6-1
SURFACE WATER ANALYTICAL RESULTS

				TAILINGS PILE												
Sample ID	*Screening Values*			Sample 1	Sample 2	Sample 3	Sample 4	SW-TP	SW-SA 1	SW-SA 1	SW-SA 1	SW-SA 1	SW-SA 2	SW-SA 2	SW-SA 2	SW-SA 2
Location	*Recommended*	*Ecological Risk*		Surface	Seep Water	Seep Water	Drainage Ditch	Surface	Seep Area #1	Seep Area #1	Seep Area #1	Seep Area #1	Seep Area #2	Seep Area #2	Seep Area #2	Seep Area #2
Date	*Water Quality*	*Fresh Wtr*	*Salt Wtr*	1986[4]	1986[4]	1986[4]	1986[4]	1987[5]	1986[5]	1987[5]	1990[5]	1991[5]	1986[5]	1987[5]	1990[5]	1991[5]
Validated (Y/N)				N	N	N	N	N	N	N	N	N	N	N	N	N
Metals (ug/L)																
Cadmium	*NA*	*1.1*	*9.3*	4	25	18	20	1 U	11	24	14	25	18	16	8	15
Copper	*1,300*	*12*	*2.9*	80	20	10	20	**20 U**	**20 U**	--	530	**20 U**	**20 U**		550	30
Cyanide				--	--	--	--	--	--	10 U	50 U	50 U	--	10 U	50 U	50 U
Lead	*NA*	*3.2*	*8.5*	20	**10 U**	**10 U**	**10 U**	3 U	3 U	1	23	3 U	3 U	2	6	10
Mercury	*0.050*	*0.012*	*2.1*	--	--	--	--	--	--	--	--	--	--	--	--	--
Nickel	*610*	*160*	*8.3*	--	--	--	--	--	--	--	40	**40 U**	--	--	60	40
Selenium	*170*	*5.0*	*71*	--	--	--	--	--	--	--	--	--	--	--	--	--
Silver	*NA*	*0.92*	*0.12*	--	--	--	--	--	--	--	--	--	--	--	--	--
Zinc	*9,100*	*110*	*86*	730	10,600	6,500	4,910	390	3,620	--	6,100	5,410	9,410	--	11,500	12,100
VOCs (ug/L)																
1,1,1-Trichloroethane	*NA*	*NA*	*NA*	--	--	--	--	--	5 U	5 U	1 U	1 U	17	5 U	1 U	1 U
Toluene	*6,800*	*NA*	*5,000*	--	--	--	--	--	5 U	5 U	1 U	1 U	5	5 U	1 U	1 U
Ethylbenzene	*3,100*	*NA*	*NA*	--	--	--	--	--	**5 U**	**5 U**	1 U	1 U	6	**5 U**	1 U	1 U
Xylenes	*NA*	*NA*	*NA*	--	--	--	--	--	5 U	5 U	1 U	1 U	36	5 U	1 U	1 U
1-Butanethiol	*NA*	*NA*	*NA*	--	--	--	--	--	5 U	5 U	1 U	1 U	5 U	5 U	2.9 J	1 U
SVOCS (ug/L)																
Di-n-butylphthalate	*2,700*	*NA*	*NA*	--	--	--	--	--	22	10 U	10 U	10 U	10 U	10 U	10 U	10 U
o,o-diethyl-s-ethyl phosphorothioate	*NA*	*NA*	*NA*	--	--	--	--	--	8 J	10 U	2.8 J	1.55	10 U	14 J	6 J	4.86
o,o-diethyl-s-methyl phosphorothioate	*NA*	*NA*	*NA*	--	--	--	--	--	10 J	18 J	3.1 J	1.71	10 U	10 U	0.6 J	TRACE
o,o-diethyl phophorodithioic acid	*NA*	*NA*	*NA*	--	--	--	--	--	10 U	10 U	10 U	TRACE	10 U	10 U	10 U	TRACE
o,o-s triethyl dithiophosphate	*NA*	*NA*	*NA*	--	--	--	--	--	10 U	10 U	10 U	10 U	10 U	13 J	10 U	10 U
Dioctyl adipate	*NA*	*NA*	*NA*	--	--	--	--	--	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Dioctyl pthalate	*NA*	*NA*	*NA*	--	--	--	--	--	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
TPH (ug/L)																
Gasoline	*NA*	*NA*	*NA*	--	--	--	--	--	10 U	--	--	--	10 U	--	--	--
Fuel Oil	*NA*	*NA*	*NA*	--	--	--	--	--	50 U	--	--	--	50 U	--	--	--

TABLE 2.6-1
SURFACE WATER ANALYTICAL RESULTS

				DYERS COVE						WASTE ROCK	BACKGROUND		
Sample ID	*Screening Values*			SW-SP Seep	SW-SP Seep	SW-SP Seep	SW-SP Seep	99-SW-38	99-SW-40	99-TPR-50	99-BKSW-26	99-RBB-44A	99-RBK-43A
Location	*Recommended*	*Ecological Risk*		Seep to Settling	Seep to Settling	Seep to Settling	Seep to Settling	Dyer's Cove	Dyer's Cove	Surface Water	Horseshoe		
Date	*Water Quality*	*Fresh Wtr*	*Salt Wtr*	1986[5]	1987[5]	1990[5]	1991[5]	10/5/1999[6]	10/5/1999[6]	10/5/1999[6]	10/5/1999[6]	10/5/1999[6]	10/5/1999[6]
Validated (Y/N)				N	N	N	N	Y	Y	Y	Y	Y	Y
Metals (ug/L)				SW-SP Seep	SW-SP Seep	SW-SP Seep	SW-SP Seep	99E-DIN-10909	99E-DIN-10908	99E-DIN-10910	99E-DIN-10914	99E-DIN-10906	99E-DIN-10907
Cadmium	*NA*	*1.1*	*9.3*	60	65	49	51	1.1	1.0	23	0.5 U	0.5 U	0.5 U
Copper	*1,300*	*12*	*2.9*	50	--	260	470	7	7	84	2 UJ	2 UJ	2 UJ
Cyanide				--	--	50 U	50 U	--	--	--	--	--	--
Lead	*NA*	*3.2*	*8.5*	3	1 U	3	104	3 UJ	3 J	31	3 UJ	3 UJ	3 UJ
Mercury	*0.050*	*0.012*	*2.1*	--	--	--	--	**0.2 U**	**0.2 U**	**0.2 U**	**0.2 U**	**0.2 U**	**0.2 U**
Nickel	*610*	*160*	*8.3*	--	--	40 U	60	--	--	--	--	--	--
Selenium	*170*	*5.0*	*71*	--	--	--	--	**6 U**	**6 U**	**6 U**	**6 U**	**6 U**	**6 U**
Silver	*NA*	*0.92*	*0.12*	--	--	--	--	**0.5 U**	**0.5 U**	**0.5 U**	**0.5 U**	**0.5 U**	**0.5 U**
Zinc	*9,100*	*110*	*86*	13,900	--	9,000	16,300	260 J	260 J	5,860 J	5 UJ	5 UJ	5 UJ
VOCs (ug/L)													
1,1,1-Trichloroethane	*NA*	*NA*	*NA*	5 U	5 U	1 U	1 U	--	--	--	--	--	--
Toluene	*6,800*	*NA*	*5,000*	5 U	5 U	1 U	1 U	--	--	--	--	--	--
Ethylbenzene	*3,100*	*NA*	*NA*	**5 U**	**5 U**	1 U	1 U	--	--	--	--	--	--
Xylenes	*NA*	*NA*	*NA*	5 U	5 U	1 U	1 U	--	--	--	--	--	--
1-Butanethiol	*NA*	*NA*	*NA*	5 U	5 U	1 U	1 U	--	--	--	--	--	--
SVOCS (ug/L)													
Di-n-butylphthalate	*2,700*	*NA*	*NA*	10 U	10 U	10 U	10 U	--	--	--	--	--	--
o,o-diethyl-s-ethyl phosphorothioate	*NA*	*NA*	*NA*	10 U	10 U	10 U	3.49	--	--	--	--	--	--
o,o-diethyl-s-methyl phosphorothioate	*NA*	*NA*	*NA*	10 U	10 U	10 U	10 U	--	--	--	--	--	--
o,o-diethyl phophorodithioic acid	*NA*	*NA*	*NA*	10 U	10 U	10 U	1.66	--	--	--	--	--	--
o,o-s triethyl dithiophosphate	*NA*	*NA*	*NA*	10 U	10 U	10 U	10 U	--	--	--	--	--	--
Dioctyl adipate	*NA*	*NA*	*NA*	260	10 U	10 U	10 U	--	--	--	--	--	--
Dioctyl pthalate	*NA*	*NA*	*NA*	100	10 U	10 U	10 U	--	--	--	--	--	--
TPH (ug/L)													
Gasoline	*NA*	*NA*	*NA*	10 U	20 U	5 U	--	--	--	--	--	--	--
Fuel Oil	*NA*	*NA*	*NA*	50 U	20 U	--	--	--	--	--	--	--	--

Elevated concentrations (exceeding ecological screening criteria) of zinc were detected in surface water samples in the pond on top of the tailings pile (also exceeding the NWQC), tailings pile seeps and in Goose Pond. The highest concentrations of zinc were detected in Dyer Cove and in the tailings pile seeps and drainage ditch. Elevated copper (exceeding ecological screening criteria) were observed primarily in the southern portion of the estuary and in Dyer's Cove.

2.6.2 Sediment Quality

Table 2.6-2 shows the results from laboratory testing of sediment from the site and background locations. The sample results are highlighted where they exceed one of two relevant screening criteria: Region IX PRGs (modified for Region I) for residential exposure pathways and risk-based ecological screening values. Note that the Region IX PRGs are a relatively conservative risk screening guideline for sediment

Figures 2.6-3, 2.6-4, 2.6-5 and 2.6-6 show maps of the sample results for arsenic, copper, lead and zinc, respectively, in sediment samples from the site.

Goose Pond at Tailings Pile: Arsenic, cadmium, copper, lead, mercury, nickel and zinc were detected at concentrations exceeding residential and ecological screening criteria at sediment sample locations near the Tailings Pile. Chromium was detected at concentrations exceeding the ecological screening criterion. In general, concentrations of metals are higher in sediment collected in this area than concentrations detected in other areas.

Two sediment samples in this area were analyzed for VOCs and SVOCS in 1994. Detected VOCs include acetone, dichloromethane, 1,1-thiobisethane, and trimethyloxepane. Detected SVOCs include butyl benzyl phthalate and di(2-ethylhexyl)phthalate. Neither VOCs nor SVOCs were present at concentrations that exceed established screening values.

Goose Pond Estuary at Waste Rock Pile 3 (WRP 3): Cadmium, copper, lead, mercury, nickel and zinc were detected at concentrations exceeding residential and ecological screening criteria at sediment sample locations near WRP 3. Sediment samples near WRP 3 were not analyzed for arsenic, chromium or nickel. No samples from WRP 3 were analyzed for VOCs or SVOCs.

Dyer Cove: Arsenic, cadmium, chromium, copper, lead, nickel and zinc were detected at concentrations exceeding residential and ecological screening criteria at sediment sample locations near WRP 3. Chromium was detected at concentrations exceeding only ecological screening criteria.

TABLE 2.6-2
SEDIMENT ANALYTICAL RESULTS

			GOOSE POND AT TAILINGS PILE									GOOSE POND AT WASTE ROCK PILE #3		GOOSE POND DAM
Sample ID	*Screening Values*		SD-SA1	SD-SA2	SD-TP Spill	TPS#1 Sed#6A	TPS#2 Sed#7A	TPS#1 Sed#6	TPS#2 Sed#7	99-SD-29	99-SD-31	99-SD-33	99-SD-35	CR-3
	Residential	*Ecological*								0-6"	0-6"	0-6"	0-6"	
Date	*PRG* [1]	*Risk Value* [2]	1987[3]	1987[3]	1987[3]	9/8/1994[4]	9/8/1994[4]	9/8/1994[4]	9/8/1994[4]	10/5/1999[5]	10/5/1999[5]	10/5/1999[5]	10/5/1999[5]	1975[9]
Validated (Y/N)			N	N	N	N	N	N	N	Y	Y	Y	Y	N
Metals (mg/kg)						94E-DIN-02226	94E-DIN-02225	94E-DIN-02228	94E-DIN-02227	99E-DIN-10866	99E-DIN-11400	99E-DIN-11416	99E-DIN-11419	
Arsenic	*0.39*	*5.9*	--	--	--	27	270	36	56	--	--	--	--	--
Barium	*540*	*NA*	--	--	--	50	230	64	64	--	--	--	--	--
Cadmium	*3.7*	*6.0*	110	21	10	28	170	33	43	33	27	5.2	3.9	6.9
Chromium	*30*	*37*	--	--	--	38	30	45	41	--	--	--	--	--
Cobalt	*900*	*NA*	--	--	--	--	--	--	--	--	--	--	--	478
Copper	*310*	*36*	370	2,800	730	1,500	1,600	970	1,400	1,800 J	1,200 J	1,900 J	170 J	--
Iron	*2,300*	*NA*	--	--	--	--	--	--	--	--	--	--	--	2.03
Lead	*40*	*35*	510	1,100	370	550	760	550	1,500	770	590	210	52	156
Mercury	*2.3*	*0.17*	--	--	--	--	--	--	--	0.7 J	0.3 J	0.2 J	R	--
Nickel	*160*	*18*	--	--	--	39	250	35	35	--	--	--	--	--
Selenium	*39*	*NA*	--	--	--	4	7	U	6	6.9	5.7	4 U	4 U	--
Silver	*39*	*NA*	--	--	--	12	1	2.9	5.8	4.6	3.2	0.8 U	0.8 U	1.49
Zinc	*2,300*	*120*	23,000	7,600	2,800	15,000	58,000	16,000	22,000	6,900	5,400	3,100	840	1,090
VOCs (mg/kg)								94E-DOR-03388	94E-DOR-03395					
Acetone	*160*	*NA*	--	--	--	--	--	0.033	**U**	--	--	--	--	--
Dichloromethane	*9.1*	*370*	--	--	--	--	--	0.075	**U**	--	--	--	--	--
1,1-Thiobisethane	*NA*	*NA*	--	--	--	--	--	2 J	**U**	--	--	--	--	--
Trimethyloxepane	*NA*	*NA*	--	--	--	--	--	0.035 J	**U**	--	--	--	--	--
Diethylbenzene	*NA*	*NA*	--	--	--	--	--	**U**	**U**	--	--	--	--	--
3,4-Dithiohexane	*NA*	*NA*	--	--	--	--	--	**U**	**U**	--	--	--	--	--
SVOCs (mg/kg)								94E-DOR-03398	94E-DOR-03397					
Butyl benzyl phthalate	*1,200*	*11* [7]	--	--	--	--	--	**U**	0.19	--	--	--	--	--
Di(2-ethylhexyl)phthalate	*NA*	*NA*	--	--	--	--	--	0.74	14.65	--	--	--	--	--
Pyrene	*230*	*0.053*	--	--	--	--	--	**U**	**U**	--	--	--	--	--
Phenanthrene	*NA*	*0.042*	--	--	--	--	--	**U**	**U**	--	--	--	--	--

Notes

1. Residential PRG - Region IX Preliminary Remediation Goal (PRG) for Residential Soil (updated 10/01/02).
   PRGs with non-cancer endpoints divided by 10 to obtain a hazard quotient of 0.1.
2. Ecological Risk Values from NOAA Screening Quick Reference Table for Inorganics in Solids
   (Freshwater Sediment TEL), September 1999. (except as noted)
3. Source: Final Hazard Ranking System Package (HRS), Reference 9.
4. Source: HRS, Reference 16.
5. Source: HRS, Reference 20.
4. "--" indicates no data for compound
5. Shaded values indicate exceedance of screening criteria
6. Bold values indicate method detection limit above lowest screening value or unknown.
7. Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Sediment -
   Associated Biota: 1997 Rivision (Secondary Chronic Value)
8. Source: HRS, Reference 6.
9. Source: HRS, Reference 31.

Data Qualifiers

U Result is below the sample detection limit.
J Quantitation is approximate due to limitations identifed in the quality control review.
R Value is rejected.

TABLE 2.6-2
SEDIMENT ANALYTICAL RESULTS

			DYER COVE/SETTLING POND								HORSESHOE COVE (BACKGRND)					GOOSE POND (BKGRND)	WEIR COVE (BCKGRND)
Sample ID	*Screening Values*		Sample 1	Sample 2	SD-SP Seep	DCS Sed#4	DCS D Sed#5	DC Sed#8	99-SD-37	99-SD-39	BK HSC Sed#9	BK HSC Sed#10	99-BKSD-23	99-BKSD-24	99-BKSD-25	BK GP Sed#11	99-SD-27
	Residential	*Ecological*							0-6"	0-6"			0-6"	0-6"	0-6"		0-6"
Date	*PRG* [1]	*Risk Value* [2]	5/1986[8]	5/1986[8]	1987[3]	9/8/1994[4]	9/8/1994[4]	9/8/1994[4]	10/5/1999[5]	10/5/1999[5]	9/8/1994[4]	9/8/1994[4]	10/6/1999[5]	10/6/1999[5]	10/6/1999[5]	9/8/1994[4]	10/5/1999[5]
Validated (Y/N)			N	N	N	N	N	N	Y	Y	N	N	Y	Y	Y	N	Y
Metals (mg/kg)						94E-DIN-02232	94E-DIN-02229	94E-DIN-02233	99E-DIN-11412	99E-DIN-11409	94E-DIN-02237	94E-DIN-02224	99E-DIN-11351	99E-DIN-11354	99E-DIN-11357	94E-DIN-02234	99E-DIN-11425
Arsenic	*0.39*	*5.9*	--	--	--	14	23	22	--	--	17	10	--	--	--	8	--
Barium	*540*	*NA*	--	--	--	55	110	70	--	--	22	21	--	--	--	69	--
Cadmium	*3.7*	*6.0*	33	19	11	3.6	4.9	11	5.5	7.3	**U**	**U**	0.8 U	0.8 U	0.8 U	0.8	0.8 U
Chromium	*30*	*37*	--	--	--	32	40	40	--	--	21	15	--	--	--	34	--
Cobalt	*900*	*NA*	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Copper	*310*	*36*	3,760	1,590	84	990	660	2,200	190 J	350 J	45	11	14 J	18 J	14 J	28	18 J
Iron	*2,300*	*NA*	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Lead	*40*	*35*	740	670	360	210	260	400	120	150	12	10	10	11	10	36	16
Mercury	*2.3*	*0.17*	--	--	--	--	--	--	R	0.1 J	--	--	R	R	R	--	R
Nickel	*160*	*18*	--	--	--	35	40	34	--	--	29	22	--	--	--	26	--
Selenium	*39*	*NA*	--	--	--	U	U	U	4 U	4 U	4 U	4 U	4 U	4 U	4 U	2 U	4 U
Silver	*39*	*NA*	--	--	--	0.6	7	2.9	0.8 U	0.8 U	0.2 U	0.1 U	0.8 U	0.8 U	0.8 U	0.2 U	0.8 U
Zinc	*2,300*	*120*	8,600	4,800	4,200	2,600	4,000	6,200	1,400	1,700	54	41	49	64	52	110	84
VOCs (mg/kg)						94E-DOR-03390	94E-DOR-03391				94E-DOR-03392						
Acetone	*160*	*NA*	--	--	--	**U**	0.032	--	--	--	**U**	--	--	--	--	--	--
Dichloromethane	*9.1*	*370*	--	--	--	0.32	0.039	--	--	--	**U**	--	--	--	--	--	--
1,1-Thiobisethane	*NA*	*NA*	--	--	--	**U**	**U**	--	--	--	**U**	--	--	--	--	--	--
Trimethyloxepane	*NA*	*NA*	--	--	--	**U**	**U**	--	--	--	**U**	--	--	--	--	--	--
Diethylbenzene	*NA*	*NA*	--	--	--	**U**	**U**	--	--	--	**U**	--	--	--	--	--	--
3,4-Dithiohexane	*NA*	*NA*	--	--	--	**U**	**U**	--	--	--	**U**	--	--	--	--	--	--
SVOCs (mg/kg)						94E-DOR-03405	94E-DOR-03406				94E-DOR-03404						
Butyl benzyl phthalate	*1,200*	*11* [7]	--	--	--	0.1	0.2	--	--	--	0.11	--	--	--	--	--	--
Di(2-ethylhexyl)phthalate	*NA*	*NA*	--	--	--	0.43	4.63	--	--	--	3.45	--	--	--	--	--	--
Pyrene	*230*	*0.053*	--	--	--	0.1 J	**U**	--	--	--	0.39	--	--	--	--	--	--
Phenanthrene	*NA*	*0.042*	--	--	--	**U**	**U**	--	--	--	0.1 J	--	--	--	--	--	--

Two samples from Dyer Cove sediment were analyzed for VOCs and SVOCS in 1994. Detected VOCs include acetone and dichloromethane. Detected SVOCs include butyl benzyl phthalate, di(2-ethylhexyl)phthalate and pyrene. The pyrene concentration detected in sample DCS SedNo. 4 exceeds the ecological screening criteria. Other VOCs and SVOCs were below both screening values.

Background: In general, detected concentrations of metals in Goose Pond sediment were significantly higher than concentrations detected in background samples collected from Horseshoe Cove, Weir Cove and a downstream Goose Pond estuary location. Concentrations of VOCs and SVOCs, however, detected in background samples similar to those detected near the source areas. The concentration of phenanthrene detected in Horseshoe Cove sample BK HSC SedNo. 9 exceeds the ecological screening criterion.

2.6.3 Soil Quality

Table 2.6-3 presents laboratory analytical results for soil samples collected at the site. These samples were collected in the former mine operations area, three waste rock piles, and the tailings pile during 1994 and 1999 site investigations by MEDEP at depths of 0 to 6 inches. Figures 2.6-3, 2.6-4, 2.6-5 and 2.6-6 show maps of the sample results for arsenic, copper, lead and zinc, respectively, in sediment samples from the site. The sample results are highlighted where they exceed Region IX PRGs (modified for Region I) for residential exposure pathway values.

Former Mine Operations Area: Detected concentrations of metals in the former mine operations area are among the highest detected in soil on site. Detected concentrations of arsenic, cadmium, copper, lead, mercury, selenium, silver, and zinc exceed residential PRGs. One soil sample collected in 1994 was analyzed for VOCs and SVOCs. Detected VOCs include acetone and dichloromethane; and the only detected SVOC was butyl benzyl phthalate. Detected concentrations of VOCs and SVOCs are below residential PRGs.

Waste Rock Piles: Soil samples from the waste rock piles were analyzed for metals only. Detected concentrations of copper and lead exceed residential PRGs in all three waste rock piles. Additionally, cadmium and zinc exceed residential PRGs in WRP 1; and cadmium, mercury, selenium, and zinc exceed residential PRGs in WRP 2.

Tailings Pile: Soil samples from the tailings pile were analyzed for metals, VOCs, and SVOCs. Detected concentrations of arsenic, cadmium, copper, lead, and zinc exceed residential PRGs. Detected VOCs include acetone, diethylbenzene, and 3,4-dithiohexane; and the only detected SVOC was butyl benzyl phthalate. Detected VOC and SVOC concentrations are below residential PRGs.

2.6.4 Ground Water Quality

Table 2.6-4 summarizes available analytical data from ground water testing conducted at the site. Ground water data is presented for samples collected from off-site drinking water supply well samples conducted in 1967 and 1968, prior to construction of the Callahan Mine and from more recent drinking water supply sampling conducted during the period of 1986 to 1991. Some of the well locations are identified in the table by the property owner's name, but the location of

TABLE 2.6-3
SOIL ANALYTICAL RESULTS

		FORMER MINE OPERATIONS AREA						WASTE ROCK PILE #1			
Sample ID		SM Soil#3	99-SS-07	99-SS-08	99-SS-09	99-SS-43	99-SS-46	99-WRP-19	99-WRP-20	99-WRP-21	99-WRP-22
Depth	*Residential*		0-6"	0-6"	0-6"	0-6"	0-6"	0-6"	0-6"	0-6"	0-6"
Date	*PRG* [1]	9/8/1994[2]	10/5/1999[3]	10/5/1999[3]	10/5/1999[3]	10/5/1999[3]	10/5/1999[3]	10/4/1999[3]	10/4/1999[3]	10/4/1999[3]	10/4/1999[3]
Validated (Y/N)		N	Y	Y	Y	Y	Y	Y	Y	Y	Y
Metals (mg/kg)		94E-DIN-02230	99E-DIN-11403	99E-DIN-10871	99E-DIN-11372	99E-DIN-11406	99E-DIN-11398	99E-DIN-11379	99E-DIN-11383	99E-DIN-10875	99E-DIN-11382
Arsenic	*0.39*	100	--	--	--	--	--	--	--	--	--
Barium	*540*	3	--	--	--	--	--	--	--	--	--
Cadmium	*3.7*	150	51	38	44	25	17	22	4.5	8.7	13
Chromium	*30*	26	--	--	--	--	--	--	--	--	--
Copper	*310*	110,000	2,600 J	2,300 J	2,400 J	1,300 J	24,000 J	1,600 J	240 J	1,600 J	2,100 J
Lead	*40*	9,100	1,100	840	880	440	8,500	430	99	780	3,000
Mercury	*2.3*	--	0.4 J	0.7 J	0.7 J	0.4 J	7.2 J	0.3 J	0.1 J	1.0 J	0.5 J
Nickel	*160*	30	--	--	--	--	--	--	--	--	--
Selenium	*39*	77	4.8	4 U	4.2	4 U	39	5.9	4 U	7.0	4 U
Silver	*39*	70	5.3	39	4.2	2.3	45	2.7	0.8 U	4.1	2.3
Zinc	*2,300*	18,000	9,600	9,100	9,700	6,300	4,700	6,500	3,100	2,400	7,200
VOCs (mg/kg)		94E-DOR-03389									
Acetone	*160*	0.017	--	--	--	--	--	--	--	--	--
Dichloromethane	*9.1*	0.056	--	--	--	--	--	--	--	--	--
1,1-Thiobisethane	*NA*	**U**	--	--	--	--	--	--	--	--	--
Trimethyloxepane	*NA*	**U**	--	--	--	--	--	--	--	--	--
Diethylbenzene	*NA*	**U**	--	--	--	--	--	--	--	--	--
3,4-Dithiohexane	*NA*	**U**	--	--	--	--	--	--	--	--	--
SVOCs (mg/kg)		94E-DOR-03400									
Butyl benzyl phthalate	*1,200*	0.13	--	--	--	--	--	--	--	--	--
Di(2-ethylhexyl)phthalate	*NA*	**U**	--	--	--	--	--	--	--	--	--
Pyrene	*230*	**U**	--	--	--	--	--	--	--	--	--
Phenanthrene	*NA*	**U**	--	--	--	--	--	--	--	--	--

Notes
1. Residential PRG - Region IX Preliminary Remediation Goal (PRG) for Residential Soil (updated 10/01/02).
   PRGs with non-cancer endpoints divided by 10 to obtain a hazard quotient of 0.1.
2. Source: Final Hazard Ranking System Package (HRS), Reference 16.
3. Source: HRS, Reference 20.
4. "--" indicates no data for compound
5. Shaded values indicate exceedance of screening criteria

Data Qualifiers

U	Result is below the sample detection limit.
J	Quantitation is approximate due to limitations identifed in the quality control review.
R	Value is rejected.

TABLE 2.6-3
SOIL ANALYTICAL RESULTS

		WASTE ROCK PILE #2								WASTE ROCK PILE #3		
Sample ID		99-SS-04	99-SS-05	99-SS-44	99-SS-45	99-WRP2-06	99-WRP2-10	99-WRP2-47	99-WRP2-48	99-TPL-16	99-TPL-17	99-TPL-18
Depth	*Residential*	0-6"	0-6"	0-6"	0-6"	0-6"	0-6"	0-6"	0-6"	0-6"	0-6"	0-6"
Date	*PRG* [1]	10/6/1999[3]	10/6/1999[3]	10/6/1999[3]	10/6/1999[3]	10/4/1999[3]	10/4/1999[3]	10/4/1999[3]	10/4/1999[3]	10/4/1999[3]	10/4/1999[3]	10/4/1999[3]
Validated (Y/N)		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Metals (mg/kg)		99E-DIN-11360	99E-DIN-11361	99E-DIN-11378	99E-DIN-11390	99E-DIN-10880	99E-DIN-10881	99E-DIN-10878	99E-DIN-10844	99E-DIN-11384	99E-DIN-11367	99E-DIN-11364
Arsenic	*0.39*	--	--	--	--	--	--	--	--	--	--	--
Barium	*540*	--	--	--	--	--	--	--	--	--	--	--
Cadmium	*3.7*	0.8 U	27	17	0.8 U	0.8 U	32	12	0.8 U	0.8 U	0.8 U	0.8 U
Chromium	*30*	--	--	--	--	--	--	--	--	--	--	--
Copper	*310*	1,400 J	1,800 J	480 J	80 J	4,000 J	1,100 J	4,000 J	540 J	670 J	520 J	630 J
Lead	*40*	210	640	210	120	1,600	790	2,100	220	230	410	150
Mercury	*2.3*	0.5 J	0.7 J	0.2 J	0.1 J	4.4 J	0.9 J	1.3 J	R	0.7 J	1.0 J	0.3 J
Nickel	*160*	--	--	--	--	--	--	--	--	--	--	--
Selenium	*39*	11	4 U	4 U	4 U	46	4 U	11	9.5	20	4.9	6.6
Silver	*39*	2.9	3.1	0.9	0.8 U	19.0	2.7	8.3	1.9	3.0	4.0	2.1 U
Zinc	*2,300*	310	8,400	4,200	130	510	7,700	5,800	150	90	390	220
VOCs (mg/kg)												
Acetone	*160*	--	--	--	--	--	--	--	--	--	--	--
Dichloromethane	*9.1*	--	--	--	--	--	--	--	--	--	--	--
1,1-Thiobisethane	*NA*	--	--	--	--	--	--	--	--	--	--	--
Trimethyloxepane	*NA*	--	--	--	--	--	--	--	--	--	--	--
Diethylbenzene	*NA*	--	--	--	--	--	--	--	--	--	--	--
3,4-Dithiohexane	*NA*	--	--	--	--	--	--	--	--	--	--	--
SVOCs (mg/kg)												
Butyl benzyl phthalate	*1,200*	--	--	--	--	--	--	--	--	--	--	--
Di(2-ethylhexyl)phthalate	*NA*	--	--	--	--	--	--	--	--	--	--	--
Pyrene	*230*	--	--	--	--	--	--	--	--	--	--	--
Phenanthrene	*NA*	--	--	--	--	--	--	--	--	--	--	--

TABLE 2.6-3
SOIL ANALYTICAL RESULTS

		TAILINGS PILE							BACKGROUND SAMPLES		
Sample ID		TP Soil#1	TP Soil#2	99-TPD-11	99-TPD-12	99-TPD-13	99-TPD-14	99-TPD-15	99-BKSS-01	99-BKSS-02	99-BKSS-03
Depth	*Residential*	0-6"	0-6"	0-6"	3-6"	3-6"	3-6"	3-6"	0-6"	0-6"	0-6"
Date	*PRG* [1]	9/8/1994[2]	9/8/1994[2]	10/5/1999[3]	10/6/1999[3]	10/6/1999[3]	10/6/1999[3]	10/6/1999[3]	10/6/1999[3]	10/6/1999[3]	10/6/1999[3]
Validated (Y/N)		N	N	Y	Y	Y	Y	Y	Y	Y	Y
Metals (mg/kg)		94E-DIN-02236	94E-DIN-02235	99E-DIN-10890	99E-DIN-10889	99D-DIN-10897	99E-DIN-10868	99E-DIN-10869	99E-DIN-11393	99E-DIN-11395	99E-DIN-11375
Arsenic	*0.39*	54	55	--	--	--	--	--	--	--	--
Barium	*540*	24	36	--	--	--	--	--	--	--	--
Cadmium	*3.7*	20	32	15	25	19	16	0.8 U	0.8 U	0.8 U	0.8 U
Chromium	*30*	25	16	--	--	--	--	--	--	--	--
Copper	*310*	670	1,900	470 J	1,400 J	1,800 J	1,400 J	180 J	56 J	51 J	49 J
Lead	*40*	560	510	780	990	840	700	290	110	110	110
Mercury	*2.3*	--	--	0.5 J	0.5 J	0.5 J	0.5 J	0.4 J	0.1 J	R	R
Nickel	*160*	20	12	--	--	--	--	--	--	--	--
Selenium	*39*	6	9	4.9	9.9	5.2	4.9	9.8	4 U	4	4.0
Silver	*39*	2.7	3.4	4.0	4.4	4.3	3.7	2.0	1.1	1.1	0.8 U
Zinc	*2,300*	15,000	17,000	4,200	5,800	4,400	3,800	50	290	270	260
VOCs (mg/kg)		94E-DOR-03397	94E-DOR-03312								
Acetone	*160*	**U**	0.033	--	--	--	--	--	--	--	--
Dichloromethane	*9.1*	**U**	**U**	--	--	--	--	--	--	--	--
1,1-Thiobisethane	*NA*	**U**	**U**	--	--	--	--	--	--	--	--
Trimethyloxepane	*NA*	**U**	**U**	--	--	--	--	--	--	--	--
Diethylbenzene	*NA*	**U**	1.27 J	--	--	--	--	--	--	--	--
3,4-Dithiohexane	*NA*	**U**	0.10 J	--	--	--	--	--	--	--	--
SVOCs (mg/kg)		94E-DOR-03403	94E-DOR-03401								
Butyl benzyl phthalate	*1,200*	**U**	0.11	--	--	--	--	--	--	--	--
Di(2-ethylhexyl)phthalate	*NA*	**U**	**U**	--	--	--	--	--	--	--	--
Pyrene	*230*	**U**	**U**	--	--	--	--	--	--	--	--
Phenanthrene	*NA*	**U**	**U**	--	--	--	--	--	--	--	--

TABLE 2.5-4
GROUNDWATER SAMPLING RESULTS

Sample ID		1 F				2 F				3 F				4 F			
Sample Date	*MCL (mg/L)*	Dec-67	May-68	Jul-68	Sep-68	Dec-67	May-68	Jul-68	Sep-68	Dec-67	May-68	Jul-68	Sep-68	Dec-67	May-68	Jul-68	Sep-68
Metals (ug/L)																	
Arsenic	*0.01*																
Cadmium	*0.005*	**0.0**	**0.01 U**	--	0.004 U	0.001	**0.01 U**	0.01	0.004 U	**0.0**	**0.01 U**	0.004 U	0.004 U	0.002	**0.01 U**	0.004 U	0.004 U
Copper	*1.3*	0.5	0.4	0.03	0.005 U	0.01	0.1	0.05	0.03	0.05	0.1	0.25	0.01 U	0.03	0.07	0.04	0.005 U
Lead	*0.015*	0.0	**0.01 U**	--	**0.03 U**	0.0	**0.01 U**	**0.03 U**	**0.03 U**	0.02	**0.01 U**	**0.03 U**	**0.03 U**	**0.0**	**0.01 U**	**0.03 U**	**0.03 U**
Nickel	*NA*	0.02	0.01 U	--	0.01 U	0.02	0.02	0.01 U	0.01 U	0.02	0.02	0.01 U	0.01 U	0.03	0.01	0.01 U	0.01 U
Zinc	*5*	1.5	0.01 U	--	0.0	1.6	1.3	1.07	0.68	0.1	0.04	0.11	0.08	0.1	0.01 U	0.04	0.08
Cyanide	*0.2*	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
VOCs																	
Total VOCs	*NA*	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SVOCs																	
Total SVOCs	*NA*	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Petroleum																	
Gasoline	*NA*	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Fuel Oil	*NA*	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Pesticides/PCBs																	
Total Pesticides/PCBs	*NA*	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Notes
1. MCL - Maximum Contaminant Level: USEPA, Office of Water, Summer 2002.
2. Source: Final Hazard Ranking System Package (HRS), References 9 & 16.
4. "--" indicates no data for compound
5. Shaded values indicate exceedance of screening criteria
6. Bold values indicate method detection limit above MCL.

Data Qualifiers
U Result is below the sample detection limit.

TABLE 2.5-4
GROUNDWATER SAMPLING RESULTS

Sample ID	5 F				6 F		7F				8F			9F Harding						
Sample Date	Dec-67	May-68	Jul-68	Sep-68	Dec-67	Sep-68	Dec-67	May-68	Jul-68	Sep-68	Dec-67	May-68	Jul-68	Dec-67	May-68	Jul-68	Sep-68	1986	1987	1990
Metals (ug/L)																				
Arsenic																				
Cadmium	0.001	**0.01 U**	0.004 U	0.004 U	**0.0**	--	0.001	**0.01 U**	0.004 U	0.004 U	**0.0**	**0.01 U**	0.004 U	0.0	**0.01 U**	0.004 U	0.004 U	0.001 U	0.005 U	0.0005 U
Copper	0.06	0.2	0.15	0.12	0.2	--	0.005	0.03	0.04	0.005 U	0.02	0.04	0.04	0.02	0.04	0.0	0.005 U	0.04	--	0.02
Lead	**0.0**	0.01 U	**0.03 U**	**0.03 U**	0.01	--	**0.0**	0.01 U	**0.03 U**	**0.03 U**	0.01	0.01 U	**0.03 U**	0.01	0.01 U	0.05	0.03 U	0.003 U	0.001 U	0.003 U
Nickel	0.03	0.02	0.01 U	0.01 U	0.0	--	0.01	0.01 U	0.01 U	0.01 U	0.05	0.15	0.01 U	0.04	0.01 U	0.01 U	0.01 U	--	--	0.04 U
Zinc	1.6	0.08	0.47	0.45	0.1	0.09	0.02	0.01 U	0.03	0.01 U	1.6	0.01 U	0.72	0.03	0.01 U	0.07	0.01	0.02 U	--	0.01 U
Cyanide	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.05 U
VOCs																				
Total VOCs	--	--	--	--	--		--	--	--	--	--	--	--	--	--	--	--	--	0.05 U	
SVOCs																				
Total SVOCs	--	--	--	--	--		--	--	--	--	--	--	--	--	--	--	--	--	0.01 U	
Petroleum																				
Gasoline	--	--	--	--	--		--	--	--	--	--	--	--	--	--	--	--	--	--	
Fuel Oil	--	--	--	--	--		--	--	--	--	--	--	--	--	--	--	--	--	--	
Pesticides/PCBs																				
Total Pesticides/PCBs	--	--	--	--	--		--	--	--	--	--	--	--	--	--	--	--	--	--	

TABLE 2.5-4
GROUNDWATER SAMPLING RESULTS

Sample ID	10F				11 F Robinson		12 F J Gray						13F Smith				
Sample Date	Dec-67	May-68	Jul-68	Sep-68	Dec-67	1986	Dec-67	May-68	Jul-68	1986	1990	1991	Dec-67	May-68	Jul-68	Sep-68	1986
Metals (ug/L)																	
Arsenic																	
Cadmium	**0.0**	**0.01 U**	0.004 U	0.004 U	0.001	0.001 U	**0.0**	**0.01 U**	0.004 U	0.001 U	0.0005 U	0.0005 U	0.001	**0.01 U**	0.008	0.004 U	0.001 U
Copper	0.02	0.06	0.03	0.005 U	0.03	0.02 U	0.01	0.04	0.02	0.2	0.09	0.26	0.14	0.08	--	0.03	0.02 U
Lead	0.02	0.01 U	**0.03 U**	**0.03 U**	0.09	0.003 U	**0.0**	0.01 U	0.05	0.003 U	0.003 U	0.003 U	0.01	0.01 U	**0.03 U**	**0.03 U**	0.003 U
Nickel	0.05	0.01 U	0.01 U	0.01 U	0.03	--	0.03	0.01 U	0.01 U	--	0.04 U	0.04 U	0.03	0.01 U	0.01 U	0.01 U	--
Zinc	0.07	0.01 U	0.04	0.02	1.6	0.3	0.04	0.01 U	0.02	0.02 U	0.01 U	0.02	0.05	0.01 U	0.03	0.01	0.02 U
Cyanide	--	--	--	--	--	--	--	--	--	--	0.05 U	0.05 U	--	--	--	--	--
VOCs																	
Total VOCs	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SVOCs																	
Total SVOCs	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Petroleum																	
Gasoline	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Fuel Oil	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Pesticides/PCBs																	
Total Pesticides/PCBs	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

TABLE 2.5-4
GROUNDWATER SAMPLING RESULTS

Sample ID	14 F Rankin							M. Gray / Sandecki				Howard	Leach	Norrington	Callahan Water Supply Well
Sample Date	Dec-67	May-68	Jul-68	Sep-68	1986	1990	1991	1986	1987	1990	1991	1987	1987	1987	1986
Metals (ug/L)															
Arsenic															
Cadmium	**0.0**	**0.01 U**	0.004 U	0.004 U	0.001 U	0.0005 U	0.0005 U	0.01	0.005	0.0005 U	0.0007	0.004 U	0.005 U	0.005 U	0.001 U
Copper	0.05	0.09	0.11	0.25	0.18	0.04	0.02 U	0.43	--	0.25	0.4	0.12	--	--	0.02 U
Lead	0.08	0.01 U	**0.1 U**	**0.03 U**	0.003 U	0.005	0.003 U	0.003	0.001	0.003 U	0.003 U	0.03 U	0.001 U	0.003	0.003 U
Nickel	0.04	0.01 U	0.01 U	0.01 U	--	0.04 U	0.04 U	--	--	0.04 U	0.04 U	0.01 U	--	--	--
Zinc	0.05	0.01 U	0.04	0.05	0.02 U	0.01 U	0.02	0.26	--	0.04	0.08	0.45	--	--	0.02
Cyanide	--	--	--	--	--	0.05 U	0.05 U	--	--	0.05 U	0.05 U	--	--	--	--
VOCs															
Total VOCs	--	--	--	--	--	--	--	--	0.05 U	--	--	0.05 U	0.05 U	0.05 U	0.005 U
SVOCs															
Total SVOCs	--	--	--	--	--	--	--	--	0.01 U	--	--	0.01 U	0.01 U	0.01 U	0.01 U
Petroleum															
Gasoline	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.01 U
Fuel Oil	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.05 U
Pesticides/PCBs															
Total Pesticides/PCBs	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.001 U

these samples are not well documented.

The results indicate that concentrations of lead and cadmium were detected in several wells above MCLs in samples collected in 1967 and 1968. Later sampling from 1986 to 1991 did not indicate metals in excess of MCLs. Detailed sample collection and analytical information including sample location (i.e.: tap vs. wellhead), sample filtering and/or analytical methods was not available.

2.6.5 Marine Flora/Fauna Contaminant Concentrations

Table 2.6-5 lists the results of available marine flora and fauna testing. Samples of fin fish (coho salmon fillets), bloodworms, soft shell clams and blue mussels were collected and analyzed for metals content. Test results are compared to EPA Region III Risk-Based Concentrations (RBCs) for fish ingestion (October 9, 2002).

The data presented in this report is compiled primarily from three monitoring programs.

- Maine Department of Marine Resources, *Bio-Accumulation of Trace Elements in Selected Marine Organisms*, November 20, 1974 to November 19, 1975
- Maine Marine Environmental Monitoring Program, *Marine Monitoring Baseline Data Final Report*, June 1993
- Maine Department of Environmental Protection, *Surface Water Ambient Toxic (SWAT) Monitoring Program*

The 1974 study by the Maine Department of Marine Resources reports that levels of cadmium, copper, lead, and zinc are several times to several orders of magnitude higher in Goose Cove biota than in samples collected from other stations in midcoastal study areas.

The latest available analytical data from the Maine Department of Environmental Protection SWAT Monitoring Program indicate elevated concentrations of cadmium, copper, lead and zinc in blue mussel samples collected at Cape Rosier in 2001. Concentrations of cadmium and lead were lower and concentrations of lead and copper were higher in 2001 compared to the 1989 sampling.

In general, based on more recent sampling results, concentrations of arsenic, cadmium and iron in blue mussel samples exceed RBCs for fish ingestion.

TABLE 2.6-5
MARINE FLORA FAUNA SAMPLING RESULTS

Category		Molluscs							
Matrix		Mya arenaria	M. edulis	M. edulis	M. edulis	M. edulis	M. edulis	M. edulis	M. edulis
Common Name		Soft-shell clam	Blue mussel	Blue mussel	Blue mussel	Blue mussel	Blue mussel	Blue mussel	Blue mussel
Sample Station	EPA Screening	CR-3	CR-3	Goose Cove	Castine 1 N	Castine 1	Castine 2	Castine 3	Castine 4
Specimens per Samples	Value[5]	9	10	15	20	20	20	20	20
Media	(mg/kg)								
Date Sampled		12/7/1974[1]	12/7/1974[1]	1993[2]	1989[3]	10/6/2001[4]	10/6/2001[4]	10/6/2001[4]	10/6/2001[4]
Metals (mg/kg)									
Aluminum	140	--	--	--	--	283.37	371.02	381.38	198.26
Arsenic	0.0021	--	--	--	--	15.13	11.97	11.89	16.5
Cadmium	0.14	0.38	0.96	9.1	9.10	7.31	6.6	6.46	6.99
Chromium	0.41	--	--	1.3	1.3	1.63	1.2	1.52	1.5
Cobalt	2.7	≥ 0.28	--	--	--	--	--	--	--
Copper	5.4	6.03	1.52	8.9	8.9	16.02	10.68	11.16	11.36
Iron	41	736	30	--	210.0	445.66	438.67	456.21	388.43
Lead	NA	7.0	1.4	6.3	6.30	11.43	8.21	9.72	11.22
Mercury	0.041	--	--	0.06	0.12	0.1059	0.1192	0.112	0.1065
Nickel	2.7	≥ 0.01	--	0.95	0.95	3.29	3.03	0.99	U
Silver	0.68	0.09	≥ 0.06	0.5	0.10	U	U	U	U
Zinc	41	28	37	180	180.0	223.87	167.52	171.38	202.54
PAHs (mg/kg)									
Naphthalene	2.7	--	--	--	--	0.0010 U	0.0010 U	0.0010 U	0.0010 U
1-Methylnaphthalene	NA	--	--	--	--	0.0010 U	0.0010 U	0.0010 U	0.0010 U
2-Methylnaphthalene	2.7	--	--	--	--	0.0010 U	0.0010 U	0.0010 U	0.0010 U
Biphenyl	6.8	--	--	--	--	0.0010 U	0.0010 U	0.0010 U	0.0010 U
2,6-Dimethylnaphthalene	NA	--	--	--	--	0.0010 U	0.0010 U	0.0010 U	0.0010 U
Acenaphthylene	NA	--	--	--	--	0.0010 U	0.0010 U	0.0010 U	0.0010 U
Acenaphthene	8.1	--	--	--	--	0.0010 U	0.0010 U	0.0010 U	0.0010 U
2,3,5-Trimethylnaphthalene	NA	--	--	--	--	0.0010 U	0.0010 U	0.0010 U	0.0010 U
Fluorene	5.4	--	--	--	--	0.0010 U	0.0010 U	0.0010 U	0.0010 U
Phenanthrene	NA	--	--	--	--	0.00073 [6]	0.00076 [6]	0.00134 [6]	0.00233 [6]
Anthracene	41	--	--	--	--	0.0010 U	0.0010 U	0.0010 U	0.0010 U
1-Methylphenanthrene	NA	--	--	--	--	0.0010 U	0.0010 U	0.00084	0.00144
Fluoranthene	5.4	--	--	--	--	0.00080 [6]	0.00092 [6]	0.00145 [6]	0.00228 [6]
Pyrene	4.1	--	--	--	--	0.00060	0.00064	0.00100	0.00136
Benz(a)anthracene	0.0043	--	--	--	--	0.0010 U	0.0010 U	0.00100	0.00089
Chrysene	0.43	--	--	--	--	0.0010 U	0.0010 U	0.00077	0.00123
Benzo(b)fluoranthene	0.0043	--	--	--	--	0.0010 U	0.0010 U	0.00077	0.00153
Benzo(k)fluoranthene	0.043	--	--	--	--	See Note 7	See Note 7	See Note 7	See Note 7
Benzo(a)pyrene	0.00043	--	--	--	--	**0.0020 U**	**0.0020 U**	**0.0020 U**	**0.0020 U**
Benzo(e)pyrene	NA	--	--	--	--	0.0020 U	0.0020 U	0.0020 U	0.0020 U
Perylene	NA	--	--	--	--	0.0020 U	0.0020 U	0.0020 U	0.0020 U
Indeno(1,2,3-cd)pyrene	0.0043	--	--	--	--	0.0020 U	0.0020 U	0.0020 U	0.0020 U
Dibenz(a,h)anthracene	0.00043	--	--	--	--	See Note 8	See Note 8	See Note 8	See Note 8
Benzo(g,h,i)perylene	NA	--	--	--	--	0.0020 U	0.0020 U	0.0020 U	0.0020 U

Notes

1. Source: Maine Department of Marine Resources, "Bioaccumulation of Trace Elements in Selected Marine Organisms," November 1975
2. Source: Maine Marine Environmental Monitoring Program, "Marine Monitoring Baseline Data, Final Report," June 1993
3. Source: Lee Doggett, State of Maine Department of Environmental Protection
4. Source: Maine Department of Environmental Protection. 2001 Surface Water Ambient Toxic (SWAT) Monitoring Program Report, Document No. DEPLW0546, October 2002
   Metals concentrations on dry weight basis.
5. EPA Screening Value = EPA Region III Risk-Based Concentration for fish ingestion. October 9, 2002. RBCs with non-cancer endpoints divided by 10 to obtain a hazard quotient of 0.1.
6. There are hits at or above the detection level in the blank for this sample.
7. Benzo(k)fluoranthene coelutes with Benzo(b)fluoranthene.
8. Dibenz(a,h)anthracene coelutes with indeno(1,2,3-cd)pyrene.
9. Shaded values indicate exceedance of one or more screening criteria
10. Bold values indicate method detection limit above screening value.

-- = Not analyzed for contaminant

Data Qualifiers

U Result is below the sample detection limit.

TABLE 2.6-5
MARINE FLORA FAUNA SAMPLING RESULTS

Category		Fin fish	Macroalgae		Marine worms
Matrix		Onchorhyncus kisutch	Fucus sp.	Chondrus crispus	Glycera dibranchiata
Common Name		coho slamon	Rockweed	Irish moss	Bloodworm
Sample Station	EPA Screening	CR-GOOSE POND	CR-3	CR-3	CR-3
Specimens per Samples	Value[5]	6	8	3	10
Media	(mg/kg)	skin-on fillets			
Date Sampled		1975[1]	12/7/1974[1]	12/7/1974[1]	12/7/1974[1]
Metals (mg/kg)					
Aluminum	140	--	--	--	--
Arsenic	0.0021	--	--	--	--
Cadmium	0.14	0.04 U	3.53	0.46	0.89
Chromium	0.41	--	--	--	--
Cobalt	2.7	--	--	4.9	--
Copper	5.4	0.67	18.4	29.6	4.67
Iron	41	--	392	1,230	57
Lead	NA	0.7 U	≥ 5	19.5	5.4 U
Mercury	0.041	--	--	--	--
Nickel	2.7	--	--	--	0.85
Silver	0.68	--	0.52	0.77	≥ 0.08
Zinc	41	8	463	188	26
PAHs (mg/kg)					
Naphthalene	2.7	--	--	--	--
1-Methylnaphthalene	NA	--	--	--	--
2-Methylnaphthalene	2.7	--	--	--	--
Biphenyl	6.8	--	--	--	--
2,6-Dimethylnaphthalene	NA	--	--	--	--
Acenaphthylene	NA	--	--	--	--
Acenaphthene	8.1	--	--	--	--
2,3,5-Trimethylnaphthalene	NA	--	--	--	--
Fluorene	5.4	--	--	--	--
Phenanthrene	NA	--	--	--	--
Anthracene	41	--	--	--	--
1-Methylphenanthrene	NA	--	--	--	--
Fluoranthene	5.4	--	--	--	--
Pyrene	4.1	--	--	--	--
Benz(a)anthracene	0.0043	--	--	--	--
Chrysene	0.43	--	--	--	--
Benzo(b)fluoranthene	0.0043	--	--	--	--
Benzo(k)fluoranthene	0.043	--	--	--	--
Benzo(a)pyrene	0.00043	--	--	--	--
Benzo(e)pyrene	NA	--	--	--	--
Perylene	NA	--	--	--	--
Indeno(1,2,3-cd)pyrene	0.0043	--	--	--	--
Dibenz(a,h)anthracene	0.00043	--	--	--	--
Benzo(g,h,i)perylene	NA	--	--	--	--

3.0 SITE PHYSICAL CHARACTERISTICS

3.1 Description of Waste Areas

Figure 2.4-7 shows the site in its current condition, with the various waste areas identified. This section describes the physical characteristics of each of the waste areas that are of potential concern as sources of contaminant releases.

3.1.1 Tailings Pile

Figure 3.1-1 shows a photograph (facing south) of the 11-acre tailings pile located is the southern portion of the Site. The tailings pile was initially a tailings "pond," as described below and is referred to as such in other reports and site maps.

Figure 3.1-1 also shows a cross section of the Tailings Pile showing how the mill tailings were accumulated behind a dike of waste rock and clay. The tailings pile was formed as a result of impoundment of flotation residue resulting from beneficiation of the metal sulfides from the ore. As tailings were deposited into the tailings pond, a series of dams were constructed to contain the tailings waste. These dams were constructed with an outer layer of waste rock and an inner layer of coarse mill tailings and clay. The final height of the dam is 82 feet above the original ground surface.

Figure 3.1-2 shows a close-up photograph of the surface of the Tailing Pile. The tailings are a fine, light colored powder that was separated from the ore after milling and flotation. The material in the center of the pile has a high moisture content and very low strength based on field observations at the site.

As part of mine reclamation, an unlined drainage channel was cut into the northern end of the tailings impoundment to prevent accumulation of water on the tailings surface after closure. Due to further consolidation of the tailings pile, subsequent to construction of the ditch, a closed depression has now formed on the surface and wetlands vegetation is established in the center of the surface of the tailings. Some minor grass has stabilized portions of the tailings pile surface (Figure 3.1-2).

A tailings water decant structure (a metal standpipe) is evident in the eastern portion of the tailings pond surface. However, the location of discharge end of the decant drain pipe and the pipe condition are unknown. According to Fred Beck (Callahan Mining Corporation Chief Geologist), there are several other drainage pipes in the tailings pond.

At least three seeps have been observed at the toe of the tailings pile. The seeps likely result from infiltration of precipitation and ponded water together with water released by continuing consolidation of the tailings. It is possible that the seeps correspond to the former discharge points of the decant structures and drains. The seeps apparently discharge directly to the Goose Pond estuary. The tailings pond is unlined and there is no leachate collection system, so it is also possible that there is seepage of leachate to underlying ground water.

3.1.2 Waste Rock Piles

There are three primary waste rock piles at the site, though waste rock is present at many places across the site where it was used for constructing pads, roads, ramps, etc. throughout the mine. The waste rock piles are referred to variously in site documentation as "tailings piles," "ore storage pads," "waste rock dumps," "Mount Callahan", and "overburden piles," but visual observations suggest that the three principal piles are comprised of waste rock or low grade ore.

According to site documentation, there are approximately 5-million tons of waste rock disposed in the various waste rock piles at the site. The waste rock piles are apparently unlined and there are no apparent leachate collection systems. The surfaces of all three of the main dumps are unreclaimed.

Waste Rock Pile 1 (WRP 1): Figure 3.1-3 shows Waste Rock Pile 1 from a vantage point at the northern end of Stink Cove. The figure shows the high elevation of WRP 1 as well as the broad lateral extent of the rock pile. WRP 1 is the largest pile of waste rock on the site, covering approximately 19 acres. This pile is referred to locally as "Mt. Callahan" and "Callahan Mountain" due to the prominent height.

The surface of WRP 1 is composed of large pieces of volcanic agglomerate, rhyolite, and talc and talc-chlorite metamorphic rocks with occasional pieces of metallic ore-bearing rocks. There is some orange staining on WRP 1 that indicates evidence of sulfide mineral oxidation possibly caused by acid rock drainage. Almost no vegetation is established on this rock pile, despite reclamation attempts by Callahan Mining Corporation.

Figure 2.4-8 showed an area of wetlands vegetation that has formed at the base of WRP 1. The soils in this area are estuarine clay that was dredged after it unexpectedly slid into the open pit area from the adjacent Stink Cove. Approximately 225,000 tons of clay was dredged from the pit and all of it was placed at the base of WRP 1.

Waste Rock Pile 2 (WRP 2): Figure 3.1-4 shows a photo of WRP 2. WRP 2 covers approximately 6 acres and is located between the Ore Pad and Goose Pond. Several seeps can be observed at the base of WRP 2 where acid rock drainage appears to be discharging at the surface. At the time the photograph was taken, the orange stained areas suspected to be seeps were noticeably moist relative to surrounding soils. Sparse vegetation is present on the pile, consisting primarily of birch trees that do not appear to be related to any reclamation efforts. The rocks observed on WRP 2 are similar to those observed on WRP 1.

Waste Rock Pile 3 (WRP 3): Figure 3.1-5 shows a photo of Waste Rock Pile 3 located adjacent to Goose Pond. WRP 3 is the smallest of the three waste rock piles, covering approximately 1.7 acres, and has been referred to in some previous reports as a tailings pile. However, field observation of this pile indicates that the side slopes and upper surface are comprised of waste rock. It is possible that there are tailings underneath this waste rock pile.

Almost no vegetation is present on WRP 3. The rocks on the face of the pile are stained orange, indicating the likely presence of acid-generating sulfide minerals.

Figure 3.1-6 shows a photo looking down from the top of WRP 3. Figure 3.1-6 shows the distinct orange color of the waste material that is indicative of sulfide mineral oxidation which can be associated with ARD. Figure 3.1-6 also shows the vegetation at the toes of the slope or WRP 3 where several trees and some of the wetland vegetation appear to have died. Further observations of the stream bank indicate the presence of blue-green leachate seeps that are also associated with dead vegetation.

Figure 3.1-7 shows an area of WRP 3 where there appears to have been a slope failure due to oversteepening. Figure 3.1-8 shows a second area where there also appears to be a minor scarp or precursor slip-surface forming adjacent to the area that slipped.

3.1.3 Dyer Cove/Former Settling Pond

Figure 3.1-9 shows a photo of Dyer Cove. Dyer Cove is a shallow embayment within the central-west portion of Goose Pond Estuary. Initially, during mining operations, water containing rock flour and silt was pumped directly from the mine-pit to Goose Cove. Due to excess siltation of Goose Cove, Dyer Cove was established as a settling pond to receive water pumped from the mine prior to discharge to Goose Cove. During operation this cove was separated from the open pit mine by a causeway. Dyer Cove was used as a settling pond for water pumped from the open-pit.

Dyer Cove is bordered by two of the Waste Rock Piles (WRP 1 and WRP 2). WRP 2 can be observed in the background in Figure 3.1-9.

3.1.4 Open Pit Mine

Figure 3.1-10 shows a historic aerial photograph of the open pit mine prior to re-filling with seawater. The mine was approximately 600 feet in diameter and 320 feet deep. Several bench-cuts are observable to catch falling rocks. The actual ore body at the bottom of the pit was located at the northern portion of the pit. Between 1968 and 1972 approximately 5-million tons of waste rock and overburden and 800,000 tons of ore-bearing rock were removed from the mine.

Figure 3.1-11 shows a photograph of the open pit mine area as it appears today. The pit was re-filled with water after mining operations ceased. The left (western edge) of the pit excavation is visible as a vertical wall along the shoreline.

There are several physical differences between the pit area today and the area as it appeared prior to mining. About half of the area of the former mining pit that is now entirely underwater, used to be land above water. Given the large depth of the excavation (approximately 350 feet deep), it is apparent that the depth of the water has been increased significantly since the mining operations and the underwater bathymetry of the mine has also been altered into a bowl shape. As tidal induced flows cause sea water to flow into Goose Pond, it is possible that the lower portion of the mining pit is now filled with sea water, due to the increased density relative to fresh water.

The ecological and hydrodynamic effects caused by the deepening of the underwater pit area if any, are not known. It is unlikely that water at the bottom of the pit exchanges with new fresh or sea water. Therefore there may be an anoxic zone at the bottom of the pit, which would prevent further oxidation of sulfides in the wall rock. The low oxygen environment would also encourage precipitation of dissolved metals as sulfide minerals. Since there is probably a higher sedimentation rate in the pit, these sulfides would be more rapidly buried.

3.1.5 Relict Facility Buildings and Structures

Figure 3.1-12 shows a historic photograph of some of the mine operations buildings during the active mining time period. Several facility buildings were present at the site during the time of operation. Most were centrally located in the operations area, but some structures were located on other portions of the site. Facility buildings in the operations area included the following.

- An assay laboratory where chemicals were stored and ore was tested
- Three rock crushers (primary and secondary crushers) used to reduce the size of the ore particles
- A metal shop building with four (removed) underground storage tanks.
- The flotation cell equipment
- An office building
- A pump house for the on-site water supply well.

Figure 3.1-13 shows the operations area as it appears today. Most of these structures were demolished as part of the reclamation effort, but some of the foundations are still observable on the site.

There is also a dilapidated structure located uphill from the tailings pile that appears to be an old building related to the former Redman Farm that was present on the site prior to construction of the mine. According to Fred Beck, Callahan Mine Corporation former Chief Geologist, Callahan Mine used this building to store test cores from exploratory drilling.

A small shed used formerly as a powder magazine is located on WRP 1.

A relic steel tank approximately 20 feet in diameter is located at the point on the shore of Dyer Cove. This structure was reportedly used for the aquaculture operation that was attempted after the mine was closed.

3.1.6 Ore Pad

Figure 3.1-14 shows a photo of the Ore Pad as it appears today. Ore that was removed from the pit was hauled up to the top of the hill located behind WRP 2 and staged in an area referred to as the Ore Pad. From this location, ore was pushed downhill into the crushers.

Figure 3.1-15 shows a close-up view of the surface of the Ore Pad. The entire surface area of the Ore Pad is stained orange from oxidation of sulfide minerals. Much of the rock is extremely weathered as a result of the acid produced by oxidation of the sulfide minerals. The photo in Figure 3.1-15 shows a piece of metal pipe that is completely disintegrated due to the acid in the surface runoff. Many samples of mineralized ore are observable on the Ore Pad.

An abandoned water supply pipe extends partially down the hill from an aqueduct located at the top of the hill. The pipe appears in broken sections, much of which are extremely weathered.

3.1.7 Discharge Pipe

During the excavation of the pit, water was pumped out into Goose Cove through a pipe extending under the Goose Falls Dam. Due to the high silt content of the discharge, Callahan Mining Corporation created a settling pond in Dyer Cove and changed the discharge point to the settling pond instead of Goose Cove. Sediment settled out of the water and then the water was discharged into Goose Cove and the discharge point for the pipe was extended 400 feet to further disperse the sediment laden water.

The silt originally discharged from the 16 inch pipe eventually covered the bottom of Goose Cove to an average thickness of about 8 inches. The total quantity of settled material was estimated to be approximately 2,500 cubic yards.

3.2 Site Geology

3.2.1 Surficial Geology

The surficial geology at the site consists primarily of bedrock outcrop and thin glacial till deposits (generally less than 10 feet thick) at the upper elevations. Marine clay and swamp deposits consisting of peat, silt, clay, and sand are located in the stream valleys and lower elevations.

Based on borings that were made by Callahan Mining Corporation, Goose Pond was originally underlain by up to 90 feet of mud and clay. The typical layering of materials in the pond consisted of a basal layer of gray gravelly silty sand (approximately 5 feet thick), overlain by 45 feet of gray silty clay and 33 feet of black organic silt.

3.2.2 Bedrock Geology

Figure 3.2-1 shows a bedrock map of the site vicinity. The Cape Rosier deposit occurs as lenses of mixed sulfides of zinc, copper, lead, and iron replacing highly sheared and altered agglomerate. The country rock of Cape Rosier and of 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. The volcanics are collectively called the Castine formation and tentatively assigned to the early or middle Paleozoic. The cover of glacial till averages only a few feet in thickness, and outcrops are numerous, especially along the shores. Four miles east of the mine as the contact between the volcanics and the southwestern end of a late Paleozoic batholith of granite and diorite. In the immediate vicinity of the Cape Rosier Mine, two agglomerates, the Goose Falls and Dyer Point, and a black rhyolite are recognized.

The Goose Falls agglomerate is characterized by fragments ranging from ¼ inch to 5 inches in size and colored grayish buff. 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 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 at the surface are rare, but drilling establishes 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 non-mineralic chlorite schist; or 2) a coarse aggregate of creamy-white non-foliate 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 chief mineralized zone (not the ore) beneath the lower diorite ranges from a few inches up to 100 feet.

Within the mineralized zone, that is, within the zone of sheared agglomerate largely or wholly altered to chlorite, talc and calcite, and carrying disseminated sulfides, there occur several sphalerite-chalcopyrite-galena ore shoots of lens-like habit. The largest of these are localized in the thickest part of the mineralized zone, in the vicinity of shafts 1 and 2. In this area, three lenses – footwall, middle, and hanging wall – lie beneath and essentially conformable in dip with the lower diorite. These lenses are separated by a very lean mineralized zone.

The mineralized zone is oriented N 17° E dipping in a southeasterly direction and was comprised of lenses of zinc-copper-lead sulfides. The country rock is composed of a series of volcanic rocks (rhyolite , andesite, agglomerate and pyroclastics), folded with northeasterly regional strike and intruded with sills and dikes of diorite.

3.3 Site Geochemistry

There are limited data available on the chemistry of materials at the site. No information exists to develop an accurate understanding of the acid generating potential of the rocks and soil at the site. Some limited information is available regarding analyses of ore and mill tailings that were developed by Callahan Mining Corporation, as discussed below.

Table 3.3-1 shows the relative concentrations of zinc, copper and lead for four ore samples from the site .

Table 3.3-1: Composition of Ore Samples			
Sample No.	***Element Percentage***		
	%Zn	***%Cu***	***%Pb***
1	28.9	1.9	0.4
2	3.3	15.4	0.0
3	23.8	2.0	11.5
4	12.3	9.3	9.1

Table 3.3-2 shows the results of elemental analysis of a sample of mine tailings prepared for the Callahan Mining Corporation. Relative to the ore analysis in Table 3.3-1, this analysis shows that the tailings are noticeably depleted in the ore elements (zinc, copper and lead) since these have been removed through the flotation process.

3.4 Site Hydrogeology and Hydrology

3.4.1 Climate

The climate is humid, slightly modified by proximity to the sea. Summer temperatures average 65°F, winter temperature 22°F. Occasional abnormal temperatures of 95°F in summer and -25°F in winter have been recorded. Total annual precipitation ranges from 35 to 55 inches, averaging about 45 inches. Precipitation is well-distributed throughout the year with fair uniformity, although May through August tend to be dry and April tends to be wet. Cumulative snowfall may occasionally reach several feet. Prevailing winds are onshore (from south) in summer, offshore (northwest) in winter. Occasional high wind velocities (70 mph) are attained.

3.4.2 Surface Water Drainage/Tidal Effects

Based on the topography, all surface water runoff from the Site discharges directly or through drainage ditches into Goose Pond Estuary. Goose Pond is tidally influenced and flushes into Goose Cove and Penobscot Bay approximately 500 feet north of the Site during the low tide cycle. Wetland areas and a small, unnamed stream are located approximately 500 to 1,000 feet west of the developed portion of the Site, in a separate surface water drainage area.

The principal surface water feature at the site is the Goose Pond Estuary. Fresh water enters the cove from upstream and salt water enters the cove at Goose Falls (during flood tides) which is now partially dammed (See Figure 3.4-1), so tidal flow is more restricted than before development of the mine. The mean tidal range in the cove is about three feet, but the range averages 10 feet outside of Goose Falls Dam. Goose Pond was approximately 5 to 30 feet deep prior to development of the mine, but now the cove is over 300 feet deep at the location of the former open pit. It is likely that other bathymetric changes have been made as a result of mining activity, including creation of a berm (now underwater) separating the pit area from Stink Cove.

Figure 3.4-1: Photo of Goose Falls Dam
Callahan Mining Superfund Site, Brooksville, Maine

Table 3.3-2: Analysis of Mine Tailings	
Element	***%***
Cu	0.15
Pb	0.06
Zn	0.71
S	5.19
Ca	4.92
Mg	9.8
As	<0.005
Cd	0.007
Sb	<0.005
Fe	7.28
Ba	0.005
Bi	<0.002
B	<0.002
Cr	<0.005
Co	<0.005
Columbium	<0.005
Gallium	0.001
Au	0.005 oz/ton
Mo	<0.002
Ni	<0.002
Paladium	<0.005 oz/ton
Ag	0.1 oz/ton
Ti	0.07
V	0.005
Yt	0.005
Zr	0.01
Na	0.3
K	0.5
From 1972 Beck Report	

A small surface water body is also ponded on top of the tailings pile. The depth of water here varies seasonally and was observed to be less than one foot in May 2002.

There are drainage features on the site which help to direct surface runoff around some of the rock piles. These drainage features are ephemeral streams, running only when there is sufficient runoff water.

3.4.3 Ground Water Flow

No sand and gravel aquifers have been located on the peninsula were the Site is located. There are no existing ground water monitoring wells or piezometers at the site, so there is no quantitative evaluation of ground water flow direction, hydraulic gradient or seepage velocity. However, it is evident that ground water in the overburden (including the multiple piles of rock and tailings at the site), is likely directed toward the Goose Pond Estuary. Given the steepness of the waste rock piles, it is likely that the horizontal hydraulic gradients in these areas are large, and given the apparent large average particle size that characterizes these deposits, it is also likely that the ground water is flowing at relatively high seepage velocities, and principally discharging to Goose Pond.

The tailings pile contains finer grained sediments, and the seepage velocity of ground water in this area is expected to be much lower.

Several seeps were observed on the steep faces of the rock piles and the tailings pile, indicating that ground water is discharging to the surface in places. Some of this seepage may re-infiltrate and some of the seepage may runoff into Goose Pond.

Ground water flow in bedrock is less predictable since there are no piezometric monitoring points. Since the cove was deepened several hundred feet into the underlying bedrock, it is likely that there is exchange of surface water and bedrock ground water.

3.5 Site Ecology

Reclamation efforts by the Callahan Mining Company were of limited success and the mine waste units and process areas appear to be largely un-reclaimed, though some areas are re-vegetated with local "volunteer" plants that have become established. Some trees that were planted over 30 years ago appear today as small saplings but many of the original plantings did not survive.

TRC conducted a site reconnaissance on August 12 and 13, 2002 to evaluate on-site ecological conditions. Information gathered during that reconnaissance identified non-vegetated areas, three aquatic/wetland habitats and four terrestrial vegetation habitat cover types present on the site and immediate vicinity. Habitats were identified based on descriptions and classifications provided in DeGraaf and Rudis (1986) and Cowardin et al. (1979). Each of the terrestrial cover types generally represents an early successional plant community that is associated with a disturbed environment. The cover types noted on the site and vicinity included the following.

Non-Vegetated Cover Types

1) Unvegetated Areas

Aquatic/Wetland Cover Types

1) Open Water (Estuarine)
2) Salt Marsh (Estuarine Emergent)
3) Shallow Marsh (Palustrine Emergent)

Terrestrial Vegetation Cover Types

1) Grass
2) Shrub – Old Field
3) Birch/Aspen Woodland
4) Spruce/Birch Woodland

Figure 3.5-1 is a map showing the distribution of various cover types. Brief descriptions of each habitat are provided below.

3.5.1 Unvegetated Areas

Areas containing no vegetation or very sparse vegetation were common on the tailings pile, waste rock pile and ore pad as well as other areas including unpaved roadways, former building/structure sites, and in the vicinity of the former settling pond (Dyers Cove). These areas predominately consisted of exposed soil and rocks with occasional scattered saplings, shrubs, and/or herbaceous vegetation present. Portions of these unvegetated areas were located on steep slopes associated with the tailings and waste rock piles.

3.5.2 Open Water (Estuarine Unconsolidated Bottom)

This cover type includes Goose Pond and Dyers Cove, an embayment to Goose Pond. Although an eight to ten foot tidal fluctuation was noted at Goose Cove (located in the Penobscot Bay) during the site reconnaissance, the tidal fluctuation within Goose Pond was considerably less (approximately 1.5 to 2.0 feet fluctuation between high and low tide). This difference is believed to be attributable to the narrow constriction (as well as the height of the constriction) associated with Goose Falls. Algae was noted to be abundant within the upper portions of Goose Pond where water depths were generally very shallow. The deepest portions of Goose Pond are associated with the former open pit mine.

3.5.3 Salt Marsh (Estuarine Emergent)

A narrow fringe of salt marsh is present along much of the shoreline of Goose Pond. The width of the salt marsh ranges from a few feet to over 100 feet. This cover type is dominated by salt-marsh cord-grass (*Spartina alternifolia*), black grass (*Juncus gerardii*), and salt-marsh plantain (*Plantago maritima*). Other species present include glasswort (*Salicornia europaea*), sea-blite (*Suaeda* sp.), spearscale (*Atriplex patula*), three-square (*Scirpus americanus*), and seaside goldenrod (*Solidago sempervirens*).

3.5.4 Shallow Marsh (Palustrine Emergent)

This habitat type is generally present slightly upgradient of the salt marsh cover type as well as within two large depressions that are present on the site. The depressions are located on the large mound where the tailings pond was formerly located (southern portion of the site) and north of the large waste rock pile (central portion of site). The predominant species in this cover type is cat-tail (*Typha angustifolia*) with Baltic sedge (*Juncus balticus*), common reed (*Phragmites australis*), rushes (*Juncus* spp.) and purple loosestrife (*Lythrum salicaria*) also present.

3.5.5 Grass

This cover type is present on the mound where the tailings pond was previously present. This habitat is located adjacent to the shallow marsh community located within the depression present

on this mound. Short (e.g., less than 12 inches in height) grass species, lichens, and paper birch (*Betula papyrifera*) seedlings comprise the vegetation within this community.

3.5.6 Shrub – Old Field

The shrub-old field habitat is present in scattered locations throughout the site. These areas are variable in plant species composition with some areas dominated by herbaceous plants and others by saplings and/or shrubs. Species noted include young eastern white pine (*Pinus strobus*), paper birch, balsam fir (*Abies balsamea*), northern white cedar (*Thuja occidentalis*) and quaking aspen (*Populus tremuloides*) with meadowsweet (*Spirea latifolia*), blackberry (*Rubus allegheniensis*), goldenrod (*Solidago* spp.), Queen Anne's lace (*Dauca carota*), thistle (*Cirsium* sp.), and various grasses also present.

3.5.7 Birch – Aspen Woodland

This early successional forested cover type is predominately present in various locations within the northern portion of the site. Vegetation is comprised predominately of sapling and pole-sized quaking aspen and paper birch trees in the overstory. Each of these tree species is considered to be a short-lived "pioneer" species that typically occur on recently disturbed sites. It is likely that this cover type will continue to expand to other areas of the site that are currently unvegetated or presently contain an earlier successional plant community (i.e., grass or shrub – old field). This habitat is succeeded by the spruce – fir woodland community.

3.5.8 Spruce – Birch Woodland

This woodland community is present within the central portion of the site and downgradient from the tailings pile. In addition, this habitat predominates in the vicinity of the site. This woodland community is comprised primarily of red spruce (*Picea rubens*) and paper birch in the tree overstory with a variety of understory vegetation present including bracken fern (*Pteridium aquilinum*) and wintergreen (*Gaultheria procumbens*). Red spruce represents a long-lived species that is often associated with disturbance.

3.5.9 Organisms

Table 3.5-1 lists potential amphibian, reptilian, avian, invertebrate, fish and mammalian receptors that were noted on the site or may potentially occur within each habitat present on the site. This table also provides foraging guild information that is useful in assessing potential exposure to site-related constituents of concern. It is expected that species inhabiting the aquatic/wetland cover types would have greater potential for exposure to constituents of concern than species that are generally associated with terrestrial cover types.

A review of Table 3.5-1 indicates that a variety of omnivorous and piscivorous bird and mammal species that forage within the aquatic/wetland habitats on the site may be exposed to site-related constituents of concern. Some of these species were noted during the site reconnaissance.

In addition to the species listed in Table 3.5-1, a variety of macroinvertebrates and fishes are also expected to inhabit the tidal wetland habitats provided by Goose Pond and the adjacent salt marsh. Invertebrate species noted during the site reconnaissance include blue crab, soft-shell clam, moon jellyfish, and common blue mussel while a dead American eel (approximately 8 inches in length) was noted near the mouth of Dyers Cove.

Table 3.5-1: Potential Ecological Receptors

Family	*Common Name*	*Scientific Name*	*Guild*	*Forage Method*	*Breeding Substrate*	*Habitat*							
						1	*2*	*3*	*4*	*5*	*6*	*7*	*8*
Amphibians													
Bufonidae	Eastern American Toad	Bufo a. americanus	I	Ground Ambusher	Water	X	X	X	X	X			X
Hylidae	Gray Treefrog	Hyla versicolor	I	Bark Ambusher	Water				X				
	Northern Spring Peeper	Pseudacris c. crucifer	I	Riparian Ambusher	Water					X			X
Plethodontidae	Redback Salamander	Plethodon c. cinereus	I	Ground Gleaner	Terrestrial Subsurface				X	X			
Ranidae	Green Frog	Rana clamitans melanota	I	Riparian Ambusher	Water								X
	Northern Leopard Frog	Rana pipiens	I	Riparian Ambusher	Water								X
	Pickerel Frog	Rana palustris	I	Riparian Ambusher	Water					X			
	Wood Frog	Rana sylvatica	I	Ground Ambusher	Water				X	X			X
Salamandridae	Red-spotted Newt	Notophthalmus viridescens	I	Water/Ground Gleaner	Water					X			X
Birds													
Accipitridae	Bald Eagle	Haliaeetus leucocephalus	P	Water-Foot Plunger	Tree Branch						X	X	
	Broad-winged Hawk	Buteo platypterus	C	Ground Pouncer	Tree-Branch		X						
	Northern Harrier	Circus cyaneus	C	Ground Pouncer	Riparian Ground						X	X	X
	*Osprey	Pandion haliaetus	P	Water-Foot Plunger	Tree Branch						X		
	Red-tailed Hawk	Buteo jamaicensis	C	Ground Pouncer	Tree-Branch	X	X	X					
	Rough-legged Hawk	Buteo lagopus	C	Ground Pouncer	Not Applicable							X	
	Sharp-shinned Hawk	Accipiter striatus	C	Air Hawker	Tree-Branch		X	X	X	X			
Alcedinidae	*Belted Kingfisher	Ceryle alcyon	P	Water Plunger	Riparian Subsurface						X		
Anatidae	*American Black Duck	Anas rubripes	O	Water Forager	Riparian Ground						X	X	X
	Blue-winged Teal	Anas discors	O	Water Forager	Riparian Ground								X
	Bufflehead	Bucephala albeola	O	Bottom Forager	Not Applicable						X	X	
	Canada Goose	Branta canadensis	H	Ground Grazer	Riparian Ground						X	X	X
	Greater Scaup	Aythya marila	O	Bottom Forager	Not Applicable						X	X	
	Green-winged Teal	Anas crecca	H	Water Grazer	Riparian Ground								X
	Mallard	Anas platyrhynchos	G	Water Forager	Riparian Ground							X	X
	Red-breasted Merganser	Mergus serrator	P	Ocean Diver	Not Applicable						X	X	
Apodidae	Chimney Swift	Chaetura pelagica	I	Air Screener	Buildings	X	X	X			X		
Ardeidae	American Bittern	Botaurus lentiginosus	C	Water Ambusher	Riparian Ground								X
	Black-crowned Night Heron	Nycticorax nycticorax	C	Water Ambusher	Riparian Twig-Branch							X	
	*Great Blue Heron	Ardea herodias	C	Water Ambusher	Riparian Twig-Branch							X	X
	Least Bittern	Ixobrychus exilis	C	Water Ambusher	Riparian Herb-Shrub								X
Bombycillidae	*Cedar Waxwing	Bombycilla cedrorum	F	Upper Canopy Gleaner	Tree-Twig			X					
Caprimulgidae	Common Nighthawk	Chordeiles minor	I	Air Screener	Buildings	X	X	X			X		
	Whip-poor-will	Caprimulgus vociferus	I	Air Screener	Ground-Herb			X					
Certhiidae	Brown Creeper	Certhia americana	I	Bark Gleaner	Tree Cavity-Crevice				X	X			
Charadriidae	Killdeer	Charadrius vociferus	I	Ground Gleaner	Ground-Herb	X	X						
Columbidae	*Mourning Dove	Zenaida macroura	G	Ground Gleaner	Tree-Branch	X	X	X		X			

Table 3.5-1: Potential Ecological Receptors

Family	Common Name	Scientific Name	Guild	Forage Method	Breeding Substrate	Habitat 1	2	3	4	5	6	7	8
Corvidae	*American Crow	Corvus brachyrhynchos	O	Ground Gleaner	Tree-Branch	X	X	X			X	X	
	*Blue Jay	Cyanocitta cristata	O	Ground Gleaner	Tree-Branch			X		X			
	*Common Raven	Corvus corax	C	Ground Scavenger	Cliff					X			
Falconidae	American Kestrel	Falco sparverius	C	Ground Pouncer	Tree Cavity-Crevice	X	X						X
Fringillidae	*American Goldfinch	Carduelis tristis	O	Ground Gleaner	Shrub	X	X	X	X	X			X
	American Tree Sparrow	Spizella arborea	O	Ground Gleaner	Not Applicable		X	X					X
	Chipping Sparrow	Spizella passerina	O	Ground Gleaner	Shrub	X	X		X	X			
	Common Redpoll	Carduelis flammea	G	Ground Gleaner	Not Applicable	X	X						
	Dark-eyed Junco	Junco hyemalis	G	Ground Gleaner	Ground-Herb		X	X	X	X			
	Evening Grosbeak	Coccothraustes vespertinus	G	Ground Gleaner	Tree-Twig			X		X			
	Field Sparrow	Spizella pusilla	O	Ground Gleaner	Ground-Herb	X	X	X					
	Indigo Bunting	Passerina cyanea	I	Lower Canopy Gleaner	Ground-Herb		X	X	X				
	Lincoln's Sparrow	Melospiza lincolnii	O	Ground Gleaner	Ground-Herb			X					
	Pine Grosbeak	Pinicola enucleator	G	Ground Gleaner	Not Applicable	X				X			
	Pine Siskin	Carduelis pinus	O	Ground Gleaner	Tree-Branch		X		X	X			
	Purple Finch	Carpodacus purpureus	G	Ground Gleaner	Tree-Branch					X			
	Red Crossbill	Loxia curvirostra	G	Upper Canopy Gleaner	Tree-Twig					X			
	Rose-breasted Grosbeak	Pheucticus ludovicianus	O	Lower Canopy Gleaner	Tree-Twig			X	X				
	Savannah Sparrow	Passerculus sandwichensis	O	Ground Gleaner	Ground-Herb	X	X					X	X
	Sharp-tailed Sparrow	Ammodramus caudacutus	O	Ground Gleaner	Ground-Herb							X	
	Snow Bunting	Plectrophenax nivalis	G	Ground Gleaner	Not Applicable	X	X						X
	Song Sparrow	Melospiza melodia	O	Ground Gleaner	Ground-Herb		X	X					
	Swamp Sparrow	Melospiza georgiana	I	Ground Gleaner	Riparian Ground								X
	White-throated Sparrow	Zonotrichia albicollis	O	Ground Gleaner	Ground-Herb			X	X	X			
	White-winged Crossbill	Loxia leucoptera	G	Upper Canopy Gleaner	Tree-Branch					X			
Gaviidae	Common Loon	Gavia immer	P	Ocean Diver	Not Applicable						X		
Hirundinidae	Bank Swallow	Riparia riparia	I	Air Screener	Terrestrial Subsurface	X	X	X			X	X	X
	Barn Swallow	Hirundo rustica	I	Air Screener	Buildings		X	X			X	X	X
	Cliff Swallow	Hirundo pyrrhonota	I	Air Screener	Buildings		X	X					X
	Tree Swallow	Tachycineata bicolor	I	Air Screener	Tree Cavity-Crevice	X	X	X				X	X
Icteridae	Baltimore Oriole	Icterus galbula	O	Upper Canopy Gleaner	Tree-Twig				X				
	Common Grackle	Quiscalus quiscula	O	Ground Gleaner	Tree-Branch		X						X
	Red-winged Blackbird	Agelaius phoeniceus	O	Ground Gleaner	Shrub		X					X	X
Laniidae	Northern Shrike	Lanius excubitor	C	Ground Pouncer	Not Applicable		X	X	X	X			X
Laridae	*Arctic Tern	Sterna paradisaea	P	Water Plunger	Beach-Rock-Dune						X		
	Common Tern	Sterna hirundo	P	Water Plunger	Beach-Rock-Dune						X		
	Great Black-backed Gull	Larus marinus	C	Coastal Scavenger	Beach-Rock-Dune						X	X	
	Herring Gull	Larus argentatus	C	Coastal Scavenger	Beach-Rock-Dune		X				X	X	
	*Ring-billed Gull	Larus delawarensis	O	Coastal Scavenger	Beach-Rock-Dune						X	X	

Table 3.5-1: Potential Ecological Receptors

Family	Common Name	Scientific Name	Guild	Forage Method	Breeding Substrate	Habitat							
						1	2	3	4	5	6	7	8
Mimidae	Brown Thrasher	Toxostoma rufum	O	Ground Gleaner	Shrub			X					
	Gray Catbird	Dumetella carolinensis	O	Ground Gleaner	Shrub			X	X				
	*Northern Mockingbird	Mimus polyglottos	O	Ground Gleaner	Shrub			X					
Paridae	*Black-capped Chickadee	Parus atricapillus	I	Lower Canopy Gleaner	Tree Cavity-Crevice			X	X	X			
Parulidae	American Redstart	Setophaga ruticilla	I	Lower Canopy Gleaner	Tree-Twig				X	X			
	Bay-breasted Warbler	Dendroica castanea	I	Lower Canopy Gleaner	Tree-Branch			X		X			
	Black-and-White Warbler	Mniotilta varia	I	Bark Gleaner	Ground-Herb				X	X			
	Blackburnian Warbler	Dendroica fusca	I	Upper Canopy Gleaner	Tree-Branch					X			
	Blackpoll Warbler	Dendroica striata	I	Lower Canopy Gleaner	Tree-Branch					X			
	Black-throated Green Warbler	Dendroica virens	I	Upper Canopy Gleaner	Tree-Branch				X	X			
	Black-throated Blue Warbler	Dendroica caerulescens	I	Lower Canopy Gleaner	Shrub				X	X			
	Canada Warbler	Wilsonia canadensis	I	Lower Canopy Gleaner	Riparian Ground				X	X			
	Cape May Warbler	Dendroica tigrina	I	Upper Canopy Gleaner	Tree-Twig					X			
	Chestnut-sided Warbler	Dendroica pensylvanica	I	Lower Canopy Gleaner	Shrub			X	X				
	Common Yellowthroat	Geothlypis trichas	I	Lower Canopy Gleaner	Ground-Herb		X	X					X
	Magnolia Warbler	Dendroica magnolia	I	Lower Canopy Gleaner	Tree-Branch					X			
	Nashville Warbler	Vermivora ruficapilla	I	Lower Canopy Gleaner	Ground-Herb			X	X	X			
	Northern Parula	Parula americana	I	Upper Canopy Gleaner	Tree-Branch					X			
	Ovenbird	Seiurus aurocapillus	I	Ground Gleaner	Ground-Herb				X	X			
	Tennessee Warbler	Vermivora peregrina	I	Upper Canopy Gleaner	Ground-Herb			X		X			
	Yellow Warbler	Dendroica petechia	I	Lower Canopy Gleaner	Shrub			X					
	Yellow-rumped Warbler	Dendroica coronata	I	Lower Canopy Gleaner	Tree-Branch			X		X			
Phalacrocoracidae	*Double-crested Cormorant	Phalacrocorax auritus	P	Ocean Diver	Riparian Ground						X		
Picidae	Downy Woodpecker	Picoides pubescens	I	Bark Gleaner	Tree Cavity-Crevice				X	X			
	*Northern Flicker	Colaptes auratus	I	Ground Gleaner	Tree Cavity-Crevice	X	X	X					
	Yellow-bellied Sapsucker	Sphyrapicus varius	O	Bark Excavator	Tree Cavity-Crevice				X	X			
Ploceidae	House Sparrow	Passer domesticus	G	Ground Gleaner	Buildings			X				X	
Podicipedidae	Horned Grebe	Podiceps auritus	O	Bottom Forager	Not Applicable						X		
Rallidae	Sora	Porzana carolina	O	Riparian Gleaner	Riparian Ground							X	X
	Virginia Rail	Rallus limicola	O	Riparian Gleaner	Riparian Ground							X	X
Scolopacidae	American Woodcock	Scolopax minor	I	Ground Prober	Ground-Herb			X	X				
	Common Snipe	Gallinago gallinago	I	Water Gleaner	Riparian Ground							X	X
	Spotted Sandpiper	Actitis macularia	O	Riparian Gleaner	Ground-Herb		X						
Sittidae	*Red-breasted Nuthatch	Sitta canadensis	I	Bark Gleaner	Tree Cavity-Crevice					X			
	White-breasted Nuthatch	Sitta carolinensis	I	Bark Gleaner	Tree Cavity-Crevice				X				
Strigidae	Barred Owl	Strix varia	C	Ground Pouncer	Tree Cavity-Branch			X		X			
	Great Horned Owl	Bubo virginianus	C	Ground Pouncer	Tree-Branch		X	X	X	X			
Sturnidae	European Starling	Sturnus vulgaris	O	Ground Gleaner	Buildings	X	X					X	

Table 3.5-1: Potential Ecological Receptors

Family	Common Name	Scientific Name	Guild	Forage Method	Breeding Substrate	Habitat 1	2	3	4	5	6	7	8
Sylviidae	Golden-crowned Kinglet	Regulus satrapa	I	Lower Canopy Gleaner	Tree-Twig					X			
	Ruby-crowned Kinglet	Regulus calendula	I	Lower Canopy Gleaner	Tree-Twig					X			
Tetraonidae	Ruffed Grouse	Bonasa umbellus	O	Ground Gleaner	Ground-Herb			X	X	X			
	Spruce Grouse	Dendragapus canadensis	O	Ground Gleaner	Ground-Herb					X			
Thraupidae	Scarlet Tanager	Piranga olivacea	I	Upper Canopy Gleaner	Tree-Twig				X				
Trochilidae	Ruby-throated Hummingbird	Archilochus colubris	O	Floral Hover-Gleaner	Tree-Branch			X	X	X			
Troglodytidae	House Wren	Troglodytes aedon	I	Lower Canopy Gleaner	Tree Cavity-Crevice			X	X				
	Winter Wren	Troglodytes troglodytes	I	Ground Gleaner	Tree Cavity-Crevice					X		X	
Turdidae	American Robin	Turdus migratorius	O	Ground Gleaner	Tree-Branch	X	X	X	X	X			
	Hermit Thrush	Catharus guttatus	I	Ground Gleaner	Ground-Herb			X	X	X			
	Swainson's Thrush	Catharus ustulatus	I	Ground Gleaner	Tree-Twig				X	X			
	Veery	Catharus fuscescens	O	Ground Gleaner	Ground-Herb			X	X	X			
	Wood Thrush	Hylocichla mustelina	O	Ground Gleaner	Tree-Branch				X	X			
Tyrannidae	Eastern Kingbird	Tyrannus tyrannus	I	Air Sallier	Tree-Twig		X	X					
	Eastern Phoebe	Sayornis phoebe	I	Air Sallier	Buildings			X					
	Least Flycatcher	Empidonax minimus	I	Air Sallier	Tree-Branch				X	X			
	Olive-sided Flycatcher	Contopus borealis	I	Air Sallier	Tree Branch					X			
	Yellow-bellied Flycatcher	Empidonax flaviventris	I	Air Sallier	Ground-Herb					X			
Vireonidae	Red-eyed Vireo	Vireo olivaceus	I	Upper Canopy Gleaner	Tree-Twig				X	X			
	Solitary Vireo	Vireo solitarius	I	Upper Canopy Gleaner	Tree-Twig					X			
Mammals													
Canidae	Coyote	Canis latrans	O	Ground Forager	Terrestrial Subsurface	X	X	X	X	X			X
	Red Fox	Vulpes vulpes	O	Ground Forager	Terrestrial Subsurface	X	X	X	X	X		X	X
Cervidae	*White-tailed Deer	Odocoileus virginianus	H	Ground Grazer	Ground-Herb		X	X	X	X		X	X
Cricetidae	Deer Mouse	Peromyscus maniculatus	O	Ground Forager	Terrestrial Subsurface			X	X	X			
	Meadow Vole	Microtus pennsylvanicus	H	Ground Grazer	Terrestrial Subsurface		X	X				X	X
	Muskrat	Ondatra zibethicus	H	Water Grazer	Riparian Subsurface						X	X	X
	S. Red-backed Vole	Clethrionomys gapperi	H	Ground Grazer	Terrestrial Subsurface			X	X	X			
	Southern Bog Lemming	Synaptomys cooperi	H	Ground Grazer	Ground-Herb								X
Erethizontidae	Porcupine	Erethizon dorsatum	H	Upper Canopy Browser	Terrestrial Subsurface					X			
Felidae	Bobcat	Felis rufus	C	Ground Stalker	Cave-Crevice			X	X	X			
Leporidae	Snowshoe Hare	Lepus americanus	H	Ground Grazer	Ground-Herb			X	X	X			
Mustelidae	Ermine	Mustela erminea	C	Ground Pursuer	Ground-Herb	X	X	X	X	X			
	Fisher	Martes pennanti	C	Upper Canopy Pursuer	Tree Cavity-Crevice			X	X	X			
	Long-tailed Weasel	Mustela frenata	C	Ground Pursuer	Terrestrial Subsurface	X	X	X	X			X	X
	Mink	Mustela vison	P	Water Diver	Riparian Subsurface					X	X	X	X
	River Otter	Lutra canadensis	P	Water Diver	Riparian Subsurface					X	X	X	X
	Striped Skunk	Mephitis mephitis	O	Ground Forager	Terrestrial Subsurface	X	X	X	X	X	X	X	X
Procyonidae	Raccoon	Procyon lotor	O	Ground Forager	Tree Cavity-Crevice	X	X	X	X	X	X	X	X

Table 3.5-1: Potential Ecological Receptors

Family	*Common Name*	*Scientific Name*	*Guild*	*Forage Method*	*Breeding Substrate*	*Habitat*							
						1	*2*	*3*	*4*	*5*	*6*	*7*	*8*
Sciuridae	Eastern Chipmunk	Tamias striatus	G	Ground Forager	Terrestrial Subsurface			X		X			
	*Red Squirrel	Tamiasciurus hudsonicus	G	Upper Canopy Forager	Tree Cavity-Crevice				X	X			
	Woodchuck	Marmota monax	H	Ground Grazer	Terrestrial Subsurface			X					
Soricidae	Masked Shrew	Sorex cinereus	I	Ground Gleaner	Terrestrial Subsurface			X		X		X	X
	N. Short-tailed Shrew	Blarina brevicauda	I	Ground Gleaner	Terrestrial Subsurface		X	X	X	X		X	X
	Pygmy Shrew	Sorex hoyi	I	Ground Gleaner	Riparian Subsurface				X	X			
	Smoky Shrew	Sorex fumeus	I	Ground Gleaner	Terrestrial Subsurface				X	X			
	Water Shrew	Sorex palustris	I	Water Gleaner	Riparian Subsurface								X
Talpidae	Hairy-tailed Mole	Parascalops breweri	I	Ground Gleaner	Terrestrial Subsurface		X	X	X	X			
	Star-nosed Mole	Condylura cristata	I	Water Gleaner	Riparian Subsurface							X	X
Vespertilionidae	Big Brown Bat	Eptesicus fuscus	I	Air Hawker	Buildings	X	X	X				X	X
	Little Brown Bat	Myotis lucifugus	I	Air Hawker	Buildings	X	X	X				X	X
	Red Bat	Lasiurus borealis	I	Air Hawker	Tree-Twig	X	X	X	X			X	X
	Small-footed Myotis	Myotis leibii	I	Air Hawker	Buildings	X	X	X				X	X
Zapodidae	Meadow Jumping Mouse	Zapus hudsonius	O	Ground Forager	Ground-Herb		X	X	X	X		X	X
	Woodland Jumping Mouse	Napaeozapus insignis	O	Ground Forager	Ground-Herb			X	X	X			
Reptiles													
Colubridae	E. Smooth Green Snake	Opheodrys v. vernalis	I	Ground Ambusher	Terrestrial Subsurface			X	X				X
	Eastern Garter Snake	Thamnophia s. sirtalis	C	Ground Ambusher	Terrestrial Subsurface		X	X	X	X			X
	Eastern Milk Snake	Lampropeltis t. triangulum	C	Ground Ambusher	Terrestrial Subsurface				X				
	Northern Redbelly Snake	Storeria o. occipitomaculata	I	Ground Ambusher	Terrestrial Subsurface				X				
	Northern Ringneck Snake	Diadophis punctatus edwardsi	C	Ground Ambusher	Terrestrial Subsurface				X	X			

NOTES:

Habitats:	1: Unvegetated Areas	5: Spruce - Birch Woodland	Guilds:	C: Carnivore	I: Insectivore
	2: Grass	6: Open Water (Goose Pond)		F: Frugivore	O: Omnivore
	3: Shrub - Old Field	7: Salt Marsh (Estuarine Emergent)		G: Granivore	P: Piscivore
	4: Aspen - Birch Woodland	8: Shallow Marsh (Palustrine Emergent)		H: Herbivore	

* Species observed on the site during site reconnaissance.

3.5.10 Observed Impacts

Figure 3.5-1 shows the location of phytotoxicity that was noted in an area located downgradient of the tailings pile within the shallow marsh (Palustrine emergent) wetland cover type. Dead cat-tails and rushes were observed within this area while apparently healthy vegetation (comprised of the same species) was present immediately adjacent to the area of observed phytotoxicity.

The area of phytotoxic effects is triangular in shape and comprised an area of approximately 450 square feet. A seep containing a blue-green precipitate that discharged to this area was noted at the base of a nearby former roadbed. The blue-green precipitate was also noted on the other side of the roadbed and within a swale that is present between the tailings pile and the large mound located where the tailings pond was formerly located. The swale is unvegetated. The presence of the dead cat-tails, trees and rushes suggests that the phytotoxicity has occurred fairly recently. If phytotoxic effects had occurred for many years, it seems unlikely that recent remnants of this vegetation would still be present within this area.

No obvious lesions or abnormalities were noted on the dead American eel observed at the mouth of Dyers Cove. Although the cause of the eel's death is unknown, possible explanations include toxic effects from site-related contaminants or other "natural", unfavorable, environmental conditions, predation (severe injury that eventually resulted in death), or human-caused (e.g., from using the eel as bait for fishing within Goose Pond).

4.0 CONCEPTUAL RISK ASSESSMENT

Figure 4.0-1 shows a diagram that presents the recognized potential source areas, release mechanisms, contaminant transport pathways and likely receptors for contamination at the site. A description of each of the aspects of the conceptual risk assessment is presented below.

4.1 Potential Source Areas

There are six primary contaminant source areas at the site: the Tailings Pile, the three Waste Rock Piles, the Ore Pad and the former Operations Area. These areas are the locations of uncontrolled accumulations of potential waste materials.

In addition, there are four secondary contaminant source areas at the site that may have primary accumulations of waste materials, or are locations of secondary accumulations of waste: Dyer Cove, Goose Pond, the Former Mine Pit and Goose Cove.

This section provides an overview of each of the potential contaminant source areas at the site.

4.1.1 Tailings Pile

The Tailings Pile contains a large accumulation of very fine grained pulverized rock from which most of the heavy metals were removed. Tailings typically are not likely to be a major contaminant source at mine sites because the ore metals and sulfide minerals have been removed or reduced and because the hydraulic conductivity of the material is so low.

However, available surface water and sediment data in the area of the Tailings Pile suggest that this area is a contaminant source for metals since some of the highest metals concentrations at the site were observed near the Tailings Pile. It is possible that the waste rock used to dam the tailings is the source of the elevated metals that were observed in this area of the site or it is possible that there is some other unknown source within the Tailings Pile.

Historical records indicate that as the tailings pile was raised in elevation, additional waste rock was placed around the edge of the tailings pond to act as a dam for the placement of additional mill tailings. This procedure led to a situation at the edge of the Tailings Pile where waste rock is likely situated on top of earlier accumulations of tailings. This situation could cause geotechnical instability of the slopes and has not been examined previously.

Based on past use and visual observations, the Tailings Pile is a potential source of metals contamination in surface soils, surface water (seeps), sediment in Goose Pond and ground water.

4.1.2 Waste Rock Piles

The Waste Rock Piles contain large accumulations of broken-up rock that were once buried deep underground. Most of the rock in the Waste Rock Piles consists of rocks that were present in the rock layers located above the target zone of ore-bearing rocks. These rocks were removed via blasting, then loaded onto trucks, hauled out of the pit and placed onto the waste rock piles. Consequently, it is unlikely that there are any organic contaminants present in the waste rock, other than possibly residual explosives.

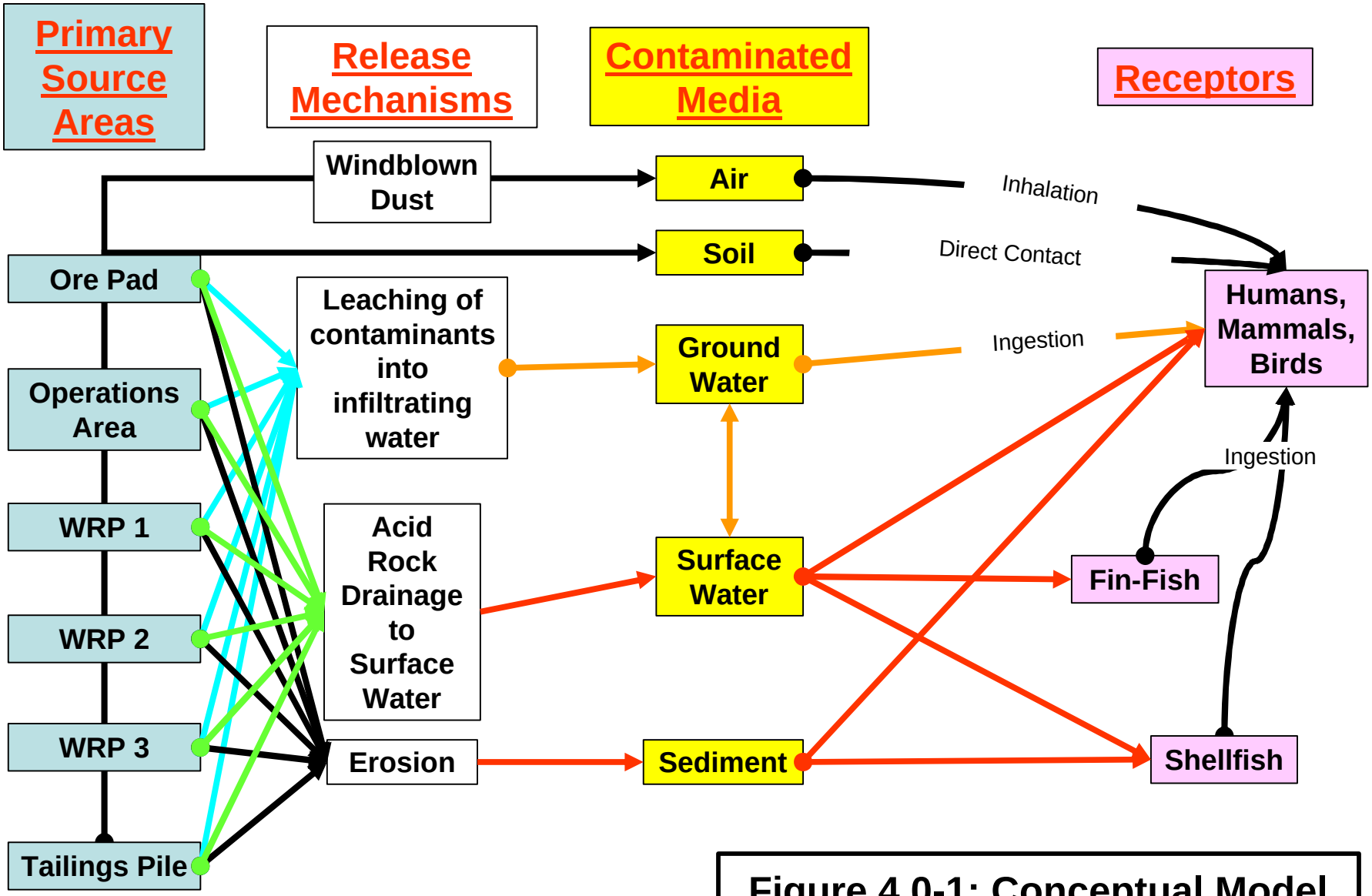

Figure 4.0-1: Conceptual Model of Site Contamination
Callahan Mining Superfund Site, Brooksville, Maine

However, the waste rock is a potential source of metals contamination, since the bedrock is comprised of naturally occurring inorganic elements and the bedrock is rich in metals. In addition, the sulfide minerals in the rock in the piles reacts with infiltrating rain water and oxygen to form sulfuric acid, which increases the ability of the infiltrating rain and surface water to leach metals from the waste rock. This "Acid Rock Drainage" can cause the leachate that discharges from the waste rock piles to have a low pH and an elevated metals concentration. Sulfide mineral oxidation is typically noticeable as an orange staining on rocks or in areas where leachate or water ponds.

The waste rock piles are not lined or covered.

Waste Rock Pile 1: Waste Rock Pile 1 contains the largest volume of waste rock, but there is only evidence of slight to moderate acid generation on WRP 1. The powder magazine is present on WRP 1 but there are no explosives test data to evaluate whether there have been releases in the area of the powder magazine. Usually, ammonium nitrate fuel oil is used for rock blasting but there were no available records to indicate what materials were used at this site.

Based on past use and visual observations, WRP 1 is a potential source of metals and explosives contamination in surface soils, surface water (seeps), sediment in Goose Pond and ground water.

Waste Rock Pile 2: Waste Rock Pile 2 is located between the Ore Pad and Dyer Cove. There is noticeable oxidation staining at the base of WRP 2, suggesting that acidic leachate is being produced and discharging either over land or underground from WRP 2.

Based on past use, available site test data and visual observations, WRP 2 is a potential source of metals contamination in surface soils, surface water (seeps and discharge to Dyer Cove), sediment in Dyer Cove and ground water.

Waste Rock Pile 3: Waste Rock Pile 3 appears to have significant staining, dead vegetation at the base of WRP 3 and blue-green leachate discharging from the base. This suggests that there may be a significant acid generation problem at this pile.

There also appears to be a potential geotechnical stability problem associated with WRP 3. Examination of the pile indicated an area where the steep slope appears to have failed. Near the failed mass of rock is a separate potential future failure surface.

WRP 3 is referred to in some historic records as a "Tailings Pile." Though no tailings are currently observable at the surface of this pile, it is possible that there is an accumulation of tailings underneath or inside of the pile. The presence of buried tailings might be one potential source for the observed geotechnical instability at WRP 3.

Based on past use and visual observations, WRP 3 is a potential source of metals contamination in surface soils, surface water, sediment in Goose Pond and ground water.

4.1.3 Ore Pad

The Ore Pad is the location where the mine placed the rock that was identified as ore-bearing. Ore was placed on the side of the hill then pushed down the hill into the rock crushers. The Ore Pad today still contains the greatest quantity of ore-bearing rocks and is the location where there is the greatest evidence of acid generation. Virtually the entire Ore Pad is stained orange and covered with disintegrated rock fragments (both indications of acid weathering). A trail of orange staining stretches from the top of the Ore Pad down the hill to the Mine Operations Area. The Ore Pad is not lined.

Based on past use and visual observations, the Ore Pad is a potential source of metals contamination in surface soils and ground water.

4.1.4 Mine Operations Area

The Mine Operations area is the former location of the machinery that was used to crush and process the rock that was staged in the Ore Pad. At lease two underground fuel storage tanks were located in this area (2,000 and 4,000 gallons respectively, but these were removed in 1987. The Operations Area included a machine shop, and assay laboratory, the two rock crushers and the flotation cells. All of these structures have been removed from the site, except for some of the old building foundations.

Based on past use and visual observations, the Mine Operations Area is a potential source of metals and organic (volatile and semivolatile) contamination in surface soils, surface water, sediment in Goose Pond and ground water.

4.1.5 Former Open Pit Mine

The Former Open Pit Mine is now located underwater in Goose Pond. This portion of the site is partially located on the Callahan Mine Property and partially under Goose Pond which is a "Water of the State" and is owned by the State of Maine. Due to the mining operations, the sediment formerly covering the underlying bedrock was removed, thereby exposing the rock. In addition, the open pit was excavated deep into the ore body, potentially resulting in the uncovering and fracturing of bedrock that is naturally enriched in metals and sulfides. Now that the mine has been inundated, these rocks are now directly exposed to the water of Goose Pond. In addition, the pit represents the deepest point on the site and is one potential receptor point for sediment that is eroded into the pond from the adjacent contaminant source areas.

Based on past use and visual observations, the Open Pit Mine Area is a potential source of metals contamination in surface water and sediments in Goose Pond.

4.1.6 Dyer Cove/Former Settling Pond

Dyer Cove was used as a settling pond for water pumped out of the pit area. As a result, the sediment contained in the cove could potentially be enriched in metals and sulfide minerals. In addition, the Cove is adjacent to other potential contaminant source areas and could be a secondary source for sediment that was deposited and accumulated in the Cove. Prior site testing data confirms the presence of elevated metals concentrations in surface water and sediment of Dyer Cove.

Based on past use and existing test data, Dyer Cove is a potential source of metals contamination in surface water and sediment.

4.1.7 Former Discharge Pipe/Goose Cove

During excavation of the mine pit, sediment laden water was pumped through a pipe that discharged into Goose Cove. Reportedly, a layer of black sediment was deposited in the cove. Elevated concentrations of metals that were measured in organisms and sediment of Goose Cove confirm that the Cove is a potential source of contamination.

Based on past use and visual observations, sediment in Goose Cove is a potential source of metals contamination in surface water and sediment.

4.2 Release Mechanisms

Releases from the contaminant source areas can occur as described below.

4.2.1 Acid Rock Drainage and Leaching of Metals into Ground Water

Precipitation that infiltrates through the various waste areas has the potential to dissolve contaminants and leach them from the rock and soil. In the areas where there are sulfide minerals present, the water and oxygen react to form sulfuric acid. The acid increases the leaching of certain metals from the soil and rock. Most metals have a higher solubility at low pH (acidic conditions) including aluminum, copper, lead, manganese, nickel and zinc which commonly are found in Acid Rock Drainage leachate. The most common metal found is iron, in the form of soluble ferrous ions, ferrous hydroxide, ferrous sulfate and ferric sulfate. The soluble iron hydroxides precipitate in non-acidic and oxic environments to cause a strong red-orange staining. The acid also causes more rapid weathering and disintegration of bedrock. The resultant acidic leachate can be greatly enriched in metals concentrations which then can be transported to the ground water.

The production of Acid Rock Drainage is dependent on the balance of the acid generation potential (AGP) and net neutralization potential (NNP) of the rock. In general, if the ratio of NNP to AGP is greater than 3, then it is unlikely that an acidic leachate will be formed. However, even if this ratio is greater than 3, large AGP values can cause leachate that is high in metals and result in rapid decomposition and weathering of the rock. Therefore, both the balance between NNP and AGP and the magnitude of the AGP are important.

The environment can naturally assimilate Acid Rock Drainage through dilution, biologic activity and neutralization, sometimes very close to the point of generation, but sometimes after migrating great distances. At Callahan Mine, the Acid Rock Drainage source areas are located close to surface water bodies, and there is not much opportunity for dilution until the leachate discharges. In addition, some of the waste rock the originally was present above the ore body contained carbonates which can buffer the acid generation. The waste rock piles containing the carbonate rocks may be less significant sources of Acid Rock Drainage, but the location of these rocks within the waste rock piles is not known. Depending on the abundance of buffering rocks and the surface area contact time of the leachate, the natural buffering capacity of the rocks can become depleted over time and again lead to increased Acid Rock Drainage as the mine waste remains exposed and uncontrolled.

4.2.2 Erosion

Contamination that is present in surface soils can be eroded via surface water runoff and transported downhill. In particular, at this site, there is little vegetation to inhibit erosion, so erosion can be an effective release mechanism for contaminants that are present on the surface.

4.2.3 Acid Rock Drainage to Surface Water

Acid Rock Drainage formed as described above, can also discharge to surface water directly or via seeps. Several known seeps are present at the site, and some are discharging blue-green water or are co-located with orange stained areas. The blue green precipitate is a copper hydroxy-oxide that forms when acidic solutions high in copper are neutralized. The importance of dilution of the Acid Rock Drainage into areas such as Dyer Cove or Goose Pond is not known, since the discharge rates and acidity of the leachate have not been measured. Regardless, the effects of Acid Rock Drainage discharging to surface water will be greatest at the edges of the surface water body where the leachate enters. The tidal range in Goose Pond is reported to be less than a foot and the surface water flow patterns in the pond are not documented, so the compensating dilution that would be caused by surface water movement cannot yet be determined.

4.2.4 Windblown Dust

Since there is little vegetation on the various terrestrial waste areas, wind is a potentially effective release/transport mechanism for contaminants present in small particles. This mechanism is particularly important at the Tailings Pile, where the contaminant mass is very fine grained, and the tailings are present over a large sparsely vegetated area. Note that large quantities of silica are likely present in the finely crushed tailings, and silica is a class A1 carcinogen. Long term inhalation of silica dust is a direct cause of silicosis, which can be fatal or lead to lung cancer.

4.2.5 Catastrophic Slope Failure

The geotechnical stability of the oversteepened rock and tailings piles is questionable, since there appear to have been prior slope failures. Decay of the rock due to sulfide oxidation can also cause instability. Geotechnical stability is a concern for the permanence of any potential remedial measures that are eventually selected as well as being a physical hazard. Though not portrayed on Figure 4.0-1, the potential for a catastrophic slope failure is present at the site, and such a failure could expose large amounts of contaminants to the environment and re-stimulate acid generation of waste rocks that are currently not exposed to infiltration or possibly release contaminants directly into the adjacent surface water bodies.

4.3 Contaminant Transport Pathways

Figure 4.3-1 portrays the various contaminant transport pathways that are likely to exist at the site. The contaminant transport pathways that are important at this site include wind, soil erosion, sediment transport, surface water flow, ground water flow and the food chain.

4.3.1 Wind

Wind is an important transport mechanism at the portion of this site where contaminants are present in small particle sizes. The specific areas where wind is likely to be effective include the

Tailings Pile and the Ore Pad. With little vegetation and the elevated topographic position of each of these areas, wind can effectively transport contaminants away from their primary source areas. Silica (a class A1 carcinogen) is expected to be a contaminant of concern at the Tailings Pile due to the high concentration of silica in bedrock (approximately 50%), the extremely fine grained size of the crushed rock particles (silt size and finer), the fact that much of the tailings are not vegetated, and dust particles can easily be transported via wind from the source area. In fact, coarse windblown tailings can be observed on the top of the Tailings Pile verifying that this mechanism is active.

4.3.2 Soil Erosion

Contaminants that are present in surface soils can be eroded via overland water flow and transported to lower elevations and typically into drainage features that exist on the site. Drainage ditches on top of the Tailings Pile and at the base of WRP 1 are possible collection points for contaminated soil that is transported by erosion. Contaminated soils at higher elevations are also susceptible to erosion, especially at the Ore Pad, which is a steeper accumulation of metal-rich crushed rock that has become disintegrated as a result of acid rock drainage. The waste rock piles are also potential areas where soil erosion can occur, but due to much larger particle sizes, erosion is likely less a concern at these locations.

4.3.3 Sediment Transport

Transport of contaminated sediment that has entered the Goose Pond Estuary is possible due to tidally-induced flow of water in and out of Goose Falls Dam. No flow information is available to evaluate the potential for sediment transport in the pond or cove. Sediment was previously transported to Goose Cove via a 16 inch drainage pipe that was used during the mining operation phase of the site.

4.3.4 Surface Water Flow

Despite some surface water controls that were constructed by Callahan Mining Corporation to mitigate this as a contaminant transport pathway, transport of contaminant by surface water is likely still occurring. Surface water erosion of materials is potentially most important at the Tailings Pile and the Ore Pile due to the smaller particle sizes that are present. Surface water seeps are also present at many of the source areas, and visual and chemical evidence of contamination at these locations is apparent. Surface water is the primary vehicle for transport of potentially contaminated sediment from Dyer Cove into Goose Pond and the Former Open Pit Area, and from Goose Pond into Goose Cove and potentially into Penobscot Bay.

4.3.5 Ground Water Flow

Contaminants that infiltrate into the ground and reach the water table can be transported by ground water advection to locations that are hydraulically down gradient. This includes possible discharge to wetlands, streams, the coves and the underlying bedrock aquifer that provides drinking water to the private residences near the site.

There are no ground water monitoring wells at the site, so there is currently no understanding of the ground water seepage velocity, hydraulic gradients, or hydraulic conductivities of the water-bearing units at the site. There are no data regarding the hydrostratigraphy at the site, so it is not

known whether there are multiple isolated water bearing zones, or if there are perched water tables or other ground water flow complications.

It is likely that the topographically elevated portions of the site, including the waste rock piles, Tailings Pile and Ore Pad are ground water recharge zones where infiltrating precipitation enters the underground flow system. These areas likely have downward vertical hydraulic gradients. Ground water flow paths probably terminate at the surface water bodies somewhere underwater or possibly discharge as springs/seeps at the ground surface.

4.4 Potential Receptors

Both human and ecological receptors potentially can be exposed to contamination that is released from the site.

4.4.1 Ecological

Section 3.5 presented an overview of the types of organisms that are or may be present at the site. If there are any contaminants that enter the surface water bodies on the site, then contaminated surface water and sediment can be ingested by aquatic organisms (fin fish and shellfish) that inhabit these areas. Terrestrial mammals and invertebrates can also ingest contaminants directly from contaminated soil and water, or through the food chain in plants and smaller organisms. Avian species can also potentially become exposed to contaminants through incidental ingestion of soil or water and through the food chain.

4.4.2 Human

There are several potential pathways that could result in human exposure to site contaminants. This analysis is conservative since there is no specific re-use plan for the site and the potential exposure scenarios might be more limited than assumed herein. Also note that there are insufficient data to determine whether certain media have actually been impacted by contamination, or whether that contamination, if present, is at concentrations that exceed the EPA's acceptable risk range. If there is no contamination, or if contamination is not present at a concentration that would cause a significant risk to human health, then some or all of these exposure pathways might not be a concern at this site.

- Dermal exposure to contaminated soil, sediment or surface water through direct contact by site trespassers, construction workers or future occupants of the site (child, teen or adult).

- Ingestion of contaminated ground water by users (child, teen and adult) of the aquifer.

- Ingestion or dermal contact with water or sediment by recreational users (child, teen and adult boaters, swimmers, bathers) in the surface water bodies.

- Inhalation of contaminated dust from the site.

- Human consumption of contaminated fin fish, shell fish, mammals or birds.

5.0 POTENTIAL/APPLICABLE REMEDIES

There are several potentially applicable technologies that could be used alone or in combination to control the exposure of humans and the ecology to contaminated media that are or may be present at the Callahan Mining Corporation Site. The applicable technologies vary depending on the media that are impacted. The need for remedial measures will be determined after completion of the Remedial Investigation and Risk Assessment (to determine if there are contaminants present that pose an unacceptable health risk) and a Feasibility Study (to evaluate the range of applicable alternatives based on site specific conditions). In order to eventually evaluate each of the following potentially applicable technologies, or possibly identify alternate technologies, certain data will be needed, and these data needs will need to be incorporated into the Remedial Investigation.

Table 5.0-1 presents a listing of each potential Contaminant Source Area and the potentially applicable General Response Actions that could are applicable to mitigate existing or potential future contaminant releases. This list is obviously preliminary and subject to change, based on the data that exist at this time, and will be adjusted as needed in the future when additional data are obtained through the Remedial Investigation or other data collection efforts.

In the following discussion, potentially applicable remedial technologies are presented for each group of similar contaminant source areas that might need to be addressed. Relative cost ranges are presented (low, medium, high, very high) as a guide to put each technology into perspective.

5.1 Waste Rock Piles/Ore Pad/Tailings Pile

5.1.1 Capping and Surface Reclamation

A commonly applied technology to address piles of waste rock and ore is to cover the materials with a layer of soil (to prevent direct exposure) and reclaim the surface with vegetation to prevent erosion. The relative cost of a vegetated soil cover system is low to medium, depending on the availability of soil.

Capping is also used to cover a waste area and prevent infiltration of precipitation through the waste. When this objective is important (i.e., when acidic or metal-bearing leachate is a problem), a more complicated cover system including geosynthetic materials is needed. This type of cover system costs more to design and install than a soil cap. The relative cost of this type of cap is high.

There are some geotechnical factors to consider if capping is selected as a remedial technology at this site. Waste Rock Piles 1 and 3 and the Tailings Pile have very steep slopes that are 50 to 80 feet high created by the successive piling of tailings and waste rock. There is evidence of slope instability at WRP 3 due to over-steepening. The steep face of these piles is comprised of large pieces of rock that are capable of maintaining high angles of repose, but placement of additional material on top of these piles for a cap could cause additional slope failures. In addition, covering of the side slopes is usually necessary, and cover systems cannot be installed or

Table 5.0-1: Potential General Response Actions		
Source Area	***Potential Release Mechanism***	***Applicable General Responses***
Waste Rock Piles and Ore Pad	Migration of leachate to surface and ground water (dissolved metals and possibly acidic leachate))	• Collection and treatment of surface seeps and impacted ground water • Reduce infiltration/generation of leachate (capping, drainage improvements, diversion of surface runoff) • Isolation from groundwater inflow (if ground water rises into waste pile) • No action (if no risk)
	Release of contaminated surface soil and runoff (suspended sediments)	• Isolation of the waste from contact with surface water (capping, cover, revegetation, drainage improvements, diversion of stormwater) • Collection, treatment and discharge of runoff (sedimentation basin, maybe with metals treatment) • No action (if no risk)
	Catastrophic release due to slope failure (rock and sediment)	• Slope buttress • Slope modification (benching, regrading to be less steep, etc.) • Excavation (partial or complete) and redisposal • No action (if no risk)
Tailings Pile	Migration of leachate to surface and ground water	• Collection and treatment of surface seeps and impacted ground water • Reduce infiltration/generation of leachate (capping, drainage improvements to eliminate pond, diversion of surface runoff) • Isolation from groundwater inflow (if ground water rises into tailings pile) • No action (if no risk)

Table 5.0-1: Potential General Response Actions		
Source Area	***Potential Release Mechanism***	***Applicable General Responses***
	Release of tailings as sediment or by wind erosion	• Isolation of the tailings from contact with surface water (capping, cover, revegetation, drainage improvements, diversion of stormwater) • Soil binders to prevent erosion of tailings • Collection, treatment and discharge of runoff (sedimentation basin, maybe with metals treatment) • No action (if no risk)
	Catastrophic release due to failure of the embankment	• Buttress for the embankment • Excavation (partial or complete) and redisposal of the tailings • No action (if no risk)
Sediments in Dyer Cove	Leaching of metals into Goose Pond	• Burial • Dredging and disposal • Natural recovery (natural burial and stabilization) • No action (if no risk)
	Sediment migration into Goose Pond	
	Bio-accumulation of metals by biota/food chain transport	
Sediments in Goose Cove	Leaching of metals into Goose Cove and Pond	• Burial • Dredging and disposal • Natural recovery (natural burial and stabilization) • No action (if no risk)
	Sediment migration out of Goose Cove	
	Bio-accumulation of metals by biota/food chain transport	
Residual sediments in former drainage to Weir Cove	Release of suspended load to Weir Cove	• Burial • Dredging and disposal • Natural recovery (natural burial and stabilization) • No Action

maintained on such steep slopes. The maximum allowable slope is less than 3:1 (vertical:horizontal). This would require large-scale reconfiguration of the waste piles in order to achieve the maximum slope criterion. It is not certain that there is sufficient area to accommodate such a reconfiguration at this site.

Another geotechnical factor is the internal strength of some of the materials that have been placed in the Waste Rock Piles and the Tailings Pile. The tailings are very fine grained and do not drain very easily which causes these materials to exhibit very low strength properties. The

center of the surface of the Tailings Pile is extremely soft and cannot currently support even medium weight loads. Tailings may also be present in WRP 3 based on unsubstantiated reports and it is also possible that some of the waste rock piles are underlain with the clay and sediment that was removed from Goose Pond during the early period of excavation. The possible unknown location of buried clay and tailings further complicates the potential implementation of a capping remedy due to long term concerns about settlement of the cover system.

Another factor to consider is the proximity to available quantities of suitable soil material for use in the cap. At the Callahan Mine, there is a large deposit of clay that was dredged from the open mine pit and placed at the foot of WRP 1. This material is likely to be fine grained, organic clay that could be blended with other materials (possibly from on-site) to create a soil mixture that might support vegetative growth.

5.1.2 Excavation/Removal/Treatment of Waste

Excavation of the entire waste volume is generally not practical due to excess cost and the difficulty in finding a suitable off-site disposal location. Excavation and removal of smaller quantities of waste may be beneficial in conjunction with other technologies or if there are limited quantities of waste that need to be addressed. In particular, the Ore Pad may represent a relatively small volume of waste that could possibly be excavated and disposed (or used as ore) off-site, or it is possible that the Remedial Investigation might identify isolated areas of elevated contaminant concentrations where excavation and off-site disposal may be warranted. The cost of this technology is high to very high.

5.1.3 Soil Binding

Soil binding uses various chemical means to modify the soil at the surface of a waste area to essentially create an in situ cover system. This technology is typically only applicable to relatively fine grained materials (i.e., tailings, not the waste rock). Various agents can be used to accomplish this including polymer/chemical surface sealers or soil amendments. Vegetation can also be used to bind the soils and prevent erosion and infiltration, especially on tailings piles.

5.2 Sediment

5.2.1 Dredging

If there are unacceptable risks to sediment on the site, then contaminated sediment could be removed via dredging. Dredging of sediment from the deeper pit area is possible, but it is not known how much sediment (if any) has accumulated on the bottom of this area. One concern of dredging is that the activity typically re-suspends a great deal of sediment that could contaminate other clean areas or temporarily affect aquatic ecology. However, the estuary is not very large and there is a dam at the discharge end that could be temporarily closed to prevent contaminated sediment discharge to Goose Cove. Depending on the extent of contaminated sediment, dredging may only be needed along the toe of the various waste area piles where they contact the water, or in isolated areas such as Goose Cove. Another method that could be used to remove contaminated sediment at this location is to dam the pond as was done previously by the mine, and excavate the contaminated sediment. Presently, the thickness of sediment in Goose pond and Goose Cove is not known. The cost of this technology is medium to high.

5.2.2 Subaqueous Capping

If the area of contaminated sediment is extensive and thick, it may be more effective to cover the sediment with material that will prevent contact by humans and/or aquatic organisms and plants. Subaqueous capping would consist of placing layers of natural and/or geosynthetic materials at the base of the pond that would isolate the contamination in place. This is a common technology for containment of contaminated sediments. Issues that need to be addressed with this technology include prevention of leaching of contaminants (metals) into the surface water, impact on existing aquatic organisms that inhabit the estuary bottom and changes to the shallow bottom bathymetry that would possibly alter the natural flow of water in the estuary. The cost of this technology is moderate.

5.3 Surface Water

5.3.1 Water Diversion

At sites where treatment technologies cannot be used to control contaminants, it may be practical to divert surface water flow. Prevention of surface runoff from entering the waste piles is an effective means of preventing contamination of surface water discharge via contact with the source waste material. Run-on controls can capture water before it enters a waste unit and becomes contaminated. In addition, this strategy can collect surface water runoff that is already contaminated and direct it to a location where it can be properly managed. A variety of engineering controls can be used to divert surface water flow including drainage ditches, retaining walls and dams. The cost of this technology is low.

5.3.2 Water Collection

Contaminated water that discharges to the surface at seeps or at the end of a drainage feature can be collected and treated prior to discharge into a surface water body or into the ground. There are several known leachate seeps at this site and if it is determined that these seeps pose an unacceptable risk, it may be possible to install a toe drain or other means to intercept the leachate prior to discharge to Goose Pond. The cost of this technology is high.

5.3.3 Water Neutralization

One mechanism that can be used to address Acid Rock Drainage is direct neutralization of the acidic condition. Neutralizing agents such as limestone, hydrated lime, soda ash, sodium hydroxide or ammonia all can be used depending upon the water chemistry and magnitude of the problem. Constructed wetlands are also utilized to take advantage of water and soil microbes that remove metals from mine drainage. The cost of this technology is medium.

6.0 REMEDIAL INVESTIGATION DATA NEEDS

6.1 Data Needs

Table 6.0-1 list the data that are needed to be developed in the RI. These data needs were developed using the data that exist for the site and the data that will be needed to complete a Feasibility Study for the site and support a Risk Assessment and Record of Decision.

6.2 Remedial Investigation Scope of Work

Appendix A contains a Scope of Work detailing the requirements for a Remedial Investigation and Feasibility Study to be conducted by the Respondents at the Callahan Mining Corporation Superfund Site. This Scope of Work is based on the conceptual model presented in this document and the identified data needs that are needed to complete a Remedial Investigation that will be adequate to support a Human Health Risk Assessment, Ecological Risk Assessment and Feasibility Study.

Table 6.0-1: RI/FS Data Needs

Data Item	*Potential Data Gaps*	*Comments*
Geology		
Bedrock Elevation	yes	• Bedrock surface is not defined.
Topography	yes	• A detailed site plan is needed to reference sample locations and for calculation of waste volumes.
Soil particle size	yes	• Data needed to evaluate contaminant fate and transport and geotechnical properties.
Hydrogeology		
Overburden hydraulic conductivity, other aquifer parameters	yes	• Data needed to evaluate fate and transport and possibly to evaluate dewatering alternatives.
Bedrock hydraulic conductivity, other aquifer parameters	yes	• No hydraulic conductivity test data are available for the bedrock. These data will be needed if bedrock aquifer is contaminated.
Vertical hydraulic gradient	yes	• Well clusters on the site to evaluate vertical hydraulic gradients in overburden and bedrock and evaluate vertical ground water transport pathways to bedrock and surface water.
Water table elevation/flow direction/seepage velocity	yes	• No water table maps exist and there are no ground water monitoring points.

Table 6.0-1: RI/FS Data Needs		
Data Item	***Potential Data Gaps***	***Comments***
Bedrock aquifer potentiometric surface	yes	• No data exist for evaluation of bedrock ground water flow direction. These data will be needed if bedrock aquifer is contaminated.
Goose Pond flow information (tidal flow, floodplain, flow rate, tidal elevation, temperature/ salinity/pH profile with depth in pit)	yes	• No data exist regarding flow in Goose Pond. These data will be needed to evaluate the fate and transport of contaminated sediment and surface water.
Sediment thickness and lateral extent	yes	• No data exist to estimate remedial costs for sediment dredging or capping.
Annual Precipitation	yes	• Data need to be compiled for site.
Ecological		
Wetland extent	yes	• No wetland delineation has been completed at the site.
Habitat	no	• TRC completed a habitat evaluation.
Bioassay	yes	• Additional data needed in Goose Pond, Goose Cove, Dyer Cove and possibly the Former Pit Area to evaluate impacts to fin fish and shell fish.
Background	yes	• No reference data exist for ecological risk assessment.
Nature and Extent of Contamination (On-site)		
Bedrock ground water	yes	• No recent test data exist to evaluate bedrock ground water quality. • Need background data for metals due to expected natural elevated metals concentrations.
Overburden ground water	yes	• No recent test data exist to evaluate overburden ground water quality.

Table 6.0-1: RI/FS Data Needs		
Data Item	***Potential Data Gaps***	***Comments***
Surface water	yes	• Water quality in Goose Cove, Dyer Cove, Goose Pond and Weir's Cove are needed for risk assessment and to determine nature and extent of contamination. • Seeps at Tailings Pile, Waste Rock Pile 3 and Waste Rock Pile 2 (and others if they exist) need to be sampled to determine nature and extent of contamination, for risk assessment and to evaluate fate and transport. • Non-chemical water quality parameters (pH, dissolved oxygen, Eh, salinity, temperature, etc.) needed in surface water bodies to evaluate fate and transport of contaminants. Data needed during all phases of tidal cycle. • Need background data for metals due to expected natural elevated metals concentrations.
Sediment	yes	• Sediment quality in Goose Cove, Dyer Cove, Goose Pond, Former Mine Pit and Weir's Cove are needed for risk assessment. • Need background data for metals due to expected natural elevated metals concentrations. • Sediment thickness and lateral extent.
Surface soil	yes	• Data needed to evaluate acid generating potential, neutralization potential, sulfur content, metals content and leachability testing of waste materials. • Need at least eight surface soil samples at each of the Waste Rock Piles, the Tailings Pile, the Ore Pad and the Former Operations Area for Risk Assessment. • Need at least eight surface soil samples at each of the Waste Rock Piles, the Tailings Pile, the Ore Pad and the Former Operations Area for Risk Assessment. • Surface soil contamination in process area not delineated. • Need background data for metals due to expected natural elevated metals concentrations.

Table 6.0-1: RI/FS Data Needs		
Data Item	***Potential Data Gaps***	***Comments***
Subsurface soil	yes	• Need at least eight subsurface soil samples at each of the Waste Rock Piles, the Tailings Pile, the Ore Pad and the Former Operations Area for Risk Assessment. • Subsurface soil contamination in process area not delineated. • Geotechnical information needed to evaluate stability of waste rock piles, Ore Pad and Tailings Pile. • Data needed to evaluate acid generating potential, neutralization potential, sulfur content, metals content and leachability testing of waste materials. • Volume of waste in rock and tailings piles. • Consolidation analysis of Tailings Pile (Cone Penetrometer data transect, moisture data, density data.
Nature and Extent of Contamination (Off-site)		
Residential Wells	yes	• No recent sampling of nearby drinking water wells has been completed.
Surface water	yes	• If Goose Cove surface water is impacted, then sampling in Penobscot Bay should be conducted.
Sediment	yes	• If Goose Cove sediment is impacted, then sampling in Penobscot Bay should be conducted. • Insufficient data in Weir Cove.
Surface soil	yes	• Need data near entry gate, on County Road side of fence. Surface soil contamination (elevated metals) not delineated

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