Nobis
Engineering a Sustainable Future

EPA Region 1 RAC2 Contract No. EP-S1-06-03

July 21, 2011
Nobis Project No. 80024

Via Electronic Submittal

U.S. Environmental Protection Agency, Region 1
Attention: Mr. Ed Hathaway, Task Order Project Officer
5 Post Office Square, Suite 100
Boston, Massachusetts 02109-3919

Subject: Transmittal of the Final Feasibility Study
Ely Copper Mine Superfund Site, Vershire, Vermont
Remedial Investigation / Feasibility Study
Task Order Number 0024-RI-CO-017L

Dear Mr. Hathaway:

Attached with this correspondence is the Final Feasibility Study for the Remedial Investigation / Feasibility Study at the Ely Copper Mine Superfund Site located in Vershire, Vermont.

Should you have any questions or comments, please contact me at (603) 724-6224, or by email at aboeckeler@nobiseng.com.

Sincerely,

NOBIS ENGINEERING, INC.

Andrew J. Boeckeler

Andrew J. Boeckeler, P.G.
Senior Project Manager

Enclosure

c: File 80024/NH

Feasibility Study

Ely Copper Mine Superfund Site
Vershire, Vermont

Remedial Investigation / Feasibility Study
EPA Task Order No. 0024-RI-CO-017L

REMEDIAL ACTION CONTRACT
No. EP-S1-06-03

FOR

US Environmental Protection Agency
Region 1

BY

Nobis Engineering, Inc.

Nobis Project No. 80024

July 2011

U.S. Environmental Protection Agency

Region 1
5 Post Office Square, Suite 100
Boston, Massachusetts 02109-3919

Nobis Engineering, Inc.

Lowell, Massachusetts
Concord, New Hampshire

Phone (800) 394-4182
www.nobisengineering.com

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Vershire, Vermont
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July 2011

Andrew J. Boeckeler, P.G.
Senior Project Manager

David W. Gorhan
Project Scientist

TABLE OF CONTENTS
FEASIBILITY STUDY
ELY COPPER MINE SUPERFUND SITE
VERSHIRE, VERMONT

SECTION **PAGE**

AC ACRONYMS AC-1

ES EXECUTIVE SUMMARY ES-1
ES.1 Introduction ES-1
ES.2 Site Description and History ES-3
ES.3 Site Investigations ES-5
ES.4 Contaminant Source Areas ES-6
ES.5 Risk Assessments ES-9
ES.6 Development of Remedial Action Objectives ES-17
ES.7 General Response Actions ES-22
ES.8 Evaluation of Alternatives ES-30
ES.9 Comparative Analysis of Alternatives ES-31
ES.10 OU2 Early Action ES-42

1.0 INTRODUCTION 1
1.1 Purpose and Scope 2
1.2 Report Organization 3
1.3 Background Information 4
1.3.1 Site Description and Setting 4
1.3.2 Topography 5
1.3.3 Population and Land Use 6
1.3.4 Vermont Copper Belt 6
1.4 OU1 Nature and Extent of Contamination 7
1.4.1 UWA 8
1.4.2 LWA 8
1.4.3 TA 9
1.4.4 ORB 9
1.4.5 Ely Brook and Tributaries 10
1.5 Site Hydrogeology 11
1.5.1 Overburden Geology 11
1.5.2 Bedrock Geology 12
1.5.3 Surficial Hydrology 12
1.5.4 Bedrock Hydrology 14
1.6 Conceptual Hydrogeologic Model 14
1.7 Basis for Action 16
1.7.1 HHRA Summary 16
1.7.2 Aquatic BERA Summary 22
1.7.3 Terrestrial Ecological Risk Assessment Summary 25

2.0 IDENTIFICATION AND SCREENING OF TECHNOLOGIES 31
2.1 Development of Remedial Action Objectives 34

TABLE OF CONTENTS (cont.)
FEASIBILITY STUDY
ELY COPPER MINE SUPERFUND SITE
VERSHIRE, VERMONT

SECTION **PAGE**

2.1.1 Applicable or Appropriate and Relevant Requirements and To-Be-Considered Criteria ... 34
2.1.2 Non-ARAR Standards ... 49
2.1.3 Development of Preliminary Remediation Goals ... 49
2.1.4 Identification of Remedial Action Objectives ... 51
2.2 Areas and Volumes of Media Exceeding PRGs ... 53
2.2.1 UWA ... 53
2.2.2 LWA ... 54
2.2.3 TA ... 54
2.2.4 ORB ... 54
2.2.5 Ely Brook and Tributaries ... 55
2.3 General Response Actions ... 56
2.4 Identification and Screening of Technologies and Process Options ... 58
2.4.1 Technology Identification ... 59
2.4.2 Technology Screening ... 59

3.0 DEVELOPMENT AND SCREENING OF ALTERNATIVES ... 60
3.1 Alternative Screening Criteria ... 60
3.2 Identification and Description of Alternatives ... 62
3.2.1 Alternative SC1 – No Action ... 63
3.2.2 Alternative SC2 – Waste Containment in the LWA Cell and in the Ore Roast Bed ... 64
3.2.3 Alternative SC3 – Waste Containment in the West Cell and in the Ore Roast Bed ... 66
3.2.4 Alternative SC4 – Off-Site Disposal and Waste Containment in the Ore Roast Bed ... 68
3.3 Screening of Alternatives ... 70

4.0 DETAILED ANALYSIS OF ALTERNATIVES ... 71
4.1 Evaluation of Alternative SC1 – No Action ... 75
4.1.1 Overall Protection of Human Health and the Environment ... 75
4.1.2 Compliance with ARARs ... 76
4.1.3 Long-Term Effectiveness and Permanence ... 76
4.1.4 Reduction of Toxicity, Mobility, and Volume through Treatment ... 76
4.1.5 Short-Term Effectiveness ... 76
4.1.6 Implementability ... 76
4.1.7 Cost ... 76
4.2 Evaluation of Alternative SC2 – Waste Containment in the Lower Waste Area Cell and in the Ore Roast Bed ... 77
4.2.1 Overall Protection of Human Health and the Environment ... 89

TABLE OF CONTENTS (cont.)
FEASIBILITY STUDY
ELY COPPER MINE SUPERFUND SITE
VERSHIRE, VERMONT

SECTION **PAGE**

4.2.2 Compliance with ARARs 90
4.2.3 Long-Term Effectiveness and Permanence 93
4.2.4 Reduction of Toxicity, Mobility, and Volume through Treatment 94
4.2.5 Short-Term Effectiveness 95
4.2.6 Implementability 97
4.2.7 Cost 99
4.3 Alternative SC3 – Waste Containment in the West Cell and in the Ore Roast Bed 99
4.3.1 Overall Protection of Human Health and the Environment 110
4.3.2 Compliance with ARARs 111
4.3.3 Long-Term Effectiveness and Permanence 115
4.3.4 Reduction of Toxicity, Mobility, and Volume through Treatment 115
4.3.5 Short-Term Effectiveness 115
4.3.6 Implementability 117
4.3.7 Cost 119
4.4 Alternative SC4 – Off-Site Disposal and Waste Containment in the Ore Roast Bed 119
4.4.1 Overall Protection of Human Health and the Environment 127
4.4.2 Compliance with ARARs 128
4.4.3 Long-Term Effectiveness and Permanence 131
4.4.4 Reduction of Toxicity, Mobility, and Volume through Treatment 131
4.4.5 Short-Term Effectiveness 132
4.4.6 Implementability 133
4.4.7 Cost 135

5.0 COMPARATIVE ANALYSIS OF ALTERNATIVES 135
5.1 Approach to the Comparative Analysis 135
5.1.1 Threshold Criteria 136
5.1.2 Primary Balancing Criteria 136
5.1.3 Modifying Criteria 136
5.2 Comparative Analysis of Alternatives 136
5.2.1 Overall Protection of Human Health and the Environment 137
5.2.2 Compliance with ARARs 138
5.2.3 Long-Term Effectiveness and Permanence 140
5.2.4 Reduction of Toxicity, Mobility, and Volume through Treatment 142
5.2.5 Short-Term Effectiveness 142
5.2.6 Implementability 145

TABLE OF CONTENTS (cont.)
FEASIBILITY STUDY
ELY COPPER MINE SUPERFUND SITE
VERSHIRE, VERMONT

SECTION **PAGE**

5.2.7 Cost 147
5.2.8 Summary 147

6.0 OU2 EARLY ACTION 147
6.1 Overall Protection of Human Health and the Environment 148
6.2 Compliance with Applicable or Relevant and Appropriate Requirements (ARARs) 149
6.3 Long-Term Effectiveness and Permanence 149
6.4 Reduction of Toxicity, Mobility, or Volume through Treatment 149
6.5 Short-Term Effectiveness 150
6.6 Implementability 150
6.7 Cost 150
6.8 State Acceptance 151

7.0 REFERENCES 152

TABLES

NUMBER

ES-1 Summary of Site Operations
ES-2 Summary of Site Investigations
ES-3 Preliminary Remediation Goals
ES-4 Estimated Areas and Volumes of Waste Rock, Tailings, and Sediment
ES-5 Applicable Treatment Technologies
ES-6 Screening of Potential Treatment Options for Waste Rock and Tailings
ES-7 Screening of Potential Treatment Options for Sediment
ES-8 Comparison Analysis of Alternatives
1-1 Summary of Site Operations
1-2 Summary of Site Investigations
1-3 COPCs and COPECs
1-4 Human Health Risk Assessment Summary
1-5 Summary of the Evidence for Ecological Risk at Pond 2 on the East Branch of Ely Brook
1-6 Summary of the Evidence for Ecological Risk at Pond 3 on the East Branch of Ely Brook
1-7 Summary of the Evidence for Ecological Risk at Pond 4 on the East Branch of Ely Brook
1-8 Summary of the Evidence for Ecological Risk at Pond 5 on the East Branch of Ely Brook

TABLE OF CONTENTS (cont.)
FEASIBILITY STUDY
ELY COPPER MINE SUPERFUND SITE
VERSHIRE, VERMONT

TABLES (cont.)

NUMBER

1-9 Summary of the Evidence for Ecological Risk in the Main Stem of Ely Brook
1-10 Summary of the Evidence for Ecological Risk in Schoolhouse Brook
1-11 Summary of the Evidence for Ecological Risk in the East Branch of the Ompompanoosuc River (EBOR)
1-12 Ecological Risk Summary Matrix – Terrestrial Exposure Areas
2-1 Summary of Location-Specific ARARs
2-2 Summary of Chemical-Specific ARARs
2-3 Summary of Action-Specific ARARs
2-4 Preliminary Remediation Goals
2-5 Remedial Action Objectives
2-6 Estimated Areas and Volumes of Waste Rock, Tailings, and Sediment
2-7 Applicable Treatment Technologies
2-8 Screening of Potential Treatment Options for Waste Rock and Tailings
2-9 Screening of Potential Treatment Options for Sediment
2-10 Alternatives Retained for Development
3-1 Screening of Alternative SC2
3-2 Screening of Alternative SC3
3-3 Screening of Alternative SC4
4-1 Chemical-Specific ARARs and TBCs for Alternative SC1
4-2 Cost Summary for Alternative SC1
4-3 Location-Specific ARARs and TBCs for Alternative SC2
4-4 Chemical-Specific ARARs and TBCs for Alternative SC2
4-5 Action-Specific ARARs and TBCs for Alternative SC2
4-6 Cost Summary for Alternative SC2
4-7 Location-Specific ARARs and TBCs for Alternative SC3
4-8 Chemical-Specific ARARs and TBCs for Alternative SC3
4-9 Action-Specific ARARs and TBCs for Alternative SC3
4-10 Cost Summary for Alternative SC3
4-11 Location-Specific ARARs and TBCs for Alternative SC4
4-12 Chemical-Specific ARARs and TBCs for Alternative SC4
4-13 Action-Specific ARARs and TBCs for Alternative SC4
4-14 Cost Summary for Alternative SC4
5-1 Comparison Analysis of Alternatives
6-1 OU2 Early Action No Action Chemical-Specific ARARs and TBCs
6-2 OU2 Early Action Institutional Controls Chemical-Specific ARARs and TBCs

TABLE OF CONTENTS (cont.)
FEASIBILITY STUDY
ELY COPPER MINE SUPERFUND SITE
VERSHIRE, VERMONT

FIGURES

NUMBER

ES-1 Site Locus
ES-2 Site Sketch
ES-3 Site Source Areas
ES-4 Alternative Remedy Map – Alternative SC2
ES-5 LWA Cell System Process Model
ES-6 ORB Cap System Process Model
ES-7 Alternative Remedy Map – Alternative SC3
ES-8 West Cell System Process Model
ES-9 Alternative Remedy Map – Alternative SC4
ES-10 SC3 Area of Potential Impact
ES-11 OU2 Early Action
1-1 Site Locus Plan
1-2 Site Sketch
1-3 Site Historical Features
1-4 Vermont Copper Belt
1-5 Site Source Areas
1-6 Shallow Overburden Groundwater Elevations and Potentiometric Surface Map
1-7 Shallow Bedrock Groundwater Elevations and Potentiometric Surface Map
1-8 HHRA-based OU1 Soil Impacts
1-9 HHRA-based OU1 Groundwater Impacts
1-10 Areas of Aquatic Ecological Impairment
1-11 Extent of Barren Areas
2-1 Site Wetland Areas
2-2 OU1 Extent of Waste Material and Soil Metals Exceedances
3-1 LWA Cell Location – Alternative SC2
3-2 LWA Cell System Process Model
3-3 Ore Roast Bed Cap System Location
3-4 ORB Cap System Process Model
3-5 Alternative Remedy Map – Alternative SC2
3-6 West Cell Location – Alternative SC3
3-7 West Cell System Process Model
3-8 Alternative Remedy Map – Alternative SC3
3-9 Waste Areas – Alternative SC4
3-10 Alternative Remedy Map – Alternative SC4
4-1 SC2 Area of Potential Impact
4-2 SC3 Area of Potential Impact
4-3 SC4 Area of Potential Impact
6-1 OU2 Early Action

TABLE OF CONTENTS (cont.)
FEASIBILITY STUDY
ELY COPPER MINE SUPERFUND SITE
VERSHIRE, VERMONT

APPENDICES

A Cost Detail
B Present Value of Annual and Periodic Costs – Years 1 through 30

ACRONYMS

ABA	Acid Base Accounting
ACHP	Advisory Council on Historic Preservation
AMD	Acid Mine Drainage
APE	Area of Potential Effect
ARAR	Applicable or Relevant and Appropriate Requirement
ARD	Acid Rock Drainage
ATV	All Terrain Vehicle
AVS	Acid Volatile Sulfides
BERA	Baseline Ecological Risk Assessment
BMPs	Best Management Practices
CAD	Computer Aided Design
CBRs	Critical Body Residues
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CERCLIS	Comprehensive Environmental Response, Compensation, and Liability Information System
CFR	Code of Federal Regulations
COC	Contaminant of Concern
COPC	Contaminant of Potential Concern
COPEC	Contaminant of Potential Ecological Concern
CSM	Conceptual Site Model
CTE	Central Tendency Exposure
cy	Cubic Yards
CWA	Clean Water Act
DEC	Vermont Department of Environmental Conservation
EBOR	East Branch of the Ompompanoosuc River
EBT	Ely Brook Tributary
EDD	Estimated Daily Dose
EEQ	Ecological Effect Quotient
ELCR	Excess Lifetime Cancer Risk
EPC	Exposure Point Concentration
EPSCP	Erosion Prevention and Sedimentation Control Plan
EU	Exposure Unit

ACRONYMS (cont.)

FOS	Factor of Safety
FR	Federal Register
FS	Feasibility Study
GPM	Gallons per Minute
GRA	General Response Actions
HHRA	Human Health Risk Assessment
HI	Hazard Index
HQ	Hazard Quotient
IEUBK	Integrated Exposure Uptake Biokinetic
ILCR	Incremental Lifetime Cancer Risks
IR	Incremental Risk
LDPE	Low Density Polyethylene
LTM	Long Term Monitoring
LWA	Lower Waste Area
MCL	Maximum Contaminant Level
MCLG	Maximum Contaminant Level Goal
mg/Kg	Milligram per Kilogram
MOA	Memorandum of Agreement
NAPLs	Non Aqueous Phase Liquids
NRWQC	National Recommended Water Quality Criteria
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NHPA	National Historic Preservation Act
Nobis	Nobis Engineering, Inc.
NPDES	National Pollution Discharge Elimination System
NPL	National Priorities List
NWI	National Wetlands Inventory
O&M	Operations and Maintenance
OMB	Office of Management and Budget
ORB	Ore Roast Bed
OSHA	Occupational Safety and Health Administration
OSWER	Office of Solid Waste and Emergency Response
OU	Operable Unit

ACRONYMS (cont.)

PAL	Public Archaeology Laboratory
PRGs	Preliminary Remediation Goals
PUBH	Palustrine with an unconsolidated bottom
QA/QC	Quality Assurance/Quality Control
RA	Remedial Action
RAO	Remedial Action Objectives
RCRA	Resource Conservation and Recovery Act
RfD	Reference Dose
RI	Remedial Investigation
RMEs	Reasonably Maximum Exposures
ROD	Record of Decision
SA	Smelter Area
SC	Source Control
SEM	Simultaneously Extracted Metals
SF	Smoke Flue
SHB	Schoolhouse Brook
SHPO	State Historic Preservation Officer
Site	Ely Copper Mine Superfund Site
SLERA	Screening Level Ecological Risk Assessment
SOW	Statement of Work
SPA	Slag Pile Area
SWPPP	Storm Water Pollution Prevention Plan
TA	Tailings Area
Task Order	Task Order Number 0024-RI-CO-017L
TBC	To-Be-Considered
T&D	Transportation and Disposal
TRVs	Toxicity Reference Values
UCL	Upper Confidence Limit
µg/dL	Micrograms per Deciliter
µg/L	Micrograms per Liter
USEPA	United States Environmental Protection Agency
$\mu g/m^3$	Micrograms per Cubic Meter

ACRONYMS (cont.)

URS	URS Corporation
USACE	United States Army Corps of Engineers
USDA	United States Department of Agriculture
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
UWA	Upper Waste Area
VCMC	Vermont Copper Mining Company
VP	Vernal Pool
VSS	Vegetative Support System
VTANR	Vermont Agency of Natural Resources
VTDEC	Vermont Department of Environmental Conservation
VTSWMR	Vermont Solid Waste Management Rules
VTWQS	Vermont Water Quality Standards
WOE	Weight-of-Evidence
XRF	X-ray Fluorescence

ES EXECUTIVE SUMMARY

ES.1 Introduction

This Operable Unit (OU) 1 Feasibility Study (FS) was prepared by Nobis Engineering, Inc. (Nobis) for the United States Environmental Protection Agency (USEPA) under Contract Number EP-S1-06-03, Task Order Number 0024-RI-CO-017L (Task Order). The work was performed in accordance with the September 27, 2007 USEPA Statement of Work (SOW). The Task Order SOW includes the completion of a Remedial Investigation (RI)/FS at the Ely Copper Mine Superfund Site (the "Site") located in Vershire, Vermont. The goal of the RI/FS is to support the selection of a remedy that eliminates, reduces, or controls risks to human health and the environment and can be used to prepare a well-supported Record of Decision (ROD).

The Site is an abandoned copper mine located in Vershire, Orange County, Vermont and encompasses approximately 350 acres, including areas containing an estimated 172,000 tons of waste rock, tailings, ore roast beds, slag heaps, smelter wastes, and over 3,000 linear feet of Underground Mine Workings with shafts and adits opening into the flooded mine. No buildings remain at the Site. Remnant foundations, pads, and stone walls, including a 1,400 foot long smoke flue, demark the location of former Site structures including a former flotation mill and the smelter plant. The Site has been determined to be eligible for listing in the National Register of Historic Places by USEPA in consultation with the State Historic Preservation Officer (SHPO). The location of the Site and RI/FS Study Area is shown in Figure ES-1.

The ore body was discovered in 1813 and explored in the 1830s. Significant mine activities began in 1853 and lasted until 1905. Prior to 1867, ore was shipped to smelters along the east coast for processing; on-site smelting operations began in 1867 and were expanded over time to include a large 24-furnace smelter plant located along the southern edge of the Site. During World War I, a flotation separation mill was constructed and operated for a short period. Table ES-1 presents a history of Site operations.

The Site was added to the USEPA National Priorities List (NPL) in September 2001 (47583 – 47591 Federal Register / Vol. 66, No. 178 / Thursday, September 13, 2001 / Rules and Regulations). The Site is undergoing investigation and clean-up activities pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act, as amended (CERCLA), 42 USC § 9601 *et seq.*, and the National Oil and Hazardous Substances Pollution

Contingency Plan (NCP), 40 Code of Federal Regulations (CFR) Part 300. The Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS) identification number for the Site is VTD988366571. Table ES-2 presents a summary of investigations conducted at the Site.

Purpose and Scope

To facilitate the evaluation and implementation of actions to reduce, eliminate, or control actual or potential human-health and ecological risks, the Site has been divided into two Operable Units (OUs). OUs are discrete actions that comprise incremental steps toward a final remedy. An OU eliminates or mitigates a release, a threat of a release, or an exposure pathway (USEPA, 1988b), and may reflect the final remediation of a defined portion of a site or may be implemented as an interim measure. The two OUs for the Site are described below and shown in Figure ES-2:

- OU1 will include the waste rock, tailings, roast beds, and contaminated soil, along with the surface water and sediment for all areas of the Ely Brook valley (except the Smelter/Slag Area and within any Underground Mine Workings).

- OU2 will include the all of the groundwater impacted by the Site (including the Underground Mine Workings), the sediment of Schoolhouse Brook, and the Smelter/Slag Area.

Addressing source control issues in OU1 first and then evaluating the OU1 remedy's affect on the remaining Site will enable a better understanding of the impacts of the OU1 source control measures on groundwater and on the Smelter/Slag Area discharges into Schoolhouse Brook. This will allow the development of appropriate remedial alternatives for OU2, which, if necessary, will be discussed in a future FS.

The purpose of this FS Report is to identify and evaluate appropriate remedial alternatives for the OU1 areas of the Site posing unacceptable human health or environmental risks as determined from information gathered during the RI, including the Human Health Risk Assessment (HHRA) (Nobis, 2010b and 2010c) and the Baseline Ecological Risk Assessment (BERA) (USEPA, 2010). The FS Report evaluates alternatives based upon the criteria defined

in the NCP and CERCLA. As required by the statute, a no-action alternative is considered in the evaluations and a detailed analysis of selected remedies is provided for each area. FS activities include:

- developing remedial action objectives (RAOs);
- developing general response actions (GRAs);
- identifying areas and volumes requiring remedial action (RA);
- identifying and screening of remedial technologies and process options;
- developing and screening of RA alternatives;
- conducting a detailed analysis of retained RA alternatives; and,
- conducting a comparative analysis of retained RA alternatives.

This FS does not select a preferred alternative for OU1, but rather describes the alternatives under consideration. The preferred alternative will be identified in the Proposed Plan and will be subject to public comment. After addressing State and public comments on the proposed alternative, a final remedy selection will be described in a ROD. In addition to the OU1 Remedial Action, an OU2 Early Action is being implemented to restrict public access to overburden and bedrock groundwater contamination and the surface soil within the Smelter/Slag Area.

ES.2 Site Description and History

The Ely Copper Mine Superfund Site is an abandoned copper mine located in Vershire, Orange County, Vermont. The Site encompasses approximately 350 acres along the south slope of Dwight Hill, to the north of Schoolhouse Brook and South Vershire Road. The Site includes features such as waste rock and mine process waste piles, intact and collapsed adits and shafts, remnant foundations of former mine operation buildings, a 1,500-foot-long smoke flue, and over 3,000 linear feet of underground workings. Waste areas include a former ore roast bed (ORB), upper and lower waste rock areas (UWA and LWA, respectively), a tailings area (TA), a former smelter area (SA), a smoke flue (SF), and a slag pile area (SPA), all located within the watershed of Ely Brook (Figure ES-3). Ely Brook joins Schoolhouse Brook at the southern margin of the Site. Schoolhouse Brook flows eastward approximately 1.75 miles to its confluence with the East Branch of the Ompompanoosuc River (EBOR). A major eastern

tributary to Ely Brook, Ely Brook tributary (EBT)2, drains from a former reservoir and a series of ponds located east of the mine waste areas.

The Site lies within the Devonian Gile Mountain Formation, in which the primary ore minerals include pyrrhotite, chalcopyrite with minor sphalerite and pyrite (Slack and others, 2001). The Site was added to the Superfund listing in September 2001 due to environmental impacts from acid rock drainage (ARD) on Ely Brook and Schoolhouse Brook. The Site is also eligible for the National Register of Historic Places due to its historical aspects (Hathaway and others, 2001).

The Ely Copper Mine is one of three major historic copper mines located within Besshi-type ore deposits that comprise the Vermont Copper Belt including the Elizabeth, Ely, and Pike Hill Mines within a 20 mile long area from south to north in the belt. The ore body was discovered in 1813 with significant mining activities beginning in 1853 by the Vermont Copper Mining Company (VCMC) and lasting until 1905 (PAL, 2005). Ore roasting began with the initial construction of the smelter in 1867 to reduce the sulfur content of the ore prior to smelting. Mine operations experienced a boom between 1872 and 1880, a period during which Ely Village expanded and the Town of Vershire grew to a population of about 1,900 in contrast to today's population of about 630 people. By 1876, sulfur fumes from the roast beds and smelter had eliminated the vegetation in the valley. A stone slab flue approximately ¼ mile long was built from the smelter up the eastern side of the valley with the intention of reducing fumes in the valley, but the flue reportedly never functioned effectively. By 1879 the smelter building was expanded to 24 furnaces and a length of 700 feet to accommodate ore from the Pike Hill Mines. During this time, the smelter slag pile was expanding south of the building toward Schoolhouse Brook. Between 1883 and the close of the mine in 1905, ownership changed hands several times and production was sporadic. An attempt to rejuvenate copper production in 1900 was unsuccessful due to both the lack of ore at the 3,500-foot downdip limit of the mine and low copper prices. In 1905, equipment was stripped from the Site and buildings were sold, moved, or demolished. In 1917, a flotation mill was constructed in an attempt to recover copper from the mine dumps. The flotation mill operated for only a short period until the end of World War I, at which time the price of copper fell, closing the operation. In 1949-50, attempts were made to recover copper from the mine waste piles and 60,000 tons of waste rock/ore assayed at about 1 percent copper were transported to the Elizabeth Mine for processing. Since 1950, the Site has been used for timber management and recreational activities, including hunting, snowmobile riding, and horseback riding. The Site is often visited by those interested in the

remnants of the mining activities or the Site geology. All-Terrain Vehicle (ATV) tracks are observed on several of the waste piles.

ES.3 Site Investigations

Since 1998, a considerable amount of data has been generated as the result of previous investigations conducted at the Site. USEPA has retained the U.S. Army Corps of Engineers (USACE), the U.S. Geological Society (USGS), URS Corporation (URS), and Nobis to perform work at the Site. Additional information has been contributed from studies performed by the State of Vermont. In 2002, the USACE, in cooperation with the USGS, completed a study of spring runoff from the Site to characterize the geochemical diversity of water sources in the Ely Brook Watershed, which included sampling from seeps in mine waste areas, Ely Brook and tributaries, Schoolhouse Brook, and the EBOR. This study documented highly acidic and highly metal-laden runoff from the mine areas (Holmes and others, 2002). Between 1998 and 2007, the USGS conducted sampling surveys and completed a series of studies at the Site, which included sampling and analysis of the various solid mine waste materials and sediment to characterize the materials, assess their acid-generating potential, and assess their potential for leaching metals (Piatak and others, 2004a; 2004b; 2007).

From 2005 through 2008, URS, in conjunction with the USACE and USEPA, completed extensive field studies, including a habitat characterization study of the Site (URS, 2005; 2009). Field investigations included test pits, borings, monitoring well installations, and the collection of surface water and sediment (over 30 locations), surface and subsurface soil (over 150 locations), and groundwater samples (approximately 30 wells) from the Site (URS, 2009). URS evaluated surface and subsurface soil samples from waste areas and transition zones around waste area, including off-site background soil metal concentrations. These data have been incorporated directly into the RI/FS analytical database for the Site.

In 2007, the Vermont Department of Environmental Conservation (VTDEC) completed an aquatic life use attainment assessment of Ely Brook, Schoolhouse Brook, and the EBOR. The assessment included the evaluation of fish and macroinvertebrate community data, which indicated impairment for portions of Schoolhouse Brook and Ely Brook likely related to runoff from the Site (VTDEC, 2007). In 2006 and 2007, the USGS, in conjunction with USEPA, conducted a detailed characterization of surface water, sediment, porewater, and fish and

macroinvertebrate communities in Ely Brook, Schoolhouse Brook, and the EBOR in support of the Aquatic BERA (TechLaw, 2008; Seal and others, 2010). These studies included toxicity tests of surface water, sediment, and porewater from each surface water reach.

In 2009, Nobis completed extensive supplemental field investigations to complete the RI. Investigations included sampling of surface/subsurface soil (over 80 samples), groundwater (2 rounds from over 40 wells), surface water (2 rounds over 30 locations, including 4 vernal pools), porewater (7 locations), sediment (16 locations), and biota. Residential drinking water samples were also collected from 6 locations near the Site. Overburden, shallow, and deep bedrock well installations were completed, along with packer testing and borehole geophysical characterization of the deep bedrock at the Site (Nobis, 2010a). Soil sampling included on-site laboratory X-ray fluorescence (XRF) analysis of over 340 soil samples from an extensive network of 26 sample transects. Sediment sampling of the Lower Reach of Ely Brook included detailed evaluation of three sediment transects to assess the vertical distribution of waste rock sediment in the brook. Investigations included the collection of soil and sediment samples for geotechnical analyses to document the physical characteristics of waste materials and support the feasibility study evaluation of remedial options. Biota sampling to support the terrestrial BERA included 8 composite samples of invertebrates and 107 small mammals from 5 transects in select transition zone areas.

ES.4 Contaminant Source Areas

Waste material from over 100 years of mining activities can be found across the entire Site, from the mine entrances high on Dwight Hill to Schoolhouse Brook. The major issue at the Site is acid rock drainage (ARD), which occurs when sulfide mineral-bearing rock and ore are exposed to oxygen and water, thereby creating a low-pH leachate (contaminated water percolating through the impacted soil and infiltrating the groundwater). At low pH, many of the metals that were bound in the ore and native soil become soluble and dissolve into the leachate. The leachate from the Site often contains elevated levels of aluminum, cadmium, cobalt, copper, iron, manganese, and zinc that are likely from the locally mined ore. Aluminum and manganese are also contributed by the leaching of metals in the native soil. In addition to the oxidation of the sulfide-bearing minerals, the cyclic formation and subsequent dissolution of evaporative metal salts on exposed waste ore and tailings also contributes to ARD at the Site. Metal salts form on the surfaces of the tailings and waste ore as metal-containing acidic

moisture evaporates. The metals stored in these salts are dissolved and remobilized during subsequent rainfall events. This run-off is eventually conveyed to receiving streams, resulting in an increase in the waterway's metals concentration and load.

Metals associated with ARD at the Site have been detected at elevated concentrations in groundwater, surface water, soil, and sediment. ARD directly affects both groundwater and surface water quality at the Site by lowering the pH and contributing elevated concentrations of metals to these media. This also occurs at the outlet of the adits, where impacted mine waters discharge directly to the ground surface as acid mine drainage (AMD). In addition, the tailings, weathered waste ore, roasted ore, and byproducts generated from the smelting process (i.e., slag) have been transported from the original areas of deposition by erosion and re-distributed nearby, causing elevated concentrations of metals in the soil adjacent to the waste areas. Some of these materials have been conveyed by overland flow, resulting in elevated concentrations of metals in sediment along these Site drainage ways, including: Ely Brook, four tributaries to Ely Brook, Schoolhouse Brook, and the EBOR.

The RI divided the Site into several sub-areas that may be contributing contamination to the surface water, groundwater, or sediment. The sub-areas (shown in Figure ES-3) that fall within OU1 are the UWA; LWA; TA; and ORB. The sub-areas within OU2 are the SA, SF, and SPA. In addition, due to the significant volume of mine waste present in the sediment and banks along Lower Ely Brook, this area is also considered a potential source area. Evaluation of results from each of these areas has led to the following findings.

Operable Unit 1 Source Areas

UWA: The UWA is comprised of a series of terraced, overlapping mine waste rock piles of varying thickness in the upper portion of the Ely Brook valley on the south side of Dwight Hill. The UWA covers an area of approximately 8.5 acres and contains about 73,000 cubic yards of mine waste. The waste piles within the UWA are up to 22 feet thick. The UWA sits just downslope of the Main Adit for the underground workings. A series of shafts and adits (including the Main Adit) are found within and adjacent to the UWA. The primary limits of the UWA were defined by the physical presence of acid generating mine waste. The edges of the UWA were also delineated to include the areas where cobalt, copper, and iron exceed

preliminary remediation goals (PRGs) established in the FS. A series of ponds numbered 1 through 5 define the downslope extent of the UWA.

Native soil underlies portions of the UWA, but some of the waste sits directly on bedrock. The groundwater extends into the lower portion of the piles, particularly during spring snowmelt and after periods of substantial rain. Water coming into contact with the mine waste creates an acidic leachate containing high levels of contamination that drains from the UWA into groundwater and several tributaries of Ely Brook (EBT2, EBT3, and EBT4A).

LWA: The LWA occupies approximately 6.4 acres of bare waste rock in the central portion of the Site and contains an estimated 29,000 cubic yards of waste rock. The LWA sits below the UWA and the foundation of the Former Flotation Mill, between the Ore Roast Bed and Ely Brook. Two major Site surface water features, EBT2 and EBT3, traverse the LWA. EBT3 merges into EBT2 prior to Ely Brook and the combined flow represents one of the most significant tributaries to Ely Brook. There are no distinct piles in the LWA. The waste material is relatively thin, typically on the order of 5 ft thick, in contrast to the thicker waste piles in the UWA. The primary limits of the LWA were defined by the physical presence of acid generating mine waste. The edges of the LWA were also delineated to include the areas where cobalt, copper, and iron exceed PRGs.

A relatively thin layer of native soil with variable thickness underlies the LWA. It is possible that some of the waste sits directly on or in close proximity to bedrock. The groundwater extends well into the waste within the LWA. Water coming into contact with the mine waste creates an acidic leachate containing high levels of contamination that drains from the LWA into groundwater and several tributaries of Ely Brook (EBT2, EBT3, and EBT5). These tributaries run across the waste within the LWA.

TA: The Tailings Area encompasses approximately 0.7 acres and contains an estimated volume of 3,600 cubic yards of tailings. The tailings waste are a remnant of the operation of the former floatation mill and are a fairly uniform fine sand/silt material produced from mined ore. The TA is located within the northwest portion of the LWA. There is no well defined tailing pile, but a tributary of Ely Brook (EBT3) has cut a channel that exposes this waste. A relatively continuous layer of glacial till approximately 10 feet thick is interpreted to underlie the Tailings Area, which may limit impact to groundwater beneath the tailings pile. Similar to the LWA, the

Tailings Area is saturated with groundwater and portions of waste source form the watershed of EBT3. Water coming into contact with the tailings creates an acidic leachate containing high levels of contamination that drains from the TA into groundwater and EBT3.

ORB: The ORB was the primary location for the roasting of the ore excavated from the Ely Mine. The ORB covers an area that is approximately 900 feet long and 200 feet wide, abutting the eastern margin of the access road, southeast of the LWA. The ORB is about 8 feet thick, covers about 2.2 acres, and contains approximately 10,300 cubic yards of roasted ore. The western limit of the ORB is demarked by a high stone slab retaining wall. The sparsely vegetated ORB soils are distinguishable from soils in the adjacent LWA by the deep red color of the hematite-rich soil. A small tributary to Ely Brook, EBT1, crosses the roast beds and the access road at a location where the retaining wall has collapsed. An abandoned exploratory shaft is located along the northeast margin of the ORB. The roasted ore in this area still contains significant levels of metals, but the waste material does not produce acidic leachate and appears to be a much less significant source of contamination than the UWA, LWA, and TA.

Ely Brook: The Lower Ely Brook contains significant accumulations of waste material that has eroded from the UWA, LWA, and TA. The waste is up to 3.5 feet thick within the stream channel and portions of the Lower Ely Brook bank. The estimated volume of waste material within the banks of the Lower Ely Brook is 3,900 cubic yards, encompassing an area of 2.5 acres. The waste material within Ely Brook contains elevated concentrations of cobalt, copper, and iron and may be a contributing source to the surface water impacts.

ES.5 Risk Assessments

Human Health Risk Assessment (HHRA) Summary

Nobis prepared the HHRA of the Site for the USEPA. The HHRA presents a description of the risk assessment methods employed for the Site, as well as a summary of the results. The objective of the HHRA was to estimate potential current and future human health risks from the presence of contamination in the soil, groundwater, sediment, and surface water. The HHRA quantitatively evaluates non-cancer health hazards, cancer risks, and lead exposures.

Data from soil, sediment, groundwater, surface water, and fish tissue were evaluated to identify maximum analyte concentrations for comparison to screening level benchmarks to determine human health contaminants of potential concern (COPCs). With regard to soil, the entire Site was combined as a single exposure area because the potential for exposure and contaminant distribution patterns do not indicate any unique areas of potential exposure. For surface water, three exposure areas were considered: the on-site tributaries/Ponds/Ely Brook, Schoolhouse Brook below the Ely Brook confluence and the EBOR below the Schoolhouse Brook confluence. Potential risk from groundwater was evaluated for individual flow units, including, overburden, shallow bedrock, and deep bedrock. Off-site groundwater was evaluated separately using residential well sample results. Fish tissue data were used to assess potential risk in Schoolhouse Brook and the EBOR.

Exposure scenarios are the assumptions used to define the potential use that may bring a person into contact with contamination. For the Ely Mine, the following exposure scenarios were considered:

- The potential risk to a person living on or adjacent to the Site and coming into contact with Site soil or indoor dust that originated as Site soil. The person was assumed to come into contact with the soil or dust for 350 days per year.

- The potential risk to a person installing a drinking water well in the contaminated groundwater at the Ely Mine Site and consuming 2 liters of water every day.

- The potential risk to a person visiting the Site 104 times per year and coming into contact with contaminated soil.

- The potential risk to a person visiting the Site 22 times per year and wading and/or swimming in Ely Brook or Schoolhouse Brook.

- The potential risk to a person whose work activities would require disturbance of the mine waste and inhaling the dust 60 days per year.

The results presented above for the HHRA indicate the following:

For the OU1 media and areas

- Surface and subsurface soils in the OU1 area contain levels of cobalt, copper, and iron that could represent an unacceptable threat to human health for children residing on and near the Site and coming into contact with the contamination 350 days per year.

- Surface and subsurface soil in the OU1 area would not represent an unacceptable threat to human health for adults residing on and near the Site and coming into contact with the contamination 350 days per year.

- Human contact with the soil in the OU1 area under less frequent exposure scenarios (recreational activities) was not considered to represent an unacceptable threat to human health.

- Human contact with sediment and surface water as a result of recreational activities in the OU1 area were also not considered to represent an unacceptable threat to human health.

- An unacceptable risk was not found to be associated with a person working in the waste material in the OU1 area for up to 60 days per year. More frequent contact, however, would result in an unacceptable risk associated with the inhalation of manganese and aluminum dust. The aluminum and manganese concentrations in soil were not significantly different from those measured in background locations.

While OU1 does not address groundwater as a response area, it is recognized that the cleanup of OU1 waste areas may indirectly improve groundwater quality since those waste areas are significant sources of the groundwater contamination.

For the OU2 media and areas

- Overburden and shallow bedrock groundwater at the Site contain contaminants that would represent an unacceptable threat to human health if used as a source of drinking water. The contaminants that are found above levels that are considered acceptable for human ingestion include: aluminum, antimony, cadmium, cobalt, copper, iron, manganese, molybdenum, nickel, zinc.

- Surface and subsurface soils in the OU2 source area (Smelter/Slag Area) contain levels of cobalt, copper, and iron that would represent an unacceptable threat to human health for children residing on and near the Site and coming into contact with the contamination 350 days per year.

- Human contact with the soil in the OU2 area under less frequent exposure scenarios (recreational activities) was not considered to represent an unacceptable threat to human health.

- Human contact with sediment, and surface water as a result of recreational activities in the OU2 area were also not considered to represent an unacceptable threat to human health.

- An unacceptable threat was not found to be associated with a person working in the waste material in the OU2 area for up to 60 days per year. More frequent contact, however, would result in an unacceptable threat associated with the inhalation of manganese and aluminum dust. The aluminum and manganese concentrations in soil were not significant different from background locations.

Aquatic BERA Summary

An aquatic BERA was performed on the aquatic habitats potentially affected by the Site. The major aquatic habitats at the Site consisted of:

- Ely Brook and its tributaries;

- Several small ponds (ponds 1 to 5) which serve as the headwaters for Ely Brook Tributary 2 (EBT2) (note: pond 1, the furthest upstream - and largest - of the five ponds, was used as a reference location because it was found to be unaffected by conditions at the Site);

- Vernal pools;

- Schoolhouse Brook; and

- Ompompanoosuc River.

Results from toxicity tests on sediment, surface water, and porewater along with analysis of the benthic and fish communities provided multiple measurement endpoints to assess potential risk. The following seven types of measurement endpoints were used in the BERA:

- Comparison of the contaminants of potential ecological concern (COPEC) levels in sediment, porewater, and surface water samples to published sediment or surface water benchmarks.

- Assessment of the bioavailability of divalent metals in sediment samples by measuring the Acid Volatile Sulfides (AVS) and Simultaneously Extracted Metals (SEM).

- Performance of toxicity tests in the laboratory by exposing sensitive life stages of aquatic invertebrates and fish to sediment, porewater, and surface water samples from the waterways.

- Performance of toxicity tests in the ponds by exposing wood frog eggs and tadpoles kept in floating cages.

- Comparison of the COPEC levels in whole fish collected from the waterways to literature-derived Critical Body Residues (CBRs).

- Quantification of the structure and function of the benthic invertebrate community and fish community in the waterways.

- Use of food chain modeling to calculate an Estimated Daily Dose (EDD) to insectivorous and piscivorous wildlife receptors from exposure to surface water and aquatic biota (winged aquatic insects and fish); compare these EDDs to Toxicity Reference Values (TRVs) from the literature.

- The results of the Aquatic BERA are summarized below.

Location	Overall Risk Conclusion/Chemicals of Concern
Pond 2	Minor risk detected for water column invertebrates and amphibians due to elevated manganese concentrations in the water. No risk detected for the benthic invertebrate community.
Pond 3	Minor risk detected for benthic invertebrate community, water column invertebrates, and amphibians due to elevated manganese concentrations in the sediment and the water.
Pond 4	Severe risk detected for amphibians and minor risk detected for benthic invertebrate community due to elevated copper concentrations in the sediment.
Pond 5	Severe risk detected for benthic invertebrate community, water column invertebrates, and amphibians due to elevated copper concentrations in the sediment and the water.
Ely Brook and its tributaries	Severe risk detected for benthic invertebrate community and the fish community as a result of ARD.
Schoolhouse Brook	Severe risk detected for benthic invertebrate community and the fish community as a result of ARD being released from the OU1 source areas.

- The Aquatic BERA documented that severe ecological impacts have occurred as a result of the release of ARD with toxic levels of metals from the Site waste areas into the surface water and sediment within the OU1 area including: Ely Brook, the tributaries of Ely Brook, and Ponds 4 and 5. The upstream (reference) areas of the Ely Brook headwaters and Pond 1 supported healthy populations of benthic invertebrates, further documenting that the Site is a significant source of ecological impairment. The measurement endpoint risk characterization is summarized in Tables 1-5 through 1-11 of the FS.

- The Aquatic BERA also documented that severe ecological impacts have occurred as a result of the release of ARD with toxic levels of metals from the OU1 waste areas into OU2 surface water and sediment. Specifically, this finding applies to Schoolhouse Brook. The upstream (reference) areas of Schoolhouse Brook supported healthy populations of benthic invertebrates, further documenting that the Site is the source of observed ecological impairment downstream of the confluence with Ely Brook. OU2 will specifically address any ecological threats associated with the sediment within

Schoolhouse Brook and the Ompompanoosuc River as well as the final restoration of these surface waters.

Terrestrial BERA

The Terrestrial BERA presents the ecological assessment for terrestrial habitats potentially affected by contaminants associated with historical mining operations at the Site. The objective of the Terrestrial BERA was to describe the likelihood, nature, and severity of observed or potential adverse effects to ecological receptors resulting from their exposure to mining-related contaminants currently present at the Site. In addition to evaluating terrestrial risk, the assessment looks at potential risk to the four vernal pools identified within the study area that were not assessed as part of the Aquatic BERA (USEPA, 2010a). Four potential vernal pools/complexes were identified as VP-1 through VP-4.

Sampling and subsequent ecological risk analysis focused on determining the potential for significant adverse ecological effects in the vegetated areas that border the barren surface of the waste piles and TA and any vernal pools located therein. Potential ecological receptors are outlined in the BERA. These include State or Federally–listed threatened bat species, known as the Indiana bat and the Eastern Small-Footed bat, which use the mine openings to hibernate. The target communities and receptors selected to evaluate potential ecological impacts include terrestrial plants, soil invertebrates, herbivorous birds and mammals, invertivorous birds and mammals, carnivorous birds and mammals, and the aquatic and amphibian communities associated with the on-site vernal pools.

The conceptual site model (CSM) includes exposure pathways for plants (direct soil contact), soil invertebrates (ingestion and contact with soil), birds and mammals (soil ingestion and food), and vernal pool species (contact and ingestion with surface water and sediment). Assessment endpoints include the survival, growth, and reproduction of plants, invertebrates, mammals, birds, and aquatic/amphibious vernal pool species. Results from soil, biota (invertebrates and small mammals) and surface water samples were used for comparison to conservative screening benchmarks obtained from a variety of sources as part of a preliminary Screening Level Environmental Risk Assessment (SLERA), including Ecological Soil Screening Levels (EcoSSLs) and PRGs for soil, ambient water quality criteria and other published sources for surface water.

Ecological risks were assessed by comparing media concentrations to benchmark values and modeled exposure concentrations to TRVs. The following table summarizes the findings of this risk analysis.

Receptor Group	Overall Risk Conclusion/Chemicals of Concern for OUI
Terrestrial Plants	The barren areas of the Site represent a significant adverse impact to the plant community. The primary cause of the impact is the acidity of the soil and pore water. There is the potential for adverse impact to individual terrestrial plants as a result of the contaminant concentrations at the Site. The COPCs are copper and, to a lesser extent, zinc. The overall impact on the plant community outside the barren waste areas was not considered significant.
Soil Invertebrates	The barren areas of the Site represent a significant adverse impact to the soil invertebrate community. The primary cause of the impact is the acidity of the soil and pore water. There is the potential for adverse impact to individual soil invertebrates as a result of the contaminant concentrations at the Site. The COPCs are copper and, to a lesser extent, zinc. The overall impact on the soil invertebrate community outside the barren waste areas was not considered significant.
Herbivorous Birds	The Terrestrial BERA concluded that significant ecological impacts to this receptor were unlikely.
Invertivorous Birds	The Terrestrial BERA concluded that significant ecological impacts to this receptor were unlikely.
Carnivorous Birds	The Terrestrial BERA concluded that significant ecological impacts to this receptor were unlikely.
Herbivorous Mammals	The Terrestrial BERA concluded that significant ecological impacts to this receptor were unlikely.
Invertivorous Mammals	The Terrestrial BERA concluded that significant ecological impacts to this receptor were unlikely.
Carnivorous Mammals	The Terrestrial BERA concluded that significant ecological impacts to this receptor were unlikely.

The only significant terrestrial ecological threat in the OU1 area is the impairment of the plant and soil invertebrate communities in the barren areas of the Site. Although concentrations of metals detected in the vegetated (non-barren) areas at the Site were higher than plant and soil invertebrate benchmarks, field observations suggest that the toxicity of the Site material is substantially reduced when the waste is incorporated into a natural soil. Areas along the fringe of the barren waste areas have concentrations of metals comparable to the barren waste areas yet these areas support a plant community and soil invertebrates. Other factors, such as the

highly acidic porewater and acid salts within the waste along with the absence of any organic matter to support vegetation are likely to be more significant factors in the absence of vegetation on the barren areas. When a soil horizon forms and provides organic matter, the plant community appears to be able to exist. As a result, a clear chemical-specific threat to the plant or soil invertebrate community is not identified for OU1 of the Site. The general Terrestrial BERA conclusion for OU1 is that the Site conditions, primarily the acidic waste material and associated acid salts and pore water have created barren areas which represent a local, yet significant, ecological harm to the plant and soil invertebrate community resulting in a loss of the critical ecological support functions including nutrient cycling, habitat, food, and soil stabilization to limit erosion. The barren areas of the Site are generally consistent with the source areas shown in Figure ES-3.

No significant ecological risk was identified for the other terrestrial receptors within the OU1 area. The hazard quotients were generally low for the mammal and bird receptors. In addition, the biota sampling suggested that most metals (particularly selenium and zinc) were not accumulating in tissue. Only copper was detected at concentrations that were statistically different from reference biota tissue samples, although individual samples suggested that some accumulation of aluminum and iron may occur. OU2 will address the ecological risk associated with the vernal pools and the Smelter/Slag area as well as any ecological risk associated with the underground mining workings.

ES.6 Development of Remedial Action Objectives

Remedial Action Objectives (RAOs) consist of medium-specific (e.g., water, soil), quantitative goals defining the extent of remediation required to protect human health and the environment. They specify contaminants of concern (COCs), exposure routes and receptors, and PRGs. In the case of groundwater, they also include a restoration time frame. RAOs are used as the framework for developing remedial alternatives. To develop RAOs, it is first necessary to identify applicable or relevant and appropriate requirements (ARARs) and PRGs.

Preliminary Remediation Goals

PRGs are long-term numerical goals used during analysis and selection of remedial alternatives. PRGs should comply with ARARs and result in residual risks consistent with NCP requirements for protection of human health and the environment. Therefore, PRGs are based

both on risk-based concentrations and on ARARs. Eventually, PRGs become the basis for final remediation goals for the selected remedy. PRGs developed for protection of human health and ecological receptors are listed in Table ES-3.

Remedial Action Objectives

The RAOs for OU1 are summarized as follows:

- Control the release of ARD and acid mine drainage from the waste rock and tailings source areas (UWA, LWA, TA, and ORB) to allow Ely Brook to achieve the numerical and biological criteria for a Class B surface water in Vermont and to achieve Class B numerical criteria in Ponds 4 and 5.

- Protect Human Health by preventing direct contact with or incidental ingestion of soil within the OU1 source areas containing:
  - copper concentrations above 629 mg/Kg;
  - cobalt concentrations above 24 mg/Kg; or
  - iron concentrations above 44,800 mg/Kg.

- Restore the sediment quality of Ely Brook and its tributaries and Ponds 4 and 5 to concentrations below the PRG for copper and achieve biological integrity for these surface water bodies as demonstrated through compliance with Vermont Water Quality Criteria (VTWQC), NRWQC, and biological measures of recovery. Recovery will be measured by benthic and fish metrics achieving populations comparable with upstream and/or reference values and a finding of the sediment being non-toxic to aquatic organisms in toxicity tests.

- Restore the surface water quality of Ely Brook and its tributaries, and Ponds 4 and 5 to achieve biological integrity for these surface water bodies as demonstrated through compliance with VTWQC, NRWQC, and biological measures of recovery. Recovery will be measured by benthic and fish metrics achieving populations comparable with upstream and/or reference values and a finding of the surface water being non-toxic to aquatic organisms in toxicity tests.

- Restore the acid-impacted barren areas containing mine waste to create a functional ecological habitat with respect to the plant and soil invertebrate communities.

Areas and Volumes of Media Exceeding PRGs

Media identified for remedial action as part of OU1 include source area soil/waste material found in the UWA, LWA, TA, and the ORB. In addition, contaminated sediment is located in Ely Brook, Ely Brook Tributaries, and Ponds 4 and 5. Surface water that exceeds PRGs is not considered a waste media since RAs would address the root cause of the surface water impairment (ARD from waste rock and tailings) rather than being directly applied to the surface water itself. Site-wide groundwater is part of OU2. The areas and volumes of the source areas and sediment are summarized in Table ES-4 and below:

- The UWA extends over an approximately 8.5-acre area, and includes an estimated 73,000 cubic yards (cy) of mine waste. These volumes do not include the Lower Adit development rock pile. No adverse impacts have been observed from this development rock pile and the lithology of this waste rock is believed to be non-reactive. Therefore, it is not anticipated to be a source of metals or acidity. However, pre-design investigations should be performed to ensure that unidentified waste sources do not underlie this development rock pile. If the development rock is found to be acid generating, it will be removed along with the other waste rock in the UWA. It may also reside above acid generating waste rock and require relocation to access that material.

- Based on the observed vertical and lateral extent of waste rock and levels of cobalt, copper, and iron above PRGs the LWA area subject to the Remedial Action covers an approximately 6.4-acre area and includes an estimated 29,000 cubic yards (cy) of contaminated material.

- Based on the observed vertical and lateral extent of waste rock and levels of cobalt, copper, and iron above PRGs the TA area subject to the Remedial Action covers an approximately 0.7-acre area and includes an estimated 3,600 cubic yards (cy) of contaminated material. The tailings are a finer-grained soil than the course-grained and cobble waste rock observed in the remainder of the LWA. The tailings are classified as

by the State of Vermont a beneficiated waste which has different closure requirements than non-beneficiated waste in accordance with the Solid Waste Management Rules.

- The ORB extends over a 2.2 acre area and includes an estimated 10,330 cy of waste rock. The extent of this waste area is defined by cobalt, copper, and iron soil concentrations exceeding the PRGs. Waste material in this area includes remnant layers of partially-roasted ore, which were left there after closure of the mine operation. The ORB material is classified by the State of Vermont as a beneficiated waste which has different closure requirements than non-beneficiated waste in accordance with the Solid Waste Management Rules.

Ely Brook and Tributaries

Ely Brook, its tributaries (EBT1, EBT2, EBT3, and EBT4) and Ponds 4 and 5 all contain sediment that exceeds the sediment PRG for copper. The areas and volumes of sediment for these three components are discussed separately below.

Ely Brook: As previously stated, the Ely Brook Headwaters are believed to be unimpacted by mine activities as evidenced by the lack of elevated metals concentrations in sediment and surface water samples collected in the reach. Therefore, the Ely Brook Headwaters are used as background or reference location. The RI and the Aquatic BERA documented that the sediments of the rest of Ely Brook exceed the PRG for copper and could be contributing metals to the surface water. For the purpose of estimating the volume of impacted sediment, the entirety of each of the remaining zones in the rest of Ely Brook is considered to exceed the copper PRG and, therefore, to require a response action. The area and volume for each reach is presented in Table ES-4 and summarized in the table below.

Reaches	Defined Location	Length (ft)	Estimated Volume of Impacted Sediments (cy)
Ely Brook Headwaters	north and upstream of old road crossing	1,500	N/A – reference
Upper Ely Brook	from EBT-2 up to old road crossing	1,700	378
Middle Ely Brook	EBT-2 to between SD-61 and SD-62	660	580
Lower Ely Brook	between SD-61 and SD-62 and includes the delta located at the confluence with Schoolhouse Brook	1,200	3,950

It should be noted that the sediment deposited in the deltaic fan at the confluence with Schoolhouse Brook is believed to be a significant source of metals and acidity to Schoolhouse Brook. Because this sediment originated from Ely Brook, is laterally contiguous with the Ely Brook impacted sediment zone, and is most feasibly addressed in conjunction with sediment removal alternatives that extend to the termination of the Ely Brook, this sediment volume will be included in the Lower Ely Brook source area as part of OU1.

Ely Brook Tributaries: Ely Brook has four designated tributaries (EBT1 through EBT4):

- EBT1 is the surface water drainage originating from the ORB and the waste rock in the Site access road;
- EBT2 is the surface water drainage originating from Ponds 4 and 5 and the LWA;
- EBT3 is the surface water drainage originating from the UWA, TA, and LWA; and
- EBT4 is the surface water drainage originating from the UWA.

The area and volume for Ely Brook's four designated tributaries (EBT1 through EBT4) are presented in Table ES-4. These tributaries receive water and waste rock or tailing sediments from the waste source areas described in the sections above. It is assumed that the entire reach of the tributaries contains sediments that exceed the copper PRG, and will therefore require being addressed by the remedial action. The estimated total volume of impacted sediments within the Ely tributaries is 3,221 cy.

Ponds 4 and 5

The RI and the Aquatic BERA documented that the sediments of Ponds 4 and 5 exceed the sediment PRG for copper and are contributing to the adverse impacts to the ecological receptors. The estimated surface area of Ponds 4 and 5 are approximately 4,800 ft^2 (0.1 acres). Due to the small size of the ponds and the small volume of the drainage connecting the pond complex, the depth of contamination is believed to be shallow. Based on the sediment data, the estimated volume of impacted sediments in Ponds 4 and 5 is 378 cy.

ES.7 General Response Actions

GRAs are broad categories consisting of remedial technologies and process options that can be selected individually or in combination in order to meet the RAOs for OU1. GRAs are included in the FS process to give a range of responses for consideration for site remediation. A complete list of these categories can be found in Table ES-5. The selected OU1 GRAs are:

- No Action
- Limited Action
- Containment
- Removal and Disposal/Discharge
- In-Situ Treatment
- Ex-Situ Treatment

Categories of remedial technologies and specific process options were identified based on a review of literature, vendor information, performance data, and experience in developing other FSs under CERCLA. The screening process assesses each technology or process option for its effectiveness, implementability with regard to site conditions, known and suspected contaminants, and affected environmental media; and relative cost. The effectiveness evaluation focuses on: (1) whether the technology is capable of handling the estimated areas or volumes of media and meeting the contaminant reduction goals identified in the RAOs; (2) the effectiveness of the technology in protecting human health and the environment during the construction and implementation phase; and (3) how proven and reliable the technology is with respect to contaminants and conditions at the site. Implementability encompasses both the technical and administrative feasibility of implementing a technology. Tables ES-6 and ES-7 display the screening of the applicable GRAs for waste rock/impacted soils and sediment, respectively.

Technologies and process options judged ineffective or not implementable were eliminated from further consideration. The RI did not identify any principal threat wastes at the Site. In addition, because the source of contamination is a large volume of low level mine waste, technologies that would require treatment of the entire volume of mine was were not retained after the identification and initial screening of alternatives. The technologies retained at the end of the

screening represent an inventory of technologies that are considered most suitable for remediation of soil and sediment in OU1.

Due to the nature of the OU1 waste material (mine waste), only a limited range of options were identified based on the general response actions and process options that passed the technology screening. Furthermore, only one technology (excavation/dredging) was retained to address the contaminated sediment in Ely Brook, its tributaries, and Ponds 4 and 5. As a result, the RA for addressing the sediments is incorporated into the alternatives that address, soil, waste rock and tailings. The four source control (SC) remedial alternatives (including No Action) that have been identified to address OU1 RAOs for sediment, soil, waste rock, and tailings are listed below.

- Alternative SC1 – No Action Alternative
- Alternative SC2 – Waste containment in the Lower Waste Area Cell and in the Ore Roast Bed of the tailings from the TA within a capped closure on the ORB.
- Alternative SC3 – Waste containment in the West Cell and in the Ore Roast Bed
- Alternative SC4 – Off-site disposal and waste containment in the Ore Roast Bed

The following subsections describe the alternatives developed for OU1 source areas and sediments.

Alternative SC1 – No Action

Alternative SC1, the No Action alternative, does not include RA components to reduce, control, or eliminate potential risks from exposure to contaminants in source-area soil. No action will be taken to reduce ARD generation or the migration of ARD-impacted groundwater or seeps to Ely Brook or its tributaries and Ponds 4 and 5 where it may contribute to surface water exceedances of NRWQC and exceedances of sediment PRGs. Alternative SC1 would not implement an environmental monitoring program to assess long-term changes in contaminant concentrations in soil in order to protect human health and the environment. Alternative SC1 would include statutorily-required five-year reviews. CERCLA requires that the No Action alternative be evaluated to establish a baseline for comparison to other remedial alternatives. Alternative SC1 will not be evaluated according to screening criteria, and will pass through screening to be evaluated during detailed analysis (USEPA, 1988b).

A detailed analysis of Alternative SC1 is included in Section 4.1 of the FS Report.

Alternative SC2 – Waste Containment in the LWA Cell and in the Ore Roast Bed

Alternative SC2 would involve the excavation of the UWA and LWA, Ely Brook and its tributaries, and Ponds 4 and 5, consolidation of the material into a containment cell located in the area of the LWA (Figure ES-4) (LWA Cell), constructing surface water diversions to redirect the surface water around the LWA Cell, installation of a low permeability cover system to contain and isolate the waste rock, installation of a continuous full-bottom containment liner below the waste and installation of a horizontal underdrain system to maintain the groundwater elevation to a level below the waste and liner (cross-section of potential cell depicted on Figure ES-5).

Several tributaries to Ely Brook are located within the UWA and LWA; these tributaries will be excavated as a source of surface water contamination and consolidated with the waste rock in the containment cell. The sediments located in Ponds 4 and 5, Middle Ely Brook and Lower Ely Brook exceeding the copper PRG will be excavated and disposed in the LWA Cell. The sediments in Upper Ely Brook will be removed by either flushing the sediments into the lower reaches prior to the removal of sediment from these areas or via vacuum extraction. Monitoring of Upper Ely Brook will be performed to assess whether all contaminated sediment was successfully removed. Temporary diversions or damming of Ely Brook and Ponds 4 and 5 would be used to enable dry working conditions. After excavation/dredging, restoration would be performed for Ely Brook. Middle Ely Brook would be restored as a rip-rap armored channel; Lower Ely Brook would be restored as a natural channel; and Ponds 4 and 5 as either a rip-rap armored channel from Pond 3 downstream to Ely Brook near the confluence with EBT2 or restored to native aquatic habitat as part of a wetland mitigation.

Alternative SC2 also includes excavation of the TA and layering of the tailings on the ORB, construction of a low-permeability cover system over the material, and construction of surface water diversions to redirect the surface water from the areas upgradient of the ORB around the cover system. A cross-section of the ORB cell is depicted on Figure ES-6.

Restoration of the excavated areas will consist of grading the slopes to allow for adequate surface water drainage and minimize soil erosion. Additional components include institutional controls, environmental monitoring, and five-year reviews.

This alternative would consist of the following key components:

- Pre-design investigations and studies;
- If on-site material is used for the containment cell, timber clearing and grading of an approximate 15-acre area west of Ely Brook to obtain soil for the containment cell;
- Excavation of the soil material and restoration of the disturbed areas;
- Excavation and consolidation of waste rock, soil, and sediment exceeding PRGs from the UWA, LWA, Ely Brook, and Ponds 4 and 5, within a containment cell in a subarea of the LWA;
- Construction of a lined cover system for the containment cell in the LWA with surface water diversion measures;
- Installation of a continuous full-bottom containment liner and horizontal underdrain beneath the containment cell in the LWA to maintain separation between the waste material and surface water/groundwater;
- Excavation of the TA and placement of the tailings on the ORB;
- Construction of a low-permeability cover system over the ORB/tailings material with surface water diversion;
- Institutional controls to protect the response actions, including protection of the cover system, surface water diversions, and restoration areas;
- Installation of monitoring wells;

- Long-term operation and maintenance;
- Environmental monitoring;
- Restoration of waterways, wetlands, and wildlife habitat, as required;
- Institutional control inspections; and
- Five-year reviews.

The containment of the waste rock and soil exceeding PRGs in the LWA using a lined cover system and a horizontal underdrain system will minimize the potential for these waste materials to come in contact with surface water and/or groundwater, thereby minimizing the potential for ARD to occur. These activities will reduce human contact with metals above the PRGs, improve surface water and groundwater quality by reducing the sources of contamination, and comply with ARARs.

The capping of the tailings and ORB will reduce human contact with metals above the PRGs. The tailings and ORB do not contribute a significant impact to the groundwater or surface water. The excavation of source material will, in addition to controlling direct exposure risks, reduce leaching and erosion that contribute to exceedances of federal and state water quality standards in Ely Brook and its tributaries sediment and surface water.

A detailed analysis of Alternative SC2 is included in Section 4.2 of the FS Report.

Alternative SC3 – Waste Containment in the West Cell and in the Ore Roast Bed

Alternative SC3 includes excavation of the UWA and LWA and consolidation into a containment cell located in an on-site area to the west of Ely Brook (Figure ES-7) (West Cell); clearing and grading the work area along with a sufficient lay-down area; construction of surface water diversions to redirect the surface water from Ponds 4 and 5 and seeps/runoff around the cell; and installation of a low-permeability cover system to contain and isolate the waste rock (cross-section of potential cell depicted on Figure ES-8).

Several tributaries to Ely Brook are located within the UWA and LWA; these tributaries will be excavated as a source of surface water contamination and consolidated with the waste rock in the containment cell. The sediments located in Ponds 4 and 5, Middle Ely Brook and Lower Ely Brook exceeding the PRGs will be excavated and disposed of in the containment cell. The sediments in Upper Ely Brook will be removed by either flushing the sediments into the lower reaches prior to the removal of sediment from these areas or via vacuum extraction. Monitoring of Upper Ely Brook will be performed to assess whether all contaminated sediment was successfully removed. Temporary diversions or damming of Ely Brook and Ponds 4 and 5 would be used to enable dry working conditions. After excavation/dredging, restoration would be performed for Ely Brook. Middle Ely Brook would be restored as a rip-rap armored channel; Lower Ely Brook would be restored as a natural channel; and Ponds 4 and 5 as either a rip-rap armored channel from Pond 3 downstream to Ely Brook near the confluence with EBT2 or restored to native aquatic habitat as part of a wetland mitigation.

Alternative SC3 also includes excavation of the TA and layering of the tailings on the ORB, construction of a low-permeability cover system over the material, and construction of surface water diversions to redirect the surface water areas upgradient of the ORB around the cover system. A cross-section of the ORB cell is depicted on Figure ES-6.

Restoration of the excavated areas will consist of grading the slopes to allow for adequate surface water drainage and minimize soil erosion. Additional components include institutional controls, environmental monitoring, and five-year reviews.

This alternative would consist of the following key components:

- Pre-design investigations and studies;
- Timber clearing and grading of cell area and lay-down area west of Ely Brook;
- Excavation and consolidation of waste rock, soil, and sediment exceeding PRGs from the UWA, LWA., Ely Brook, Ponds 4 and Pond 5, within a containment cell west of Ely Brook;
- Construction of a cover system for the containment cell west of Ely Brook with surface water diversion measures;
- Excavation of the TA and placement of the tailings on the ORB;

- Construction of a low-permeability cover system over the ORB/tailings material with surface water diversion;
- Institutional controls to protect the response actions: including protection of the cover system, surface water diversions, and restoration areas;
- Installation of monitoring wells;
- Long-term operation and maintenance;
- Environmental monitoring;
- Restoration of waterways, wetlands, and wildlife habitat, as required;
- Institutional control inspections; and
- Five-year reviews.

The containment of the waste rock and soil exceeding PRGs in a cell west of Ely Brook using a lined cover system will minimize the potential for the waste material to come in contact with surface water and/or groundwater, thereby minimizing the potential for ARD to occur. These activities will reduce human contact with metals above the PRGs, improve surface water and groundwater quality by reducing the sources of contamination, and comply with ARARs.

The capping of the tailings and ORB will reduce human contact with metals above the PRGs. The tailings and ORB do not contribute a significant impact to the groundwater or surface water. The excavation of source material will, in addition to controlling direct exposure risks, reduce leaching and erosion that contribute to exceedances of federal and state water quality standards in Ely Brook and its tributaries sediment and surface water.

A detailed analysis of Alternative SC3 is included in Section 4.3 of the FS Report.

Alternative SC4 – Off-Site Disposal and Waste Containment in the Ore Roast Bed

Alternative SC4 includes excavation of waste rock and soils that exceed PRGs from the UWA and LWA with off-site disposal of the material and construction of surface water diversions to redirect the surface water from Ponds 4 and 5 (Figure ES-9). Several tributaries that act as a source of surface water contamination to Ely Brook are located within the UWA and LWA. These tributaries will be excavated and consolidated with the waste rock transported for off-site disposal. The sediments located in Ponds 4 and 5, Middle Ely Brook and Lower Ely Brook that exceed PRGs will be excavated and disposed of off-site with the waste rock. The sediments in

Upper Ely Brook will be removed by either flushing the sediments into the lower reaches prior to the removal of sediment from these areas or via vacuum extraction. Monitoring of Upper Ely Brook will be performed to assess whether all contaminated sediment was successfully removed. Temporary diversions or damming of Ely Brook and Ponds 4 and 5 would be used to enable dry working conditions. After excavation/dredging, restoration would be performed for Ely Brook. Middle Ely Brook would be restored as a rip-rap armored channel; Lower Ely Brook would be restored as a natural channel; and Ponds 4 and 5 as either a rip-rap armored channel from Pond 3 downstream to Ely Brook near the confluence with EBT2 or restored to native aquatic habitat as part of a wetland mitigation.

Alternative SC4 also includes excavation of the TA and layering of the tailings on the ORB, construction of a low permeability cover system over the material, and construction of surface water diversions to redirect the surface water areas upgradient of the ORB around the cover system. A cross-section of the ORB cell is depicted on Figure ES-6.

Restoration of the excavated areas will consist of grading the slopes to allow for adequate surface water drainage and minimize soil erosion. Additional components include institutional controls, environmental monitoring, and five-year reviews.

This alternative would consist of the following key components:

- Pre-design investigations and studies;
- Excavation and off-site disposal of waste rock, soil, and sediment exceeding PRGs from the UWA, LWA, Ely Brook, and Pond 4 and Pond 5;
- Excavation of the TA and placement of the tailings on the ORB;
- Construction of a low-permeability cover system over the ORB/tailings material with surface water diversion;
- Institutional controls to protect the response actions: including protection of the cover system, surface water diversions, and restoration areas;
- Installation of monitoring wells;
- Long-term operation and maintenance;
- Environmental monitoring;
- Restoration of waterways, wetlands, and wildlife habitat, as required;

- Institutional control inspections; and
- Five-year reviews

The removal of the waste rock and soil exceeding PRGs will minimize the potential for the waste material to come in contact with surface water and/or groundwater, thereby minimizing the potential for ARD to occur. These activities will reduce human contact with metals above the PRGs, improve surface water and groundwater quality by reducing the sources of contamination, and comply with ARARs. The capping of the tailings and ORB will reduce human contact with metals above the PRGs. The tailings and ORB do not contribute a significant impact to the groundwater or surface water. The excavation of source material will, in addition to controlling direct exposure risks, reduce leaching and erosion that contribute to exceedances of federal and state water quality standards in Ely Brook and its tributaries sediment and surface water.

A detailed analysis of Alternative SC4 is included in Section 4.4 of the FS Report.

ES.8 Evaluation of Alternatives

The detailed analysis included in the FS is intended to provide decision makers with information on specific statutory requirements for RAs that must be addressed in the ROD (USEPA, 1988b). The comparative analysis compares the remedial alternatives with respect to the evaluation criteria used during the detailed analysis of alternatives. The purposes of the comparative analysis are to identify the advantages and disadvantages of alternatives relative to one another, and to assist in the eventual selection of a preferred remedial alternative for OU1 that will be included in the OU1 Proposed Plan for public comment and documented in the OU1 ROD.

The NCP outlines the approach for performing the comparative analysis of remedial alternatives. The proposed remedy must reflect the scope and purpose of the actions undertaken and how these actions relate to other RAs and the long-term response at the site. Identification of the preferred alternative and final selection of a remedy are based on an evaluation of the major tradeoffs among alternatives in terms of the nine evaluation criteria. USEPA categorizes the evaluation criteria into three groups: threshold, balancing, and modifying. Each criteria group is discussed in the following subsections.

Threshold Criteria

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

Primary Balancing Criteria

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

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

Modifying Criteria

State and community acceptance are factored into a final balancing that determines the preferred remedy and the extent of permanent solutions and treatment practicable for the site. Formal state regulatory agency comments will not be received until after the agencies have reviewed the FS and public comments to the Proposed Plan. Community input will be factored into the remedy selection process following the public comment period on the Proposed Plan.

ES.9 Comparative Analysis of Alternatives

Based on the results of the detailed analysis of alternatives, it was determined that each of the waste rock alternatives (SC2, SC3, and SC4) was technically feasible and has been brought forward for the comparative analysis.

Overall Protection of Human Health and the Environment

According to CERCLA, this criterion must be met for a remedial alternative to be chosen as a final site remedy. Alternative SC1, the No Action Alternative, would not eliminate, reduce, or control source areas or potential future exposure to contaminants exceeding PRGs and would not meet RAOs. Therefore, this alternative is not protective of human health and the environment and cannot be chosen as a final remedy.

Alternatives SC2, SC3, and SC4 would each be protective of human health and the environment. Each of the alternatives would eliminate the direct contact and incidental ingestion risks from cobalt, copper and iron within the waste rock, tailing, and sediment areas through removal or capping of these materials.

The removal of the UWA and LWA source material and containment in either the LWA Cell (SC2) or the West Cell (SC3) or off-site disposal (SC4) would remove and/or control the most significant sources of sediment and surface water contamination by preventing the formation of ARD and the erosion of mine waste. Restoration of the areas formerly occupied by the waste material would also eliminate the barren soil that was toxic to plants and soil invertebrates.

Capping of the tailings within the ORB would prevent this material from acting as a source of sediment and surface water contamination. Also, removal of acutely toxic sediments from Ely Brook, its tributaries, and Ponds 4 and 5 and consolidating them in the LWA Cell (SC2) or the West Cell (SC3) or transporting them off site for disposal (SC4) would eliminate that threat to the ecological system of OU1. Each of the alternatives would implement institutional controls to prevent site use that could damage the components of the cleanup.

Alternatives SC2, SC3, and SC4 are very similar in the degree to which they achieve protection of human health and the environment. SC3 would be more protective than SC2 because the waste material would be isolated in a containment cell that is specifically engineered to prevent direct contact and ARD generation for the site specific waste. The disposal location chosen under SC4 could have a less protective cover system because the waste material is not a regulated solid waste. The location of the West Cell makes SC3 more protective than SC2 since SC2 would create a LWA Cell in a location that is more susceptible to infiltration by groundwater and surface waters from the adjacent waterway. In addition, a LWA cell would

potentially be susceptible to uncontrolled discharges from the Underground Mine Workings (OU2). Each of the alternatives includes those components that result in direct and indirect impacts to wetlands and aquatic habitat. SC4 would have a lower short-term environmental impact to wetlands because it would not require clearing for staging areas, borrow areas, or for construction of the West Cell (SC3) or LWA Cell (SC2). SC4 would, however, have a substantially greater overall environmental impact as there are no disposal facilities in close proximity to the Site. The nearest licensed solid waste facility in VT is 50 miles away, resulting in a 100-mile round trip for trucks to bring material from the Site to the landfill. These short term impacts associated with the additional truck traffic and generation of greenhouse gases reduce the overall protectiveness of SC4. If the waste material required substantial processing (due to size restrictions or pre-treatment requirements to reduce acid generating potential) additional cost and short-term impacts would arise. SC2 and SC3 are considered equally protective with respect to the environment as a whole because SC2 would result in a smaller footprint of disturbance than SC3 in the event that on-site materials are not used, although SC2 would result in a 63 percent increase in trucking requirements over SC3, resulting in a much higher carbon footprint. Furthermore, if on-site materials are utilized, SC2 would require an estimated 15 acres of forest clearing, while SC3 would only require 12 acres, all of which is in the footprint of the West Cell and staging area.

The relative ranking of protectiveness is SC3 > SC4 > SC2.

Compliance with ARARs

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

Location-Specific ARARs. Alternative SC1 – No Action does not include any actions, therefore this alternative does not trigger location-specific ARARs.

Alternatives SC2, SC3, and SC4 would be designed and implemented to comply with regulations related to wetlands, historical preservation, land use and development, stream flow, fish and wildlife habitat, endangered species, floodplains, and wetlands. Each of the alternatives includes components that result in unavoidable direct and indirect impacts to both

wetlands and historic resources, but these impacts can be mitigated. USEPA has determined that SC3 is the least environmentally damaging practicable alternative for protecting wetland resources as called for under Section 404 of the federal Clean Water Act and is therefore more ARAR compliant than SC2 and SC4. The extents of the impacts are shown on Figure ES-10. This finding was made because SC3 will permanently contain Site contamination in Site uplands where long-term impacts to wetland resources will be minimized in comparison with SC2 which would locate the LWA Cell adjacent to Site waterways in an area with a high groundwater table. While SC4 permanently removes a large volume of contamination from the Site the operation to ship such a large volume of waste is less practicable than SC3's on-site option.

EPA will need to consult with federal and state wildlife officials to determine what measures may be required to mitigate for impacts to endangered bat habitat on Site. All other identified location-specific ARARs can be satisfied by all the alternatives. The relative ranking of location-specific ARAR compliance is SC3 >SC4>SC2 (i.e., SC3 is more compliant than SC4 which is more compliant than SC2).

Chemical-Specific ARARs. Alternative SC1 would not attain protective concentrations for Site contaminants in soil or sediment and would not comply with chemical-specific ARARs and standards to be considered (TBCs).

SC2, SC3, and SC4 would each result in effective containment or removal of the waste rock, sediment, and tailings sources, resulting in restoration of OU1 surface water to PRGs following implementation. Each would achieve equal compliance with chemical-specific ARARs and TBCs, therefore, the relative ranking of chemical-specific ARAR compliance is SC4 = SC3 = SC2.

Action-Specific ARARs. Because Alternative SC1 does not include any actions, the alternative does not trigger action-specific ARARs.

Alternatives SC2 and SC3 would construct a containment cell for the waste rock (which is not regulated as solid waste in Vermont) and sediments and therefore meet relevant and appropriate mine closure and risk-based standards. SC2 can achieve these standards only if implementability issues with citing the LWA contaminant cell in an area of high groundwater adjacent to Site waterways can be addressed. Alternative SC4 will meet these standards by

removing all of the material and disposing of it off-site. All three alternatives will consolidate and permanently cap tailings and ORB in the ORB Cell in compliance with Vermont Solid Waste standards. Alternatives SC2, SC3, and SC4 are equally compliant with respect to action-specific ARARs regarding long-term monitoring of the waste management areas that would include federal and state drinking/groundwater standards for monitoring groundwater, as well as federal and State surface water quality standards for monitoring Site waterways. The remediation of OU1 sediments under all three alternatives would meet TBC standards under USEPA contaminated sediment guidance. The three alternatives would also meet State erosion control TBC guidance standards. Therefore, the relative ranking of action-specific ARAR compliance is SC4 = SC3 = >SC2.

Long-Term Effectiveness and Permanence

This criterion evaluates the magnitude of residual risk and the reliability of controls after response objectives have been met. Alternative SC1 would not eliminate, reduce, or control source areas or potential future exposure to contaminants exceeding PRGs and would not provide long-term effectiveness at protecting human health and the environment.

Alternatives SC2, SC3, and SC4 would each provide similar actions to control exposure risk for the waste rock and sediments in OU1. These actions would provide good long-term effectiveness and permanence. Alternatives SC2, SC3, and SC4 each take actions to cap the tailings on the ORB, excavate the source areas, and either consolidate waste materials in containment cells (SC2 and SC3) or dispose of them off-site (SC4), thereby controlling the generation of ARD at these source areas. For Alternative SC2, excavated material would be removed and isolated in the LWA Cell. For Alternative SC3, excavated material would be removed and isolated by consolidation and capping in the West Cell.

Alternatives SC2, SC3, and SC4 would reduce ecological risk from exposure to contaminated sediments exceeding PRGs by excavating/dredging the reaches of Ely Brook and Ponds 4 and 5 and then isolating the excavated sediments in the containment cells or at an off-site location.

Consolidation of source material in the LWA as part of Alternative SC2 is considered a long-term solution. However, because the LWA Cell footprint is located within the low point of the Ely

Brook drainage area, below the existing water table, significant engineering controls will be required to divert surface water and groundwater discharge from the cell. The requirement to construct an underdrain that isolates waste from groundwater and surface water may require additional long-term maintenance and repairs. Because this closure cell design is atypical and non-ideal, it creates greater uncertainty regarding the long-term effectiveness and permanence relative to SC3 and SC4. Long-term maintenance and repair of the SC2 underdrain system is expected to be more problematic than maintenance of the SC3 cell, which is more effectively isolated from surface water and groundwater.

In comparison, Alternative SC3 would be constructed in an area isolated from low-lying wet areas and would utilize standard design and construction components. Based on its reliance on proven technology, SC3 is considered to be more implementable and have greater long-term effectiveness and permanence than Alternative SC2.

Alternative SC4 includes excavating the waste material and transporting it to an off-site location for permanent disposal. Since Alternative SC4 does not rely on an on-site engineering control for the waste rock and sediments it is considered to have slightly more long-term effectiveness and permanence than SC3, which is more effective and permanent than SC2, provided the off-site facility places the unregulated material beneath a cover system of equal performance to the cover system to be installed for SC2 or SC3. If a less substantial cover system is used to cover the waste at the off-site facility, then SC2 and SC3 would have greater long-term effectiveness.

The relative ranking of long-term effectiveness, therefore, is SC3 = > SC34 > SC2, due to the long-term effectiveness of disposing of the waste off-site rather than on-site.

Reduction of Toxicity, Mobility, and Volume through Treatment

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

Alternative SC1 does not contain any components to reduce the toxicity, mobility, or volume of contaminants through treatment. Alternatives SC2, SC3, and SC4 all may have limited treatment components pertaining to treatment of dewatering liquid and the potential use of

limestone in settling ponds, drainage channels, or in streams to reduce the toxicity and mobility of ARD. SC2 and SC3 may include added treatment processes for leachate generated from the LWA and West Cells, respectively. SC4 may include limited stabilization of contaminated sediments prior to off-site shipment.

The relative ranking of the alternatives at reducing the toxicity, mobility, or volume of contaminants through treatment is SC3 = SC2 > SC4.

Short-Term Effectiveness

CERCLA requires that potential adverse short-term effects to workers, the surrounding community, and the environment be considered during implementation of an RA and until response objectives have been met. Under this criterion, the time period to achieve protectiveness is also evaluated. Alternative SC1 does not lead to any exposure risks and, therefore, results in no short-term effects; however, it never achieves protectiveness of human health or the environment and therefore is not effective in the short-term.

Each of the alternatives would use on-site materials and resources to reduce short-term risks to the community from construction traffic to and from the Site. In the event that sufficient on-site sources for earthen materials are not identified, SC2 and SC3 would need to rely on imported materials. The construction of SC2 would require an estimated 93,000 cy of stone, borrow, and topsoil, resulting in approximately 5,150 truck loads. The construction of SC3 would require an estimated 52,000 cy of stone, borrow, and topsoil, resulting in approximately 2,901 truck loads, significantly less than the trucking required for SC2. As a result, SC2 would have a larger short-term environmental footprint than SC3.

In the event that sufficient on-site sources for earthen materials are identified, SC2 and SC3 would generate earthen materials from previously undisturbed areas. Based on an estimated yield of 7,000 cy per acre, the construction of SC2 could potentially require 15 acres of land to be cleared, while the construction of SC3 would require 12 acres, all of which may potentially be within the footprint of the SC3 cell construction and staging area. As a result, SC2 would have a larger short-term environmental footprint than SC3.

Under both alternatives SC2 and SC3, the areas where waste is removed will be reclaimed to the extent practical. Some areas may be left as exposed rock, whereas areas with clean soil remaining after waste removal will be restored to establish native vegetation, including wetland habitat, which will dramatically decrease the environmental footprint of the Site when compared to current conditions. The surface of the containment cells will also be vegetated.

For the other common components of SC2 and SC3, there would also be similar short-term impacts resulting from truck traffic importing the necessary materials to the Site for the remediation activities, including the restoration of Ely Brook and the Ponds 4 and 5 Area, as well as the construction of containment cell cover systems.

Alternative SC4 would include significantly higher short-term impacts related to the estimated 7,400 to 9,500 truck loads required to transport the waste material to an off-site facility. Some of these would be offset by the significantly fewer loads coming to the Site with needed materials for construction of containment cells; however, the ORB cap and stream channel restoration work included in SC4 will require material deliveries. In total, assuming that all needed borrow materials can be found on site, SC2 and SC3 result in an estimated 5,333 fewer truck trips on local roads. Due to the distance to the off-site disposal facility, SC4 would have a substantially greater overall environmental impact as there are no disposal facilities in close proximity to the Site. The nearest licensed solid waste facility in Vermont is 50 miles away, resulting in a 100-mile round trip for trucks to bring material from the Site to the landfill. If the waste material required substantial processing (due to size restrictions or pre-treatment requirements to reduce acid generating potential) additional cost and short-term impacts would arise.

SC2 would also require that LWA waste rock be removed and placed in a temporary stockpile area. This is necessary for the construction of the underdrain system, as well as to provide some dewatering of these wastes prior to placement in the closure cell. This stockpile area would be located in an area previously altered to minimize short-term impacts to wetlands and terrestrial habitats. Although temporary, the construction of the LWA relocation stockpiles would require some features typical of the final closure cells, such as surface water diversions, groundwater interceptor trenches, leachate collection systems, and covers to provide protection from erosion and stormwater discharge.

Alternatives SC2, SC3, and SC4 would all result in construction-related concerns (e.g., blasting, noise, and dust) and would result in some short-term effects to the community from truck traffic to deliver equipment and materials.

Both SC2 and SC3 would result in short-term impacts to known wetland areas and aquatic habitats (Ely Brook and Ponds 4 and 5). Some permanent loss of these areas may occur depending on the need for engineered structures to protect the cover systems. The areas that are not subject to permanent loss are expected to fully recover and achieve a higher level of function and value post-cleanup with the removal of the site contaminants. There would be short-term impacts to Ely Brook, Ponds 4 and 5, and areas subject to dredging or excavation as part of SC2, SC3, and SC4. Besides the wetland areas destroyed to excavate the waste material, no other unaltered wetlands areas would be impacted due to activities associated with Alternative SC4.

At this time it has not been determined how each alternative may impact endangered bat habitat. USEPA will consult with federal and state wildlife authorities to determine if any of the components of the proposed alternatives poses significant negative impacts on endangered bats at the Site.

For Alternatives SC2, SC3, and SC4, the time period to achieve the PRGs is estimated to be 2 to 4 years after the source control and sediment activities are completed.

Because SC2 creates a larger environmental footprint under both an off-site material import and an on-site material generation scenario, SC3 ranks higher than SC2 with respect to short-term effectiveness. Based on the overall impacts to the community and increased traffic hazards resulting from the significant truck loads required to transport waste off-site, both SC2 and SC3 rank higher than SC4 with respect to short-term effectiveness. SC2 and SC3 are equal in terms of short-term impacts and in time needed to achieve protection and SC4 results in significant short-term impacts to the local community regarding heavy truck traffic on local roads.

The relative ranking of the alternatives with respect to short-term effectiveness is SC3 > SC2 > SC4.

Implementability

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

Alternative SC1 does not include any actions, other than Five-Year Reviews, and, therefore, would be technically easy to implement. No permits would be required, and administrative feasibility would be high.

Services and equipment are available to implement Alternatives SC2, SC3, and SC4. Waste removal from the UWA, LWA, Ely Brook and tributaries, and the Ponds 4 and 5 Area, as well as the construction of the tailings cover over the ORB is similar for each alternative.

SC2 is considered less implementable than SC3 and SC4 based on its location in the center and low point of the Ely Brook drainage. The LWA Cell (SC2) relies on a location partially within the groundwater table at the lowest point in a steep-sided topographic drainage. This setting presents distinct engineering challenges for the construction of an effective waste containment cell whose primary objective is to separate waste rock and tailings from interacting with water. The construction the LWA Cell on a high-transmissivity underdrain and drainage barrier is more complicated engineering design and has a greater dependence on the successful performance of the maintenance activities.

The LWA Cell footprint is also the current location of the LWA waste rock. Therefore the LWA waste will need to be excavated and relocated twice. LWA would also require the construction of a temporary staging area that is constructed with a liner and leachate collection system to prevent residual saturation in the waste and to prevent sediments from draining to groundwater and surface water. Lastly, long-term maintenance and repair of the SC2 underdrain system is expected to be more problematic than maintenance of the SC3 cell, which is more effectively isolated from surface water and groundwater.

In comparison, the construction of the West Cell (SC3) relies on proven methods and technologies and could be sequenced in a manner that would eliminate the need for a temporary lay-down area and leachate collection system for waste. The West Cell's location on

the side-slope of the Ely Brook drainage would also allow for surface water diversions that are sized for significantly smaller flows than would be required for SC2. Therefore, SC3 is considered to be more implementable than SC2.

For the implementation of SC4, South Vershire Road would require improvements to safely handle the heavy truck traffic. In addition, nearly 1,000 waste characterization samples would be required to meet the disposal facility requirements. Despite these difficulties, SC4 is considered easily implementable from a technical perspective because it does not include the design and construction of a geosynthetic cap.

The administrative feasibility of Alternatives SC2 and SC3 is equally high since neither requires off-site permits or approvals. The administrative process to obtain institutional controls to protect the remedy components (caps, stream restoration, monitoring wells) for SC2, SC3, and SC4 are readily implementable. SC4 could experience substantial implementability issues with respect to the off-site disposal of the waste material. There is limited capacity at many regional facilities within a reasonable haul distance. If the facility with sufficient capacity were a substantial distance from the Site, the cost could be significantly higher. Also, there could be substantial delays in the implementation of SC4 associated with obtaining approval for the off-site disposal.

While each of the alternatives is implementable, the relative ranking of the alternatives for implementability is SC3 > SC4 > SC2.

Cost

The following table summarizes capital, annual O&M, present worth for 30 years at 7 percent discount rate, and total estimated non-discounted costs for the evaluated alternatives.

Cost Category	SC1	SC2	SC3	SC4
Capital Costs	$0	$18,402,286	$16,446,057	$29,754,186
Annual O&M	$8,050	$74,907	$74,907	$27,753
Total Non-Discounted Cost	$241,000	$20,713,786	$18,757,557	$30,586,786
Total Present Worth (30 yrs @ 7 percent)	$113,015	$19,428,508	$17,472,278	$30,123,830

Comparative Analysis Summary

Table ES-8 summarizes the comparative analysis of alternatives. A detailed comparative analysis of the alternatives is included in Section 5.0 of the FS Report.

ES.10 OU2 Early Action

USEPA has identified the need for an early cleanup action for the OU2 area. Specifically, since the finalization of the OU2 RI/FS and selection of an OU2 cleanup action is dependent upon the completion of the OU1 Remedial Action, many years may pass before an OU2 cleanup can be implemented. The Site HHRA identified the future consumption of contaminated groundwater and the direct contact and incidental ingestion of soil contaminated with cobalt, copper, and iron as potential threats to human health. To address this threat to human health, USEPA will implement an Early Action to prevent groundwater use within the portions of the Site where groundwater is not suitable for human consumption. The Early Action will also prevent residential development of the Smelter/Slag Area.

The RAOs for the Early Action are:

- Prevent exposure to soil or waste with concentrations of cobalt, copper, and iron above the Site specific cleanup levels listed in Table 2-4 of this FS for future residential use within the Site; and

- Prevent ingestion of bedrock groundwater in excess of federal safe drinking water act Maximum Contaminant Levels (MCLs); Maximum Contaminant Level Goals (MCLGs); VTGWPS; or USEPA risk standards within portions of the Site.

The design for the Early Action will identify the extent of the Ely Copper Mine Site where groundwater that exceeds MCLs, MCLGs, VTGWPS, or risk based standards in the absence of these. Figure ES-11 shows the extent of the area of the Site that would be subject to institutional controls using the existing Site data.

The Early Action will include the placement of land use restrictions that run with the land to effectively prevent future residential use or installation of water supply wells within the portions of the Site where such use could result in exposure to contamination or adversely impact the

response actions. Restrictive covenants are the primary mechanism to achieve this objective with local and/or state ordinances or zoning to supplement the property restriction.

Because the only RAOs are to prevent the groundwater or residential use of certain portions of the Site and not restore groundwater or contain/remove contaminated soil, no other technologies or alternatives were considered, other than No Action. The OU2 FS will develop and analyze technologies with respect to any groundwater restoration, migration control, or soil remediation determined to be necessary for OU2. A very simplified nine criteria analysis was performed in Section 6 of the OU1 FS for No Action and Institutional Controls for an Early Action for OU2.

USEPA has determined that a cleanup action is appropriate for OU2 at the Site. The early cleanup action provides the best balance of the NCP criteria to ensure protection of human health prior to the implementation of the OU2 response action. The Early Action early cleanup may be the only cleanup action for OU2 or may be the first component of additional cleanup actions that will be evaluated in the OU2 FS and selected in a future OU2 ROD.

Table ES-1
Summary of Site Operations
Ely Copper Mine Superfund Site
Vershire, Vermont

Year of Investigation	Era of Operation	Operation Description
1813	Discovery	Gossan discovered by Richardson Family, used for dye.
1820s-1861	Upper Workings and Development Rock	Includes Tyson 1834/Pollard1854 Adit, Shaft II, 1850s/1860s Pollard Shaft and Adit
1820s-1861	Upper Waste Pile 4	Low grade ore
1830s	Vershire Copper Manufacturing Co.	Isaac Tyson, Jr. sporadically worked the deposit
1840s	Sporadic Prospecting	Pliny Dwight controlled the land
1853-1883	Vermont Copper Mining Company	Began large scale working of the deposit led by Thomas Pollard
mid-1850s-1918	Copper Mine Production	Peak production from 1870s-1880s. 30-40 million pounds total production
1850s-1860s	Deep Adit	Collapsed entrance, development rock pile remains
1850s-1880s	Washhouse	Schist slab foundation remains in Lower Waste Pile Area
1859	Rittler Map/Report	Documentation for Vermont Copper Mining Company (VCMC) of mine related features and associated buildings.
1861-1905	Main Adit (1861 Adit)	Main haulageway
1861-1905	Upper Waste Piles 6, 7, 8, and 9	Low grade ore, 1949-50 loading platform, 1861 Adit spur road
1864-1883	Smith Ely Era	Smith Ely became president of VCMC
1867-1905	Ore Roast Beds	Schist slab retaining wall, 900 ft of oxidized low grade ore, collapsed shaft
1867-1905	Smelter Building	Tramway embankment, retaining wall, furnace bases, bldg nearly 1,000 ft long, refined pig copper.
1867-1905	Slag Pile	Smelter/Slag pot skull layers remain
1870s-1880s	Burleigh Shaft	Shaft entrance remains partially collapsed.
1877	Smoke Flue	Schist slab flue, stack footing remain
1881-1905	Main Shaft	Primary shaft hoist access
1882	Vermont Copper Company of NY	Francis Cazin and Ely -Goddard took control of the mine
1882-pre-1902	Reservoir (Pond 1)	Earthen/rubble dam on the east branch of Ely Brook. Possibly Westinghouse Era
1883	The "Ely War"	Vermont Copper Company worker revolt and company collapse
Late 1800s	Shaft No 4	Collapsed entrance, development rock pile remains
1883-1899	Mine Decline	Mine ownership changed hands multiple times
1900-1905	Westinghouse Era	Modernization of smelting process, little production
1905	End of Underground Mining	Site buildings and equipment were sold, and property was stripped
1917-1918	World War I Era Flotation Mill	Foundations, walls, floor slabs remain
1917-1918	Ely-Copperfield Association of NY, NY	Flotation Mill constructed to reprocess 19,000 tons of mine waste piles. Mill shut down at end of WWI
1942-1950	World War II Era	Assay of mine dumps. 1949-50, 60,000 tons of waste ore transported to Elizabeth Mine yielding 1.2 million pounds of copper
mid-1950s	Appalachian Sulphides, Inc	Prospect drill holes completed

Table ES-2
Summary of Site Investigations
Ely Copper Mine Superfund Site
Vershire, Vermont

Year of Investigation	Principle Investigator	Investigation Description	Sampling Summary
2001	Slack and others	Geology and geochemistry of ore and rocks of Vermont Copper Belt	
2002	USGS and USACE	Geochemical diversity of water sources in the Ely Brook Watershed	surface water sampling from seeps from mine waste areas, Ely Brook and tributaries, Schoolhouse Brook, and the Ompompanoosuc River
2004 and 2007	USGS		various solid mine waste materials and sediment, geochemistry of the slag material deposited along South Vershire Road
2005 to 2008	URS and USACE	Habitat characterization	terrestrial habitats, potential wetland areas, potential terrestrial receptors
			test pits and borings in waste areas
			monitoring well installation
			surface water samples
			sediment samples
			surface and subsurface soil samples
			groundwater samples
			residential samples
2007	VTDEC	Aquatic Life Use Attainment Assessment	evaluation of fish and macroinvertebrate data
2008	Techlaw	Aquatic Baseline Ecological Risk Assessment	surface water samples
			sediment samples
			porewater samples
2009	Nobis	Remedial Investigation	terrestrial habitats, potential wetland areas, potential terrestrial receptors
			test pits and borings in waste areas
			monitoring well installation
			surface water samples
			sediment samples
			surface and subsurface soil samples
			groundwater samples
			residential samples

Notes:
USGS = United States Geological Survey
USACE = United States Army Corp of Engineers
VTDEC = Vermont Department of Environmental Conservation

Table ES-3
Preliminary Remediation Goals
Ely Copper Mine Superfund Site
Vershire, Vermont

Analyte	OU1 Maximum Detected Concentration	Average Background Concentration	Preliminary Remediation Goal	Basis for cleanup level
Soil (mg/Kg)				
Cobalt	4,330	6.6	**24**	HHRA risk-based standard (NC) [1]
Copper	65,700	15	**629**	HHRA risk-based standard (NC)
Iron	190,000	13,852	**44,800**	HHRA risk-based standard (NC)
Sediment (mg/Kg)				
Copper	11,000	5.6	**149**	Aquatic BERA risk-based standard
Surface Water (µg/L)				
Aluminum	120,000	82	**87**	NRWQC [2]
Cadmium	55.8	ND (0.24) [6]	**1.10**	VTWQC [3, 4]
Chromium	130	1.2	**11**	VTWQC
Copper	88,500	2.4	**8.6**	Site-Specific [5]
Iron	199,000	102	**1,000**	NRWQC
Lead	17	0.089	**3.2**	VTWQC
Mercury	0.2	ND (0.2)	**0.012**	VTWQC
Nickel	456	0.61	**52**	NRWQC [4]
Selenium	27	ND (1.0)	**5**	VTWQC
Silver	4.2	ND (2.2)	**3.2**	NRWQC [4]
Zinc	8,192	150	**106**	VTWQC
Sulfide	1,300	ND (100)	**2**	NRWQC
pH	2.8[7]	7.41	**6.5-8.5**	VTWQC

Notes:

1. NC = non-cancer based level, hazard index = 1
2. NRWQC = National Recommended Water Quality Criteria. 2009.
3. VTWQC = Vermont Water Quality Criteria. Jan 2008.
4. Interim clean-up level adjusted for hardness based on VTWQC Appendix C or NRWQC note E. assumes hardness = 100 mg/L.
5. Recommended aquatic BERA site-specific interim clean-up level adjusted for hardness = 9 µg/L x CF
   CF = 0.96 (EPA National Recommended Water Quality Criteria: Appendix A. 2009.)
6. ND = non-detect with the average detection limit shown in parentheses.
7. Value displayed for pH reflects minimum detected OU1 surface water value.

Table ES-4
Estimated Areas and Volumes of Waste Rock, Tailings, and Sediment
Ely Copper Mine Superfund Site
Vershire, Vermont

OU1 Waste Rock, Tailing, and Soil					
	Average Thickness (ft)	**Area (ft^2)**	**Area (acres)**	**Volume (ft^3)**	**Volume (yd^3)**
Upper Waste Area (UWA)	varies	287,500	7.8	1,873,800	69,400
UWA soil above cleanup levels outside limits of mine waste	varies	30,300	0.7	90,900	3,363
Lower Waste Area (LWA)	varies	255,290	5.9	702,000	26,000
LWA soil above cleanup levels outside limits of mine waste	varies	23,600	0.5	70,800	2,620
Tailing Area (TA)	varies	28,990	0.7	97,200	3,600
Ore Roast Bed (ORB)	varies	96,970	2.2	278,910	10,330
Development Rock within UWA	varies	45,530	1.05	327,807	12,141
OU1 Sediment					
	Average Thickness (ft)	**Length (ft)**	**Width (ft)**	**Volume (ft^3)**	**Volume (yd^3)**
Upper Ely Brook	0.5	1,700	6	5,100	190
Ponds 4 and 5	3.0	60	80	10,200	378
Middle Ely Brook	2.0	660	12	15,660	580
Lower Ely Brook	2.0	1,200	12	106,650	3,950
OU1 Surface Water Channels in UWA and LWA					
	Average Thickness (ft)	**Length (ft)**	**Width (ft)**	**Volume (ft^3)**	**Volume (yd^3)**
EBT1	2	500	12	12,000	445
EBT2	2	530	12	12,720	471
EBT3	2	773	12	43,680	1,618
EBT4	2	650	12	18,552	687
OU2 Areas					
	Average Thickness (ft)	**Area (ft^2)**	**Area (acres)**	**Volume (ft^3)**	**Volume (yd^3)**
Smelter Area	varies	165,515	3.8	840,240	31,120
Slag Area	varies	185,130	4.2	675,000	25,000
Schoolhouse Brook Hot Spots	1.0	100	0.002	1,100	41

Notes:

1. OU1 Waste Rock and Tailings and OU2 Waste Rock values calculated with AutoCAD. The irregular shape of the piles does not allow for specific thickness values to be presented.
2. Sediment thickness are assumed and should be considered estimates. Actual depths will be confirmed during pre-design studies.

Table ES-5
Applicable Treatment Technologies
Ely Copper Mine Superfund Site
Vershire, Vermont

General Technology	Waste Rock and Tailings	Sediment
No-Action	x	x
Institutional Controls	x	
Monitored Natural Recovery		x
Surface Controls	x	
Capping Systems	x	x
Excavation/Dredging	x	x
Land Disposal	x	x
Ex-Situ Physical or Chemical Treatment	x	x
In-Situ Physical or Chemical Treatment	x	x

Notes:
"x" indicates that the General Technology is applicable to the media listed and will be selected for alternative screening.

Table ES-6
Screening of Potential Treatment Options for Waste Rock and Tailings
Ely Copper Mine Superfund Site
Vershire, Vermont

General Response Action	Technology	Process Option	Description	Effectiveness	Cost	Implementability	Retained For Further Consideration	Notes
No Action	No Action	No action	The "No Action" GRA is required in accordance with CERCLA and NCP to serve as a baseline comparison for other GRA technologies. The "No Action" alternative includes only scheduled 5-Year Reviews to assess the alternative effectiveness and compliance with OU1 PRGs. It does not include any active or passive treatment of media, institutional controls, or monitoring.	The alternative does not address the RAOs developed for OU1.	**Low** Include periodic monitoring and 5-Year Reviews	This technology would be implementable.	**Yes** (Required by CERCLA/NCP)	(Required by CERCLA/NCP)
Limited Action	Institutional Controls	Land use restrictions	Land use restrictions would be used to prevent certain use and activities such as residential building or recreational use. The restrictions would be included in the chain of title/deed for the property and would continue into the future regardless of change in ownership or zoning in the vicinity of the Site.	The alternative does not address the RAOs developed for the OU1, and although the Land Use Restriction is in place, the technology does not physically prevent the exposure to human receptors. However, the technology could be used in conjunction with other technologies in a larger system.	**Low** Capital and O&M costs	This technology would be implementable.	**Yes** (as component in larger system)	Although this process option would not achieve the remedial action objectives, it may be included as part of a more comprehensive alternative
		Access controls	Engineered controls include restricting access to the OU1 area but does include treating the waste material with any physical or chemical processes. Fencing, signage, and security patrols could be utilized. Fencing would minimize human and animal access and warning signs would alert people to the specific OU1 hazards located within the fence. Security patrols would deter vandalism and unauthorized access to the OU1 and would notify EPA of breaches in the controls.	The alternative does not address the RAOs developed for OU1, but it would be effective in reducing the access to the OU1 area. OU1 is relatively large, however, and the fence would have to extend to around the entire property with gates located at all access points. Due to the remoteness of OU1, it would be difficult to completely prevent vandalism and unauthorized access by humans and/or animals.	**Low** Capital and O&M costs	This technology would be implementable.	**Yes** (as component in larger system)	Although this process option would not achieve the remedial action objectives, it may be included as part of a more comprehensive alternative
Containment	Surface Controls	Grading	Grading of the existing ground surface/waste can be used to improve slope stability and run-off and reduce erosion of the waste piles, and to divert surface water away from the impacted material.	The alternative does not address the RAOs developed for OU1. It would be effective in minimizing erosion and precipitation percolated through the impacted material into the aquifer; however, portions of the waste piles are seasonally within the overburden aquifer; therefore, impacts from the waste on the aquifer would not be addressed.	**Moderate** Capital costs **Low** O&M costs	This technology would be implementable.	**Yes** (as component in larger system)	Although this process option would not achieve the remedial action objectives, it may be included as part of a more comprehensive alternative
		Revegetation	Revegetation includes planting in order to stabilize the impacted soils and to reduce erosion of the soils. The root systems will hold surface soils in place while the aboveground portions of the plants disrupts the flow and removes the energy from overland surface water allowing for the plants to take and use the water. The plants may also serve some utility as filtering devices, both physical and chemical, through straining and biological processes.	The alternative does not address the RAOs developed for OU1; however, it would be an effective alternative in conjunction with a more active alternative. Revegetation is commonly used with a consolidation and capping system to stabilize the soils and reduce run-off of the cap.	**Low** Capital and O&M costs	This technology would be implementable.	**Yes** (as component in larger system)	Although this process option would not achieve the remedial action objectives, it may be included as part of a more comprehensive alternative
	Capping System	Close in place	Grading the existing waste and constructing an engineered cap to conform with low-permeability cover system requirements. Surface water diversions will be constructed as needed to eliminate potential infiltration. Prior to capping, the waste material will be dried to reduce leachate, if necessary.	This alternative would be effective in preventing human contact; however, it would not remove and isolate the contaminated material from the overburden groundwater aquifer. Waste/groundwater contact would perpetuate the impacts to the groundwater aquifer and surface water downgradient of the waste. Institutional controls and a monitoring program would be required to maintain the effectiveness of the cell.	**Moderate** Capital costs **Moderate** O&M costs	This technology would be implementable.	**Yes** (as component in larger system)	This process option was eliminated because there are similar process option approaches that could achieve the remedial action objectives without the need for long-term treatment.
		On-site consolidation and containment cell construction in the LWA	Excavate the Upper and Lower Waste Piles and consolidate the waste material into a constructed cell within the current WMU. The engineered cap will conform with low-permeability cover system requirements and includes a bottom liner to prevent groundwater infiltration into the waste. Underdrains and surface water diversions will be constructed as needed to eliminate potential infiltration. Prior to capping, the waste material will be dried to reduce leachate. if necessary.	This alternative would be effective in preventing human contact and would remove and isolate the contaminated material from the overburden groundwater aquifer, therefore, allowing the groundwater pH to adjust to a more neutral level and reducing the metals mobility. Institutional controls and a monitoring program would be required to maintain the effectiveness of the cell.	**High** Capital Costs	This technology would be implementable.	**Yes**	
		On-site consolidation and containment cell construction west of Ely Brook	Excavate the Upper and Lower Waste Piles and consolidate the waste material into a constructed cell located to the west of Ely Brook and outside of the current WMU. The engineered cap will conform with low-permeability cover system requirements. Underdrains and surface water diversions will be constructed as needed to eliminate potential infiltration. Prior to capping, the waste material will be dried to reduce leachate, if necessary.		**Moderate** O&M costs			

Table ES-6
Screening of Potential Treatment Options for Waste Rock and Tailings
Ely Copper Mine Superfund Site
Vershire, Vermont

General Response Action	Technology	Process Option	Description	Effectiveness	Cost	Implementability	Retained For Further Consideration	Notes
Removal	Excavation and Disposal	On-site disposal of treated excavation water	Treat leachate water from waste material and excavation dewatering through settling and discharge to on-site waterways. Additional treatment could include bag filters and chemical amendments depending on analytical results.	This alternative would be effective in treating the water to achieve performance goals prior to discharge to the on-site waterways through settling, amendments, and/or dilution with clean diverted surface water.	**Low** Capital and O&M costs	This technology would be implementable.	**Yes** (as component in larger system)	
		Off-Site disposal	Excavate the Upper and Lower Waste Piles and the Tailings pile and transport waste to a off-site location for disposal at an approved disposal facility. The alternative includes restoration of the natural grade and vegetation.	This alternative would be effective in preventing human contact and would remove and isolate the contaminated material from the overburden groundwater aquifer, therefore, allowing the groundwater pH to adjust to a more neutral level and reducing the metals mobility.	**High** Capital costs **Low** O&M costs	This technology would be implementable.	**Yes**	
Treatment	In-situ	Injection of an alkaline stabilizer	Perform a series of soil borings completed as injection wells. An alkaline stabilizer is injected reducing the soluble metals present to their lowest valence state. This reduces or eliminates their mobility and solubility and reduces their impact on groundwater and surface water.	Difficult to achieve adequate mixing and coverage without very large quantity of material. Long-term effectiveness for oxidized waste is unknown. Surface contact threats would not be mitigated.	**High** Capital costs **Moderate** O&M costs	This technology would be implementable.	**No**	Although the technology would be implementable, it would be difficult and likely not very effective; therefore, it is not retained for further consideration.
	Ex-Situ	Excavation and mixing with chemicals to neutralize or passivate	Excavate the waste material and mix with passivation/neutralization chemicals to bring the pH of the soils and groundwater more neutral and to reduce the reactivity of the metals. The excavated and amended soil would be replaced in the original locations.	Passivation technologies are more applicable to fresh un-oxidized waste. Neutralization would require substantial quantities of material and would not eliminate surface contact with waste. Also, long-term degradation of an alkaline addition would be a concern.	**High** Capital costs **Moderate** O&M costs	This technology would be implementable.	**No**	Although the technology would be implementable, it would be difficult and likely not very effective; therefore, it is not retained for further consideration.
		Treatment of groundwater and stormwater from excavations	Treat leachate water from waste material and excavation dewatering through settling and discharge to on-site waterways. Additional treatment could include bag filters and chemical amendments depending on analytical results.	This alternative would be effective in treating the water to achieve performance goals prior to discharge to the on-site waterways through settling, amendments, and/or dilution with clean diverted surface water.	**Low** Capital and O&M costs	This technology would be implementable.	**Yes** (as component in larger system)	

Notes:
GRA = General Remedial Action
CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act
NCP = National Contingency Plan
RAO = Remedial Action Objective

Table ES-7
Screening of Potential Treatment Options for Sediment
Ely Copper Mine Superfund Site
Vershire, Vermont

General Response Action	Technology	Process Option	Description	Effectiveness	Cost	Implementability	Retained For Further Consideration	Notes
No Action	No Action	No Action	The "No Action" GRA is required in accordance with CERCLA and NCP to serve as a baseline comparison for other GRA technologies. The "No Action" alternative includes scheduled 5-Year Reviews to assess the alternative effectiveness and compliance with OU1 PRGs. It does not include any active or passive treatment of media, institutional controls, or monitoring.	The alternative does not address the RAOs developed for OU1.	**Low** Includes 5-Year Reviews	This technology would be implementable.	**Yes** (Required by CERCLA/NCP)	(Required by CERCLA/NCP)
Limited Action	Institutional Controls	Land Use Restrictions	Land use restrictions would be used to prevent certain use and activities such as recreational use. The restrictions would be included in the chain of title/deed for the property and would continue into the future regardless of change in ownership or zoning in the vicinity of the Site.	The alternative does not address the RAOs developed for OU1, and although the Land Use Restriction is in place, the technology does not physically prevent the exposure to human receptors. However, the technology could be used in conjunction with other technologies in a larger system.	**Low** Capital and O&M costs	This technology would be implementable.	**Yes** (as component in larger system)	Although this process option would not achieve the remedial action objectives, it may be included as part of a more comprehensive alternative
		Access Controls	Engineered controls include restricting access to the OU1 area but does include treating the waste material with any physical or chemical processes. Fencing, signage, and security patrols could be utilized. Fencing would minimize human and animal access and warning signs would alert people to the specific OU1 hazards located within the fence. Security patrols would deter vandalism and unauthorized access to OU1 area and would notify EPA of breaches in the controls.	The alternative does not address the RAOs developed for the OU1 area, but it would be effective in reducing the access to the OU1 area. The OU1 area is relatively large, however, and the fence would have to extend to around the entire property with gates located at all access points. Due to the remoteness of the OU1 area, it would be difficult to completely prevent vandalism and unauthorized access by humans and/or animals.	**Low** Capital and O&M costs	This technology would be implementable.	**Yes** (as component in larger system)	Although this process option would not achieve the remedial action objectives, it may be included as part of a more comprehensive alternative
	Monitored Natural Recovery	Sediment Sampling	Relies on sediment transport processes to disperse the contaminated sediment downstream, thereby reducing OU1 exposure risks.	In Ely Brook this process option may address inaccessible areas of contaminated sediment that is not removed by other process options.	**Moderate** Low **Low** O&M costs	This technology would be implementable.	**Yes** (as component in larger system)	
Containment	Capping System	In-Place Cap Construction	Capping of the impacted sediments with clean material in the existing stream bed. The clean materials would be laid down in a 1 foot thick layer to protect the surface water from contacting the impacted sediment. The capping material would be graded to match the existing the runs, riffles, and pools of the current streambed.	This alternative would be effective in preventing human contact and would separate the surface water from the impacted sediment; however, Ely Brook is a gaining stream and impacted groundwater will percolate through the cap material, potentially creating another impacted mass.	**Moderate** capital costs **Low** O&M costs	This technology would be implementable.	**No**	It would be possible to build a sub-aqueous cap over the contaminated sediments and maintain the stream hydrology. Ely Brook flow is often less than 1 foot in depth. The steep gradient would cause erosion of the cover system. The stream habitat is also dependent on exposed boulders and gravel for the benthic community.
	Excavation and Disposal	On-Site Consolidation into a Containment Cell	Excavate the sediments above cleanup levels in Ponds 4 and 5, Ely Brook and its tributaries, and consolidate the waste material into a on-site constructed cell.	This alternative would be effective in preventing human contact and would remove and isolate the contaminated material from the surface water, therefore, allowing the surface water pH to adjust to a more neutral level and reducing the metals mobility. Institutional controls and a monitoring program would be required to maintain the effectiveness of the cell.	**High** capital costs **Moderate** O&M costs	This technology would be implementable	**Yes** (as component in larger system)	
		On-Site Discharge of Treated Dewatering Liquid	Discharge of treated dewatering liquid to on-site waterways.	This alternative would be effective in treating the water to achieve performance goals prior to discharge to the on-site waterways through settling, amendments, and/or dilution with clean diverted surface water.	**Low** Capital and O&M costs	This technology would be implementable	**Yes** (as component in larger system)	
Removal		Off-Site Disposal	Excavate the sediments above cleanup levels in Ponds 4 and 5, Ely Brook and its tributaries, and transport the material to an off-site disposal facility. Disposal of treatment media off-site.	This alternative would be effective in preventing human contact and would remove and isolate the contaminated material from the overburden groundwater aquifer, therefore, allowing the groundwater pH to adjust to a more neutral level and reducing the metals mobility.	**High** capital costs **Low** O&M costs	This technology would be implementable	**Yes** (as component in larger system)	

Table ES-7
Screening of Potential Treatment Options for Sediment
Ely Copper Mine Superfund Site
Vershire, Vermont

General Response Action	Technology	Process Option	Description	Effectiveness	Cost	Implementability	Retained For Further Consideration	Notes
Treatment	In-Situ Chemical Treatment	Adding Limestone	Add limestone to waterways to neutralize pH.	This alternative may be effective in concert with other process options.	**Low** Capital and O&M costs	This technology would be implementable	**Yes** (as component in larger system)	
	Ex-Situ Physical Treatment	Dewatering	Removing water from sediment prior to disposal by open-air drying.	This alternative may be effective in concert with other process options.	**Low** Capital and O&M costs	This technology would be implementable.	**Yes** (as component in larger system)	
		Treatment of Dewatering Liquid	Filtration through bag filters to remove sediment.	This alternative may be effective in concert with other process options.	**Low** Capital and O&M costs	This technology would be implementable.	**Yes** (as component in larger system)	

Notes: GRA = General Remedial Action
CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act
NCP = National Contingency Plan
RAO = Remedial Action Objective

Table ES-8
Comparison Analysis of Alternatives
Ely Copper Mine Superfund Site
Vershire, Vermont

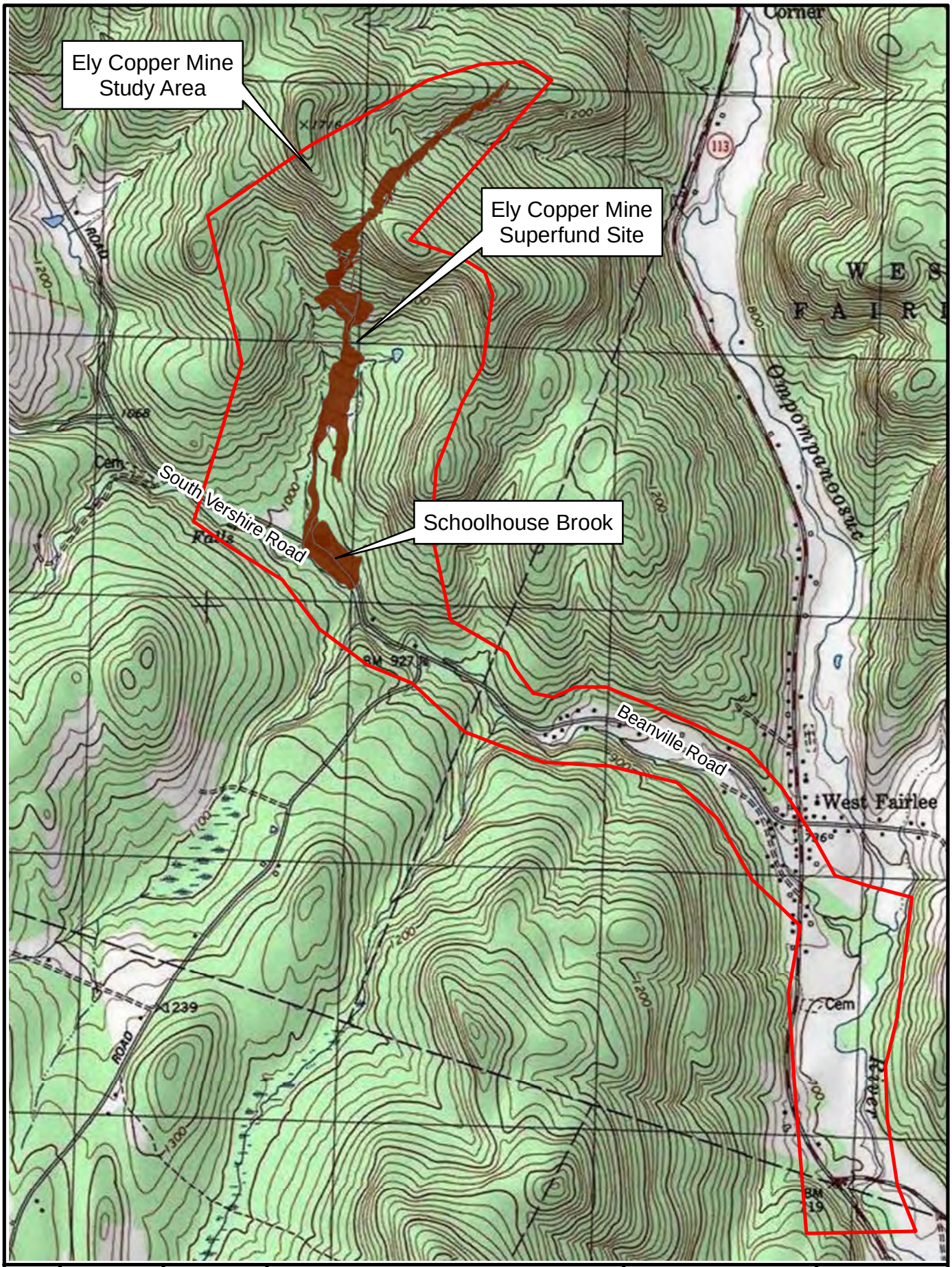
Evaluation Criteria	Alternative SC1	Alternative SC2	Alternative SC3	Alternative SC4
Overall Protection of Human Health and the Environment	Does not meet the criterion. Would not eliminate, reduce, or control source areas or potential future exposure to contaminants exceeding PRGs and would not meet remedial action objectives.	Good Would eliminate the ecological risks from copper and other metals within the waste rock, tailing, and sediment areas and from ARD generated from the sediments and waste rock through consolidation and capping of these materials in the LWA Containment Cell. Human health risks posed by the tailings will be addressed by consolidation and capping of these materials at the ore roast bed containment cell. The location of the LWA Containment Cell will require additional engineering controls and O&M to remain protective.	Better Would be protective of human health and the environment. Would eliminate the ecological risks from copper within the sediment areas and from ARD generated from the sediments and waste rock through consolidation and capping of these materials in the West Containment Cell. Human health risks posed by the tailings will be addressed by consolidation and capping of these materials at the ore roast bed containment cell. SC3 is slightly more protective than SC2 because of the greater long-term effectiveness afforded by placing the material in a location that is more effectively isolated from groundwater and Ely Brook.	Good Would be protective of human health and the environment. Would eliminate the ecological risks from copper within the sediment areas and from ARD generated from the sediments and waste rock through removal and offsite disposal. Human health risks posed by the tailings will be addressed by consolidation and capping of these materials at the ore roast bed containment cell. SC4 is slightly more protective than SC2 because of the waste material is either removed from the OU1 area or is capped at the ore roast beds where it is more effectively isolated from groundwater and Ely Brook.
Compliance with ARARs	Does not meet the criterion. Would not attain protective concentrations for copper in soil or sediment and would not attain ecological risk-based standards based on chemical-specific ARARs and TBCs.	Good Would be designed to attain ARARs pertaining to management of mine waste and copper and protection of wetlands. Source control actions would be designed to protect groundwater and surface water quality. The LWA containment Cell would be located in more environmentally sensitive resource areas that would require additional engineering controls and O&M to remain compliant.	Best Would be designed to attain ARARs pertaining to management of mine waste and copper and protection of wetlands. Source control actions would be designed to protect groundwater and surface water quality. SC3 is the least environmentally damaging practicable alternative under the Federal Clean Water Act, Sec. 404 for protecting wetland resources within the Site. On site containment of contaminated materials at the West Containment Cell poses less impacts to protected resources under State facility siting standards than off-site disposal through SC4.	Good Would be designed to attain ARARs pertaining to management of mine waste and copper and protection of wetlands. Source control actions would be designed to protect groundwater and surface water quality. However, the off-site disposal of large volumes of materials poses significant impacted to protective resources under State facility siting standards.

Table ES-8
Comparison Analysis of Alternatives
Ely Copper Mine Superfund Site
Vershire, Vermont

Evaluation Criteria	Alternative SC1	Alternative SC2	Alternative SC3	Alternative SC4
Long-term Effectiveness and Permanence	Does not meet the criterion Would not eliminate, reduce, or control source areas or potential future exposure to contaminants exceeding PRGs and would not provide long-term effectiveness at protecting human health and the environment.	Good Would isolated the acid generating material that contains cobalt, copper, and iron above PRGs in either the ORB cell (tailings) or the LWA cell for the waste rock. This would have a high degree of long-term effectiveness and permanence provided the cover systems and underdrain are maintained. The reliance upon a most engineering and maintenance intensive groundwater control system reduces the overall effectiveness relative to SC3 which would not rely of the underdrain.	Better Would isolated the acid generating material that contains cobalt, copper, and iron above PRGs in either the ORB cell (tailings) or the West cell for the waste rock. This would have a high degree of long-term effectiveness and permanence provided the cover systems are maintained. Less maintenance would be required to maintain the SC3 West Cell than the SC2 LWA cell resulting in greater long-term effectiveness and permanence for SC3. SC3 also will dispose of the ARD generating waste rock in a location designed to isolate the waste and prevent ARD, whereas the integrity of the off-site disposal of the non-regulated waste rock is uncertain.	Better Would take actions to cap the Tailings Area in the ORB and excavate and dispose of the source areas off-site, thereby controlling the generation of ARD at these source areas. Waste rock and sediment is permanently removed from OU1; therefore, permanence of the alternative could be better than SC2 and SC3. The Long-Term Effectiveness may not be greater since the material is not regulated and may not be disposed in a manner that protects the new disposal location. SC3 is less permanent but has the highest degree of long-term effectiveness due to the ability to select the location for disposal and control the design for the long-term cover system.
Reduction of Toxicity, Mobility, and Volume through Treatment	SC1 would not use treatment to accomplish the reduction of toxicity, mobility, and volume.	SC2 would potentially only use limited treatment to accomplish the reduction of toxicity, mobility, and volume of water produced from dewatering operations or leachate from containment cells that may require treatment prior to discharge.	SC3 would potentially only use treatment to accomplish the reduction of toxicity, mobility, and volume of water produced from dewatering operations or leachate from containment cells that may require treatment prior to discharge.	SC4 would potentially only use treatment to accomplish the reduction of toxicity, mobility, and volume of water produced from dewatering operations that may require treatment prior to discharge.
Short-term Effectiveness	Poor Does not lead to any exposure risks and, therefore, results in no short-term effects; however, it never achieves protectiveness of human health or the environment.	Better Substantially higher requirement for borrow materials to cap the LWA Containment Cell results in either more truck traffic to import materials, or a larger area of clearing for on-site generation when compared to SC3. The time period to achieve the remedial action objectives for each media is estimated to be 2 to 4 years.	Best Would utilize on-site materials eliminating several thousand truck trips on local roads, result in construction related concerns (e.g., blasting, noise, and dust), results in a smaller environmental footprint than SC2, the time period to achieve the remedial action objectives for each media is estimated to be 2 to 4 years. Also significantly less truck trips would be required than for disposing of all of the ARD producing waste rock and sediment off-site under SC4.	Good Significant short-term improvements to local roads and on-site haulage and access roads would be required to address the high volume of truck traffic that would be required under this alternative. Would require several thousand truck trips on local roads, result in construction related concerns and hazards. The time period to achieve the remedial action objectives for each media is estimated to be 2 to 4 years.

Table ES-8
Comparison Analysis of Alternatives
Ely Copper Mine Superfund Site
Vershire, Vermont

Evaluation Criteria	Alternative SC1	Alternative SC2	Alternative SC3	Alternative SC4
Implementability	Implementable. Does not include any actions, other than Five-Year Reviews, and, therefore, would be technically easy to implement.	Good Services and equipment are available, construction of the Tailings Area cover over the ORB is similar for Alternatives SC2, SC3 and SC4. Eighteen acres of on-site borrow would be need to be excavated to obtain material. Construction of the LVA Containment Cell considered less implementable based on its location in the center and low point of the Ely Brook drainage and will require more O&M because of the required underdrain. May require unproven methods or technologies.	Best Services and equipment are available, construction of the Tailings Area cover over the ORB is similar for Alternatives SC2, SC3, and SC4. Less of an area of on-site borrow would be needed than SC2 because borrow could be dug in the same area as where the West Containment Cell will be built and the total requirement for material is less than SC2. The West Containment Cell is considered more implementable based on its standard design and contriction and location higher and west of Ely Brook drainage and potentially above the water table. SC3 is considered more implementable than SC4 because it does not require the large volume of truck use to remove contaminated material from the Site and does not include the uncertainty associated with securing a location for the off-site disposal of 110,000 cubic yards of mine waste.	Better Services and equipment are available, construction of the Tailings Area cover over the ORB is similar for Alternatives SC2, SC3, and SC4. Only limited on-site borrow would be needed to cap the ore roast bed containment cell. There may be significant implementability issues maintaining local roadways from the impact of transporting up to 110,000 cy of waste material off-site on local roads along with the uncertainty associated with securing a location for the off-site disposal of the material.
Cost	Excellent $113,015 - Total Present Worth (30 yrs)	Good $19,428,508 - Total Present Worth (30 yrs)	Better $17,472,278 - Total Present Worth (30 yrs)	Poor $30,123,830 - Total Present Worth (30 yrs)



Drawn By: JRS	Checked By: AJB	
June 24, 2011	Revision No. 00	
APPROXIMATE SCALE 0 400 800 1,600 Feet		

Quadrangle Location

USGS TOPOGRAPHIC MAP

VERSHIRE, VERMONT
1981; (Photo-inspected 1983)

FIGURE ES-1
Site Locus
Ely Copper Mine
Vershire, Vermont

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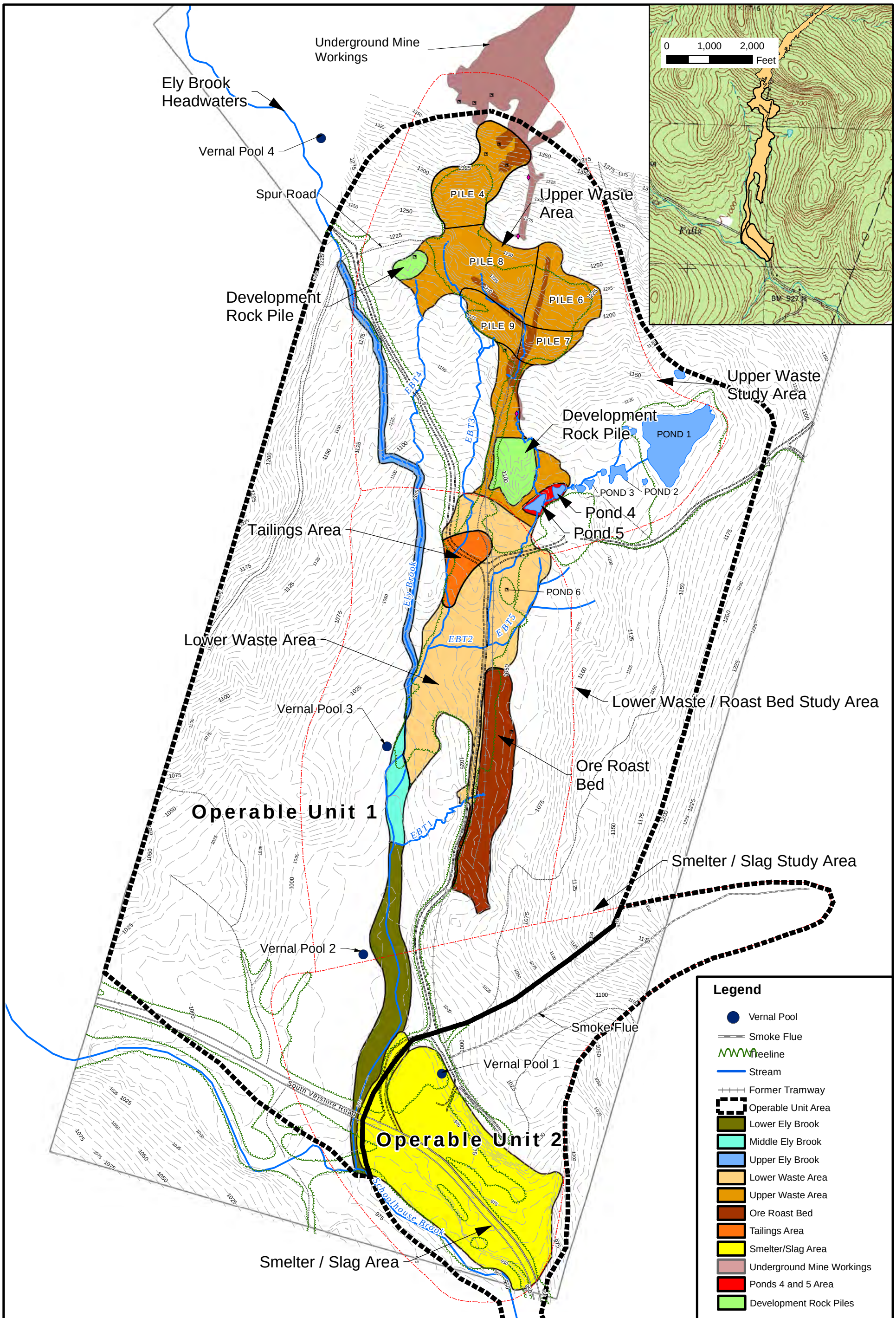

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Drawn By: JRS	Checked By: AJB
June 7, 2011	Revision No. 00

APPROXIMATE SCALE
0 150 300 600 Feet

NOTE: Elevations shown are feet above mean sea level (FT-AMSL).

FIGURE ES-2

Site Sketch
Ely Copper Mine
Vershire, Vermont

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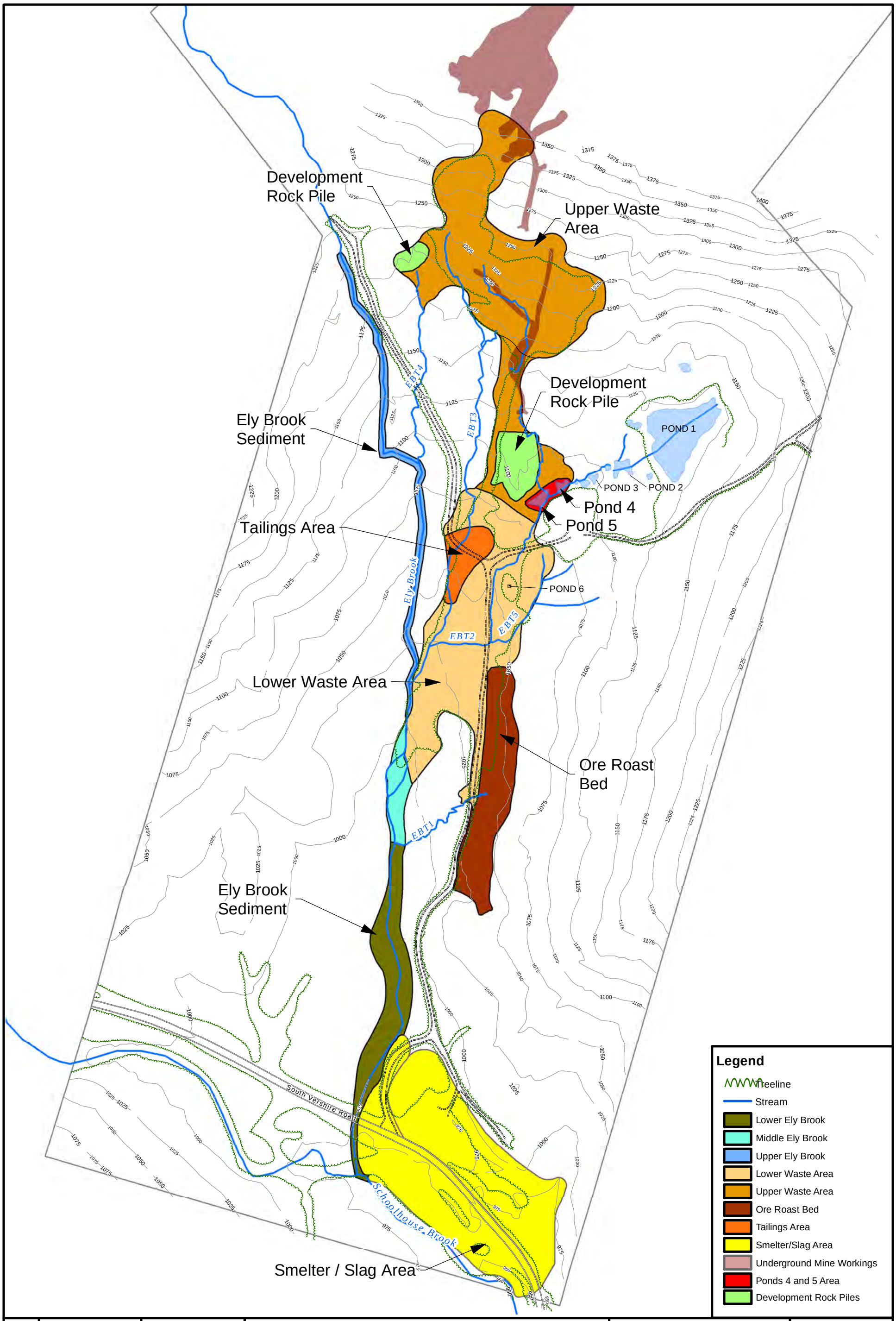

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June 7, 2011	Revision No. 00

APPROXIMATE SCALE
0 150 300 600 Feet

NOTE: Elevations shown are feet above mean sea level (FT-AMSL).

FIGURE ES-3

Site Source Areas
Ely Copper Mine
Vershire, Vermont

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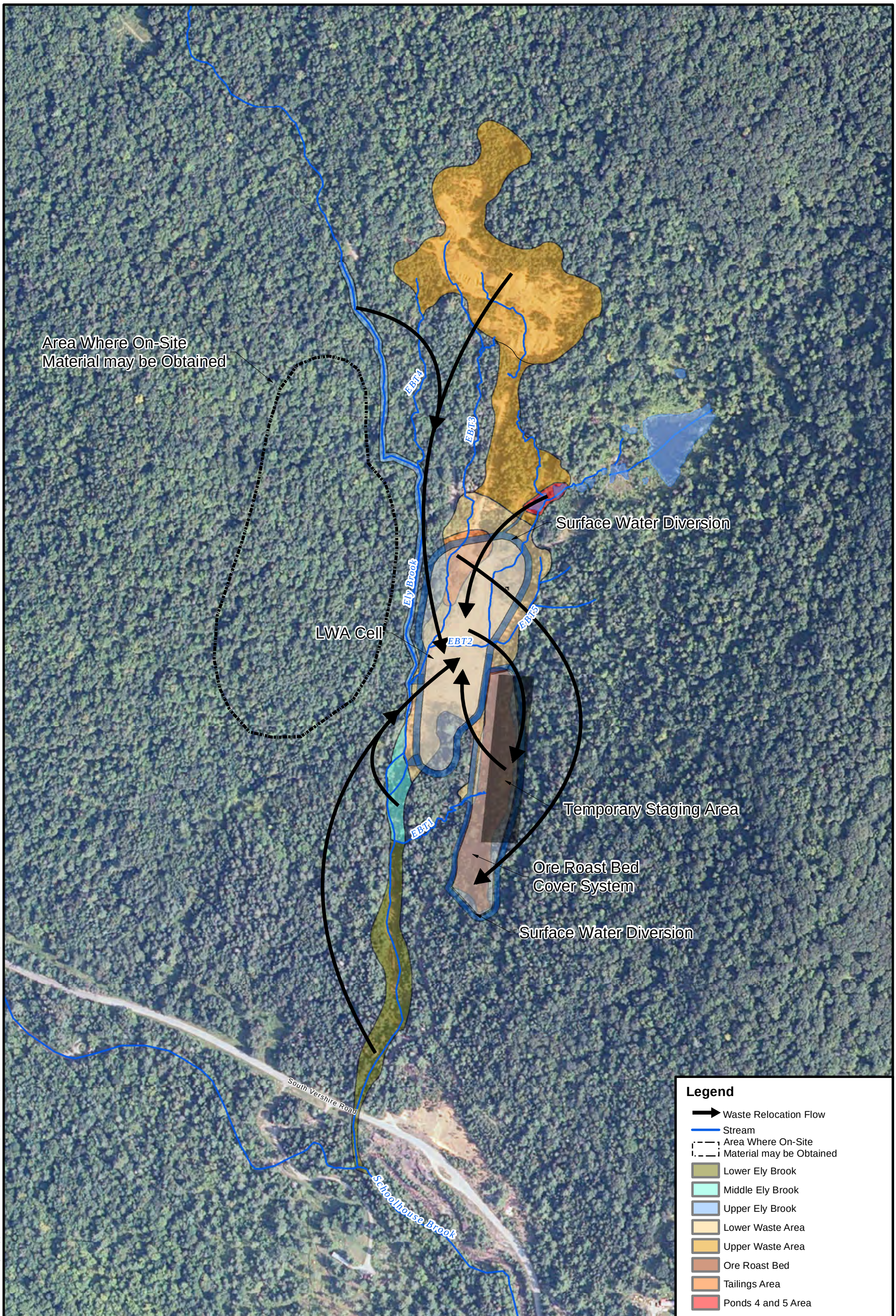
R:\80000 Task Orders\80024 Ely Copper Mine\Technical Data (TD)\GIS\Maps\FS\2-1 Site Source Areas



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Drawn By: JRS	Checked By: AJB
June 24, 2011	Revision No. 00

APPROXIMATE SCALE
0 150 300 600 Feet

FIGURE ES-4

Alternative Remedy Map - Alternative SC2
Ely Copper Mine
Vershire, Vermont

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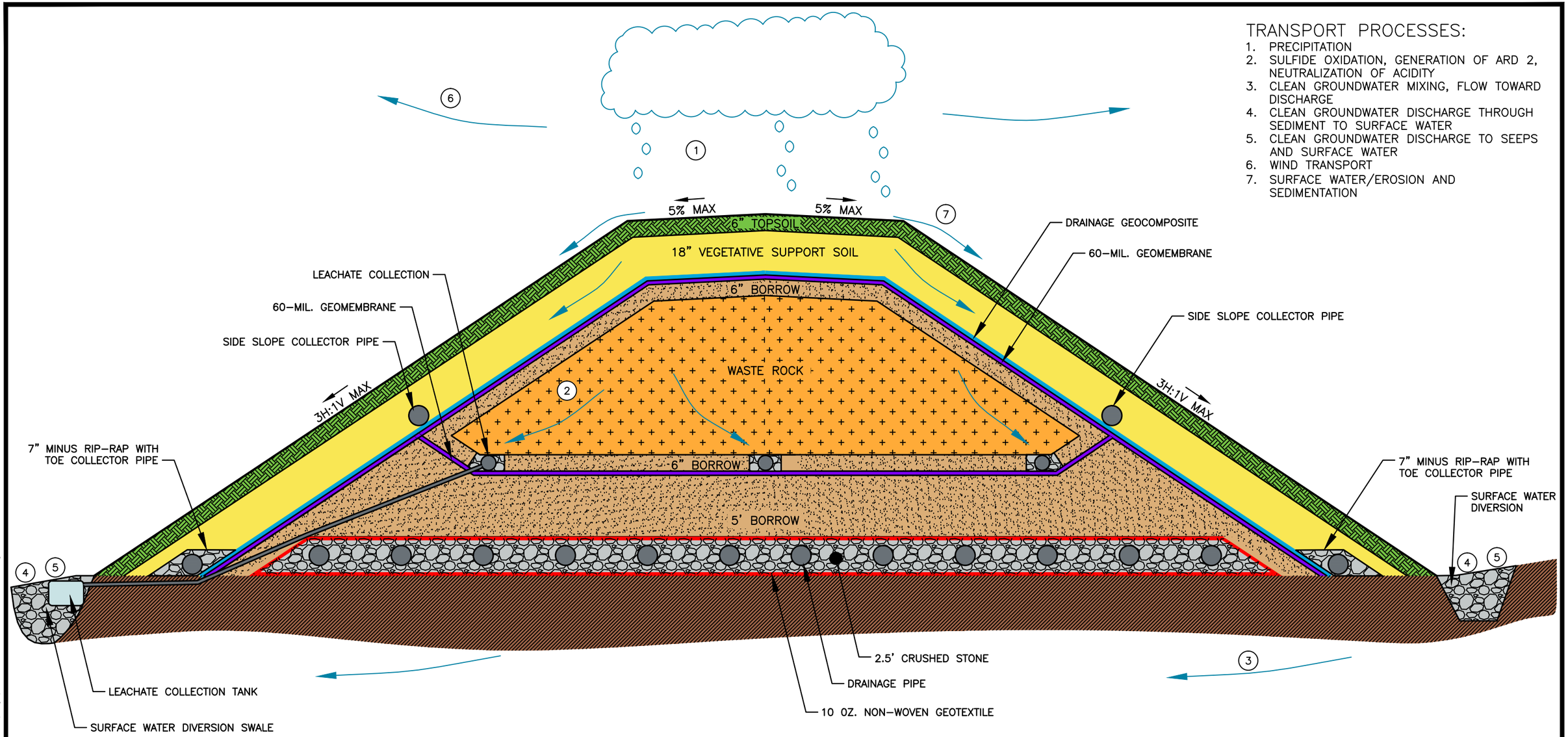

TRANSPORT PROCESSES:

1. PRECIPITATION
2. SULFIDE OXIDATION, GENERATION OF ARD 2, NEUTRALIZATION OF ACIDITY
3. CLEAN GROUNDWATER MIXING, FLOW TOWARD DISCHARGE
4. CLEAN GROUNDWATER DISCHARGE THROUGH SEDIMENT TO SURFACE WATER
5. CLEAN GROUNDWATER DISCHARGE TO SEEPS AND SURFACE WATER
6. WIND TRANSPORT
7. SURFACE WATER/EROSION AND SEDIMENTATION

METAL RETENTION MECHANISMS:

A. FORMATION OF METAL OXIDES INSIDE WASTE ROCK PILES
B. PRECIPITATION MECHANISMS OPERATING WITHIN WASTE ROCK PILE
C. MINERAL PRECIPITATES IN SURFACEWATER/SEEP DISCHARGE AREAS
D. METALS IN GROUNDWATER; DISCHARGED TO AND RETAINED BY SEDIMENTS
E. METALS RETAINED IN "MINE WASTE" LAYER SEDIMENT

NOT TO SCALE

Nobis
Engineering a Sustainable Future
Nobis Engineering, Inc.
18 Chenell Drive
Concord, New Hampshire 03301
Tel (603) 224-4182
Fax (603) 224-2507
www.nobiseng.com

FIGURE ES-5

LWA CELL SYSTEM PROCESS MODEL

ELY COPPER MINE
VERSHIRE, VERMONT

DRAWN BY:	ML	APPROVED BY:	AB
PROJECT:	80024.12		JUNE 24, 2011

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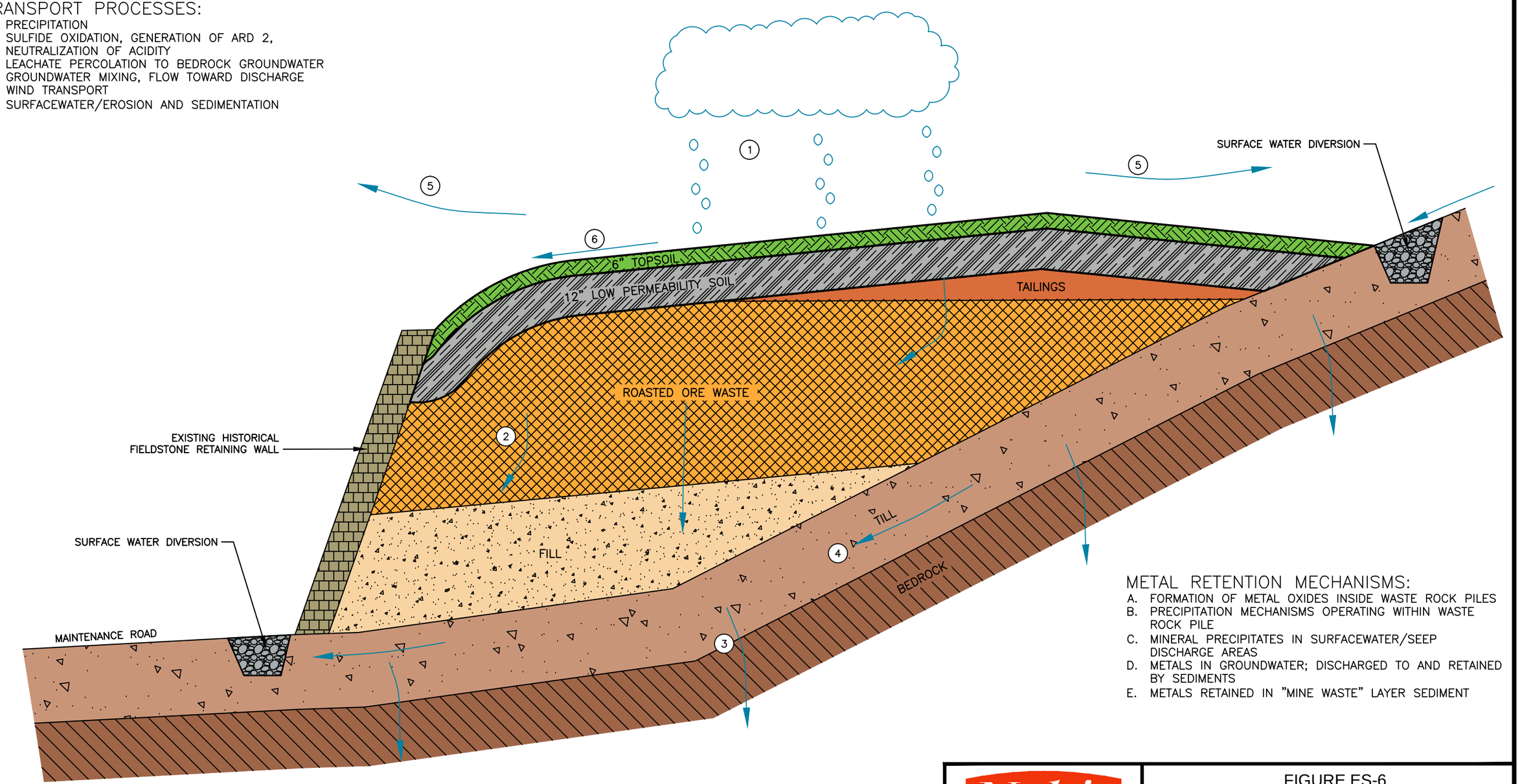
TRANSPORT PROCESSES:

1. PRECIPITATION
2. SULFIDE OXIDATION, GENERATION OF ARD 2, NEUTRALIZATION OF ACIDITY
3. LEACHATE PERCOLATION TO BEDROCK GROUNDWATER
4. GROUNDWATER MIXING, FLOW TOWARD DISCHARGE
5. WIND TRANSPORT
6. SURFACEWATER/EROSION AND SEDIMENTATION



METAL RETENTION MECHANISMS:

A. FORMATION OF METAL OXIDES INSIDE WASTE ROCK PILES
B. PRECIPITATION MECHANISMS OPERATING WITHIN WASTE ROCK PILE
C. MINERAL PRECIPITATES IN SURFACEWATER/SEEP DISCHARGE AREAS
D. METALS IN GROUNDWATER; DISCHARGED TO AND RETAINED BY SEDIMENTS
E. METALS RETAINED IN "MINE WASTE" LAYER SEDIMENT

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18 Chenell Drive
Concord, New Hampshire 03301
Tel (603) 224-4182
Fax (603) 224-2507
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FIGURE ES-6

ORB CAP SYSTEM PROCESS MODEL

ELY COPPER MINE
VERSHIRE, VERMONT

DRAWN BY:	ML	APPROVED BY:	AJB
PROJECT:	80024.12		JUNE 24, 2011

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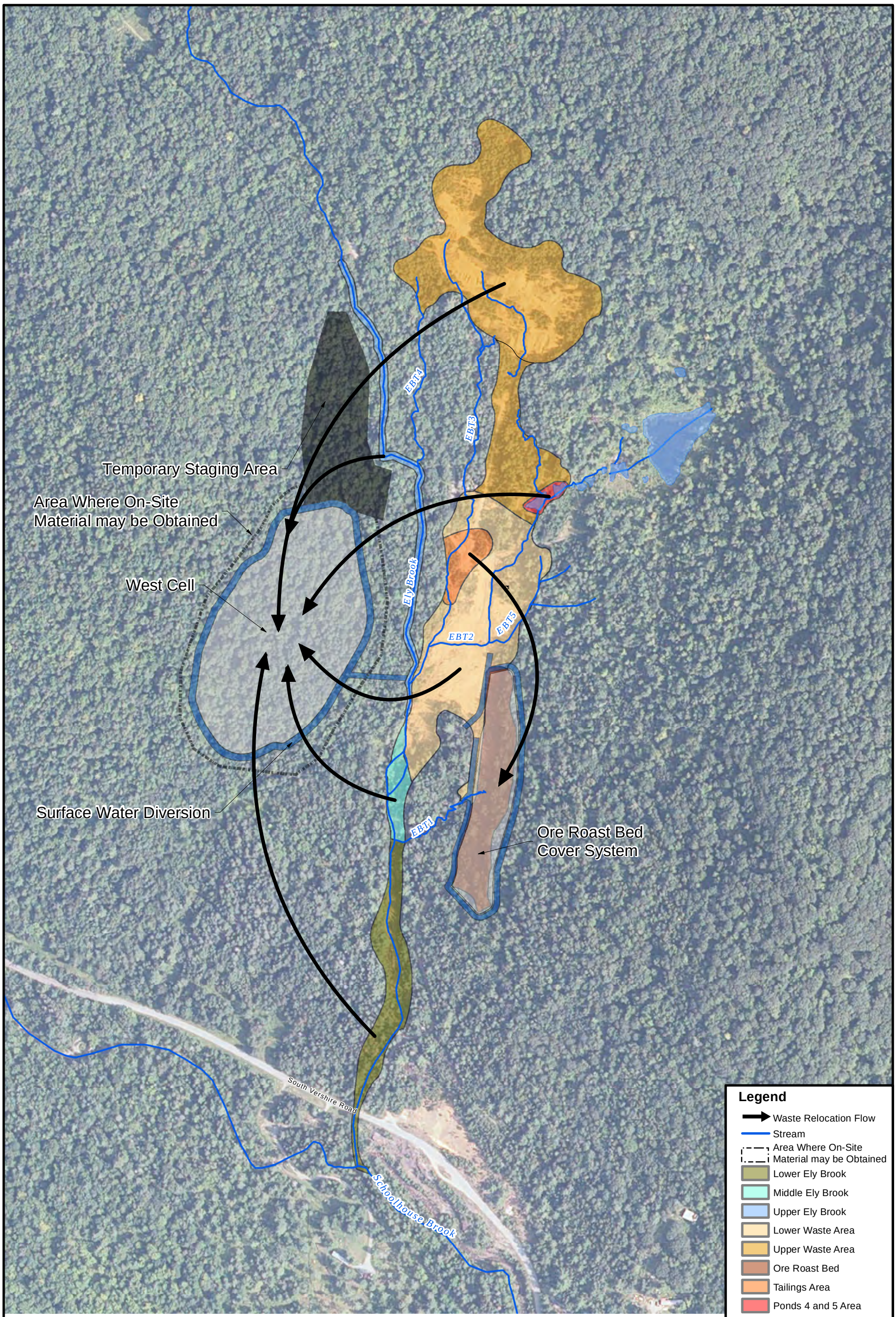

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Drawn By: JRS	Checked By: AJB
June 24, 2011	Revision No. 00

APPROXIMATE SCALE
0 150 300 600 Feet

FIGURE ES-7
Alternative Remedy Map
Alternative SC3
Ely Copper Mine
Vershire, Vermont

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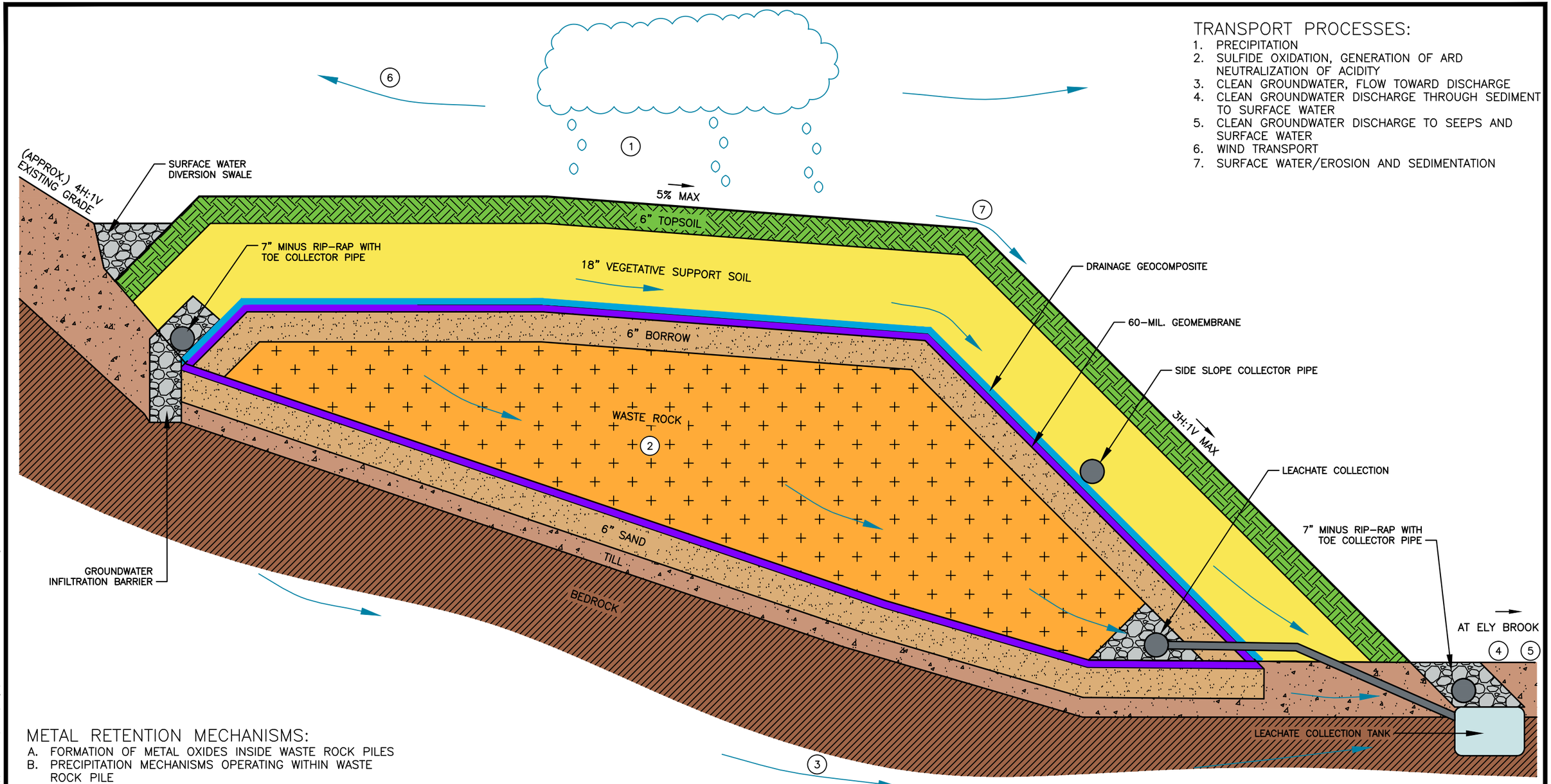

TRANSPORT PROCESSES:

1. PRECIPITATION
2. SULFIDE OXIDATION, GENERATION OF ARD NEUTRALIZATION OF ACIDITY
3. CLEAN GROUNDWATER, FLOW TOWARD DISCHARGE
4. CLEAN GROUNDWATER DISCHARGE THROUGH SEDIMENT TO SURFACE WATER
5. CLEAN GROUNDWATER DISCHARGE TO SEEPS AND SURFACE WATER
6. WIND TRANSPORT
7. SURFACE WATER/EROSION AND SEDIMENTATION

METAL RETENTION MECHANISMS:

A. FORMATION OF METAL OXIDES INSIDE WASTE ROCK PILES
B. PRECIPITATION MECHANISMS OPERATING WITHIN WASTE ROCK PILE
C. MINERAL PRECIPITATES IN SURFACEWATER/SEEP DISCHARGE AREAS
D. METALS IN GROUNDWATER; DISCHARGED TO AND RETAINED BY SEDIMENTS
E. METALS RETAINED IN "MINE WASTE" LAYER SEDIMENT

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Engineering a Sustainable Future
Nobis Engineering, Inc.
18 Chenell Drive
Concord, New Hampshire 03301
Tel (603) 224-4182
Fax (603) 224-2507
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FIGURE ES-8

WEST CELL SYSTEM PROCESS MODEL

ELY COPPER MINE
VERSHIRE, VERMONT

DRAWN BY:	ML	APPROVED BY:	AJB
PROJECT:	80024.12		JUNE 24, 2011

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Drawn By: JRS	Checked By: AJB
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APPROXIMATE SCALE
0 150 300 600 Feet

FIGURE ES-9
Alternative Remedy Map - Alternative SC4
Ely Copper Mine
Vershire, Vermont

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Concord, NH 03301
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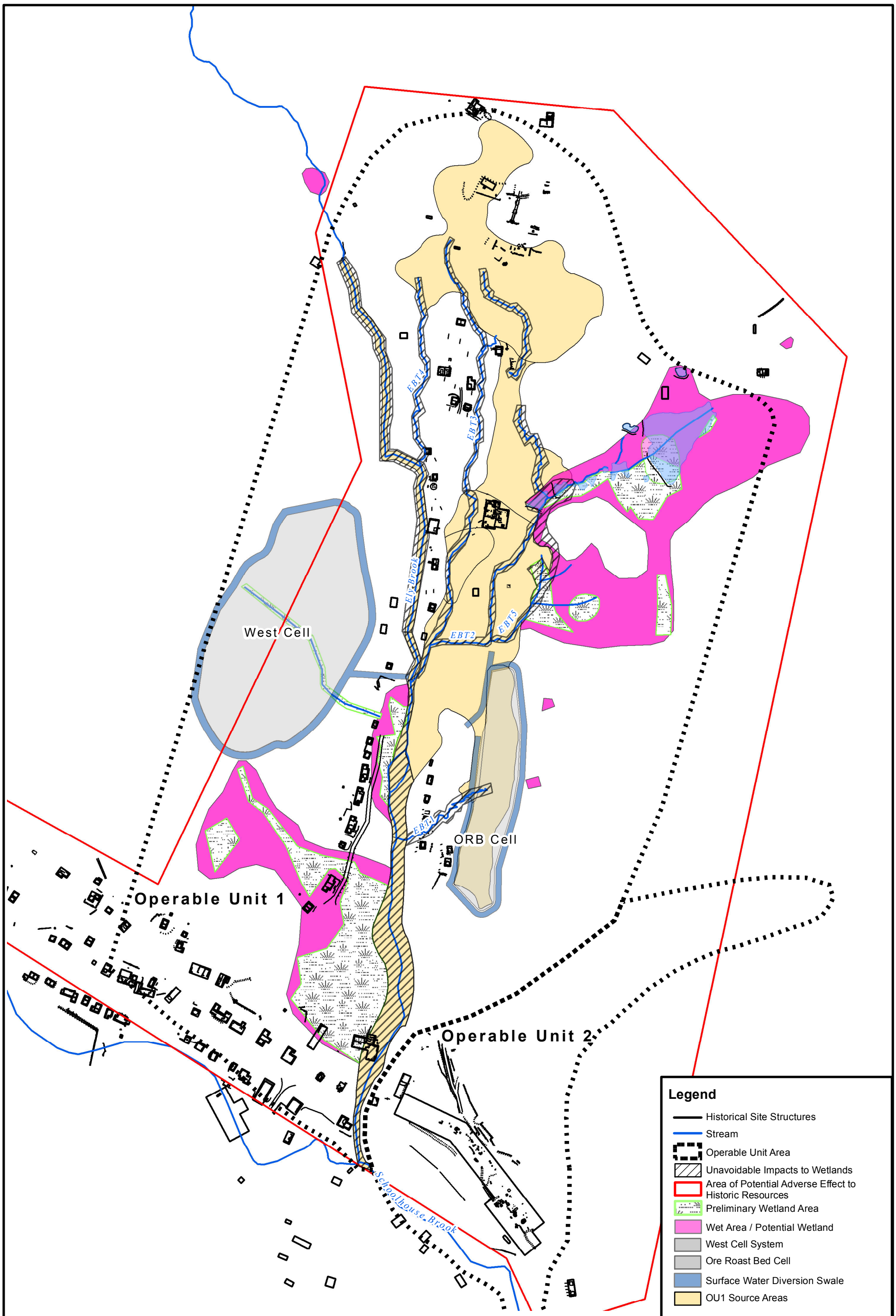

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Drawn By: JRS	Checked By: AJB
June 24, 2011	Revision No. 00

APPROXIMATE SCALE
0 150 300 600 Feet

FIGURE ES-10
SC3 Area of Potential Impact
Ely Copper Mine
Vershire, Vermont

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Nobis Engineering, Inc.
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Concord, NH 03301
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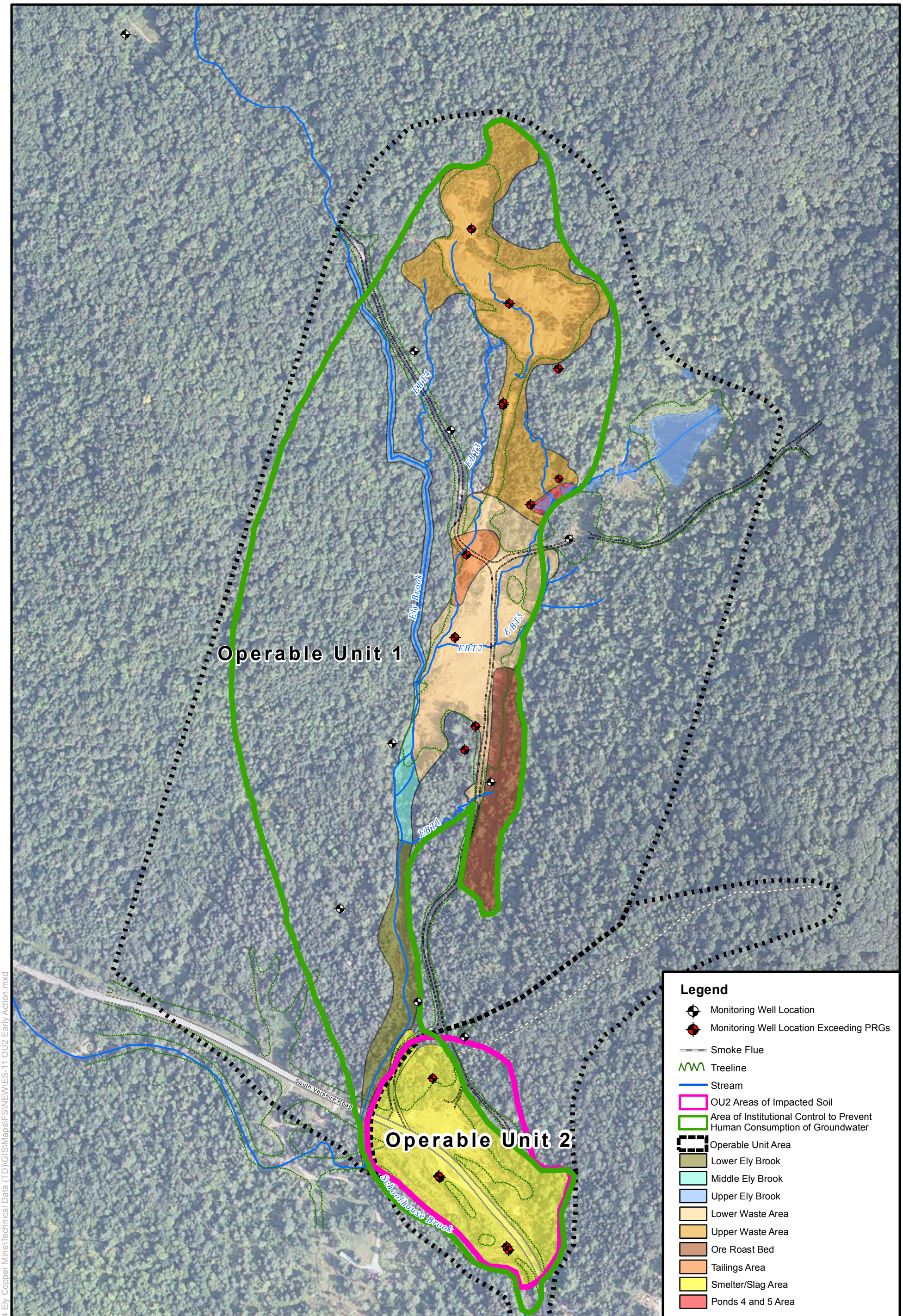

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June 24, 2011	Revision No. 00

APPROXIMATE SCALE
0 150 300 600 Feet

NOTE:
Limit of Groundwater Exceedances based on Total/Dissolved Metal Exceedances From 2009 Groundwater Sampling by Nobis Engineering, Inc.
Soil Impact areas are based on sample results in exceedance of the site soil PRGs

FIGURE ES-11

OU2 Early Action
Ely Copper Mine
Vershire, Vermont

Nobis
Engineering a Sustainable Future
Nobis Engineering, Inc.
18 Chenell Drive
Concord, NH 03301
(603) 224-4182

1.0 INTRODUCTION

This Operable Unit 1 (OU1) Feasibility Study (FS) was prepared by Nobis Engineering, Inc. (Nobis) for the United States Environmental Protection Agency (USEPA) under Contract Number EP-S1-06-03, Task Order Number 0024-RI-CO-017L (Task Order). The work was performed in accordance with the September 27, 2007 USEPA Statement of Work (SOW). The Task Order SOW includes the completion of a RI/FS at the Ely Copper Mine Superfund Site (the "Site") located in Vershire, Vermont. The goal of the RI/FS is to support the selection of a remedy that eliminates, reduces, or controls risks to human health and the environment and can be used to prepare a well-supported Record of Decision (ROD).

The Site is an abandoned copper mine located in Vershire, Orange County, Vermont and encompasses approximately 350 acres, including areas containing an estimated 172,000 tons of waste rock, tailings, ore roast beds, slag heaps, smelter wastes, and over 3,000 linear feet of Underground Mine Workings with shafts and adits opening into the flooded mine. No buildings remain at the Site. Remnant foundations, pads, and stone walls, including a 1,400-foot long smoke flue, demark the location of former Site structures including a former flotation mill and the smelter plant. The Site has been determined to be eligible for listing in the National Register of Historic Places by USEPA in consultation with the State Historic Preservation Officer (SHPO). The location of the Site and RI/FS Study Area is shown in Figure 1-1.

The ore body was discovered in 1813 and explored in the 1830s. Significant mine activities began in 1853 and lasted until 1905. Mineralogy of the ore body was similar to that in other mines that are part of the Vermont Copper Belt (discussed further in Section 1.3.4), with ore consisting primarily of pyrrhotite, chalcopyrite and minor pyrite and sphalerite. Prior to 1867, ore was shipped to smelters along the east coast for processing. On-site smelting operations began in 1867 and were expanded over time to include a large 24-furnace smelter plant. Ely Mine was among the top ten copper producing operations for a period of its history, with an average annual production of 500 tons of ingot copper and an estimated total copper production of 20,000 tons. It was the only copper mine in Vermont that successfully produced refined ingot copper on a large scale (Kierstead, 2001). During World War I, a flotation separation mill was constructed and operated for a short period. During World War II, some waste ore material was scavenged for milling at the Elizabeth Mine. Table 1-1 presents a history of Site operations.

The Site was added to the USEPA National Priorities List (NPL) in September 2001 (47583 – 47591 Federal Register / Vol. 66, No. 178 / Thursday, September 13, 2001 / Rules and Regulations). The Site is undergoing investigation and clean-up activities pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act, as amended (CERCLA), 42 USC § 9601 *et seq.*, and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), 40 Code of Federal Regulations (CFR) Part 300. The Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS) identification number for the Site is VTD988366571. Table 1-2 presents a summary of investigations conducted at the Site.

1.1 Purpose and Scope

To facilitate the evaluation and implementation of actions to reduce, eliminate, or control actual or potential human-health and ecological risks, the Site has been divided into two Operable Units (OUs). OUs are discrete actions that comprise incremental steps toward a final remedy. An OU eliminates or mitigates a release, a threat of a release, or an exposure pathway (USEPA, 1988b), and may reflect the final remediation of a defined portion of a site or may be implemented as an interim measure. The two OUs for the Site are described below and shown in Figure 1-2:

- OU1 will include the waste rock, tailings, roast beds, and contaminated soil, along with the surface water and sediment for all areas of the Ely Brook valley (except the Smelter/Slag Area) and within any Underground Mine Workings).

- OU2 will include the all of the groundwater impacted by the Site, including the Underground Mine Workings, the sediment of Schoolhouse Brook, and the Smelter/Slag Area.

Addressing source control issues in OU1 first and then evaluating the OU1 remedy's affect on the remaining Site will enable a better understanding of the impacts of the OU1 source control measures on groundwater and on the Smelter/Slag Area discharges into Schoolhouse Brook. This will allow the development of appropriate remedial alternatives for OU2, which, if necessary, will be discussed in a future FS.

The purpose of this FS Report is to identify and evaluate appropriate remedial alternatives for the OU1 areas of the Site posing unacceptable human health or environmental risks as determined from information gathered during the Remedial Investigation (RI), including the Human Health Risk Assessment (HHRA) and the Baseline Ecological Risk Assessment (BERA). The FS Report evaluates alternatives based upon the criteria defined in the NCP and CERCLA. As required by the statute, a no-action alternative is considered in the evaluations and a detailed analysis of selected remedies is provided for each area. FS activities include:

- developing remedial action objectives (RAOs);
- developing general response actions (GRAs);
- identifying areas and volumes requiring remedial action (RA);
- identifying and screening of remedial technologies and process options;
- developing and screening of RA alternatives;
- conducting a detailed analysis of retained RA alternatives; and,
- conducting a comparative analysis of retained RA alternatives.

This FS does not select a preferred alternative for OU1, but rather describes the alternatives under consideration. The preferred alternative will be identified in the Proposed Plan and will be subject to public comment. After addressing State and public comments on the proposed alternative, a final remedy selection will be described in a ROD. In addition to the OU1 Remedial Action, an OU2 Early Action (discussed ion Section 6.0) is being implemented to restrict public access to overburden and bedrock groundwater contamination and the surface soil within the Smelter/Slag Area.

1.2 Report Organization

Section 1.0 introduces the FS report and its purpose, and presents report topics. This Section includes a brief background description and history of the Site, the nature and extent of OU1 contamination and a site conceptual model presenting the interrelationships of contaminant source areas, site geology and hydrogeology, contaminant persistence, and contaminant distribution. Section 1.0 also summarizes human-health and ecological risks.

Section 2.0 identifies the basis for remediation, and identifies and screens remedial technologies for the corresponding response actions. This section links the results of the risk

assessments to the selection of remedial technologies by identifying preliminary remediation goals (PRGs), developing RAOs, and listing the resultant general response actions (GRAs). This section initiates the risk-management decision process.

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

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

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

Section 6.0 presents the Early Action.

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

1.3 Background Information

This subsection summarizes background information on the Site. Topics include a Site description and general history, a history of environmental investigations leading up to this FS, a summary of the nature and extent of contamination, a discussion of contaminant fate and transport, the conceptual site model, and a summary of the human-health and ecological risk assessments. Additional detail pertaining to these subjects is provided in the RI report (Nobis, 2011).

1.3.1 Site Description and Setting

The Site is located approximately four miles southeast of the village of Vershire Center, and approximately five miles northwest of the village of West Fairlee in Vershire, Orange County, Vermont. The Site encompasses approximately 350 acres along the south slope of Dwight Hill, to the north of Schoolhouse Brook and South Vershire Road (Figure 1-1). The mine area includes features such as intact and collapsed adits and shafts, reservoirs, over 3,000 linear feet of underground mine workings (largely flooded) and remnant foundations of former mine

operation buildings. Waste areas are sparsely vegetated and include an ore roast bed, waste rock, tailings, slag heaps, and a former smelter (Piatak, et. al., 2004; URS Corporation [URS], 2004; The Public Archaeology Laboratory, Inc. [PAL], 2005). No buildings exist on the Site. The locations of the former Main Shaft Hoist, the Westinghouse Hoist House, smelter buildings, a World War I-era ore flotation separation mill, and other structures associated with historic mining operations have been documented at the Site (PAL, 2005). Refer to Figure 1-2 for a Site Sketch depicting the current conditions and Figure 1-3 for the historical features at the Site.

The Site landscape is a combination of barren open areas and patches of birch and evergreen trees. The south slope of Dwight Hill, which contains most of the waste rock associated with the mine, lies within the watershed of a small stream, Ely Brook, which flows south to join Schoolhouse Brook on the south side of South Vershire Road. Schoolhouse Brook borders the southern margin of the Site and flows eastward approximately 1.75 miles to its confluence with the East Branch of the Ompompanoosuc River (EBOR). Schoolhouse Brook upstream of Ely Brook and the EBOR support healthy fish populations. Schoolhouse Brook is also suitable for recreational purposes such as swimming and wading.

1.3.2 Topography

Site topography is dominated by the peak and steep south slope of Dwight Hill extending from an elevation of approximately 1,600 feet above mean sea level down to Schoolhouse Brook at an elevation of approximately 940 feet above mean sea level, some 660 feet of relief. The main shaft and several adits leading to the Underground Mine Workings are located along the steep, upper portion of this slope at the head of the valley. Most of the mine wastes lie within the more gently sloping, lower portions of this valley. The crest of Dwight Hill occurs along a northwest trending ridge, which forms the northern boundary of the Ely Brook watershed. The Underground Mine Workings extend approximately 3,000 feet to the northeast of the mine openings beneath and beyond the top of the ridge. North-south trending ridges to the west and east of the mine areas define two smaller upland valleys that merge into an open U-shaped valley facing south-southwest and define the Ely Brook watershed. The small upland valley located on the western side of the watershed contains the headwaters for Ely Brook. The other small upland valley drains the eastern side of the watershed into a series of beaver ponds (Ponds 1 through 5). The northeast slope of Dwight Hill, which extends away from the waste

piles, is moderately steep with an elevation drop of approximately 800 feet down to Route 113 to the east. Figure 1-1 shows the topographic contours for the Site and Study Area.

1.3.3 Population and Land Use

The Site is located in the Town of Vershire, Orange County, Vermont, which has a population of approximately 630 people (Town of Vershire website, 2000 Census). The Site is located in a rural, sparsely populated area of the town accessed by Beanville and South Vershire Roads, approximately 1.5 miles northwest of the Village of West Fairlee. It is estimated that less than 100 people live within a one-mile radius of the Site. The nearest residents are located approximately ¼ mile east of the Site along Beanville Road. The Site and vicinity is forested with the exception of open areas occupied by mine waste rock and tailings. The Site is currently privately owned. The land is undeveloped and has generally been undisturbed since cessation of activities in 1950. The current land use of the Site is quite limited; the land has been managed for timber harvesting and is used by a local hunting club. There are no residents or buildings on the Site. The Site is reportedly also frequented for limited recreational use by off-road vehicles, hunters, hikers, and spelunkers. There are no land use restrictions in place that would prevent future residential use.

1.3.4 Vermont Copper Belt

The Vermont Copper Belt, also known as the Orange County copper district, lies within the Connecticut River watershed in Orange County, Vermont. It is reported to have supplied the largest historic metal production in New England from the early 1800's to 1958 derived primarily from the Elizabeth, Ely, and Pike Hill Mines within a 20-mile long area from south to north in the belt (Figure 1-4). Other smaller deposits known as the Cookeville, Orange, and Gove Deposits also occur within this belt. Early production at the Elizabeth Mine was focused on copperas (iron sulfate), followed later by copper production at all three mines. The ore bodies are stratiform massive sulfide deposits similar to those of the Besshi-type deposits in Japan and are believed to have formed by syngenetic-exhalative processes on the sea floor during the Silurian-Devonian age. The primary ore minerals include pyrrhotite, chalcopyrite with minor sphalerite and pyrite (Slack and others, 2001). The Elizabeth and Ely Mines lie within the Devonian Gile Mountain Formation, and the Pike Hill Mines lie within the Silurian Waits River Formation. The Ely Copper Mine lies between the Elizabeth and Pike Hill Copper Mines.

1.4 OU1 Nature and Extent of Contamination

Waste material from over 100 years of mining activities can be found across the entire Site, from the mine entrances high on Dwight Hill to Schoolhouse Brook. The major issue at the Site is acid rock drainage (ARD), which occurs when sulfide mineral-bearing rock and ore are exposed to oxygen and water, thereby creating a low-pH leachate (contaminated water percolating through the impacted soil and infiltrating the groundwater). At low pH, many of the metals that were bound in the ore and native soil become soluble and dissolve into the leachate. The leachate from the Site often contains elevated levels of aluminum, cadmium, cobalt, copper, iron, manganese, and zinc that are likely from the locally mined ore. Aluminum and manganese are also contributed by the leaching of metals in the native soil. In addition to the oxidation of the sulfide-bearing minerals, the cyclic formation and subsequent dissolution of evaporative metal salts on exposed waste ore and tailings also contributes to ARD at the Site. Metal salts form on the surfaces of the tailings and waste ore as metal-containing acidic moisture evaporates. The metals stored in these salts are dissolved and remobilized during subsequent rainfall events. This run-off is eventually conveyed to receiving streams, resulting in an increase in the waterway's metals concentration and load.

Metals associated with ARD at the Site have been detected at elevated concentrations in groundwater, surface water, soil, and sediment. ARD directly affects both groundwater and surface water quality at the Site by lowering the pH and contributing elevated concentrations of metals to these media. This also occurs at the outlet of the adits, where impacted mine waters discharge directly to the ground surface as acid mine drainage (AMD) and then flow into surface water and groundwater. In addition, the tailings, weathered waste ore, roasted ore, and byproducts generated from the smelting process (i.e., slag) have been transported from the original areas of deposition by erosion and redistributed nearby, causing elevated concentrations of metals in the soil adjacent to the waste areas. Some of these materials have been conveyed by overland flow, resulting in elevated concentrations of metals in sediment along these Site drainage ways, including: Ely Brook, four tributaries to Ely Brook, Schoolhouse Brook, and the EBOR.

In addition to ARD generation, the waste material and soil contain levels of cobalt, copper, and iron above levels considered acceptable for year-round residential-type exposure.

The RI divided the Site into several different areas that may be contributing contamination to the surface water, groundwater, or sediment. The areas (shown on Figure 1-5) that fall within OU1 are the: Upper Waste Area (UWA); Lower Waste Area (LWA); Tailings Area (TA); Ore Roast Bed (ORB); and Ely Brook and its Tributaries. Evaluation of results from each of these areas has led to the following findings.

1.4.1 UWA

The UWA is comprised of a series of terraced, overlapping mine waste rock piles of varying thickness in the upper portion of the Ely Brook valley on the south side of Dwight Hill. The piles are a mixture of barren country rock (from development of mine openings) and ore-bearing rock. The UWA sits just downslope of the Main Adit for the Underground Mine Workings. A series of shafts and adits (including the Main Adit) are found within and adjacent to the UWA. The primary limits of the UWA were defined by the physical presence of acid generating mine waste. The edges of the UWA were also delineated to include the areas where cobalt, copper, and iron exceed preliminary remedial goals (PRGs) (see Section 2.1.3 of this FS). Ponds 1 through 5 mark the downslope extent of the UWA (Figure 1-5).

Native soil underlies portions of the UWA, but some of the waste sits directly on bedrock. The groundwater extends into the lower portion of the piles, particularly during spring snowmelt and after periods of substantial rain. Water coming into contact with the mine waste in the UWA creates ARD that drains from the UWA into groundwater, several Ely Brook tributaries (EBT2, EBT3, and EBT4), and Ponds 4 and 5. The UWA also contains two development rock piles that were created when bedrock was excavated to create the shafts and adits. The rock within the development rock pile does not appear to be part of the sulfide ore and is not considered to be contributing to the ARD release at the Site.

1.4.2 LWA

The LWA, an area of barren waste rock, sits below the UWA and the foundation of the former Flotation Mill, between the ORB and Ely Brook. Two major tributaries to Ely brook (EBT2 and EBT3) traverse the LWA. Like much of the rest of the Site waste areas, this area is largely devoid of vegetation. The waste in this area forms a uniform, gentle slope between the access road and Ely Brook that has subsequently been dissected by shallow erosion gullies. The waste material is relatively thin (typically on the order of 5 feet thick) in contrast to the thicker

waste piles in the UWA. The primary limits of the LWA were defined by the physical presence of acid generating mine waste. The edges of the LWA were also delineated to include the areas where cobalt, copper, and iron exceed PRGs (see Section 2.1.3 of this FS).

A relatively thin layer of native soil with variable thickness underlies the LWA. It is possible that some of the waste sits directly on or in close proximity to bedrock. The groundwater extends well into the waste within the LWA. Water coming into contact with the mine waste creates ARD that drains from the LWA into groundwater, Ely Brook, and several Ely Brook tributaries (EBT2, EBT3, and EBT5). These tributaries run across the waste within the LWA. Figure 1-5 shows the LWA.

1.4.3 TA

The TA sits along the northwest edge of the LWA and the two areas do not have a clearly defined boundary where they meet. The tailings are a remnant of the operation of a flotation mill at the Site for a short period of time from 1917 to 1918. The tailings are produced from the ore excavated from the Ely Mine and are a fairly uniform, fine sand/silt material.

A relatively continuous layer of glacial till approximately 10 feet thick is interpreted below the TA, which may limit the impact to groundwater beneath the TA. Similar to the LWA, the TA is saturated with groundwater and portions of the TA sit within the watershed of an Ely Brook tributary (EBT3). Water coming into contact with the tailings creates ARD that drains from the TA into groundwater and EBT3. Figure 1-5 shows the TA.

1.4.4 ORB

The ORB, which abuts the eastern margin of the access road southeast of the LWA, was the primary location for the roasting of the ore excavated from the Ely Mine. Waste material in this area includes layers of partially-roasted ore that were left there when mine operations closed down. The western limit of the ORB is demarked by a high, stone-slab retaining wall. The sparsely vegetated ORB soils are distinguishable from soils in the adjacent LWA by the deep red color of the hematite-rich soil. A small tributary to Ely Brook (EBT1) crosses the roast beds and the access road at a location where the retaining wall has collapsed. An abandoned exploratory shaft is located along the northeast margin of the ORB. The roasted ore in this area still contains significant levels of metals, but the waste material does not produce acidic

leachate and, therefore, appears to be a much less significant source of contamination than the UWA, LWA, and TA. Figure 1-5 shows the ORB.

1.4.5 Ely Brook and Tributaries

Ely Brook runs North-to-South along the west side of the waste areas until its confluence with Schoolhouse Brook a short distance after Ely Brook crosses South Vershire Road near the entrance to the Site. Portions of the Brook have been impaired by ARD from several of the Site waste areas, as well as eroded waste rock and tailings (which become sediment). The eroded waste rock and tailings, which contain elevated concentrations of cobalt, copper, iron, and sulfide that have become sediment in Ely Brook and its tributaries, are believed to be a significant source of dissolved metals loads to downgradient surface water.

For the purpose of the FS, Ely Brook itself has been segmented into four zones that correspond to depositional and/or contaminant characteristics: the Ely Brook Headwaters, Upper Ely Brook, Middle Ely Brook, and Lower Ely Brook. The four segments of Ely Brook and the location of the tributaries and ponds are shown on Figure 1-5. The Ely Brook Headwaters (the uppermost portion of the drainage) is believed to be unimpacted by Site waste areas. However, various levels of impairment have been observed in Upper, Middle, and Lower Ely Brook.

Upper Ely Brook (just downstream of the headwaters) is a high-energy channel made up of primarily of cobbles and boulders. Elevated sediment and surface water metals concentrations within the surface water and sediment of Upper Ely Brook are believed to be associated with ARD and weathered waste rock (which has become sediment) from the UWA. EBT4 is the surface water feature most likely to be transporting ARD from the UWA to Upper Ely Brook. It is possible that mine waste used as fill in the area may also be contributing to the impairment of Upper Ely Brook.

Both Middle Ely Brook (from the confluence with EBT2 to the confluence with EBT1) and Lower Ely Brook (from the confluence with EBT1 to the confluence with Schoolhouse Brook) contain sediment accumulations of eroded waste rock up to 3.5 feet thick and receive ARD originating from the UWA, LWA, and TA. The channel gradient of Ely Brook decreases in the lower portion of the Middle Ely Brook, where the channel widens and begins to meander as it enters the lower-energy depositional environment of the Lower Ely Brook.

Ely Brook is fed on the east by three significant tributary streams referred to as the EBT1, EBT2, and EBT4. Tributary EBT2 has one significant contributing branch from the north identified as EBT3 with the main stem of EBT2 flowing from a series of Ponds (Ponds 1 through 5) and a small eastern tributary EBT5. Sediment samples collected from locations along tributaries EBT1 through EBT5 (not including the Ponds) have elevated copper and selenium concentrations and paste pH, conductivity, and acid base accounting (ABA) values that indicate a relatively strong acid-generating potential. These tributaries generally flow from and over the waste rock areas and, as a result, are lined with waste rock sediment.

Sediment samples collected from Ponds 1 through 5 show that Ponds 4 and 5 have the highest copper concentrations. Sediment aluminum concentrations in Ponds 4 and 5 are nearly twice that of Pond 3, indicating that these ponds receive the greatest amount of surface water and groundwater impacted by ARD from upslope areas to the northwest. The impact to Ponds 4 and 5 is consistent with visual observations of gray, aluminum-rich flocculation on the bottom of these ponds. The pond sediment samples display paste pH and ABA values that indicate low or non-acid-generating potential, suggesting that significant quantities of waste rock and tailings have not accumulated in the shallow sediment of these ponds.

1.5 Site Hydrogeology

This section briefly describes the general geology and hydrology of the area encompassing the Site.

1.5.1 Overburden Geology

The dominant overburden unit overlying bedrock in the Site region is glacial till. The United States Department of Agriculture (USDA) classification of soils in the vicinity of the Site is described as a Tunbridge-Woodstock-Buckland association. These are typical of soils formed in glacial till on upland terrain and range from stony silty loam to very stony loam (PAL, 2005). Existing data from OU1 soils is limited to shallow depth characterization of waste source areas, which focused on the mineralogical and chemical characterization of the mine wastes (Piatak et al., 2004; URS, 2008). Based on the relatively steep topography at the Site and the extent of bedrock exposure, it is anticipated that glacial till at the Site is relatively thin (less than 10 ft). The thickest deposits would be anticipated in the central part of the valley near Ely Brook.

1.5.2 Bedrock Geology

The Vermont Copper Belt lies within a group of Silurian-Devonian rocks comprising the western portion of the Connecticut Valley-Gaspé Trough, which extends from Massachusetts to Quebec, Canada. Stratigraphic units in east-central Vermont include (from oldest to youngest), the Northfield Formation, Waits River Formation, Standing Pond Volcanics, and the Gile Mountain Formation (Slack and others, 2001). The massive sulfide deposits of the Elizabeth and Ely Mines lie within the Gile Mountain Formation of Devonian age, while the deposit at Pike Hill lies within the Waits River Formation of Silurian age. These rocks have been deformed during three stages of folding and amphibolite-grade metamorphism during the Devonian Acadian Orogeny.

The bedrock at the Site is exposed at many locations in the upper elevations of Dwight Hill and is composed primarily of siliciclastic metasedimentary rock (pelite and graywacke) representing a turbidite protolith, with minor mafic metavolcanic rocks (amphibolite). The main belt of Gile Mountain rocks lies to the east of the Waits River Formation and is comprised primarily of metamorphosed siliciclastic rocks (graphitic pelite and quartzose granofels) representing a quartz-rich turbidite protolith. The Amphibolites of the Standing Pond Volcanics typically occur along the contact between the Waits River and Gile Mountain Formations, and locally within the uppermost Waits River Formation, representing a suite of primarily thin metabasalts. The variations in the stratigraphic position of the Standing Pond Volcanics suggest that the contact between the Waits River and Gile Mountain Formations is time transgressive. The ore body at the Ely Mine had an elongated shape extended over 3,000 feet inclined at approximately 25 degrees and formed along the crest of a fold in the bedrock layering along a trend of approximately N40E (Slack et al., 2001). The mineralogy of the ore at Ely Mine is similar to that at the Elizabeth and Pike Hill Mines. The ore is dominated by pyrrhotite and chalcopyrite, with minor sphalerite and pyrite. The dominant minerals in the host rock are quartz, feldspar, and muscovite.

1.5.3 Surficial Hydrology

The Site is situated along the central and eastern flank of a broad U-shaped valley. Ely Brook is the primary stream draining the valley defined by Dwight Hill to the north and two branching ridges west and east of the mine areas. The headwaters of Ely Brook lie to the northwest of the mine waste areas. Shallow groundwater and surface water flow at the Site mimics Site

topography, such that flow is directed toward Ely Brook and then southward toward Schoolhouse Brook. Ely Brook flows south along the central part of the valley, along the western margin of the mine waste areas extending approximately 0.8 mile from the headwater to the confluence with Schoolhouse Brook. Four tributaries drain into Ely Brook from the mine waste areas. Two of these tributaries (EBT4 and EBT3) are created from seepage from the UWA and associated mine features; the third (EBT2) originates from a series of ponds formed by former dam and beaver activity and flows across the LWA. EBT3 actually merges into EBT2 prior to reaching Ely Brook. The fourth tributary (EBT1) drains from the forest across the ORB.

Four vernal pools (VPs) have been also been identified and mapped within the Site. VPs are small pools of standing water that form in the spring from melt-water and are often dry by mid-summer, typically holding water for two to three months or more. Although generally isolated, they are sometimes connected to each other or to larger wetlands. VPs do not typically support fish populations, but provide essential breeding habitat for certain amphibians and invertebrates, including wood frogs, spotted and marbled salamanders, and fairy shrimp. In addition, birds such as herons, ducks, and hawks use VPs as a seasonal source of food and water. The VPs identified at the Site are described below and shown on Figure 1-2:

- VP-1 Complex (VP-1) – Located in the southeast end of the smelter area, this pool is approximately 45 meters by 20 meters in size.

- VP-2 – Located west of Ely Brook in a mature conifer forest, this ditch/swale is approximately 200 meters long and appears to be an old man-made excavated trench.

- VP-3 – Located west of Ely Brook in an open canopy deciduous forest, this short, narrow ditch is approximately 5 meters by 2 meters in size and appears to be an old man-made excavated pit. VP-3 could be considered part of a small wetland complex.

- VP-4 – Located west of Ely Brook in a mature deciduous forest stand with almost 100 percent crown cover, this pool is approximately 5 meters by 2 meters in size. VP-4 is adjacent to an extensive emergent wetland area.

Schoolhouse Brook flows approximately 1.75 miles southeast from the Site to its confluence with the EBOR. An unnamed, intermittent tributary drains the north slope of Dwight Hill, flowing

approximately 1 mile northeast to the EBOR. The EBOR eventually joins the West Branch of the Ompompanoosuc River approximately 7 miles downstream of Schoolhouse Brook, after which it flows into the Connecticut River.

1.5.4 Bedrock Hydrology

Groundwater in the bedrock is largely stored in open fractures which form an important groundwater flow pathway when interconnected. In general, the shallow bedrock typically contains a higher frequency of open fractures than deeper portions, though the degree to which this trend is observed depends on the rock type, rock fabric, and extent of weathering of the rock. Even though the frequency of open fractures typically decreases with depth in bedrock; the presence of large-aperture, interconnected fractures can provide significant flow through the bedrock at depth. The flooded Underground Mine Workings form unique reservoirs of groundwater that likely play an important role in the subsurface hydrology of the Site. In general, bedrock groundwater underlying the Site on the south side of Dwight Hill is anticipated to flow southward toward Schoolhouse Brook. Bedrock groundwater north of Dwight Hill and groundwater associated with the deeper portions of the flooded mine is anticipated to flow eastward toward the EBOR.

1.6 Conceptual Hydrogeologic Model

The conceptual model of site-wide groundwater flow under August 2009 flow conditions is illustrated through overburden and shallow bedrock (upper 20 feet) groundwater flow maps (Figures 1-6 and 1-7, respectively). Due to the moderate slopes at the Site, natural soil overlying bedrock is relatively thin (less than 10 ft) and, as such, has a limited capacity to store groundwater. The majority of the natural soil overburden in the upper part of the Ely Brook valley is glacial till with a relatively low hydraulic conductivity (i.e. water does not move easily through it). The till beneath waste areas is typically groundwater-saturated. The waste materials overlying the till are generally more permeable and only locally saturated with groundwater in the lowermost portions of the areas. A thicker alluvial deposit overlies the till in the lower part of the valley in the Smelter/Slag Area. Groundwater in the bedrock is largely stored in open fractures. The shallow bedrock at the Site appears to have a hydraulic conductivity similar to the overburden and, based on groundwater sample results from two well clusters (MW-19 and MW-21), is locally impacted by groundwater in the overlying waste rock and overburden soil. Observations from packer tests and geophysical logging of the deep

bedrock boreholes suggest that the deeper bedrock has a relatively low density of significant water-bearing fractures. The flooded Underground Mine Workings form a unique reservoir of groundwater, which is an important consideration in interpreting the subsurface hydrology of the northern portion of the Site. Based on the projection of fractures observed in deep bedrock well (MW-19D), located relatively close to the southern limit of the mine pool, the detected impact in this well is correlated to a surface mine waste source and does not indicate any significant direct impact from the mine pool to bedrock groundwater on the south side of Dwight Hill. However, results from analyses of groundwater discharge from three mine openings (Main Adit, Lower Adit, and Shaft No 4) confirm that water from the Underground Mine Workings does have an impact on the surface water quality at the Site.

The upper slope of Dwight Hill, above the UWA, is an area of groundwater recharge, such that precipitation will tend to infiltrate downward through the overburden and into the bedrock. However, during large rain storms and snow melt events, significant volumes of overland flow are directed to the lower portions of the valley due to the steep topography, the thin overburden and the limited infiltration capacity of the bedrock in these areas as evidenced by the flashy nature of Ely Brook (Holmes and others, 2002). In areas overlying the Underground Mine workings, groundwater may be intercepted and flow through the open areas of the mine, eventually reaching the mine pool level. The mine pool surface elevation documented in White and Eric (1944) is consistent with the elevation of the Main Adit. The Main Adit represents the outlet for the mine pool and creates a drain feature that regulates the hydraulic head of groundwater in bedrock in the vicinity of the mine. As a result, bedrock groundwater at shallow depths in the vicinity of the mine may migrate toward the mine pool during periods of significant recharge.

On the south side of Dwight Hill, shallow groundwater flows south and southwest beneath the UWA, where the lowermost foot of the waste rock was observed to be periodically saturated due to the slight mounding of groundwater above the glacial till. A greater degree of mounding is anticipated in the waste rock areas during high flow periods such as spring snowmelt and high precipitation periods. Impacted overburden groundwater discharges at the downslope margin of the piles within the UWA to form surface seeps and tributary streams that lead to Ely Brook. Further downslope, the LWA and TA have significant saturated thicknesses as a result of the coalescence of shallow groundwater and tributary streams converging on Ely Brook. The UWA and TA lie within an area of groundwater discharge where slope gradients are somewhat gentler

and multiple groundwater seeps occur. The base flow of the seeps, tributary streams, and Ely Brook are generally fed by the discharge of groundwater from the shallow overburden, and to a lesser extent, shallow bedrock groundwater moving through the overburden. The exception to this recharge from groundwater is in the lowermost portions of the Ely Brook and Schoolhouse Brook Valleys, where thicker, less permeable, glacial till inhibits such flow.

Groundwater data indicates that the mine waste rock significantly impacts shallow groundwater locally and more directly affects the quality of overland flow in the Ely Brook Valley. The discharge of shallow groundwater and upward bedrock groundwater gradients in the lower portions of the valley preclude the potential impact to deeper groundwater in those areas. Results from on-site monitoring wells indicate a localized impact to the uppermost 20 feet of shallow bedrock groundwater beneath the UWA and LWA. Results from residential drinking water sources near the Site do not indicate any impact to deep bedrock groundwater from surface mine waste source areas at the Site.

1.7 Basis for Action

A HHRA and BERA have been prepared in conjunction with the RI (Nobis, 2010b and 2010c, USEPA 2010). Separate BERAs were completed for the aquatic receptors and the terrestrial receptors. These documents were completed prior to the designation of the OUs and address the entire Site area, except for the Underground Mine Workings. The sections below outline the assessment approaches used and the current understanding of the human health and ecological risks at the Site.

1.7.1 HHRA Summary

A HHRA for the Site was prepared in 2010 by Nobis. This section presents a description of the risk assessment methods employed for the Site, as well as a summary of the results. The objective of the HHRA was to estimate potential current and future human health risks from the presence of contamination in the soil, groundwater, sediment, and surface water assuming baseline conditions. The HHRA was performed in accordance with national and regional USEPA risk assessment guidelines.

The HHRA focused on those human populations that are most likely to be exposed to the potentially contaminated Site media, currently and/or in the future. These potentially exposed populations include:

- Current/future recreational visitors (adolescent and adult) – soil exposure to the recreational visitors was based on riding all-terrain vehicles (ATVs), since this is a common recreational activity at the Site that could result in an intensive level of soil contact. The ATV-riding exposure was based on conservative assumptions that cover the potential exposure associated with other, less-intensive soil contact activities. It was assumed that the recreational visitors would come into contact with the on-site piles and the surface soil surrounding the Site. Therefore, the incidental soil ingestion, the dermal contact and absorption, and the inhalation pathways were evaluated for these receptors.

- Current/future swimmers/waders (adolescent and adult) – the swimmers/waders were assumed to come into contact with the surface water and sediment while engaging in recreational activities in Ely Brook and the downstream waterbodies. Ely Brook is not sufficiently deep to support swimming. As a result, the incidental ingestion and the dermal contact and absorption pathways were evaluated for these receptors.

- Current/future residents (young child and adult) – The current residential exposure was based on the presence of abutting residences that could result in a frequency and duration of exposure similar to that of an on-site residence. Since the current residential exposure is based on the conditions of nearby residences, it was assumed that they would not be using contaminated groundwater from the Site. The current residents were assumed to come into contact with the surface soil only (and not subsurface soil). It is possible that the Site could be used for residential purposes in the future. Future residents were assumed to come into contact with the surface and subsurface soil as a result of soil mixing during future excavation and construction activities. Therefore, incidental soil ingestion, the dermal contact and absorption, and the inhalation pathways were evaluated for residential receptors. The future residential exposure scenario assumes that future residents would be using the groundwater underlying the Site, and therefore would be exposed through the ingestion and showering/bathing exposure routes.

- Future construction workers (adult) – the Site may undergo some type of construction activity at some point in the future, which may result in contact with surface and subsurface soil (top 10 feet assumed). Therefore, the incidental soil ingestion, the dermal contact and absorption, and the inhalation pathways were evaluated for these future receptors. The duration of intensive contact with the Site soil during construction activities such as excavation is expected to be short.

Risk (cancer and non-cancer) was calculated for the contaminants of potential concern (COPCs) identified in each exposure media. The COPCs were selected using USEPA's risk-based Regional Screening Levels. The COPCs identified in all exposure media are listed in Table 1-3.

The HHRA was conducted using an exposure point concentration (EPC) for each COPC. Each EPC represents the concentration of a COPC to which a receptor was assumed to be continuously exposed while in contact with an environmental medium. For soil, sediment, and surface water exposure, the EPC was generally defined as the 95 percent upper confidence limit (UCL) of the mean concentration and was calculated using USEPA's ProUCL software (Version 4.00.05, USEPA 2010c). For groundwater, the EPC was defined by the maximum detected concentration for each COPC from the available wells. EPCs were derived for each groundwater COPC in the three water-bearing units on Site (overburden, shallow bedrock, and deep bedrock). In addition, EPCs were derived for the off-site residential groundwater.

Health risks were calculated as follows:

- Incremental lifetime cancer risks (ILCR) were calculated for the carcinogenic COPCs using USEPA-approved cancer slope factors and unit risk factors. The calculated cancer risks were evaluated against the USEPA acceptable risk range of 1E-06 (one in a million) to 1E-04 (one in ten thousand).

- Non-cancer hazard quotients (HQs) and hazard indices (HIs) were calculated for all COPCs using USEPA-approved reference doses (RfDs) and reference concentrations. The calculated HQs/HIs were evaluated against a non-cancer benchmark of one, such that a value greater than one represents possible adverse health effects. The calculated HQs/HIs were grouped by the specific target organ effects associated with each COPC.

- Lead exposure was evaluated using the lead uptake model developed by USEPA. This model, the Integrated Exposure Uptake Biokinetic (IEUBK) model, estimates the blood lead levels that could result from lead exposure. The blood lead levels estimated by the model were compared to the threshold level of 10 micrograms per deciliter (µg/dL), which is the level identified by multiple agencies as being protective of sensitive populations, including neonates, infants, and young children. USEPA prescribes that 95 percent of the potentially exposed population should have blood lead levels that do not exceed 10 µg/dL.

Table 1-4 provides a summary of the HHRA. The risks are discussed below in greater detail.

Soil Exposure

The ILCRs calculated for potential exposure to Site soil were within or less than USEPA's cancer risk range. The non-cancer HIs were greater than one for current and future child residents, with cobalt and iron as the primary contributors to the total HIs. The target-organ-specific HIs for gastrointestinal effects (due to copper and iron) and thyroid effects (due to cobalt) were greater than one. The aggregate HI was greater than one for future construction workers; however, no individual COPC HI exceeded one. The total HI for the nervous system was 1.1 (aluminum, manganese, and mercury). The HIs for the recreational visitors were less than one. Exposures to lead in Site soil did not exceed USEPA's target level of concern for all soil exposure scenarios. Figure 1-8 presents the HHRA-based soil impacts at the Site.

Sediment and Surface Water Exposure

The ILCRs calculated for potential exposure to sediment and surface water were less than USEPA's cancer risk range. The non-cancer HIs were less than the non-cancer benchmark of one. Exposures to lead in sediment and surface water did not exceed USEPA's target level of concern.

Groundwater Exposure

The ILCR from exposure to the overburden groundwater was at the upper end of USEPA's acceptable cancer risk range. This was due solely to arsenic exposure at a concentration that is

below the federal Safe Drinking Water standard of 10 micrograms per liter (µg/L). The ILCRs for the other water-bearing units were within USEPA's acceptable cancer risk range. Non-cancer HIs were greater than one for exposure to Site groundwater. In each case, cobalt was the primary contributor to the groundwater HIs followed by copper. Target specific HIs greater than one are presented in the table below, segregated by water-bearing unit.

Overburden	Shallow Bedrock	Deep Bedrock
Nervous system (aluminum, manganese)	Nervous system (aluminum, manganese)	Nervous system (manganese)
Skin (arsenic)	Skin (arsenic)	Thyroid (cobalt)
Thyroid (cobalt)	Thyroid (cobalt)	Gastrointestinal (copper, iron)
Gastrointestinal (copper, iron)	Gastrointestinal (copper, iron)	
Kidney (cadmium, molybdenum)	Kidney (cadmium, molybdenum)	
Systemic toxicity (nickel)	Blood (antimony, zinc)	

The HIs based on exposure to the residential wells were less than one. Exposures to lead in Site groundwater did not exceed USEPA's target level of concern. Figure 1-9 shows the extent of the HHRA-based groundwater impacts at the Site.

The results presented above for the HHRA indicate the following:

For the OU1 Media and Areas

- Surface and subsurface soils in the OU1 area contain levels of cobalt, copper, and iron that could represent an unacceptable threat to human health for children residing on and near the Site and coming into contact with the contamination 350 days per year.

- Surface and subsurface soil in the OU1 area would not represent an unacceptable threat to human health for adults residing on and near the Site and coming into contact with the contamination 350 days per year.

- Human contact with the soil in the OU1 area under less frequent exposure scenarios (recreational activities) was not considered to represent an unacceptable threat to human health.

- Human contact with sediment and surface water as a result of recreational activities in the OU1 area were also not considered to represent an unacceptable threat to human health.

- An unacceptable risk was not found to be associated with a person working in the waste material in the OU1 area for up to 60 days per year. More frequent contact, however, would result in an unacceptable risk associated with the inhalation of manganese and aluminum dust. The aluminum and manganese concentrations in soil were not significantly different from those measured in background locations.

While OU1 does not address groundwater as a response area, it is recognized that the cleanup of OU1 waste areas may indirectly improve groundwater quality since those waste areas are significant sources of the groundwater contamination.

For the OU2 Media and Areas

- Overburden and shallow bedrock groundwater at the Site contain contaminants that would represent an unacceptable threat to human health if used as a source of drinking water. The contaminants that are found above levels that are considered acceptable for human ingestion include: aluminum, antimony, cadmium, cobalt, copper, iron, manganese, molybdenum, nickel, zinc.

- Surface and subsurface soils in the OU2 source area (Smelter/Slag Area) contain levels of cobalt, copper, and iron that would represent an unacceptable threat to human health for children residing on and near the Site and coming into contact with the contamination 350 days per year.

- Human contact with the soil in the OU2 area under less frequent exposure scenarios (recreational activities) was not considered to represent an unacceptable threat to human health.

- Human contact with sediment, and surface water as a result of recreational activities in the OU2 area were also not considered to represent an unacceptable threat to human health.

- An unacceptable threat was not found to be associated with a person working in the waste material in the OU2 area for up to 60 days per year. More frequent contact, however, would result in an unacceptable threat associated with the inhalation of manganese and aluminum dust. The aluminum and manganese concentrations in soil were not significant different from background locations.

1.7.2 Aquatic BERA Summary

An Aquatic BERA was completed by USEPA in 2008 assessing the impact of Site sources on the downstream surface water receptors in the vicinity of the Site (TechLaw, 2008). The Aquatic BERA was performed on the aquatic habitats potentially affected by the Site. The major aquatic habitats at the Site consisted of several small ponds (Ponds 2 to 5) located on the east branch of Ely Brook (note: Pond 1, the furthest upstream and largest of the five ponds, was used as a reference location), and the main stem of Ely Brook itself. Several other Ely Brook tributaries had surface water high in acidity and metals but were too small and/or ephemeral to be considered viable aquatic habitats. The major off-Site aquatic habitats consisted of Schoolhouse Brook downstream of the confluence with the main stem of Ely Brook, and the EBOR downstream of the confluence with Schoolhouse Brook.

Results from toxicity tests on sediment, surface water, and porewater along with analysis of the benthic and fish communities provided multiple measurement endpoints to assess potential risk. Data collected prior to 2008 were used to define the nature and extent of contamination, and a Screening Level Ecological Risk Assessment (SLERA) was conducted to identify contaminants of potential ecological concern (COPECs) for each media. Appropriate toxicity benchmarks were identified for comparison with sample and test results to assess the potential for ecological risk to invertebrates, fish, amphibians, birds, and mammals that utilize surface waters in the vicinity of the Site. Table 1-3 lists the COPECs identified in the Aquatic BERA. The following seven types of measurement endpoints were used in the Aquatic BERA:

- Comparison of the COPEC levels in sediment, porewater, and surface water samples to published sediment or surface water benchmarks.

- Assessment of the bioavailability of divalent metals in sediment samples by measuring the Acid Volatile Sulfides (AVS) and Simultaneously Extracted Metals (SEM).

- Performance of toxicity tests in the laboratory by exposing sensitive life stages of aquatic invertebrates and fish to sediment, porewater, and surface water samples from the waterways.

- Performance of toxicity tests in the ponds by exposing wood frog eggs and tadpoles kept in floating cages.

- Comparison of the COPEC levels in whole fish collected from the waterways to literature-derived Critical Body Residues (CBRs).

- Quantification of the structure and function of the benthic invertebrate community and fish community in the waterways.

- Use of food chain modeling to calculate an Estimated Daily Dose (EDD) to insectivorous and piscivorous wildlife receptors from exposure to surface water and aquatic biota (winged aquatic insects and fish); compare these EDDs to Toxicity Reference Values (TRVs) from the literature.

The Aquatic BERA considered four exposure units (EUs) and their respective reference EUs and included: Ponds 2 through 5 and the Ely Brook main stem (within OU1) and Schoolhouse Brook below the Ely Brook confluence and the EBOR below the Schoolhouse Brook confluence (within OU2). EU-wide Central Tendency Exposures (CTEs) were calculated based on arithmetic means, and Reasonable Maximum Exposures (RMEs) were calculated based either on the COPEC-specific 95th percentile UCL or the maximum concentration.

Where appropriate, the potential for ecological risk was determined based on HQs. An HQ was calculated for each COPEC by dividing an exposure or dose by a corresponding toxicity value

(i.e., published benchmarks, CBRs, or TRVs). Statistics were also used to determine the presence of risk as identified by the toxicity tests and community surveys.

During risk characterization, all HQ-derived risks at the OU1 waterways were compared to their corresponding risk at the reference EU by calculating an incremental risk (IR). The IR was obtained by subtracting the reference risk from the Site risk. The presence of risk was deemed unrelated to past Site activities if the reference risk exceeded the Site risk. This approach allowed for a more thorough and accurate assessment of Site-related impacts by factoring in reference COPEC levels.

The results of the Aquatic BERA are summarized below:

Location	Overall Risk Conclusion/Chemicals of Concern
Pond 2	Minor risk detected for water column invertebrates and amphibians due to elevated manganese concentrations in the water. No risk detected for the benthic invertebrate community.
Pond 3	Minor risk detected for benthic invertebrate community, water column invertebrates, and amphibians due to elevated manganese concentrations in the sediment and the water.
Pond 4	Severe risk detected for amphibians and minor risk detected for benthic invertebrate community due to elevated copper concentrations in the sediment.
Pond 5	Severe risk detected for benthic invertebrate community, water column invertebrates, and amphibians due to elevated copper concentrations in the sediment and the water.
Ely Brook and its tributaries	Severe risk detected for benthic invertebrate community and the fish community as a result of ARD.
Schoolhouse Brook	Severe risk detected for benthic invertebrate community and the fish community as a result of ARD being released from the OU1 source areas.

The Aquatic BERA documented that severe ecological impacts have occurred as a result of the release of ARD with toxic levels of metals from the Site waste areas into the surface water and sediment within the OU1 area including: Ely Brook, the tributaries of Ely Brook, and Ponds 4 and 5. The upstream (reference) areas of the Ely Brook headwaters and Pond 1 supported healthy populations of benthic invertebrates, further documenting that the Site is a significant source of ecological impairment. The measurement endpoint risk characterization is summarized in Tables 1-5 through 1-11.

The Aquatic BERA also documented that severe ecological impacts have occurred as a result of the release of ARD with toxic levels of metals from the OU1 waste areas into OU2 surface water and sediment. Specifically, this finding applies to Schoolhouse Brook. The upstream (reference) areas of Schoolhouse Brook supported healthy populations of benthic invertebrates, further documenting that the Site is the source of observed ecological impairment downstream of the confluence with Ely Brook. OU2 will specifically address any ecological threats associated with the sediment within Schoolhouse Brook and the Ompompanoosuc River as well as the final restoration of these surface waters.

Figure 1-10 show the extent of aquatic ecological impairment for sediment and surface water within the Site.

1.7.3 Terrestrial Ecological Risk Assessment Summary

A Terrestrial BERA was performed as part of the RI. The objective of the Terrestrial BERA was to evaluate the risk of ecological harm associated with Site-related contaminants, which consist only of metals. The Terrestrial BERA process at the Ely Copper Mine Superfund Site follows the USEPA (1997) *Ecological Risk Assessment guidance for Superfund, Process for Designing and Conducting Ecological risk Assessments*. The Terrestrial BERA considered eight assessment endpoints to evaluate risk in terrestrial exposure areas and two assessment endpoints to evaluate risk in the VPs.

Exposure Assessment and Effects Assessment

Assessment and measurement endpoints were evaluated for one terrestrial exposure area and 4 VPs as shown in the table below:

Receptor	Representative Species	Assessment Endpoint	Measurement Endpoint
Terrestrial Plants	NA	Plant growth, yield, or germination	Ecological effects quotient based on COPEC soil concentration comparison with the most sensitive soil-based ecological benchmark.
Invertebrates	NA	Growth, reproduction, or activity	
Herbivorous Mammals	Deer Mouse	Survival, growth, or reproduction	
Invertivorous Mammals	Short-tailed Shrew	Survival, growth, or reproduction	
Carnivorous Mammals	Mink	Survival, growth, or reproduction	
Herbivorous Birds	Song Sparrow	Survival, growth, or reproduction	
Omnivorous Birds	American Robin	Survival, growth, or reproduction	
Carnivorous Birds	American Kestrel	Survival, growth, or reproduction	
VP Aquatic Life	NA	Survival, growth, or reproduction	Comparison of surface water chemistry with freshwater benchmark values.
VP Reptiles/ Amphibians	NA	Survival, growth, or reproduction	

Note:
NA = not applicable.

Both RMEs and central tendency exposures (CTEs) were considered when assessing and characterizing risk. CTEs represent the most likely concentration to which a population of receptors would be exposed. In general, RME exposure point concentrations (EPCs) were based on UCLs recommended by ProUCL, with the exception of EPCs for soil invertebrates, where the maximum detected concentrations were used due to small data set sizes. CTE EPCs for all media were based on the average (arithmetic mean) concentration using the whole sample quantification limit for non-detects.

Pathways that were evaluated included direct contact with surface soil for terrestrial plants and invertebrates; ingestion of dietary items and incidental ingestion of surface soil for wildlife receptors; and direct contact with surface water for aquatic life and reptiles/amphibians.

Risk Characterization

Risk characterization involves the integration of exposure and effects data to determine the potential for adverse effects. A weight-of-evidence (WOE) approach was used to make

conclusions regarding risk of harm for assessment endpoints. First, measurement endpoints were each assigned a weight based on how closely they represent the assessment endpoint.

The second step of the WOE approach evaluated the magnitude of response in the measurement endpoint, considering two questions:

- Does the measurement endpoint indicate the presence of risk (possible, unlikely, or undetermined)?
- Is the response low or high?

Specifically, likelihood and magnitude of response determinations were made for each COPEC within an endpoint. Criteria for determining evidence of harm and magnitude of response for all lines of evidence are provided below.

Sample-by-sample Comparisons with Soil Screening Values:

- If ≤ 10% of the detected Site concentrations have ecological effect quotients (EEQ) > 10, "Risk?" = "Unlikely."

- If the COPEC concentrations at the Site are greater than background concentrations, >10% of the detected Site concentrations have EEQs >1, and >10% of the detected background concentrations exceeded the benchmark, "Risk?" = "Undetermined."

- If the COPEC concentrations at the Site are greater than background concentrations, ≤ 10% of the detected background concentrations exceeded the benchmark, and ≥ 10% of the detected Site concentrations was greater than the benchmark value, "Risk?" = "Possible."

    - If "Risk" was noted as "Possible," and < 10% of the EEQs greater than one were > 10, "Magnitude" = "Low;" else "Magnitude" = "High."

Estimated Daily Intake Comparisons with TRVs:

An "Interpretive Ecological Risk Matrix" was developed. A general matrix is as follows:

RME Case	CTE Case	Population Risk?	Magnitude	Confidence
N≤1 & L≤1	N≤1 & L≤1	Unlikely	---	High
N>1 & L≤1	N≤1 & L≤1	Unlikely	---	Moderate
N>1 & L>1	N≤1 & L≤1	Undetermined	---	Low
N>1 & L≤1	N>1 & L≤1	Undetermined	---	Low
N>1 & L>1	N>1 & L≤1	Possible	Low	Moderate
N>1 & L>1	N>1 & L>1	Possible	If RME Case EEQs < 5 then "Low," else "High"	High

N = an EEQ based on dividing an exposure by its appropriate no-effect benchmark
L = an EEQ based on dividing an exposure by its appropriate effect benchmark

In addition, it is important to note that "unlikely" indicates that *population-level* effects are unlikely to the receptors represented by the measurement endpoint and that "possible" indicates that there is a potential for adverse *population-level* effects to the receptors represented by the measurement endpoint. The confidence rating was assigned using professional judgment based on the combination of the RME and CTE case results. For example, if EEQs for a COPEC did not exceed one under any circumstance, it is assumed that there is a high level of confidence in stating that population risks are "unlikely." The confidence rating was employed in the risk conclusions.

Vernal Pool Water Concentration Comparisons with National Recommended Water Quality Criteria (NRWQC):

- If the concentration was less than the chronic value, "Risk?" = "Unlikely."
- If the concentration was greater than the chronic value, "Risk?" = "Possible."
    - If "Risk" was noted as "Possible," and the concentration was less than the acute value, "Magnitude" = "Low;" else, "Magnitude" = "High."

Note that undetermined is not a possibility for these comparisons.

Vernal Pool Water Concentration Comparisons with Herptile Toxicity Values:

- If the concentration was less than the toxicity value, "Risk?" = "Unlikely."
- If the concentration was greater than the toxicity value, "Risk?" = "Possible."

- If “Risk” was noted as “Possible,” and the EEQ was <10, “Magnitude” = “Low;” else “Magnitude” = “High.”

Note that undetermined is not a possibility for these comparisons.

The third step of the WOE process evaluated the degree of concurrence among measurement endpoints by plotting the output of the endpoint weighting and magnitude of response on a matrix for all measurement endpoints per assessment endpoint. Because only one or two measurement endpoints were evaluated per assessment endpoint, all of the endpoints evaluated were presented on one matrix (Table 4-19 of the HHRA), allowing easy visual examination of agreements or divergences among the endpoints.

When evaluating concurrence among measurement endpoints, there is an examination of the agreement or lack thereof among measurement endpoints as they relate to a specific assessment endpoint. Logical connection, interdependence, and correlations among measurement endpoints need to be considered.

Agreement between different lines of evidence increases confidence in the conclusions derived in the risk estimation. When lines of evidence disagree, it is important to distinguish between true inconsistencies and those related to uncertainty and variability associated with each measurement endpoint. The evaluation process involves more than just listing the evidence that supports or refutes the risk estimate. The Terrestrial BERA presents in detail the considerations and interpretations involved in evaluating all lines of evidence. As with assigning qualitative significance ratings to the measurement endpoints, professional judgment is required when evaluating the various results and conflicting lines of evidence.

Terrestrial Baseline Ecological Risk Assessment Conclusions

Risk levels identified in the Terrestrial BERA are summarized in Table 1-12 and presented in the following text.

Sampling and subsequent ecological risk analysis focused on determining the potential for significant adverse ecological effects in the vegetated areas that border these barren areas and any VPs located therein. The following table summarizes the findings of this risk analysis.

Receptor Group	Overall Risk Conclusion/Chemicals of Concern for OU1
Terrestrial Plants	The barren areas of the Site represent a significant adverse impact to the plant community. The primary cause of the impact is the acidity of the soil and pore water. There is the potential for adverse impact to individual terrestrial plants as a result of the contaminant concentrations at the Site. The COPCs are copper and, to a lesser extent, zinc. The overall impact on the plant community outside the barren waste areas was not considered significant.
Soil Invertebrates	The barren areas of the Site represent a significant adverse impact to the soil invertebrate community. The primary cause of the impact is the acidity of the soil and pore water. There is the potential for adverse impact to individual soil invertebrates as a result of the contaminant concentrations at the Site. The COPCs are copper and, to a lesser extent, zinc. The overall impact on the soil invertebrate community outside the barren waste areas was not considered significant
Herbivorous Birds	The Terrestrial BERA concluded that significant ecological impacts to this receptor were unlikely.
Invertivorous Birds	The Terrestrial BERA concluded that significant ecological impacts to this receptor were unlikely.
Carnivorous Birds	The Terrestrial BERA concluded that significant ecological impacts to this receptor were unlikely.
Herbivorous Mammals	The Terrestrial BERA concluded that significant ecological impacts to this receptor were unlikely.
Invertivorous Mammals	The Terrestrial BERA concluded that significant ecological impacts to this receptor were unlikely.
Carnivorous Mammals	The Terrestrial BERA concluded that significant ecological impacts to this receptor were unlikely.

The only significant terrestrial ecological threat in the OU1 area is the impairment of the plant and soil invertebrate communities in the barren areas of the Site. Although concentrations of metals detected in the vegetated (non-barren) areas at the Site were higher than plant and soil invertebrate benchmarks, field observations suggest that the toxicity of the Site material is substantially reduced when the waste is incorporated into a natural soil. Areas along the fringe of the barren waste areas have concentrations of metals comparable to the barren waste areas yet these areas support a plant community and soil invertebrates. Other factors, such as the highly acidic porewater and acid salts within the waste along with the absence of any organic

matter to support vegetation are likely to be more significant factors in the absence of vegetation on the barren areas. When a soil horizon forms and provides organic matter, the plant community appears to be able to exist. As a result, a clear chemical-specific threat to the plant or soil invertebrate community is not identified for OU1 of the Site. The general Terrestrial BERA conclusion for OU1 is that the Site conditions, primarily the acidic waste material and associated acid salts and pore water have created barren areas which represent a local, yet significant, ecological harm to the plant and soil invertebrate community resulting in a loss of the critical ecological support functions including nutrient cycling, habitat, food, and soil stabilization to limit erosion. Figure 1-11 shows the extent of the barren areas at the Site.

No significant ecological risk was identified for the other terrestrial receptors within the OU1 area. The hazard quotients were generally low for the mammal and bird receptors. In addition, the biota sampling suggested that most metals (particularly selenium and zinc) were not accumulating in tissue. Only copper was detected at concentrations that were statistically different from reference biota tissue samples, although individual samples suggested that some accumulation of aluminum and iron may occur. OU2 will address the ecological risk associated with the vernal pools and the Smelter/Slag area as well as any ecological risk associated with the underground workings.

2.0 IDENTIFICATION AND SCREENING OF TECHNOLOGIES

This section identifies and screens remedial technologies using the process outlined in USEPA RI/FS guidance, Principal Threats Guidance, Groundwater Presumptive Strategy, and the NCP (USEPA, 1988b, 1990, 1991, and 1993). The FS process begins with the identification of remedial response objectives which establish general cleanup goals and identification of applicable or relevant and appropriate requirements (ARARs). Chemical-specific numerical cleanup standards are established and used to identify RAOs based on ARARs and risk-based standards. Once these tasks are completed, estimates are made of the areas and volumes of media in the OU source areas that exceed PRGs. OU1 source areas are depicted in Figure 1-5. Potential remedial technologies are identified and screened to produce an inventory of suitable technologies that can be developed into remedial alternatives that are capable of mitigating actual or potential risks within the OU.

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

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

Identification of Principal and Low-Level Threat Wastes

The NCP establishes an expectation that treatment will be used to address the principal threats at a site wherever practicable, whereas engineering controls, such as containment, may be used for wastes that pose a relatively low long-term threat or where treatment is impracticable (40 CFR 300.430(a)(1)(iii)). The concept of principal threat and low-level threat wastes is applied on a site-specific basis when characterizing source material. Source material is defined

as material that includes or contains hazardous substances, pollutants, or contaminants that act as a reservoir for migration of contamination to groundwater, surface water, or air, or that act as a source for direct exposure (Office of Solid Waste and Emergency Response [OSWER] 9380.3-06FS [USEPA, 1991c]). Contaminated groundwater generally is not considered to be source material, although non-aqueous phase liquids (NAPLs) may be.

Principal threat wastes are those source materials considered to be highly toxic or highly mobile that cannot be reliably contained or that would present a significant risk to human health or the environment should exposure occur (USEPA, 1991). The manner in which principal threats are addressed will generally determine whether the statutory preference for treatment as a principal element is satisfied. The reasonably anticipated future land use at a site is significant in defining principal threat waste areas. Pursuant to the NCP and the 1995 guidance *Land Use in the CERCLA Remedy Selection Process* (USEPA, 1995), current land use and reasonably anticipated future land use should be considered in identifying realistic exposure scenarios for estimating site risks. When baseline risks associated with the reasonably anticipated future land use trigger action, the definition of principal threat waste may be determined by the reasonably anticipated future land-use scenario as well. For example, soil contamination that could be considered a principal threat under a residential exposure scenario might not be considered a principal threat under a non-residential exposure scenario. Although no “threshold level” of risk has been established to identify principal threat waste, a general rule of thumb is to consider a principal threat those source materials with toxicity and mobility characteristics that combine to pose a potential risk several orders of magnitude greater than the risk that is acceptable for the current or reasonably anticipated future land use, given realistic exposure scenarios (USEPA, 1997b). Furthermore, characterizing a waste as a principal threat does not necessarily mean that the waste poses the primary risk at a site. Examples of source materials that generally constitute principal threats include liquid wastes in drums, lagoons, or tanks; NAPLs floating on or under groundwater; soil, sediment, sludge, or debris containing high concentrations of mobile or potentially mobile contaminants; buried non-liquid wastes; and soil containing significant concentrations of highly toxic material (OSWER 9200.1-23P [USEPA, 1999]).

Low-level threat wastes are those source materials that generally can be readily contained and that would present only a low risk in the event of a release or exposure. Examples of wastes generally considered to constitute low-level threats include soil containing contaminants that are

relatively immobile in air or groundwater (i.e., non-liquid, low volatility, low leachability) in the specific environmental setting and soil containing contaminant concentrations that are not greatly above RfD levels or that present an excess cancer risk near the acceptable risk range (USEPA, 1999).

Investigations at the Site have not identified liquid waste in drums, tanks or impoundments; free-phase non-aqueous phase liquid (NAPLs); or significant concentrations of highly toxic or mobile contaminants in soil or other source material. The waste rock, tailings, slag, roasted ore, and contaminated sediment are low-level threat wastes, because, although metals will continue to leach from waste materials, they pose a chronic risk rather than a short-term or acute risk to human health. Although the ARD generated by the Site is highly toxic and highly mobile acute threat with respect to the impact to the environment, the waste generating the ARD can be reliably contained and is not considered a principal threat waste.

2.1 Development of Remedial Action Objectives

RAOs consist of medium-specific (e.g., water, soil), quantitative goals defining the extent of remediation required to protect human health and the environment. They specify COCs, exposure routes and receptors, and PRGs. In the case of groundwater, they also include a restoration time frame. RAOs are used as the framework for developing remedial alternatives. To develop RAOs, it is first necessary to identify ARARs and PRGs.

2.1.1 Applicable or Appropriate and Relevant Requirements and To-Be-Considered Criteria

A preliminary identification of ARARs and To-Be-Considered (TBC) criteria (i.e. non-promulgated advisories or guidance) has been performed. The ARARs and TBCs have been characterized as chemical-specific, location-specific, or action-specific. State and Federal regulations, policies, and guidelines are summarized and presented in Tables 2-1, 2-2, and 2-3.

CERCLA and the NCP require that Superfund RAs must attain federal standards, requirements, limitations, or more stringent state standards that are determined to be legally applicable or relevant and appropriate to the circumstances at a given site. ARARs are federal and state environmental and facility-siting requirements used to: (1) evaluate the appropriate extent of site cleanup; (2) define and formulate RA alternatives; and (3) govern implementation and operation

of the selected action. Inherent in the interpretation of ARARs is the assumption that protection of human health and the environment is ensured.

Definitions of ARARs and TBC Criteria

To properly consider ARARs and to clarify their function in the remedy selection process, the NCP defines two ARAR components: (1) applicable requirements; and (2) relevant and appropriate requirements. Requirements under federal or state law may be either applicable or relevant and appropriate to CERCLA cleanup actions, but not both. These definitions are discussed in the following paragraphs:

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

Relevant and Appropriate Requirements. Relevant and appropriate requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations that, while not applicable to a hazardous substance, pollutant, contaminant, RA, location or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the site, such that their use is well-suited to the particular site (40 CFR 300.400(g)(2)). For example, RCRA landfill design standards could be relevant and appropriate to a landfill at a Superfund site if the wastes being disposed of were sufficiently similar to RCRA hazardous wastes. It is important to note that requirements must be both relevant and appropriate for compliance to be necessary. Also, in the case where both a federal and a state ARAR are available, or where two potential ARARs address the same issue, the

more stringent regulation must be selected. As with applicable requirements, a state standard must be legally enforceable and more stringent than a corresponding federal standard to be considered relevant and appropriate (40 CFR 300.400(g)(4)).

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

1. The alternative is an interim measure and will become part of a total RA that will attain the applicable or relevant and appropriate federal or state requirement.

2. Compliance with the requirement will result in greater risk to human health and the environment than other alternatives.

3. Compliance with the requirement is technically impracticable from an engineering perspective.

4. The alternative will attain a standard of performance that is equivalent to that required under the otherwise applicable standard, requirement, or limitation through use of another method or approach.

5. With respect to a state requirement, the state has not consistently applied, or demonstrated the intention to consistently apply, the promulgated requirement in similar circumstances at other RAs within the state.

6. For Fund-financed response actions only, an alternative that attains the ARAR will not provide a balance between the need for protection of human health and the environment at the site and the availability of Fund monies to respond to other sites that may present a threat to human health and the environment.

Only the substantive, rather than administrative, provisions of ARARs must be followed under a CERCLA remedy. Substantive requirements pertain directly to the actions or conditions at a site, while administrative requirements facilitate their implementation. CERCLA on-site remedial response actions must only comply with all substantive requirements that are “applicable” or

"relevant and appropriate," but not the administrative requirements, such as any requirement to obtain federal, state, or local permits (CERCLA §121(e)). The NCP defines on-site as "the aerial extent of contamination and all suitable areas in very close proximity to the contamination necessary for implementation of the response action." As noted in the ARARs guidance (USEPA, 1988a): "The CERCLA program has its own set of administrative procedures, which assure proper implementation of CERCLA. The application of additional or conflicting administrative requirements could result in delay or confusion." To ensure that CERCLA response actions proceed as rapidly as possible, USEPA has reaffirmed that administrative ARARs need not be followed for on-site response actions. The USEPA recognizes that certain administrative requirements, such as consultation with state agencies or reporting, are accomplished through the state involvement and public participation requirements of the NCP. Off-site response actions must comply with both the substantive and administrative requirements of an applicable (but not a relevant and appropriate) regulation, but such regulations pertaining to off-site actions are not classified as ARARs (OSWER 9347.1-0; USEPA, 1998b).

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

ARARs and TBC Criteria typically fall into one of three categories: location-specific, chemical-specific, and action-specific. The following sections discuss these categories of ARARs and TBC Criteria in further detail, as well as how they specifically apply to the Site's OU1.

Location-Specific ARARs

Location-specific ARARs set restrictions on the implementation of remedial activities in special locations solely based on where they are (USEPA, 1998a). Location-specific ARARs are triggered by the presence of specific natural or manmade features or potentially affected

resources at a disposal or cleanup site. Features and resources that can trigger location-specific ARARs include, but are not limited to, the following:

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

Location-specific ARARs were identified that apply for selected RAs for OU1 at the Site. Of the features and resources listed above, the following will affect response actions: underground mines and caves; wetlands and waterbodies; floodplain; rare, threatened, or endangered species; archaeological resources and historic sites; and wildlife resources. A complete list is included in Table 2-1 and alternative specific location-specific ARARs are listed in Tables 4-3, 4-7, and 4-11. Several of the most critical location-specific ARARs are discussed in detail below.

Federal Clean Water Act, Section 404 and regulations (33 U.S.C. §§ 1344; 40 C.F.R. Part 230; 33 CFR Parts 320-323): These parts of the CWA set guidelines to "restore and maintain the chemical, physical, and biological integrity of waters of the United States through the control of discharges of dredged or fill material." These guidelines prohibit the discharge of dredged or fill material into an aquatic ecosystem, "unless it can be demonstrated that such a discharge will not have an unacceptable adverse impact either individually or in combination with known and/or probable impacts of other activities affecting the ecosystem of concern." If there is no other practicable alternative, adverse effects must be mitigated. The excavation/dredging of sediment as a part of remedial activities will result in the unavoidable destruction of existing wetlands and aquatic habitats; although the effects of remedial activities on the wetlands and aquatic habitats will be evaluated and minimized during design. These guidelines have a particular focus on preventing the filling of special aquatic sites such as federal-jurisdictional wetlands, but are applicable to all waters of the United States. In addition, freshwater wetlands on Site may be affected by the RA. Freshwater wetlands that are contiguous to "waters of the United States" are federal jurisdictional wetlands subject to Section 404 of the CWA.

Compensatory habitat mitigation will be performed as necessary to comply with this ARAR. As part of compliance with this section, an alternative that qualifies as the "Least Environmentally Damaging Practicable Alternative" will be identified based on balancing the remediation of contamination negatively effecting wetland resources versus the areal extent of wetlands that may be temporarily or permanently altered due to implementation of the remedial alternative.

Within OU1, waters of the United States would include the Ely Brook and its tributaries, as well as Ponds 1-5, and any federal-jurisdictional wetlands. Federal jurisdictional wetlands and potential wetland areas for the OU1 area at the Site are depicted on Figure 2-1.

Federal Fish and Wildlife Coordination Act (16 USC 661 *et seq.*, as amended): This Act requires that the United States Fish and Wildlife Service (USFWS) and the appropriate state wildlife agency be consulted when modifications to a body of water are contemplated or when potential habitat of a federally-listed endangered species may be altered. According to the Act, USEPA must consult with the applicable resource agencies on measures to prevent, mitigate, or compensate for losses of fish and wildlife or endangered-species habitat. These requirements would apply to the modification of any of the surface waterbodies, fish and wildlife resources, or federal endangered species habitat identified in the OU1 Area.

Federal Endangered Species Act of 1973 (16 U.S.C. 1531 *et seq.*; 33 C.F.R. Part 320): The purpose of the Federal Endangered Species Act is to "conserve the ecosystems upon which threatened and endangered species depend" and to conserve and recover listed species. Federal agencies must consult with the USFWS to ensure that the actions they authorize, fund, or carry out will not jeopardize listed species. The law provides for critical habitat designations for listed species. The Indiana Bat may be present on the Site and is specifically listed as a threatened or endangered species under this statute. Any alternatives proposed for OU1 will be designed, constructed, and maintained in consultation with federal wildlife agencies.

National Historic Preservation Act (NHPA), Section 106 (16 USC 470 *et seq.*; 36 CFR Part 800): The NHPA requires Federal agencies to take into account the effect of their actions on historic properties, and to afford the Advisory Council on Historic Preservation (ACHP) a reasonable opportunity to comment on the activities. The goal of this consultation is to identify potential adverse effects on historic properties and avoid adverse effects to historic resources when possible. If an adverse effect cannot be avoided then measures to minimize or mitigate any

such effects on historic properties will be included in the response action. The USEPA has consulted with the Vermont State Historic Preservation Officer (SHPO) and has determined that the Site is eligible for listing in the National Register of Historic Places. Therefore, the substantive provisions of Section 106 would apply to the alternatives.

Archeological and Historic Preservation Act (16 USC 469 *et seq.*, 36 CFR, Part 65): This statute requires Federal agencies to identify where a federal project may cause irreparable loss or destruction of significant scientific, pre-historic, historic, or archeological data. As part of any chosen remedial action USEPA is required take measures to data recover, protect, and preserve data.

In accordance with this regulation, United States Army Corps of Engineers (USACE) contracted PAL from 2002 to 2005 to complete a historic/archaeological mapping and testing survey of the Site. The goal of the survey was to locate, identify, photograph, map (and in some cases, draw) visible structural and landscape features and artifacts associated with Ely Copper Mine. The PAL study focused on the core area of historic mining activity and the surrounding Area of Potential Effect (APE), the two of which total approximately 225 acres. The PAL investigations included background research, site mapping, identification of visible structural remains related to both pre-mining and mining activities, and limited subsurface testing to locate and identify prehistoric and historic period resources within the Study Area. The PAL study identified archaeological resources including well-preserved industrial and domestic structural remains and artifact assemblages representative of the historic mine operations during the nineteenth and early- to mid-twentieth century. No prehistoric period archaeological resources were identified within the Site or Study Area. Additional details regarding the historical/archaeological mapping and testing survey are summarized in the report titled Historical/Archaeological Mapping and Testing, Ely Mine Site (PAL, 2005). The evaluation of remedial alternatives for OU1 will need to consider data recovery, preservation, and protection of identified remains and features.

Vermont Wetlands Act, 10 VSA § 905; Vermont Wetlands Rules (Natural Resources, Water Resources, 6 CVR 12-004-056): These standards establish criteria for delineating Class I and Class II wetlands, which are considered significant wetlands, and set forth allowable and conditional uses for these wetlands. The uses must not have undue adverse impacts on the

significant functions of the wetland. Class III wetlands are defined, but are not protected under these rules.

According to Appendix A of the Rules, there are no Class I wetlands in Orange County, Vermont. Class II wetlands are those defined by the National Wetlands Inventory (NWI) maps for the State of Vermont (published by the USFWS) and all wetlands contiguous to such mapped wetlands, with some exceptions. The NWI quadrangle map for the Site (dated October 1977) depicts one wetland feature present at the Site. Pond 1 was listed as a permanently flooded Palustrine with an unconsolidated bottom (PUBH). This wetland, shown on Figure 2-1, is by definition a Class II wetland unless a finding is made that the functional values of the wetland is not significant enough to warrant a classification. For some alternatives, potential Class III wetlands areas on the Site will be altered or destroyed in order to protect downstream Class II wetlands and surface water bodies from degradation as a result of ARD.

Vermont's Land Use and Development Law (10 VSA Chapter 151): The substantive environmental and facility-siting requirements of Vermont's Land Use and Development Law, known as Act 250, are applicable to the Site. Remediation strategies must comply with these criteria of Act 250 in the following ways:

- Criterion 1 – Undue Water and Air Pollution – RAs will not result in undue water or air pollution (including construction-related dust);

- Criterion 1(A) – Protection of Headwaters – RAs will not reduce the quality of the ground or surface waters flowing through or upon lands that are headwaters of watersheds characterized by steep slopes and shallow soils;

- Criterion 1(B) – Waste Disposal – RAs will meet all standards regarding the disposal of wastes, and will not involve the injection of waste materials or any harmful or toxic substances into groundwater or wells;

- Criterion 1(D) – Floodways – All work within a floodway will not restrict or divert the flow of flood waters, and endanger the health, safety and welfare of the public or of riparian owners during flooding, and will not significantly increase the peak discharge of the river

or stream within or downstream from the area of development and endanger the health, safety, or welfare of the public or riparian owners during flooding;

- Criterion 1(E) – Streams – All work on or adjacent to the banks of a stream will, whenever feasible, maintain the natural condition of the stream, and will not endanger the health, safety, or welfare of the public or of adjoining landowners;

- Criterion 1(G) – Wetlands – RAs will protect State jurisdictional wetland resources (including Class Three wetlands not addressed under the Vermont Wetlands Rules);

- Criterion 4 – Soil Erosion – RAs will not cause unreasonable soil erosion or reduction in the capacity of the land to hold water so that a dangerous or unhealthy condition may result;

- Criterion 8(A) – Historic Sites – RAs will not have an undue adverse effect on historic sites;

- Criterion 8(B) – Endangered Species – RAs will not destroy or significantly imperil any state endangered species, or, if impacts are unavoidable, it is determined that the economic, social, cultural, recreational, or other benefit to the public from the remediation outweighs the economic, environmental, or recreational loss to the public from the destruction or imperilment of the species, or all feasible and reasonable means of preventing or lessening the destruction, diminution, or imperilment of the species have been applied;

- Criterion 9(E) – Extraction of Earth Resources - The extraction and the disposal of waste will not have an unduly harmful impact upon the environment or surrounding land uses and development; and the project establishes a rehabilitation plan that insures that upon completion of the operation, the site will be left in a condition suited for an approved alternative use or development.;

- Criterion 9(F) - Energy Conservation – The remedial activity will seek to minimize energy usage to the extent possible;

- Criterion 9(K) - Public Investments – The remedial action will minimize, to the extent possible, negative impacts to local investments (in particular, roads).

Vermont Regulation of Stream Flow (10 VSA Chapter 41): This law regulates activities in streams in order to "assure as nearly continuous flow of waters in the natural watercourses as may be possible consistent with reasonable use of riparian rights". This statute regulates activities that change, alter, or modify a watercourse. Substantive standards for prohibited activity under the statute include:

- adversely affecting the public safety by increasing flood hazards;
- significantly damaging fish life or wildlife; and/or
- significantly damaging the rights of riparian owners.

The substantive portions of this regulation are applicable to remediation activities that have the potential to alter stream flow at OU1 of the Site.

Vermont Endangered Species Law (10 VSA Chapter 123, Section 5402[a]): The Vermont Endangered Species Law outlines the definition of endangered and threatened, the procedure for obtaining permits to take endangered or threatened species, and the species listed as endangered or threatened. Three bat species that may be present on the Site are specifically listed as threatened or endangered species in Vermont: the Small-footed Bat, Northern Long-eared Bat, and the Little Brown Bat. The statute prohibits the taking, possession, or transport of wildlife or plants that are members of an endangered or threatened species without a permit, and sets forth fines for violators. RAs for OU1 must take into consideration any potential adverse impacts to threatened or endangered species.

Location-Specific TBC Criteria, Advisories, Guidance, and Technical Reports:

Federal Endangered Species Act of 1973 (16 U.S.C. 1531 *et seq.*; 33 C.F.R. Part 320): The purpose of the Federal Endangered Species Act is to "conserve the ecosystems upon which threatened and endangered species depend" and to conserve and recover listed species. Federal agencies must consult with the USFWS to ensure that the actions they authorize, fund, or carry out will not jeopardize listed species. The law provides for critical habitat designations for listed species. The Small-footed Bat may be present on the Site and has been proposed for

listing as a threatened or endangered species under this statute. Any alternatives proposed for OU1 will be designed, constructed, and maintained in consultation with federal wildlife agencies.

Chemical-Specific ARARs:

Chemical specific ARARs are usually health- or risk-based numerical values that establish the acceptable amount or concentration of a chemical that may remain in, or be discharged to, the environment (USEPA, 1988a). They govern the extent of site remediation by providing either actual cleanup levels, or the basis for calculating such levels. There are no chemical-specific ARARs for the OU1 alternatives, but there are chemical-specific To Be Considered (TBC) standards which are discussed below and listed in Table 2-2.

Chemical-Specific TBC Criteria, Advisories, Guidance, and Technical Reports:

The chemical-specific criteria, advisories, guidance documents and technical papers listed below are identified as TBCs for the remedial alternatives evaluated in this FS and are discussed in the alternative-specific chemical-specific ARARs sections and are listed in Tables 4-1, 4-4, 4-8, and 4-12:

- USEPA Risk RfDs – These values estimate daily exposure levels that are unlikely to cause significant adverse non-carcinogenic health effects over a lifetime. Though they are not regulations, these values are used to evaluate risks to humans exposed to contaminants and to develop risk-based cleanup levels.

- USEPA Carcinogen Assessment Group, Cancer Slope Factors – These values are used to compute the incremental cancer risk from exposure to contaminants. They are not regulations, but are used in the evaluation of risks to human populations and to develop risk-based cleanup levels. USEPA Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens – Guidance of assessing cancer risks to children. Used to develop risk-based cleanup levels.

- USEPA Guidelines for Carcinogen Risk Assessment – Used to develop risk-based cleanup levels.

- Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens EPA/630/R-03/003F (March 2005).

- Proposed Guidelines for the Clean-Up of Contaminated Sites in Ontario (Ministry of Environment and Energy of Ontario [MOE], 1994).

- Preliminary Remediation Goals for Ecological Endpoints, Efroymson et al., August 1997.

Action-Specific ARARs

Action-specific ARARs are usually technology- or activity-based requirements or limitations actions taken to implement a proposed alternative (USEPA, 1988a). Selection of a particular response action at a site will invoke the appropriate action-specific ARARs, which may specify particular performance standards or technologies, as well as specific environmental levels for discharged or residual chemicals. Since there are usually several possible alternative actions for any remedial site, very different requirements can come into play.

Action-specific ARARs for OU1 of this Site include the, but are not limited to, Vermont Water Pollution Control Act, Vermont Solid Waste Management Rules (VTSWMR), Vermont Stormwater Management Act, Vermont Waste Management Act, Federal Safe Drinking Water MCLs, RCRA, Federal Clean Water Act, and Federal Surface Mining Control and Reclamation Act. A complete list is included in Table 2-3. Alternative specific action-specific ARARs are listed in Tables 4-5, 4-9, and 4-13. Several of the most critical action-specific ARARs are discussed in detail below.

<u>Federal Clean Water Act, Section 402 – NPDES (33 U.S.C. 1342; 40 CFR 122–135, 131)</u>: The CWA contains discharge limitations, monitoring requirements, and best management practices (BMPs) for discharges into federally regulated waters. These regulations would be applicable to remedial strategies involving discharge to surface waters.

<u>Federal Clean Water Act – Stormwater Requirements for Construction Sites (40 CFR 122.26)</u>: The CWA contains requirements that apply to construction activity including clearing, grading, and excavation of equal or greater than one acre. These regulations, therefore, would apply to

construction activity undertaken during remediation of the Site that impact one or more acres of total land area. The substantive standards under these regulations will be met.

Federal Surface Mining Control and Reclamation Act of 1977 (30 CFR 816 and 817): This Act, as revised through December 1993 (Public Law 95-87) provides closure guidelines for coal mining sites. Although the Site is not a coal site, the design criteria contained in the act for the closure of tailings at coal sites are cited as relevant and appropriate standards for the closure of the tailings at the Site. Section 515(b) sets forth Environmental Protection Performance Standards, which include the following provisions that will apply to the Site:

- The affected land should be restored to a condition capable of supporting pre-mining land use.

- At a minimum, mined areas should be backfilled, graded, and compacted using available overburden and other spoil and waste materials to attain the lowest practicable grade, to cover acid-forming and other toxic materials, and to achieve an ecologically sound land use.

- Surface areas, including spoil piles, should be stabilized to effectively control erosion and attendant air and water pollution.

- Surface soil should be restored to support vegetation.

- Permanent impoundments of water should be created only if authorized and only if they meet criteria related to size, stability, and water quality (i.e., discharges must meet applicable Federal and state standards in receiving stream).

- Disturbances to the prevailing hydrologic balance at the Site and site areas and to the quality and quantity of water in surface and groundwater systems must be minimized.

- Any debris, acid-forming materials, or toxic materials must be “treated or buried and compacted or otherwise disposed of in a manner designed to prevent contamination of ground or surface waters.”

- Access roads into and across the site must be maintained to “control or prevent erosion and siltation, pollution of water, damage to fish or wildlife or their habitat, or public or private property.”

- Roads may not be constructed “up a stream bed or drainage channel or in such proximity to such a channel so as to seriously alter the normal flow of water.”

- A “diverse, effective, and permanent vegetative cover of the same seasonal variety native to the area” must be established on degraded areas.

This Act takes into consideration the physical, climatological, and other characteristics of the site, and “to the extent possible, requires the use of the best technology currently available to minimize disturbances and adverse impacts of the mining operation on fish, wildlife, and related environmental values, and achieve enhancement of such resources where practicable.”

At the Site, these regulations would be relevant to those areas where the VTSWMR does not apply and no other regulations or risk-based standards provide guidance regarding the performance requirements for closure. These areas include the UWA, LWA, and the sediments of Ely Brook, its tributaries, and Ponds 4 and 5.

Vermont Water Pollution Control Act (10 VSA Chapter 47), Vermont Water Quality Standards (Env. Prot. R. Ch. 1, 2, and 3 and Appendix C and D), and Vermont National Pollution Discharge Elimination System (NPDES) Regulations (Env. Prot. R. Ch. 13): These statutes establish classifications and water quality standards for protecting surface waters of Vermont, and are applicable to any OU1 alternatives that will affect surface waterbodies. The NPDES regulations stipulate requirements for discharges to surface waters (Env. Prot. R. Ch. 2 and 3) as well as for stormwater controls. The Water Quality Standards are used standards for monitoring water quality both during remedial action and long-term monitoring of waterways downgradient of areas where contamination will be managed in place.

<u>Vermont Solid Waste Management Rules ([VTSWMR] Env. Prot. R. Ch. 6)</u>: The VTSWMR were revised to include specific provisions for mine waste. Based on the revised rules, waste rock at the Site is not subject to the VTSWMR. However, tailings and the roasted ore would be subject

to the rules as they are wastes that result from the beneficiation of the ore. Therefore, closure and post-closure of the TA and ORB would need to comply with the VTSWMR.

Vermont Stormwater Management Act (10 VSA § 1263 and § 1264 and Stormwater Management Rule (Env. Prot. R. Ch. 18): This rule applies to discharges of regulated stormwater runoff to waters that are not listed on the USEPA-approved Vermont 303(d) List of Waters as being impaired principally due to stormwater runoff. The rule establishes standards for post-construction management of stormwater runoff; establishes thresholds for discharges; sets forth treatment standards. The substantive requirements of the Vermont Stormwater Management Rule are applicable.

The rule generally applies to stormwater discharges from new developments, from the expansion of impervious surfaces, or from the redevelopment of existing impervious surfaces. In each case, the affected area must be greater than or equal to one acre for a permit to be required and alternatives that affect an area of one acre or more will meet the substantive requirements of the rule.

Vermont Air Pollution Control Act (10 VSA Chapter 23) and Air Pollution Control Regulations (Env. Prot. R. Ch. 5): The purpose of this act is:

> "to achieve and maintain such levels of air quality as will protect human health and safety, and to the greatest degree practicable, prevent injury to plant and animal life and property, foster the comfort and convenience of the people, promote the economic and social development of the state, and facilitate the enjoyment of the natural attractions of this state."

The Air Pollution Control Regulations list prohibited activities affecting air quality and establish primary and secondary ambient air quality standards for sulfur oxides, particulate matter, carbon monoxide, ozone, nitrogen dioxide, and lead. The requirements relating to fugitive dust emissions of particulates would be applicable to all construction activities. The secondary ambient air quality standard for particulate matter is 150 micrograms per cubic meter ($\mu g/m^3$), 24-hour average, not to be exceeded more than once per year (Subchapter III, 5-305).

Action-Specific TBC Criteria, Advisories, and Guidance

Action-specific TBCs that will be considered for particular alternatives include the following:

- *USEPA Contaminated Sediment Remediation Guidance for Hazardous Waste Sites* (USEPA December 2005) – Guidance for making remedy decisions for contaminated sediment sites.

- *Vermont Handbook for Erosion Prevention and Sediment Control*, Working Interim Document (Vermont Department of Environmental Conservation [VTDEC, 2003]) – This handbook is a compilation of information from various sources released by the VTDEC for use in developing the Erosion Prevention and Sedimentation Control Plans (EPSCPs) required for construction-related stormwater discharge permitting.

2.1.2 Non-ARAR Standards

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

2.1.3 Development of Preliminary Remediation Goals

A PRG is a COC concentration that is protective for media exposures at *de minimis* risk levels. PRGs include risk-based concentrations that are back-calculated from the site-specific exposure scenarios at a target excess lifetime cancer risk (ELCR) of 1×10^{-6} and a HI of 1.0, ARARs, and background concentrations. A COC is a chemical that is associated with an excess lifetime cancer risk greater than 1×10^{-6} (1 in a million) or a HI greater than 1. The determination of whether a response action is required is generally made by determining if a medium (or, more specifically, an exposure area such as source area soil or Ely Brook sediment) is associated with health risks that exceed risk management limits as defined in the NCP or in USEPA guidance documents. A response action is generally warranted if one or more of the following conditions are met:

- The cumulative excess carcinogenic risk to an individual exceeds 1×10^{-4} (using reasonable maximum exposure assumptions for either the current or reasonably anticipated future land use).

- The non-carcinogenic HI is greater than 1.0 (using reasonable maximum exposure assumptions for either the current or reasonably anticipated future land use).

- Site contaminants cause adverse environmental impacts.

- Chemical-specific standards or other measures that define acceptable risk levels are exceeded and exposure to contaminants above these acceptable levels is predicted for the RME. Examples include: drinking water standards that are exceeded in groundwater when that groundwater is a current or potential source of drinking water; or water quality standards that are exceeded in surface waters or groundwater that support the designated uses of these waters (e.g., support aquatic life).

The NCP stipulates that PRGs must initially be established as concentrations that correspond to an excess lifetime cancer risk greater than 1×10^{-6} (1 in a million) or a HI of 1, but can be modified upwards in consideration of site-specific factors, ARARs, background, etc. Risk-based PRG values were derived using a simple algebraic equality as follows:

(PRG) = (EPC from HHRA)*(target risk for PRG)*(risk associated with EPC from HHRA)

Based on the defined areas and media for OU1 and the outcome of the HHRA, Aquatic BERA, and Terrestrial BERA, PRGs were developed for the following environmental media:

- Soil and waste in the OU1 area (based on the potential threat to human health under a residential exposure scenario);
- Surface water (to protect ecological receptors in Ely Brook, its tributaries, and Ponds 4 and 5); and
- Sediment (to protect ecological receptors in Ely Brook, its tributaries, and Ponds 4 and 5).

All Site groundwater (overburden and bedrock), sediment, and surface water within Schoolhouse Brook, Ompompanoosuc River, and VP-1, and the soil/waste in the Smelter/Slag study area will be addressed as part of the OU2 RI/FS.

The PRGs for surface water, as listed in Table 2-4, are generally derived from the VTWQS for Class B water and the NRWQC. There were no identified human health risks associated with surface water and, therefore, no additional surface water PRGs for human health were identified in this FS.

The PRGs for soil, as listed in Table 2-4, are risk-based concentrations resulting in HIs less than 1.0. Copper and iron both target the gastrointestinal system; therefore, the PRG for each of these metals is set at a concentration where the HI would be less than 1.0 with an exposure to either or both of the metals, resulting in PRG concentrations of 629 milligrams per kilogram (mg/Kg) and 44,800 mg/Kg, respectively. Cobalt targets the thyroid and is the only Site COC that targets that organ. The PRG for cobalt is set at a concentration of 24 mg/Kg, at which the HI would be less than 1.0 for an exposure to a child or an adult. The Terrestrial BERA did not identify any chemical-specific ecological threats for exposure to soil. There was, however, a significant ecological threat to the plant and soil invertebrate communities as a result of the acid conditions in the soil caused by the Site waste material. Chemical-specific soil PRGs were not developed for ecological receptors, but a narrative RAO will be developed to address the ecological threats from acidic soil and waste.

The sole PRG for sediment in the OU1 area, which includes Ely Brook, its tributaries, and Ponds 4 and 5, as listed in Table 2-4, is an aquatic risk-based concentration of 149 mg/Kg for copper. There were no identified human health risks associated with sediment COPCs and, therefore, no additional sediment PRGs for human health were identified in this FS.

2.1.4 Identification of Remedial Action Objectives

This Section outlines the RAOs for OU1. The RAOs, which are based on the HHRA and the BERA work previously performed at the Site, are intended to protect human health and the environment within OU1 for specific media, such as waste rock, tailings, sediment, or surface water. The OU1 RAOs are used as the framework for developing remedial alternatives. The OU1 RAOs are summarized below and in Table 2-5.

OU1 RAOs

- Control the release of ARD and acid mine drainage from the waste rock and tailings source areas (UWA, LWA, TA, and ORB) to allow Ely Brook to achieve the numerical and biological criteria for a Class B surface water in Vermont and to achieve Class B numerical criteria in Ponds 4 and 5.

- Protect Human Health by preventing direct contact with or incidental ingestion of soil within the OU1 source areas containing:

    - copper concentrations above 629 mg/Kg;
    - cobalt concentrations above 24 mg/Kg; or
    - iron concentrations above 44,800 mg/Kg.

- Restore the sediment quality of Ely Brook and its tributaries and Ponds 4 and 5 to concentrations below the PRG for copper and achieve biological integrity for these surface water bodies as demonstrated through compliance with Vermont Water Quality Criteria (VTWQC), NRWQC, and biological measures of recovery. Recovery will be measured by benthic and fish metrics achieving populations comparable with upstream and/or reference values and a finding of the sediment being non-toxic to aquatic organisms in toxicity tests.

- Restore the surface water quality of Ely Brook and its tributaries, and Ponds 4 and 5 to achieve biological integrity for these surface water bodies as demonstrated through compliance with VTWQC, NRWQC, and biological measures of recovery. Recovery will be measured by benthic and fish metrics achieving populations comparable with upstream and/or reference values and a finding of the surface water being non-toxic to aquatic organisms in toxicity tests.

- Restore the acid-impacted barren areas containing mine waste to create a functional ecological habitat with respect to the plant and soil invertebrate communities.

2.2 Areas and Volumes of Media Exceeding PRGs

This section describes the areas and volumes for media exceeding PRGs in each of the defined OU1 waste source areas are presented in the following sections and summarized in Table 2-6. Unless otherwise stated, Computer Aided Design (CAD) software, specifically Autodesk's Civil 3D 2010 software packages, was used to determine areas and volumes for each media within the designated RA areas. The general areas of impacted soil, groundwater, and sediment/surface water were previously depicted on Figures 1-8, 1-9, and 1-10, respectively.

Waste rock and tailings can be found in four OU1 waste source areas: the UWA, the LWA, the TA, and the ORB. Based on the results of the RI and the information presented in this document, these areas are believed to be responsible for ARD impacts to overburden and shallow bedrock groundwater and surface water in Ely Brook and the tributaries to Ely Brook. Surface water that exceeds PRGs is not considered a waste media since RAs would address the root cause of the surface water impairment (ARD from waste rock and tailings) rather than being directly applied to the surface water itself.

The soil within the UWA, the LWA, the TA, and the ORB also exceeds the risk-based site-specific cleanup levels for cobalt, copper, and iron. Figure 2-2 identifies these areas and outlines the extent of waste material along with the waste/soil containing cobalt, copper, or iron concentrations above the RAO. The lateral limits of the waste areas were determined by evaluating a combination of both fixed laboratory and on-site laboratory x-ray fluorescence (XRF) analyses of soil samples. The extent of the barren areas that represent a significant ecological threat is shown in Figure 1-11.

The sediments of Ely Brook, its Tributaries and Ponds 4 and 5 exceed the sediment PRG for copper. These sediments are composed primarily of eroded waste rock and, therefore, also act as significant source of ARD to downgradient surface water. VP-1 is not included in the OU1 area as it is within the OU2 area of the Site.

2.2.1 UWA

Based on the observed vertical and lateral extent of waste rock and levels of cobalt, copper, and iron above PRGs subject to the Remedial Action, the UWA covers an approximately 8.5-acre area and includes an estimated 73,000 cubic yards (cy) contaminated material. These volumes

do not include the Lower Adit development rock pile. No adverse impacts have been observed from this development rock pile and the lithology of this waste rock is believed to be non-reactive. Therefore, it is not anticipated to be a source of metals or acidity. However, pre-design investigations should be performed to ensure that that unidentified waste sources do not underlie this development rock pile. If the development rock is found to be acid generating, it will be removed along with the other waste rock in the UWA. It may also reside above acid generating waste rock and require relocation to access that material.

2.2.2 LWA

Based on the observed vertical and lateral extent of waste rock and levels of cobalt, copper, and iron above PRGs subject to the Remedial Action, the LWA covers an approximately 6.4-acre area and includes an estimated 29,000 cubic yards (cy) contaminated material..

2.2.3 TA

Based on the observed vertical and lateral extent of waste rock and levels of cobalt, copper, and iron above PRGs subject to the Remedial Action, the TA covers an approximately 0.7-acre area and includes an estimated 3,600 cubic yards (cy) contaminated material. The TA contains tailings, which are a finer-grained soil than the course-grained and cobble waste rock observed in the remainder of the LWA. The tailings are classified as a beneficiated waste by the State of Vermont which has different closure requirements than non-beneficiated waste in accordance with the Solid Waste Management Rules.

2.2.4 ORB

The extent of this waste area is defined by cobalt, copper, and iron soil concentrations exceeding the PRGs. Waste material in this area includes remnant layers of partially-roasted ore, which were left there after closure of the mine operation. Based on surface and subsurface observations, the estimated volume of waste material in the ORB is 10,330 cy, covering an area of approximately 2.2 acres. The ORB is classified as a beneficiated waste by the State of Vermont which has different closure requirements than non-beneficiated waste in accordance with the Solid Waste Management Rules.

The southwestern margin of the ORB is delineated by a dry-set field-stone retaining wall supporting the waste material from the access road. It should be noted that the wall is of particular historical significance due the age and masonry and may affect RAs in this area.

2.2.5 Ely Brook and Tributaries

Ely Brook, its tributaries (EBT1, EBT2, EBT3, and EBT4) and Ponds 4 and 5 all contain sediment that exceeds the sediment PRG for copper. The areas and volumes of sediment for these three components are discussed separately below.

Ely Brook

As previously stated, the Ely Brook Headwaters are believed to be unimpacted by mine activities as evidenced by the lack of elevated metals concentrations in sediment and surface water samples collected in the reach. Therefore, the Ely Brook Headwaters are used as background or reference location. The RI and the Aquatic BERA documented that the sediments of the rest of Ely Brook exceed the PRG for copper and are a source of metals and acidity to the surface water. For the purpose of estimating the volume of impacted sediment, the entirety of each of the remaining zones (Upper Ely Brook, Middle Ely Brook, and Lower Ely Brook) is considered to exceed the copper PRG and, therefore, to require a response action. The area and volume for each reach is presented in Table 2-6 and summarized in the table below.

Reaches	Defined Location	Length (ft)	Estimated Volume of Impacted Sediments (cy)
Ely Brook Headwaters	north and upstream of old road crossing	1,500	N/A- reference
Upper Ely Brook	from EBT-2 up to old road crossing	1,700	190
Middle Ely Brook	EBT-2 to between SD-61 and SD-62	660	580
Lower Ely Brook	between SD-61 and SD-62 and includes the delta located at the confluence with Schoolhouse Brook	1,200	3,950

It should be noted that the sediment deposited in the deltaic fan at the confluence with Schoolhouse brook is believed to be a significant source of metals and acidity to Schoolhouse Brook. Because this sediment originated from Ely Brook, is laterally contiguous with the Ely

Brook impacted sediment zone, and is most feasibly addressed in conjunction with sediment removal alternatives that extend to the termination of the Ely Brook, this sediment volume will be included in the Lower Ely Brook source area as part of OU1.

Ely Brook Tributaries

Ely Brook has four designated tributaries (EBT1 through EBT4):

- EBT1 is the surface water drainage originating from the ORB and the waste rock in the Site access road;
- EBT2 is the surface water drainage originating from Ponds 4 and 5 and the LWA;
- EBT3 is the surface water drainage originating from the UWA, TA, and LWA; and
- EBT4 is the surface water drainage originating from the UWA.

The area and volume for Ely Brook's four designated tributaries (EBT1 through EBT4) are presented in Table 2-6. These tributaries receive water and waste rock or tailing sediments from the waste source areas described in the sections above. It is assumed that the entire reach of the tributaries contains sediments that exceed the copper PRG, and will therefore require being addressed by the remedial action. The estimated total volume of impacted sediments within the Ely tributaries is 3,221 cy. This volume is included in the volume estimate for the UWA, LWA, and TA.

Ponds 4 and 5

The RI and the Aquatic BERA documented that the sediments of Ponds 4 and 5 exceed the sediment PRG for copper and are contributing to the adverse impacts to the ecological receptors. The estimated surface area of Ponds 4 and 5 are approximately 4,800 ft^2 (0.1 acres). Due to the small size of the ponds and the small volume of the drainage connecting the pond complex, the depth of contamination is believed to be shallow. Based on the sediment data, the estimated volume of impacted sediments in Ponds 4 and 5 is 378 cy.

2.3 General Response Actions

General Response Actions (GRAs) are broad categories consisting of remedial technologies and process options that can be selected individually or in combination in order to meet the

RAOs for OU1. GRAs are included in the FS process to give a range of responses for consideration for site remediation. The OU1 GRAs are:

No Action

Under this response, no action would be taken to address impacted media in OU1. In accordance with the NCP and USEPA's *Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA* (1988), a no-action response must be developed and evaluated to provide a baseline against which other response actions can be compared. The No Action response does not include environmental monitoring or actions to reduce the potential for exposure (e.g., fencing, deed restrictions). It does include conducting five-year reviews, as required by CERCLA.

Limited Action

The Limited Action response would consist of the implementation and maintenance of institutional and/or engineered controls aimed at limiting access to a particular area of concern and/or media. Institutional controls are non-engineered, administrative and/or legal measures (e.g., land use restrictions [restrictive covenants] or informational/educational devices [deed notices]) that minimize the potential for exposure to contamination by limiting land or resource utilization. Engineered controls are physical deterrents (e.g., fencing or posted warnings) that serve to impede the potential for exposure to contamination.

Containment

Containment options are physical measures that are applied to the source(s) that aim to inhibit the migration of contaminants as well as prevent direct contact between contaminated media and potential receptors. Containment measures can include covers and/or perimeter controls to isolate waste material from water and/or oxygen.

Removal and Disposal/Discharge

For soil and sediment, this GRA involves a complete or partial removal of source material, followed by on-site consolidation or transportation to a permitted, off-site facility for disposal. Some type of treatment and/or dewatering may be required either prior to transport or prior to ultimate disposal, depending on the physical and chemical characterization of the material.

Treatment of groundwater or stormwater from Site excavations may also be required if the dewatered fluids become contaminated.

For surface water and groundwater, this GRA involves the extraction/collection of groundwater/surface water via pumps, drainage trenches, or other means. The water would then undergo on-site treatment and discharge or it would be transported to an off-site facility for treatment and discharge.

In-Situ Treatment

In-situ treatment technologies consist of those biological, physical, chemical, and thermal processes that could be applied to treat impacted media without the need for removal. In-situ treatment aims to reduce the overall toxicity, mobility, and/or volume of the impacted media.

Ex-Situ Treatment

Ex-situ treatment technologies consist of those biological, physical, chemical, and thermal processes that could be applied to treat impacted media after it has been removed from its current location. Ex-situ treatment could result in the impacted media being returned to its original location and re-located to another location on-site or off-site. This treatment aims to reduce the overall toxicity, mobility, and/or volume of the impacted media.

2.4 Identification and Screening of Technologies and Process Options

This subsection identifies and screens remedial technologies using the process outlined in USEPA RI/FS guidance and the NCP (USEPA, 1988b, 1990, and 1993). First, technologies are identified to attain the RAOs established in Section 2.1.3 and to correspond to the categories of general response actions described in Section 2.2. Demonstrated performance of each technology for site contaminants and conditions is considered during technology identification. The result is a list of potential remedial technologies that are then screened based on their applicability to site- and waste-limiting characteristics. The purpose of the screening is to produce an inventory of suitable technologies that can be assembled into remedial alternatives capable of mitigating actual or potential risks at the site. An extensive list of potential technologies representing a range of general response actions (i.e., no action, institutional controls, containment, in-situ treatment, collection, ex-situ treatment, treatment, and disposal)

was considered to develop the remedial alternatives. This process is consistent with USEPA guidance.

2.4.1 Technology Identification

Categories of remedial technologies and specific process options were identified based on a review of literature, vendor information, performance data, and experience in developing other FSs under CERCLA. A complete list of these categories can be found in Table 2-7. Technologies and process options that were considered potentially applicable to attaining the remedial response objectives for the different media that were identified as OU1 waste sources were selected for screening. For simplicity in the tables, soil, waste rock, and tailings have been grouped together as a single media due to the similarities between the posed threat and the methods needed to address those threats.

2.4.2 Technology Screening

The screening process assesses each technology or process option for its effectiveness and implementability with regard to site conditions, known and suspected contaminants, and affected environmental media. The effectiveness evaluation focuses on: (1) whether the technology is capable of handling the estimated areas or volumes of media and meeting the contaminant reduction goals identified in the RAOs; (2) the effectiveness of the technology in protecting human health and the environment during the construction and implementation phase; and (3) how proven and reliable the technology is with respect to contaminants and conditions at the site. Implementability encompasses both the technical and administrative feasibility of implementing a technology.

Waste-limiting characteristics primarily establish the effectiveness and performance of a technology; site-limiting characteristics affect implementability of a technology. Waste-limiting characteristics consider the suitability of a technology based on contaminant types, individual compound properties (e.g., volatility, solubility, specific gravity, adsorption potential, and biodegradability), and interactions that may occur between mixtures of compounds (e.g., chemical reactions or increased solubility). Site-limiting characteristics consider the effect of site-specific physical features on the implementability of a technology, including topography, buildings, underground utilities, available space, and proximity to sensitive operations. Technology screening based on waste- and site-limiting characteristics serves a twofold

purpose of screening out technologies whose applicability is limited by site-specific waste or site considerations, while retaining as many potentially applicable technologies as possible. At this stage in the process, relative costs are considered to eliminate technologies that are substantially less cost-effective.

Tables 2-8 and 2-9 show the technology screening process for waste rock and tailings and sediment, respectively. Technologies and process options judged ineffective or not implementable were eliminated from further consideration. The technologies retained at the end of the screening represent an inventory of technologies that are considered most suitable for remediation of soil and sediment in OU1. Technologies and the process options retained in this subsection may be used either alone or in combination with other technologies as remedial alternatives.

Based on the evaluation of each technology type using the above-mentioned criteria, viable technologies were identified and retained post-screening to be used in the development of remedial alternatives that will be further evaluated in the FS. The retained technologies are listed in Table 2-10.

3.0 DEVELOPMENT AND SCREENING OF ALTERNATIVES

In this section, alternatives are developed to meet the RAOs presented in Subsection 2.1.4, using the GRAs identified in Section 2.3, either individually or in combination. Remedial alternatives have been developed to address specific waste material source areas (i.e., waste rock and tailings and sediment) based on the screening of technology types and process options. Developed remedial alternatives are then screened with respect to the criteria of effectiveness, implementability, and cost to meet the requirements of CERCLA and the NCP (40 CFR 300.430(e)(7)). Retained alternatives will then be combined into alternatives with site-wide applicability for detailed evaluation in Section 4.0.

3.1 Alternative Screening Criteria

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

screening remedial alternatives are effectiveness, implementability, and cost. These criteria are discussed in the paragraphs below.

Effectiveness

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

Implementability

Each alternative is also evaluated in terms of technical and administrative implementability, or feasibility. Much like the evaluation of effectiveness, the evaluation of technical feasibility can be broken into short- and long-term aspects. Short-term technical feasibility considers the availability of a technology for construction or mobilization and operation, as well as compliance with action-specific ARARs during the RA. Long-term technical feasibility considers the ease of operation and maintenance, technical reliability, the ease of undertaking additional RAs, and the necessary degree of monitoring for residuals and untreated wastes after employing specific technical controls. Meanwhile, administrative feasibility for implementing a given technology addresses the ability to obtain approvals from pertinent offices and agencies for off-site activities, the availability of treatment, storage, and disposal services, and the commercial availability of required services and trained specialists or operators. Alternatives that are technically or administratively infeasible or that would require equipment, specialists, or facilities

that are not available within a reasonable period of time may be eliminated from further consideration (NCP, 40 CFR 300.430(e)(7)).

Cost

This criterion considers the costs of construction and any long-term operations and maintenance (O&M) costs associates with each alternative. As noted in USEPA guidance, the overall goal of the remedy selection process is to remediate contaminated sites to the maximum extent practicable, which requires a co-equal mandate for remedies to be cost-effective (USEPA, 1996). The NCP thus requires consideration of the use of engineering and institutional controls, as an alternative to treatment, when appropriate. Costs may be used to eliminate alternatives when an alternative provides effectiveness and implementability similar to that of another alternative by employing a similar method of treatment or engineering control, but at greater cost (40 CFR 300.430(e)(7)(iii)) or when an alternative has costs that are grossly excessive as compared to its overall effectiveness (40 CFR 300.430(e)(7)(iii)). For example, the costs associated with treating a complex mixture of heterogeneous wastes without discrete hot spots (e.g., a large municipal landfill) would likely be considered excessive in comparison to the effectiveness of such treatment. As a result, a treatment alternative for such a site would likely be eliminated from consideration during the screening process.

It is important to note that the alternatives screening process does not formally evaluate costs. Rather, professional judgment is used to identify the relative cost-effectiveness of each alternative based on knowledge of relative costs. Detailed cost evaluations will be presented as part of the detailed evaluation of alternatives that passed the initial screening (See Section 4.0).

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

3.2 Identification and Description of Alternatives

This subsection develops remedial alternatives for OU1 source areas. The alternatives consider the residual sources remaining in-place, the hydrogeologic system, affected media, and contaminant type and distribution. In assembling these alternatives, general response actions and process options chosen to represent the various technology types are combined to

form alternatives for the OU as a whole. The RI did not identify any principal threat wastes at the Site. In addition, because the source of contamination is a large volume of low level mine waste, technologies that would require treatment of the entire volume of mine were not retained after the identification and initial screening of alternatives. Alternatives are developed to provide a range of options consistent with USEPA RI/FS guidance (USEPA, 1988b).

Due to the nature of the OU1 waste material (mine waste), only a limited range of options were identified based on the general response actions and process options that passed the technology screening in Section 2.0. Furthermore, only one technology (excavation/dredging) was retained to address the contaminated sediment in Ely Brook, its tributaries, and Ponds 4 and 5. As a result, this RA for addressing the sediments is incorporated into the alternatives that address, soil, waste rock and tailings. The four remedial alternatives (including No Action) that have been identified to address OU1 RAOs for sediment, soil, waste rock and tailings areas are listed below.

- Alternative SC1 – No Action Alternative
- Alternative SC2 – Waste containment in the LWA Cell and in the Ore Roast Bed
- Alternative SC3 – Waste containment in the West Cell and in the Ore Roast Bed
- Alternative SC4 – Off-site disposal and waste containment in the Ore Roast Bed

The following subsections describe the alternatives developed for OU1 source areas and sediments.

3.2.1 Alternative SC1 – No Action

Alternative SC1, the No Action alternative, does not include RA components to reduce, control, or eliminate potential risks from exposure to contaminants in source-area soil. No action will be taken to reduce ARD generation or the migration of ARD-impacted groundwater or seeps to Ely Brook or its tributaries and Ponds 4 and 5 where it may contribute to surface water exceedances of NRWQC and exceedances of sediment PRGs. Alternative SC1 would not implement an environmental monitoring program to assess long-term changes in contaminant concentrations in soil in order to protect human health and the environment. Alternative SC1 would include statutorily-required five-year reviews. CERCLA requires that the No Action alternative be evaluated to establish a baseline for comparison to other remedial alternatives.

Alternative SC1 will not be evaluated according to screening criteria, and will pass through screening to be evaluated during detailed analysis (USEPA, 1988b).

3.2.2 Alternative SC2 – Waste Containment in the LWA Cell and in the Ore Roast Bed

Alternative SC2 would involve the excavation of the UWA and LWA, Ely Brook and its tributaries, and Ponds 4 and 5 and consolidation of the material in a containment cell located in the area of the LWA (Figure 3-1) (LWA Cell), constructing surface water diversions to redirect the surface water around the LWA cell, installation of a low permeability cover system to contain and isolate the waste rock, installation of a continuous full-bottom containment liner below the waste and installation of a horizontal underdrain system to maintain the groundwater elevation to a level below the waste and liner (cross-section of potential cell depicted on Figure 3-2).

Several tributaries to Ely Brook are located within the UWA and LWA; these tributaries will be excavated as a source of surface water contamination and consolidated with the waste rock in the containment cell. The sediments located in Ponds 4 and 5, Middle Ely Brook and Lower Ely Brook exceeding the copper PRG will be excavated and disposed in the LWA Cell. The sediments in Upper Ely Brook will be removed by either flushing the sediments into the lower reaches prior to the removal of sediment from these areas or via vacuum extraction. Monitoring of Upper Ely Brook will be performed to assess whether all contaminated sediment was successfully removed. Temporary diversions or damming of Ely Brook and Ponds 4 and 5 would be used to enable dry working conditions. After excavation/dredging, restoration would be performed for Ely Brook. Middle Ely Brook would be restored as a rip-rap armored channel; Lower Ely Brook would be restored as a natural channel; and Ponds 4 and 5 as either a rip-rap armored channel from Pond 3 downstream to Ely Brook near the confluence with EBT2 or restored to native aquatic habitat as part of a wetland mitigation.

Alternative SC2 also includes excavation of the TA and layering of the tailings on the ORB, construction of a low-permeability cover system over the material, and construction of surface water diversions to redirect the surface water from the areas upgradient of the ORB around the cover system as illustrated in Figure 3-3. A cross-section of the ORB cell is depicted on Figure 3-4.

Restoration of the excavated areas will consist of grading the slopes to allow for adequate surface water drainage and minimize soil erosion. Additional components include institutional controls, environmental monitoring, and five-year reviews.

This alternative would consist of the following key components:

- Pre-design investigations and studies;
- If on-site material is used for the containment cell, timber clearing and grading of an approximate 15-acre area west of Ely Brook to obtain soil for the containment cell;
- Excavation of the soil material and restoration of the disturbed areas;
- Excavation and consolidation of acid generating waste rock and soil exceeding PRGs from the UWA and LWA within a containment cell in a subarea of the LWA;
- Construction of a lined cover system for the containment cell in the LWA with surface water diversion measures;
- Installation of a continuous full-bottom containment liner and horizontal underdrain beneath the containment cell in the LWA to maintain separation between the waste material and surface water/groundwater;
- Excavation of the TA and placement of the tailings on the ORB;
- Construction of a low-permeability cover system over the ORB/tailings material with surface water diversion;
- Institutional controls to protect the response actions, including protection of the cover system, surface water diversions, and restoration areas;
- Installation of monitoring wells;
- Long-term operation and maintenance;

- Environmental monitoring;
- Restoration of waterways, wetlands, and wildlife habitat, as required;
- Institutional control inspections; and
- Five-year reviews.

A map showing the major construction components of this alternative is included as Figure 3-5.

The containment of the waste rock and soil exceeding PRGs in the LWA using a lined cover system and a horizontal underdrain system will minimize the potential for these waste materials to come in contact with surface water and/or groundwater, thereby minimizing the potential for ARD to occur. These activities will reduce human contact with metals above the PRGs, improve surface water and groundwater quality by reducing the sources of contamination, and comply with ARARs.

The capping of the tailings and ORB will reduce human contact with metals above the PRGs. The tailings and ORB do not contribute a significant impact to the groundwater or surface water. The excavation of source material will, in addition to controlling direct exposure risks, reduce leaching and erosion that contribute to exceedances of federal and state water quality standards in Ely Brook and its tributaries sediment and surface water. The screening of Alternative SC-2 is presented in Table 3-1.

3.2.3 Alternative SC3 – Waste Containment in the West Cell and in the Ore Roast Bed

Alternative SC3 includes excavation of the UWA and LWA and consolidation of the material into a containment cell located in an on-site area to the west of Ely Brook (Figure 3-6) (West Cell); clearing and grading the work area along with a sufficient lay-down area; construction of a surface water diversions to redirect the surface water from Ponds 4 and 5 and seeps/runoff around the cell; and installation of a low-permeability cover system to contain and isolate the waste rock (cross-section of potential cell depicted on Figure 3-7).

Several tributaries to Ely Brook are located within the UWA and LWA; these tributaries will be excavated as a source of surface water contamination and consolidated with the waste rock in the containment cell. The sediments located in Ponds 4 and 5, Middle Ely Brook and Lower Ely Brook exceeding the PRGs will be excavated and disposed of in the containment cell. The sediments in Upper Ely Brook will be removed by either flushing the sediments into the lower reaches prior to the removal of sediment from these areas or via vacuum extraction. Monitoring of Upper Ely Brook will be performed to assess whether all contaminated sediment was successfully removed. Temporary diversions or damming of Ely Brook and Ponds 4 and 5 would be used to enable dry working conditions. After excavation/dredging, restoration would be performed for Ely Brook. Middle Ely Brook would be restored as a rip-rap armored channel; Lower Ely Brook would be restored as a natural channel; and Ponds 4 and 5 as either a rip-rap armored channel from Pond 3 downstream to Ely Brook near the confluence with EBT2 or restored to native aquatic habitat as part of a wetland mitigation.

Alternative SC3 also includes excavation of the TA and layering of the tailings on the ORB, construction of a low-permeability cover system over the material, and construction of surface water diversions to redirect the surface water areas upgradient of the ORB around the cover system as illustrated on Figure 3-3. A cross-section of the ORB cell is depicted on Figure 3-4.

Restoration of the excavated areas will consist of grading the slopes to allow for adequate surface water drainage and minimize soil erosion. Additional components include institutional controls, environmental monitoring, and five-year reviews.

This alternative would consist of the following key components:

- Pre-design investigations and studies; Timber clearing and grading of an approximate 12-acre cell area and lay-down area west of Ely Brook;
- Excavation of soil material for cover system from footprint of West Cell and lay-down area;
- Excavation and consolidation of waste rock and soil exceeding PRGs from the UWA and LWA within a containment cell west of Ely Brook;
- Construction of a lined cover system for the containment cell west of Ely Brook with surface water diversion measures;

- Excavation of the TA and placement of the tailings on the ORB;
- Construction of a low-permeability cover system over the ORB/tailings material with surface water diversion;
- Institutional controls to protect the response actions: including protection of the cover system, surface water diversions, and restoration areas;
- Installation of monitoring wells;
- Long-term operation and maintenance;
- Environmental monitoring;
- Restoration of waterways, wetlands, and wildlife habitat, as required;
- Institutional control inspections; and
- Five-year reviews.

An alternative remedy map showing the major construction components of this alternative is included as Figure 3-8.

The containment of the waste rock and soil exceeding PRGs in a cell west of Ely Brook using a lined cover system will minimize the potential for the waste material to come in contact with surface water and/or groundwater, thereby minimizing the potential for ARD to occur. These activities will reduce human contact with metals above the PRGs, improve surface water and groundwater quality by reducing the sources of contamination, and comply with ARARs.

The capping of the tailings and ORB will reduce human contact with metals above the PRGs. The tailings and ORB do not contribute a significant impact to the groundwater or surface water. The excavation of source material will, in addition to controlling direct exposure risks, reduce leaching and erosion that contribute to exceedances of federal and state water quality standards in Ely Brook and its tributaries sediment and surface water. The screening of Alternative SC3 is presented in Table 3-2.

3.2.4 Alternative SC4 – Off-Site Disposal and Waste Containment in the Ore Roast Bed

Alternative SC4 includes excavation of waste rock and soils that exceed PRGs from the UWA and LWA with off-site disposal of the material and construction of surface water diversions to redirect the surface water from Ponds 4 and 5 (Figure 3-9). Several tributaries that act as a

source of surface water contamination to Ely Brook are located within the UWA and LWA. These tributaries will be excavated and consolidated with the waste rock transported for off-site disposal. The sediments located in Ponds 4 and 5, Middle Ely Brook and Lower Ely Brook that exceed PRGs will be excavated and disposed of off-site with the waste rock. The sediments in Upper Ely Brook will be removed by either flushing the sediments into the lower reaches prior to the removal of sediment from these areas or via vacuum extraction. Monitoring of Upper Ely Brook will be performed to assess whether all contaminated sediment was successfully removed. Temporary diversions or damming of Ely Brook and Ponds 4 and 5 would be used to enable dry working conditions. After excavation/dredging, restoration would be performed for Ely Brook. Middle Ely Brook would be restored as a rip-rap armored channel; Lower Ely Brook would be restored as a natural channel; and Ponds 4 and 5 as either a rip-rap armored channel from Pond 3 downstream to Ely Brook near the confluence with EBT2 or restored to native aquatic habitat as part of a wetland mitigation.

Alternative SC4 also includes excavation of the TA and layering of the tailings on the ORB, construction of a low permeability cover system over the material, and construction of surface water diversions to redirect the surface water areas upgradient of the ORB around the cover system as illustrated on Figure 3-3. A cross-section of the ORB cell is depicted on Figure 3-4.

Restoration of the excavated areas will consist of grading the slopes to allow for adequate surface water drainage and minimize soil erosion. Additional components include institutional controls, environmental monitoring, and five-year reviews.

This alternative would consist of the following key components:

- Pre-design investigations and studies,
- Excavation and off-site disposal of waste rock and soil exceeding PRGs from the UWA and LWA,
- Excavation of the TA and placement of the tailings on the ORB,
- Construction of a low-permeability cover system over the ORB/tailings material with surface water diversion,
- Institutional controls to protect the response actions: including protection of the cover system, surface water diversions, and restoration areas,
- Installation of monitoring wells,

- Long-term operation and maintenance,
- Environmental monitoring,
- Restoration of waterways, wetlands, and wildlife habitat, as required;
- Institutional control inspections, and
- Five-year reviews

An alternative remedy map showing the major construction components of this alternative is included as Figure 3-10.

The removal of the waste rock and soil exceeding PRGs will minimize the potential for the waste material to come in contact with surface water and/or groundwater, thereby minimizing the potential for ARD to occur. These activities will reduce human contact with metals above the PRGs, improve surface water and groundwater quality by reducing the sources of contamination, and comply with ARARs. The capping of the tailings and ORB will reduce human contact with metals above the PRGs. The tailings and ORB do not contribute a significant impact to the groundwater or surface water. The excavation of source material will, in addition to controlling direct exposure risks, reduce leaching and erosion that contribute to exceedances of federal and state water quality standards in Ely Brook and its tributaries sediment and surface water. The screening of Alternative SC4 is presented in Table 3-3.

3.3 Screening of Alternatives

Tables 3-1 through 3-3 present the screening of remedial alternatives SC2, SC2, and SC3, respectively. The following table summarizes the results of the screening:

Alternative	Status
Alternative SC2 – Waste containment in the LWA Cell and in the Ore Roast Bed	Retained
Alternative SC3 – Waste containment in the West Cell and in the Ore Roast Bed	Retained
Alternative SC4 – Off-site disposal and waste containment in the Ore Roast Bed	Retained

Alternatives SC1, was not included in the screening step, but was retained for the detailed evaluation included in the Section 4.0 below, consistent with CERCLA and USEPA guidance.

4.0 DETAILED ANALYSIS OF ALTERNATIVES

This section presents the detailed analyses of RA alternatives for OU1 soil, waste rock, tailings, and sediment at the Site. The detailed analysis is intended to provide decision makers with information on specific statutory requirements for RAs that must be addressed in the ROD (USEPA, 1988b). RAs must:

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

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

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

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

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

Overall Protection of Human Health and the Environment

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

Compliance with ARARs

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

Long-Term Effectiveness and Permanence

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

Reduction of Toxicity, Mobility, and Volume through Treatment

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

Short-Term Effectiveness

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

Implementability

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

Cost

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

State Acceptance

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

Community Acceptance

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

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

- engineering design at a percentage of direct capital costs;
- project and construction management, including health and safety, legal, and administrative fees, at a percentage of direct capital costs; and

- a contingency to account for unforeseen project complexities such as adverse weather, the need for additional and unexpected site characterization, and increased construction standby times at a percentage of direct capital costs.

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

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

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

In addition to the No Action alternative, three remedial alternatives were retained in Section 3.0 to address soil, waste rock, tailings, and sediment at the Site. The retained alternatives are as follows:

- Alternative SC1 – No Action

- Alternative SC2 – Waste containment in the Lower Waste Area Cell and in the Ore Roast Bed
- Alternative SC3 – Waste containment in the West Cell and in the Ore Roast Bed
- Alternative SC4 – Off-site disposal and waste containment in the Ore Roast Bed

4.1 Evaluation of Alternative SC1 – No Action

Alternative SC1, the No Action alternative, was retained as a baseline with which to compare the other alternatives, as required by the NCP. This alternative would not include RA components to reduce the contribution of site source areas to groundwater, surface water, or sediment contamination. No action would be taken to reduce, control, or eliminate direct exposure risks to current and future. No action would be taken to reduce, eliminate, or control risks to ecological receptors in the surface water and sediment areas. The alternative includes statutorily-required Five-Year Reviews. The following assessment of the No Action alternative is based on the first seven evaluation criteria of the NCP.

4.1.1 Overall Protection of Human Health and the Environment

Alternative SC1 would not protect human health from exposure to mine-related contamination above the site-specific PRGs. Specifically, a future child resident at the Site or an adjacent child resident who visits the Site frequently would be exposed to levels of cobalt, copper, and iron in the soil above levels considered acceptable to protect human health. Therefore, Alternative SC1 would not be protective of human health under current and potential future land-use conditions for those waste source areas identified within OU1.

Alternative SC1 would not reduce, control, or eliminate contaminant source areas that contribute to exceedances of the various applicable water quality standards in groundwater and surface water, or that contribute to sediment contamination that exceeds protective concentrations. As a result, the discharge of highly toxic leachate from the waste areas would not be eliminated. This would continue the significant impairment of Ely Brook, its tributaries, Ponds 4 and 5, and Schoolhouse Brook. Alternative SC1 would also not eliminate the contaminated sediments that are contributing to the ecological impacts in Ely Brook, its tributaries, and Ponds 4 and 5. Therefore, Alternative SC1 is not considered protective of the environment.

4.1.2 Compliance with ARARs

Because no action is proposed, neither location-specific nor action-specific ARARs would be triggered by this alternative. The chemical-specific TBCs for Alternative SC1 are identified in Table 4-1.

4.1.3 Long-Term Effectiveness and Permanence

Alternative SC1 would not provide controls to reduce, control, or eliminate contaminant source areas, and inorganic contaminants at the Site are not expected to naturally degrade. Alternative SC1 would not provide any long-term effectiveness or permanence for protection of human health or the environment.

4.1.4 Reduction of Toxicity, Mobility, and Volume through Treatment

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

4.1.5 Short-Term Effectiveness

As no active remedial action is taken under Alternative SC1, there are no short-term impacts to the community, workers, or the environment SC1, however, would never achieve the remedial action objectives and there would be no reduction in risks in the short term.

4.1.6 Implementability

Because Alternative SC1 does not propose remedial action, there would be no technical difficulties associated with implementation. Five-Year Reviews would be easily implemented. The No Action alternative would not limit or interfere with the ability to perform future RAs.

4.1.7 Cost

There is no cost associated with the No Action alternative except for the cost of Five-Year Reviews, because no RAs would be performed. Table 4-2 presents a summary of the

estimated present worth and total non-discounted costs to implement Alternative SC1. The present worth for Alternative SC1 based on a 7 percent discount rate and a 30-year duration is estimated to be $113,015. Appendix A contains additional cost assumptions and a detailed cost estimate for this alternative.

4.2 Evaluation of Alternative SC2 – Waste Containment in the Lower Waste Area Cell and in the Ore Roast Bed

This subsection describes Alternative SC2, provides a cost estimate, and evaluates the alternative using the first seven evaluation criteria of the NCP. It is likely that some changes to the components described below will be required as a result of the performance of the remedial design.

Alternative SC2 would prevent human contact with soil/waste in the OU1 area that is above PRGs, prevent ARD formation within the UWA, LWA, and TA, and eliminate the toxic effect of the waste on the plant and soil communities which is creating the barren areas by isolating the soil/waste in a confined cell. This cell, which will be referred to as the LWA Cell, will have sufficient capacity to include the LWA, UWA, sediments from Ely Brook, its tributaries, and Ponds 4 and 5. Disturbed areas outside of the confined cell will be stabilized and restored. A cover system that will prevent contact of water and oxygen with the waste will be installed over the waste within the confined cell along with channels to divert water around the cell. The cell will have a bottom liner to prevent residual water within the waste from causing groundwater or surface water to exceed standards and to prevent groundwater from entering the LWA cell.

The primary elements of alternative SC2 are:

- Clearing and grading of the work area, including an additional lay-down area, and haul roads, as well as further construction of the haul roads;

- Installation of the temporary staging area, with liner, to hold the LWA waste to allow for construction of the horizontal underdrain and bottom liner;

- Potential mining of an estimated undeveloped 15 acres to obtain the necessary on-site stone and borrow material needed for developing the containment cells - restoration of the area when the removal is completed;

- Installation of surface water and shallow groundwater diversions as necessary to prevent the flow of surface water or groundwater into the LWA Cell or ORB cell;

- Excavation of approximately 29,000 cubic yards of material from the LWA area and temporary placement in the staging area to allow installation of the underdrain and bottom liner;

- Installation of a horizontal underdrain system to convey groundwater away from the LWA cell and liner;

- Installation of a full-bottom containment liner below the LWA Cell to ensure that groundwater and surface water are not adversely impacted by residual drainage from the waste material;

- Excavation of the UWA and consolidation in the LWA containment cell;

- Treatment of any water generated from the excavation activities, including the dewatering of sediments, saturated soil/waste, or residual drainage from the soil/waste using pH neutralization to create a neutral pH and filtration and or settling ponds/tanks to remove the metals;

- Dewatering of Ponds 4 and 5;

- Excavation of all contaminated sediment exceeding PRGs and any waste/soil that may be generating ARD from the Ponds 4 and 5 area;

- Restoration of Ponds 4 and 5 area as native wetland habitat;

- Construction of surface water drainage features to convey water from Ponds 4 and 5 and for the tributaries of Ely Brook that will be excavated;

- Use of minimally invasive extraction methods such as vacuum or hand removal of impacted fine-grained sediments in Upper Ely Brook;

- Restoration of Upper Ely Brook;

- Construction of a temporary surface water diversion and excavation of impacted sediments in Middle and Lower Ely Brook;

- Reconstruction of Middle Ely Brook, possibly as a rip-rap armored channel due to the expected slope of the channel;

- Restoration of Lower Ely Brook as a natural stream corridor;

- Consolidation of sediment with waste rock in the LWA Cell;

- Installation of a low-permeability cover system on the LWA Cell that meets relevant and appropriate mine reclamation and applicable risk-based standards to contain and isolate the waste rock and sediment;

- Excavation of the TA and layering of tailings on the ORB;

- Construction of a low permeability cover system that meets Vermont Solid Waste standards over the ORB and tailings with surface water diversion;

- Collection of leachate (for at least two years) and on-site treatment through treatment wetlands and/or settling basins and discharge to surface waters;

- Treatment of dewatering water from the excavation of UWA and LWA material, the sediment removal operations, or the TA consolidation into the ORB cell, with discharge to surface water;

- Protection of the historic retaining wall that is adjacent to the ORB;

- Restoration of the disturbed areas within the UWA, LWA, ORB, and TA;
- Endangered bat habitat mitigation measures, as required;
- Historic resource assessment and documentation via photographs, mapping, drawing, archaeological data recovery, and/or construction monitoring/recordation;
- Installation of monitoring wells;
- Long-term O&M;
- Use of institutional controls to protect the response action and prevent exposure to contaminants;
- Environmental monitoring to evaluate the performance of the cleanup action and to assess compliance with the institutional controls; and
- 5-year reviews.

Investigations and studies that may be necessary to support the design would consist of the following items:

- Topographic surveys of waste areas and sediment areas;
- Exploratory borings and/or test pits to determine depth to groundwater and bedrock west of Ely Brook and to determine suitability of soils as cover materials;
- Test pit surveys and a drilling program to determine the quantities and suitability of on-site materials for construction materials (e.g. stone, common fill), and the dewatering, and surface water and groundwater diversion requirements for temporary waste stockpiles;
- Analytical modeling for stormwater drainage design;

- Wetland delineation and an assessment of wetland mitigation requirements and design options;

- Geotechnical pre-design investigation(s), including an assessment of the structural integrity of the ORB retaining wall using test pits to determine the geometry of the wall and global stability analysis to determine the structural integrity of the ORB retaining wall and retaining wall near Ely Brook;

- Borings within the LWA and ORB to characterize physical properties and spatial variability of in-situ soils in cut/fill areas (excavations, construction traffic, settlement, dewatering, etc.);

- Historic resource assessments to evaluate the areas targeted for the LWA Cell and borrow area;

- Assess bat habitat mitigation measures, if required;

- Pre-excavation sampling to refine estimates of the extent of mine-related waste rock and tailings contamination exceeding PRGs; and

- Pre-dredge sampling to refine estimates of the extent of sediment contamination exceeding PRGs.

The following describes the primary elements of Alternative SC2 in more detail:

A staging/lay-down area will be required to temporarily stockpile the LWA material during containment cell construction. The staging area will be located partially on the ORB and partially to the east of the ORB. A stability assessment will be performed to avoid damaging the historic wall along the ORB. This approximate two-acre area will be cleared of trees and brush. In the event that a pre-design wetland delineation identifies protected wetlands in that area, an alternate location will be identified. The area will include a temporary liner to limit groundwater infiltration and potential impacts to the ORB and the overburden aquifer. A temporary leachate/runoff collection system in the form of a collection trench will be constructed on the

downslope edge of the stockpile to collect leachate and precipitation recharge draining from the stockpile. Water collected in the trench will be treated on-site and discharged to Ely Brook.

After construction of the staging area, the LWA will be excavated to the vertical and lateral extent of the source material (approximately 29,000 cy), essentially to the bedrock or till surface, and transported to the staging area. The excavated area in the LWA is expected to include approximately 3,000 linear feet of Ely Brook tributaries. Sampling would be performed to confirm that any soil remaining within the footprint of the excavation does not exceed the PRGs for cobalt, copper, or iron.

A horizontal underdrain system for the containment cell would be constructed prior to placing waste within the cell. The underdrain would be designed to prevent groundwater from flowing into the containment cell after the cell is completed. The underdrain system would likely consist of drain pipes surrounded by 2.5 feet of 4” stone (18,000 cy) enclosed in 10-ounce non-woven geotextile. To ensure adequate separation is achieved between the bottom liner in the containment cell and the underdrain, a base layer of approximately 5 feet of soil would be placed above the stone drain and below the bottom liner, requiring approximately 35,000 cy of additional borrow. Above the liner, approximately 6 inches of sand (3,500 cy) would be used to protect the liner from damage from the waste rock and allow drainage of leachate generated within the containment cell. The entire bottom liner will be constructed of 60-mil linear low density polyethylene (LDPE) or other suitable geosynthetic material as determined during the design.

An area of about 15 acres would need to be cleared and excavated to generate the on-site soil for the cover system for the LWA Cell. The area will be restored after the removal of the material.

Any surface water and shallow groundwater that could flow into the LWA Cell will be intercepted and conveyed around the LWA Cell by surface water channels or groundwater interceptor trenches. The current assumption is that approximately 2,100 linear feet of surface water diversion swales. These diversion measures may be integrated with the toe details surrounding the containment. Any federal jurisdictional wetlands impacted as a result of the construction of the LWA Cell will be mitigated.

The waste material within the UWA and LWA containing contaminant levels above the soil/waste PRGs and/or that is considered a source of ARD will be excavated and transported to the LWA Cell. An estimated 73,000 cubic yards of material will be removed from the UWA. This volume includes material within the 3,000 linear feet of Ely Brook tributaries within the UWA. If possible, the excavated material will be brought directly to the LWA Cell to limit the handling of the material. The material from Ponds 4 and 5 along with the sediments of Ely Brook will also be excavated and placed in the LWA Cell, as described below. Mine openings (i.e., shafts and adits) that are within the excavation area or exposed as a result of the excavation will be secured to protect public safety. The design of any measures associated with the mine openings will minimize any potential impact on bats.

A temporary cover system may be used to limit the infiltration of water into the waste once placed within the LWA Cell. The final cover system for the LWA Cell will be designed to limit the infiltration of waster and oxygen and prevent contact with the material. The components of the cover system are expected to include:

- A subgrade layer that would act as a buffer between the waste material and the geosynthetic cover. A minimum of six inches of a uniform fine grained sand or similar material is typically used for this layer. The subgrade is shaped to create an overall grade for the cover system that would cause water to run off the cover system to the perimeter channels and toe drains.

- The barrier layer would be a geosynthetic membrane, assumed to be a 60 mil LDPE geomembrane or other suitable geosynthetic material as determined during the design.

- Above the geomembrane will be a drainage layer, assumed to be a drainage geocomposite or 12 inch sand layer or other suitable geosynthetic material as determined during the design. This layer will allow the water that is intercepted by the barrier layer to flow to the outside of the LWA Cell.

- To protect the geosynthetic layers, approximately 18 inches of vegetative support soil VSS and 6 inches of topsoil will be placed over the geosynthetic layers. The topsoil will be seeded to promote vegetation, enhance slope stability, and reduce erosion.

Calculations based on porosity, saturated waste volume, and effective moisture content indicate that the drainage of saturated contaminated soil, waste rock, and sediments could generate up to 825,000 gallons of leachate after placement of this material within the LWA Cell. Based on the measured geotechnical soil parameters and hydraulic conductivity of the waste rock, it is estimated that residual saturation in the cell waste would drain within the first two years after placement within the LWA Cell, resulting in an average discharge rate of 0.8 GPM. The design will evaluate this water could degrade the groundwater below the LWA Cell or violate water quality standards if discharged to Ely Brook. The leachate could be acidic and contain elevated levels of metals. If necessary to further prevent adverse impacts to the groundwater and surface water within OU1, a leachate collection system would be installed along the downgradient toe edge of the cell to capture water draining from the waste. The collected leachate would then be treated using a pH adjustment and settling or filtration to remove the metals after pH adjustment. It is possible that a limestone-lined channel and treatment wetland or settling pond could also be used to treat the leachate before being discharged to Ely Brook.

An estimated 400 cubic yards of contaminated sediment will be removed from Ponds 4 and 5 and placed in the LWA Cell and covered along with the UWA and LWA material. Ponds 4 and 5 will drained by diverting the flow from Ponds 1-3 around Ponds 4 and 5 and using mechanical pumps to physically remove the water from Ponds 4 and 5. The areas formerly occupied by Ponds 4 and 5 will be restored a native wetland habitat. Downstream of this new wetland habitat, a natural channel will be installed to carry the flow to Ely Brook. Some portion of the channel may require a culvert to allow for an access road and may contain rip rap if the slope is steep.

The contaminated sediment within Upper Ely Brook will be removed by the least intrusive method possible to promote the maintenance of the existing natural channel and bottom substrate. Upper Ely Brook is a relatively high-energy depositional environment and contains a small volume of contaminated sediments, with less than 200 cy of contaminated sediments over 1,700 linear feet of stream channel. Rather than relying on bulk excavation, sediments in this reach will be removed using minimally invasive procedures such as vacuum extraction, hand-digging, or artificial flushing. Given the relatively small volume of contaminated sediments that require removal, this approach will greatly reduce impacts and disturbance to the natural drainage features and will provide for a more effective ecological restoration than would be possible with bulk excavation. After the removal of the contaminated sediment, Upper Ely

Brook will be surveyed to determine if sections require restoration. It is possible that clean sediment may be added, if necessary, to prevent channel destabilization.

The channels for the Middle and Lower sections of Ely Brook are filled with waste material and only physical excavation will remove the material. Surface water will be diverted around the section being excavated to minimize downstream transportation of sediment and reduce the water content of the excavated material. Check dams, coffer dams, mechanical pumps, and culverts may be used to convey the water from above the work zone to a suitable location downstream of the work zone during excavation and restoration work. Once the impacted sediment areas are dewatered, heavy equipment will be used to excavate the impacted sediment. The channel section would then be restored and the water will then be returned to the newly restored channel section. Work zones will be sequenced in a manner that ensures that upstream source areas are excavated initially and that work progresses downstream to the confluence with Schoolhouse Brook, thereby eliminating the potential for recontamination from mobilized upstream sediments. The remedial design will consider alternate work sequences that will allow for minimal surface water diversion structures.

Middle Ely Brook may need to be reconstructed as an armored rip-rap channel due to the relatively high-energy environment through this reach. The design will evaluate whether a more natural channel restoration would be possible.

Due to the low-energy depositional environment along Lower Ely Brook, it will be restored to a habitat hospitable to aquatic life and features typical of a New England cold water stream, such as pools, runs, riffles, cascades, and woody debris.

The waste material with the TA containing contaminant levels above the soil/waste PRGs and/or that is considered a source of ARD will be excavated and transported to the ORB. The tailings will be placed over the in-place ORB material. The design will determine optimal location within the ORB for the placement of the tailings. The FS assumed that the tailings will be placed within a discreet, 2-foot-thick zone that is approximately 60 feet long and 30 feet wide. A temporary cover system may be used to limit the infiltration of water into the waste once placed within the ORB Cell. The final cover system for the ORB Cell will be designed to limit the infiltration of waster and oxygen and prevent contact with the material and comply with the cover

required in the Vermont Solid Waste Management Rules for a mining waste. The components of the cover system are expected to include:

- A subgrade layer that would act as a buffer between the waste material and the geosynthetic cover. A minimum of six inches of a uniform fine grained sand or similar material is typically used for this layer. The subgrade for the ORB cell could be tailings. The subgrade is shapped to create an overall grade for the cover system that would cause water to run off the cover system to the perimeter channels and toe drains.

- The barrier layer would be a geosynthetic membrane, assumed to be a 60 mil LDPE geomembrane or other suitable geosynthetic material as determined during the design.

- Above the geomembrane will be a drainage layer, assumed to be a drainage geocomposite or 12 inch sand layer or other suitable geosynthetic material as determined during the design. This layer will allow the water that is intercepted by the barrier layer to flow to the outside of the ORB Cell.

- To protect the geosynthetic layers, approximately 18 inches of vegetative support soil VSS and 6 inches of topsoil will be placed over the geosynthetic layers. The topsoil will be seeded to promote vegetation, enhance slope stability, and reduce erosion.

- The cap will join the top of the existing retaining wall where exposed and key into the natural grade elsewhere.

A surface water diversion in the form of an interceptor trench (approximately 1,300 linear feet) will be constructed around the upslope edges of the cap to convey runoff around the cap and toward Lower or Middle Ely Brook.

The areas within the UWA and TA subject to excavation will be restored to minimize erosion of disturbed soil and promote ecological recovery of the area. The areas within the LWA outside the limits of the LWA cell will also be restored to minimize erosion of disturbed soil and promote ecological recovery of the area. Locations that are excavated to bedrock may be left as exposed bedrock. For other areas where the excavations terminate in glacial till, a 6-inch layer

of topsoil or other amendment will be placed over the disturbed area and then seeded with an appropriate seed mix.

A new access road would be required to access the LWA Cell during LTM; the existing road adjacent to the LWA will be destroyed during construction. The lower portions of the existing access road would be retained and connected with the required haul roads after excavation of the LWA to provide construction, maintenance, and long-term inspection/monitoring access to the area and the ORB containment cell.

Replacement/installation of a select number of shallow bedrock and overburden monitoring wells will be required to evaluate the competency of the containment cells. Existing monitoring wells damaged during remedial activities will be replaced if they are needed for long-term monitoring purposes.

To the extent the implementation of the cleanup has an adverse impact on historic resources a mitigation plan will be developed to address these impacts. For historic resources, the design will determine if further assessment and documentation will be necessary prior to implementation of the cleanup action. It is also possible that data recovery may be necessary for certain archaeological resources. Construction monitoring may also be included in the implementation plan. Post-cleanup mitigation measures could include the development of interpretive reports and development of public information.

To the extent the cleanup results in a permanent loss of State Class II or federal jurisdictional wetlands, a mitigation plan will be developed to create new wetland to compensate for the loss.

The design and implementation of the cleanup will also take into consideration any potential impact on bats. The cleanup plan will be developed and implemented to minimize and adverse impact on bats and to maintain any bat habitat to the extent possible. If adverse impacts are anticipated, then mitigation measures would be developed to off-set the potential impacts.

SC2 would require long-term O&M. Active operation of remedial facilities would not be required. Anticipated maintenance activities would be expected to include: periodic inspections; mowing and general upkeep erosion control; maintenance of surface water diversions and drainage structures to prevent/repair erosion damage; possible addition of media to the drainage swales

to promote continual pH buffering; and repair/replacement of damaged monitoring wells. Significant maintenance could be associated with the underdrain system for the LWA Cell. The management of the residual leachate from the excavated waste material is expected to be completed by the time the O&M period begins.

Environmental monitoring would be conducted during the waste rock and tailings excavations to document that the waste above soil PRGs and that may represent an ARD hazard has been removed. The monitoring will also be used to document that construction measures are successfully protecting Ely Brook and Schoolhouse Brook from erosion. Long-term environmental monitoring would also include collection of groundwater and surface water samples site-wide and biological monitoring to assess the containment of the closure cell and the effectiveness of the remedy. Groundwater elevation data would be collected at the time of sample collection to allow interpretation of the direction of groundwater flow. Field parameter measurements for dissolved oxygen, oxidation-reduction potential, pH, temperature, turbidity, and specific conductance would be made prior to sample collection.

Details of the monitoring program, including target monitoring wells, analytes, and quality assurance/quality control (QA/QC) protocols, would be specified in the OU1 Long-Term Monitoring (LTM) program.

An institutional control monitoring plan would be prepared as part of the OU1 LTM program[1]. The LTM would detail the land-use restrictions to be incorporated/referenced within the title for the property(ies) and will be recorded in a manner that meets State recordings standards for environmental restrictions. The plan would include a checklist of elements to be assessed during regularly scheduled on-site inspections. Annually scheduled inspections would be performed to confirm that land--use restrictions are implemented and adhered to as required to prevent disturbance of the components of the remedy.

Under §121(c) of CERCLA (42 USC § 9621(c)), any RA that results in contaminants remaining on-site (ORB and tailings) at concentrations above those allowing unlimited exposure and

[1] ICs to prevent use of contaminated groundwater under the OU1 areas will be established as part of an early action under OU2. It is likely one land use restriction will be created that will include both the applicable OU1 and OU2 IC restrictions.

unrestricted use must be reviewed at least once every five years. During five-year OU reviews, an assessment is made as to whether the implemented remedy continues to be protective of human health and the environment, or whether the implementation of additional RA is appropriate. The USEPA document Comprehensive Five-Year Review Guidance (USEPA, 2001) provides guidance on the performance of five-year reviews. The five-year review for this alternative is statutorily required. The five-year period will be triggered by the actual OU1 RA start date (USEPA, 2001).

4.2.1 Overall Protection of Human Health and the Environment

Alternative SC2 would protect human health by preventing direct contact or incidental ingestion of soil or waste containing cobalt, copper, or iron above levels acceptable for human exposure. The excavation and isolation of waste rock, tailings, partially-roasted ore, sediment, and soil above the OU1 PRGs in containment cells with multi-layer low-permeability caps would effectively prevent human contact with contaminants in OU1 areas of the Site. The low-permeability caps will prevent migration of OU1 contaminants into groundwater (which will facilitate the implementation of the final groundwater remedy for OU2). After completion of this remedy, direct contact and incidental ingestion of metals in contaminated soil will no longer be an unacceptable threat to human health.

Human contact with the sediment and surface water for the exposure scenarios evaluated in the HHRA were not considered to represent an unacceptable threat to human health.

Alternative SC2 would also protect the environment by eliminating the major sources of ARD. The excavation of UWA and LWA source material, followed by its consolidation and containment in a capped, low permeability closure cell would eliminate the interaction of water and oxygen with those mine wastes, thereby eliminating the discharge of ARD and metals to surface water. The ultimate effect of this waste containment remedy would be the restoration of OU1 surface water and sediment to levels below the ecological PRGs. The restoration of OU1 surface water would also prevent migration of COCs to downgradient sediment. The capping of the TA, in conjunction with surface drainage improvements at the ORB, would reduce the leaching of metals from the tailings to concentrations below the ecological PRGs.

Furthermore, SC2 would address the severe ecological risk to the benthic invertebrate community that exists due to OU1 sediments. The sediment component of SC2 would protect the benthic invertebrate community in Ely Brook, its tributaries, and Ponds 4 and 5 by removing metals contamination above the site-specific PRGs and arranging for proper disposal of this material beneath a low-permeability cap in a containment cell and restoring the habitats with clean materials to create a more hospitable environment.

To ensure the protectiveness of SC2, institutional controls would be implemented to prevent future use within the OU1 remedy area that would disturb the caps, surface water diversion systems, and monitoring wells.

4.2.2 Compliance with ARARs

Location-specific ARARs and TBCs triggered by Alternative SC2 are presented in Table 4-3.

In accordance with federal Executive Order 11990, entitled “Protection of Wetlands,” (as promulgated in relevant and appropriate regulations at 44 C.F.R. § 9) USEPA has determined that Alternative SC2 would result in unavoidable adverse impacts to federal jurisdictional wetlands and aquatic resources. SC2 would require the permanent disturbance of about 1.25 acres of severely impaired wetland habitat including middle Ely Brook and the portions of the Ely Brook tributaries that are located within the LWA. The permanent disturbance is required in order to protect the environment from the release of contamination at the Site. These wetlands were found to be toxic and unable to support aquatic life. The alternative will remove the contamination and restore Ely Brook and Ponds 4 and 5 to achieve Vermont Class B water quality standards. The Ely Brook tributaries have been historically altered as part of the mine development. To the extent possible, the tributaries will be restorated as aquatic habitat. For SC2, it is possible that some portions of EBT3 and EBT2 may need to be designed as engineered structures to convey water around the LWA Cell. Alternative SC2 may also result in some temporary impacts to wetlands that may require disturbance to implement this RA (sections of Ely Brook and its tributaries and Ponds 4 and 5). These areas will be restored to natural conditions after the removal of contaminated sediment. Every effort will be made to avoid impacts to State and federal jurisdictional wetlands. The design will include a detailed wetland assessment prior to any Site clearing activities. Impacted areas of Ely Brook will be reconstructed in kind (Lower Ely Brook) or as rip-rap armored channels (Middle Ely Brook and

discharge from Pond 5). Upper Ely Brook will require minimally invasive work and reconstruction will include replacement of fine-grain sediment with similarly sized sand. Ponds 4 and 5 will be restored as native wetland habitat. A new channel will be constructed from the outfall of Pond 5 to Ely Brook. A temporary staging/lay-down area will need to be constructed; however, it is anticipated that the area can be located in previously-disturbed areas to avoid impacting existing wetlands. OU1 wetland areas at the Site are shown in Figure 2-1 and potential areas of the SC2 wetland impacts are shown in Figure 4-1.

USEPA has evaluated the requirements of Section 404(b) of the Clean Water Act to identify the proposed actions that are the least environmentally damaging practicable alternatives to protect federally regulated wetland and aquatic resources from exposure to contaminated sediments and contaminated surface water. While SC2 meets the substantive standards of the Clean Water Act it has been determined not to be the least environmentally damaging practicable alternative since it relies on engineering controls to prevent waste permanently stored in the LWA Cell from being released to adjacent regulated wetland resources.

In accordance with federal Executive Order 11988, entitled “Floodplain Management,” (as promulgated in relevant and appropriate regulations at 44 C.F.R. § 9) USEPA has determined that SC2 can be implemented in a manner that will protect downstream floodplain resources. The standards will be achieved through the use of best management practices to address Site contaminant remediation, stream alterations, stormwater controls, and long-term O&M of the remedial components adjacent to the Site’s waterways.

Design and implementation of the SC2 alternative will also address measures that may be required to protect habitat for State and federally-listed endangered bat species in compliance with State and federal Endangered Species Acts and the federal Fish and Wildlife Coordination Act (which also requires coordination with federal and state officials concerning the alteration of wetland habitat resources).

Section 106 of the NHPA of 1966, as amended (16 USC 470f), requires USEPA to take into account the effects of all actions on historic properties, including archaeological sites that have been determined to be eligible for the National Register of Historic Places. USEPA has determined that the Site is eligible for listing in the National Register of Historic Places. USEPA has also determined that the construction activities required to implement this RA will have

unavoidable direct and indirect impacts on historic features, including archaeological sites, at the Site, but that these impacts are necessary to protect human health and the environment. The preliminary Area of Potential Effect (APE), as defined under the NHPA for direct effects is shown in Figure 4-1. The APE will be further defined to address indirect effects, cumulative effects and other effects as part of the design. The USEPA will work with the Vermont State Historic Protection Officer (SHPO) and other consulting parties to address minimize and mitigate any adverse effects to historic resources and archaeological sites.

State land use control and development standards under Vermont Act 250 would be met in the design and implementation of the SC2 alternative regarding regulated activities, including water and air pollution, protection of headwaters, waste disposal, floodways, streams, wetlands (including Vermont Class 3 wetlands not regulated under the Vermont Wetland Rules), soil erosion, historic sites, endangered species, and extraction of earth resources, energy conservation, and protecting public investments.

To the extent that remedial activities affect other protected resource areas, the location-specific ARARs in Table 4-3 will apply.

Chemical-specific ARARs and TBCs triggered by Alternative SC2 are presented in Table 4-4.

Chemical-specific TBCs were used to develop risk-based cleanup standards for soil and sediment and to create risk-based standards for the LWA Cell. This alternative would attain chemical-specific ARARs and TBCs.

Action-specific ARARs and TBCs that are triggered by Alternative SC2 are listed in Table 4-5.

It is expected that all activities can be designed and implemented to comply with action-specific ARARs, regarding the containment of OU1 contaminants, stormwater controls, water treatment/discharge standards, leachate collection and either off-site disposal or on-site treatment/discharge, Site monitoring, and institutional controls. Because the LWA Cell would only contain non-beneficiated waste rock, the cell would be exempt from Vermont Solid Waste Regulation requirements, but instead would be capped under federal Mine Reclamation and risk-based standards. Meanwhile, all of the flotation mill tailings and the partially-roasted ore, which are defined as beneficiated waste under the VTSWMR would be contained within a cover

system at the ORB that would comply with the regulations. These substantive requirements under these rules regulate the tailing wastes and roast bed material that were produced as part of the benefication of ore at the Site, but the rules do not apply to unprocessed waste rock. However, Section 6-1301(f) permits the waiver of technical and siting requirements of these rules provided there is a response action under CERCLA to a release or threatened release of hazardous substances or materials; and the proposed response action will not adversely affect public health, safety or the environment; and the technical and siting requirements will be complied with to the extent practical in light of the overall objectives of the response. In particular, liner requirements for disposal areas under § 1305(c)(2)(D) and (F) are waived. The remainder of § 6-1305 establishes the closure and post-closure performance standards that are applicable to the remedial action. That is, all facilities subject to closure requirements must be closed in a manner that: (a) Minimizes the need for further maintenance related to the waste facility; and (b) Controls, minimizes, or eliminates, to the extent necessary to prevent threats to public health and safety and the environment, including post-closure emission or discharge of waste, waste constituents, leachate, contaminated runoff, and/or waste decomposition products to the groundwater or surface waters or the atmosphere. Leachate for at least the first two years after the containment areas are completed will meet standards for collection and either off-site disposal or on-site treatment and discharge. Long-term monitoring of the waste management areas would include federal and state drinking/groundwater standards for monitoring groundwater, as well as federal and State surface water quality standards for monitoring Site waterways. The remediation of OU1 sediments would meet TBC standards under USEPA contaminated sediment guidance. Remediation throughout OU1 would meet State erosion control TBC guidance standards.

4.2.3 Long-Term Effectiveness and Permanence

With proper design, construction, and maintenance of the liner and cover system for the LWA Cell of SC2 would provide long-term effectiveness for minimizing infiltration of precipitation and runoff into the containment cells. However, the location of the LWA Cell at the lowest point of the Ely Brook drainage area presents potential long-term issues.

The LWA waste rock is located partially within the groundwater table and is dissected by numerous surface water channels. The construction of a waste cell, whose primary objective is to isolate waste rock from surface water and groundwater within the lowest point in a steep-

sided topographic drainage, presents distinct engineering challenges. To provide effective isolation of the waste, a high-transmissivity underdrain and separation barrier would be required to transport groundwater and surface water around the waste material. The performance of this underdrain would, therefore, be critical to ensuring the long-term effectiveness of the SC2 alternative. However, once constructed, inspections and maintenance of the underdrain would be very difficult and costly. Potential issues that might arise related to biofouling of the drain system or other reductions in transmissivity through the drain would be extremely difficult to correct or repair. A loss in transmissivity could allow the water table to rise again and come in contact with the bottom liner of the containment cell. If pinholes were present in the liner the waste material could be rewetted and metals would leach into the aquifer. If identified as necessary during the design, additional stabilization measures would be implemented as needed to achieve an acceptable factor of safety (FOS) for the containment cell slopes and retaining walls.

The cover system for the LWA cell and ORB cell would provide good long-term effectiveness and permanence. The cover systems would effectively prevent infiltration and direct contact. Routine maintenance would ensure that the effectiveness of the cover systems is maintained.

With proper design, removal, construction, and maintenance, the removal of impacted sediment would provide long-term effectiveness for minimizing future impacts to surface water. Impacted sediment will be isolated and contained, preventing human contact and impacts to ecological receptors.

4.2.4 Reduction of Toxicity, Mobility, and Volume through Treatment

SC2 would potentially only use limited treatment to accomplish the reduction of toxicity, mobility, and volume. Water removed from excavations or sediment dewatering may be treated prior to discharge back to OU1 waterways. Leachate from the containment areas may require treatment for at least the first two years of operation of the containment cells (potentially 825,000 gallons) prior to discharge to OU1 waterways (unless the leachate is shipped off-site without treatment). In addition limestone stone may be used as part of the sediment backfill to reduce the toxicity and mobility of ARD and metals.

4.2.5 Short-Term Effectiveness

The areas targeted for remediation under OU1 would achieve protection of human health and the environment upon completion of the cleanup activities for the soil, waste rock, tailings, roasted ore, and sediments. Furthermore, the conditions that result in unacceptable environment risks within Ely Brook and Ponds 4 and 5 would be eliminated upon completion of the cleanup. The time period to implement the cleanup, once design and administrative issues have been addressed, would be 2-4 years. Some potential for leachate discharge from the LWA containment cell would exist up to 2 years after capping, at which point the residual moisture within the contained wastes is expected to be reduced to a level that would result in an insignificant discharge from the leachate collection system. It is estimated that approximately 825,000 gallons of leachate will be generated in total and collected at an average rate of discharge of 0.8 GPM over the first 2 years. The collection system will be designed to minimize the uncontrolled discharge from the LWA Cell and collected leachate will either be or treated on site.

Alternative SC2 would require the excavation and dredging of large volumes of material with heavy construction equipment. These activities would present a potential risk to construction workers and may result in construction-related concerns (e.g., blasting, noise, and dust) from area residents. To minimize short-term risks to the community and area residents, Alternative SC2 would minimize the movement of construction equipment on the narrow and twisting roads approaching the Site. Most construction equipment (e.g., bulldozers, excavators, dredges) would be expected to remain on site and move on/off Site infrequently. All excavated/dredged material would be disposed of on site.

The conceptual design of SC2 requires approximately 93,000 cy of stone, borrow, and topsoil. These materials could be procured from local commercial operations, but would result in significant truck traffic in the vicinity of the Site with an estimated 5,150 truck trips. To reduce the generation of greenhouse gases and reduce short-term impacts associated with truck traffic, alternative SC2 will use on-site materials to provide the earthen materials required for the construction of access roads, closure cell components, and area restoration to the greatest extent practical. It is anticipated that substantial quantities of soil for use in the containment cells could be obtained on site. Since the footprint of the SC2 LWA Cell is not itself a source for clean fill, other on-site sources would need to be developed from previously undisturbed areas,

requiring the clearing of trees to access soil outside the UWA and LWA. Predesign investigations will be conducted to identify sources and provide estimates of available on-site materials. In a similar topographic and geologic setting at Elizabeth Mine, on-site borrow generation has yielded approximately 7,000 cy of common borrow per acre. Based on this quantity, a total estimated area of approximately 15 acres may need to be cleared to obtain the necessary on-site stone and borrow. These cleared areas will be reclaimed after completion of the cleanup.

While there may be some short-term impacts associated with the larger environmental footprint that would be required under this alternative, the on-site generation of borrow materials will eliminate the estimated 5,150 truck trips that would have resulted from outside procurement of these materials However, some increase in traffic would still be expected as a result of construction and material transport vehicles (e.g., rip-rap stone, geomembrane and geocomposite for cap construction, and media for treatment wetland), which would result in a short-term increase in traffic hazards and potential road impacts in the area. Predesign investigations would identify if on-site materials could be used as construction materials including separation layers, cap materials, and haul and access road construction. If on-site materials are used, the volume of truck traffic would be reduced significantly.

To further minimize short-term risks to the community and area residents, SC2 would also implement erosion and sediment control measures to prevent uncontrolled downstream transport of mobilized sediment during construction. Coffer dams, check dams, silt fences, and other control devices will be used on site to prevent migration off site. Dust control measures would also be implemented on site to minimize dust generation and airborne transport of contaminants. Best management practices will be implemented to ensure that the short-term alterations of the Site to not result in increased downstream flooding.

Short-term risks to the environment would include short-term loss of aquatic habitat as a result of excavation activities. Altered habitats will be restored to natural conditions to the extent practicable. The potential quarrying of on-site rock for use as containment cell construction material could impact small areas of existing upland habitat in the vicinity of the Site, although any altered area will be restored.

4.2.6 Implementability

Although traditional construction equipment and methods can be used in the implementation of this alternative, the requirement to construct the LWA Cell within a footprint that is located at the lowest point in a steep-sided topographic drainage presents distinct engineering challenges.

Furthermore, moving and consolidating waste rock and tailings as proposed poses the following issues that must be address as part of the implementation of this alternative:

- Haul roads will need to be constructed, a process that will include clearing and grading;
- Additional truck traffic will be created to import materials to the Site, including low-permeability soil;
- Increased truck traffic and construction activities may result in impacts to the community;
- Wetlands will be disturbed;
- A significant quantity of stone and fill (60,000 cy) are required to construct a high transmissivity underdrain system that will provide an effective barrier between consolidated waste rock and surface water/groundwater;
- The construction of the cell footprint, underdrain, and liner within the topographic drainage of Ely Brook will require robust temporary surface water diversions that are properly sized to handle significant peak storm flows;
- The proposed containment cell footprint is the current location of the LWA waste rock, and would, therefore, require that the LWA waste be excavated and placed on a temporary staging area that is constructed with a liner and leachate collection system;
- A fully contained bottom liner and leachate collection and treatment system (or the implementation of off-site disposal of collected leachate) will need to be constructed to facilitate the post-cap dewatering of the waste rock;

- Working on the steep slopes of UWA to remove waste rock may result in stability issues;

- There may be some stability concerns for the historic stone wall that borders the ORB due to the construction of the ORB's low-permeability cap;

- Waste excavation activities in the UWA, LWA, TA, ORB, and Ely Brook will impact historic resources and some construction activities will require historic resource data recovery and construction monitoring or observation; and

- Endangered bat habitat adjacent to the remediation area may require additional mitigation measures, including limitations on when work may be conducted. USEPA will need to consult with federal and state wildlife management officials to determine what mitigation measure may be required to protect the area's endangered bats.

For the most part, these limitations are considered reasonable and typical for the general construction objectives and can be overcome by using standard engineered solutions and implementing best management practices. However, the construction of a closure cell on a high-transmissivity underdrain and drainage barrier within the existing water table at the low point of a topographic drainage is non-standard and would require site-specific and specialized work practices, equipment, and materials.

The sediment cleanup components of SC2 are implementable, as all identified issues can be overcome by using engineered solutions and implementing best management practices. Traditional construction equipment and methods can be used in the removal of sediment in Ponds 4 and 5, Middle Ely Brook, Lower Ely Brook. Some specialized construction equipment may be used to remove the sediment in Upper Ely Brook using minimally invasive procedures. Traditional construction equipment and methods can be used to reconstruct the rip-rap armored channels; however, specialists in stream restoration design and construction are required for the Lower Ely Brook restoration.

Administrative implementability is expected to be good. Close communication and coordination with the landowners and environmental protection and natural resource agencies (e.g., Vermont Agency of Natural Resources (ANR), and U.S. Fish and Wildlife Service) would be necessary to establish institutional controls.

4.2.7 Cost

Table 4-6 presents a summary of the estimated present worth and total non-discounted costs to implement Alternative SC2. The present worth represents the amount of money that, if invested now and disbursed as needed, would be sufficient to cover costs associated with the RA over its planned life, whereas the total non-discounted costs estimate assumes that all costs are paid as they accrue. Both present worth and total costs estimates include direct and indirect capital costs; annual costs such as O&M, quarterly monitoring, and annual reporting; and periodic costs such as five-year reviews.

The present worth for SC2 based on a 7 percent discount rate and a 30-year duration is estimated to be $19,428,508. Appendices A and B contain additional cost assumptions and a detailed cost estimate for this alternative.

4.3 Alternative SC3 – Waste Containment in the West Cell and in the Ore Roast Bed

This subsection describes Alternative SC3 and evaluates the alternative using the first seven evaluation criteria of the NCP. Alternative SC3 would prevent human contact with soil/waste in the OU1 area that is above PRGs, prevent ARD formation within the UWA, LWA, and TA, and eliminate the toxic effect of the waste on the plant and soil communities which is creating the barren areas by isolating the soil/waste in a confined cell. The cell would be located to the west of Ely Brook, north of the historic mining village, and west of potential wetlands located surrounding Ely Brook. This cell, which will be referred to as the West Cell will have sufficient capacity to include the LWA, UWA, sediments from Ely Brook, its tributaries, and Ponds 4 and 5. Disturbed areas outside of the confined cell will be stabilized and restored. A cover system that will prevent contact of water and oxygen with the waste will be installed over the waste within the confined cell along with channels to divert water around the cell. The cell will have a bottom liner, if necessary to prevent residual water within the waste from causing groundwater or surface water to exceed standards. It is likely that some changes to the components described below will be required as a result of the performance of the remedial design.

The primary elements of this alternative are:

- Clearing and grading of the work area, including an additional lay-down area for the temporary stockpiling of clean earthen materials removed to create the West Cell (approximately 12 acres), and haul roads, as well as further construction of the haul roads;

- Potential mining of an estimated undeveloped 7.5 acres to obtain the necessary on-site stone and borrow material needed for developing the containment cells - restoration of the area when the removal is completed (unless all of the required material can be obtained from the clearing and development of the West Cell area);

- Installation of surface water and shallow groundwater diversions as necessary to prevent the flow of surface water or groundwater into the West Cell or ORB cell;

- Installation of a bottom containment liner below the West Cell, if necessary, to ensure that groundwater and surface water are not adversely impacted by residual drainage from the waste material;

- Excavation of the UWA and LWA and consolidation in an approximately 8.5-acre containment cell located to the west of Ely Brook (the West Cell);

- Treatment of any water generated from the excavation activities, including the dewatering of sediments, saturated soil/waste, or residual drainage from the soil/waste using pH neutralization to create a neutral pH and filtration and or settling ponds/tanks to remove the metals;

- Dewatering of Ponds 4 and 5;

- Excavation of all contaminated sediment exceeding PRGs and any waste/soil that may be generating ARD from the Ponds 4 and 5 area;

- Restoration of Ponds 4 and 5 area as native wetland habitat;

- Construction of surface water drainage features to convey water from Ponds 4 and 5 and for the tributaries of Ely Brook that will be excavated;

- Use of minimally invasive extraction methods such as vacuum or hand removal of impacted fine-grained sediments in Upper Ely Brook;

- Restoration of Upper Ely Brook;

- Construction of a temporary surface water diversion and excavation of impacted sediments in Middle and Lower Ely Brook;

- Reconstruction of Middle Ely Brook, possibly as a rip-rap armored channel due to the expected slope of the channel;

- Restoration of Lower Ely Brook as a natural stream corridor;

- Consolidation of sediment with waste rock in the West Cell;

- Installation of a low-permeability cover system on the West Cell that meets relevant and appropriate mine reclamation and applicable risk-based standards to contain and isolate the waste rock and sediment;

- Excavation of the TA and layering of tailings on the ORB;

- Construction of a low permeability cover system that meets Vermont Solid Waste standards over the ORB and tailings with surface water diversion;

- Collection of leachate (for at least two years) and on-site treatment through treatment wetlands and/or settling basins and discharge to surface waters;

- Treatment of dewatering water from the excavation of UWA and LWA material, the sediment removal operations, or the TA consolidation into the ORB cell, with discharge to surface water;

- Protection of the historic retaining wall that is adjacent to the ORB;
- Restoration of the disturbed areas within the UWA, LWA, ORB, and TA;
- Endangered bat habitat mitigation measures, as required;
- Historic resource assessment and documentation via photographs, mapping, drawing, archaeological data recovery, and/or construction monitoring/recordation;
- Installation of monitoring wells;
- Long-term O&M;
- Use of institutional controls to protect the response action and prevent exposure to contaminants;
- Environmental monitoring to evaluate the performance of the cleanup action and to assess compliance with the institutional controls; and
- 5-year reviews.

Investigations and studies that may be necessary to support the design would consist of the following items:

- Topographic surveys of waste areas and sediment areas;
- Exploratory borings and/or test pits to determine depth to groundwater and bedrock west of Ely Brook and to determine suitability of soils as cover materials and identify the best location for the West Cell;
- Test pit surveys and a drilling program to determine the quantities and suitability of on-site materials for construction materials (e.g. stone, common fill), and the dewatering, and surface water and groundwater diversion requirements for temporary waste stockpiles;

- Analytical modeling for stormwater drainage design;

- Wetland delineation and an assessment of wetland mitigation requirements and design options;

- Geotechnical pre-design investigation(s), including an assessment of the structural integrity of the ORB retaining wall using test pits to determine the geometry of the wall and global stability analysis to determine the structural integrity of the ORB retaining wall and retaining wall near Ely Brook;

- Borings within the LWA and ORB to characterize physical properties and spatial variability of in-situ soils in cut/fill areas (excavations, construction traffic, settlement, dewatering, etc.);

- Historic resource assessments to evaluate the areas targeted for the West cell and borrow area;

- Assess bat habitat mitigation measures, if required;

- Pre-excavation sampling to refine estimates of the extent of mine-related waste rock and tailings contamination exceeding PRGs; and

- Pre-dredge sampling to refine estimates of the extent of sediment contamination exceeding PRGs.

The following describes the primary elements of Alternative SC3 in more detail:

A staging/lay-down area will be required to temporarily stockpile the clean earthen materials and construction material during the construction of the West Cell. The staging area, which will be approximately 3.5 acres in area and is located adjacent to the former village (southeast of the West Cell location, will be cleared of trees and brush and graded to slope away from the West Cell, toward Lower Ely Brook. The 8.5 acre area for the West Cell will also be cleared of trees and brush.

An area of about 7.5 acres would need to be cleared and excavated to generate the on-site soil for the cover system for the West Cell. If possible, this material will be acquired within the footprint of the West Cell to minimize the overall environmental impact of the cleanup. If the area is located outside of the limits of the West Cell, the area will be restored.

Any surface water and shallow groundwater that could flow into the West Cell will be intercepted and conveyed around the West Cell by surface water channels or groundwater interceptor trenches. The current assumption is that a 1,025-linear-foot groundwater interceptor trench will be constructed along the upgradient boundary of the cell and along with approximately 1,480 linear feet of surface water diversion swales. These diversion measures may be integrated with the toe details surrounding the containment. Any federal jurisdictional wetlands impacted as a result of the construction of the West Cell will be mitigated.

The design will determine whether a bottom of the West Cell would include a liner to minimize groundwater intrusion into the waste material or to reduce the potential for leachate to percolate into the overburden or bedrock aquifers. It is possible that only a portion of the West Cell may need a liner if only a small percent of the waste material is expected to contain sufficient residual moisture to present a threat to surface water or groundwater.

The waste material within the UWA and LWA containing contaminant levels above the soil/waste PRGs and/or that is considered a source of ARD will be excavated and transported to the West Cell. An estimated 73,000 cubic yards of material will be removed from the UWA. An additional 29,000 cubic yards will be excavated and transported from the LWA. These volumes include material within the 5,000 linear feet of Ely Brook tributaries within the UWA and LWA. If possible, the excavated material will be brought directly to the West Cell to limit the handling of the material. If some of the material is too wet for placement, it may be mixed with material containing less moisture or set in a staging area within the West Cell that would be designed to manage excessively wet material. The material from Ponds 4 and 5 along with the sediments of Ely Brook will also be excavated and placed in the West Cell, as described below. Mine opening that are within the excavation area or exposed as a result of the excavation will be secured to protect public safety. The design of any measures associated with the mine openings will minimize any potential impact on bats.

A temporary cover system may be used to limit the infiltration of water into the waste once placed within the West Cell. The final cover system for the West Cell will be designed to limit the infiltration of waster and oxygen and prevent contact with the material. The components of the cover system are expected to include:

- A subgrade layer that would act as a buffer between the waste material and the geosynthetic cover. A minimum of six inches of a uniform fine grained sand or similar material is typically used for this layer. The subgrade is shaped to create an overall grade for the cover system that would cause water to run off the cover system to the perimeter channels and toe drains.

- The barrier layer would be a geosynthetic membrane, assumed to be a 60 mil LDPE geomembrane or other suitable geosynthetic material as determined during the design.

- Above the geomembrane will be a drainage layer, assumed to be a drainage geocomposite or 12 inch sand layer or other suitable geosynthetic material as determined during the design. This layer will allow the water that is intercepted by the barrier layer to flow to the outside of the West Cell.

- To protect the geosynthetic layers, an approximate 18 inches of vegetative support soil VSS and 6 inches of topsoil will be placed over the geosynthetic layers. The topsoil will be seeded to promote vegetation, enhance slope stability, and reduce erosion.

Calculations based on porosity, saturated waste volume, and effective moisture content indicate that the drainage of saturated contaminated soil, waste rock, and sediments could generate up to 825,000 gallons of leachate after placement of this material within the West Cell. Based on the measured geotechnical soil parameters and hydraulic conductivity of the waste rock, it is estimated that residual saturation in the cell waste would drain within the first two years after placement within the West Cell, resulting in an average discharge rate of 0.8 GPM. The design will evaluate this water could degrade the groundwater below the West Cell or violate water quality standards if discharged to Ely Brook. The leachate could be acidic and contain elevated levels of metals. If necessary to further prevent adverse impacts to the groundwater and surface water within OU1, a leachate collection system would be installed along the downgradient toe edge of the cell to capture water draining from the waste. The collected

leachate would then be treated using a pH adjustment and settling or filtration to remove the metals after pH adjustment. It is possible that a limestone-lined channel and treatment wetland or settling pond could also be used to treat the leachate before being discharged to Ely Brook.

An estimated 400 cubic yards of contaminated sediment will be removed from Ponds 4 and 5 and placed in the West Cell and covered along with the UWA and LWA material. Ponds 4 and 5 will drained by diverting the flow from Ponds 1-3 around Ponds 4 and 5 and using mechanical pumps to physically remove the water from Ponds 4 and 5. The areas formerly occupied by Ponds 4 and 5 will be restored a native wetland habitat. Downstream of this new wetland habitat, a natural channel will be installed to carry the flow to Ely Brook. Some portion of the channel may require a culvert to allow for an access road and may contain rip rap if the slope is steep.

The contaminated sediment within Upper Ely Brook will be removed by the least intrusive method possible to promote the maintenance of the existing natural channel and bottom substrate. Upper Ely Brook is a relatively high-energy depositional environment and contains a small volume of contaminated sediments, with less than 200 cy of contaminated sediments over 1,700 linear feet of stream channel. Rather than relying on bulk excavation, sediments in this reach will be removed using minimally invasive procedures such as vacuum extraction, hand-digging, or artificial flushing. Given the relatively small volume of contaminated sediments that require removal, this approach will greatly reduce impacts and disturbance to the natural drainage features and will provide for a more effective ecological restoration than would be possible with bulk excavation. After the removal of the contaminated sediment, Upper Ely Brook will be surveyed to determine if sections require restoration. It is possible that clean sediment may be added, if necessary, to prevent channel destabilization.

The channels for the Middle and Lower sections of Ely Brook are filled with waste material and only physical excavation will remove the material. Surface water will be diverted around the section being excavated to minimize downstream transportation of sediment and reduce the water content of the excavated material. Check dams, coffer dams, mechanical pumps, and culverts may be used to convey the water from above the work zone to a suitable location downstream of the work zone during excavation and restoration work. Once the impacted sediment areas are dewatered, heavy equipment will be used to excavate the impacted sediment. The channel section would then be restored and the water will then be returned to

the newly restored channel section. Work zones will be sequenced in a manner that ensures that upstream source areas are excavated initially and that work progresses downstream to the confluence with Schoolhouse Brook, thereby eliminating the potential for recontamination from mobilized upstream sediments. The remedial design will consider alternate work sequences that will allow for minimal surface water diversion structures.

Middle Ely Brook is likely to be reconstructed as an armored rip-rap channel due to the relatively high-energy environment through this reach. The design will evaluate whether a more natural channel, restoration would be possible.

Due to the low-energy depositional environment along Lower Ely Brook will be restored to a habitat hospitable to aquatic life and features typical of a New England cold water stream, such as pools, runs, riffles, cascades, and woody debris.

The waste material with the TA containing contaminant levels above the soil/waste PRGs and/or that is considered a source of ARD will be excavated and transported to the ORB. The tailings will be placed over the in-place ORB material. The design will determine optimal location within the ORB for the placement of the tailings. The FS assumed that the tailings will be placed within a discreet, 2-foot-thick zone that is approximately 60 feet long and 30 feet wide. A temporary cover system may be used to limit the infiltration of water into the waste once placed within the ORB Cell. The final cover system for the ORB Cell will be designed to limit the infiltration of waster and oxygen and prevent contact with the material and comply with the cover required in the Vermont Solid Waste Management Rules for a mining waste. The components of the cover system are expected to include:

- A subgrade layer that would act as a buffer between the waste material and the geosynthetic cover. A minimum of six inches of a uniform fine grained sand or similar material is typically used for this layer. The subgrade for the ORB cell could be tailings. The subgrade is shaped to create an overall grade for the cover system that would cause water to run off the cover system to the perimeter channels and toe drains.

- The barrier layer would be a geosynthetic membrane, assumed to be a 60 mil LDPE geomembrane or other suitable geosynthetic material as determined during the design.

- Above the geomembrane will be a drainage layer, assumed to be a drainage geocomposite or 12 inch sand layer or other suitable geosynthetic material as determined during the design). This layer will allow the water that is intercepted by the barrier layer to flow to the outside of the ORB Cell.

- To protect the geosynthetic layers, an approximate 18 inches of vegetative support soil VSS and 6 inches of topsoil will be placed over the geosynthetic layers. The topsoil will be seeded to promote vegetation, enhance slope stability, and reduce erosion.

- The cap will join the top of the existing retaining wall where exposed and key into the natural grade elsewhere.

A surface water diversion in the form of an interceptor trench (approximately 1,300 linear feet) will be constructed around the upslope edges of the cap to convey runoff around the cap and toward Lower or Middle Ely Brook.

The areas within the UWA, LWA, and TA subject to excavation will be restored to minimize erosion of disturbed soil and promote ecological recovery of the area. Locations that are excavated to bedrock may be left as exposed bedrock. For other areas where the excavations terminate in glacial till, a 6-inch layer of topsoil or other amendment will be placed over the disturbed area and then seeded with an appropriate seed mix.

A new access road would be required to access the West Cell during LTM. The existing access road would be retained and connected with the required haul roads after excavation of the LWA to provide construction, maintenance, and long-term inspection/monitoring access to the area and the ORB containment cell.

Replacement/installation of a select number of shallow bedrock and overburden monitoring wells will be required to evaluate the competency of the containment cell. Existing monitoring wells damaged during remedial activities will be replaced if they are needed for long-term monitoring purposes.

To the extent the implementation of the cleanup has an adverse impact on historic resources a mitigation plan will be developed to address these impacts. For historic resources, the design

will determine if further assessment and documentation will be necessary prior to implementation of the cleanup action. It is also possible that data recovery may be necessary for certain archaeological resources. Construction monitoring may also be included in the implementation plan. Post-cleanup mitigation measures could include the development of interpretive reports and development of public information.

To the extent the cleanup results in a permanent loss of State Class II or federal jurisdictional wetlands, a mitigation plan will be developed to create new wetland to compensate for the loss.

The design and implementation of the cleanup will also take into consideration any potential impact on bats. The cleanup plan will be developed and implemented to minimize and adverse impact on bats and to maintain any bat habitat to the extent possible. If adverse impacts are anticipated, then mitigation measures would be developed to off-set the potential impacts.

SC3 would require minimal long-term O&M. Active operation of remedial facilities would not be required. Anticipated maintenance activities would be expected to include: periodic inspections; mowing and general upkeep erosion control; maintenance of surface water diversions and drainage structures to prevent/repair erosion damage; possible addition of media to the drainage swales to promote continual pH buffering; and repair/replacement of damaged monitoring wells. The management of the residual leachate from the excavated waste material is expected to be completed by the time the O&M period begins.

Environmental monitoring would be conducted during the waste rock and tailings excavations to document that the waste above soil PRGs and that may represent an ARD hazard has been removed. The monitoring will also be used to document that construction measures are successfully protecting Ely Brook and Schoolhouse Brook from erosion. Long-term environmental monitoring would also include collection of groundwater and surface water samples site-wide and biological monitoring to assess the containment of the closure cell and the effectiveness of the remedy. Groundwater elevation data would be collected at the time of sample collection to allow interpretation of the direction of groundwater flow. Field parameter measurements for dissolved oxygen, oxidation-reduction potential, pH, temperature, turbidity, and specific conductance would be made prior to sample collection.

Details of the monitoring program, including target monitoring wells, analytes, and QA/QC protocols, would be specified in the OU1 LTM.

An institutional control monitoring plan would be prepared as part of the OU1 LTM program[2]. The LTM would detail the land-use restrictions to be incorporated/referenced within the title for the property(ies) and will be recorded in a manner that meets State recordings standards for environmental restrictions. The plan would include a checklist of elements to be assessed during regularly scheduled on-site inspections. Annually scheduled inspections would be performed to confirm that land--use restrictions are implemented and adhered to as required to prevent disturbance of the components of the remedy.

Under §121(c) of CERCLA (42 USC § 9621(c)), any RA that results in contaminants remaining on-site at concentrations above those allowing unlimited exposure and unrestricted use must be reviewed at least once every five years. During five-year site reviews, an assessment is made as to whether the implemented remedy continues to be protective of human health and the environment, or whether the implementation of additional RA is appropriate. The USEPA document Comprehensive Five-Year Review Guidance (USEPA, 2001) provides guidance on the performance of five-year reviews. The five-year review for this alternative would be statutorily required. The five-year period will be triggered by the actual OU1 RA start date (USEPA, 2001).

4.3.1 Overall Protection of Human Health and the Environment

Alternative SC3 would protect human health by preventing direct contact or incidental injection of soil or waste containing cobalt, copper, or iron above levels acceptable for human exposure. The excavation and isolation of waste rock, tailings, partially-roasted ore, and soil above the OU1 PRGs in containment cells with multi-layer low-permeability caps would effectively prevent human contact with these waste materials in OU1 areas of the Site. After completion of this remedy, direct contact and incidental ingestion of metals would no longer be an unacceptable threat to human health.

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[2] ICs to prevent use of contaminated groundwater under the OU1 areas will be established as part of an early action under OU2. It is likely one land use restriction will be created that will include both the applicable OU1 and OU2 IC restrictions.

Alternative SC3 would also protect the environment by eliminating the major sources of ARD and copper in the sediment that exceeds ecological PRGs. The excavation of UWA and LWA source material, followed by its consolidation and containment in a capped closure cell would prevent the interaction of water and oxygen with those mine wastes, thereby eliminating the discharge of ARD and metals to groundwater and surface water. The ultimate effect of this waste containment remedy would be the restoration of OU1 surface water and sediment COC concentrations to levels below PRGs. The restoration of OU1 surface water would also prevent migration of COCs to downgradient (OU2) sediment. The capping of the TA, in conjunction with surface drainage improvements at the ORB would reduce the leaching of metals from the tailings to concentrations below PRGs.

SC3 would address the severe ecological risk to the benthic invertebrate community exists due to OU1 sediments. The sediment component of SC3 would protect the benthic invertebrate community in Ely Brook and Ponds 4 and 5 by removing metals contamination above the OU1 PRGs and arranging for proper disposal of this material beneath a low-permeability cap in the West Cell and restoring the habitats with clean materials to create a more hospitable environment.

To ensure the protectiveness of SC3, institutional controls would be implemented to prevent future use within the OU1 remedy area that would disturb the cap, wetland treatment areas, surface water diversion systems, and monitoring wells.

4.3.2 Compliance with ARARs

Location-specific ARARs and TBCs triggered by Alternative SC3 are presented in Table 4-7.

In accordance with federal Executive Order 11990, entitled “Protection of Wetlands,” (as promulgated in relevant and appropriate regulations at 44 C.F.R. § 9) USEPA has determined that Alternative SC3 would result in unavoidable adverse impacts to federal jurisdictional wetlands and aquatic resources. SC3 would require the permanent disturbance of about 0.92 acres of severely impaired wetland habitat including middle Ely Brook and any wetlands located within the footprint of the West Cell. The permanent disturbance is required in order to protect the environment from the release of contamination at the Site. Middle Ely Brook was found to be toxic and unable to support aquatic life. The alternative will remove the contamination and

restore Ely Brook and Ponds 4 and 5 to achieve Vermont Class B water quality standards. The Ely Brook tributaries have been historically altered as part of the mine development. To the extent possible, the tributaries will be restorated as aquatic habitat. For SC3, it is possible that some portions of EBT3 and EBT2 will be restored in kind in the LWA. Alternative SC3 may also result in some temporary impacts to wetlands that may require disturbance to implement this RA (sections of Ely Brook and its tributaries and Ponds 4 and 5). These areas will be restored to natural conditions after the removal of contaminated sediment. Every effort will be made to avoid impacts to State and federal jurisdictional wetlands. The design will include a detailed wetland assessment prior to any Site clearing activities. Impacted areas of Ely Brook will be reconstructed in kind (Lower Ely Brook) or as rip-rap armored channels (Middle Ely Brook and discharge from Pond 5). Upper Ely Brook will require minimally invasive work and reconstruction will include replacement of fine-grain sediment with similarly sized sand. Ponds 4 and 5 will be restored as native wetland habitat. A new channel will be constructed from the outfall of Pond 5 to Ely Brook. A temporary staging/lay-down area will need to be constructed; however, it is anticipated that the area can be located outside of existing wetland areas. OU1 wetland areas at the Site are shown in Figure 2-1 and potential areas of the SC3 wetland impacts are shown in Figure 4-2.

USEPA has evaluated the requirements of Section 404(b) of the Clean Water Act to identify the proposed actions that are the least environmentally damaging practicable alternatives to protect federally regulated wetland and aquatic resources from exposure to contaminated sediments and contaminated surface water. Alternative SC3 meets the substantive standards of the Clean Water Act and it has been determined to be the least environmentally damaging practicable alternative since it will consolidate all of the Site contamination from the UWA, LWA, and waterways in upland areas that are not immediately adjacent to Site waterways as opposed to SC2. Therefore, the protectiveness of the remedy is not reliant on maintaining engineering controls in an area with significant implementability challenges such as SC2. Removal of all contaminated material off-site under Alternative SC4 is not as practicable as SC3 due to the volume of contaminated material that would require removal.

In accordance with federal Executive Order 11988, entitled “Floodplain Management,” (as promulgated in relevant and appropriate regulations at 44 C.F.R. § 9) USEPA has determined that SC3 can be implemented in a manner that will protect downstream floodplain resources. The standards will be achieved through the use of best management practices to address Site

contaminant remediation, stream alterations, stormwater controls, and long-term O&M of the remedial components adjacent to the Site's waterways.

Design and implementation of the SC3 alternative will also address measures that may be required to protect habitat for State and federally-listed endangered bat species in compliance with State and federal Endangered Species Acts and the federal Fish and Wildlife Coordination Act (which also requires coordination with federal and state officials concerning the alteration of wetland habitat resources).

Section 106 of the NHPA of 1966, as amended (16 USC 470f), requires USEPA to take into account the effects of all actions on historic properties, including archaeological sites that have been determined to be eligible for the National Register of Historic Places. USEPA has determined that the Site is eligible for listing in the National Register of Historic Places. USEPA has also determined that the construction activities required to implement this RA will have unavoidable direct and indirect impacts on historic features, including archaeological sites, at the Site, but that these impacts are necessary to protect human health and the environment. The preliminary APE, as defined under the NHPA for direct effects is shown in Figure 4-2. The APE will be further defined to address indirect effects, cumulative effects and other effects as part of the design. The USEPA will work with the Vermont SHPO and other consulting parties to address minimize and mitigate any adverse effects to historic resources and archaeological sites.

State land use control and development standards under Vermont Act 250 would be met in the design and implementation of the SC3 alternative regarding regulated activities, including water and air pollution, protection of headwaters, waste disposal, floodways, streams, wetlands (including Vermont Class 3 wetlands not regulated under the Vermont Wetland Rules), soil erosion, historic sites, endangered species, and extraction of earth resources, energy conservation, and protecting public investments..

To the extent that remedial activities affect other protected resource areas, the location-specific ARARs in Table 4-7 will apply.

Chemical-specific ARARs and TBCs triggered by Alternative SC3 are presented in Table 4-8.

Chemical-specific TBCs were used to develop risk-based cleanup standards for soil and sediment and to create risk-based standards for the West Cell. This alternative would attain chemical-specific ARARs and TBCs.

Action-specific ARARs and TBCs that are triggered by Alternative SC3 are listed in Table 4-9.

It is expected that all activities can be designed and implemented to comply with action-specific ARARs, regarding the containment of OU1 contaminants, stormwater controls, water treatment/discharge standards, leachate collection and either off-site disposal or on-site treatment/discharge, Site monitoring, and institutional controls. Because the West Cell would only contain non-beneficiated waste rock, the cell would be exempt from Vermont Solid Waste Regulation requirements, but instead would be capped under federal Mine Reclamation and risk-based standards. Meanwhile, all of the flotation mill tailings and the partially-roasted ore, which are defined as beneficiated waste under the VTSWMR would be contained within a cover system at the ORB that would comply with the regulations. These substantive requirements under these rules regulate the tailing wastes and roast bed material that were produced as part of the benefication of ore at the Site, but the rules do not apply to unprocessed waste rock. However, Section 6-1301(f) permits the waiver of technical and siting requirements of these rules provided there is a response action under CERCLA to a release or threatened release of hazardous substances or materials; and the proposed response action will not adversely affect public health, safety or the environment; and the technical and siting requirements will be complied with to the extent practical in light of the overall objectives of the response. In particular, liner requirements for disposal areas under § 1305(c)(2)(D) and (F) are waived. The remainder of § 6-1305 establishes the closure and post-closure performance standards that are applicable to the remedial action. That is, all facilities subject to closure requirements must be closed in a manner that: (a) Minimizes the need for further maintenance related to the waste facility; and (b) Controls, minimizes, or eliminates, to the extent necessary to prevent threats to public health and safety and the environment, including post-closure emission or discharge of waste, waste constituents, leachate, contaminated runoff, and/or waste decomposition products to the groundwater or surface waters or the atmosphere. Leachate for at least the first two years after the containment areas are completed will meet standards for collection and either off-site disposal or on-site treatment and discharge. Long-term monitoring of the waste management areas would include federal and state drinking/groundwater standards for monitoring groundwater, as well as federal and State surface water quality standards for

monitoring Site waterways. The remediation of OU1 sediments would meet TBC standards under USEPA contaminated sediment guidance. Remediation throughout OU1 would meet State erosion control TBC guidance standards.

4.3.3 Long-Term Effectiveness and Permanence

With proper design, construction, and maintenance, the low-permeability cover systems for the West and ORB Cells of SC3 will provide long-term effectiveness by minimizing infiltration of precipitation and runoff into the containment cells. If identified as necessary during the design, additional stabilization measures would be implemented as needed to achieve an acceptable FOS for the containment cell slopes and retaining wall at the ORB. With proper design, removal, construction, and maintenance, the removal of impacted sediment would provide long-term effectiveness for minimizing future impacts to surface water. Impacted sediment will be isolated and contained, preventing human contact and impacts to ecological receptors.

4.3.4 Reduction of Toxicity, Mobility, and Volume through Treatment

SC3 potentially only uses limited treatment to accomplish the reduction of toxicity, mobility, and volume. Water removed from excavations or sediment dewatering may be treated prior to discharge back to OU1 waterways. Leachate from the containment areas may require treatment using treatment wetlands and/or settling basins for potentially the first two years after placement (potentially 825,000 gallons) prior to discharge to OU1 waterways. Limestone stone/sediments may be added to waterways to reduce the toxicity and mobility of ARD and metals.

4.3.5 Short-Term Effectiveness

The areas targeted for remediation under Alternative SC3 would achieve protection of human health and the environment upon completion of the cleanup activities for the soil, waste rock, tailings, partially-roasted ore, and sediments. Furthermore, the conditions that result in unacceptable environment risks within Ely Brook and Ponds 4 and 5 would be eliminated upon completion of the cleanup. The time period to implement the cleanup, once design and administrative issues have been addressed, would be 2-4 years. Some potential for leachate discharge from the containment cells would exist up to 2 years after capping, at which point the

residual moisture within the contained wastes is expected to be reduced to a level that would result in an insignificant discharge from the leachate collection system. It is estimated that approximately 825,000 gallons of leachate will be generated in total and collected at an average rate of discharge of 0.8 GPM over the first 2 years. The collection system will be designed to minimize the uncontrolled discharge from the containment cell and collected leachate will be treated on site before being discharged to Middle Ely Brook.

Alternative SC3 would require the excavation and dredging of large volumes of material with heavy construction equipment. These activities would present a potential risk to construction workers and may result in construction-related concerns (e.g., blasting, noise, and dust) from area residents. To minimize short-term risks to the community and area residents, Alternative SC3 would minimize the movement of construction equipment on the narrow and twisting roads approaching the Site. Most construction equipment (e.g., bulldozers, excavators, dredges) would be expected to remain on site and move on/off site infrequently. All excavated/dredged material would be disposed of on site.

The conceptual design of SC3 requires approximately 52,000 cy of stone, borrow, and topsoil. If an on-site source of material is not available, these materials could be procured from local commercial operations requiring significant truck traffic in the vicinity of the site with an estimated 2,901 truck trips. To reduce the generation of greenhouse gases and reduce short-term impacts associated with truck traffic, Alternative SC3 will use on-site materials to provide the earthen materials required for the construction of access roads, closure cell components, and area restoration to the greatest extent practical. It is anticipated that substantial quantities of soil for use in the containment cells could be obtained on-site. Predesign investigations would be conducted to identify sources and provide estimates of available material. The conceptual design of SC3 requires approximately 52,000 cy of stone, borrow, and topsoil. Generating this material from on-site sources for SC3 would eliminate an estimated 2,901 truck trips.

Because the West Cell would be constructed outside of the UWA and LWA, the soils within the footprint of the West Cell and the associated staging area are potential sources for clean fill. Predesign investigations will be conducted to identify additional sources and provide estimates of available material. In a similar topographic and geologic setting at Elizabeth Mine, located in Strafford, VT where a similar remedial action was implemented, on-site borrow generation has

yielded approximately 7,000 cy of common borrow per acre. Based on this quantity, an area of approximately 7.5 acres would be cleared to obtain on-site stone and borrow. Based on the estimated 12-acre footprint for the construction of the West Cell and lay-down area, it is possible that all the required borrow needed for alternative SC3 could be generated without additional clearing of forested areas. This would result in a total estimated area of disturbance for the West Cell of approximately 12 acres of vegetated forest.

While the on-site generation of needed borrow materials would eliminate the estimated 2,901 truck trips, some increase in traffic would still be respected as a result of construction and material transport vehicles (e.g., geomembrane and geocomposite for cap construction, and media for treatment wetland), which would result in a short-term increase in traffic hazards and potential road impacts in the area. Predesign investigations would identify if on-site materials could be used as construction materials including separation layers, cap materials, and haul and access road construction. If on-site materials are used, the volume of truck traffic would be reduced significantly.

To further minimize short-term risks to the community and area residents, Alternative SC3 would also implement erosion and sediment control measures to prevent uncontrolled downstream transport of mobilized sediment during construction. Coffer dams, check dams, silt fence, and other control devices will be used on site to prevent migration off site. Dust control measures would be implemented on-site to minimize dust generation and airborne transport of contaminants. Best management practices will be implemented to ensure that the short-term alterations of the Site to not result in increased downstream flooding.

Short-term risks to the environment would include short-term loss of aquatic habitat as a result of excavation activities. Altered habitats will be restored to natural conditions to the extent practicable.

4.3.6 Implementability

Traditional construction equipment and methods can be used in the implementation of this alternative. Moving and consolidating waste rock and tailings as proposed poses the following issues that must be addressed as part of the implementation of this alternative:

- Haul roads will need to be constructed, a process that includes clearing and grading;
- Additional truck traffic will be created to import materials to the Site, including low-permeability soil;
- Increased truck traffic and construction activities may result in impacts to the community;
- Wetlands will be disturbed;
- Working on the steep slopes of UWA to remove waste rock may result in stability issues;
- Stability issues related to working on steep slopes to construct the consolidation cell;
- Construction of a fully contained bottom liner and leachate collection and treatment wetland system to facilitate the post-cap dewatering of the waste rock;
- There may be some stability concerns for the historic stone wall that borders the ORB due to the construction of the ORB's low-permeability cap;
- Waste excavation activities in the UWA, LWA, TA, ORB, and Ely Brook will impact historic resources and some construction activities will require historic resource data recovery and construction monitoring or observation; and
- Endangered bat habitat adjacent to the remediation area may require additional mitigation measures, including limitations on when work may be conducted.

These issues are considered reasonable and typical for the general construction objectives. They can be overcome using standard engineered solutions and implementing best management practices.

The sediment cleanup components of SC3 are also implementable, as all identified issues can be overcome by using engineered solutions and implementing best management practices. Traditional construction equipment and methods can be used in the removal of sediment in Ponds 4 and 5, Middle Ely Brook, and Lower Ely Brook. Some specialized construction

equipment may be used to remove the sediment in Upper Ely Brook using minimally invasive procedures. Traditional construction equipment and methods can be used to reconstruct the rip-rap armored channels; however, specialists in stream restoration design and construction are required for Lower Ely Brook restoration.

Administrative implementability is expected to be good. Close communication and coordination with the landowners, and environmental protection and natural resource agencies (e.g., Vermont ANR, U.S. Fish and Wildlife Service) would be necessary to establish institutional controls.

4.3.7 Cost

Table 4-10 presents a summary of the estimated present worth and total non-discounted costs to implement Alternative SC3. The present worth represents the amount of money that, if invested now and disbursed as needed, would be sufficient to cover costs associated with the RA over its planned life, whereas the total non-discounted costs estimate assumes that all costs are paid as they accrue. Both present worth and total costs estimates include direct and indirect capital costs; annual costs such as O&M, quarterly monitoring, and annual reporting; and periodic costs such as five-year reviews.

The present worth for Alternative SC3 based on a 7 percent discount rate and a 30-year duration is estimated to be $17,472,278. Appendices A and B contain additional cost assumptions and a detailed cost estimate for this alternative.

4.4 Alternative SC4 – Off-Site Disposal and Waste Containment in the Ore Roast Bed

This subsection describes Alternative SC4, provides a cost estimate, and evaluates the alternative using the first seven evaluation criteria of the NCP. Alternative SC4 would prevent contact with soil/waste above PRGs and prevent ARD by removing the waste rock and sediments from OU1 and transporting the material to an off-site disposal facility. It is assumed for the purposes of this FS that the off-site disposal facility is located in Vermont. The UWA and LWA, along with sediments in Ely Brook and Ponds 4 and 5 would be excavated and loaded into lined trucks/trailers and transported over local roads to a licensed disposal facility for permanent disposal. The alternative also includes preparing the ORB area; excavation of the

TA; layering of the tailings over the ORB material; and installation of a low-permeability cover system meeting Vermont Solid Waste standards to contain and isolate the tailings and ORB material.

Additional components include institutional controls to prevent disturbance to the components of the remedy, environmental monitoring, and five-year reviews to control potential human-health and ecological risks due to exposure to contaminated waste material. Further discussion of these features is included below.

The primary elements of this alternative are:

- Excavation of the UWA and LWA and loading of excavated materials into lined trucks/trailers for transportation to a licensed disposal facility;

- Dewatering and excavation of the Ponds 4 and 5 Area to include all observed impacted sediment;

- Restoration of the Ponds 4 and 5 Area as native wetlands habitat;

- Restoration of EBT2 from the outfall of Pond 5 to the confluence with Ely Brook;

- Use of minimally invasive extraction methods, such as vacuum or hand removal of impacted fine-grained sediments, in Upper Ely Brook;

- Treatment of dewatering water from the excavation of UWA and LWA material, the sediment removal operations, or the TA consolidation into the ORB cell, with discharge to surface water;

- Restoration of Upper Ely Brook in kind with sediment of similar grain size, including some limestone sediment to assist in buffering any contributing acidic groundwater infiltration;

- Construction of a temporary surface water diversion to excavate impacted sediments in Middle and Lower Ely Brook;

- Reconstruction of Middle Ely Brook as a rip-rap armored channel;
- Restoration of Lower Ely Brook to its current condition and habitat;
- Excavation of the TA and layering of tailings on the ORB;
- Construction of a low-permeability cover system meeting Vermont Solid Waste standards over the ORB and tailings with surface water diversion;
- Bat habitat mitigation measures, if required;
- Protection of the historic retaining wall that is adjacent to the ORB;
- Installation of monitoring wells;
- Use of institutional controls to protect the response action and prevent exposure to contaminants;
- Long-term O&M;
- Environmental monitoring to evaluate compliance with the institutional controls; and
- 5-year reviews.

Pre-design investigations and studies would consist of the following items:

- Topographic surveys of waste areas and sediment areas;
- Analytical modeling for stormwater drainage design;
- Wetland delineation and an assessment of wetland mitigation requirements and design options;

- Geotechnical pre-design investigation(s), including an assessment of the structural integrity of the ORB retaining wall using test pits to determine the geometry of the wall and global stability analysis to determine the structural integrity of the ORB retaining wall and retaining wall near Ely Brook;

- Borings within the LWA and ORB to characterize physical properties and spatial variability of in-situ soils in cut/fill areas (excavations, construction traffic, settlement, dewatering, etc.);

- Historic resource documentation via photographs, mapping, drawing, archaeological data recovery, and/or construction monitoring/recordation;

- Assess bat habitat mitigation measures, if required;

- Pre-excavation sampling to refine estimates of the extent of mine-related waste rock and tailings contamination exceeding PRGs; and

- Pre-dredge sampling to refine estimates of the extent of sediment contamination exceeding PRGs.

The following summarizes the primary elements of Alternative SC4:

The UWA and LWA will be excavated and loaded into lined trucks/trailers for transportation to an off-site facility for permanent disposal. The total volume of waste requiring disposal at the Site is approximately 107,000 cy (139,100 cy with a 30 percent swell factor). Each truck load has an estimated capacity of 14 cy for typical tri-axle dump trucks to 18 cy for trailer-body dump trucks, resulting in approximately 7,400 to 9,500 truck loads. Analytical testing would be required throughout the process of loading and transporting the material to ensure compliance at the disposal facility. Typically, waste characterization is required for every 200 tons of material disposed; therefore, at 1.41 tons per cy, based on geotechnical density analysis performed in 2009, approximately 187,000 tons of waste material will require approximately 935 samples to be analyzed over the duration of the work.

Dewatering of Ponds 4 and 5 will require constructing a temporary surface water diversion from the outfall of Pond 3 to Ely Brook and using mechanical pumps to physically remove the water from Ponds 4 and 5 and divert surface water drainage and flow from EBT2. Following removal and an acceptable time period to allow for some degree of sediment dewatering, heavy equipment would be used to excavate the impacted sediments located on the pond-bottom and side walls, as well as sediment in the channel that flows from the Pond 5 outfall to Ely Brook. It is noted that some of this channel will already have been excavated during the excavation of the LWA, which is where the channels lies. Dewatering and treatment prior to disposal will be required throughout the process to handle infiltrating groundwater and ongoing surface water drainage.

Once the sediments are excavated, dewatered, and transported off-site, the Ponds 4 and 5 Area will be restored to native wildlife habitat. A permanent channel will be constructed extending from the outfall of Pond 5 to a terminus near the EBT2 confluence with Ely Brook. The channel will be armored with rip-rap and will pass through culverts at access and haul road crossings to minimize impacts to the channel during construction activities and future use of the Site.

Upper Ely Brook is a relatively high-energy depositional environment and contains a small volume of contaminated sediments, with less than 200 cy of contaminated sediment over 1,700 linear feet of stream channel. Rather than relying on bulk excavation, sediments in this reach will be removed using minimally invasive procedures such as vacuum extraction, hand-digging, or artificial flushing. Given the relatively small volume of contaminated sediments that require removal, this approach will greatly reduce impacts and disturbance to the natural drainage features and will provide for a more effective ecological restoration than would be possible with bulk excavation.

The restoration of Upper Ely Brook will consist of replacing removed sediment with a similar material, (i.e. material with a similar grain size), including some limestone sediment to provide a pH buffer to reduce any limited impacts that might result from the short-term flushing and discharge of acidic groundwater. Check dams, coffer dams, mechanical pumps, and culverts will be used to convey the water from above the work zone to a suitable location downstream of the work zone during excavation and restoration work. Once the impacted sediment areas are dewatered, heavy equipment will be used to excavate the impacted sediment. The water will

then be returned to the newly restored channels as the work in this zone is completed. This process will be repeated for each work zone. Work zones will be sequenced in a manner that ensures that upstream source areas are excavated initially and that work progresses downstream to the confluence with Schoolhouse Brook, thereby eliminating the potential for recontamination from mobilized upstream sediments. The remedial design should consider alternate work sequences that will allow for minimal surface water diversion structures.

Middle Ely Brook will be reconstructed in its current location as an armored rip-rap channel. Since the brook remains in a relatively high-energy environment through this reach, restoration in kind would be difficult and cost-prohibitive and would not offer suitable aquatic habitat; therefore, the armored channel was selected as a reconstruction option.

Lower Ely Brook is a low-energy depositional environment. This reach will be restored to its current environment with a habitat hospitable to aquatic life and features typical of a New England cold water stream, such as pools, runs, riffles, cascades, and woody debris.

All of the sediment excavated from the waterways will be dewatered, if necessary, transported, and disposed of at an off-site facility along with the waste rock and soils exceeding PRGs from the LWA and UWA. The sediment may require drying prior to transportation. Drying would be performed by stockpiling in a staging area that would likely be within the footprint of the LWA and letting it drain, using passive drying tubes, or by mixing with soil or a desiccant.

The waste material with the TA containing contaminant levels above the soil/waste PRGs and/or that is considered a source of ARD will be excavated and transported to the ORB. The tailings will be placed over the in-place ORB material. The design will determine optimal location within the ORB for the placement of the tailings. The FS assumed that the tailings will be placed within a discreet, 2-foot-thick zone that is approximately 60 feet long and 30 feet wide. A temporary cover system may be used to limit the infiltration of water into the waste once placed within the ORB Cell. The final cover system for the ORB Cell will be designed to limit the infiltration of waster and oxygen and prevent contact with the material and comply with the cover required in the Vermont Solid Waste Management Rules for a mining waste. The components of the cover system are expected to include:

- A subgrade layer that would act as a buffer between the waste material and the geosynthetic cover. A minimum of six inches of a uniform fine grained sand or similar material is typically used for this layer. The subgrade for the ORB cell could be tailings. The subgrade is shaped to create an overall grade for the cover system that would cause water to run off the cover system to the perimeter channels and toe drains.

- The barrier layer would be a geosynthetic membrane, assumed to be a 60 mil LDPE geomembrane or other suitable geosynthetic material as determined during the design.

- Above the geomembrane will be a drainage layer, assumed to be a drainage geocomposite or 12 inch sand layer or other suitable geosynthetic material as determined during the design. This layer will allow the water that is intercepted by the barrier layer to flow to the outside of the ORB Cell.

- To protect the geosynthetic layers, an approximate 18 inches of vegetative support soil VSS and 6 inches of topsoil will be placed over the geosynthetic layers. The topsoil will be seeded to promote vegetation, enhance slope stability, and reduce erosion.

The cap will join the top of the existing retaining wall where exposed and key into the natural grade elsewhere.

The areas subject to excavation will be restored to minimize erosion of disturbed soil. Locations that are excavated to bedrock may be left as exposed bedrock. For other areas where the excavations terminate in glacial till, a 6-inch layer of topsoil or other amendment will be placed over the disturbed area and then seeded.

Improvements to the access road would be required to provide safe access to the waste areas for the trucks. Haul roads would be constructed for temporary access to the UWA during construction activities. In addition to on-site roadways, approximately one mile of improvements to local roads would be required to ensure that the volume of truck traffic would not damage the existing roads.

Replacement/installation of a select number of shallow bedrock and overburden monitoring wells will be required to evaluate the effectiveness of the waste removal. Existing monitoring

wells damaged during remedial activities will be replaced if they are needed for long-term monitoring purposes.

This alternative would require minimal long-term O&M. Active operation of remedial facilities would not be required. Anticipated maintenance activities would be expected to include: periodic inspections; mowing and general upkeep; maintenance of surface water drainages structures to prevent/repair erosion damage; and repair/replacement of damaged monitoring wells. It is assumed that the management of any leachate generated by the dewatering activities will be completed prior to the initiation of operation and maintenance activities.

Environmental monitoring would be conducted during the waste rock and tailings excavations to maximize the extent of waste removed and contained, and to confirm compliance with water quality criteria. Long-term environmental monitoring would also include collection of surface water samples to assess the effectiveness of the remedy along with biological monitoring to confirm that benthic invertebrate and fish populations have recovered. Groundwater elevation data would be collected at the time of sample collection to allow interpretation of the direction of groundwater flow. Field parameter measurements for dissolved oxygen, oxidation-reduction potential, pH, temperature, turbidity, and specific conductance would be made prior to sample collection. Details of the monitoring program, including target monitoring wells, analytes, and QA/QC protocols, would be specified in an LTM plan to be submitted for regulatory review and approval.

An institutional control monitoring plan would be prepared as part of the OU1 LTM program. The LTM would detail the land-use restrictions to be incorporated/referenced in the title for the property(ies) and will be recorded in a manner that meets State recordings standards for environmental restrictions. The plan would include a checklist of elements to be assessed during regularly scheduled on-site inspections. Annually scheduled inspections would be performed to confirm that land-use restrictions are implemented and adhered to as required to prevent disturbance of the components of the remedy.

Under §121(c) of CERCLA (42 USC § 9621(c)), any RA that results in contaminants remaining on-site (ORB and tailings) at concentrations above those allowing unlimited exposure and unrestricted use must be reviewed at least once every five years. During five-year OU reviews, an assessment is made as to whether the implemented remedy continues to be protective of

human health and the environment, or whether the implementation of additional RA is appropriate. The USEPA document Comprehensive Five-Year Review Guidance (USEPA, 2001) provides guidance on the performance of five-year reviews. The five-year review for this alternative is statutorily required. The five-year period will be triggered by the actual OU1 RA start date (USEPA, 2001).

4.4.1 Overall Protection of Human Health and the Environment

Alternative SC4 would protect human health by removing metals contamination above the OU1 PRGs and arranging for proper disposal of this material at an off-site facility, isolating the material from human contact. This alternative results in the complete removal of the material within the UWA, LWA, and the contaminated sediments and a cover system over the flotation tailings and ore roast bed. After completion of this remedy, direct contact and incidental ingestion of metals would no longer be an unacceptable threat to human health.

Human contact with the sediment and surface water for the exposure scenarios evaluated in the HHRA were not considered to represent and unacceptable threat to human health.

Alternative SC4 would also protect the environment by eliminating the major sources of ARD. The excavation of UWA and LWA source material followed by off-site disposal would prevent the interaction of water and oxygen with those mine wastes, thereby eliminating the discharge of ARD and metals to groundwater and surface water. The ultimate effect of this waste disposal remedy would be the restoration of OU1 surface water and sediment COC concentrations to levels below PRGs. The restoration of OU1 surface water would also prevent migration of COCs to downgradient sediment. The capping of the TA material, in conjunction with surface drainage improvements at the ORB, would reduce the leaching of metals from the tailings to concentrations to levels below PRGs.

Furthermore, Alternative SC4 would address the severe ecological risk to the benthic invertebrate community exists due to OU1 sediments. The sediment component of SC4 would protect the benthic invertebrate community in Ely Brook and Ponds 4 and 5, and by removing metals contamination above the OU1 PRGs and arranging for proper off-site disposal of this material, and restoring the habitats with clean materials to create a more hospitable environment.

4.4.2 Compliance with ARARs

Location-specific ARARs and TBCs triggered by Alternative SC4 are presented in Table 4-11.

In accordance with federal Executive Order 11990, entitled "Protection of Wetlands," (promulgated at 44 C.F.R. § 9) USEPA has determined that Alternative SC4 would result in unavoidable adverse impacts to federal jurisdictional wetlands and aquatic resources. SC4 would require the permanent disturbance of about 0.55 acres of severely impaired wetland habitat (Middle Ely Brook being restored as rip-rap channel). The permanent disturbance is required in order to protect the environment from the release of contamination at the Site. Middle Ely Brook was found to be toxic and unable to support aquatic life. The alternative will remove the contamination and restore Ely Brook and Ponds 4 and 5 to achieve Vermont Class B water quality standards. The Ely Brook tributaries have been historically altered as part of the mine development. To the extent possible, the tributaries will be restorated as aquatic habitat. For SC4, it is possible that some portions of EBT3 and EBT2 will be restored in kind in the LWA. Alternative SC4 may also result in some temporary impacts to wetlands that may require disturbance to implement this RA (sections of Ely Brook and its tributaries and Ponds 4 and 5). These areas will be restored to natural conditions after the removal of contaminated sediment. Every effort will be made to avoid impacts to State and federal jurisdictional wetlands. The design will include a detailed wetland assessment prior to any Site clearing activities. Impacted areas of Ely Brook will be reconstructed in kind (Lower Ely Brook) or as rip-rap armored channels (Middle Ely Brook and discharge from Pond 5). Upper Ely Brook will require minimally invasive work and reconstruction will include replacement of fine-grain sediment with similarly sized sand. Ponds 4 and 5 will be restored as native wetland habitat. A new channel will be constructed from the outfall of Pond 5 to Ely Brook. OU1 wetland areas at the Site are shown in Figure 2-1 and potential areas of the SC4 wetland impacts are shown in Figure 4-3.

USEPA has evaluated the requirements of Section 404(b) of the Clean Water Act to identify the proposed actions that are the least environmentally damaging practicable alternatives to protect federally regulated wetland and aquatic resources from exposure to contaminated sediments and contaminated surface water. Alternative SC4 meets the substantive standards of the Clean Water Act but it has been determined not to be the least environmentally damaging practicable alternative. While the alternative will remove all of the Site contamination from the UWA, LWA,

and waterway, the transportation of all contaminated material off-site under Alternative SC4 is not as practicable as SC3 due to the volume of contaminated material that would require removal.

In accordance with federal Executive Order 11988, entitled “Floodplain Management,” (as promulgated in relevant and appropriate regulations at 44 C.F.R. § 9) USEPA has determined that SC4 can be implemented in a manner that will protect downstream floodplain resources. The standards will be achieved through the use of best management practices to address Site contaminant remediation, stream alterations, stormwater controls, and long-term O&M of the remedial components adjacent to the Site’s waterways.

Design and implementation of the SC4 alternative will also address measures that may be required to protect habitat for State and federally-listed endangered bat species in compliance with State and federal Endangered Species Acts and the federal Fish and Wildlife Coordination Act (which also requires coordination with federal and state officials concerning the alteration of wetland habitat resources).

Section 106 of the NHPA of 1966, as amended (16 USC 470f), requires USEPA to take into account the effects of all actions on historic properties, including archaeological sites that have been determined to be eligible for the National Register of Historic Places. USEPA has determined that the Site is eligible for listing in the National Register of Historic Places. USEPA has also determined that the construction activities required to implement this RA will have unavoidable direct and indirect impacts on historic features, including archaeological sites, at the Site, but that these impacts are necessary to protect human health and the environment. The preliminary APE, as defined under the NHPA for direct effects is shown in Figure 4-3. The APE will be further defined to address indirect effects, cumulative effects and other effects as part of the design. The USEPA will work with the Vermont SHPO and other consulting parties to address minimize and mitigate any adverse effects to historic resources and archaeological sites.

State land use control and development standards under Vermont Act 250 would be met in the design and implementation of the SC3 alternative regarding regulated activities, including water and air pollution, protection of headwaters, waste disposal, floodways, streams, wetlands (including Vermont Class 3 wetlands not regulated under the Vermont Wetland Rules), soil

erosion, historic sites, endangered species, and extraction of earth resources, energy conservation, and protecting public investments. However, the large amount of truck traffic this alternative would entail does not satisfy the Act's energy conservation criterion, nor does the wear and tear that the truck traffic would have on local roads meet the Act's public investment criterion.

To the extent that remedial activities affect other protected resource areas, the location-specific ARARs in Table 4-11 will apply.

Chemical-specific ARARs and TBCs triggered by Alternative SC3 are presented in Table 4-12.

Chemical-specific TBCs were used to develop risk-based cleanup standards for soil and sediment and to create risk-based standards for the SC4 alternative. This alternative would attain chemical-specific ARARs and TBCs.

Action-specific ARARs and TBCs that are triggered by Alternative SC4 are listed in Table 4-13.

It is expected that all activities can be designed and implemented to comply with action-specific ARARs, regarding the containment of OU1 contaminants, stormwater controls, water treatment/discharge standards, leachate collection and either off-site disposal or on-site treatment/discharge, Site monitoring, and institutional controls. Because the West Cell would only contain non-beneficiated waste rock, the cell would be exempt from Vermont Solid Waste Regulation requirements, but instead would be capped under federal Mine Reclamation and risk-based standards. Meanwhile, all of the flotation mill tailings and the partially-roasted ore, which are defined as beneficiated waste under the VTSWMR would be contained within a cover system at the ORB that would comply with the regulations. These substantive requirements under these rules regulate the tailing wastes and roast bed material that were produced as part of the benefication of ore at the Site, but the rules do not apply to unprocessed waste rock. However, Section 6-1301(f) permits the waiver of technical and siting requirements of these rules provided there is a response action under CERCLA to a release or threatened release of hazardous substances or materials; and the proposed response action will not adversely affect public health, safety or the environment; and the technical and siting requirements will be complied with to the extent practical in light of the overall objectives of the response. In particular, liner requirements for disposal areas under § 1305(c)(2)(D) and (F) are waived. The

remainder of § 6-1305 establishes the closure and post-closure performance standards that are applicable to the remedial action. That is, all facilities subject to closure requirements must be closed in a manner that: (a) Minimizes the need for further maintenance related to the waste facility; and (b) Controls, minimizes, or eliminates, to the extent necessary to prevent threats to public health and safety and the environment, including post-closure emission or discharge of waste, waste constituents, leachate, contaminated runoff, and/or waste decomposition products to the groundwater or surface waters or the atmosphere. Leachate for at least the first two years after the containment areas are completed will meet standards for collection and either off-site disposal or on-site treatment and discharge. Long-term monitoring of the waste management areas would include federal and state drinking/groundwater standards for monitoring groundwater, as well as federal and State surface water quality standards for monitoring Site waterways. The remediation of OU1 sediments would meet TBC standards under USEPA contaminated sediment guidance. Remediation throughout OU1 would meet State erosion control TBC guidance standards.

4.4.3 Long-Term Effectiveness and Permanence

With proper design, removal and management the off-site disposal of contaminated waste rock and soil portion of SC4 would provide long-term effectiveness for eliminating contact between the waste rock and oxygen, which results in ARD and subsequently impacts groundwater and surface water. The removal of the waste rock material in addition to the capping of the tailings and ORB would provide long-term effectiveness for minimizing future impacts to OU1 surface water, as well as OU2 groundwater.

With proper design, removal, and management, the removal of impacted sediment would provide long-term effectiveness for eliminating future impacts to surface water. Impacted sediment will be removed and managed and permanently disposed of off-site, preventing human contact and impacts to ecological receptors.

4.4.4 Reduction of Toxicity, Mobility, and Volume through Treatment

SC4 does not include treatment to reduce the toxicity, mobility, or volume of contaminants, except for the limited circumstances in which sediment is dewatered or stabilized. Liquid generated from dewatering liquid may require treatment prior to discharge or stabilizers may be

added to sediment to reduce contaminant mobility. In addition, limestone rock or sediment may be added to waterways to reduce the toxicity and mobility of any remaining ARD.

4.4.5 Short-Term Effectiveness

Alternative SC4 would be effective in the short term because the waste rock would be removed and disposed of off-site thereby eliminating risk from direct contact and ingestion. The areas targeted for remediation under OU1 would achieve protection of human health and the environment upon completion of the removal of the contaminated soil sediment, and waste rock, as well as the containment of the tailings in the ORB cell. Furthermore, the conditions that result in unacceptable environment risks within Ely Brook and Ponds 4 and 5 would be eliminated upon completion of the cleanup. The time period to implement the cleanup, once design and administrative issues have been addressed, would be 2-4 years.

Alternative SC4 would require the excavation and dredging of large volumes of material with heavy construction equipment under typical working conditions for the area. These activities would present a potential risk to construction workers and would result in construction related concerns (e.g., blasting, noise, and dust) to area residents. To minimize short-term risks to the community and area residents, Alternative SC4 would minimize the movement of construction equipment on the narrow and twisting roads approaching the Site. Most construction equipment (e.g., bulldozers, excavators, dredges) would be expected to remain on site and move on/off site infrequently.

However, due to the estimated 7,400 to 9,500 loads requiring off-site disposal, approximately one mile of South Vershire Road would require upgrades to safely handle the additional heavy truck traffic. An estimated 7,400 trailer-dump truck loads with 18 cy-capacities on local roads (up to 9,500 using typical tri-axle dump trucks with 14 cy-capacities) will be required to transport the waste material off-site, resulting in a significant increase in traffic that will result in increased traffic hazards and road impacts in the area.

Borrow materials would be procured from local commercial operations requiring additional truck traffic in the vicinity. Pre-design investigations would identify if on-site materials could be used as construction materials including separation layers, cap materials, and haul and access road construction. If on-site materials are used, the volume of truck traffic would be reduced.

To further minimize short-term risks to the community and area residents, Alternative SC4 would implement erosion and sediment control measures to prevent uncontrolled downstream transport of mobilized sediment during construction. Coffer dams, check dams, silt fence, and other control devices will be used on site to prevent migration off site. Dust control measures would also be implemented on-site to minimize dust generation and airborne transport of contaminants. Best management practices would ensure that alteration of waterways and other remedial activities to not increase flooding risks to downstream areas.

Short-term risks to the environment would include short-term loss of aquatic habitat as a result of excavation activities. However, in most cases altered habitat will be restored. The potential quarrying of on-site rock for rip-rap in channel restoration could impact small areas of existing upland habitat in the vicinity of the Site, but these areas would be restored once rip-rap material is no longer needed.

4.4.6 Implementability

Traditional construction equipment and methods can be used in the implementation of this alternative. Moving and consolidating waste rock and tailings as proposed poses the following issues to be considered in the implementation of this alternative:

- Haul roads will need to be constructed, a process that will include clearing and grading;
- Increased truck traffic and construction activities may result in impacts to the community;
- Additional truck traffic will be created to transport waste materials off-site;
- Wetlands will be disturbed;
- Endangered bat habitat adjacent to the remediation area may require additional mitigation measures, including limitations on when work may be conducted. Working on the steep slopes of the UWA to remove waste rock may result in stability issues;

- Additional truck traffic would be created to import materials to the Site including low permeability soil;

- There may be stability concerns for the historic stone wall that borders the ORB due to the construction of the ORB's low-permeability cap; and

- Waste excavation activities in the UWA, LWA, TA, ORB, and Ely Brook will impact historic resources and some construction activities will require historic resource data recovery and construction monitoring or observation.

However, these issues are considered reasonable and typical for the general construction objectives and can be overcome by using standard engineered solutions and implementing best management practices.

The sediment cleanup components of Alternative SC4 are also implementable, as all identified issues can be overcome by using engineered solutions and implementing best management practices. Traditional construction equipment and methods can be used in the removal of sediment in Ponds 4 and 5, Middle Ely Brook and Lower Ely Brook. Some specialized construction equipment may be used to remove the sediment in Upper Ely Brook using minimally invasive procedures. Traditional construction equipment and methods can be used to reconstruct the rip-rap armored channels; however, specialists in stream restoration design and construction are required for Lower Ely Brook restoration. Sediment dewatering and/or stabilization and potential treatment of dewatering liquid may be required, but are implementable.

SC4 could have significant issues from an administrative perspective. There could be substantial implementability issues with respect to the off-site disposal of the waste material. There is limited capacity at many regional facilities within a reasonable haul distance. If the facility with sufficient capacity were a substantial distance from the Site, the cost could be substantially higher. Also, there could be substantial delays in the implementation of the SC4 associated with obtaining approval for the off-site disposal. Close communication and coordination with the landowners and environmental protection and natural resource agencies (e.g., Vermont ANR, U.S. Fish and Wildlife Service) would be necessary to establish institutional controls.

4.4.7 Cost

Table 4-14 presents a summary of the estimated present worth and total non-discounted costs to implement Alternative SC4. The present worth represents the amount of money that, if invested now and disbursed as needed, would be sufficient to cover costs associated with the RA over its planned life, whereas the total non-discounted costs estimate assumes that all costs are paid as they accrue. Both present worth and total costs estimates include direct and indirect capital costs; annual costs such as O&M, quarterly monitoring, and annual reporting; and periodic costs such as five-year reviews.

The present worth for Alternative SC4 based on a 7 percent discount rate and a 30-year duration is estimated to be $30,123,830. Appendices A and B contain additional cost assumptions and a detailed cost estimate for this alternative.

5.0 COMPARATIVE ANALYSIS OF ALTERNATIVES

The comparative analysis compares the remedial alternatives with respect to the evaluation criteria used during the detailed analysis of alternatives. The purposes of the comparative analysis are to identify the advantages and disadvantages of alternatives relative to one another, and to assist in the eventual selection of a preferred remedial alternative for OU1 that will be included in the OU1 Proposed Plan for public comment and documented in the OU1 ROD. Subsection 5.1 presents the approach to the comparative analysis based on the NCP. Subsection 5.2 presents the comparison of remedial alternatives.

5.1 Approach to the Comparative Analysis

The NCP outlines the approach for performing the comparative analysis of remedial alternatives. The proposed remedy must reflect the scope and purpose of the actions undertaken and how these actions relate to other RAs and the long-term response at the site. Identification of the preferred alternative and final selection of a remedy are based on an evaluation of the major tradeoffs among alternatives in terms of the nine evaluation criteria. USEPA categorizes the evaluation criteria into three groups: threshold, balancing, and modifying. Each criteria group is discussed in the following subsections.

5.1.1 Threshold Criteria

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

5.1.2 Primary Balancing Criteria

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

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

5.1.3 Modifying Criteria

State and community acceptance are factored into a final balancing that determines the preferred remedy and the extent of permanent solutions and treatment practicable for the site. Formal state regulatory agency comments will not be received until after the agencies have reviewed the FS and public comments to the Proposed Plan. Community input will be factored into the remedy selection process following the public comment period on the Proposed Plan.

5.2 Comparative Analysis of Alternatives

This subsection contains a comparative analysis of alternatives associated with OU1. Based on the results of the detailed analysis of alternatives, it was determined that each of the waste rock alternatives (SC2, SC3, and SC4) was technically feasible and has been brought forward for the comparative analysis. The remedial alternatives that are the focus of this comparative analysis are:

- Alternative SC1 – No Action;
- Alternative SC2 – Waste containment in the Lower Waste Area Cell and Ore Roast Bed;
- Alternative SC3 – Waste containment in the West Cell and in the Ore Roast Bed; and
- Alternative SC4 – Off-site disposal and waste containment in the Ore Roast Bed.

5.2.1 Overall Protection of Human Health and the Environment

According to CERCLA, this criterion must be met for a remedial alternative to be chosen as a final site remedy. Alternative SC1, the No Action Alternative, would not eliminate, reduce, or control source areas or potential future exposure to contaminants exceeding PRGs and would not meet RAOs. Therefore, this alternative is not protective of human health and the environment and cannot be chosen as a final remedy.

Alternatives SC2, SC3, and SC4 would each be protective of human health and the environment. Each of the alternatives would eliminate the direct contact and incidental ingestion risks from cobalt, copper and iron within the waste rock, tailing, and sediment areas through removal or capping of these materials.

The removal of the UWA and LWA source material and containment in either the LWA Cell (SC2) or the West Cell (SC3) or off-site disposal (SC4) would remove and/or control the most significant sources of sediment and surface water contamination by preventing the formation of ARD and the erosion of mine waste. Restoration of the areas formerly occupied by the waste material would also eliminate the barren soil that was toxic to plants and soil invertebrates.

Capping of the tailings within the ORB would prevent this material from acting as a source of sediment and surface water contamination. Also, removal of acutely toxic sediments from Ely Brook, its tributaries, and Ponds 4 and 5 and consolidating them in the LWA Cell (SC2) or the West Cell (SC3) or transporting them off site for disposal (SC4) would eliminate that threat to the ecological system of OU1. Each of the alternatives would implement institutional controls to prevent site use that could damage the components of the cleanup.

Alternatives SC2, SC3, and SC4 are very similar in the degree to which they achieve protection of human health and the environment. SC3 would be more protective than SC2 because the waste material would be isolated in a containment cell that is specifically engineered to prevent

direct contact and ARD generation for the site specific waste. The disposal location chosen under SC4, because the waste material is not a regulated solid waste, could have less protective cover system. The location of the West Cell makes SC3 more protective than SC2 since SC2 would create a LWA Cell in a location that is more susceptible to infiltration by groundwater and surface waters from the adjacent waterway. In addition, a LWA cell would potentially be susceptible to uncontrolled discharges from the Underground Mine Workings (OU2). Each of the alternatives includes those components that result in direct and indirect impacts to wetlands and aquatic habitat. SC4 would have a smaller short-term environmental impact to wetlands because it would not require clearing for staging areas, borrow areas, or for construction of the West Cell (SC-3) or LWA Cell (SC-2). SC4 would, however, have a substantially greater overall environmental impact as there are no disposal facilities in close proximity to the Site. The nearest licensed solid waste facility in VT is 50 miles away, resulting in a 100 mile round trip for trucks to bring material from the Site to the landfill. These short term impacts associated with the additional truck traffic and generation of greenhouse gases reduce the overall protectiveness of SC4. If the waste material required substantial processing (due to size restrictions or pre-treatment requirements to reduce acid generating potential) additional cost and short-term impacts would arise. SC2 and SC3 are considered equally protective with respect to the environment as a whole because, although SC2 would result in a smaller footprint of disturbance in the event that on-site materials are not used, it would result in a 63 percent increase in trucking requirements, resulting in a much higher carbon footprint. Furthermore, if on-site materials are utilized, SC2 would require an estimated 15 acres of forest clearing, while SC3 would only require 12 acres, all of which is in the footprint of the West Cell and staging area.

The relative ranking of protectiveness is SC3 > SC4 > SC2.

5.2.2 Compliance with ARARs

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

Location-Specific ARARs. Alternative SC1 – No Action does not include any actions, therefore this alternative does not trigger location-specific ARARs.

Alternatives SC2, SC3, and SC4 would be designed and implemented to comply with regulations related to wetlands, historical preservation, land use and development, stream flow, fish and wildlife habitat, endangered species, floodplains, and wetlands. Each of the alternatives includes components that result in unavoidable direct and indirect impacts to both wetlands and historic resources, but these impacts can be mitigated. USEPA has determined the SC3 is the least environmentally damaging practicable alternative for protecting wetland resources as called for under Section 404 of the federal Clean Water Act and is therefore more ARAR compliant than SC2 and SC4. This finding was made because SC3 will permanently contain Site contamination in Site uplands where long-term impacts to wetland resources will be minimized in comparison with SC2 which would locate the LWA Cell adjacent to Site waterways in an area with a high groundwater table. While SC4 permanently removes a large volume of contamination from the Site the operation to ship such a large volume of waste is less practicable than SC3's on-site option.

USEPA will need to consult with federal and state wildlife officials to determine what measures may be required to mitigate for impacts to endangered bat habitat on Site. All other identified location-specific ARARs can be satisfied by all the alternatives, except SC4 does not satisfy Vermont Act 250 criterion regarding energy conservation and public investment due to the large amount of trucking the alternative requires. The relative ranking of location-specific ARAR compliance is SC3 > SC4> SC2 (i.e., SC3 is more compliant than SC4 which is more compliant than SC2).

Chemical-Specific ARARs. Alternative SC1 would not attain protective concentrations for Site contaminants in soil or sediment and would not comply with chemical-specific ARARs and TBCs.

SC2, SC3, and SC4 would each result in effective containment or removal of the waste rock, sediment, and tailings sources, resulting in restoration of OU1 surface water to PRGs following implementation. Each would achieve equal compliance with chemical-specific ARARs and TBCs, therefore, the relative ranking of chemical-specific ARAR compliance is SC2 = SC3 = SC4.

Action-Specific ARARs. Because Alternative SC1 does not include any actions, the alternative does not trigger action-specific ARARs.

Alternatives SC2 and SC3 would construct a containment cell for the waste rock (which is not regulated as solid waste in Vermont) and sediments and therefore meet relevant and appropriate mine closure and risk-based standards (SC2 can achieve these standards only if implementability issues with citing the LWA contaminant cell in an area of high groundwater adjacent to Site waterways can be addressed). Alternative SC4 will meet these standards by removing all of the material and disposing of it off-site. All three alternatives will consolidate and permanently cap tailings and ORB in the ORB Cell in compliance with Vermont Solid Waste standards. Alternatives SC2, SC3, and SC4 are equally compliant with respect to action-specific ARARs regarding long-term monitoring of the waste management areas that would include federal and state drinking/groundwater standards for monitoring groundwater, as well as federal and State surface water quality standards for monitoring Site waterways. The remediation of OU1 sediments under all three alternatives would meet TBC standards under USEPA contaminated sediment guidance. The three alternatives would also meet State erosion control TBC guidance standards. Therefore, the relative ranking of action-specific ARAR compliance is. SC3 =SC4>SC2.

5.2.3 Long-Term Effectiveness and Permanence

This criterion evaluates the magnitude of residual risk and the reliability of controls after response objectives have been met. Alternative SC1 would not eliminate, reduce, or control source areas or potential future exposure to contaminants exceeding PRGs and would not provide long-term effectiveness at protecting human health and the environment.

Alternatives SC2, SC3, and SC4 would each provide similar actions to control exposure risk for the waste rock and sediments in OU1. These actions would provide good long-term effectiveness and permanence. Alternatives SC2, SC3, and SC4 each take actions to cap the tailings on the ORB, excavate the source areas, and either consolidate waste materials in containment cells (SC2 and SC3) or dispose of them off-site (SC4), thereby controlling the generation of ARD at these source areas. For Alternative SC2, excavated material would be removed and isolated in the LWA Cell. For Alternative SC3, excavated material would be transferred and isolated by consolidation and capping in the West Cell.

Alternatives SC2, SC3, and SC4 would reduce ecological risk from exposure to contaminated sediments exceeding PRGs by excavating/dredging the reaches of Ely Brook and Ponds 4 and 5 and then isolating the excavated sediments in the containment cells or at an off-site location.

Consolidation of source material in the LWA as part of Alternative SC2 is considered a long-term solution. However, because the LWA Cell footprint is located within the low point of the Ely Brook drainage area, below the existing water table, significant engineering controls will be required to divert surface water and groundwater discharge from the cell. The requirement to construct an underdrain that isolates waste from groundwater and surface water may require additional long-term maintenance and repairs. Because this closure cell design is atypical and non-ideal, it creates greater uncertainty regarding the long-term effectiveness and permanence relative to SC3 and SC4 Long-term maintenance and repair of the SC2 underdrain system is expected to be more problematic than maintenance of the SC3 cell, which is more effectively isolated from surface water and groundwater.

In comparison, Alternative SC3 would be constructed in an area isolated from low-lying wet areas and would utilize standard design and construction components. Based on its reliance on proven technology, SC3 is considered to be more implementable and have greater long-term effectiveness and permanence than Alternative SC2.

Alternative SC4 includes excavating the waste material and transporting it to an off-site location for permanent disposal. Since Alternative SC4 does not rely on an on-site engineering control for the waste rock and sediments it is considered to have slightly more long-term effectiveness and permanence than SC3, which is more effective and permanent than SC2, provided the off-site facility places the unregulated material beneath a cover system of equal performance to the cover system to be installed for SC2 or SC3. If a less substantial cover system is used to cover the waste at the off-site facility, then SC2 and SC3 would have greater long-term effectiveness.

The relative ranking of long-term effectiveness, therefore, is SC4 > SC3 > SC2, due to the long-term effectiveness of disposing of the waste off-site rather than on-site.

5.2.4 Reduction of Toxicity, Mobility, and Volume through Treatment

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

Alternative SC1 does not contain any components to reduce the toxicity, mobility, or volume of contaminants through treatment. Alternatives SC2, SC3, and SC4 all may have limited treatment components pertaining to treatment of dewatering liquid and the potential use of limestone in settling ponds, drainage channels, or in streams to reduce the toxicity and mobility of ARD. SC2 and SC3 may include added treatment processes for leachate generated from the LWA and West Cells, respectively. SC4 may include limited stabilization of contaminated sediments prior to off-site shipment.

The relative ranking of the alternatives at reducing the toxicity, mobility, or volume of contaminants through treatment is SC3 = SC2 > SC4 >= SC1.

5.2.5 Short-Term Effectiveness

CERCLA requires that potential adverse short-term effects to workers, the surrounding community, and the environment be considered during implementation of an RA and until response objectives have been met. Under this criterion, the time period to achieve protectiveness is also evaluated. Alternative SC1 does not lead to any exposure risks and, therefore, results in no short-term effects; however, it never achieves protectiveness of human health or the environment and therefore is not effective in the short-term.

Each of the alternatives would use on-site materials and resources to reduce short-term risks to the community from construction traffic to and from the Site.

In the event that sufficient on-site sources for earthen materials are not identified, SC2 and SC3 would need to rely on imported materials. The construction of SC2 would require an estimated 93,000 cy of stone, borrow, and topsoil, resulting in approximately 5,150 truck loads. The construction of SC3 would require an estimated 52,000 cy of stone, borrow, and topsoil,

resulting in approximately 2,901 truck loads, significantly less than the trucking required for SC2. As a result, SC2 would have a larger short-term environmental footprint than SC3.

In the event that sufficient on-site sources for earthen materials are identified, SC2 and SC3 would generate earthen materials from previously undisturbed areas. Based on an estimated yield of 7,000 cy per acre, the construction of SC2 could potentially require 15 acres of land to be cleared, while the construction of SC3 would require 12 acres, all of which may potentially be within the footprint of the SC3 cell construction and staging area. As a result, SC2 would have a larger short-term environmental footprint than SC3.

Under both alternatives SC2 and SC3, the areas where waste is removed will be reclaimed to the extent practical. Some area may be left as exposed rock, whereas areas with clean soil remaining after waste removal will be restored to establish native vegetation, including wetland habitat that will dramatically decrease the environmental footprint of the Site when compared to current conditions. The surface of the containment cells will also be vegetated.

For the other common components of SC2 and SC3, there would also be similar short-term impacts resulting from truck traffic importing the necessary materials to the Site for the remediation activities, including the restoration of Ely Brook and the Ponds 4 and 5 Area, as well as the construction of containment cell cover systems.

Alternative SC4 would include significantly higher short-term impacts related to the estimated 7,400 to 9,500 truck loads required to transport the waste material to an off-site facility. Some of these would be offset by the significantly fewer loads coming to the Site with needed materials for construction of containment cells; however, the ORB cap and stream channel restoration work included in SC4 will require material deliveries. In total, assuming that all needed borrow materials can be found on site, SC2 and SC3 result in an estimated 5,333 fewer truck trips on local roads. Due to the distance to the off-site disposal facility, SC-4 would have a substantially greater overall environmental impact as there are no disposal facilities in close proximity to the Site. The nearest licensed solid waste facility in VT is 50 miles away, resulting in a 100 mile round trip for trucks to bring material from the Site to the landfill. If the waste material required substantial processing (due to size restrictions or pre-treatment requirements to reduce acid generating potential) additional cost and short-term impacts would arise.

SC2 would also require that LWA waste rock be removed and placed in a temporary stockpile area. This is necessary for the construction of the underdrain system, as well as to provide some dewatering of these wastes prior to placement in the closure cell. This stockpile area would be located in an area previously altered to minimize short-term impacts to wetlands and terrestrial habitats. Although temporary, the construction of the LWA relocation stockpiles would require some features typical of the final closure cells, such as surface water diversions, groundwater interceptor trenches, leachate collection systems, and covers to provide protection from erosion and stormwater discharge.

Alternatives SC2, SC3, and SC4 would all result in construction-related concerns (e.g., blasting, noise, and dust) and would result in some short-term effects to the community from truck traffic to deliver equipment and materials.

Both SC2 and SC3 would result in short-term impacts to known wetland areas and aquatic habitats (Ely Brook and floodplain, Ponds 4 and 5). Some permanent loss of these areas may occur depending on the need for engineered structures to protect the cover systems. The areas that are not subject to permanent loss are expected to fully recover and achieve a higher level of function and value post-cleanup with the removal of the site contaminants. There would be short-term impacts to Ely Brook, Ponds 4 and 5, and areas subject to dredging or excavation as part of SC2, SC3, and SC4. Besides the wetland areas destroyed to excavate the waste material, no other unaltered wetlands areas would be impacted due to activities associated with Alternative SC4.

At this time it has not been determined how each alternative may impact endangered bat habitat. USEPA will consult with federal and state wildlife authorities to determine if any of the components of the proposed alternatives poses significant negative impacts on endangered bats at the Site.

For Alternatives SC2, SC3, and SC4, the time period to achieve the PRGs is estimated to be 2 to 4 years after the source control and sediment activities are completed.

Because SC2 creates a larger environmental footprint under both an off-site material import and an on-site material generation scenario, SC3 ranks higher than SC2 with respect to short-term effectiveness. Based on the overall impacts to the community and increased traffic hazards

resulting from the significant truck loads required to transport waste off-site, both SC2 and SC3 rank higher than SC4 with respect to short-term effectiveness. SC2 and SC3 are equal in terms of short-term impacts and in time needed to achieve protection and SC4 results in significant short-term impacts to the local community regarding heavy truck traffic on local roads.

The relative ranking of the alternatives with respect to short-term effectiveness is SC3 > SC2 > SC4.

5.2.6 Implementability

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

Alternative SC1 does not include any actions, other than Five-Year Reviews, and, therefore, would be technically easy to implement. No permits would be required, and administrative feasibility would be high.

Services and equipment are available to implement Alternatives SC2, SC3, and SC4. Waste removal from the UWA, LWA, Ely Brook and tributaries, and the Ponds 4 and 5 Area, as well as the construction of the tailings cover over the ORB is similar for each alternative.

SC2 is considered less implementable than SC3 and SC4 based on its location in the center and low point of the Ely Brook drainage. The LWA Cell (SC2) relies on a location partially within the groundwater table at the lowest point in a steep-sided topographic drainage. This setting presents distinct engineering challenges for the construction of an effective waste containment cell whose primary objective is to separate waste rock and tailings from interacting with water. The construction the LWA Cell on a high-transmissivity underdrain and drainage barrier is more complicated engineering design and has a greater dependence on the successful performance of the maintenance activities.

The LWA Cell footprint is also the current location of the LWA waste rock. Therefore the LWA waste will need to be excavated and relocated twice. LWA would also require the construction of a temporary staging area that is constructed with a liner and leachate collection system to

prevent residual saturation in the waste and sediments from draining to groundwater and surface water. Lastly, long-term maintenance and repair of the SC2 underdrain system is expected to be more problematic than maintenance of the SC3 cell, which is more effectively isolated from surface water and groundwater.

In comparison, the construction of the West Cell (SC3) relies on proven methods and technologies and could be sequenced in a manner that would eliminate the need for a temporary lay-down area and leachate collection system for waste. The West Cell's location on the side-slope of the Ely Brook drainage would also allow for surface water diversions that are sized for significantly smaller flows than would be required for SC2. Therefore, SC3 is considered to be more implementable than SC2.

For the implementation of SC4, South Vershire Road would require improvements to safely handle the heavy truck traffic. In addition nearly 1,000 waste characterization samples would be required to meet the disposal facility requirements. Despite these difficulties, SC4 is considered easily implementable from a technical perspective because it does not include the design and construction of a geosynthetic cap.

The administrative feasibility of Alternatives SC2 and SC3 is equally high since neither requires off-site permits or approvals. The administrative process to obtain institutional controls to protect the remedy components (caps, stream restoration, monitoring wells) for SC2, SC3, and SC4 are readily implementable. SC4 could experience substantial implementability issues with respect to the off-site disposal of the waste material. There is limited capacity at many regional facilities within a reasonable haul distance. If the facility with sufficient capacity were a substantial distance from the Site, the cost could be significantly higher. Also, there could be substantial delays in the implementation of the SC4 associated with obtaining approval for the off-site disposal.

While each of the alternatives is implementable, the relative ranking of the alternatives for implementability is SC3 > SC4 > SC2.

5.2.7 Cost

The following table summarizes capital, annual O&M, present worth for 30 years at 7 percent discount rate, and total estimated non-discounted costs for the evaluated alternatives.

Cost Category	SC1	SC2	SC3	SC4
Capital Costs	$0	$18,402,286	$16,446,057	$29,754,186
Annual O&M	$8,050	$74,907	$74,907	$27,753
Total Non-Discounted Cost	$241,000	$20,713,786	$18,757,557	$30,586,786
Total Present Worth (30 yrs @ 7 percent)	$113,015	$19,428,508	$17,472,278	$30,123,830

5.2.8 Summary

Table 5-1 summarizes the comparative analysis of alternatives.

6.0 OU2 EARLY ACTION

USEPA has identified the need for an Early Action for the OU2 area. Specifically, since the finalization of the OU2 RI/FS and selection of an OU2 cleanup action is dependent upon the completion of the OU1 Remedial Action, many years may pass before an OU2 cleanup can be implemented. The Site HHRA identified the future consumption of contaminated groundwater and the direct contact and incidental ingestion of soil contaminated with cobalt, copper, and iron as potential threats to human health. To address this threat to human health, USEPA will implement an Early Action to prevent groundwater use within the portions of the Site where groundwater is not suitable for human consumption. The OU2 Early Action will also prevent residential development of the Smelter/Slag Area.

The Remedial Action Objectives for the Early Action are:

- Prevent residential exposure to soil or waste with concentrations of cobalt, copper, and iron above the Site specific cleanup levels for future residential use within the Site which were identified in Table 2-4; and

- Prevent ingestion of bedrock groundwater in excess of federal Safe Drinking Water Act MCLs; Maximum Contaminant Level Goals (MCLGs); VTGWPS; or USEPA risk standards within portions of the Site.

The design for the Early Action will identify the extent of the Ely Copper Mine Site where groundwater that exceeds MCLs, MCLGs, VTGWPS, or risk based standards in the absence of these. Figure 6-1 shows the extent of the area of the Site that would be subject to institutional controls using the existing Site data.

The Early Action will include the placement of land use restrictions that stay with the land to effectively prevent future residential use or installation of water supply wells within the portions of the Site where such use could result in exposure to contamination or adversely impact the response actions. Restrictive covenants are the primary mechanism to achieve this objective with local and/or state ordinances or zoning to supplement the property restriction.

Because the only RAOs are to prevent the groundwater or residential use of certain portions of the Site and not restore groundwater or contain/remove contaminated soil, no other technologies or alternatives were considered, other than No Action. The OU2 FS will develop and analyze technologies with respect to any groundwater restoration, migration control, or soil remediation. A very simplified NCP criteria analysis was performed in Section 6 of the OU1 FS for No Action and Institutional Controls for the Early Action for OU2.

6.1 Overall Protection of Human Health and the Environment

Will the alternative protect human health and plant and animal life from the contamination released by the Site? The chosen cleanup plan must meet this criterion.

The Early Action would provide overall protection of human health and the environment by preventing a change in land use that could result in an exposure that was identified as unacceptable from a human-health perspective. The OU2 FS and ROD will determine whether addition response measures are necessary in addition to institutional controls. The No Action alternative would allow land use changes that could result in an unacceptable threat to human health from direct contact with cobalt, copper, and iron contaminated soil and ingestion of contaminated groundwater.

6.2 Compliance with Applicable or Relevant and Appropriate Requirements (ARARs)

Does the alternative meet all pertinent federal and state environmental statutes, regulations, and requirements? Is a waiver is required? The chosen cleanup plan must meet this criterion.

The No Action alternative only has chemical-specific ARARs and TBC standards which the alternative does not satisfy, because the No Action alternative does not address risks from groundwater (see Table 6-1). The Early Action alternative will meet risk standards by preventing use of contaminated groundwater. There are no action- or location-specific standards because no remedial measures need to be conducted in protected resource areas. There are chemical-specific groundwater protection standards that the Early Action will meet (see Table 6-2).

6.3 Long-Term Effectiveness and Permanence

How reliable will the alternative be at long-term protection of human health and the environment? Is contamination likely to present a potential risk again?

The long-term effectiveness of the Early Action would be dependent upon the successful implementation and maintenance of the land use restrictions that would prevent residential use or the installation of water supply wells. The Early Action would not reduce the level of contamination or contain the contamination; therefore, the OU2 FS and ROD will need to determine whether addition response measures are necessary in addition to institutional controls. The No Action alternative does not provide any long-term effectiveness or permanence.

6.4 Reduction of Toxicity, Mobility, or Volume through Treatment

Does the alternative incorporate treatment to reduce the harmful effects of the contaminants, their ability to spread, and the amount of contaminated material present?

The Early Action does not address any principal threat waste. Neither the Early Action nor the No Action alternative will reduce the toxicity, mobility, or volume of contamination through treatment.

6.5 Short-Term Effectiveness

How soon will the risks be adequately reduced? Are there short-term hazards to workers, the community, or the environment that could occur during the cleanup process?

There are no short term hazards for either the Early Action or the No Action alternative. The Early Action could be implemented within 1 year of the approval of the Early Action as a component of the OU2 remedy.

6.6 Implementability

Is the alternative technically and administratively feasible? Are the materials and services needed to implement the cleanup alternative (e.g., treatment machinery, space at an approved disposal facility) readily available?

There are no implementation issues for the No Action alternative. The early cleanup action has a high degree of implementability. The Early Action is dependent, however, on landowner cooperation to achieve the implementation of the early action the shortest time frame.

6.7 Cost

What is the cost of constructing and maintaining the cleanup alternative? Capital costs and the present value of all costs over the anticipated life of the cleanup alternative are presented?

There are no costs associated with the No Action alternative. For the Early Action there are some costs that will be associated with the transaction costs to transfer title as part of the land use restriction. There will also be costs associated with inspections and monitoring of the land use restrictions.

6.8 State Acceptance

Do state environmental agencies agree with the recommendations?

This criterion considers the state's preferences among or concerns about the alternatives, including comments on ARARs or the proposed use of waivers. This criterion is addressed following state input on the FS.

7.0 REFERENCES

Efroymson, R. et. al., 1997. Preliminary remediation goals for ecological endpoints. 10.2172/204209. USDOE, Washington, DC (United States).

Hathaway, E.M. and others, 2001. The Other Side of Mining: Environmental Assessment and the Process for Developing a Cleanup Approach for the Elizabeth Mine. Society of Economic Geologists Guidebook Series, v. 35, p. 277-293. October.

Hammarstrom, J.M., and others, 2001. Sources of Metals and Acidity at the Elizabeth and Ely Mines: Geochemistry and Mineralogy of Solid Mine Waste and the Role of Secondary Minerals in Metal Recycling. Soc. Econ. Geol., Guidebook Series, V. 35, p. 213-248. October.

Holmes. J.V., Bigl, S.R., Lawson, D.E., Seal II, R.R., Piatak, N.M., 2002. Spring Runoff Characterization, Ely Mine, Vershire, Vermont, Spring 2002. August, 2002.

Kiah, Richard G., Deacon, Jeffrey R., Piatak, Nadine M., Seal, Robert R., II, Coles, James F., Hammarstrom, Jane M., 2007. Surface-Water Hydrology and Quality at the Pike Hill Superfund Site, Corinth, Vermont, October 2004 to December 2005. SIR 2007-5003.

Kierstead, M. A., 2001. History and Historical Resources of the Vermont Copper Belt. Society of Economic Geologist Guidebook Series, v. 35, p. 165-191.

Long, E. et. al., 1995. Incidence of adverse biological effects within ranges of chemical concentrations in marine and estuarine sediments. Environmental Management 19(1): 81-97.

MacDonald, D. et. al., 2000. Development and Evaluation of Consensus-Based Sediment Quality Guidelines for Freshwater Ecosystems. Archives of Environmental Contamination Toxicology 39, 20-31 (2000): 9798-9821.

McGreer, J. and others, 2004. Issues Paper of the Bioavailability and Bioaccumulation of Metals. Eastern Research Group, Inc. submitted to: USEPA Risk Assessment Forum.

Public Archaeological Laboratory (PAL), 2005. Final Historic/Archaeological Mapping and Testing, Ely Mine Site. January.

Public Archaeological Laboratory (PAL), 2007. Draft Historic/Archaeological Mapping and Testing, Pike Hill Mines Site (VT-OR-27). October.

Piatak, N.M., Hammarstrom, J.M., Seal II, R.R., Briggs, P.H., Meier, A.L., Muzik, T.L., Jackson, J.C., 2004a. Geochemical Characterization of Mine Waste at the Ely Copper Mine Superfund Site, Orange County, Vermont. OFR 2004-1248.

Piatak, N.M., Seal II, R.R., Hammarstrom, J.M., Meier, A.L., Briggs, P.H., 2004b. Geochemical Characterization of Slags. Other Mine Waste, ands Their Leachate from the Elizabeth and Ely Mines (Vermont), the Ducktown Mining District (Tennessee), and the Clayton Smelter Site (Idaho). OFR 03-260.

Piatak, N. M., Seal, R. R., II, Sanzolone, R. F., Lamothe, P. J., Brown, Z. A., Adams, M., 2007. Sequential Extraction Results and Mineralogy of Mine Waste and Stream Sediments Associated With Metal Mines in Vermont, Maine, and New Zealand. OFR 2007-1063.

Seal, R.R., II, Kornfeld, J.M., Meier, A.L., and Hammarstrom, J.M., 2001. Geochemical Setting of Mine Drainage in the Vermont Copper Belt. Society of Economic Geologists Guidebook Series, v. 35, p. 255-276.

Shacklette, H.T., and Boerngen, J.G., 1984. Element Concentrations in Soils and Other Surficial Materials of the Conterminous United States. United States Geological Survey Professional Paper 1270, 105 p. (Online at http://pubs.er.usgs.gov/usgspubs/pp/pp1270).

Slack, J.F., Whitlow, J.W., and Annis, M.P., 1984. Gold in Stream Sediments from the Orange County Copper District, East-Central Vermont. United States Geological Survey OFR 84-889, 21 p. (Online at http://pubs.er.usgs.gov/usgspubs/ofr/ofr84889).

Slack, J.F., Atelsek, P.J., and Whitlow, J.W., 1990. Geochemistry of Stream Sediments and Heavy-Mineral Concentrates from the Orange County Copper District, East-Central Vermont: Summary Results of the Glens Falls CUSMAP Project, New York, Vermont, and New Hampshire. United States Geological Survey Bulletin, p. Q1-Q21. (Online at http://pubs.er.usgs.gov/usgspubs/b/b1887).

Slack, J.F., Offield, T.W., Shanks, W.C., III, and Woodruff, L.G., 1993. Besshi-Type Massive Sulfide Deposits of the Vermont Copper Belt. Society of Economic Geologists Guidebook Series, v. 17, Part II, p. 32-73.

Slack, J.F., Offield, T.W., Woodruff, L.G., and Shanks, W.C., III, 2001. Geology and Geochemistry of Besshi-Type Massive Sulfide Deposits of the Vermont Copper Belt. Society of Economic Geologists Guidebook Series, v. 35, p. 193-211.

Thompson, K.M., and J.D. Graham, 1996. Going beyond the single number: using probabilistic risk assessment to improve risk management. Human and Ecological Risk Assessment 2(4):1008-1034.

Totten, B., 1999. Analysis of Iron Oxide Coating That Have Formed As a Result of Acid Mine Drainage From the Pike Hill Copper Mine in Northeastern Vermont. The Vermont Geological Society's spring meeting, presentation of student papers: The Green Mountain Geologist, v. 26, n. 2, p. 13-14.

Town of Vershire, 2000. Town of Vershire, Vermont, 2000 Census. (Online at http://www.usgennet.org/usa/vt/county/orange/vershire/index.htm).

URS Corporation (URS), 2004). Draft Field Sampling Plan, Ely Mine. October 26.

URS, 2005. Habitat Characterization Report, Ely Mine, Vershire, Vermont. April 4.

URS, 2006a. Draft Final Report, Remedial Investigation Report, Elizabeth Mine, South Strafford, VT. 19 May.

URS, 2006b. Draft Final Report, Feasibility Study Report, Elizabeth Mine, Strafford, VT. 7 July.

URS, 2008. Data Transmittal – Remedial Investigation Data, Ely Mine, Vershire, Vermont. March 2008.

USGS, Unpublished 2008. Summary Data from Slides Presented at Ely Mine and Pike Hill Mine Eco Team Meeting. March 13.

USEPA, (1988). Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA. October.

USEPA, (1989). Risk Assessment Guidance for Superfund (RAGS), Volume I, Human Health Evaluation (Part A) Interim Final. Office of Emergency and Remedial Response, Washington, DC. USEPA/540/1-89/002. December.

USEPA, (1992). CERCLA/Superfund Orientation Manual. Section XII. USEPA 542/R-92/005. October.

USEPA, 1993a and 1993b. Wildlife Exposure Factors Handbook. Volumes I and II. Office of Research and Development. USEPA/600/R-93/187a, USEPA/600/R-93/187b.

USEPA, 1997a. Exposure Factors Handbook. Office of Research and Development, USEPA/600/P 95/002F. Washington, DC.

USEPA, 1997b. Health Effects Assessment Summary Tables (HEAST). FY-1997 Update. USEPA 540/R 97-036. Publication No. 9200.6 303(97-1). NTIS No. PB97 921199. Office of Emergency and Remedial Response and Office of Research and Development, Washington, DC.

USEPA 1998. Clarification to the 1994 Revised Interim Soil Lead (Pb) Guidance for CERCLA Sites and RCRA Corrective Action Facilities. USEPA/540/F-98-030, August.

USEPA, 2001. USEPA Requirements for Quality Assurance Project Plans. USEPA QA/R-5. March.

USEPA, 2002a. Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites. OSWER 9355.4-24. Office of Solid Waste and Emergency Response, Washington, DC. December.

USEPA, 2002b. Child-Specific Exposure Factors Handbook. USEPA-600-P-00-002B. National Center for Environmental Assessment, Washington, DC. Interim Report. September.

USEPA 2004a. NPL Site Narrative for Pike Hill Copper Mine. 22 July.

USEPA, 2004b. Risk Assessment Guidance for Superfund (RAGS). Volume 1: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment). Final. USEPA/540/R/99/005. NTIS No. PB99 963312. Office of Emergency and Remedial Response, Washington, DC. July.

USEPA, 2005. Guidance for Developing Soil Screening Levels. OSWER Directive 9285.7-55. Office of Solid Waste and Emergency Protection.

USEPA, 2007a. Framework for Metals Risk Assessment. Office of the Science Advisor. Risk Assessment Forum. USEPA 120/ R-07/001.

USEPA, 2007b. Guidance for Evaluating the Oral Bioavailability of Metals in Soils for Use in Human Health Risk Assessment. OSWER 9285.7-80. May.

USEPA, 2007c. Statement of Work, Ely Copper Mine Superfund Site, Remedial Investigation/Feasibility Study. September.

USEPA, 2010c. USEPA's ProUCL software.

Vermont Agency of Natural Resources (VTANR), 2003. Vermont Wetlands Bioassessment Program: An Evaluation of the Chemical, Physical, and Biological Characteristics of Seasonal Pools and Northern White Cedar Swamps. Final Report. June.

VTDEC, 2006. Low Risk Site Handbook for Erosion Prevention and Sediment Control. August.

VTDEC, 2007. Aquatic Life Use Attainment Assessment of Streams Influenced by the Ely Mine Site – Vermont, Ompompanoosuc River, Schoolhouse Brook, and Schoolhouse Brook Tributary 3.

White, W.S., and J.H. Eric, 1944. Preliminary Report – Geology of the Orange County Copper District, Vermont. USGS Open File Report, August.

Wiercinski, S., 1999. Geochemical and Mineralogical Analysis of the Pike Hill Mine Tailings, Corinth, Vermont. The Vermont Geological Society's spring meeting, presentation of student papers: The Green Mountain Geologist, v. 26, n. 2, p. 14-15.

TABLES

Table 1-1
Summary of Site Operations
Ely Copper Mine Superfund Site
Vershire, Vermont

Year of Investigation	Era of Operation	Operation Description
1813	Discovery	Gossan discovered by Richardson Family, used for dye.
1820s-1861	Upper Workings and Development Rock	Includes Tyson 1834/Pollard1854 Adit, Shaft II, 1850s/1860s Pollard Shaft and Adit
1820s-1861	Upper Waste Pile 4	Low grade ore
1830s	Vershire Copper Manufacturing Co.	Isaac Tyson, Jr. sporadically worked the deposit
1840s	Sporadic Prospecting	Pliny Dwight controlled the land
1853-1883	Vermont Copper Mining Company	Began large scale working of the deposit led by Thomas Pollard
mid-1850s-1918	Copper Mine Production	Peak production from 1870s-1880s. 30-40 million pounds total production
1850s-1860s	Deep Adit	Collapsed entrance, development rock pile remains
1850s-1880s	Washhouse	Schist slab foundation remains in Lower Waste Pile Area
1859	Rittler Map/Report	Documentation for Vermont Copper Mining Company (VCMC) of mine related features and associated buildings.
1861-1905	Main Adit (1861 Adit)	Main haulageway
1861-1905	Upper Waste Piles 6, 7, 8, and 9	Low grade ore, 1949-50 loading platform, 1861 Adit spur road
1864-1883	Smith Ely Era	Smith Ely became president of VCMC
1867-1905	Ore Roast Beds	Schist slab retaining wall, 900 ft of oxidized low grade ore, collapsed shaft
1867-1905	Smelter Building	Tramway embankment, retaining wall, furnace bases, bldg nearly 1,000 ft long, refined pig copper.
1867-1905	Slag Pile	Smelter/Slag pot skull layers remain
1870s-1880s	Burleigh Shaft	Shaft entrance remains partially collapsed.
1877	Smoke Flue	Schist slab flue, stack footing remain
1881-1905	Main Shaft	Primary shaft hoist access
1882	Vermont Copper Company of NY	Francis Cazin and Ely -Goddard took control of the mine
1882-pre-1902	Reservoir (Pond 1)	Earthen/rubble dam on the east branch of Ely Brook. Possibly Westinghouse Era
1883	The "Ely War"	Vermont Copper Company worker revolt and company collapse
Late 1800s	Shaft No 4	Collapsed entrance, development rock pile remains
1883-1899	Mine Decline	Mine ownership changed hands multiple times
1900-1905	Westinghouse Era	Modernization of smelting process, little production
1905	End of Underground Mining	Site buildings and equipment were sold, and property was stripped
1917-1918	World War I Era Flotation Mill	Foundations, walls, floor slabs remain
1917-1918	Ely-Copperfield Association of NY, NY	Flotation Mill constructed to reprocess 19,000 tons of mine waste piles. Mill shut down at end of WWI
1942-1950	World War II Era	Assay of mine dumps. 1949-50, 60,000 tons of waste ore transported to Elizabeth Mine yielding 1.2 million pounds of copper
mid-1950s	Appalachian Sulphides, Inc	Prospect drill holes completed

Table 1-2
Summary of Site Investigations
Ely Copper Mine Superfund Site
Vershire, Vermont

Year of Investigation	Principle Investigator	Investigation Description	Sampling Summary
2001	Slack and others	Geology and geochemistry of ore and rocks of VT Copper Belt	
2002	USGS and USACE	Geochemical diversity of water sources in the Ely Brook Watershed	surface water sampling from seeps from mine waste areas, Ely Brook and tributaries, Schoolhouse Brook, and the Ompompanoosuc River
2004 and 2007	USGS		various solid mine waste materials and sediment, geochemistry of the slag material deposited along South Vershire Road
2005 to 2008	URS and USACE	Habitat characterization	terrestrial habitats, potential wetland areas, potential terrestrial receptors
			test pits and borings in waste areas
			monitoring well installation
			surface water samples
			sediment samples
			surface and subsurface soil samples
			groundwater samples
			residential samples
2007	VTDEC	Aquatic Life Use Attainment Assessment	evaluation of fish and macroinvertebrate data
2008	Techlaw	Aquatic Baseline Ecological Risk Assessment	surface water samples
			sediment samples
			porewater samples
2009	Nobis	Remedial Investigation	terrestrial habitats, potential wetland areas, potential terrestrial receptors
			test pits and borings in waste areas
			monitoring well installation
			surface water samples
			sediment samples
			surface and subsurface soil samples
			groundwater samples
			residential samples

Notes:
USGS = United States Geological Survey
USACE = United States Army Corp of Engineers
VTDEC = Vermont Department of Environmental Conservation

Table 1-3
COPCs and COPECs
Ely Copper Mine Site Superfund Site
Vershire, Vermont

Analyte	Surface Soil - 0'-1' ft bgs [3]	Total Soil - 0'-10' ft bgs	Sediment	Surface Water	Vernal Pools	Overburden Groundwater	Shallow Bedrock Groundwater	Deep Bedrock Groundwater	Residential Groundwater	Soil Invertebrates	Small Mammals
Aluminum	H [1]	H	H	H		H, E [2]	H	H		E	E
Aroclor 1248								H			
Antimony	H	H				E	H				
Arsenic	H	H	H	H		H, E	H	H			E
Barium					E	H					
Beryllium							H				
Bis(2-Ethylhexyl)Phthalate								H			
Cadmium	H	H		H	E	H, E	H	H		E	E
Chromium	H	H	H	H		H, E	H	H	H	E	E
Cobalt	H	H	H	H		H, E	H	H			
Copper	H	H	H	H, E	E	H, E	H	H	H	E	E
Iron	H	H	H	H		H, E	H	H		E	E
Lithium			H	H							
Lead	H	H				H, E	H				E
Manganese	H	H	H	H	E	H, E	H	H		E	E
Mercury	H	H		H		E					
Molybdenum	H	H				H, E	H				
Nickel		H		H		H, E	H	H			
Selenium	H	H	H			E					
Silver	E					E				E	
Strontium	E					E					
Thallium	E					E					
Vanadium	H	H	H	H		H, E	H	H	H		
Zinc	E	H		H		H, E	H			E	E

Notes:
1. H = maximum detected concentration in exceedance of human health risk screening level.
2. E = maximum detected soil or surface water concentration in exceedance of ecological risk screening level or any compound detected in biota.
3. ft bgs = feet below ground surface.

Table 1-4
Human Health Risk Assessment Summary
Ely Copper Mine Superfund Site
Vershire, Vermont

Exposure Point	RME																	
	Current				Future						Current/Future							
	Resident				Construction Worker		Resident				Recreational Visitor				Swimmer/Wader			
	Child		Adult		Adult		Child		Adult		Adolescent		Adult		Adolescent		Adult	
	ILCR	HI	ILCR	HI	ILCR	HI	ILCR	HI	ILCR	HI	ILCR	HI	ILCR	HI	ILCR	HI	ILCR	HI
Ely Copper Mine Surface Soil	4.9E-06	3.1 GI HI = 1.6 (Fe = 1.2); Thyroid HI = 1.0 (Co)	2.2E-06	0.34							6.7E-07	0.32	1.8E-06	0.29				
Ely Copper Mine Total Soil					7.4E-07	2.3 Nervous system HI = 1.1 (Mn = 0.85)	4.1E-06	4.5 Thyroid HI = 2.1 (Co); GI HI = 1.8 (Fe = 1.2)	1.9E-06	0.49								
Ely Brook Sediment															1.1E-07	0.050	2.7E-07	0.037
Ely Brook Surface Water															6.3E-09	0.12	1.5E-08	0.098
Schoolhouse Brook Sediment															4.4E-08	0.021	1.0E-07	0.015
Schoolhouse Brook Surface Water															NC	0.0074	NC	0.0059
Ompompanoosuc River Sediment															1.6E-07	0.019	3.7E-07	0.015
Ompompanoosuc River Surface Water															NC	0.00041	NC	0.00035
Overburden Groundwater							6.3E-05	274 (see table below)	1.1E-04 (due to arsenic)	117								
Shallow Bedrock Groundwater							4.0E-05	141 (see table below)	6.9E-05	60								
Deep Bedrock Groundwater							2.2E-05	55 (see table below)	3.8E-05	24								
Residential Groundwater							NC	0.32	NC	0.13								

Notes:
Geometric mean blood lead levels were below 10 µg/dL for all exposure points.
ILCR = Incremental lifetime cancer risk.
GI = gastrointestinal
HI = Hazard index.
NC = No carcinogens evaluated for this exposure point.

Total Overburden HI = 274	**Total Shallow Bedrock HI = 141**	**Total Deep Bedrock HI = 55**
Thyroid HI = 142 (Co)	Thyroid HI = 57 (Co)	Thyroid HI = 33 (Co)
GI HI = 98 (Cu = 80)	GI HI = 46 (Fe = 28)	GI HI = 16 (Cu = 14)
Nervous system HI = 22 (Mn = 12)	Nervous system HI = 32 (Al = 23)	Nervous system HI = 4.9 (Mn = 4.4)
Kidney HI = 6.4 (Cd = 5.3)	Kidney HI = 3.1 (Cd = 1.9)	
Skin HI = 1.6 (As)	Blood HI = 1.1 (Sb = 0.72)	
Systemic HI = 1.3 (Ni)	Skin HI = 1.0 (As)	

Green shading indicates ILCR less than 1E-06 and/or HI less than 1.
Blue shading indicates ILCR between 1E-06 and 1E-04.
Red shading indicates ILCR greater than 1E-04 and/or target organ HI greater than 1.

Table 1-5
Summary of the Evidence for Ecological Risk at Pond 2 on the East Branch of Ely Brook
Ely Copper Mine Superfund Site
Vershire, Vermont

Receptor Group	Measurement Endpoint	Weight of Evidence	Risk Conclusion	Major Uncertainties	Comments
Benthic Invertebrates	1.A: Compare the COPEC levels in bulk sediment samples to conservative no effect and effect sediment benchmarks.	Low	It was concluded, with a high level of confidence, that adverse effects to the benthic invertebrate community were unlikely.	The potential for ecological risk may be moderately overestimated because the sediment benchmarks were generic and conservative, site bioavailability was not considered, and exposure concentrations were obtained by strong acid digestion of sediment.	--
	OVERALL RISK CONCLUSION		***No ecological risk is expected to the benthic invertebrate community in Pond 2.***		
Water Column Invertebrates	2.A: Compare the dissolved COPEC levels in surface water samples to acute and chronic surface water benchmarks.	Low	It was concluded, with a high level of confidence, that adverse effects to the water column invertebrate community were possible.	The potential for ecological risk may be moderately underestimated, mainly because the water samples were collected mostly in May and June and did not include "high flow" events. However, the surface water benchmarks were generic and conservative.	Manganese had the highest IR CTE chronic HQ. The exceedance was relatively small (HQ = 4.4) and not expected to cause severe impairment.
	OVERALL RISK CONCLUSION		***Only minor ecological risk to the water column invertebrate community is expected in Pond 2.***		
Fish	This receptor group was not evaluated for ecological risk in Pond 2.	--	--	--	--
Amphibians	4.A: Compare the dissolved COPEC levels in surface water samples to acute and chronic surface water benchmarks.	Low	It was concluded, with a high level of confidence, that averse effects to the embryo-larval stages of amphibians were possible.	The potential for ecological risk may be slightly underestimated, mainly because the surface water benchmarks did not account for potential low pH effects in Pond 2 during the breeding season. However, the surface water benchmarks were generic and	Manganese had the highest IR CTE chronic HQ. The exceedance was relatively small (HQ = 4.4) and not expected to cause severe impairment.
	4.B: Evaluate survival and growth in neonates of the fathead minnow (*Pimephales promelas*, used as surrogates for the embryo-larval life stages of amphibians) exposed in the laboratory for seven days to surface water samples.	Medium	Measurement endpoint 4.B was not evaluated in Pond 2.	--	--
	4.C: Evaluate *in-situ* survival and development of wood frog eggs and tadpoles collected from an off-site reference locations and transferred to the on-site ponds.	High	Measurement endpoint 4.C was not evaluated in Pond 2.	--	--
	OVERALL RISK CONCLUSION		***A small potential for ecological risk is expected to the embryo-larval stages of amphibians in Pond 2.***		
Insectivorous Birds	This receptor group was not evaluated for ecological risk in Pond 2.	--	--	--	--
Insectivorous Mammals	This receptor group was not evaluated for ecological risk in Pond 2.	--	--	--	--
Piscivorous Birds	This receptor group was not evaluated for ecological risk in Pond 2.	--	--	--	--
Piscivorous Mammals	This receptor group was not evaluated for ecological risk in Pond 2.	--	--	--	--

Notes: COPEC = contaminant of potential concern
CTE = central tendency exposure
HQ = hazard quotient
IR = incremental risk
RME = reasonable maximum exposure

Table 1-6
Summary of the Evidence for Ecological Risk at Pond 3 on the East Branch of Ely Brook
Ely Copper Mine Superfund Site
Vershire, Vermont

Receptor Group	Measurement Endpoint	Weight of Evidence	Risk Conclusion	Major Uncertainties	Comments
Benthic Invertebrates	1.A: Compare the COPEC levels in bulk sediment samples to conservative no effect and effect sediment benchmarks.	Low	It was concluded, with a high level of confidence, that adverse effects to the benthic invertebrate community were possible.	The potential for eco risk may be moderately overestimated because the sediment benchmarks were generic and conservative, site bioavailability was not considered, and exposure concentrations were obtained by strong acid digestion of sediment.	Manganese had the highest IR CTE effect HQ. The exceedance was small (HQ = 2.5) and not expected to cause severe impairment.
	OVERALL RISK CONCLUSION		***Minor ecological risk is expected to the benthic invertebrate community in Pond 3.***		
Water Column Invertebrates	2.A: Compare the dissolved COPEC levels in surface water samples to acute and chronic surface water benchmarks.	Low	It was concluded, with a high level of confidence, that adverse effects to the water column invertebrate community were possible.	The potential for eco risk may be moderately underestimated, mainly because the water samples were collected mostly in May and June and did not include "high flow" events. However, the surface water benchmarks were generic and conservative.	Manganese had the highest IR CTE chronic HQ. The exceedance was small (HQ = 3.6) and not expected to cause severe impairment.
	OVERALL RISK CONCLUSION		***Minor ecological risk is expected to the water column invertebrate community in Pond 3.***		
Fish	This receptor group was not evaluated for ecological risk in Pond 3.	--	--	--	--
Amphibians	4.A: Compare the dissolved COPEC levels in surface water samples to acute and chronic surface water benchmarks.	Low	It was concluded, with a high level of confidence, that adverse effects to the embryo-larval stages of amphibians were possible.	The potential for eco risk may be slightly underestimated, mainly because the surface water benchmarks did not account for potential low pH effects in Pond 3 during the breeding season. However, the surface water benchmarks were generic and conservative.	Manganese had the highest IR CTE chronic HQ. The exceedance was small (HQ = 3.6) and not expected to cause severe impairment.
	4.B: Evaluate survival and growth in neonates of the fathead minnow (*Pimephales promelas*, used as surrogates for the embryo-larval life stages of amphibians) exposed in the laboratory for seven days to surface water samples.	Medium	Measurement endpoint 4.B was not evaluated in Pond 3.	--	--
	4.C: Evaluate in-situ survival and development of wood frog eggs and tadpoles collected from an off-site reference locations and transferred to the on-site ponds.	High	Measurement endpoint 4.C was not evaluated in Pond 3.	--	--
	OVERALL RISK CONCLUSION		***Minor ecological risk is expected to the embryo-larval stages of amphibians in Pond 3.***		

Table 1-6
Summary of the Evidence for Ecological Risk at Pond 3 on the East Branch of Ely Brook
Ely Copper Mine Superfund Site
Vershire, Vermont

Receptor Group	Measurement Endpoint	Weight of Evidence	Risk Conclusion	Major Uncertainties	Comments
Insectivorous Birds	This receptor group was not evaluated for ecological risk in Pond 3.	--	--	--	--
Insectivorous Mammals	This receptor group was not evaluated for ecological risk in Pond 3.	--	--	--	--
Piscivorous Birds	This receptor group was not evaluated for ecological risk in Pond 3.	--	--	--	--
Piscivorous Mammals	This receptor group was not evaluated for ecological risk in Pond 3.	--	--	--	--

Notes:
COPEC = contaminant of potential concern
CTE = central tendency exposure
HQ = hazard quotient
IR = incremental risk
RME = reasonable maximum exposure

Table 1-7
Summary of the Evidence for Ecological Risk at Pond 4 on the East Branch of Ely Brook
Ely Copper Mine Superfund Site
Vershire, Vermont

Receptor Group	Measurement Endpoint	Weight of Evidence	Risk Conclusion	Major Uncertainties	Comments
Benthic Invertebrates	1.A: Compare the COPEC levels in bulk sediment samples to conservative no effect and effect sediment benchmarks.	Low	It was concluded, with a high level of confidence, that adverse effects to the benthic invertebrate community were possible.	The potential for eco risk may be moderately overestimated because the sediment benchmarks were generic and conservative, site bioavailability was not considered, and exposure concentrations were obtained by strong acid digestion of sediment.	Copper had the highest IR CTE effect HQ. The exceedance was small (HQ = 2.2) and not expected to cause severe impairment.
	OVERALL RISK CONCLUSION		***Minor ecological risk to the benthic invertebrate community is expected in Pond 4.***		
Water Column Invertebrates	2.A: Compare the dissolved COPEC levels in surface water samples to acute and chronic surface water benchmarks.	Low	It was concluded, with a moderate level of confidence, that adverse effects to the water column invertebrate community were possible.	The potential for eco risk may be moderately underestimated, mainly because the water samples were collected mostly in May and June and did not include "high flow" events in early spring and fall. However, the surface water benchmarks were generic and conservative.	No IR CTE chronic HQs exceeded 1.0. Only copper and manganese had chronic IR RME HQ's above 1.0 (6.6 and 1.7, respectively). These relatively small exceedances of a "worst case" exposure scenario are not expected to cause severe impairment.
	OVERALL RISK CONCLUSION		***Minor ecological risk to the water column invertebrates is expected in Pond 4.***		
Fish	This receptor group was not evaluated for ecological risk in Pond 4.	--	--	--	--
Amphibians	4.A: Compare the dissolved COPEC levels in surface water samples to acute and chronic surface water benchmarks.	Low	It was concluded, with a moderate level of confidence, that adverse effects to the embryo-larval stages of amphibians were possible.	The potential for eco risk may be slightly underestimated, mainly because the surface water benchmarks did not account for potential low pH effects in Pond 4 during the breeding season. However, the surface water benchmarks were generic and conservative.	No IR CTE chronic HQs exceeded 1.0. Only copper and manganese had chronic IR RME HQ's above 1.0 (6.6 and 1.7, respectively). These small exceedances of a "worst case" exposure scenario are not expected to cause severe impairment.
	4.B: Evaluate survival and growth in neonates of the fathead minnow (*Pimephales promelas*, used as surrogates for the embryo-larval life stages of amphibians) exposed in the laboratory for seven days to surface water samples.	Medium	It was concluded that adverse effects to the embryo-larval stages of amphibians were present.	The potential for eco risk may be moderately underestimated, mainly because the water samples were collected over three days in late June and did not represent the full exposure potential during the amphibian breeding season (May-June). Metal precipitation in the test water may also have decreased toxicity.	Only 20% of the fathead minnow neonates survived the seven-day exposure to Pond 4 surface water.
	4.C: Evaluate in-situ survival and development of wood frog eggs and tadpoles collected from an off-site reference locations and transferred to the on-site ponds.	High	It was concluded that adverse effects to the embryo-larval stages of amphibians were present.	The potential for eco risk may be moderately underestimated, mainly because the physical and chemical conditions inside the Nytex cages may have caused some of the dissolved metals to precipitate out or bind to organic matter. On the other hand, the exposure was realistic (*in-situ* in early May) and used a local amphibian species.	Hatching success was no different from that observed in the reference Ponds. However, survival of wood frog tadpoles exposed for eight days to Pond 4 surface water was poor.
	OVERALL RISK CONCLUSION		***Severe ecological risk to the embryo-larval stages of amphibians is expected in Pond 4.***		

Table 1-7
Summary of the Evidence for Ecological Risk at Pond 4 on the East Branch of Ely Brook
Ely Copper Mine Superfund Site
Vershire, Vermont

Receptor Group	Measurement Endpoint	Weight of Evidence	Risk Conclusion	Major Uncertainties	Comments
Insectivorous Birds	This receptor group was not evaluated for ecological risk in Pond 4.	--	--	--	--
Insectivorous Mammals	This receptor group was not evaluated for ecological risk in Pond 4.	--	--	--	--
Piscivorous Birds	This receptor group was not evaluated for ecological risk in Pond 4.	--	--	--	--
Piscivorous Mammals	This receptor group was not evaluated for ecological risk in Pond 4.	--	--	--	--

Notes:
COPEC = contaminant of potential concern
CTE = central tendency exposure
HQ = hazard quotient
IR = incremental risk
RME = reasonable maximum exposure

Table 1-8
Summary of the Evidence for Ecological Risk at Pond 5 on the East Branch of Ely Brook
Ely Copper Mine Superfund Site
Vershire, Vermont

Receptor Group	Measurement Endpoint	Weight of Evidence	Risk Conclusion	Major Uncertainties	Comments
Benthic Invertebrates	1.A: Compare the COPEC levels in bulk sediment samples to conservative no effect and effect sediment benchmarks.	Low	It was concluded, with a high level of confidence, that adverse effects to the benthic invertebrate community were possible.	The potential for eco risk may be moderately overestimated because screening benchmarks are generic and conservative; site bioavailability was not considered, and the exposure concentrations were obtained by strong acid digestion of sediment.	Copper had the highest IR CTE effect HQ. The exceedance equaled 23 and was expected to cause severe impairment.
	OVERALL RISK CONCLUSION		***Severe ecological risk to the benthic invertebrate community is expected in Pond 5.***		
Water Column Invertebrates	2.A: Compare the dissolved COPEC levels in surface water samples to acute and chronic surface water benchmarks.	Low	It was concluded, with a high level of confidence, that adverse effects to the water column invertebrate community were possible.	The potential for eco risk may be moderately underestimated, mainly because the water samples were collected mostly in May and June and did not include "high flow" events. However, the benchmarks were generic and conservative.	Copper had the highest IR CTE chronic HQ. The exceedance equaled 45 and was expected to cause severe impairment.
	OVERALL RISK CONCLUSION		***Severe ecological risk to the water column invertebrate community is expected in Pond 5.***		
Fish	This receptor group was not evaluated for ecological risk in Pond 5.	--	--	--	--
Amphibians	4.A: Compare the dissolved COPEC levels in surface water samples to acute and chronic surface water benchmarks.	Low	It was concluded, with a high level of confidence, that adverse effects to the embryo-larval stages of amphibians were possible.	The potential for eco risk may be slightly underestimated, mainly because the surface water benchmarks did not account for potential low pH effects in Pond 5 during the breeding season. However, the surface water benchmarks were generic and conservative.	Copper had the highest IR CTE chronic HQ. The exceedance equaled 45 and was expected to cause severe impairment.
	4.B: Evaluate survival and growth in neonates of the fathead minnow (*Pimephales promelas*, used as surrogates for the embryo-larval life stages of amphibians) exposed in the laboratory for seven days to surface water samples.	Medium	It was concluded that adverse effects to the embryo-larval stages of amphibians were present.	The potential for eco risk may be moderately underestimated, mainly because the water samples were collected over three days in late June and did not represent the full exposure potential during the amphibian breeding season (May-June). Metal precipitation in the test water may also have decreased toxicity.	None of the fathead minnow neonates survived the seven-day exposure to Pond 5 surface water.
	4.C: Evaluate in-situ survival and development of wood frog eggs and tadpoles collected from an off-site reference locations and transferred to the on-site ponds.	High	It was concluded that adverse effects to the embryo-larval stages of amphibians were present.	The potential for eco risk may be moderately underestimated, mainly because the physical and chemical conditions inside the Nytex cages could have caused some of the dissolved metals to precipitate out or bind to organic matter. On the other hand, the exposure was realistic (*in-situ* in early May) and used a local amphibian species.	Hatching success was no different from that observed in the reference Ponds. However, 100% of the tadpoles died within a few days of hatching.
	OVERALL RISK CONCLUSION		***Severe ecological risk to the embryo-larval stages of amphibians is expected in Pond 5.***		

Table 1-8
Summary of the Evidence for Ecological Risk at Pond 5 on the East Branch of Ely Brook
Ely Copper Mine Superfund Site
Vershire, Vermont

Receptor Group	Measurement Endpoint	Weight of Evidence	Risk Conclusion	Major Uncertainties	Comments
Insectivorous Birds	This receptor group was not evaluated for ecological risk in Pond 5.	--	--	--	--
Insectivorous Mammals	This receptor group was not evaluated for ecological risk in Pond 5.	--	--	--	--
Piscivorous Birds	This receptor group was not evaluated for ecological risk in Pond 5.	--	--	--	--
Piscivorous Mammals	This receptor group was not evaluated for ecological risk in Pond 5.	--	--	--	--

Notes:
COPEC = contaminant of potential concern
CTE = central tendency exposure
HQ = hazard quotient
IR = incremental risk
RME = reasonable maximum exposure

Table 1-9
Summary of the Evidence for Ecological Risk in the Main Stem of Ely Brook
Ely Copper Mine Superfund Site
Vershire, Vermont

Receptor Group	Measurement Endpoint	Weight of Evidence	Risk Conclusion	Major Uncertainties	Comments
Benthic Invertebrates	1.A: Compare the COPEC levels in bulk sediment samples to conservative no effect and effect sediment benchmarks.	Low	It was concluded, with a high level of confidence, that adverse effects to the benthic invertebrate community were possible.	The potential for ecological risk may be moderately overestimated because screening benchmarks are generic and conservative; site bioavailability was not considered, and the exposure concentrations were obtained by strong acid digestion of sediment.	Cu had the highest IR CTE effect HQ. The exceedance equaled 19 and was expected to cause severe impairment.
	1.B: Compare the dissolved COPEC levels in sediment pore water samples to acute and chronic surface water benchmarks.	Low	It was concluded, with a high level of confidence, that adverse effects to the benthic invertebrate community were possible.	The potential for ecological risk may be moderately to severely underestimated because the pore water samples were collected only during base flow when COPEC levels were expected to be the lowest. Acidity may also become an issue during high flow.	Mn and Cu had the highest IR CTE chronic HQs. The exceedances equaled 6.4 and 4.7, respectively, and were expected to cause some impairment.
	1.C: Estimate the bioavailability of divalent metals in sediment based on AVS-SEM.	Low	It was concluded that adverse effects were possible because SEM exceeded AVS in all nine sediment samples collected for analysis, indicating that the divalent metals could be bioavailable.	The potential for ecological risk may be moderately overestimated. Sediment is not always toxic when SEM exceeds AVS because other (unquantified) binding phases, such as iron oxides, can decrease metal bioavailability.	--
	1.D: Measure survival in *H. azteca* and *C. tentans* exposed for 96 hours in the laboratory to sediment pore water samples.	Medium	It was concluded that adverse effects were present for sensitive species of the benthic invertebrate community.	The potential for ecological risk may be moderately to severely underestimated because the pore water samples were collected only during base flow (August) when COPEC levels were expected to be the lowest. Acidity may also become an issue during high flow.	All three pore water samples were acutely toxic to the amphipod, but none was toxic to the chironomid fly larvae (*C. tentans*).
	1.E: Measure survival and growth in the benthic invertebrate species *H. azteca* and *C. tentans* exposed in the laboratory to bulk sediment samples.	Medium	It was concluded that adverse effects were present for sensitive species of the benthic invertebrate community.	The potential for ecological risk may be moderately overestimated because (1) the sediment samples were collected from depositional areas which do not represent the whole stream, and (2) conditions in the test beakers are more static than those present in native substrate.	Two of the three samples were toxic to both species. A third sample had the highest metal levels and lowest pH, but was non-toxic. The hard water used for the daily water renewals appeared to have increased pH and caused all dissolved metals to precipitate out.
	1.F: Evaluate the structure and function of the benthic invertebrate community.	High	It was concluded that the benthic invertebrate community was severely impaired in the main stem of Ely Brook.	The potential for ecological risk was expected to be as reported. The structure of the benthic invertebrate community represents a chronic response of chemical conditions integrated over time.	The health of the benthic community did not improve between 1987 and 2006.
	OVERALL RISK CONCLUSION		***Severe ecological risk to the benthic invertebrate community was present in the main stem of Ely Brook.***		

Table 1-9
Summary of the Evidence for Ecological Risk in the Main Stem of Ely Brook
Ely Copper Mine Superfund Site
Vershire, Vermont

Receptor Group	Measurement Endpoint	Weight of Evidence	Risk Conclusion	Major Uncertainties	Comments
Water Column Invertebrates	This receptor group was not evaluated for ecological risk in the main stem of Ely Brook.		--	--	No comment.
Fish	3.A: Compare the dissolved COPEC levels in surface water samples to acute and chronic surface water benchmarks	Low	It was concluded, with a high level of confidence, that adverse effects to the fish community were possible.	The potential for ecological risk was expected to be moderately underestimated because the surface water benchmarks did not account for the effects of potential low pH episodes during certain times of the year.	Cu and Al had the highest IR CTE chronic HQs. The exceedances equaled 281and 68, respectively, and were expected to cause severe impairment.
	3.B: Evaluate survival and growth in juvenile fathead minnows (*Pimephales promelas*) exposed in the laboratory for seven days to surface water samples.	Medium	It was concluded, with a high level of confidence, that adverse effects to the fish community were possible.	The potential for ecological risk was expected to be moderately underestimated because (1) the samples were collected in late June of 2006 when chemical conditions were less severe than during high-flow events, (2) a single fish species was tested for a relatively short period of time, and (3) COPEC levels may have changed in the renewal samples due to metal precipitation.	The one surface water sample collected from the main stem of Ely Brook for toxicity testing resulted in 100% mortality in fathead minnow neonates after seven days of exposure.
	3.C: Compare COPEC levels measured in whole fish to no effect and effect Critical Body Residues (CBRs).	Medium	Measurement endpoint 3.C was not evaluated because no fish live in the main stem of Ely Brook.	--	No comment.
	3.D: Evaluate the structure and function of the fish community.	High	Measurement endpoint 3.D was not evaluated because no fish live in the main stem of Ely Brook.	--	The lack of fish in the main stem of Ely Brook indicates the presence of high toxicity in its surface waters.
	OVERALL RISK CONCLUSION		***Severe ecological risk to the fish community was present in the main stem of Ely Brook.***		

Table 1-9
Summary of the Evidence for Ecological Risk in the Main Stem of Ely Brook
Ely Copper Mine Superfund Site
Vershire, Vermont

Receptor Group	Measurement Endpoint	Weight of Evidence	Risk Conclusion	Major Uncertainties	Comments
Amphibians	This receptor group was not evaluated for ecological risk in the main stem of Ely Brook.	--	--	--	--
Insectivorous Birds	This receptor group was not evaluated for ecological risk in the main stem of Ely Brook.	--	--	--	--
Insectivorous Mammals	This receptor group was not evaluated for ecological risk in the main stem of Ely Brook.	--	--	--	--
Piscivorous Birds	This receptor group was not evaluated for ecological risk in the main stem of Ely Brook.	--	--	--	--
Piscivorous Mammals	This receptor group was not evaluated for ecological risk in the main stem of Ely Brook.	--	--	--	--

Notes:
AVS = acid-volatile sulfides
COPEC = contaminant of potential ecological concern
CTE = central tendency exposure
IR = incremental risk
HQ = hazard quotient
RME = reasonable maximum exposure
SEM = simultaneously extracted metals

Table 1-10
Summary of the Evidence for Ecological Risk in Schoolhouse Brook
Ely Copper Mine Superfund Site
Vershire, Vermont

Receptor Group	Measurement Endpoint	Weight of Evidence	Risk Conclusion	Major Uncertainties	Comments
Benthic Invertebrates	1.A: Compare the COPEC levels in bulk sediment samples to conservative no effect and effect sediment benchmarks.	Low	It was concluded, with a high level of confidence, that adverse effects to the benthic invertebrate community were possible.	The potential for ecological risk may be moderately overestimated because screening benchmarks are generic and conservative; site bioavailability was not considered, and the exposure concentrations were obtained by strong acid digestion of sediment.	Copper had the highest IR CTE effect HQ. The exceedance equaled 1.9 and was not expected to cause severe impairment by itself.
	1.B: Compare the dissolved COPEC levels in sediment pore water samples to acute and chronic surface water benchmarks.	Low	It was concluded, with a high level of confidence, that adverse effects to the benthic invertebrate community were possible.	The potential for ecological risk may be moderately to severely underestimated because the pore water samples were collected only during base flow when COPEC levels were expected to be the lowest.	The potential for ecological risk was associated mainly with thallium, which had the only IR CTE chronic HQ > 1.0 (HQ = 6.7).
	1.C: Estimate the bioavailability of divalent metals in sediment based on AVS-SEM.	Low	It was concluded that risk was possible because SEM exceeded AVS in all ten sediment samples collected for analysis, indicating that the divalent metals could be bioavailable.	The potential for ecological risk may be moderately overestimated. Sediment is not always toxic when SEM exceeds AVS because other (unquantified) binding phases, such as iron oxides, can decrease metal bioavailability.	--
	1.D: Measure survival in *H. azteca* and *C. tentans* exposed for 96 hours in the laboratory to sediment pore water samples.	Medium	It was concluded that adverse effects were not present because the pore water samples collected from Schoolhouse brook were not acutely toxic to either *H. azteca* or *C. tentans*.	The potential for ecological risk may be moderately to severely underestimated because the pore water samples were collected only during base flow (August) when COPEC levels were expected to be the lowest.	The evidence showed that conditions in the substrate were suitable for sensitive benthic invertebrates under short-term exposures at the time of pore water sampling.
	1.E: Measure survival and growth in the benthic invertebrate species *H. azteca* and *C. tentans* exposed in the laboratory to bulk sediment samples.	Medium	It was concluded that adverse effects were present because all four bulk sediment samples were toxic to both *H. azteca* and *C. tentans*.	The potential for ecological risk may be moderately overestimated because (1) the sediment samples were collected from depositional areas which do not represent the whole stream, and (2) conditions in the test beakers were more static than those present in native substrate.	--
	1.F: Evaluate the structure and function of the benthic invertebrate community.	High	It was concluded that the benthic invertebrate community was severely impaired in Schoolhouse Brook below the confluence with Ely Brook.	The potential for ecological risk was expected to be as reported. The structure of the benthic invertebrate community represents a chronic response of chemical conditions integrated over time.	The health of the benthic community did not improve appreciably between 1987 and 2006.
	OVERALL RISK CONCLUSION		***Severe ecological risk to the benthic invertebrate community was present in Schoolhouse Brook.***		

Table 1-10
Summary of the Evidence for Ecological Risk in Schoolhouse Brook
Ely Copper Mine Superfund Site
Vershire, Vermont

Receptor Group	Measurement Endpoint	Weight of Evidence	Risk Conclusion	Major Uncertainties	Comments
Water Column Invertebrates	This receptor group was not evaluated for ecological risk in Schoolhouse Brook.		--	--	--
Fish	3.A: Compare the dissolved COPEC levels in surface water samples to acute and chronic surface water benchmarks.	Low	It was concluded, with a high level of confidence, that adverse effects to the fish community were possible.	The potential for ecological risk was expected to be moderately underestimated because the surface water benchmarks did not account for the effects of potential low pH episodes during certain times of the year.	Copper had an IR CTE effect HQ equal to 7.8. This exceedance was likely to cause impairment to the local fish community.
	3.B: Evaluate survival and growth in juvenile fathead minnows (*Pimephales promelas*) exposed in the laboratory for seven days to surface water samples.	Medium	It was concluded that adverse effects were present for a sensitive fish life stage.	The potential for ecological risk was expected to be moderately underestimated because (1) the samples were collected in late June of 2006 when chemical conditions were less severe than during high-flow events, (2) a single fish species was tested for a relatively short period of time, and (3) COPEC levels may have changed in the renewal samples due to metal precipitation.	Fish survival was significantly lower at all four sampling locations in Schoolhouse Brook.
	3.C: Compare COPEC levels measured in whole fish to no effect and effect Critical Body Residues (CBRs).	Medium	It was concluded, with a high level of confidence, that adverse effects to the fish community were possible.	The potential for ecological risk was expected to be moderately overestimated because the fish tissue CBRs were quite conservative. On the other hand, cumulative risk was not considered and fish with higher residue levels may have been absent from the stream because they died out.	Cu was the only COPEC with an IR CTE effect HQ > 1.0. The Cu exceedances were small (HQ = 2.5 for brook trout and 1.3 for dace) and not expected to cause impairment by themselves. However, fish with higher tissue residues could have been eliminated from the local population.
	3.D: Evaluate the structure and function of the fish community.	High	It was concluded that the fish community was severely impaired in the entire section of Schoolhouse Brook below the confluence with Ely Brook.	The potential for ecological risk was expected to be as reported. The structure of the fish community represents a chronic response of chemical conditions integrated over time.	--
	OVERALL RISK CONCLUSION		***Severe ecological risk to the fish community was present in Schoolhouse Brook.***		

Table 1-10
Summary of the Evidence for Ecological Risk in Schoolhouse Brook
Ely Copper Mine Superfund Site
Vershire, Vermont

Receptor Group	Measurement Endpoint	Weight of Evidence	Risk Conclusion	Major Uncertainties	Comments
Amphibians	This receptor group was not evaluated for ecological risk in Schoolhouse Brook.	--	--	--	--
Insectivorous Birds	5.A: Use sediment analytical data to estimate the body residues of COPECs in winged aquatic insects; use food chain modeling to calculate daily doses from the ingestion of surface water (total metals) and winged aquatic insects, and compare these values to TRVs.	Medium-Low	It was concluded, with a high level of confidence, that adverse effects to insectivorous birds feeding over Schoolhouse Brook were possible.	The potential for ecological risk may be overestimated by a large margin because: (1) the COPEC levels in insects were derived using generic BAFs instead of Site-collected tissue samples, (2) some exposure parameters (e.g., AUFs and COPEC bioavailability) were conservative values for lack of site- or species-specific information, and (3) the TRVs were conservative, non species-specific, literature-derived values.	Cu and Se were the only COPECs with an IR RME and CTE effect HQ > 1.0. Both exceedances were relatively small (Cu CTE HQ = 6.4 and Se CTE HQ = 2.5) and would not be expected to cause severe impairment by themselves.
	OVERALL RISK CONCLUSION		***The potential exists for some ecological risk to insectivorous birds feeding on insects from Schoolhouse Brook.***		
Insectivorous Mammals	6.A: Use sediment analytical data to estimate the body residues of COPECs in winged aquatic insects; use food chain modeling to calculate daily doses from the ingestion of surface water (total metals) and winged aquatic insects, and compare these values to TRVs.	Medium-Low	It was concluded, with a high level of confidence, that adverse effects to insectivorous mammals feeding over Schoolhouse Brook were possible.	The potential for ecological risk may be overestimated by a large margin because: (1) the COPEC levels in insects were derived using generic BAFs instead of Site-collected tissue samples, (2) some exposure parameters (e.g., AUFs and COPEC bioavailability) were conservative values for lack of site- or species-specific information, and (3) the TRVs were conservative, non species-specific, literature-derived values .	Cu was the only COPEC with an IR RME and CTE effect HQ > 1.0. The CTE effect exceedance was large (HQ = 24) and could cause severe impairment.
	OVERALL RISK CONCLUSION		***The potential exists for severe ecological risk to insectivorous mammals feeding on insects from Schoolhouse Brook.***		
Piscivorous Birds	7.A: Use food chain modeling to calculate daily doses from the ingestion of surface water (total metals) and fish, and compare these values to TRVs.	Medium	It was concluded, with a moderate level of confidence, that adverse effects to piscivorous birds were unlikely.	The potential for ecological risk may be moderately overestimated because: (1) some exposure parameters (e.g., AUFs and COPEC bioavailability) were conservative values for lack of site- or species-specific information, and (2) the TRVs were conservative, non species-specific, literature-derived values.	No COPECs had an IR CTE effect HQ > 1.0.
	OVERALL RISK CONCLUSION		***Ecological risk is not expected to piscivorous birds feeding on fish from Schoolhouse Brook.***		
Piscivorous Mammals	8.A: Use food chain modeling to calculate daily doses from the ingestion of surface water (total metals) and fish, and compare these doses to TRVs.	Medium	It was concluded, with a high level of confidence, that adverse effects to piscivorous mammals were unlikely.	The potential for ecological risk may be moderately overestimated because: (1) some exposure parameters (e.g., AUFs and COPEC bioavailability) were conservative values for lack of site- or species-specific information, and (2) the TRVs were conservative, non species-specific, literature-derived values.	No COPECs had an IR CTE effect HQ > 1.0.
	OVERALL RISK CONCLUSION		***Ecological risk is not expected to piscivorous mammals feeding on fish from Schoolhouse Brook.***		

Notes:

AUF = area use factor
AVS = acid-volatile sulfides
COPEC = contaminant of potential ecological concern
CTE = central tendency exposure
IR = incremental risk
HQ = hazard quotient
RME = reasonable maximum exposure
SEM = simultaneously extracted metals
BAF = Bioaccumulation factor
TRV = toxicity reference value

Table 1-11
Summary of the Evidence for Ecological Risk in the East Branch of the Ompompanoosuc River (EBOR)
Ely Copper Mine
Vershire, Vermont

Receptor Group	Measurement Endpoint	Weight of Evidence	Risk Conclusion	Major Uncertainties	Comments
Benthic Invertebrates	1.A: Compare the COPEC levels in bulk sediment samples to conservative no effect and effect sediment benchmarks.	Low	It was concluded, with a high level of confidence, that adverse effects to the benthic invertebrate community were unlikely.	The potential for ecological risk may be moderately overestimated because screening benchmarks are generic and conservative; site bioavailability was not considered, and the exposure concentrations were obtained by strong acid digestion of sediment.	No COPECs had IR RME and IR CTE effects HQs > 1.0.
	1.B: Compare the dissolved COPEC levels in sediment pore water samples to acute and chronic surface water benchmarks.	Low	It was concluded, with a high level of confidence, that adverse effects to the benthic invertebrate community were unlikely.	The potential for ecological risk may be moderately to severely underestimated because the pore water samples were collected only during base flow when COPEC levels were expected to be the lowest.	No COPECs had IR RME and IR CTE chronic HQs > 1.0.
	1.C: Estimate the bioavailability of divalent metals in sediment based on AVS-SEM.	Low	It was concluded that risk was possible because SEM exceeded AVS in all five sediment samples collected for analysis, indicating that the divalent metals could be bioavailable.	The potential for ecological risk may be moderately overestimated. Sediment is not always toxic when SEM exceeds AVS because other (unquantified) binding phases, such as iron oxides, can decrease metal bioavailability.	--
	1.D: Measure survival in *H. azteca* and *C. tentans* exposed for 96 hours in the laboratory to sediment pore water samples	Medium	It was concluded that adverse effects were not present because the pore water sample collected from the EBOR for testing was not acutely toxic to either *H. azteca* or *C. tentans*.	The potential for ecological risk may be moderately to severely underestimated because the pore water samples were collected only during base flow (August) when COPEC levels were expected to be the lowest.	Only one pore water sample was tested for toxicity. The evidence showed that conditions in the substrate were suitable for sensitive benthic invertebrates under short-term exposures at the time of pore water sampling.
	1.E: Measure survival and growth in the benthic invertebrate species *H. azteca* and *C. tentans* exposed in the laboratory to bulk sediment samples.	Medium	It was concluded that adverse effects were unlikely because the bulk sediment sample collected from the EBOR for testing was not toxic to either *H. azteca* or *C. tentans*.	The potential for ecological risk may be moderately overestimated because (1) the sediment sample was collected from a depositional area which may not represent the whole stream, and (2) conditions in the test beakers were more static than those present in native substrate.	The conclusion of no adverse effect is based on testing a single bulk sediment sample collected in the EBOR about 0.5 miles below the confluence with Schoolhouse Brook. An effect might have been detected if samples had been collected closer to the confluence.
	1.F: Evaluate the structure and function of the benthic invertebrate community	High	It was concluded that the benthic invertebrate community was not impaired in the EBOR. Conditions stayed stable between 2005 and 2006.	The potential for ecological risk was expected to be as reported. The structure of the benthic invertebrate community represents a chronic response of chemical conditions integrated over time.	--
	OVERALL RISK CONCLUSION		***Ecological risk is not expected to the benthic invertebrate community in the EBOR.***		

Table 1-11
Summary of the Evidence for Ecological Risk in the East Branch of the Ompompanoosuc River (EBOR)
Ely Copper Mine
Vershire, Vermont

Receptor Group	Measurement Endpoint	Weight of Evidence	Risk Conclusion	Major Uncertainties	Comments
Water Column Invertebrates	This receptor group was not evaluated for ecological risk in the EBOR.		--	--	--
Fish	3.A: Compare the dissolved COPEC levels in surface water samples to acute and chronic surface water benchmarks.	Low	It was concluded, with a high level of confidence, that adverse effects to the fish community were possible.	The potential for ecological risk was expected to be slightly over estimated because the surface water benchmarks are generic, conservative values.	The high levels of dissolved silver (IR CTE chronic HQ = 8.0) and zinc (IR CTE chronic HQ = 6.5) were likely to impair the local fish community.
	3.B: Evaluate survival and growth in juvenile fathead minnows (*Pimephales promelas*) exposed in the laboratory for seven days to surface water samples.	Medium	This measurement endpoint was not evaluated in the EBOR	--	--
	3.C: Compare COPEC levels measured in whole fish to no effect and effect Critical Body Residues (CBRs).	Medium	It was concluded, with a high level of confidence, that adverse effects to the fish community were unlikely.	The potential for ecological risk was expected to be moderately overestimated because the fish tissue CBRs were quite conservative. On the other hand, cumulative risk was not considered and fish with higher residue levels may have been absent from the stream because they died out.	All of the IR RME and CTE effect HQs for brook trout and blacknose dace fell below 1.0
	3.D: Evaluate the structure and function of the fish community	High	It was concluded that the fish community was probably not impaired in the EBOR.	The potential for ecological risk was expected to be as reported. The structure of the fish community represents a chronic response of chemical conditions integrated over time.	This conclusion is weakened by the fact that the fish community response in the EBOR was not consistent over space (different sampling locations in the same year) or over time (same sampling location over different years), in part due to a possible sampling bias.
	OVERALL RISK CONCLUSION		***Ecological risk is not expected to the fish community in the EBOR.***		
Amphibians	This receptor group was not evaluated for ecological risk in the EBOR.	--	--	--	--
Insectivorous Birds	5.A: Use sediment analytical data to estimate the body residues of COPECs in winged aquatic insects; use food chain modeling to calculate daily doses from the ingestion of surface water (total metals) and winged aquatic insects, and compare these values to TRVs.	Medium - Low	It was concluded, with a high level of confidence, that adverse effects to insectivorous birds were possible.	The potential for ecological risk may be overestimated by a large margin because: (1) the COPEC levels in insects were derived using generic BAFs instead of Site-collected tissue samples, (2) some exposure parameters (e.g., AUFs and COPEC bioavailability) were conservative values for lack of site- or species-specific information, and (3) the TRVs were conservative, non species-specific, literature-derived values .	Cu was the only COPEC with an IR CTE effect HQ > 1.0 (HQ = 1.6). This relatively small exceedance would not be expected to cause severe impairment by itself to insectivorous birds.
	OVERALL RISK CONCLUSION		***The potential exists for minor ecological risk to insectivorous birds feeding on insects from the EBOR.***		

Table 1-11
Summary of the Evidence for Ecological Risk in the East Branch of the Ompompanoosuc River (EBOR)
Ely Copper Mine
Vershire, Vermont

Receptor Group	Measurement Endpoint	Weight of Evidence	Risk Conclusion	Major Uncertainties	Comments
Insectivorous Mammals	6.A: Use sediment analytical data to estimate the body residues of COPECs in winged aquatic insects; use food chain modeling to calculate daily doses from the ingestion of surface water (total metals) and winged aquatic insects, and compare these values to TRVs.	Medium - Low	It was concluded, with a high level of confidence, that adverse effects to insectivorous mammals were possible.	The potential for ecological risk may be overestimated by a large margin because: (1) the COPEC levels in insects were derived using generic BAFs instead of Site-collected tissue samples, (2) some exposure parameters (e.g., AUFs and COPEC bioavailability) were conservative values for lack of site- or species-specific information, and (3) the TRVs were conservative, non species-specific, literature-derived values .	Cu was the only COPEC with an IR CTE effect HQ > 1.0 (HQ = 5.9). This exceedance has the potential to cause some impairment to insectivorous mammals.
	OVERALL RISK CONCLUSION		***The potential exists for ecological risk to insectivorous mammals feeding on insects from the EBOR.***		
Piscivorous Birds	7.A: Use food chain modeling to calculate daily doses from the ingestion of surface water (total metals) and fish, and compare these values to TRVs	Medium	It was concluded, with a high level of confidence, that adverse effects to piscivorous birds were unlikely.	The potential for ecological risk may be moderately overestimated because: (1) some exposure parameters (e.g., AUFs and COPEC bioavailability) were conservative values for lack of site- or species-specific information, and (2) the TRVs were conservative, non species-specific, literature-derived values.	--
	OVERALL RISK CONCLUSION		***Ecological risk is not expected to piscivorous birds feeding on fish caught in the EBOR***		
Piscivorous Mammals	8.A: Use food chain modeling to calculate daily doses from the ingestion of surface water (total metals) and fish, and compare these doses to TRVs	Medium	It was concluded, with a high level of confidence, that adverse effects to piscivorous mammals were unlikely.	The potential for ecological risk may be moderately overestimated because: (1) some exposure parameters (e.g., AUFs and COPEC bioavailability) were conservative values for lack of site- or species-specific information, and (2) the TRVs were conservative, non species-specific, literature-derived values.	--
	OVERALL RISK CONCLUSION		***Ecological risk is not expected to piscivorous mammals feeding on fish caught in the EBOR***		

Notes:

AUF = area use factor
AVS = acid-volatile sulfides
COPEC = contaminant of potential ecological
CTE = central tendency exposure
IR = incremental risk
HQ = hazard quotient
RME = reasonable maximum exposure
SEM = simultaneously extracted metals
BAF = Bioaccumulation factor
TRV = toxicity reference value

Table 1-12
Ecological Risk Summary Matrix - Terrestrial Exposure Areas
Ely Copper Mine Superfund Site
Vershire, Vermont

Endpoint	Receptor Group	Assessment Endpoint	Measurement Endpoint	Weight of Evidence	Uncertainty	Summary
1	Terrestrial Plants	Plant growth, yield, or germination	Compare soil concentrations to phytotoxicity benchmarks	Low	Risks are likely moderately overestimated because of the high bioavailability of the inorganics used to develop benchmarks and the use of uncertainty factors in some benchmarks.	It was concluded that adverse effects are possible due to concentrations of Sb, Cu, and Zn. The magnitude of exceedance was moderate for Sb and Zn, and high for Cu.
					Assessment Endpoint 1 Weight of Evidence Conclusion	***Risks to the vegetative community may be possible due to concentrations of copper, and to a lesser extent, zinc.***
2	Soil Invertebrates	Growth, reproduction, or activity	Compare soil invertebrate to microbe benchmarks	Low	Risks are likely moderately overestimated because of the conservatism inherent in the benchmarks used to evaluate risk.	It was concluded that adverse effects are possible due to concentrations of Cu, Se, and Zn. The magnitude of exceedance was moderate for Zn and high for Cu and Se.
					Assessment Endpoint 2 Weight of Evidence Conclusion	***Risks to the soil invertebrate community may be possible due to concentrations of copper, and to a lesser extent, zinc.***
3	Herbivorous Birds	Survival, growth, or reproduction	Compare modeled intakes to TRVs	Low-Medium	Risks are up to largely overestimated because plant concentrations may be overestimated by up to an order of magnitude.	It was concluded, with a high level of confidence, that adverse effects are possible due to concentrations of Se.
					Assessment Endpoint 3 Weight of Evidence Conclusion	***Population effects are not expected to occur in herbivorous birds at the Ely Mine Site.***
4	Invertivorous Birds	Survival, growth, or reproduction	Compare modeled intakes to TRVs	Medium	Risks are likely slightly overestimated because some of the prey were caught in the barren areas.	It was concluded that adverse effects are not occurring.
					Assessment Endpoint 4 Weight of Evidence Conclusion	***Population effects are not expected to occur in invertivorous birds at the Ely Mine Site.***
5	Carnivorous Birds	Survival, growth, or reproduction	Compare modeled intakes to TRVs	Medium	Risks are likely moderately overestimated because the area use factor was assumed to be 1.	It was concluded that adverse effects are not occurring.
					Assessment Endpoint 5 Weight of Evidence Conclusion	***Population effects are not expected to occur in carnivorous birds at the Ely Mine Site.***
6	Herbivorous Mammals	Survival, growth, or reproduction	Compare modeled intakes to TRVs	Low-Medium	Risks are up to largely overestimated because plant concentrations may be overestimated by up to an order of magnitude.	It was concluded that adverse effects are possible due to concentrations of Fe.
					Assessment Endpoint 6 Weight of Evidence Conclusion	***Population effects are not expected to occur in herbivorous mammals at the Ely Mine Site.***

Table 1-12
Ecological Risk Summary Matrix - Terrestrial Exposure Areas
Ely Copper Mine Superfund Site
Vershire, Vermont

Endpoint	Receptor Group	Assessment Endpoint	Measurement Endpoint	Weight of Evidence	Uncertainty	Summary
7	Invertivorous Mammals	Survival, growth, or reproduction	Compare modeled intakes to TRVs	Medium	Risks are likely slightly overestimated because some of the prey were caught in the barren areas.	It was concluded that adverse effects are possible due to concentrations of Fe.
					Assessment Endpoint 7 Weight of Evidence Conclusion	***Population effects are not expected to occur in invertivorous mammals at the Ely Mine Site.***
8	Carnivorous Mammals	Survival, growth, or reproduction	Compare modeled intakes to TRVs	Medium	Risks are likely up to largely overestimated because it was assumed that the mink could obtain 100% of its diet from terrestrial-based prey within the confines of the Ely Mine Site.	It was concluded that adverse effects are not occurring.
					Assessment Endpoint 8 Weight of Evidence Conclusion	***Population effects are not expected to occur in carnivorous mammals at the Ely Mine Site.***
9	Aquatic Community	Survival, growth, or reproduction	Compare surface water concentrations to AWQCs	Low	Risks are likely slightly underestimated, mainly because the AWQCs do not account for low pH surface water, which increases bioavailability, that is likely to occur in the vernal pools.	The magnitude of exceedance was moderate for Ba, Cd, and Mn and high for Cu.
					Assessment Endpoint 9 Weight of Evidence Conclusion	***Population effects may be possible in VP-1 only due to concentrations of cadmium and copper.***
10	Herptile Community	Survival, growth, or reproduction	Compare surface water concentrations to herptile toxicity values	Low	There are many uncertainties associated with this endpoint; however most are ambiguous as to their effect on risk.	The magnitude of exceedance was moderate for Cd and high for Cu and Mn.
			Compare surface water concentrations to *P. promelas* toxicity values	Low-Medium	There are many uncertainties associated with this endpoint; however most are ambiguous as to their effect on risk.	The magnitude of exceedance was high for Cu.
					Assessment Endpoint 10 Weight of Evidence Conclusion	***Population effects may be possible in VP-1 only due to concentrations of cadmium, copper, and manganese.***

Table 2-1
Summary of Location-Specific ARARs
Ely Copper Mine Superfund Site
Vershire, Vermont

REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS
STATE ARARs and TO BE CONSIDERED GUIDANCES		
Vermont Wetlands Act, 10 VSA Ch. 37; Vermont Wetland Rules (Nat. Res. Brd., Water Res. P. 12-004-056)	Applicable	These standards establish criteria for delineating Class One and Class Two wetlands, which are considered significant wetlands, and set forth allowed and conditional uses for these wetlands. Jurisdiction under the Rules includes within a 50 foot buffer zone to Class Two wetlands. The uses must not have undue adverse impacts on the significant functions of the wetland. Class Three wetlands are defined, but are not protected under these rules (they are addressed under Title 10 V.S.A. Chapter 151, below).
Vermont's Land Use and Development Law (Act 250), 10 VSA Chapter 151	Applicable	Issues to be addressed in assessing compliance with Act 250 include substantive environmental and facility siting requirements associated with: • will not result in undue water and air pollution (including construction-related dust) (criterion 1); • protection of headwaters (criterion 1(A)); • will meet all standards for disposal of wastes (criterion 1(B)); • floodways (criterion 1(D)); • streams (criterion 1(E)); • impact on state-regulated wetlands (Class One, Two, and Three); (criterion 1(G)); • erosion control (criterion 4); • impact on historic sites (criterion 8(A)); • endangered species (criterion 8(B)); • extraction of earth resources (criterion 9(E)); • energy conservation (criterion 9(F)); and • public investments (roads) (criterion 9(K)).
Vermont Regulation of Stream Flow, 10 VSA Chapter 41	Applicable	Regulates and permits activities in streams to protect against damage to fish life or wildlife, prevent creation of flood hazards, and protect from damaging the rights of riparian owners.
Vermont Obstruction of Streams, 10 VSA Chapter 111, § 1407	Applicable	Regulation of obstructions that the prevent the passing of fish in a stream or the outlet or inlet of a natural or artificial pond on a public stream, by means of a rack, screen, weir or other obstruction.
Vermont Historic Preservation Law, 22 VSA §§ 743(4), 761, 763, and 767.	Relevant and Appropriate	Places controls on actions conducted by the state that may impact historic, scientific, or archaeological sites and data.
Vermont Endangered Species Law, 10 VSA, Chapter 123.	Applicable for Listed Species; To Be Considered for Proposed Listed Species	This Vermont statute outlines the definition of endangered and threatened, the procedure for obtaining permits to take endangered or threatened species, and the species listed as endangered or threatened. The statute prohibits the taking, possession or transport of wildlife or plants that are members of an endangered or threatened species without a permit, and sets forth fines for violators. One bat species that may occur on the Site is specifically listed as threatened or endangered species in Vermont,: the Small-footed Bat. Two additional bat species, the Little Brown Bat and the Northern Long-eared Bat, have been proposed for endangered status.
Vermont ANR Guidance on Riparian Buffers (December 5, 2005)	To Be Considered	This guidance provides technical information on the functions and values of riparian buffers, as well as describing acceptable activities within buffer zones. It recommends the establishment of 100 foot buffer zones to streams under circumstances where there is an increased risk of erosion and/or potential for overland flow of pollutants. Where Class II wetlands are contiguous to a waterbody, buffer widths of greater than 50 feet may be recommended based on case-specific application of this Guidance. This Guidance will also be used to recommend buffers for Class III wetlands contiguous to waterbodies, as necessary to maintain the functions and values of the riparian area.

Table 2-1
Summary of Location-Specific ARARs
Ely Copper Mine Superfund Site
Vershire, Vermont
Page 2 of 2

REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS
FEDERAL ARARs and TO BE CONSIDERED GUIDANCES		
Floodplain Management and Protection of Wetlands, 44 C.F.R. 9	Relevant and Appropriate	Remedial alternatives that may cause alteration within a 500-year floodplain/cause negative impacts to downstream floodplain or that will cause alteration of federal jurisdictional wetlands/aquatic habitats will be implemented in compliance with these relevant and appropriate FEMA standards (which promulgate requirements under Executive Order 11988 (Floodplain Management) and Executive Order 11990 (Protection of Wetlands)). Prohibits activities that adversely affect a federally-regulated wetland unless there is no practicable alternative and the proposed action includes all practicable measures to minimize harm to wetlands that may result from such use. Requires soliciting public comment on any disturbance of floodplains or federally-regulated wetlands.
Federal Clean Water Act, Section 404, 33 USC § 1344; 40 CFR Part 230; 33 CFR Parts 320-323	Applicable	Prohibits the discharge of dredge or fill material into a federally-regulated aquatic ecosystem if a practicable alternative with lesser effects is available. For any alternative selected that may dredge or fill a water of the U.S., a finding that No Practicable Alternative was available and that the general prohibitions in 40 CFR 230.10 and the factual determinations of 40 CFR 230.11 were unavoidable is required. Under these standards EPA must solicit public comment through the Proposed Plan on its finding that one of the alternatives is the Least Environmentally Damaging Practicable Alternative.
Federal Fish and Wildlife Coordination Act; 16 USC 661 *et seq* .	Applicable	Consultation with the U.S. Fish and Wildlife Service and appropriate state wildlife agency is required for modification of a body of water or federally-listed endangered or threatened species habitat. Consultation is required to develop measures to prevent, mitigate, or compensate for the loss of fish and wildlife or federally-listed endangered or threatened species habitat.
Federal Endangered Species Act of 1973 (ESA), 16 USC 1531 *et seq* .; 33 CFR Part 320	To Be Considered	The purpose of the ESA is to “conserve the ecosystems upon with threatened and endangered species depend” and to conserve and recover listed species. Federal agencies must consult with the U.S. Fish and Wildlife Service to ensure that the actions they authorize, fund, or carry out will not jeopardize listed species. The law provides for critical habitat designations for listed species. Critical habitat designations affect Federal agency actions and federally funded or permitted activities. The Small Footed Bat, which may occur on the Site, has been proposed for listing as a threatened or endangered species.
National Historic Preservation Act (NHPA), Section 106, 16 USC 470 *et seq* ., 36 CFR Part 800	Applicable	Section 106 of the NHPA of 1966 requires EPA to take into account the effect of all of its actions on historic properties. In consultation with the State Historic Preservation Officer (SHPO). A determination has been made that the Ely Mine Site eligible for the National Register. The consultation is to identify potential adverse effects on historic properties and seek ways to avoid, minimize or mitigate any such effects on historic properties.
Archeological and Historic Preservation Act, 16 USC 469 *et seq* ., 36 CFR, Part 65	Applicable	This standard requires that, whenever any federal agency finds or is made aware that its activity in connection with any construction project or federally licensed project, activity, or program may cause irreparable loss or destruction of significant scientific, pre-historical, historical, or archeological data such agency shall undertake the recovery, protection, and preservation of such data or notify the Secretary of the Interior. The undertaking could include a preliminary survey (or other investigation as needed) and analysis and publication of the reports resulting from such investigation.

Table 2-2
Summary of Chemical-Specific ARARs
Ely Copper Mine Superfund Site
Vershire, Vermont

REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS
STATE ARARs - None		
FEDERAL ARARs		
EPA Risk Reference Doses (RfDs)	To Be Considered	Risk reference doses (RfDs) are estimates of daily exposure levels that are unlikely to cause significant adverse non-carcinogenic health effects over a lifetime. Used to establish risk-based standards for managing waste rock at the Site.
EPA Carcinogen Assessment Group, Cancer Slope Factors (CSFs)	To Be Considered	CSFs are used to compute the incremental cancer risk from exposure to contaminants and represent the most up-to-date information on cancer risk from EPA's Carcinogen Assessment Group. Used to establish risk-based standards for managing waste rock at the Site.
Guidelines for Carcinogen Risk Assessment EPA/630/P-03/001F (March 2005)	To Be Considered	Guidance for assessing cancer risk. Used to establish risk-based standards for managing waste rock at the Site.
Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens EPA/630/R-03/003F (March 2005)	To Be Considered	Guidance of assessing cancer risks to children. Used to establish risk-based standards for managing waste rock at the Site.
Proposed Guidelines for the Clean-Up of Contaminated Sites in Ontario (Ministry of Environment and Energy of Ontario [MOE], 1994)	To Be Considered	This guidance document lists surface water and sediment criteria that are considered protective for aquatic organisms.
Preliminary Remediation Goals for Ecological Endpoints, Efroymson et al., August 1997	To Be Considered	This technical memorandum was prepared to present recommended preliminary remediation goals (PRGs) for surface water, sediment and soil for ecological endpoints for risk assessments and decision making at CERCLA sites.

Table 2-3
Summary of Action-Specific ARARs
Ely Copper Mine Superfund Site
Vershire, Vermont

REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS
STATE ARARs and TO BE CONSIDERED GUIDANCES		
Vermont Water Pollution Control Act, 10 VSA Chapter 47; Vermont Water Quality Standards, Ch. 1, 2, and 3 and Appendix C and D	Applicable	Establishes water quality standards for surface waters and applies to alternatives that call for monitoring surface water bodies on and off of the Site. In particular, monitoring will ensure that source control remedies at the Site are preventing metals and ARD from migrating to surface waters and exceeding the waterways' water quality standards.
Vermont National Pollutant Discharge Elimination System (NPDES) Regulations Ch. 13 (Nat. Res. Brd., Water Res. P. 12-004-052)	Applicable	The regulations stipulate requirements for discharges to surface waters, compliance with NPDES standards, and meeting stormwater management requirements. Groundwater and stormwater removed from excavations and dewatering liquid from dewatering soil and sediment may require treatment prior to discharge.
Vermont Groundwater Protection Act, 10 VSA §§ 1390-94; Vermont Groundwater Protection Rule and Strategy, Env. Prot. Ch. 12-702 and 703	Applicable	Establishes standards for groundwater quality. Management criteria for each groundwater class are established as well as primary and secondary standards for groundwater protection. These are the primary groundwater standards if they are more stringent than federal standards. Within the compliance boundary for any waste management unit these standards are used as monitoring standards.
Vermont Department of Health Drinking Water Guidance (October 2000).	To Be Considered	Lists the Vermont Health Advisories (VHAs) for chemicals of concern in drinking water. Vermont Health Advisories are researched and calculated concentrations of chemicals in drinking water in instances where the chemicals do not have a promulgated federal or state standard, or more stringent federal risk-based standard. Within the compliance boundary for any waste management unit these standards are used as monitoring
Vermont Solid Waste Management Rules (VSWMR), Management of Mining and Mineral Processing Waste, Env. Prot. R. Ch. 6, Subchapter 13	Applicable	These substantive requirements under these rules regulate the tailing wastes and roast bed material that were produced as part of the benefication of ore at the Site, but the rules do not apply to unprocessed waste rock. However, Section 6-1301(f) permits the waiver of technical and siting requirements of these rules provided there is a response action under CERCLA to a release or threatened release of hazardous substances or materials; and the proposed response action will not adversely affect public health, safety or the environment; and the technical and siting requirements will be complied with to the extent practical in light of the overall objectives of the response. In particular, liner requirements for disposal areas under § 1305(c)(2)(D) and (F). are waived. The remainder of § 6-1305 establishes the closure and post closure performance standards that are applicable to the remedial action. That is, all facilities subject to closure requirements must be closed in a manner that: (a) Minimizes the need for further maintenance related to the waste facility; and (b) Controls, minimizes, or eliminates, to the extent necessary to prevent threats to public health and safety and the environment, including post-closure emission or discharge of waste, waste constituents, leachate, contaminated runoff, and/or waste decomposition products to the groundwater or surface waters or the atmosphere.
Vermont Stormwater Management Act, 10 VSA § 1263 and §1264; Vermont Stormwater Management Rule, Env. Prot. R. Ch. 18	Applicable	This rule applies to discharges of regulated stormwater runoff to waters that are not listed on the EPA-approved Vermont 303(d) List of Waters as being impaired principally due to stormwater runoff. The rule establishes a state permit program for post-construction management of stormwater runoff; establishes permitting thresholds for discharges; sets forth treatment standards; provides for the issuance of individual and general permits; specifies application requirements; and amends the Vermont Stormwater Management manual. The rule generally applies to stormwater discharges from new developments, from the expansion of impervious surfaces, or from the redevelopment of existing impervious surfaces. In each case, the affected area must be greater than or equal to one-acre.

Table 2-3
Summary of Action-Specific ARARs
Ely Copper Mine Superfund Site
Vershire, Vermont

REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS
STATE ARARs and TO BE CONSIDERED GUIDANCES (cont.)		
Vermont Air Pollution Control Act, 10 VSA Chapter 23 and Air Pollution Control Regulations, Env. Prot. R. Ch. 5	Relevant and Appropriate	Establishes authority for a coordinated statewide program of air pollution prevention, abatement and control. Lists prohibited activities affecting air quality and establishes primary and secondary ambient air quality standards for sulfur oxides, particulate matter, carbon monoxide, ozone, nitrogen dioxide, and lead. The secondary standard for particulate matter is 150 micrograms per cubic meter, 24 hour average, not to be exceeded more than once per year.
Vermont Waste Management Act, 10 VSA Chapter 159 and Hazardous Waste Management Regulations, Env. Prot. R. Ch. 7	Applicable	Establishes requirements for the identification and management of hazardous waste. These regulations apply to solutions having pH less than 2 or contaminated media that exceeds toxicity standards under these regulations. Treatment media or any other wastes that are disposed of off-site will be tested to determine if it exceeds the standards to be managed and disposed of as hazardous waste. Incorporates requirements of the federal Resource Conservation and Recovery Act regulations, 40 CFR 264.
Vermont Slash Removal, 10 VSA § 2648	Applicable	Forest growth may only be cut if all slash adjoining the right-of-way of any public highway, or the boundary lines of woodlots owned by adjoining property owners, is removed for a distance of 50 feet from the right-of-way of any public highway or from the boundary lines of woodlots owned by adjoining property owners. Furthermore, main roads through cut-over areas must be kept free from slash so that there is unobstructed access for fire fighting equipment and fire suppression crews.
Vermont Handbook for Erosion Prevention and Sediment Control, Working Interim Document, Released in 2003 (VTDEC, 2003)	To Be Considered	A compilation of information from various sources released by the Vermont Department of Environmental Conservation for use in developing the erosion prevention and sediment control plans required for construction-related stormwater discharge permitting.
FEDERAL ARARs and TO BE CONSIDERED GUIDANCE		
Federal Safe Drinking Water Maximum Contaminant Levels (MCLs) and Maximum Contaminant Level Goals (MCLGs), National Primary Drinking Water Regulations, 40 CFR Parts 141.11 – 141.16 and 141.50 – 141.53	Relevant and Appropriate for MCLs and non-zero MCLGs only; MCLGs set as zero are To Be Considered	These standards protect drinking water quality by limiting the levels of specific contaminants that can adversely affect public health and are known or anticipated to occur in public water systems. MCLs are the highest level of a contaminant that is allowed in drinking water. MCLGs are the level of a contaminant in drinking water below which there is no known or expected risk to health. MCLs are set as close to MCLGs as feasible using the best available treatment technology and taking cost into consideration. MCLs are enforceable standards, while MCLGs are non-enforceable public health goals. Within the compliance boundary for any waste management unit these standards are used as monitoring standards.
Health Advisories (EPA Office of Drinking Water)	To Be Considered	Health Advisories are estimates of risk due to consumption of contaminated drinking water; they consider non-carcinogenic effects only. To be considered for monitoring contaminants in groundwater where the standard is more conservative than either federal or state statutory or regulatory standards. The Health Advisory standard for manganese is 0.3 ppm. Within the compliance boundary for any waste management unit these standards are used as monitoring standards.
Resource Conservation and Recovery Act, 42 USC §§ 6901-6992; 40 CFR Part 264	Applicable	Vermont is delegated to implement these standards through its Hazardous Waste Management Regulations (see above).
Federal Clean Water Act, National Recommended Water Quality Criteria (NRWQC), 40 CFR Part 122.44	Relevant and Appropriate	These standards are used to develop numerical and biological water quality standards for monitoring surface water quality. In particular, monitoring will ensure that source control remedies at the Site are preventing metals and ARD from migrating to surface waters and exceeding the waterways' water quality standards.

Table 2-3
Summary of Action-Specific ARARs
Ely Copper Mine Superfund Site
Vershire, Vermont
Page 3 of 3

REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS
FEDERAL ARARs and TO BE CONSIDERED GUIDANCE		
Federal Clean Water Act, Section 402 – National Pollution Discharge Elimination System (33 USC 1342; 40 CFR 122-135, 131)	Relevant and Appropriate	The CWA contains discharge limitation, monitoring requirements, and best management practices (BMPs) for discharges into navigable waters, i.e., surface waters. These regulations would be applicable to remedial strategies involving discharge to surface waters. Groundwater and stormwater removed from excavations and dewatering liquid from dewatering soil and sediment may require treatment prior to discharge.
Federal Clean Water Act – Stormwater Requirements for Construction Sites; 40 CFR 122.26(b)(15), (c)(1)	Applicable	Applicable to construction activity including clearing, grading and excavation, except operations that result in the disturbance of over one acre of total land area.
Contaminated Sediment Remediation Guidance for Hazardous Waste Sites (EPA-540-R-05-012 OSWER 9355.0-85 December 2005)	To Be Considered	Guidance for making remedy decisions for contaminated sediment sites. Specific sections of the guidance address dredging, disposal, and monitored natural recovery.
Federal Surface Mining Control and Reclamation Act of 1977, 30 USC §§ 1201-1328; 30 CFR 816 and 817	Relevant and Appropriate	Provides closure guidelines for coal sites. Design criteria for the closure of tailing at coal sites are relevant and appropriate for use for the construction and closure of waste management cells at this Site.

Table 2-4
Preliminary Remediation Goals
Ely Copper Mine Superfund Site
Vershire, Vermont

Analyte	OU1 Maximum Detected Concentration	Average Background Concentration	Preliminary Remediation Goal	Basis for cleanup level
Soil (mg/Kg)				
Cobalt	4,330	6.6	**24**	HHRA risk-based standard (NC) [1]
Copper	65,700	15	**629**	HHRA risk-based standard (NC)
Iron	190,000	13,852	**44,800**	HHRA risk-based standard (NC)
Sediment (mg/Kg)				
Copper	11,000	5.6	**149**	Aquatic BERA risk-based standard
Surface Water (µg/L)				
Aluminum	120,000	82	**87**	NRWQC [2]
Cadmium	55.8	ND (0.24) [6]	**1.10**	VTWQC [3, 4]
Chromium	130	1.2	**11**	VTWQC
Copper	88,500	2.4	**8.6**	Site-Specific [5]
Iron	199,000	102	**1,000**	NRWQC
Lead	17	0.089	**3.2**	VTWQC
Mercury	0.2	ND (0.2)	**0.012**	VTWQC
Nickel	456	0.61	**52**	NRWQC [4]
Selenium	27	ND (1.0)	**5**	VTWQC
Silver	4.2	ND (2.2)	**3.2**	NRWQC [4]
Zinc	8,192	150	**106**	VTWQC
Sulfide	1,300	ND (100)	**2**	NRWQC
pH	2.8[7]	7.41	**6.5-8.5**	VTWQC

Notes:

1. NC = non-cancer based level, hazard index = 1
2. NRWQC = National Recommended Water Quality Criteria. 2009.
3. VTWQC = Vermont Water Quality Criteria. Jan 2008.
4. Interim clean-up level adjusted for hardness based on VTWQC Appendix C or NRWQC note E. assumes hardness = 100 mg/L.
5. Recommended aquatic BERA site-specific interim clean-up level adjusted for hardness = 9 µg/L x CF, CF = 0.96 (EPA National Recommended Water Quality Criteria: Appendix A. 2009.)
6. ND = non-detect with the average detection limit shown in parentheses.
7. Value displayed for pH reflects minimum detected OU1 surface water value.

Table 2-5
Remedial Action Objectives
Ely Copper Mine Superfund Site
Vershire, Vermont

Media	Area of Impact	Remedial Action Objectives		Historic Preservation Considerations
		Human Health	Ecological and Environmental Protection	
Waste Rock and Tailings	Upper Waste Area, Lower Waste Area, Tailing Area, and Ore Roast Bed	Prevent direct contact with or incidental ingestion of soil containing: • copper concentrations above 692 mg/kg • cobalt concentrations above 24 mg/kg • iron concentrations above 44,800 mg/kg Prevent migration of soil contamination to groundwater beyond the compliance boundary for the waste management area.	Control the release of acid rock drainage and acid mine drainage from the source areas (Upper Waste Area, Lower Waste Area, Tailing Area) into surface waters and groundwater.	Minimize impacts to former building foundations, retaining walls, and other anthropogenic features within OU1. Minimize impacts to endangered bat habitat.
Sediment	Ely Brook, Ely Brook tributaries, and the Ponds 4 and 5	No significant human health risks identified.	Restore the sediment quality of Ely Brook, Ely Brook tributaries, and the Ponds 4 and 5 to achieve biological integrity for these surface water bodies. Recovery will be measured by benthic and fish metrics achieving populations comparable with upstream and/or reference values and a finding of the sediment being non-toxic to aquatic organisms in toxicity tests.	None
			Reduce sediment concentrations to levels that are no longer acutely toxic. The PRG for copper in sediment is 149 mg/kg.	
Surface Water	Ely Brook, Ely Brook tributaries, and the Ponds 4 and 5	No significant human health risks identified.	Restore the surface water quality of Ely Brook, Ely Brook tributaries, and the Ponds 4 and 5 to achieve biological integrity for these surface water bodies Recovery will be measured by benthic and fish metrics achieving populations comparable with upstream and/or reference values and a finding of the surface water being non-toxic to aquatic organisms in toxicity tests.	None
			Achieve federal Clean Water Act and Vermont Water Quality Standards for a Class B surface water in Ely Brook, Ely Brook tributaries, and the Ponds 4 and 5.	
			Reduce surface water copper concentrations to levels that are no longer acutely toxic. The PRG for copper in surface water is 9.0 mg/L (8.64 mg/kg when corrected for hardness).	

Table 2-6
Estimated Areas and Volumes of Waste Rock, Tailings, and Sediment
Ely Copper Mine Superfund Site
Vershire, Vermont

OU1 Waste Rock, Tailing, and Soil					
	Average Thickness (ft)	**Area (ft^2)**	**Area (acres)**	**Volume (ft^3)**	**Volume (yd^3)**
Upper Waste Area (UWA)	varies	287,500	7.8	1,873,800	69,400
UWA soil above cleanup levels outside limits of mine waste	varies	30,300	0.7	90,900	3,363
Lower Waste Area (LWA)	varies	255,290	5.9	702,000	26,000
LWA soil above cleanup levels outside limits of mine waste	varies	23,600	0.5	70,800	2,620
Tailing Area (TA)	varies	28,990	0.7	97,200	3,600
Ore Roast Bed (ORB)	varies	96,970	2.2	278,910	10,330
Development Rock within UWA	varies	45,530	1.05	327,807	12,141
OU1 Sediment					
	Average Thickness (ft)	**Length (ft)**	**Width (ft)**	**Volume (ft^3)**	**Volume (yd^3)**
Upper Ely Brook	0.5	1,700	6	5,100	190
Ponds 4 and 5	3.0	60	80	10,200	378
Middle Ely Brook	2.0	660	12	15,660	580
Lower Ely Brook	2.0	1,200	12	106,650	3,950
OU1 Surface Water Channels in UWA and LWA					
	Average Thickness (ft)	**Length (ft)**	**Width (ft)**	**Volume (ft^3)**	**Volume (yd^3)**
EBT1	2	500	12	12,000	445
EBT2	2	530	12	12,720	471
EBT3	2	773	12	43,680	1,618
EBT4	2	650	12	18,552	687
OU2 Areas					
	Average Thickness (ft)	**Area (ft^2)**	**Area (acres)**	**Volume (ft^3)**	**Volume (yd^3)**
Smelter Area	varies	165,515	3.8	840,240	31,120
Slag Area	varies	185,130	4.2	675,000	25,000
Schoolhouse Brook Hot Spots	1.0	100	0.002	1,100	41

Notes:

1. OU1 Waste Rock and Tailings and OU2 Waste Rock values calculated with AutoCAD. The irregular shape of the piles does not allow for specific thickness values to be presented.
2. Sediment thickness are assumed and should be considered estimates. Actual depths will be confirmed during pre-design studies.

Table 2-7
Applicable Treatment Technologies
Ely Copper Mine Superfund Site
Vershire, Vermont

General Technology	Waste Rock and Tailings	Sediment
No-Action	x	x
Institutional Controls	x	
Monitored Natural Recovery		x
Surface Controls	x	
Capping Systems	x	x
Excavation/Dredging	x	x
Land Disposal	x	x
Ex-Situ Physical or Chemical Treatment	x	x
In-Situ Physical or Chemical Treatment	x	x

Notes:
"x" indicates that the General Technology is applicable to the media listed and will be selected for alternative screening.

Table 2-8
Screening of Potential Treatment Options for Waste Rock and Tailings
Ely Copper Mine Superfund Site
Vershire, Vermont

General Response Action	Technology	Process Option	Description	Effectiveness	Cost	Implementability	Retained For Further Consideration	Notes
No Action	No Action	No action	The "No Action" GRA is required in accordance with CERCLA and NCP to serve as a baseline comparison for other GRA technologies. The "No Action" alternative includes only scheduled 5-Year Reviews to assess the alternative effectiveness and compliance with OU1 PRGs. It does not include any active or passive treatment of media, institutional controls, or monitoring.	The alternative does not address the RAOs developed for OU1.	**Low** Include periodic monitoring and 5-Year Reviews	This technology would be implementable.	**Yes** (Required by CERCLA/NCP)	(Required by CERCLA/NCP)
Limited Action	Institutional Controls	Land use restrictions	Land use restrictions would be used to prevent certain use and activities such as residential building or recreational use. The restrictions would be included in the chain of title/deed for the property and would continue into the future regardless of change in ownership or zoning in the vicinity of the Site.	The alternative does not address the RAOs developed for the OU1, and although the Land Use Restriction is in place, the technology does not physically prevent the exposure to human receptors. However, the technology could be used in conjunction with other technologies in a larger system.	**Low** Capital and O&M costs	This technology would be implementable.	**Yes** (as component in larger system)	Although this process option would not achieve the remedial action objectives, it may be included as part of a more comprehensive alternative
		Access controls	Engineered controls include restricting access to the OU1 area but does include treating the waste material with any physical or chemical processes. Fencing, signage, and security patrols could be utilized. Fencing would minimize human and animal access and warning signs would alert people to the specific OU1 hazards located within the fence. Security patrols would deter vandalism and unauthorized access to the OU1 and would notify EPA of breaches in the controls.	The alternative does not address the RAOs developed for OU1, but it would be effective in reducing the access to the OU1 area. OU1 is relatively large, however, and the fence would have to extend to around the entire property with gates located at all access points. Due to the remoteness of OU1, it would be difficult to completely prevent vandalism and unauthorized access by humans and/or animals.	**Low** Capital and O&M costs	This technology would be implementable.	**Yes** (as component in larger system)	Although this process option would not achieve the remedial action objectives, it may be included as part of a more comprehensive alternative
Containment	Surface Controls	Grading	Grading of the existing ground surface/waste can be used to improve slope stability and run-off and reduce erosion of the waste piles, and to divert surface water away from the impacted material.	The alternative does not address the RAOs developed for OU1. It would be effective in minimizing erosion and precipitation percolated through the impacted material into the aquifer; however, portions of the waste piles are seasonally within the overburden aquifer; therefore, impacts from the waste on the aquifer would not be addressed.	**Moderate** Capital costs **Low** O&M costs	This technology would be implementable.	**Yes** (as component in larger system)	Although this process option would not achieve the remedial action objectives, it may be included as part of a more comprehensive alternative
		Revegetation	Revegetation includes planting in order to stabilize the impacted soils and to reduce erosion of the soils. The root systems will hold surface soils in place while the aboveground portions of the plants disrupts the flow and removes the energy from overland surface water allowing for the plants to take and use the water. The plants may also serve some utility as filtering devices, both physical and chemical, through straining and biological processes.	The alternative does not address the RAOs developed for OU1; however, it would be an effective alternative in conjunction with a more active alternative. Revegetation is commonly used with a consolidation and capping system to stabilize the soils and reduce run-off of the cap.	**Low** Capital and O&M costs	This technology would be implementable.	**Yes** (as component in larger system)	Although this process option would not achieve the remedial action objectives, it may be included as part of a more comprehensive alternative
	Capping System	Close in place	Grading the existing waste and constructing an engineered cap to conform with low-permeability cover system requirements. Surface water diversions will be constructed as needed to eliminate potential infiltration. Prior to capping, the waste material will be dried to reduce leachate, if necessary.	This alternative would be effective in preventing human contact; however, it would not remove and isolate the contaminated material from the overburden groundwater aquifer. Waste/groundwater contact would perpetuate the impacts to the groundwater aquifer and surface water downgradient of the waste. Institutional controls and a monitoring program would be required to maintain the effectiveness of the cell.	**Moderate** Capital costs **Moderate** O&M costs	This technology would be implementable.	**Yes** (as component in larger system)	This process option was eliminated because there are similar process option approaches that could achieve the remedial action objectives without the need for long-term treatment.
		On-site consolidation and containment cell construction in the LWA	Excavate the Upper and Lower Waste Piles and consolidate the waste material into a constructed cell within the current WMU. The engineered cap will conform with low-permeability cover system requirements and includes a bottom liner to prevent groundwater infiltration into the waste. Underdrains and surface water diversions will be constructed as needed to eliminate potential infiltration. Prior to capping, the waste material will be dried to reduce leachate. if necessary.	This alternative would be effective in preventing human contact and would remove and isolate the contaminated material from the overburden groundwater aquifer, therefore, allowing the groundwater pH to adjust to a more neutral level and reducing the metals mobility. Institutional controls and a monitoring program would be required to maintain the effectiveness of the cell.	**High** Capital costs **Moderate** O&M costs	This technology would be implementable.	**Yes**	
		On-site consolidation and containment cell construction west of Ely Brook	Excavate the Upper and Lower Waste Piles and consolidate the waste material into a constructed cell located to the west of Ely Brook and outside of the current WMU. The engineered cap will conform with low-permeability cover system requirements. Underdrains and surface water diversions will be constructed as needed to eliminate potential infiltration. Prior to capping, the waste material will be dried to reduce leachate, if necessary.			This technology would be implementable.		

Table 2-8
Screening of Potential Treatment Options for Waste Rock and Tailings
Ely Copper Mine Superfund Site
Vershire, Vermont

General Response Action	Technology	Process Option	Description	Effectiveness	Cost	Implementability	Retained For Further Consideration	Notes
Removal	Excavation and Disposal	On-site disposal of treated excavation water	Treat leachate water from waste material and excavation dewatering through settling and discharge to on-site waterways. Additional treatment could include bag filters and chemical amendments depending on analytical results.	This alternative would be effective in treating the water to achieve performance goals prior to discharge to the on-site waterways through settling, amendments, and/or dilution with clean diverted surface water.	**Low** Capital and O&M costs	This technology would be implementable.	**Yes** (as component in larger system)	
		Off-Site disposal	Excavate the Upper and Lower Waste Piles and the Tailings pile and transport waste to a off-site location for disposal at an approved disposal facility. The alternative includes restoration of the natural grade and vegetation.	This alternative would be effective in preventing human contact and would remove and isolate the contaminated material from the overburden groundwater aquifer, therefore, allowing the groundwater pH to adjust to a more neutral level and reducing the metals mobility.	**High** Capital costs **Low** O&M costs	This technology would be implementable.	**Yes**	
Treatment	In-situ	Injection of an alkaline stabilizer	Perform a series of soil borings completed as injection wells. An alkaline stabilizer is injected reducing the soluble metals present to their lowest valence state. This reduces or eliminates their mobility and solubility and reduces their impact on groundwater and surface water.	Difficult to achieve adequate mixing and coverage without very large quantity of material. Long-term effectiveness for oxidized waste is unknown. Surface contact threats would not be mitigated.	**High** Capital costs **Moderate** O&M costs	This technology would be implementable.	**No**	Although the technology would be implementable, it would be difficult and likely not very effective; therefore, it is not retained for further consideration.
	Ex-Situ	Excavation and mixing with chemicals to neutralize or passivate	Excavate the waste material and mix with passivation/neutralization chemicals to bring the pH of the soils and groundwater more neutral and to reduce the reactivity of the metals. The excavated and amended soil would be replaced in the original locations.	Passivation technologies are more applicable to fresh un-oxidized waste. Neutralization would require substantial quantities of material and would not eliminate surface contact with waste. Also, long-term degradation of an alkaline addition would be a concern.	**High** Capital costs **Moderate** O&M costs	This technology would be implementable.	**No**	Although the technology would be implementable, it would be difficult and likely not very effective; therefore, it is not retained for further consideration.
		Treatment of groundwater and stormwater from excavations	Treat leachate water from waste material and excavation dewatering through settling and discharge to on-site waterways. Additional treatment could include bag filters and chemical amendments depending on analytical results.	This alternative would be effective in treating the water to achieve performance goals prior to discharge to the on-site waterways through settling, amendments, and/or dilution with clean diverted surface water.	**Low** Capital and O&M costs	This technology would be implementable.	**Yes** (as component in larger system)	

Notes:
GRA = General Remedial Action
CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act
NCP = National Contingency Plan
RAO = Remedial Action Objective

Table 2-9
Screening of Potential Treatment Options for Sediment
Ely Copper Mine Superfund Site
Vershire, Vermont

General Response Action	Technology	Process Option	Description	Effectiveness	Cost	Implementability	Retained For Further Consideration	Notes
No Action	No Action	No Action	The "No Action" GRA is required in accordance with CERCLA and NCP to serve as a baseline comparison for other GRA technologies. The "No Action" alternative includes scheduled 5-Year Reviews to assess the alternative effectiveness and compliance with OU1 PRGs. It does not include any active or passive treatment of media, institutional controls, or monitoring.	The alternative does not address the RAOs developed for OU1.	**Low** Includes 5-Year Reviews	This technology would be implementable.	**Yes** (Required by CERCLA/NCP)	(Required by CERCLA/NCP)
Limited Action	Institutional Controls	Land Use Restrictions	Land use restrictions would be used to prevent certain use and activities such as recreational use. The restrictions would be included in the chain of title/deed for the property and would continue into the future regardless of change in ownership or zoning in the vicinity of the Site.	The alternative does not address the RAOs developed for OU1, and although the Land Use Restriction is in place, the technology does not physically prevent the exposure to human receptors. However, the technology could be used in conjunction with other technologies in a larger system.	**Low** Capital and O&M costs	This technology would be implementable.	**Yes** (as component in larger system)	Although this process option would not achieve the remedial action objectives, it may be included as part of a more comprehensive alternative
		Access Controls	Engineered controls include restricting access to the OU1 area but does include treating the waste material with any physical or chemical processes. Fencing, signage, and security patrols could be utilized. Fencing would minimize human and animal access and warning signs would alert people to the specific OU1 hazards located within the fence. Security patrols would deter vandalism and unauthorized access to OU1 area and would notify EPA of breaches in the controls.	The alternative does not address the RAOs developed for the OU1 area, but it would be effective in reducing the access to the OU1 area. The OU1 area is relatively large, however, and the fence would have to extend to around the entire property with gates located at all access points. Due to the remoteness of the OU1 area, it would be difficult to completely prevent vandalism and unauthorized access by humans and/or animals.	**Low** Capital and O&M costs	This technology would be implementable.	**Yes** (as component in larger system)	Although this process option would not achieve the remedial action objectives, it may be included as part of a more comprehensive alternative
	Monitored Natural Recovery	Sediment Sampling	Relies on sediment transport processes to disperse the contaminated sediment downstream, thereby reducing OU1 exposure risks.	In Ely Brook this process option may address inaccessible areas of contaminated sediment that is not removed by other process options.	**Moderate** Low **Low** O&M costs	This technology would be implementable.	**Yes** (as component in larger system)	
Containment	Capping System	In-Place Cap Construction	Capping of the impacted sediments with clean material in the existing stream bed. The clean materials would be laid down in a 1 foot thick layer to protect the surface water from contacting the impacted sediment. The capping material would be graded to match the existing the runs, riffles, and pools of the current streambed.	This alternative would be effective in preventing human contact and would separate the surface water from the impacted sediment; however, Ely Brook is a gaining stream and impacted groundwater will percolate through the cap material, potentially creating another impacted mass.	**Moderate** capital costs **Low** O&M costs	This technology would be implementable.	**No**	It would be possible to build a sub-aqueous cap over the contaminated sediments and maintain the stream hydrology. Ely Brook flow is often less than 1 foot in depth. The steep gradient would cause erosion of the cover system. The stream habitat is also dependent on exposed boulders and gravel for the benthic community.
	Excavation and Disposal	On-Site Consolidation into a Containment Cell	Excavate the sediments above cleanup levels in Ponds 4 and 5, Ely Brook and its tributaries, and consolidate the waste material into a on-site constructed cell.	This alternative would be effective in preventing human contact and would remove and isolate the contaminated material from the surface water, therefore, allowing the surface water pH to adjust to a more neutral level and reducing the metals mobility. Institutional controls and a monitoring program would be required to maintain the effectiveness of the cell.	**High** capital costs **Moderate** O&M costs	This technology would be implementable	**Yes** (as component in larger system)	
		On-Site Discharge of Treated Dewatering Liquid	Discharge of treated dewatering liquid to on-site waterways.	This alternative would be effective in treating the water to achieve performance goals prior to discharge to the on-site waterways through settling, amendments, and/or dilution with clean diverted surface water.	**Low** Capital and O&M costs	This technology would be implementable	**Yes** (as component in larger system)	
Removal		Off-Site Disposal	Excavate the sediments above cleanup levels in Ponds 4 and 5, Ely Brook and its tributaries, and transport the material to an off-site disposal facility. Disposal of treatment media off-site.	This alternative would be effective in preventing human contact and would remove and isolate the contaminated material from the overburden groundwater aquifer, therefore, allowing the groundwater pH to adjust to a more neutral level and reducing the metals mobility.	**High** capital costs **Low** O&M costs	This technology would be implementable	**Yes** (as component in larger system)	
Treatment	In-Situ Chemical Treatment	Limestone Amendments	Add limestone to waterways to neutralize pH.	This alternative may be effective in concert with other process options.	**Low** Capital and O&M costs	This technology would be implementable	**Yes** (as component in larger system)	
	Ex-Situ Physical Treatment	Dewatering	Removing water from sediment prior to disposal by open-air drying.	This alternative may be effective in concert with other process options.	**Low** Capital and O&M costs	This technology would be implementable.	**Yes** (as component in larger system)	
		Treatment of Dewatering Liquid	Filtration through bag filters to remove sediment.	This alternative may be effective in concert with other process options.	**Low** Capital and O&M costs	This technology would be implementable.	**Yes** (as component in larger system)	

Notes: GRA = General Remedial Action
CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act
NCP = National Contingency Plan
RAO = Remedial Action Objective

Table 2-10
Alternatives Retained for Development
Ely Copper Mine Superfund Site
Vershire, Vermont

Alternative	Source	GRA	Process Option
SC1	UWA	No action	No action
	LWA		
	Tailings Area		
	ORB		
SC2	UWA	Containment	Excavation and consolidation in a containment cell within the LWA with on-site treatment and discharge of leachate and excavation water
	LWA		
	Tailings Area	Cap in place	Excavation and Consolidation within ORB containment cap with on-site treatment and discharge of leachate and excavation water
	ORB		Containment and capping in-place
SC3	UWA	Containment	Excavation and consolidation in a containment cell west of Ely Brook with on-site treatment and discharge of leachate and excavation water
	LWA		
	Tailings Area	Cap in place	Excavation and consolidation within ORB containment cell with on-site treatment and discharge of leachate and excavation water
	ORB		Containment and capping in-place
SC4	UWA	Removal	Excavation and consolidation within ORB containment cap with on-site treatment and discharge of leachate and excavation water
	LWA		
	Tailings Area	Cap in place	Containment and capping in-place
	ORB		

Notes:
UWA = Upper Waste Area
LWA = Lower Waste Area
ORB = Ore Roast Bed

Table 3-1
Screening of Alternative SC2
Ely Copper Mine Superfund Site
Vershire, Vermont

Alternative SC2	
This alternative includes excavating the waste from the LWA, building a containment cell in the LWA with an impermeable cap, an underdrain system, full bottom containment, and sufficient separation from groundwater. In addition, the UWA will be excavated and consolidated into the LWA Cell, along with contaminated sediment from Site waterways. Surface water diversions will be constructed to route runoff and Ely Brook tributaries around the containment cell. Disturbed waterways and wetlands will be restored. The tailings pile will be excavated and placed on the ORB Roast Bed where an impermeable cap will be placed.	
Effectiveness Advantages • Consolidation and capping of the waste rock will isolate waste and reduce the mobility of contaminants by reducing leaching and erosion. • Excavation and containment of the waste rock and tailings will remove these areas as sources of groundwater and surface water contamination. • Full containment and isolation is one of the most effective means of preventing acid generation associated with disposal of mine wastes and negative environmental impacts to the Site's waterways. • Monitoring of the natural recovery of the Site's waterways will ensure that sediment remediation measures are protective. • Cleanup levels within excavation areas will be protective of human receptors based on recreational direct contact exposure.	Disadvantages • Will not reduce the volume or toxicity of tailings or mine waste material. • Long-term effectiveness requires monitoring and maintenance of capping systems and institutional controls. • Will site the LWA containment cell within the immediate buffer zone to wetlands and waterways on Site. • If on-site development of borrow materials is used for capping materials and Site grading/access will result in the clearing of 15 acres of forest land on site.
Implementability Advantages • Technical resources are readily available for design and implementation of remedy. • Will be designed and implemented to comply with all ARARs, including capping and wetlands protection requirements. • Significant adverse short-term effects to community are not expected (except for the large volume of trucking that would be required if borrow materials are brought in from off-site).	Disadvantages • Separation from groundwater will require up to 5 feet of fill to be placed and an underdrain system installed. • Potential for clogging of the underdrain will increase periodic maintenance costs. • Unexpected rises in groundwater and/or damage to the liners could result in re-impacted groundwater. • Will permanent leave capped waste in place immediately adjacent to wetlands and waterways. • Will require the use of a large volume of borrow materials that either need to be developed from on-site or transported from off-site. • The large volume of truck traffic required for using off-site borrowed material may require the repair of local roads. • Will require handling the LWPA waste multiple times, increasing worker exposure, and time for completion. • Potential interferences with historical structures and foundations. • Will likely require mitigation of impacted wetlands.
Cost Advantages • None.	Disadvantages • Capital costs for excavation and disposal are high. • O&M costs are potentially higher given the underdrain system and the frequent monitoring that it will be required to prevent biofouling and physical clogging. • Higher costs for either developing borrow sources on site or transporting them from off-site (including maintenance of local roads).
Screening Decision: This alternative is **retained** for detailed evaluation.	

Table 3-2
Screening of Alternative SC3
Ely Copper Mine Superfund Site
Vershire, Vermont

Alternative SC3	
This alternative includes clearing and grading an area west of Ely Brook sufficient to hold the waste and a laydown/staging area, excavating the waste from the UWA and the LWA and the sediment from contaminated waterways, sufficient and placement of the waste rock and sediment in a constructed cell located on the west side of the property in an undeveloped section of woodland. The cell will have an impermeable cap and surface water diversions will be constructed to route runoff around the containment cell. The tailings pile will be excavated and placed on the ORB Roast Bed where an impermeable cap will be placed.	
Effectiveness Advantages • Capping of the waste rock and sediment will isolate waste and reduce the mobility of contaminants by reducing leaching and erosion. • Excavation and containment of the waste rock, contaminated sediment, and tailings will remove these areas as sources of groundwater and surface water contamination. • Full containment and isolation is one of the most effective means of preventing acid generation associated with disposal of mine wastes from negatively affecting the environmental health of Site waterways. • Monitoring of the natural recovery of the Site's water waterways will ensure that sediment remediation measures are protective. • Cleanup levels within excavation areas will be protective of human receptors based on recreational direct contact exposure.	Disadvantages • Will not reduce the volume or toxicity of tailings or mine waste material. • Long-term effectiveness requires monitoring and maintenance of capping systems and institutional controls.
Implementability Advantages • Technical resources are readily available for design and implementation of remedy. • Will be designed and implemented to comply with all ARARs, including capping, site development, and wetlands standards. • Significant adverse short-term effects to community are not expected (except for the large volume of trucking that would be required if borrow materials are brought in from off-site). • Does not require sophisticated or intensive operation and maintenance. • Will allow for consolidation and disposal of sediments and other OU1-related wastes. • Anticipated depths to groundwater and bedrock will allow for the cell to be built above the groundwater table without additional separation and underdrains. • Sufficient on-Site borrow materials can be removed from the area that will already be developed for the West Cell, so limited addition woodland clearing will be required for borrow development.	Disadvantages • Significant clearing and grading will be required. • Potential interferences with historical structures and foundations. • Will likely require mitigation of impacted wetlands
Cost Advantages • O&M costs are low. Requires periodic inspection and monitoring of the cell to ensure erosion, excessive leachate production, and vandalism is not occurring is required. • Due to likely development of on-Site borrow materials the cost of repairing local roads, as the result of increased truck traffic, will likely not be required.	Disadvantages • Capital costs for excavation and disposal are high.
Screening Decision: This alternative is **retained** for detailed evaluation.	

Table 3-3
Screening of Alternative SC4
Ely Copper Mine Superfund Site
Vershire, Vermont

Alternative SC4	
This alternative includes excavating the UWA, LWA, and contaminated sediments, and loading the material into trucks for transport to and disposal at a licensed disposal facility. This alternative includes improvements to local roads, on-site access roads, and analytical requirements determined by the receiving facility. The tailings pile will be excavated and placed on the ORB Roast Bed where an impermeable cap will be placed.	
Effectiveness Advantages • Removal of the waste rock and contaminated sediment will stop the flow of dissolved contaminants into the Site's waterways by reducing leaching and erosion. • Removal of the waste rock, contaminated sediment, and tailings will remove these areas as sources of groundwater and surface water contamination. • Clean closure is one of the most effective means of preventing acid generation associated with disposal of mine wastes with negatively impact the environmental health of Site waterways. • Monitoring of the natural recovery of the Site's water waterways will ensure that sediment remediation measures are protective. • Cleanup levels within excavation areas will be protective of human receptors based on recreational direct contact exposure.	Disadvantages • Generation of additional green house gases to relocate the waste material a long distance to a disposal facility. • Damage to local roadways and risks to local residence from significantly increased truck traffic on local roads. • There may be additional measures required to protect/restore historic features during the removal of contaminated material from the Site.
Implementability Advantages • Technical resources are readily available for design and implementation of remedy. • Will be designed and implemented to comply with all ARARs, including capping, site development, wetlands, and historic protection standards. • Does not require sophisticated or intensive operation and maintenance for the capped ore roast bed.	Disadvantages • Significant adverse short-term effects to community are expected from the large volume of truck traffic required. • Will require improvements to local roads and on-site access roads. • Will require a large number of truck loads to transport the waste material off-site. • Will require a large amount of analytical samples for the receiving facility to accept the waste.
Cost Advantages • O&M costs are low. Requires periodic inspection and monitoring of the capped ore roast bed and Site waterways to ensure future impacts to sensitive receptors do not re-emerge.	Disadvantages • Capital costs for excavation and disposal are high.
Screening Decision: This alternative is **retained** for detailed evaluation.	

Table 4-1
Chemical-Specific ARARs and TBCs for Alternative SC1
Ely Copper Mine Superfund Site
Vershire, Vermont

REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	ACTION TAKEN TO COMPLY WITH ARARs
STATE ARARs - None			
FEDERAL ARARS AND TBCs			
EPA Risk Reference Doses (RfDs)	To Be Considered	Risk reference doses (RfDs) are estimates of daily exposure levels that are unlikely to cause significant adverse non-carcinogenic health effects over a lifetime.	The alternative does not address risks identified under these criteria.
EPA Carcinogen Assessment Group, Cancer Slope Factors (CSFs)	To Be Considered	CSFs are used to compute the incremental cancer risk from exposure to contaminants and represent the most up-to-date information on cancer risk from EPA's Carcinogen Assessment Group.	The alternative does not address risks identified under these criteria.
Guidelines for Carcinogen Risk Assessment EPA/630/P-03/001F (March 2005)	To Be Considered	Guidance for assessing cancer risk. Used to establish risk-based standards for managing waste rock at the Site.	The alternative does not address risks identified under these criteria.
Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens EPA/630/R-03/003F (March 2005)	To Be Considered	Guidance of assessing cancer risks to children. Used to establish risk-based standards for managing waste rock at the Site.	The alternative does not address risks identified under these criteria.
Proposed Guidelines for the Clean-Up of Contaminated Sites in Ontario (Ministry of Environment and Energy of Ontario [MOE], 1994)	To Be Considered	This guidance document lists surface water and sediment criteria that are considered protective for aquatic organisms.	The alternative does not address risks identified under these criteria.
Preliminary Remediation Goals for Ecological Endpoints, Efroymson et al., August 1997	To Be Considered	This technical memorandum was prepared to present recommended preliminary remediation goals (PRGs) for surface water, sediment and soil for ecological endpoints for risk assessments and decision making at CERCLA sites.	The alternative does not address risks identified under these criteria.

Table 4-2
Cost Summary for Alternative SC1
Ely Copper Mine Superfund Site
Vershire, Vermont

CAPITAL COSTS	
ITEM	**COST**
Direct Cost Subtotal $0	$0
Contingency Cost (@30 Percent) $0	$0
Direct and Contingency Cost Subtotal $0	$0
TOTAL CAPITAL COSTS $0	**$0**
LONG-TERM OPERATION, MAINTENANCE, AND MONITORING ANNUAL COST	
Annualized Five-Year Review Cost	$7,000
Contingency (10%) and Project Management (5%)	$1,050
Annual O&M Subtotal	$8,050
TOTAL LONG-TERM OPERATION, MAINTENANCE, AND MONITORING PRESENT VALUE COSTS, 30-YEARS, 7% (See Note 1)	**$113,015**
TOTAL PV COST (CAPITAL + LONG TERM PV, 30-YR, 7%)	**$113,015**

Notes:
1. PV = Present Value
2. Includes project management and technical support as a percentage of operation, maintenance, and monitoringcosts. See Present Value Cost Sheet
3. Each line item represents the average cost of the O&M over the 30 year period. See Appendix B for an annual cost for each specific year.

Table 4-3
Location-Specific ARARs and TBCs for Alternative SC2
Ely Copper Mine Superfund Site
Vershire, Vermont

REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	ACTION TAKEN TO COMPLY WITH ARARs
STATE ARARs and TBCs			
Vermont's Land Use and Development Law (Act 250), 10 VSA Chapter 151	Applicable	Issues to be addressed in assessing compliance with Act 250 include substantive environmental and facility siting requirements associated with: • will not result in undue water and air pollution (including construction-related dust) (criterion 1); • protection of headwaters (criterion 1(A)); • will meet all standards for disposal of wastes (criterion 1(B)); • floodways (criterion 1(D)); • streams (criterion 1(E)); • impact on state-regulated wetlands (Class One, Two, and Three; (criterion 1(G)); • erosion control (criterion 4); • impact on historic sites (criterion 8(A)); • endangered species (criterion 8(B)); and • extraction of earth resources (criterion 9(E)) • energy conservation (criterion 9(F)); and • public investments (roads) (criterion 9(K)).	Alternative SC2 will be designed to minimize impacts on protected resources under the Act's criteria, including impacts to wetlands, as appropriate. The EPA has determined that unavoidable impacts to wetlands (primarily Class Three), and historic resources are necessary to abate the release of ARD. Furthermore, under Alternative WR 2 development of the LWA containment cell will be located immediately adjacent to waterways which may result in a greater impact to streams and floodways than other alternatives being considered. Alternative SC2 will be designed to minimize energy consumption and impacts on pubic investments (roads) by obtaining material for the cover system from on-site sources to the extent practical. Measures to minimize impacts from the extraction of earth resources (soil and rock) will be implemented. Site work needs to be managed to minimize impacts to potential endangered species habitat onsite.
Vermont Wetlands Act, 10 VSA Ch. 37; Vermont Wetland Rules (Nat. Res. Brd., Water Res. P. 12-004-056)	Applicable	These standards establish criteria for delineating Class One and Class Two wetlands, which are considered significant wetlands, and set forth allowed and conditional uses for these wetlands. Jurisdiction under the Rules includes within a 50 foot buffer zone to Class Two wetlands. The uses must not have undue adverse impacts on the significant functions of the wetland. Class Three wetlands are defined, but are not protected under these rules (they are addressed under Title 10 V.S.A. Chapter 151, above).	No Class One wetlands occur onsite and Class Two wetlands are limited to the Pond 1 area on the east side of the Site. Alteration of any Class Two wetlands will be mitigated, as required, to restore ecological functions and values. Class Three wetlands will also be disturbed but are not regulated under the Act.
Vermont Regulation of Stream Flow, 10 VSA Chapter 41	Applicable	Regulates and permits activities in streams to protect against damage to fish life or wildlife, prevent creation of flood hazards, and protect from damaging the rights of riparian owners.	Permanent alteration of the streams (permanent and intermittent ephemeral) during the completion of Alternative WR2 will occur as an unavoidable consequence of the activities required to restore the stream to meet Vermont Class B Water Quality Standards within OU1.
Vermont Obstruction of Streams, 10 VSA Chapter 111, § 1407	Applicable	Regulation of obstructions that the prevent the passing of fish in a stream or the outlet or inlet of a natural or artificial pond on a public stream, by means of a rack, screen, weir or other obstruction,	Remedial work in streams will be conducted to permit the passage of fish through the waterways once water quality is restored to support fish populations in the applicable portions of the streams.

Table 4-3
Location-Specific ARARs and TBCs for Alternative SC2
Ely Copper Mine Superfund Site
Vershire, Vermont

REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	ACTION TAKEN TO COMPLY WITH ARARs
STATE ARARs and TBCs (cont.)			
Vermont ANR Guidance on Riparian Buffers (December 5, 2005)	To Be Considered	This guidance provides technical information on the functions and values of riparian buffers, as well as describing acceptable activities within buffer zones. It recommends the establishment of 100 foot buffer zones to streams under circumstances where there is an increased risk of erosion and/or potential for overland flow of pollutants. Where Class II wetlands are contiguous to a waterbody, buffer widths of greater than 50 feet may be recommended based on case-specific application of this Guidance. This Guidance will also be used to recommend buffers for Class III wetlands contiguous to waterbodies, as necessary to maintain the functions and values of the riparian area.	Alternative SC2 remedial measures, particularly the LWA containment cell to be sited within riparian buffer zone, will be implemented and maintained to protect the Site's riparian buffer zone resources and protect the water quality of the adjacent waterways.
Vermont Historic Preservation Law, 22 VSA §§ 743(4), 761, 763, and 767.	Relevant and Appropriate	Places controls on actions conducted by the state that may impact historic, scientific, or archaeological sites and data.	EPA has determined that unavoidable adverse impacts will occur to historic resources at the Site. Alternative SC2 would result in the damage of former building foundations as well as covering the ORB and potentially the retaining wall. EPA will consult with the SHPO and the community regarding the loss of historic resources. Additional investigation will be required for any areas to be developed as an onsite borrow source.
Vermont Endangered Species Law, 10 VSA, Chapter 123, § 5402(a).	Applicable for Listed Species; To Be Considered for Proposed Listed Species	This Vermont statute outlines the definition of endangered and threatened, the procedure for obtaining permits to take endangered or threatened species, and the species listed as endangered or threatened. The statute prohibits the taking, possession or transport of wildlife or plants that are members of an endangered or threatened species without a permit, and sets forth fines for violators. Three bat species that may be present on the Site are specifically listed as threatened or endangered species in Vermont: the Small-footed Bat, Northern Long-eared Bat, and the Little Brown Bat.	Alternative SC2 would be managed to prevent disturbance to any potential rare bat habitat.

Table 4-3
Location-Specific ARARs and TBCs for Alternative SC2
Ely Copper Mine Superfund Site
Vershire, Vermont

REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	ACTION TAKEN TO COMPLY WITH ARARs
FEDERAL ARARs and TBCs			
Floodplain Management and Protection of Wetlands, 44 C.F.R. 9	Relevant and Appropriate	Remedial alternatives that may cause alteration within a 500-year floodplain/cause negative impacts to downstream floodplain or that will cause alteration of federal jurisdictional wetlands/aquatic habitats will be implemented in compliance with these relevant and appropriate FEMA standards (which promulgate requirements under Executive Order 11988 (Floodplain Management) and Executive Order 11990 (Protection of Wetlands)). Prohibits activities that adversely affect a federally-regulated wetland unless there is no practicable alternative and the proposed action includes all practicable measures to minimize harm to wetlands that may result from such use. Requires soliciting public comment on any disturbance of floodplains or federally-regulated wetlands.	There will be unavoidable impacts to federally-regulated wetlands during the implementation of the remedy which would occur in order to abate the ongoing impacts to the wetlands and surface water surrounding the waste rock and tailings. Wetland restoration will be conducted, as required. A wetlands delineation would be implemented as a component of the design for Alternative SC2. The EPA will seek public comment regarding the potential impacts to wetlands at the Site. The remedial action will be managed to prevent any downstream flooding impacts.
Federal Clean Water Act, Section 404, 33 USC § 1344; 40 CFR Part 230; 33 CFR Parts 320-323	Applicable	Prohibits the discharge of dredge or fill material into a federally-regulated aquatic ecosystem if a practicable alternative with lesser effects is available. For any alternative selected that may dredge or fill a water of the U.S., a finding that No Practicable Alternative was available and that the general prohibitions in 40 CFR 230.10 and the factual determinations of 40 CFR 230.11 were unavoidable is required. Under these standards EPA must solicit public comment on its finding that one of the alternatives is the Least Environmentally Damaging Practicable Alternative.	Alternative SC2 would include potential dredge and fill activities associated with the removal of contaminated sediments from Ely Brook and its tributaries and ponds: and the excavation and re-location waste rock within the UWA and LWA and the consolidation and capping of the tailings pile onto the ore roast bed. The implementation would use BMPs to minimize the impacts of the cleanup, particularly on downstream surface water resources. EPA will solicit public comment in the Proposed Plan as to its finding that SC2 is not the Least Environmentally Damaging Practicable Alternative to protect wetland resources at the Site.
Federal Fish and Wildlife Coordination Act; 16 USC 661 *et seq*., as amended	Applicable	Consultation with the U.S. Fish and Wildlife Service and appropriate state wildlife agency is required for modification of a body of water or federally- listed endangered or threatened species habitat. Consultation is required to develop measures to prevent, mitigate, or compensate for the loss of fish and wildlife or federally-listed endangered or threatened species habitat.	The implementation of the design and cleanup for Alternative SC2 will be coordinated with the U.S. Fish and Wildlife Service and State wildlife officials.

Table 4-3
Location-Specific ARARs and TBCs for Alternative SC2
Ely Copper Mine Superfund Site
Vershire, Vermont

REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	ACTION TAKEN TO COMPLY WITH ARARs
FEDERAL ARARs and TBCs (cont.)			
Federal Endangered Species Act of 1973 (ESA), 16 USC 1531 *et seq* .; 33 CFR Part 320	To Be Considered	The purpose of the ESA is to "conserve the ecosystems upon with threatened and endangered species depend" and to conserve and recover listed species. Federal agencies must consult with the U.S. Fish and Wildlife Service to ensure that the actions they authorize, fund, or carry out will not jeopardize listed species. The law provides for critical habitat designations for listed species. Critical habitat designations affect Federal agency actions and federally funded or permitted activities. The Small-footed Bat, which may occur on the Site, has been proposed for federal-listing as a threatened or endangered species.	EPA will consult with federal and state wildlife officials to identify measures to prevent disturbance to any potential rare bat habitat.
National Historic Preservation Act (NHPA), Section 106, 16 USC 470 *et seq* ., 36 CFR Part 800	Applicable	Section 106 of the NHPA of 1966 requires EPA to take into account the effect of all of its actions on historic properties. In consultation with the State Historic Preservation Officer (SHPO), a determination has been made that the Ely Mine Site is eligible for the National Register. The consultation is to identify potential adverse effects on historic properties and seek ways to avoid, minimize or mitigate any such effects on historic properties.	EPA has determined that unavoidable adverse impacts will occur to historic resources at the Site. Alternative SC2 would result in the damage of former building foundations as well as covering the ORB and potentially the retaining wall. EPA will consult with the SHPO and the community regarding the loss of historic resources. Additional investigations will be required for any areas on Site that may be developed for borrow materials for the remedy or not that have not been previously investigated within areas where remedial activities will take place.
Archeological and Historic Preservation Act, 16 USC 469 *et seq* ., 36 CFR, Part 65	Applicable	This standard requires that, whenever any federal agency finds or is made aware that its activity in connection with any construction project or federally licensed project, activity, or program may cause irreparable loss or destruction of significant scientific, pre-historical, historical, or archeological data such agency shall undertake the recovery, protection, and preservation of such data or notify the Secretary of the Interior. The undertaking could include a preliminary survey (or other investigation as needed) and analysis and publication of the reports resulting from such investigation.	Preliminary surveys have identified significant archaeological data that may be located in the area subject to disturbance. The design will identify any significant scientific, pre-historic, historical, or archaeological data that may suffer irreparable loss or destruction and develop plans for appropriate data recovery. No data recovery efforts will be necessary for Alternative SC2. Additional investigations may be required for any areas on Site that may be altered for the remedy and have not been previously investigated.

Table 4-4
Chemical-Specific ARARs and TBCs for Alternative SC2
Ely Copper Mine Superfund Site
Vershire, Vermont

REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	ACTION TAKEN TO COMPLY WITH ARARs
STATE ARARs - None			
FEDERAL ARARs and TBCs			
EPA Risk Reference Doses (RfDs)	To Be Considered	Risk reference doses (RfDs) are estimates of daily exposure levels that are unlikely to cause significant adverse non-carcinogenic health effects over a lifetime.	This alternative will achieve cleanup standards based on this guidance, since the actions taken will address site risks through consolidation and capping of site contamination and elimination of contaminants that pose a non-carcinogenic human-health risk.
EPA Carcinogen Assessment Group, Cancer Slope Factors (CSFs)	To Be Considered	CSFs are used to compute the incremental cancer risk from exposure to contaminants and represent the most up-to-date information on cancer risk from EPA's Carcinogen Assessment Group.	This alternative will achieve cleanup standards based on this guidance, since the actions taken will address site risks through consolidation and capping of site contamination and elimination of contaminants that -pose a carcinogenic human-health risk.
Guidelines for Carcinogen Risk Assessment EPA/630/P-03/001F (March 2005)	To Be Considered	Guidance for assessing cancer risk. Used to establish risk-based standards for managing waste rock at the Site.	This alternative will achieve cleanup standards based on this guidance, since the actions taken will address site risks through consolidation and capping of site contamination and elimination of contaminants that pose a carcinogenic human-health risk.
Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens EPA/630/R-03/003F (March 2005)	To Be Considered	Guidance of assessing cancer risks to children. Used to establish risk-based standards for managing waste rock at the Site.	This alternative will achieve cleanup standards based on this guidance, since the actions taken will address site risks through consolidation and capping of site contamination and elimination of contaminants that pose a carcinogenic human-health risk to children.
Proposed Guidelines for the Clean-Up of Contaminated Sites in Ontario (Ministry of Environment and Energy of Ontario [MOE], 1994)	To Be Considered	This guidance document lists surface water and sediment criteria that are considered protective for aquatic organisms.	This alternative will achieve cleanup standards based on this guidance, since the actions taken will address site risks through consolidation and capping of site contamination and elimination of contaminants that pose an ecological risk.
Preliminary Remediation Goals for Ecological Endpoints , Efroymson et al., August 1997	To Be Considered	This technical memorandum was prepared to present recommended preliminary remediation goals (PRGs) for surface water, sediment and soil for ecological endpoints for risk assessments and decision making at CERCLA sites.	This alternative will achieve cleanup standards based on this guidance, since the actions taken will address site risks through consolidation and capping of site contamination and elimination of contaminants that pose an ecological risk.

Table 4-5
Action-Specific ARARs and TBCs for Alternative SC2
Ely Copper Mine Superfund Site
Vershire, Vermont

REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	ACTION TAKEN TO COMPLY WITH ARARs
STATE ARARs and TBCs			
Vermont Water Pollution Control Act, 10 VSA Chapter 47; Vermont Water Quality Standards, Ch. 1, 2, and 3 and Appendix C and D	Applicable	Establishes water quality standards for surface waters and applies to alternatives that call for monitoring surface water bodies on and off of the Site. In particular, monitoring will ensure that source control remedies at the Site are preventing metals and ARD from migrating to surface waters and exceeding the waterways' water quality standards.	These standards will be used to monitor the water quality of the OU1 waterways to assess the success of Alternative SC2 in eliminating the source of OU1 contaminants migrating to Site waterways. Within the cold water streams Class B waters standards will be used for monitoring. Ponds/warm water habitats on the Site will be monitored to assess whether the waterways meet aquatic health standards for warm waters. Water quality monitoring using these standards will be used to assess any monitored natural recovery component of the remedy.
Vermont National Pollutant Discharge Elimination System (NPDES) Regulations Ch. 13 (Nat. Res. Brd., Water Res. P. 12-004-052)	Applicable	The regulations stipulate requirements for discharges to surface waters, compliance with NPDES standards, and meeting stormwater management requirements. Groundwater and stormwater removed from excavations and dewatering liquid from dewatering soil and sediment may require treatment prior to discharge.	Water generated from remedial activities will be treated to meet discharge standards. Site disturbance will be conducted in compliance with stormwater management standards.
Vermont Stormwater Management Act, 10 VSA § 1263 and §1264; Vermont Stormwater Management Rule, Env. Prot. R. Ch. 18	Applicable	This rule applies to discharges of regulated stormwater runoff to waters that are not listed on the EPA-approved Vermont 303(d) List of Waters as being impaired principally due to stormwater runoff. The rule establishes a state permit program for post-construction management of stormwater runoff; establishes permitting thresholds for discharges; sets forth treatment standards; provides for the issuance of individual and general permits; specifies application requirements; and amends the Vermont Stormwater Management manual. The rule generally applies to stormwater discharges from construction activities covering greater than or equal to one-acre.	Alternative SC2 would include measures to comply with these requirements through the design of measures to mitigate the release of stormwater from disturbed areas of the Site.
Vermont Groundwater Protection Act, 10 VSA §§ 1390-94; Vermont Groundwater Protection Rule and Strategy, Env. Prot. Ch. 12-702 and 703	Applicable	Establishes standards for groundwater quality. Management criteria for each groundwater class are established as well as primary and secondary standards for groundwater protection. These are the primary groundwater standards if they are more stringent than federal standards. Within the compliance boundary for any waste management unit these standards are used as monitoring standards.	These standards will be used for monitoring groundwater within and outside of the compliance boundary for the waste management area established for the Site to make sure that contaminants do not migrate from the LVA Containment Cell and the Ore Roast Bed Cell into the groundwater.
Vermont Department of Health Drinking Water Guidance (October 2000).	To Be Considered	Lists the Vermont Health Advisories (VHAs) for chemicals of concern in drinking water. Vermont Health Advisories are researched and calculated concentrations of chemicals in drinking water in instances where the chemicals do not have a promulgated federal or state standard, or more stringent federal risk-based standard. Within the compliance boundary for any waste management unit these standards are used as monitoring standards.	These standards will be used for monitoring groundwater within and outside of the compliance boundary for the waste management area established for the Site to make sure that contaminants do not migrate from the LVA Containment Cell and the Ore Roast Bed Cell into the groundwater.

Table 4-5
Action-Specific ARARs and TBCs for Alternative SC2
Ely Copper Mine Superfund Site
Vershire, Vermont

REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	ACTION TAKEN TO COMPLY WITH ARARs
STATE ARARs and TBCs (cont.)			
Vermont Solid Waste Management Rules (VSWMR), Management of Mining and Mineral Processing Waste, Env. Prot. R. Ch. 6, Subchapter 13	Applicable	These substantive requirements under these rules regulate the tailing wastes and roast bed material that were produced as part of the benefication of ore at the Site, but the rules do not apply to unprocessed waste rock. However, Section 6-1301(f) permits the waiver of technical and siting requirements of these rules provided there is a response action under CERCLA to a release or threatened release of hazardous substances or materials; and the proposed response action will not adversely affect public health, safety or the environment; and the technical and siting requirements will be complied with to the extent practical in light of the overall objectives of the response. In particular, liner requirements for disposal areas under § 1305(c)(2)(D) and (F) are waived. The remainder of § 6-1305 establishes the closure and post-closure performance standards that are applicable to the remedial action. That is, all facilities subject to closure requirements must be closed in a manner that: (a) Minimizes the need for further maintenance related to the waste facility; and (b) Controls, minimizes, or eliminates, to the extent necessary to prevent threats to public health and safety and the environment, including post-closure emission or discharge of waste, waste constituents, leachate, contaminated runoff, and/or waste decomposition products to the groundwater or surface waters or the atmosphere.	This Alternative will meet these standards, except for standards that have been waived, for the management, consolidation, and capping of tailings and roasted ore that are regulated under these regulations. Waiver of liner requirements will not adversely affect public health, safety, or the environment.
Vermont Waste Management Act, 10 VSA Chapter 159 and Hazardous Waste Management Regulations, Env. Prot. R. Ch. 7	Applicable	Establishes requirements for the identification and management of hazardous waste. These regulations apply to solutions having pH less than 2 or contaminated media that exceeds toxicity standards under these regulations. Treatment media or any other wastes that are disposed of off-site will be tested to determine if it exceeds the standards to be managed and disposed of as hazardous waste. Incorporates requirements of the federal Resource Conservation and Recovery Act regulations, 40 CFR 264.	Wastes generated by the remedial action for off-site disposal will be tested for hazardous waste characteristics. If the wastes exceed these standards they will be handled under the requirements of these regulations.
Vermont Slash Removal, 10 VSA § 2648	Applicable	Forest growth may only be cut if all slash adjoining the right-of-way of any public highway, or the boundary lines of woodlots owned by adjoining property owners, is removed for a distance of 50 feet from the right-of-way of any public highway or from the boundary lines of woodlots owned by adjoining property owners. Furthermore, main roads through cut-over areas must be kept free from slash so that there is unobstructed access for fire fighting equipment and fire suppression crews.	Wooded debris produced from clearing wooded areas for borrow development and other remedial actions will be managed so as not to pose a fire or site access risk.
Vermont Air Pollution Control Act, 10 VSA Chapter 23 and Air Pollution Control Regulations, Env. Prot. R. Ch. 5	Relevant and Appropriate	Establishes authority for a coordinated statewide program of air pollution prevention, abatement and control. Lists prohibited activities affecting air quality and establishes primary and secondary ambient air quality standards for sulfur oxides, particulate matter, carbon monoxide, ozone, nitrogen dioxide, and lead. The secondary standard for particulate matter is 150 micrograms per cubic meter, 24 hour average, not to be exceeded more than once per year.	Alternatives WR2 will be designed to comply with these requirements. Cleanup actions and long term maintenance of the capped cells will be designed and implemented to meet these requirements by limiting particulate matter emissions.

Table 4-5
Action-Specific ARARs and TBCs for Alternative SC2
Ely Copper Mine Superfund Site
Vershire, Vermont

REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	ACTION TAKEN TO COMPLY WITH ARARs
STATE ARARs and TBCs (cont.)			
Vermont Handbook for Erosion Prevention and Sediment Control, Working Interim Document, Released in 2003 (VTDEC, 2003)	To Be Considered	A compilation of information from various sources released by the Vermont Department of Environmental Conservation for use in developing the erosion prevention and sediment control plans required for construction-related stormwater discharge permitting.	The manual will be used as guidance in the development of measures to prevent erosion and sedimentation from remedial activities at the Site.
FEDERAL ARARs and TBCs			
Federal Clean Water Act, Section 402 – National Pollution Discharge Elimination System (33 USC 1342; 40 CFR 122-135, 131)	Applicable	The CWA contains discharge limitation, monitoring requirements, and best management practices (BMPs) for discharges into navigable waters, i.e., surface waters. These regulations would be applicable to remedial strategies involving discharge to surface waters. Groundwater and stormwater removed from excavations and dewatering liquid from dewatering soil and sediment may require treatment prior to discharge.	Water generated from remedial activities will be treated to meet discharge standards prior to being discharge back to Site waterways. Site disturbance will be conducted in compliance with stormwater management standards.
Federal Clean Water Act – Stormwater Requirements for Construction Sites; 40 CFR 122.26 (b)(15), (c)(1)	Applicable	Applicable to construction activity including clearing, grading and excavation, except operations that result in the disturbance of over one acres of total land area.	Construction activities and long-term maintenance will use best management practices to comply with these requirements.
Federal Safe Drinking Water Maximum Contaminant Levels (MCLs) and Maximum Contaminant Level Goals (MCLGs), National Primary Drinking Water Regulations, 40 CFR Parts 141.11 – 141.16 and 141.50 – 141.53	Relevant and Appropriate for MCLs and non-zero MCLGs only; MCLGs set as zero are To Be Considered	These standards protect drinking water quality by limiting the levels of specific contaminants that can adversely affect public health and are known or anticipated to occur in public water systems. MCLs are the highest level of a contaminant that is allowed in drinking water. MCLGs are the level of a contaminant in drinking water below which there is no known or expected risk to health. MCLs are set as close to MCLGs as feasible using the best available treatment technology and taking cost into consideration. MCLs are enforceable standards, while MCLGs are non-enforceable public health goals. Within the compliance boundary for any waste management unit these standards are used as monitoring standards.	These standards will be used for monitoring groundwater within and outside of the compliance boundary for the waste management area established for the Site to make sure that contaminants do not migrate from the LVA Containment Cell and the Ore Roast Bed Cell into the groundwater.
Resource Conservation and Recovery Act, 42 USC §§ 6901-6992; 40 CFR Part 264	Applicable	Vermont is delegated to implement these standards through its Hazardous Waste Management Regulations (see above).	Wastes generated by the remedial action for off-site disposal will be tested for hazardous waste characteristics. If the wastes exceed these standards they will be handled under the requirements of these regulations.

Table 4-5
Action-Specific ARARs and TBCs for Alternative SC2
Ely Copper Mine Superfund Site
Vershire, Vermont

REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	ACTION TAKEN TO COMPLY WITH ARARs
FEDERAL ARARs and TBCs			
Federal Clean Water Act, National Recommended Water Quality Criteria (NRWQC), 40 CFR Part 122.44	Relevant and Appropriate	These standards are used to develop numerical and biological water quality standards for monitoring surface water quality. In particular, monitoring will ensure that source control remedies at the Site are preventing metals and ARD from migrating to surface waters and exceeding the waterways' water quality standards.	These standards will be used to monitor the water quality of the OU1 waterways to assess the success of Alternative SC2 in eliminating the source of OU1 contaminants migrating to Site waterways. Within the cold water streams Class B waters standards will be used for monitoring. Ponds/warm water habitats on the Site will be monitored to assess whether the waterways meet aquatic health standards for warm waters. Water quality monitoring using these standards will be used to assess any monitored natural recovery component of the remedy.
Contaminated Sediment Remediation Guidance for Hazardous Waste Sites (EPA-540-R-05-012 OSWER 9355.0-85 December 2005)	To Be Considered	Guidance for making remedy decisions for contaminated sediment sites. Specific sections of the guidance address dredging, disposal, and monitored natural recovery.	Removal of contaminated sediments from ponds and waterways will comply with standards identified in this guidance. Provides standards for the monitored natural recover of Ely Brook in areas where it may not be possible to remove all contaminated sediment.
Federal Surface Mining Control and Reclamation Act of 1977, 30 USC §§ 1201-1328; 30 CFR 816 and 817	Relevant and Appropriate	Provides closure guidelines for coal sites. Design criteria for the closure of tailing at coal sites are relevant and appropriate for use for the construction and closure of waste management cells at this Site.	Alternative SC2 will be designed to minimize the exposure of ARD through consolidation of containment cells with impermeable caps. Areas of exposed mine material will be revegetated to achieve reclamation standards

Table 4-6
Cost Summary for Alternative SC2
Ely Copper Mine Superfund Site
Vershire, Vermont

CAPITAL COSTS	
ITEM	**COST**
Pre-Design Studies	$361,000
Temporary Facilities	$142,500
Haulage Way Construction	$266,000
Mobilization / Demobilization	$152,000
Upgrade of Existing Access Roads	$147,820
Erosion and Sediment Control	$190,000
Staging Area and Temporary Leachate Collection	$168,000
Surface Water Diversions	$279,300
UWA, LWA, TA Waste Material Excavation, Transport, and Stockpiling	$1,386,000
Ely Brook, Ponds, Tributary Excavations and Restoration	$1,772,740
UWA, LWA, TA Tribs and Seeps	$212,594
Containment Cell Construction	$4,747,273
Cap Construction Ore Roast Bed with Tailings	$748,476
UWA and LWA Restoriation	$321,052
Staging Area Restoriation	$15,200
Cultural/Historical Preservation	$195,000
Wetland and Habitat Mitigation	$266,000
Institutional Controls	$95,000
Long-Term Monitoring Plan	$57,000
Monitoring Well Installations	$80,000
Direct Cost Subtotal	$11,602,955
Contingency Cost (@30 Percent)	$3,480,886
Direct and Contingency Cost Subtotal	$15,083,841
Indirect Capital Costs (Engineering, Const. Mgmt., Proj. Mgmt., etc.)	$3,318,445
TOTAL CAPITAL COSTS	**$18,402,286**
LONG-TERM OPERATION, MAINTENANCE, AND MONITORING ANNUAL COST	
Site Inspections, Sampling, and Reporting	$36,000
Routine Site Maintenance, Repairs, etc.	$24,000
Annualized Five-Year Review Cost	$7,000
Contingency (10%) and Project Management (5%)	$10,050
Annual O&M Subtotal[3]	$77,050
TOTAL LONG-TERM OPERATION, MAINTENANCE, AND MONITORING PRESENT VALUE COSTS, 30-YEARS, 7% (See Note 1)	**$1,026,221**
TOTAL PV COST (CAPITAL + LONG TERM PV, 30-YR, 7%)	**$19,428,508**

Notes:

1. PV = Present Value
2. Includes project management and technical support as a percentage of operation, maintenance, and monitoringcosts. See Present Value Cost Sheet.
3. Each line item represents the average cost of the O&M over the 30 year period. See Appendix B for an annual cost for each specific year.

Table 4-7
Location-Specific ARARs and TBCs for Alternative SC3
Ely Copper Mine Superfund Site
Vershire, Vermont

REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	ACTION TAKEN TO COMPLY WITH ARARs
STATE ARARs and TBCs			
Vermont's Land Use and Development Law (Act 250), 10 VSA Chapter 151	Applicable	Issues to be addressed in assessing compliance with Act 250 include substantive environmental and facility siting requirements associated with: • will not result in undue water and air pollution (including construction-related dust) (criterion 1); • protection of headwaters (criterion 1(A)); • will meet all standards for disposal of wastes (criterion 1(B)); • floodways (criterion 1(D)); • streams (criterion 1(E)); • impact on state-regulated wetlands (Class One, Two, and Three; (criterion 1(G)); • erosion control (criterion 4); • impact on historic sites (criterion 8(A)); • endangered species (criterion 8(B)); and • extraction of earth resources (criterion 9(E)) • energy conservation (criterion 9(F)); and • public investments (roads) (criterion 9(K))..	Alternative WR3 will be designed to minimize impacts on protected resources under the Act's criteria, as appropriate. The EPA has determined that unavoidable impacts to wetlands (primarily Class Three), and historic resources are necessary to abate the release of ARD. Furthermore, under Alternative SC3 development of the West Containment Cell will be located away from waterways resulting in less impact on streams and floodways. Alternative SC3 will be designed to minimize energy consumption and impacts on pubic investments (roads) by obtaining material for the cover system from on-site sources to the extent practical. Measures to minimize impacts from the extraction of earth resources (soil and rock) will be implemented. Site work needs to be managed to minimize impacts to potential endangered species habitat onsite.
Vermont Wetlands Act, 10 VSA Ch. 37; Vermont Wetland Rules (Nat. Res. Brd., Water Res. P. 12-004-056)	Applicable	These standards establish criteria for delineating Class One and Class Two wetlands, which are considered significant wetlands, and set forth allowed and conditional uses for these wetlands. Jurisdiction under the Rules includes within a 50 foot buffer zone to Class Two wetlands. The uses must not have undue adverse impacts on the significant functions of the wetland. Class Three wetlands are defined, but are not protected under these rules (they are addressed under Title 10 V.S.A. Chapter 151, above).	No Class One wetlands occur onsite and Class Two wetlands are limited to the Pond 1 area on the east side of the Site. Alteration of any Class Two wetlands will be mitigated, as required, to restore ecological functions and values. Class Three wetlands will also be disturbed but are not regulated under the Act.
Vermont Regulation of Stream Flow, 10 VSA Chapter 41	Applicable	Regulates and permits activities in streams to protect against damage to fish life or wildlife, prevent creation of flood hazards, and protect from damaging the rights of riparian owners.	Permanent alteration of the streams (permanent or intermittent ephemeral) during the completion of Alternative SC3 will occur as an unavoidable consequence of the activities required to restore the stream to meet Vermont Class B Water Quality Standards within OU1.
Vermont Obstruction of Streams, 10 VSA Chapter 111, § 1407	Applicable	Regulation of obstructions that the prevent the passing of fish in a stream or the outlet or inlet of a natural or artificial pond on a public stream, by means of a rack, screen, weir or other obstruction,	Remedial work in streams will be conducted to permit the passage of fish through the waterways once water quality is restored to support fish populations in the applicable portions of the streams.
Vermont ANR Guidance on Riparian Buffers (December 5, 2005)	To Be Considered	This guidance provides technical information on the functions and values of riparian buffers, as well as describing acceptable activities within buffer zones. It recommends the establishment of 100 foot buffer zones to streams under circumstances where there is an increased risk of erosion and/or potential for overland flow of pollutants. Where Class II wetlands are contiguous to a waterbody, buffer widths of greater than 50 feet may be recommended based on case-specific application of this Guidance. This Guidance will also be used to recommend buffers for Class III wetlands contiguous to waterbodies, as necessary to maintain the functions and values of the riparian area.	Alternative SC3 remedial measures, particularly the West Containment Cell to be sited within riparian buffer zone, will be implemented and maintained to protect the Site's riparian buffer zone resources and protect the water quality of the adjacent waterways.

Table 4-7
Location-Specific ARARs and TBCs for Alternative SC3
Ely Copper Mine Superfund Site
Vershire, Vermont

REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	ACTION TAKEN TO COMPLY WITH ARARs
STATE ARARs and TBCs (cont.)			
Vermont Historic Preservation Law, 22 VSA §§ 743(4), 761, 763, and 767.	Relevant and Appropriate	Places controls on actions conducted by the state that may impact historic, scientific, or archaeological sites and data.	EPA has determined that unavoidable adverse impacts will occur to historic resources at the Site. Alternative WR3 would result in the damage of former building foundations as well as covering the ORB and potentially the retaining wall. EPA will consult with the SHPO and the community regarding the loss of historic resources. Additional investigation will be required for any areas to be developed as an onsite borrow source.
Vermont Endangered Species Law, 10 VSA, Chapter 123, § 5402(a).	Applicable for Listed Species; To Be Considered for Proposed Listed Species	This Vermont statute outlines the definition of endangered and threatened, the procedure for obtaining permits to take endangered or threatened species, and the species listed as endangered or threatened. The statute prohibits the taking, possession or transport of wildlife or plants that are members of an endangered or threatened species without a permit, and sets forth fines for violators. Three bat species that may be present on the Site are specifically listed as threatened or endangered species in Vermont: the Small-footed Bat, Northern Long-eared Bat, and the Little Brown Bat.	Alternative SC3 would be managed to prevent disturbance to any potential rare bat habitat.
FEDERAL ARARs and TBCs			
Floodplain Management and Protection of Wetlands, 44 C.F.R. 9	Relevant and Appropriate	Remedial alternatives that may cause alteration within a 500-year floodplain/cause negative impacts to downstream floodplain or that will cause alteration of federal jurisdictional wetlands/aquatic habitats will be implemented in compliance with these relevant and appropriate FEMA standards (which promulgate requirements under Executive Order 11988 (Floodplain Management) and Executive Order 11990 (Protection of Wetlands)). Prohibits activities that adversely affect a federally-regulated wetland unless there is no practicable alternative and the proposed action includes all practicable measures to minimize harm to wetlands that may result from such use. Requires soliciting public comment on any disturbance of floodplains or federally-regulated wetlands.	There will be unavoidable impacts to federally-regulated wetlands during the implementation of the remedy which would occur in order to abate the ongoing impacts to the wetlands and surface water surrounding the waste rock and tailings. Wetlands mitigation will be conducted, as required. A wetlands delineation would be implemented as a component of the design for Alternative WR3. The EPA will seek public comment regarding the potential impacts to wetlands at the Site. The remedial action will be managed to prevent any downstream flooding impacts.
Federal Clean Water Act, Section 404, 33 USC § 1344; 40 CFR Part 230; 33 CFR Parts 320-323	Applicable	Prohibits the discharge of dredge or fill material into a federally-regulated aquatic ecosystem if a practicable alternative with lesser effects is available. For any alternative selected that may dredge or fill a water of the U.S., a finding that No Practicable Alternative was available and that the general prohibitions in 40 CFR 230.10 and the factual determinations of 40 CFR 230.11 were unavoidable is required. Under these standards EPA must solicit public comment on its finding that one of the alternatives is the Least Environmentally Damaging Practicable Alternative.	Alternative SC3 would include potential dredge and fill activities associated with the removal of contaminated sediments from Ely Brook and its tributaries and ponds, the construction of the West Containment Cell, the excavation and re-location of UWA and LWA, and the consolidation of the tailings at the roast ore beds. The implementation would use BMPs to minimize the impacts of the cleanup, particularly on downstream surface water resources. EPA will solicit public comment in the Proposed Plan as to its finding that SC3 is the Least Environmentally Damaging Practicable Alternative to protect wetland resources at the Site.

Table 4-7
Location-Specific ARARs and TBCs for Alternative SC3
Ely Copper Mine Superfund Site
Vershire, Vermont

REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	ACTION TAKEN TO COMPLY WITH ARARs
FEDERAL ARARs and TBCs (cont.)			
Federal Fish and Wildlife Coordination Act; 16 USC 661 *et seq*., as amended	Applicable	Consultation with the U.S. Fish and Wildlife Service and appropriate state wildlife agency is required for modification of a body of water or federally- listed endangered or threatened species habitat. Consultation is required to develop measures to prevent, mitigate, or compensate for the loss of fish and wildlife or federally-listed endangered or threatened species habitat.	The implementation of the design and cleanup for Alternative SC3 will be coordinated with the U.S. Fish and Wildlife Service and State wildlife officials.
Federal Endangered Species Act of 1973 (ESA), 16 USC 1531 *et seq*.; 33 CFR Part 320	To Be Considered	The purpose of the ESA is to "conserve the ecosystems upon with threatened and endangered species depend" and to conserve and recover listed species. Federal agencies must consult with the U.S. Fish and Wildlife Service to ensure that the actions they authorize, fund, or carry out will not jeopardize listed species. The law provides for critical habitat designations for listed species. Critical habitat designations affect Federal agency actions and federally funded or permitted activities. The Small-footed Bat, which may occur on the Site, is proposed to be federally-listed as a threatened or endangered species.	EPA will consult with federal and state wildlife officials to identify measures to prevent disturbance to any potential rare bat habitat.
National Historic Preservation Act (NHPA), Section 106, 16 USC 470 *et seq*., 36 CFR Part 800	Applicable	Section 106 of the NHPA of 1966 requires EPA to take into account the effect of all of its actions on historic properties. In consultation with the State Historic Preservation Officer (SHPO), a determination has been made that the Ely Mine Site is eligible for the National Register. The consultation is to identify potential adverse effects on historic properties and seek ways to avoid, minimize or mitigate any such effects on historic properties.	EPA has determined that unavoidable adverse impacts will occur to historic resources at the Site. Alternative SC3 would result in the damage of former building foundations as well as covering the ORB and potentially the retaining wall. EPA will consult with the SHPO and the community regarding the loss of historic resources. Additional investigations will be required for any areas on Site that may be developed, such as the West Containment Cell area, that has not been previously investigated.
Archeological and Historic Preservation Act, 16 USC 469 *et seq*., 36 CFR, Part 65	Applicable	This standard requires that, whenever any federal agency finds or is made aware that its activity in connection with any construction project or federally licensed project, activity, or program may cause irreparable loss or destruction of significant scientific, pre-historical, historical, or archeological data such agency shall undertake the recovery, protection, and preservation of such data or notify the Secretary of the Interior. The undertaking could include a preliminary survey (or other investigation as needed) and analysis and publication of the reports resulting from such investigation.	Preliminary surveys have identified significant archaeological data that may be located in the area subject to disturbance. The design will identify any significant scientific, pre-historic, or archaeological data that may suffer irreparable loss or destruction and develop plans for appropriate data recovery. Additional investigations may be required for any areas on Site that may be altered for the remedy and have not been previously investigated.

Table 4-8
Chemical-Specific ARARs and TBCs for Alternative SC3
Ely Copper Mine Superfund Site
Vershire, Vermont

REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	ACTION TAKEN TO COMPLY WITH ARARs
STATE ARARs - None			
FEDERAL ARARs and TBCs			
EPA Risk Reference Doses (RfDs)	To Be Considered	Risk reference doses (RfDs) are estimates of daily exposure levels that are unlikely to cause significant adverse non-carcinogenic health effects over a lifetime.	This alternative will achieve cleanup standards based on this guidance, since the actions taken will address site risks through consolidation and capping of site contamination and elimination of contaminants that pose a non-carcinogenic human-health risk.
EPA Carcinogen Assessment Group, Cancer Slope Factors (CSFs)	To Be Considered	CSFs are used to compute the incremental cancer risk from exposure to contaminants and represent the most up-to-date information on cancer risk from EPA's Carcinogen Assessment Group.	This alternative will achieve cleanup standards based on this guidance, since the actions taken will address site risks through consolidation and capping of site contamination and elimination of contaminants that pose a carcinogenic human-health risk.
Guidelines for Carcinogen Risk Assessment EPA/630/P-03/001F (March 2005)	To Be Considered	Guidance for assessing cancer risk. Used to establish risk-based standards for managing waste rock at the Site.	This alternative will achieve cleanup standards based on this guidance, since the actions taken will address site risks through consolidation and capping of site contamination and elimination of contaminants that pose a carcinogenic human-health risk.
Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens EPA/630/R-03/003F (March 2005)	To Be Considered	Guidance of assessing cancer risks to children. Used to establish risk-based standards for managing waste rock at the Site.	This alternative will achieve cleanup standards based on this guidance, since the actions taken will address site risks through consolidation and capping of site contamination and elimination of contaminants that pose a carcinogenic human-health risk to children.
Proposed Guidelines for the Clean-Up of Contaminated Sites in Ontario (Ministry of Environment and Energy of Ontario [MOE], 1994)	To Be Considered	This guidance document lists surface water and sediment criteria that are considered protective for aquatic organisms.	This alternative will achieve cleanup standards based on this guidance, since the actions taken will address site risks through consolidation and capping of site contamination and elimination of contaminants that pose an ecological risk.
Preliminary Remediation Goals for Ecological Endpoints , Efroymson et al., August 1997	To Be Considered	This technical memorandum was prepared to present recommended preliminary remediation goals (PRGs) for surface water, sediment and soil for ecological endpoints for risk assessments and decision making at CERCLA sites.	This alternative will achieve cleanup standards based on this guidance, since the actions taken will address site risks through consolidation and capping of site contamination and elimination of contaminants that pose an ecological risk.

Table 4-9
Action-Specific ARARs and TBCs for Alternative SC3
Ely Copper Mine Superfund Site
Vershire, Vermont

REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	ACTION TAKEN TO COMPLY WITH ARARs
STATE ARARs and TBCs			
Vermont Water Pollution Control Act, 10 VSA Chapter 47; Vermont Water Quality Standards, Ch. 1, 2, and 3 and Appendix C and D	Applicable	Establishes water quality standards for surface waters and applies to alternatives that call for monitoring surface water bodies on and off of the Site. In particular, monitoring will ensure that source control remedies at the Site are preventing metals and ARD from migrating to surface waters and exceeding the waterways' water quality standards.	These standards will be used to monitor the water quality of the OU1 waterways to assess the success of Alternative WR3 in eliminating the source of OU1 contaminants migrating to Site waterways. Within the cold water streams Class B waters standards will be used for monitoring. Ponds/warm water habitats on the Site will be monitored to assess whether the waterways meet aquatic health standards for warm waters. Water quality monitoring using these standards will be used to assess any monitored natural recovery component of the remedy.
Vermont National Pollutant Discharge Elimination System (NPDES) Regulations Ch. 13 (Nat. Res. Brd., Water Res. P. 12-004-052)	Applicable	The regulations stipulate requirements for discharges to surface waters, compliance with NPDES standards, and meeting stormwater management requirements. Groundwater and stormwater removed from excavations and dewatering liquid from dewatering soil and sediment may require treatment prior to discharge.	Water generated from remedial activities will be treated to meet discharge standards. Site disturbance will be conducted in compliance with stormwater management standards.
Vermont Stormwater Management Act, 10 VSA § 1263 and §1264; Vermont Stormwater Management Rule, Env. Prot. R. Ch. 18	Applicable	This rule applies to discharges of regulated stormwater runoff to waters that are not listed on the EPA-approved Vermont 303(d) List of Waters as being impaired principally due to stormwater runoff. The rule establishes a state permit program for post-construction management of stormwater runoff; establishes permitting thresholds for discharges; sets forth treatment standards; provides for the issuance of individual and general permits; specifies application requirements; and amends the Vermont Stormwater Management manual. The rule generally applies to stormwater discharges from construction activities greater than or equal to one-acre.	Alternative SC3 would include measures to comply with these requirements through the design of measures to mitigate the release of stormwater from disturbed areas of the Site.
Vermont Groundwater Protection Act, 10 VSA §§ 1390-94; Vermont Groundwater Protection Rule and Strategy, Env. Prot. Ch. 12-702 and 703	Applicable	Establishes standards for groundwater quality. Management criteria for each groundwater class are established as well as primary and secondary standards for groundwater protection. These are the primary groundwater standards if they are more stringent than federal standards. Within the compliance boundary for any waste management unit these standards are used as monitoring standards.	These standards will be used for monitoring groundwater within and outside of the compliance boundary for the waste management area established for the Site to make sure that contaminants do not migrate from the West Containment Cell and the Ore Roast Bed Cell into the groundwater.
Vermont Department of Health Drinking Water Guidance (October 2000).	To Be Considered	Lists the Vermont Health Advisories (VHAs) for chemicals of concern in drinking water. Vermont Health Advisories are researched and calculated concentrations of chemicals in drinking water in instances where the chemicals do not have a promulgated federal or state standard, or more stringent federal risk-based standard. Within the compliance boundary for any waste management unit these standards are used as monitoring standards.	These standards will be used for monitoring groundwater within and outside of the compliance boundary for the waste management area established for the Site to make sure that contaminants do not migrate from the West Containment Cell and the Ore Roast Bed Cell into the groundwater.

Table 4-9
Action-Specific ARARs and TBCs for Alternative SC3
Ely Copper Mine Superfund Site
Vershire, Vermont

REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	ACTION TAKEN TO COMPLY WITH ARARs
STATE ARARs and TBCs (cont.)			
Vermont Solid Waste Management Rules (VSWMR), Management of Mining and Mineral Processing Waste, Env. Prot. R. Ch. 6, Subchapter 13	Applicable	These substantive requirements under these rules regulate the tailing wastes and roast bed material that were produced as part of the benefication of ore at the Site, but the rules do not apply to unprocessed waste rock. However, Section 6-1301(f) permits the waiver of technical and siting requirements of these rules provided there is a response action under CERCLA to a release or threatened release of hazardous substances or materials; and the proposed response action will not adversely affect public health, safety or the environment; and the technical and siting requirements will be complied with to the extent practical in light of the overall objectives of the response. In particular, liner requirements for disposal areas under § 1305(c)(2)(D) and (F) are waived. The remainder of § 6-1305 establishes the closure and post-closure performance standards that are applicable to the remedial action. That is, all facilities subject to closure requirements must be closed in a manner that: (a) Minimizes the need for further maintenance related to the waste facility; and (b) Controls, minimizes, or eliminates, to the extent necessary to prevent threats to public health and safety and the environment, including post-closure emission or discharge of waste, waste constituents, leachate, contaminated runoff, and/or waste decomposition products to the groundwater or surface waters or the atmosphere.	This Alternative will meet these standards, except for standards that have been waived, for the management, consolidation, and capping of tailings and roasted ore that are regulated under these regulations. Waiver of liner requirements will not adversely affect public health, safety, or the environment.
Vermont Waste Management Act, 10 VSA Chapter 159 and Hazardous Waste Management Regulations, Env. Prot. R. Ch. 7	Applicable	Establishes requirements for the identification and management of hazardous waste. These regulations apply to solutions having pH less than 2 or contaminated media that exceeds toxicity standards under these regulations. Treatment media or any other wastes that are disposed of off-site will be tested to determine if it exceeds the standards to be managed and disposed of as hazardous waste. Incorporates requirements of the federal Resource Conservation and Recovery Act regulations, 40 CFR 264.	Wastes generated by the remedial action for off-site disposal will be tested for hazardous waste characteristics. If the wastes exceed these standards they will be handled under the requirements of these regulations.
Vermont Slash Removal, 10 VSA § 2648	Applicable	Forest growth may only be cut if all slash adjoining the right-of-way of any public highway, or the boundary lines of woodlots owned by adjoining property owners, is removed for a distance of 50 feet from the right-of-way of any public highway or from the boundary lines of woodlots owned by adjoining property owners. Furthermore, main roads through cut-over areas must be kept free from slash so that there is unobstructed access for fire fighting equipment and fire suppression crews.	Wooded debris produced from clearing wooded areas for borrow development and other remedial actions will be managed so as not to pose a fire or site access risk.
Vermont Air Pollution Control Act, 10 VSA Chapter 23 and Air Pollution Control Regulations, Env. Prot. R. Ch. 5	Relevant and Appropriate	Establishes authority for a coordinated statewide program of air pollution prevention, abatement and control. Lists prohibited activities affecting air quality and establishes primary and secondary ambient air quality standards for sulfur oxides, particulate matter, carbon monoxide, ozone, nitrogen dioxide, and lead. The secondary standard for particulate matter is 150 micrograms per cubic meter, 24 hour average, not to be exceeded more than once per year.	Alternatives WR3 will be designed to comply with these requirements. Cleanup actions and long term maintenance of the capped cells will be designed and implemented to meet these requirements by limiting particulate matter emissions.

Table 4-9
Action-Specific ARARs and TBCs for Alternative SC3
Ely Copper Mine Superfund Site
Vershire, Vermont

REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	ACTION TAKEN TO COMPLY WITH ARARs
STATE ARARs and TBCs (cont.)			
Vermont Handbook for Erosion Prevention and Sediment Control, Working Interim Document, Released in 2003 (VTDEC, 2003)	To Be Considered	A compilation of information from various sources released by the Vermont Department of Environmental Conservation for use in developing the erosion prevention and sediment control plans required for construction-related stormwater discharge permitting.	The manual will be used as guidance in the development of measures to prevent erosion and sedimentation from remedial activities at the Site..
FEDERAL ARARs and TBCs			
Federal Clean Water Act, Section 402 – National Pollution Discharge Elimination System (33 USC 1342; 40 CFR 122-135, 131)	Applicable	The CWA contains discharge limitation, monitoring requirements, and best management practices (BMPs) for discharges into navigable waters, i.e., surface waters. These regulations would be applicable to remedial strategies involving discharge to surface waters. Groundwater and stormwater removed from excavations and dewatering liquid from dewatering soil and sediment may require treatment prior to discharge.	Water generated from remedial activities will be treated to meet discharge standards. Site disturbance will be conducted in compliance with stormwater management standards.
Federal Clean Water Act – Stormwater Requirements for Construction Sites; 40 CFR 122.26(b)(15), (c)(1)	Applicable	Applicable to construction activity including clearing, grading and excavation, except operations that result in the disturbance of one acre~~s~~ or more of total land area.	Construction activities and long-term maintenance will use best management practices to comply with these requirements.
Federal Safe Drinking Water Maximum Contaminant Levels (MCLs) and Maximum Contaminant Level Goals (MCLGs), National Primary Drinking Water Regulations, 40 CFR Parts 141.11 – 141.16 and 141.50 – 141.53	Relevant and Appropriate for MCLs and non-zero MCLGs only; MCLGs set as zero are To Be Considered	These standards protect drinking water quality by limiting the levels of specific contaminants that can adversely affect public health and are known or anticipated to occur in public water systems. MCLs are the highest level of a contaminant that is allowed in drinking water. MCLGs are the level of a contaminant in drinking water below which there is no known or expected risk to health. MCLs are set as close to MCLGs as feasible using the best available treatment technology and taking cost into consideration. MCLs are enforceable standards, while MCLGs are non-enforceable public health goals. Within the compliance boundary for any waste management unit these standards are used as monitoring standards.	These standards will be used for monitoring groundwater within and outside of the compliance boundary for the waste management area established for the Site to make sure that contaminants do not migrate from the West Containment Cell and the Ore Roast Bed Cell into the groundwater.
Resource Conservation and Recovery Act, 42 USC §§ 6901-6992; 40 CFR Part 264	Applicable	Vermont is delegated to implement these standards through its Hazardous Waste Management Regulations (see above).	Wastes generated by the remedial action for off-site disposal will be tested for hazardous waste characteristics. If the wastes exceed these standards they will be handled under the requirements of these regulations.

Table 4-9
Action-Specific ARARs and TBCs for Alternative SC3
Ely Copper Mine Superfund Site
Vershire, Vermont

REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	ACTION TAKEN TO COMPLY WITH ARARs
FEDERAL ARARs and TBCs (cont.)			
Federal Clean Water Act, National Recommended Water Quality Criteria (NRWQC), 40 CFR Part 122.44	Relevant and Appropriate	These standards are used to develop numerical and biological water quality standards for monitoring surface water quality. In particular, monitoring will ensure that source control remedies at the Site are preventing metals and ARD from migrating to surface waters and exceeding the waterways' water quality standards.	These standards will be used to monitor the water quality of the OU1 waterways to assess the success of Alternative SC3 in eliminating the source of OU1 contaminants migrating to Site waterways. Within the cold water streams Class B waters standards will be used for monitoring. Ponds/warm water habitats on the Site will be monitored to assess whether the waterways meet aquatic health standards for warm waters. Water quality monitoring using these standards will be used to assess any monitored natural recovery component of the remedy.
Contaminated Sediment Remediation Guidance for Hazardous Waste Sites (EPA-540-R-05-012 OSWER 9355.0-85 December 2005)	To Be Considered	Guidance for making remedy decisions for contaminated sediment sites. Specific sections of the guidance address dredging, disposal, and monitored natural recovery.	Removal of contaminated sediments from ponds and waterways will comply with standards identified in this guidance. Provides standards for the monitored natural recover of Ely Brook in areas where it may not be possible to remove all contaminated sediment.
Federal Surface Mining Control and Reclamation Act of 1977, 30 USC §§ 1201-1328; 30 CFR 816 and 817	Relevant and Appropriate	Provides closure guidelines for coal sites. Design criteria for the closure of tailing at coal sites are relevant and appropriate for construction and closure of containment cells at this Site.	Alternative SC3 will be designed to minimize the exposure through consolidation of containment cells with impermeable caps. Areas of exposed mine material will be revegetated to achieve reclamation standards

Table 4-10
Cost Summary for Alternative SC3
Ely Copper Mine Superfund Site
Vershire, Vermont

CAPITAL COSTS	
ITEM	**COST**
Pre-Design Studies	$285,000
Temporary Facilities	$142,500
Haulage Way Construction	$365,000
Mobilization / Demobilization	$152,000
Upgrade of Existing Access Roads	$147,820
Erosion and Sediment Control	$190,000
Staging Area	$32,400
Surface Water Diversions	$279,300
UWA, LWA, TA Waste Material Excavation, Transport, and Stockpiling	$1,386,000
Ely Brook, Ponds, Tributary Excavations and Restoration	$1,772,740
Waste Area Tribs and Seeps	$212,594
Containment Cell Construction	$3,407,624
Cap Construction Ore Roast Bed with Tailings	$776,976
UWA and LWA Restoriation	$472,165
Staging Area Restoriation	$30,400
Cultural/Historical Preservation	$195,000
Wetland and Habitat Mitigation	$290,000
Institutional Controls	$95,000
Long-Term Monitoring Plan	$57,000
Monitoring Well Installations	$80,000
Direct Cost Subtotal	$10,369,519
Contingency Cost (@30 Percent)	$3,110,856
Direct and Contingency Cost Subtotal	$13,480,374
Indirect Capital Costs (Engineering, Const. Mgmt., Proj. Mgmt., etc.)	$2,965,682
TOTAL CAPITAL COSTS	**$16,446,057**
LONG-TERM OPERATION, MAINTENANCE, AND MONITORING COST	
Site Inspections, Sampling, and Reporting	$36,000
Routine Site Maintenance, Repairs, etc.	$24,000
Annualized Five-Year Review Cost	$7,000
Contingency (10%) and Project Management (5%)	$10,050
Annual O&M Subtotal[3]	$77,050
TOTAL LONG-TERM OPERATION, MAINTENANCE, AND MONITORING PRESENT VALUE COSTS, 30-YEARS, 7% (See Note 1)	**$1,026,221**
TOTAL PV COST (CAPITAL + LONG TERM PV, 30-YR, 7%)	**$17,472,278**

Notes:

1. PV = Present Value
2. Includes project management and technical support as a percentage of operation, maintenance, and monitoringcosts. See Present Value Cost Sheet.
3. Each line item represents the average cost of the O&M over the 30 year period. See Appendix B for an annual cost for each specific year.

Table 4-11
Location-Specific ARARs and TBCs for Alternative SC4
Ely Copper Mine Superfund Site
Vershire, Vermont

REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	ACTION TAKEN TO COMPLY WITH ARARs
STATE ARARs and TBCs			
Vermont's Land Use and Development Law (Act 250), 10 VSA Chapter 151	Applicable	Issues to be addressed in assessing compliance with Act 250 include substantive environmental and facility siting requirements associated with: • will not result in undue water and air pollution (including construction-related dust) (criterion 1); • protection of headwaters (criterion 1(A)); • will meet all standards for disposal of wastes (criterion 1(B)); • floodways (criterion 1(D)); • streams (criterion 1(E)); • impact on state-regulated wetlands (Class One, Two, and Three; (criterion 1(G)); • erosion control (criterion 4); • impact on historic sites (criterion 8(A)); • endangered species (criterion 8(B)); and • extraction of earth resources (criterion 9(E)) • energy conservation (criterion 9(F)); and • public investments (roads) (criterion 9(K)).	Alternative SC4 will be designed to minimize impacts on protected areas as appropriate. The EPA has determined that unavoidable impacts to wetlands (primarily Class 3), and historic resources are necessary to abate the release of ARD, which may require mitigation measures under these standards. Under Alternative WR4 the large volume of truck traffic required to remove all of the ARD producing waste rock and sediment off-site will result in significant impacts under the energy conservation and public investments criteria. Consolidation of the tailings onto the roast ore bed area will be conducted to meet protectiveness standards under all of the criteria. Site work needs to be managed to minimize impacts to potential endangered species habitat onsite.
Vermont Wetlands Act, 10 VSA Ch. 37; Vermont Wetland Rules (Nat. Res. Brd., Water Res. P. 12-004-056)	Applicable	These standards establish criteria for delineating Class One and Class Two wetlands, which are considered significant wetlands, and set forth allowed and conditional uses for these wetlands. Jurisdiction under the Rules includes within a 50 foot buffer zone to Class Two wetlands. The uses must not have undue adverse impacts on the significant functions of the wetland. Class Three wetlands are defined, but are not protected under these rules (they are addressed under Title 10 V.S.A. Chapter 151, above).	No Class One wetlands occur onsite and Class Two wetlands are limited to the Pond 1 area on the east side of the Site. Alteration of any Class Two wetlands will be mitigated, as required, to restore ecological functions and values. Class Three wetlands will also be disturbed but are not regulated under the Act.
Vermont Regulation of Stream Flow, 10 VSA Chapter 41	Applicable	Regulates and permits activities in streams to protect against damage to fish life and wildlife, prevent creation of flood hazards, and protect from damaging the rights of riparian owners.	Permanent alteration of the streams (perennial and intermittent ephemeral) during the removal of the ARD producing material and the consolidation/capping of the tailings at the roast ore bed will occur as an unavoidable consequence of the activities required to restore the stream to meet Vermont Class B Water Quality Standards within OU1.
Vermont Obstruction of Streams, 10 VSA Chapter 111, § 1407	Applicable	Regulation of obstructions that the prevent the passing of fish in a stream or the outlet or inlet of a natural or artificial pond on a public stream, by means of a rack, screen, weir, or other obstruction.	Remedial work in streams will be conducted to permit the passage of fish through the waterways once water quality is restored to support fish populations in the applicable portions of the streams.

Table 4-11
Location-Specific ARARs and TBCs for Alternative SC4
Ely Copper Mine Superfund Site
Vershire, Vermont

REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	ACTION TAKEN TO COMPLY WITH ARARs
STATE ARARs and TBCs (cont.)			
Vermont ANR Guidance on Riparian Buffers (December 5, 2005)	To Be Considered	This guidance provides technical information on the functions and values of riparian buffers, as well as describing acceptable activities within buffer zones. It recommends the establishment of 100 foot buffer zones to streams under circumstances where there is an increased risk of erosion and/or potential for overland flow of pollutants. Where Class II wetlands are contiguous to a waterbody, buffer widths of greater than 50 feet may be recommended based on case-specific application of this Guidance. This Guidance will also be used to recommend buffers for Class III wetlands contiguous to waterbodies, as necessary to maintain the functions and values of the riparian area.	Alternative SC4 remedial measures will be implemented and maintained to protect the Site's riparian buffer zone resources and protect the water quality of the adjacent waterways.
Vermont Historic Preservation Law, 22 VSA §§ 743(4), 761, 763, and 767.	Relevant and Appropriate	Places controls on actions conducted by the state that may impact historic, scientific, or archaeological sites and data.	EPA has determined that unavoidable adverse impacts will occur to historic resources at the Site. The removal of ARD producing material under Alternative SC4 would result in the damage of former building foundations as well as covering the ORB and potentially the retaining wall. EPA will consult with the SHPO and the community regarding the loss of historic resources.
Vermont Endangered Species Law, 10 VSA, Chapter 123.	Applicable for Listed Species; To Be Considered for Proposed Listed Species	This Vermont statute outlines the definition of endangered and threatened, the procedure for obtaining permits to take endangered or threatened species, and the species listed as endangered or threatened. The statute prohibits the taking, possession or transport of wildlife or plants that are members of an endangered or threatened species without a permit, and sets forth fines for violators. Three bat species that may be present on the Site are specifically listed as threatened or endangered species in Vermont: the Small-footed Bat, Northern Long-eared Bat, and the Little Brown Bat.	Alternative SC4 would be managed to minimize disturbance to potential bat habitat.
FEDERAL ARARs and TBCs			
Floodplain Management and Protection of Wetlands, 44 C.F.R. 9	Relevant and Appropriate	Remedial alternatives that may cause alteration within a 500-year floodplain/cause negative impacts to downstream floodplain or that will cause alteration of federal jurisdictional wetlands/aquatic habitats will be implemented in compliance with these relevant and appropriate FEMA standards (which promulgate requirements under Executive Order 11988 (Floodplain Management) and Executive Order 11990 (Protection of Wetlands)). Prohibits activities that adversely affect a federally-regulated wetland unless there is no practicable alternative and the proposed action includes all practicable measures to minimize harm to wetlands that may result from such use. Requires soliciting public comment on any disturbance of floodplains or federally-regulated wetlands.	There will be unavoidable impacts to federally-regulated wetlands during the implementation of the remedy which would occur in order to abate the ongoing impacts to the wetlands and surface water surrounding the waste rock and tailings. Wetlands mitigation will be conducted, as required. A wetlands delineation would be implemented as a component of the design for Alternative SC4. The EPA will seek public comment regarding the potential impacts to wetlands in OU1. The remedial action will be managed to prevent any downstream flooding impacts.

Table 4-11
Location-Specific ARARs and TBCs for Alternative SC4
Ely Copper Mine Superfund Site
Vershire, Vermont

REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	ACTION TAKEN TO COMPLY WITH ARARs
FEDERAL ARARs and TBCs (cont.)			
Federal Clean Water Act, Section 404, 33 USC § 1344; 40 CFR Part 230; 33 CFR Parts 320-323	Applicable	Prohibits the discharge of dredge or fill material into a federally-regulated aquatic ecosystem if a practicable alternative with lesser effects is available. For any alternative selected that may dredge or fill a water of the U.S., a finding that No Practicable Alternative was available and that the general prohibitions in 40 CFR 230.10 and the factual determinations of 40 CFR 230.11 were unavoidable is required. Under these standards EPA must solicit public comment on its finding that one of the alternatives is the Least Environmentally Damaging Practicable Alternative.	Alternative SC4 would include potential dredge and fill activities associated with the remediation of Ely Brook and its tributaries, and the excavation and removal of the waste rock from the UWA and LWA, and the consolidation and capping of the tailings at the roast ore beds. The implementation would use BMPs to minimize the impacts of the cleanup, particularly on downstream surface water resources. EPA has determined that Alternative SC4 is not the least environmentally damaging practicable alternative since the removal and off-site disposal of all contaminated sediments and ARD-producing waste rock is less practicable than consolidating and capping the material on-site under Alternative SC3.
Federal Fish and Wildlife Coordination Act; 16 USC 661 *et seq* .	Applicable	Consultation with the U.S. Fish and Wildlife Service and appropriate state wildlife agency is required for modification of a body of water or federally- listed endangered or threatened species habitat. Consultation is required to develop measures to prevent, mitigate, or compensate for the loss of fish and wildlife or federally-listed endangered or threatened species habitat.	The implementation of the design and cleanup for Alternative SC4 will be coordinated with the U.S. Fish and Wildlife Service and state wildlife officials.
Federal Endangered Species Act of 1973 (ESA), 16 USC 1531 *et seq* .; 33 CFR Part 320	To Be Considered	The purpose of the ESA is to "conserve the ecosystems upon with threatened and endangered species depend" and to conserve and recover listed species. Federal agencies must consult with the U.S. Fish and Wildlife Service to ensure that the actions they authorize, fund, or carry out will not jeopardize listed species. The law provides for critical habitat designations for listed species. Critical habitat designations affect Federal agency actions and federally funded or permitted activities. The Small-footed Bat, which may occur in OU1, is specifically proposed for federal-listing as a threatened or endangered species.	EPA will consult with federal and state wildlife officials to identify measures to prevent disturbance to any potential rare bat habitat.
National Historic Preservation Act (NHPA), Section 106, 16 USC 470 *et seq* ., 36 CFR Part 800	Applicable	Section 106 of the NHPA of 1966 requires EPA to take into account the effect of all of its actions on historic properties. In consultation with the State Historic Preservation Officer (SHPO), a determination has been made that the Ely Copper Mine is eligible for the National Register. The consultation is to identify potential adverse effects on historic properties and seek ways to avoid, minimize or mitigate any such effects on historic properties.	EPA has determined that unavoidable adverse impacts will occur to historic resources in OU1. Alternative SC4 would result in the damage of former building foundations as well as covering the ORB and potentially the retaining wall. EPA will consult with the SHPO and the community regarding the loss of historic resources. Additional investigations will be required for any areas on Site that may be remediated that have not been previously investigated.
Archeological and Historic Preservation Act, 16 USC 469 *et seq* ., 36 CFR, Part 65	Applicable	This standard requires that, whenever any federal agency finds or is made aware that its activity in connection with any construction project or federally licensed project, activity, or program may cause irreparable loss or destruction of significant scientific, pre-historical, historical, or archeological data such agency shall undertake the recovery, protection, and preservation of such data or notify the Secretary of the Interior. The undertaking could include a preliminary survey (or other investigation as needed) and analysis and publication of the reports resulting from such investigation.	Preliminary surveys have identified significant archaeological data that may be located in the area subject to disturbance. The design will identify any significant scientific, pre-historic, historical, or archaeological data that may suffer irreparable loss or destruction and develop plans for appropriate data recovery. Additional investigations may be required for any areas on Site that may be altered for the remedy and have not been previously investigated.

Table 4-12
Chemical-Specific ARARs and TBCs for Alternative SC4
Ely Copper Mine Superfund Site
Vershire, Vermont

REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	ACTION TAKEN TO COMPLY WITH ARARs
STATE ARARs - None			
FEDERAL ARARs and TBCs			
EPA Risk Reference Doses (RfDs)	To Be Considered	Risk reference doses (RfDs) are estimates of daily exposure levels that are unlikely to cause significant adverse non-carcinogenic health effects over a lifetime.	This alternative will achieve cleanup standards based on this guidance, since the actions taken will address site risks through consolidation and capping of site contamination and elimination of contaminants that pose a non-carcinogenic human-health risk.
EPA Carcinogen Assessment Group, Cancer Slope Factors (CSFs)	To Be Considered	CSFs are used to compute the incremental cancer risk from exposure to contaminants and represent the most up-to-date information on cancer risk from EPA's Carcinogen Assessment Group.	This alternative will achieve cleanup standards based on this guidance, since the actions taken will address site risks through consolidation and capping of site contamination and elimination of contaminants that pose a carcinogenic human-health risk.
Guidelines for Carcinogen Risk Assessment EPA/630/P-03/001F (March 2005)	To Be Considered	Guidance for assessing cancer risk. Used to establish risk-based standards for managing waste rock at the Site.	This alternative will achieve cleanup standards based on this guidance, since the actions taken will address site risks through consolidation and capping of site contamination and elimination of contaminants that pose a carcinogenic human-health risk.
Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens EPA/630/R-03/003F (March 2005)	To Be Considered	Guidance of assessing cancer risks to children. Used to establish risk-based standards for managing waste rock at the Site.	This alternative will achieve cleanup standards based on this guidance, since the actions taken will address site risks through consolidation and capping of site contamination and elimination of contaminants that pose a carcinogenic human-health risk to children.
Proposed Guidelines for the Clean-Up of Contaminated Sites in Ontario (Ministry of Environment and Energy of Ontario [MOE], 1994)	To Be Considered	This guidance document lists surface water and sediment criteria that are considered protective for aquatic organisms.	This alternative will achieve cleanup standards based on this guidance, since the actions taken will address site risks through off-site disposal of contaminated sediments and ARD producing waste rock and consolidation and capping of tailings at the roast ore beds that will address all of the OU1 contamination that poses an ecological risk.
Preliminary Remediation Goals for Ecological Endpoints , Efroymson et al., August 1997	To Be Considered	This technical memorandum was prepared to present recommended preliminary remediation goals (PRGs) for surface water, sediment and soil for ecological endpoints for risk assessments and decision making at CERCLA sites.	This alternative will achieve cleanup standards based on this guidance, since the actions taken will address site risks through off-site disposal of contaminated sediments and ARD producing waste rock and consolidation and capping of tailings at the roast ore beds that will address all of the OU1 contamination that poses an ecological risk.

Table 4-13
Action-Specific ARARs and TBCs for Alternative SC4
Ely Copper Mine Superfund Site
Vershire, Vermont

REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	ACTION TAKEN TO COMPLY WITH ARARs
STATE ARARs and TBCs			
Vermont Water Pollution Control Act, 10 VSA Chapter 47; Vermont Water Quality Standards, Ch. 1, 2, and 3 and Appendix C and D	Applicable	Establishes water quality standards for surface waters and applies to alternatives that call for monitoring surface water bodies on and off of the Site. In particular, monitoring will ensure that source control remedies at the Site are preventing metals and ARD from migrating to surface waters and exceeding the waterways' water quality standards.	These standards will be used to monitor the water quality of the OU1 waterways to assess the success of Alternative SC4 in eliminating the source of OU1 contaminants migrating to Site waterways. Within the cold water streams Class B waters standards will be used for monitoring. Ponds/warm water habitats on the Site will be monitored to assess whether the waterways meet aquatic health standards for warm waters. Water quality monitoring using these standards will be used to assess any monitored natural recovery component of the remedy.
Vermont National Pollutant Discharge Elimination System (NPDES) Regulations Ch. 13 (Nat. Res. Brd., Water Res. P. 12-004-052)	Applicable	The regulations stipulate requirements for discharges to surface waters, compliance with NPDES standards, and meeting stormwater management requirements. Groundwater and stormwater removed from excavations and dewatering liquid from dewatering soil and sediment may require treatment prior to discharge.	Water generated from remedial activities will be treated to meet discharge standards. Site disturbance will be conducted in compliance with stormwater management standards.
Vermont Stormwater Management Act, 10 VSA § 1263 and §1264; Vermont Stormwater Management Rule, Env. Prot. R. Ch. 18	Applicable	This rule applies to discharges of regulated stormwater runoff to waters that are not listed on the EPA-approved Vermont 303(d) List of Waters as being impaired principally due to stormwater runoff. The rule establishes a state permit program for post-construction management of stormwater runoff; establishes permitting thresholds for discharges; sets forth treatment standards; provides for the issuance of individual and general permits; specifies application requirements; and amends the Vermont Stormwater Management manual. The rule generally applies to stormwater discharges from construction activities greater than or equal to one-acre.	Alternative SC4 would include measures to comply with these requirements through the design of measures to mitigate the release of stormwater from disturbed areas of the Site.
Vermont Groundwater Protection Act, 10 VSA §§ 1390-94; Vermont Groundwater Protection Rule and Strategy, Env. Prot. Ch. 12-702 and 703	Applicable	Establishes standards for groundwater quality. Management criteria for each groundwater class are established as well as primary and secondary standards for groundwater protection. These are the primary groundwater standards if they are more stringent than federal standards. Within the compliance boundary for any waste management unit these standards are used as monitoring standards.	These standards will be used for monitoring groundwater within and outside of the compliance boundary for the waste management area established for the Site to make sure that contaminants do not migrate from the Ore Roast Bed Cell into the groundwater.
Vermont Department of Health Drinking Water Guidance (October 2000).	To Be Considered	Lists the Vermont Health Advisories (VHAs) for chemicals of concern in drinking water. Vermont Health Advisories are researched and calculated concentrations of chemicals in drinking water in instances where the chemicals do not have a promulgated federal or state standard, or more stringent federal risk-based standard. Within the compliance boundary for any waste management unit these standards are used as monitoring standards.	These standards will be used for monitoring groundwater within and outside of the compliance boundary for the waste management area established for the Site to make sure that contaminants do not migrate from the Ore Roast Bed Cell into the groundwater.

Table 4-13
Action-Specific ARARs and TBCs for Alternative SC4
Ely Copper Mine Superfund Site
Vershire, Vermont

REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	ACTION TAKEN TO COMPLY WITH ARARs
STATE ARARs and TBCs (cont.)			
Vermont Solid Waste Management Rules (VSWMR), Management of Mining and Mineral Processing Waste, Env. Prot. R. Ch. 6, Subchapter 13	Applicable	These substantive requirements under these rules regulate the tailing wastes and roast bed material that were produced as part of the benefication of ore at the Site, but the rules do not apply to unprocessed waste rock. However, Section 6-1301(f) permits the waiver of technical and siting requirements of these rules provided there is a response action under CERCLA to a release or threatened release of hazardous substances or materials; and the proposed response action will not adversely affect public health, safety or the environment; and the technical and siting requirements will be complied with to the extent practical in light of the overall objectives of the response. In particular, liner requirements for disposal areas under § 1305(c)(2)(D) and (F). are waived. The remainder of § 6-1305 establishes the closure and post-closure performance standards that are applicable to the remedial action. That is, all facilities subject to closure requirements must be closed in a manner that: (a) Minimizes the need for further maintenance related to the waste facility; and (b) Controls, minimizes, or eliminates, to the extent necessary to prevent threats to public health and safety and the environment, including post-closure emission or discharge of waste, waste constituents, leachate, contaminated runoff, and/or waste decomposition products to the groundwater or surface waters or the atmosphere.	This Alternative will meet these standards, except for standards that have been waived, for the management, consolidation, and capping of tailings and roasted ore that are regulated under these regulations. Waiver of liner requirements will not adversely affect public health, safety, or the environment.
Vermont Waste Management Act, 10 VSA Chapter 159 and Hazardous Waste Management Regulations, Env. Prot. R. Ch. 7	Applicable	Establishes requirements for the identification and management of hazardous waste. These regulations apply to solutions having pH less than 2 or contaminated media that exceeds toxicity standards under these regulations. treatment media or any other wastes that are disposed of off-site will be tested to determine if it exceeds the standards to be managed and disposed of as hazardous waste. Incorporates requirements of the federal Resource Conservation and Recovery Act regulations, 40 CFR 264.	Wastes generated by the remedial action for off-site disposal will be tested for hazardous waste characteristics. If the wastes exceed these standards they will be handled under the requirements of these regulations.
Vermont Air Pollution Control Act, 10 VSA Chapter 23 and Air Pollution Control Regulations, Env. Prot. R. Ch. 5	Relevant and Appropriate	Establishes authority for a coordinated statewide program of air pollution prevention, abatement and control. Lists prohibited activities affecting air quality and establishes primary and secondary ambient air quality standards for sulfur oxides, particulate matter, carbon monoxide, ozone, nitrogen dioxide, and lead. The secondary standard for particulate matter is 150 micrograms per cubic meter, 24 hour average, not to be exceeded more than once per year.	Alternatives WR4 will be designed to comply with these requirements. Excavation and removal and other WR4 remedial activities, Including long term maintenance of the cap on the roast ore bed cell, will be designed and implemented to meet these requirements by limiting particulate matter emissions.
Vermont Handbook for Erosion Prevention and Sediment Control, Working Interim Document, Released in 2003 (VTDEC, 2003)	To Be Considered	A compilation of information from various sources released by the Vermont Department of Environmental Conservation for use in developing the erosion prevention and sediment control plans required for construction-related stormwater discharge permitting.	The manual will be used as guidance in the development of measures to prevent erosion and sedimentation from remedial activities at the Site.

Table 4-13
Action-Specific ARARs and TBCs for Alternative SC4
Ely Copper Mine Superfund Site
Vershire, Vermont

REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	ACTION TAKEN TO COMPLY WITH ARARs
FEDERAL ARARs and TBCs			
Federal Clean Water Act, Section 402 – National Pollution Discharge Elimination System (33 USC 1342; 40 CFR 122-135, 131)	Relevant and Appropriate	The CWA contains discharge limitation, monitoring requirements, and best management practices (BMPs) for discharges into navigable waters, i.e., surface waters. These regulations would be applicable to remedial strategies involving discharge to surface waters. Groundwater and stormwater removed from excavations and dewatering liquid from dewatering soil and sediment may require treatment prior to discharge.	Water generated from remedial activities will be treated to meet discharge standards. Site disturbance will be conducted in compliance with stormwater management standards.
Federal Clean Water Act – Stormwater Requirements for Construction Sites; 40 CFR 122.26	Applicable	Applicable to construction activity including clearing, grading and excavation, except operations that result in the disturbance of over one acre of total land area.	Construction activities and long-term maintenance will use best management practices to comply with these requirements.
Federal Safe Drinking Water Maximum Contaminant Levels (MCLs) and Maximum Contaminant Level Goals (MCLGs), National Primary Drinking Water Regulations, 40 CFR Parts 141.11 – 141.16 and 141.50 – 141.53	Relevant and Appropriate for MCLs and non-zero MCLGs only; MCLGs set as zero are To Be Considered	These standards protect drinking water quality by limiting the levels of specific contaminants that can adversely affect public health and are known or anticipated to occur in public water systems. MCLs are the highest level of a contaminant that is allowed in drinking water. MCLGs are the level of a contaminant in drinking water below which there is no known or expected risk to health. MCLs are set as close to MCLGs as feasible using the best available treatment technology and taking cost into consideration. MCLs are enforceable standards, while MCLGs are non-enforceable public health goals. Within the compliance boundary for any waste management unit these standards are used as monitoring standards.	These standards will be used for monitoring groundwater within and outside of the compliance boundary for the waste management area established for the Site to make sure that contaminants do not migrate from the Ore Roast Bed Cell into the groundwater.
Resource Conservation and Recovery Act, 42 USC §§ 6901-6992; 40 CFR Part 264	Applicable	Vermont is delegated to implement these standards through its Hazardous Waste Management Regulations (see above).	Wastes generated by the remedial action for off-site disposal will be tested for hazardous waste characteristics. If the wastes exceed these standards they will be handled under the requirements of these regulations.
Federal Clean Water Act, National Recommended Water Quality Criteria (NRWQC), 40 CFR Part 122.44	Relevant and Appropriate	These standards are used to develop numerical and biological water quality standards for monitoring surface water quality. In particular, monitoring will ensure that source control remedies at the Site are preventing metals and ARD from migrating to surface waters and exceeding the waterways' water quality standards.	These standards will be used to monitor the water quality of the OU1 waterways to assess the success of Alternative SC4 in eliminating the source of OU1 contaminants migrating to Site waterways. Within the cold water streams Class B waters standards will be used for monitoring. Ponds/warm water habitats on the Site will be monitored to assess whether the waterways meet aquatic health standards for warm waters. Water quality monitoring using these standards will be used to assess any monitored natural recovery component of the remedy.

Table 4-13
Action-Specific ARARs and TBCs for Alternative SC4
Ely Copper Mine Superfund Site
Vershire, Vermont

REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	ACTION TAKEN TO COMPLY WITH ARARs
FEDERAL ARARs and TBCs (cont.)			
Contaminated Sediment Remediation Guidance for Hazardous Waste Sites (EPA-540-R-05-012 OSWER 9355.0-85 December 2005)	To Be Considered	Guidance for making remedy decisions for contaminated sediment sites. Specific sections of the guidance address dredging, disposal, and monitored natural recovery.	Removal of contaminated sediments from ponds and waterways will comply with standards identified in this guidance. Provides standards for the monitored natural recover of Ely Brook in areas where it may not be possible to remove all contaminated sediment.
Federal Surface Mining Control and Reclamation Act of 1977, 30 USC §§ 1201-1328; 30 CFR 816 and 817	Relevant and Appropriate	Provides closure guidelines for coal sites. Includes criteria for the reclamation of ARD producing mine waste.	Alternative SC4 will be designed to minimize the exposure of ARD, as appropriate, by removing mine waste and contaminated sediments from OU1. Areas of exposed mine material will be revegetated to achieve reclamation standards

Table 4-14
Cost Summary for Alternative SC4
Ely Copper Mine Superfund Site
Vershire, Vermont

CAPITAL COSTS	
ITEM	**COST**
Pre-Design Studies	$150,000
Temporary Facilities	$142,500
Haulage Way Construction	$265,000
Mobilization / Demobilization	$107,000
Upgrade of Existing Access Roads	$147,820
Erosion and Sediment Control	$145,000
Off-Site Road Improvements	$500,000
Surface Water Diversions	$279,300
Site Clearing	$171,000
Waste Material Excavation, Transport, and Stockpiling	$1,530,200
UWA, LWA, TA Tribs and Seeps	$212,594
Ely Brook, Ponds, Tributary Excavations and Restoration	$1,772,740
Waste Transportation and Disposal	$11,416,326
Cap Construction Ore Roast Bed with Tailings	$748,476
UWA and LWA Restoriation	$472,165
Staging Area Restoriation	$68,400
Cultural/Historical Preservation	$195,000
Wetland and Habitat Mitigation	$228,000
Institutional Controls	$95,000
Long-Term Monitoring Plan	$19,000
Monitoring Well Installations	$95,000
Direct Cost Subtotal	$18,760,521
Contingency Cost (@30 Percent)	$5,628,156
Direct and Contingency Cost Subtotal	$24,388,677
Indirect Capital Costs (Engineering, Const. Mgmt., Proj. Mgmt., etc.)	$5,365,509
TOTAL CAPITAL COSTS	**$29,754,186**
LONG-TERM OPERATION, MAINTENANCE, AND MONITORING COST	
Site Inspections, Sampling, and Reporting	$11,133
Routine Site Maintenance, Repairs, etc.	$6,000
Annualized Five-Year Review Cost	$7,000
Contingency (10%) and Project Management (5%)	$3,620
Annual O&M Subtotal[3]	$27,753
TOTAL LONG-TERM OPERATION, MAINTENANCE, AND MONITORING PRESENT VALUE COSTS, 30-YEARS, 7% (See Note 1)	**$369,644**
TOTAL PV COST (CAPITAL + LONG TERM PV, 30-YR, 7%)	**$30,123,830**

Notes:

1. PV = Present Value
2. Includes project management and technical support as a percentage of operation, maintenance, and monitoringcosts. See Present Value Cost Sheet.
3. Each line item represents the average cost of the O&M over the 30 year period. See Appendix B for an annual cost for each specific year.

Table 5-1
Comparison Analysis of Alternatives
Ely Copper Mine Superfund Site
Vershire, Vermont

Evaluation Criteria	Alternative SC1	Alternative SC2	Alternative SC3	Alternative SC4
Overall Protection of Human Health and the Environment	Does not meet the criterion. Would not eliminate, reduce, or control source areas or potential future exposure to contaminants exceeding PRGs and would not meet remedial action objectives.	Good Would eliminate the ecological risks from copper and other metals within the waste rock, tailing, and sediment areas and from ARD generated from the sediments and waste rock through consolidation and capping of these materials in the LWA Containment Cell. Human health risks posed by the tailings will be addressed by consolidation and capping of these materials at the ore roast bed containment cell. The location of the LWA Containment Cell will require additional engineering controls and O&M to remain protective.	Better Would be protective of human health and the environment. Would eliminate the ecological risks from copper within the sediment areas and from ARD generated from the sediments and waste rock through consolidation and capping of these materials in the West Containment Cell. Human health risks posed by the tailings will be addressed by consolidation and capping of these materials at the ore roast bed containment cell. SC3 is slightly more protective than SC2 because of the greater long-term effectiveness afforded by placing the material in a location that is more effectively isolated from groundwater and Ely Brook.	Good Would be protective of human health and the environment. Would eliminate the ecological risks from copper within the sediment areas and from ARD generated from the sediments and waste rock through removal and offsite disposal. Human health risks posed by the tailings will be addressed by consolidation and capping of these materials at the ore roast bed containment cell. SC4 is slightly more protective than SC2 because of the waste material is either removed from the OU1 area or is capped at the ore roast beds where it is more effectively isolated from groundwater and Ely Brook.
Compliance with ARARs	Does not meet the criterion. Would not attain protective concentrations for copper in soil or sediment and would not attain ecological risk-based standards based on chemical-specific ARARs and TBCs.	Good Would be designed to attain ARARs pertaining to management of mine waste and copper and protection of wetlands. Source control actions would be designed to protect groundwater and surface water quality. The LWA containment Cell would be located in more environmentally sensitive resource areas that would require additional engineering controls and O&M to remain compliant.	Best Would be designed to attain ARARs pertaining to management of mine waste and copper and protection of wetlands. Source control actions would be designed to protect groundwater and surface water quality. SC3 is the least environmentally damaging practicable alternative under the Federal Clean Water Act, Sec. 404 for protecting wetland resources within the Site. On site containment of contaminated materials at the West Containment Cell poses less impacts to protected resources under State facility siting standards than off-site disposal through SC4.	Good Would be designed to attain ARARs pertaining to management of mine waste and copper and protection of wetlands. Source control actions would be designed to protect groundwater and surface water quality. However, the off-site disposal of large volumes of materials poses significant impacted to protective resources under State facility siting standards.

Table 5-1
Comparison Analysis of Alternatives
Ely Copper Mine Superfund Site
Vershire, Vermont

Evaluation Criteria	Alternative SC1	Alternative SC2	Alternative SC3	Alternative SC4
Long-term Effectiveness and Permanence	Does not meet the criterion Would not eliminate, reduce, or control source areas or potential future exposure to contaminants exceeding PRGs and would not provide long-term effectiveness at protecting human health and the environment.	Good Would isolated the acid generating material that contains cobalt, copper, and iron above PRGs in either the ORB cell (tailings) or the LWA cell for the waste rock. This would have a high degree of long-term effectiveness and permanence provided the cover systems and underdrain are maintained. The reliance upon a most engineering and maintenance intensive groundwater control system reduces the overall effectiveness relative to SC3 which would not rely of the underdrain.	Better Would isolated the acid generating material that contains cobalt, copper, and iron above PRGs in either the ORB cell (tailings) or the West cell for the waste rock. This would have a high degree of long-term effectiveness and permanence provided the cover systems are maintained. Less maintenance would be required to maintain the SC3 West Cell than the SC2 LWA cell resulting in greater long-term effectiveness and permanence for SC3. SC3 also will dispose of the ARD generating waste rock in a location designed to isolate the waste and prevent ARD, whereas the integrity of the off-site disposal of the non-regulated waste rock is uncertain.	Better Would take actions to cap the Tailings Area in the ORB and excavate and dispose of the source areas off-site, thereby controlling the generation of ARD at these source areas. Waste rock and sediment is permanently removed from OU1; therefore, permanence of the alternative could be better than SC2 and SC3. The Long-Term Effectiveness may not be greater since the material is not regulated and may not be disposed in a manner that protects the new disposal location. SC3 is less permanent but has the highest degree of long-term effectiveness due to the ability to select the location for disposal and control the design for the long-term cover system.
Reduction of Toxicity, Mobility, and Volume through Treatment	SC1 would not use treatment to accomplish the reduction of toxicity, mobility, and volume.	SC2 would potentially only use limited treatment to accomplish the reduction of toxicity, mobility, and volume of water produced from dewatering operations or leachate from containment cells that may require treatment prior to discharge.	SC3 would potentially only use treatment to accomplish the reduction of toxicity, mobility, and volume of water produced from dewatering operations or leachate from containment cells that may require treatment prior to discharge.	SC4 would potentially only use treatment to accomplish the reduction of toxicity, mobility, and volume of water produced from dewatering operations that may require treatment prior to discharge.
Short-term Effectiveness	Poor Does not lead to any exposure risks and, therefore, results in no short-term effects; however, it never achieves protectiveness of human health or the environment.	Better Substantially higher requirement for borrow materials to cap the LWA Containment Cell results in either more truck traffic to import materials, or a larger area of clearing for on-site generation when compared to SC3. The time period to achieve the remedial action objectives for each media is estimated to be 2 to 4 years.	Best Would utilize on-site materials eliminating several thousand truck trips on local roads, result in construction related concerns (e.g., blasting, noise, and dust), results in a smaller environmental footprint than SC2, the time period to achieve the remedial action objectives for each media is estimated to be 2 to 4 years. Also significantly less truck trips would be required than for disposing of all of the ARD producing waste rock and sediment off-site under SC4.	Good Significant short-term improvements to local roads and on-site haulage and access roads would be required to address the high volume of truck traffic that would be required under this alternative. Would require several thousand truck trips on local roads, result in construction related concerns and hazards. The time period to achieve the remedial action objectives for each media is estimated to be 2 to 4 years.

Table 5-1
Comparison Analysis of Alternatives
Ely Copper Mine Superfund Site
Vershire, Vermont

Evaluation Criteria	Alternative SC1	Alternative SC2	Alternative SC3	Alternative SC4
Implementability	Implementable. Does not include any actions, other than Five-Year Reviews, and, therefore, would be technically easy to implement.	Good Services and equipment are available, construction of the Tailings Area cover over the ORB is similar for Alternatives SC2, SC3 and SC4. Eighteen acres of on-site borrow would be need to be excavated to obtain material. Construction of the LVA Containment Cell considered less implementable based on its location in the center and low point of the Ely Brook drainage and will require more O&M because of the required underdrain. May require unproven methods or technologies.	Best Services and equipment are available, construction of the Tailings Area cover over the ORB is similar for Alternatives SC2, SC3, and SC4. Less of an area of on-site borrow would be needed than SC2 because borrow could be dug in the same area as where the West Containment Cell will be built and the total requirement for material is less than SC2. The West Containment Cell is considered more implementable based on its standard design and construction, and location higher and west of Ely Brook drainage and potentially above the water table. SC3 is considered more implementable than SC4 because it does not require the large volume of truck use to remove contaminated material from the Site and does not include the uncertainty associated with securing a location for the off-site disposal of 110,000 cubic yards of mine waste.	Better Services and equipment are available, construction of the Tailings Area cover over the ORB is similar for Alternatives SC2, SC3, and SC4. Only limited on-site borrow would be needed to cap the ore roast bed containment cell. There may be significant implementability issues maintaining local roadways from the impact of transporting up to 110,000 cy of waste material off-site on local roads along with the uncertainty associated with securing a location for the off-site disposal of the material.
Cost	Excellent $113,015 - Total Present Worth (30 yrs)	Good $19,428,508 - Total Present Worth (30 yrs)	Better $17,472,278 - Total Present Worth (30 yrs)	Poor $30,123,830 - Total Present Worth (30 yrs)

Table 6-1
OU2 Early Action No Action Chemical-Specific ARARs and TBCs
Ely Copper Mine Superfund Site
Vershire, Vermont

REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	ACTION TAKEN TO COMPLY WITH ARARs
STATE ARARs and TBCs			
Vermont Groundwater Protection Act, 10 VSA §§ 1390-94; Vermont Groundwater Protection Rule and Strategy, Env. Prot. Ch. 12-702 and 703	Applicable	Establishes standards for groundwater quality. Management criteria for each groundwater class are established as well as primary and secondary standards for groundwater protection. These are the primary groundwater standards if they are more stringent than federal standards. Within the compliance boundary for any waste management unit these standards are used as monitoring standards.	The alternative does not address risks from consuming drinking water identified under these standards.
Vermont Department of Health Drinking Water Guidance (October 2000).	To Be Considered	Lists the Vermont Health Advisories (VHAs) for chemicals of concern in drinking water. Vermont Health Advisories are researched and calculated concentrations of chemicals in drinking water in instances where the chemicals do not have a promulgated federal or state standard, or more stringent federal risk-based standard. Within the compliance boundary for any waste management unit these standards are used as monitoring standards.	The alternative does not address risks from consuming drinking water identified under these standards.
FEDERAL ARARS AND TBCs			
EPA Risk Reference Doses (RfDs)	To Be Considered	Risk reference doses (RfDs) are estimates of daily exposure levels that are unlikely to cause significant adverse non-carcinogenic health effects over a lifetime.	The alternative does not address soil and groundwater risks identified in OU2 under these criteria.
EPA Carcinogen Assessment Group, Cancer Slope Factors (CSFs)	To Be Considered	CSFs are used to compute the incremental cancer risk from exposure to contaminants and represent the most up-to-date information on cancer risk from EPA's Carcinogen Assessment Group.	The alternative does not address soil and groundwater risks identified in OU2 under these criteria.
Guidelines for Carcinogen Risk Assessment EPA/630/P-03/001F (March 2005)	To Be Considered	Guidance for assessing cancer risk. Used to establish risk-based standards for managing waste rock at the Site.	The alternative does not address soil and groundwater risks identified in OU2 under these criteria.
Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens EPA/630/R-03/003F (March 2005)	To Be Considered	Guidance of assessing cancer risks to children. Used to establish risk-based standards for managing waste rock at the Site.	The alternative does not address soil and groundwater risks identified in OU2 under these criteria.

Table 6-1
OU2 Early Action No Action Chemical-Specific ARARs and TBCs
Ely Copper Mine Superfund Site
Vershire, Vermont

REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	ACTION TAKEN TO COMPLY WITH ARARs
FEDERAL ARARS AND TBCs (cont.)			
Federal Safe Drinking Water Maximum Contaminant Levels (MCLs) and Maximum Contaminant Level Goals (MCLGs), National Primary Drinking Water Regulations, 40 CFR Parts 141.11 – 141.16 and 141.50 – 141.53	Relevant and Appropriate for MCLs and non-zero MCLGs only; MCLGs set as zero are To Be Considered	These standards protect drinking water quality by limiting the levels of specific contaminants that can adversely affect public health and are known or anticipated to occur in public water systems. MCLs are the highest level of a contaminant that is allowed in drinking water. MCLGs are the level of a contaminant in drinking water below which there is no known or expected risk to health. MCLs are set as close to MCLGs as feasible using the best available treatment technology and taking cost into consideration. MCLs are enforceable standards, while MCLGs are non-enforceable public health goals. Within the compliance boundary for any waste management unit these standards are used as monitoring standards.	The alternative does not address risks from consuming drinking water identified under these standards.
Health Advisories (EPA Office of Drinking Water)	To Be Considered	Health Advisories are estimates of risk due to consumption of contaminated drinking water; they consider non-carcinogenic effects only. To be considered for monitoring contaminants in groundwater where the standard is more conservative than either federal or state statutory or regulatory standards. The Health Advisory standard for manganese is 0.3 ppm. Within the compliance boundary for any waste management unit these standards are used as monitoring standards.	The alternative does not address risks from consuming drinking water identified under these standards.

Note:
There are no location-specific or action-specific ARARs for Institutional Controls.

Table 6-2
OU2 Early Action Institutional Controls Chemical-Specific ARARs and TBCs
Ely Copper Mine Superfund Site
Vershire, Vermont

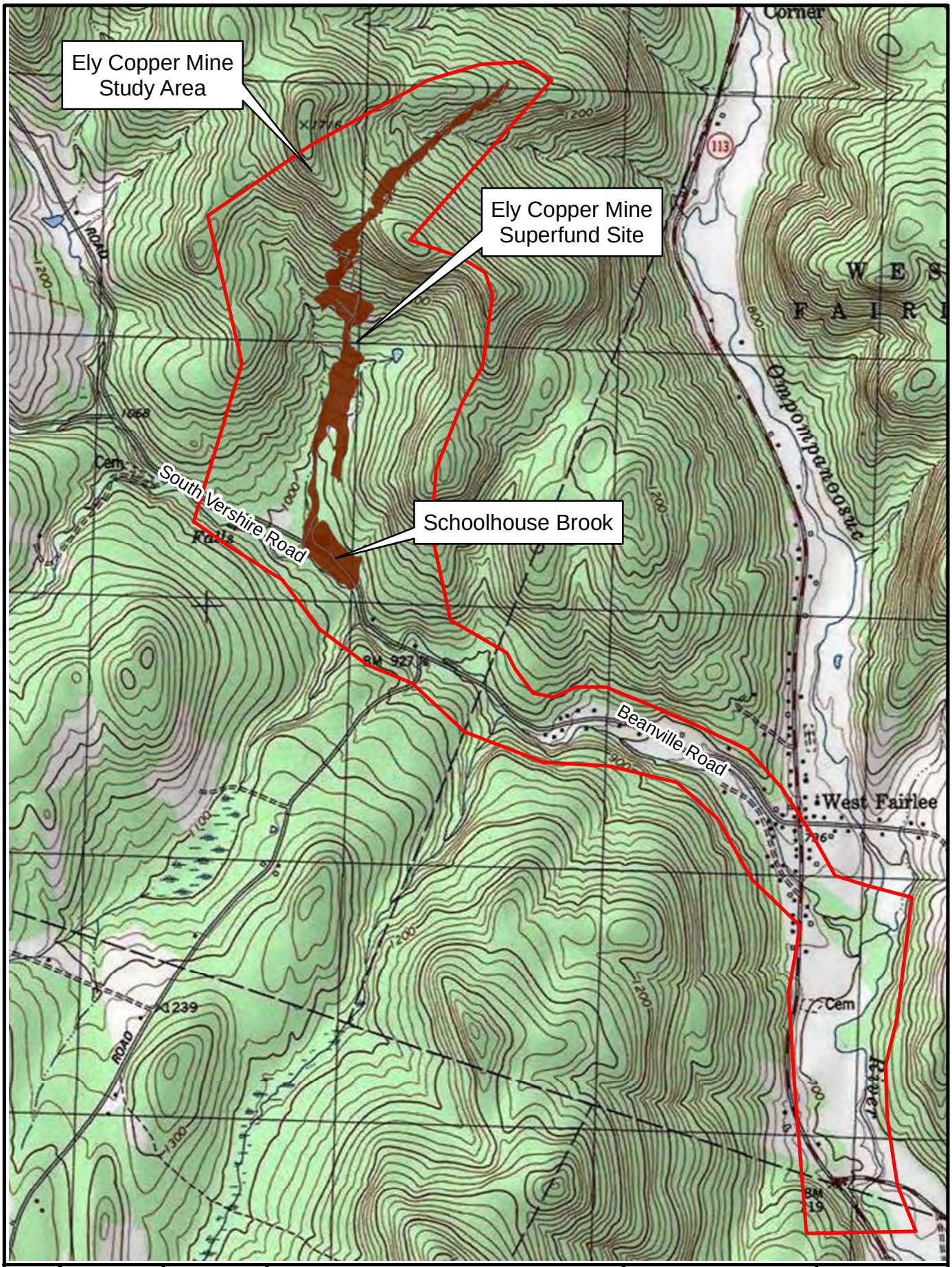
REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	ACTION TAKEN TO COMPLY WITH ARARs
STATE ARARs and TBCs			
Vermont Groundwater Protection Act, 10 VSA §§ 1390-94; Vermont Groundwater Protection Rule and Strategy, Env. Prot. Ch. 12-702 and 703	Applicable	Establishes standards for groundwater quality. Management criteria for each groundwater class are established as well as primary and secondary standards for groundwater protection. These are the primary groundwater standards if they are more stringent than federal standards. Within the compliance boundary for any waste management unit these standards are used as monitoring standards.	The alternative establishes institiutional control to prevent risks from consuming contaminated groundwater identified under these standards. This Early Action does not address the remediation of contaminated groundwater to attain these drinking water standards.
Vermont Department of Health Drinking Water Guidance (October 2000).	To Be Considered	Lists the Vermont Health Advisories (VHAs) for chemicals of concern in drinking water. Vermont Health Advisories are researched and calculated concentrations of chemicals in drinking water in instances where the chemicals do not have a promulgated federal or state standard, or more stringent federal risk-based standard. Within the compliance boundary for any waste management unit these standards are used as monitoring standards.	The alternative establishes institiutional control to prevent risks from consuming contaminated groundwater identified under these standards. This Early Action does not address the remediation of contaminated groundwater to attain these drinking water standards.
FEDERAL ARARS AND TBCs			
EPA Risk Reference Doses (RfDs)	To Be Considered	Risk reference doses (RfDs) are estimates of daily exposure levels that are unlikely to cause significant adverse non-carcinogenic health effects over a lifetime.	The alternative establishes institutional controls to prevent contact with OU2 contaminated soil and groundwater to poses risks identified under these criteria. The Early Action does not address the remediation of contaminated OU2 media to attain these risk standards.
EPA Carcinogen Assessment Group, Cancer Slope Factors (CSFs)	To Be Considered	CSFs are used to compute the incremental cancer risk from exposure to contaminants and represent the most up-to-date information on cancer risk from EPA's Carcinogen Assessment Group.	The alternative establishes institutional controls to prevent contact with OU2 contaminated soil and groundwater to poses risks identified under these criteria. The Early Action does not address the remediation of contaminated OU2 media to attain these risk standards.
Guidelines for Carcinogen Risk Assessment EPA/630/P-03/001F (March 2005)	To Be Considered	Guidance for assessing cancer risk. Used to establish risk-based standards for managing waste rock at the Site.	The alternative establishes institutional controls to prevent contact with OU2 contaminated soil and groundwater to poses risks identified under these criteria. The Early Action does not address the remediation of contaminated OU2 media to attain these risk standards.
Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens EPA/630/R-03/003F (March 2005)	To Be Considered	Guidance of assessing cancer risks to children. Used to establish risk-based standards for managing waste rock at the Site.	The alternative establishes institutional controls to prevent contact with OU2 contaminated soil and groundwater to poses risks identified under these criteria. The Early Action does not address the remediation of contaminated OU2 media to attain these risk standards.

Table 6-2
OU2 Early Action Institutional Controls Chemical-Specific ARARs and TBCs
Ely Copper Mine Superfund Site
Vershire, Vermont

REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	ACTION TAKEN TO COMPLY WITH ARARs
FEDERAL ARARS AND TBCs (cont.)			
Federal Safe Drinking Water Maximum Contaminant Levels (MCLs) and Maximum Contaminant Level Goals (MCLGs), National Primary Drinking Water Regulations, 40 CFR Parts 141.11 – 141.16 and 141.50 – 141.53	Relevant and Appropriate for MCLs and non-zero MCLGs only; MCLGs set as zero are To Be Considered	These standards protect drinking water quality by limiting the levels of specific contaminants that can adversely affect public health and are known or anticipated to occur in public water systems. MCLs are the highest level of a contaminant that is allowed in drinking water. MCLGs are the level of a contaminant in drinking water below which there is no known or expected risk to health. MCLs are set as close to MCLGs as feasible using the best available treatment technology and taking cost into consideration. MCLs are enforceable standards, while MCLGs are non-enforceable public health goals. Within the compliance boundary for any waste management unit these standards are used as monitoring standards.	The alternative establishes institiutional control to prevent risks from consuming contaminated groundwater identified under these standards. This Early Action does not address the remediation of contaminated groundwater to attain these drinking water standards.
Health Advisories (EPA Office of Drinking Water)	To Be Considered	Health Advisories are estimates of risk due to consumption of contaminated drinking water; they consider non-carcinogenic effects only. To be considered for monitoring contaminants in groundwater where the standard is more conservative than either federal or state statutory or regulatory standards. The Health Advisory standard for manganese is 0.3 ppm. Within the compliance boundary for any waste management unit these standards are used as monitoring standards.	The alternative establishes institiutional control to prevent risks from consuming contaminated groundwater identified under these standards. This Early Action does not address the remediation of contaminated groundwater to attain these drinking water standards.

Note:
There are no location-specific or action-specific ARARs for Institutional Controls.

FIGURES



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Drawn By: JRS	Checked By: AJB
June 24, 2011	Revision No. 00

APPROXIMATE SCALE
0 400 800 1,600 Feet

Quadrangle Location

USGS TOPOGRAPHIC MAP

VERSHIRE, VERMONT
1981; (Photo-inspected 1983)

FIGURE 1-1
Site Locus
Ely Copper Mine
Vershire, Vermont

Nobis
Engineering a Sustainable Future
Nobis Engineering, Inc.
18 Chenell Drive
Concord, NH 03301
(603) 224-4182

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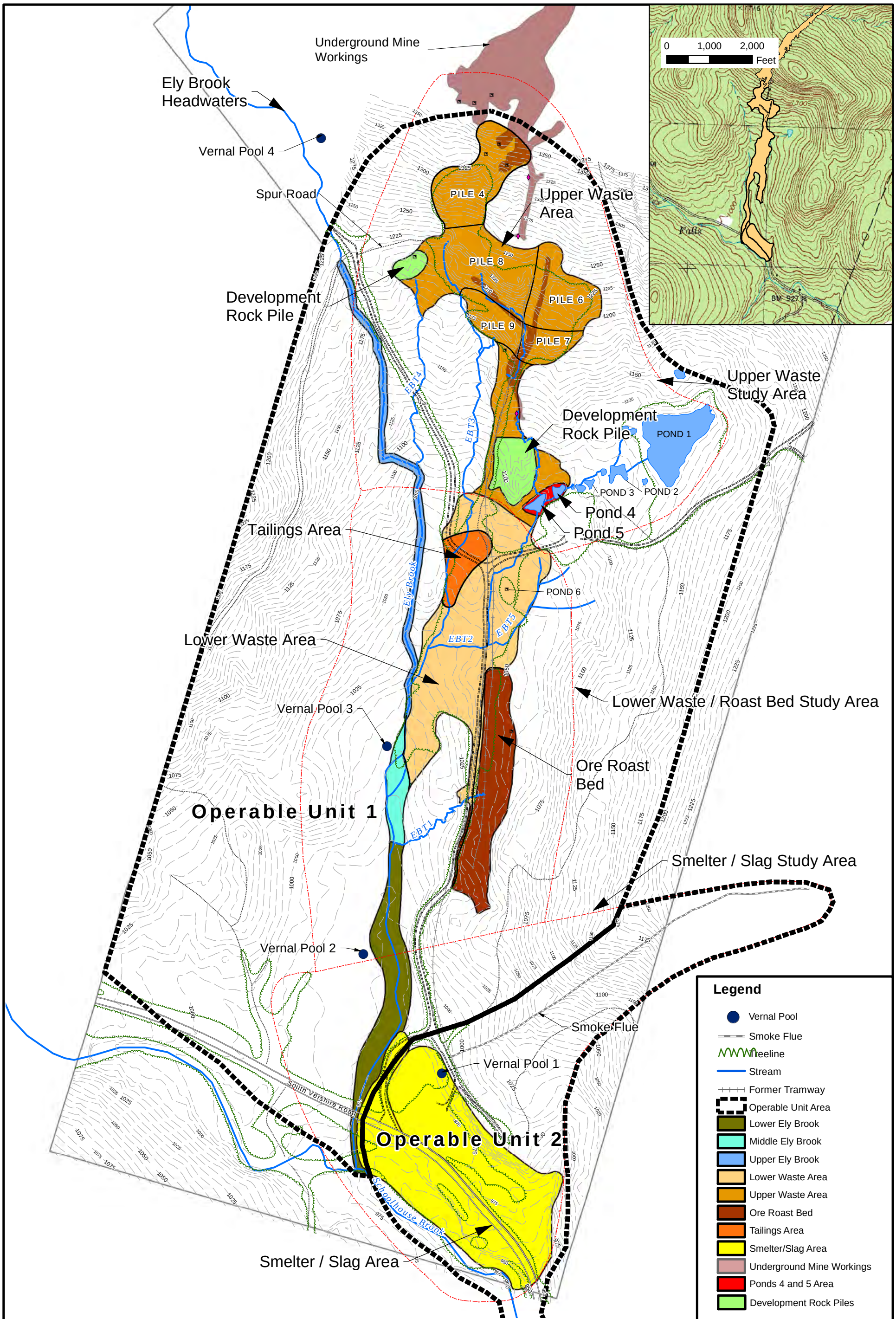

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Drawn By: JRS	Checked By: AJB
June 24, 2011	Revision No. 00

APPROXIMATE SCALE
0 150 300 600 Feet

NOTE: Elevations shown are feet above mean sea level (FT-AMSL).

FIGURE 1-2

Site Sketch
Ely Copper Mine
Vershire, Vermont

Nobis
Engineering a Sustainable Future
Nobis Engineering, Inc.
18 Chenell Drive
Concord, NH 03301
(603) 224-4182

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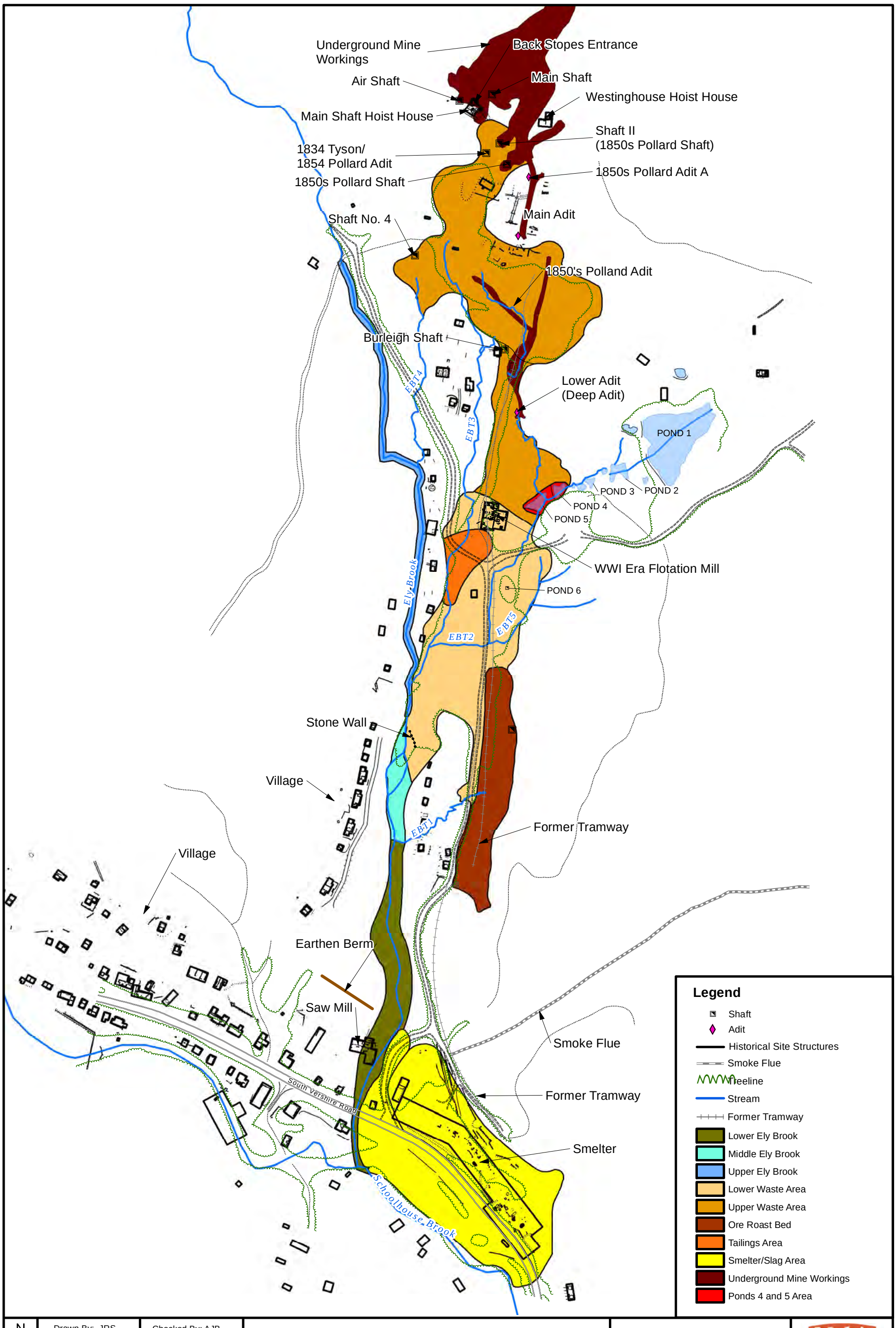

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Drawn By: JRS	Checked By: AJB
June 24, 2011	Revision No. 00

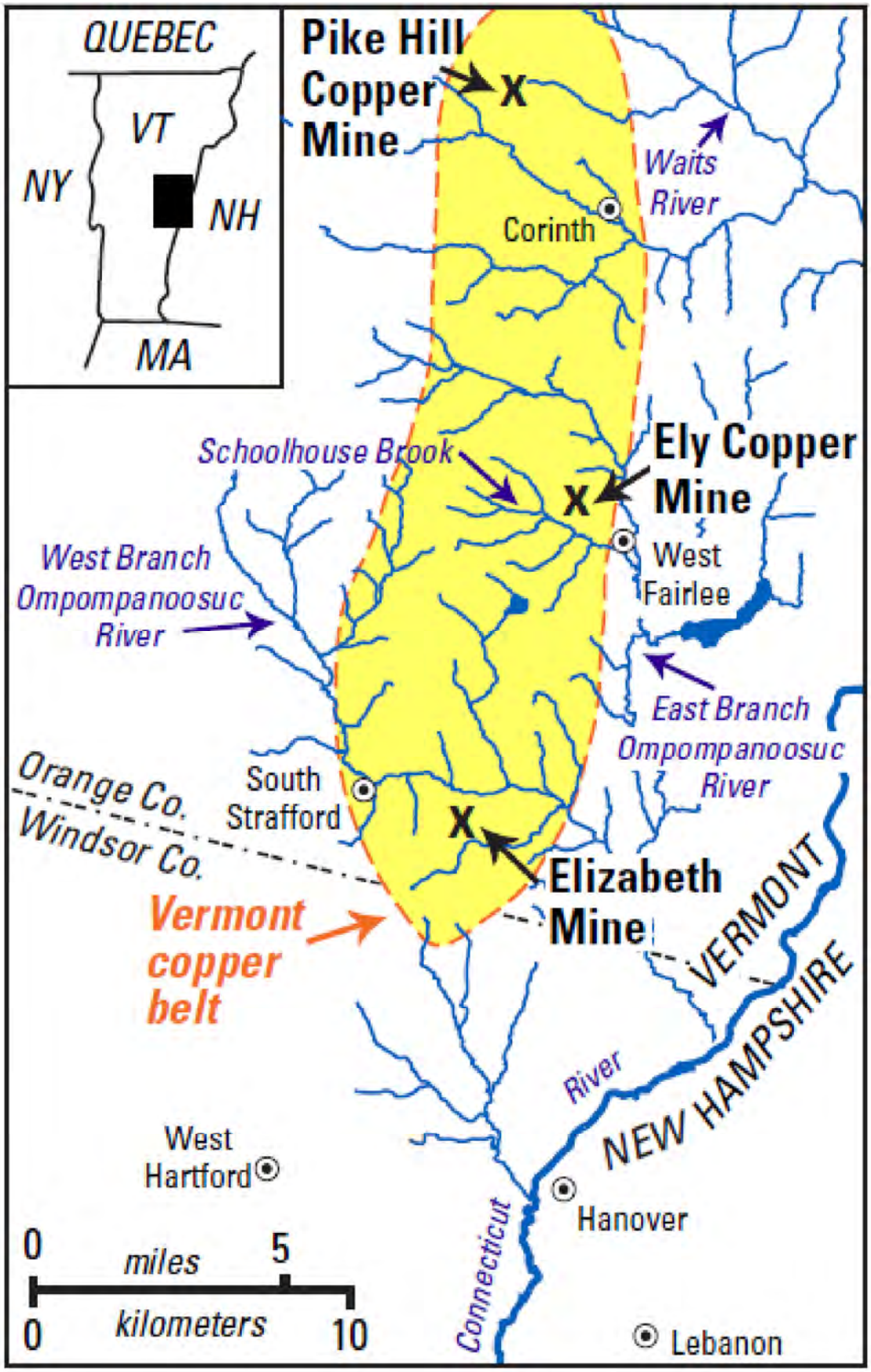
APPROXIMATE SCALE
0 150 300 600 Feet

FIGURE 1-3

Site Historical Features
Ely Copper Mine
Vershire, Vermont

Nobis
Engineering a Sustainable Future
Nobis Engineering, Inc.
18 Chenell Drive
Concord, NH 03301
(603) 224-4182

Path: R:\80000 Task Orders\80024 Ely Copper Mine\Technical Data (TD)\GIS\Maps\FS\NEW\1-3 Site Historical Features.mxd



N	Drawn By: JRS	Checked By: AJB	This figure was developed from information found within the "USGS Geochemical Characterization of Mine Waste, Mine Drainage and Stream Sediments at the Pike Hill Copper Mine Superfund Site, Orange County, Vermont, Scientific Investigations Report 2006-5303."
	June 24, 2011	Revision No. 00	

FIGURE 1-4
Vermont Copper Belt
Ely Copper Mine
Vershire, Vermont

Nobis
Engineering a Sustainable Future
Nobis Engineering, Inc.
18 Chenell Drive
Concord, NH 03304
(603) 224-4182

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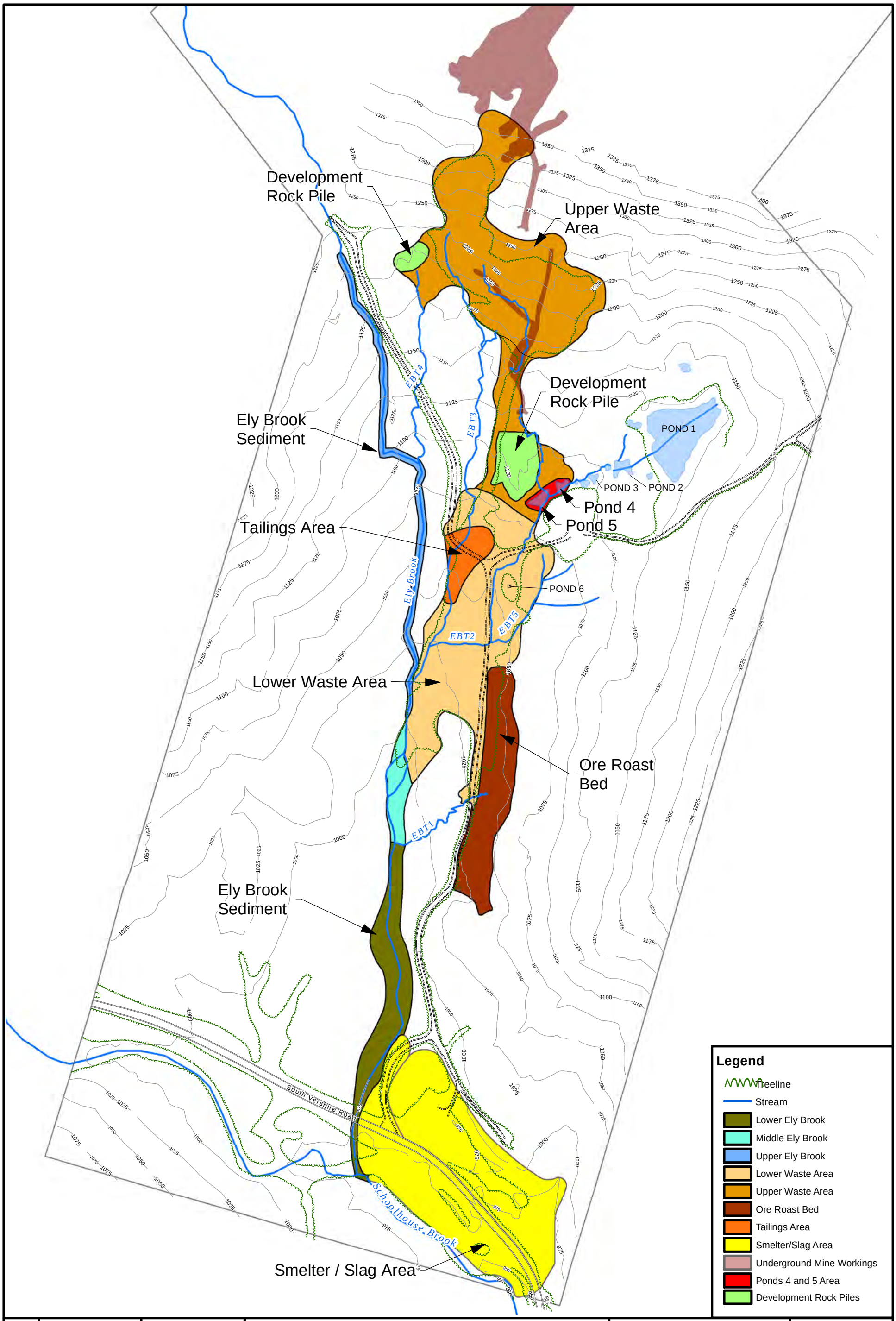

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Drawn By: JRS	Checked By: AJB
June 24, 2011	Revision No. 00

APPROXIMATE SCALE
0 150 300 600 Feet

NOTE: Elevations shown are feet above mean sea level (FT-AMSL).

FIGURE 1-5

Site Source Areas
Ely Copper Mine
Vershire, Vermont

Nobis
Engineering a Sustainable Future
Nobis Engineering, Inc.
18 Chenell Drive
Concord, NH 03301
(603) 224-4182

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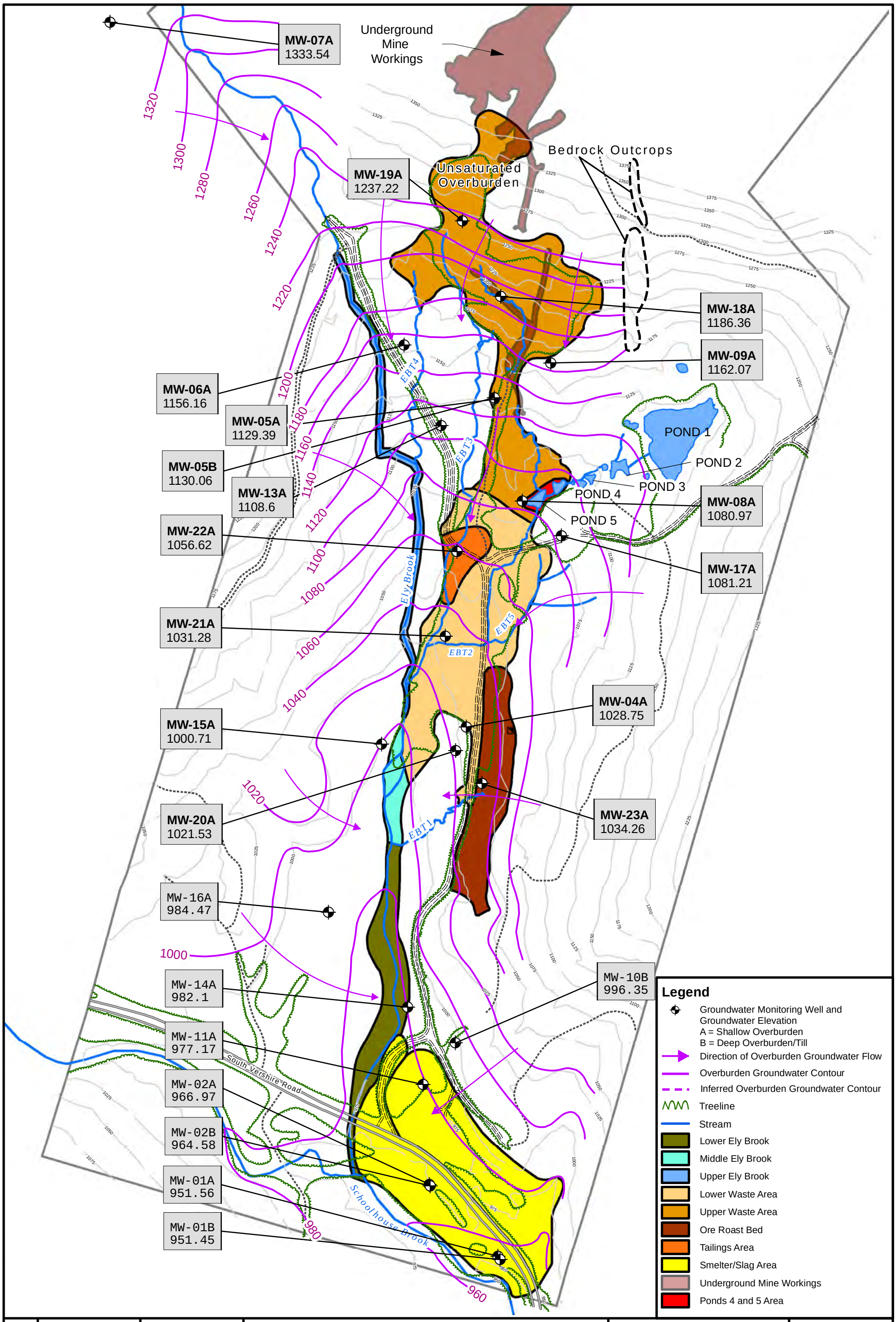

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Drawn By: JRS	Checked By: AJB
June 24, 2011	Revision No. 00

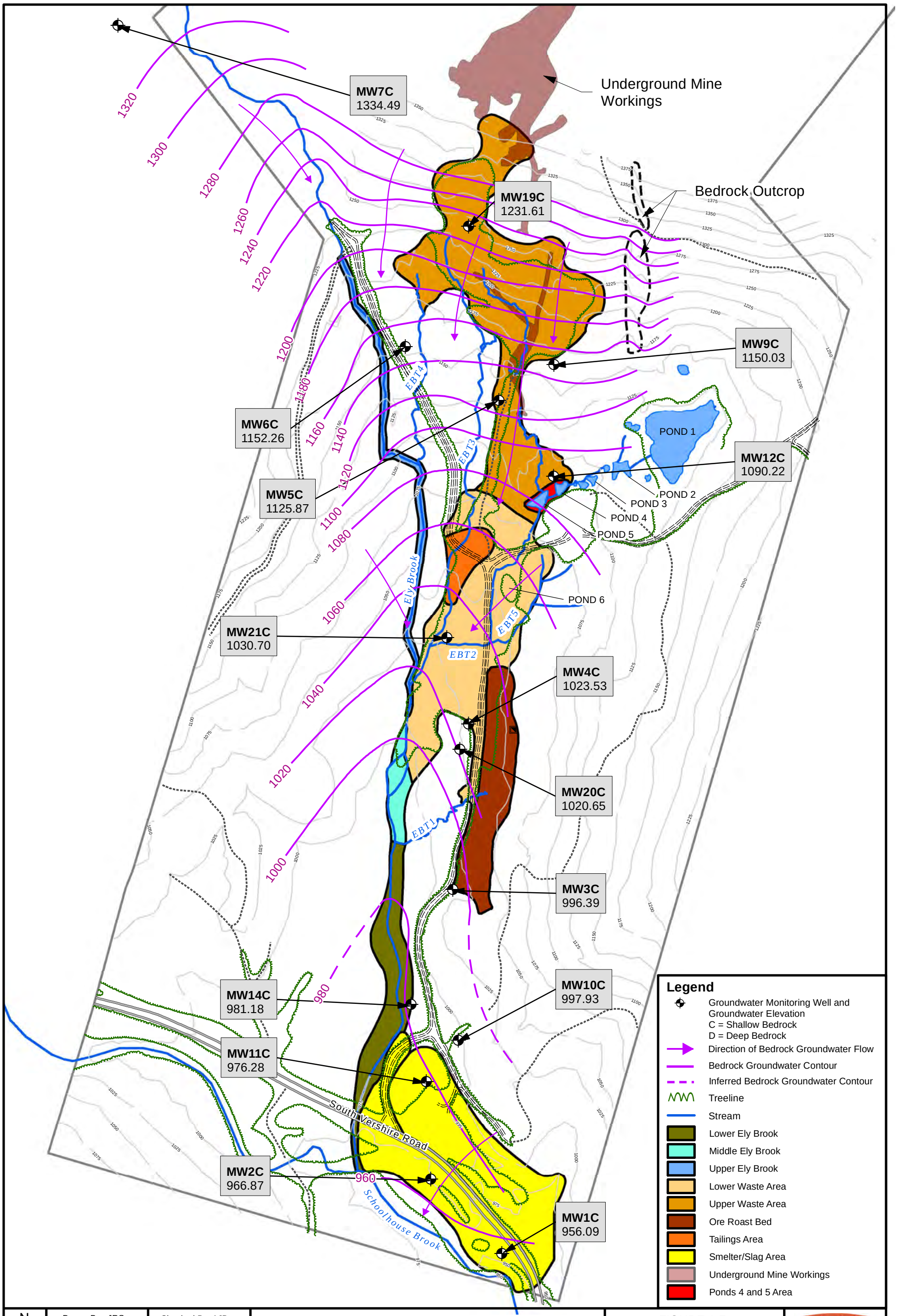
APPROXIMATE SCALE
0 150 300 600 Feet

NOTE: Elevations shown are feet above mean sea level (FT-AMSL) and were measured by Nobis Engineering, Inc. August 2009.

FIGURE 1-6
Shallow Overburden Groundwater Elevations and Potentiometric Surface Map
Ely Copper Mine
Vershire, Vermont

Nobis
Engineering a Sustainable Future
Nobis Engineering, Inc.
18 Chenell Drive
Concord, NH 03301
(603) 224-4182

Path: R:\80000 Task Orders\80024 Ely Copper Mine\Technical Data (TD)\GIS\Maps\FS\NEW\1-6_ShallowOB_PiezoSurface_Aug2009.mxd



N

Drawn By: JRS	Checked By: AJB
June 24, 2011	Revision No. 00

APPROXIMATE SCALE
0 150 300 600 Feet

NOTE: Elevations shown are feet above mean sea level (FT-AMSL) measured by Nobis Engineering, Inc. in August 2009.

FIGURE 1-7
Shallow Bedrock Groundwater Elevations and Potentiometric Surface Map
Ely Copper Mine
Vershire, Vermont

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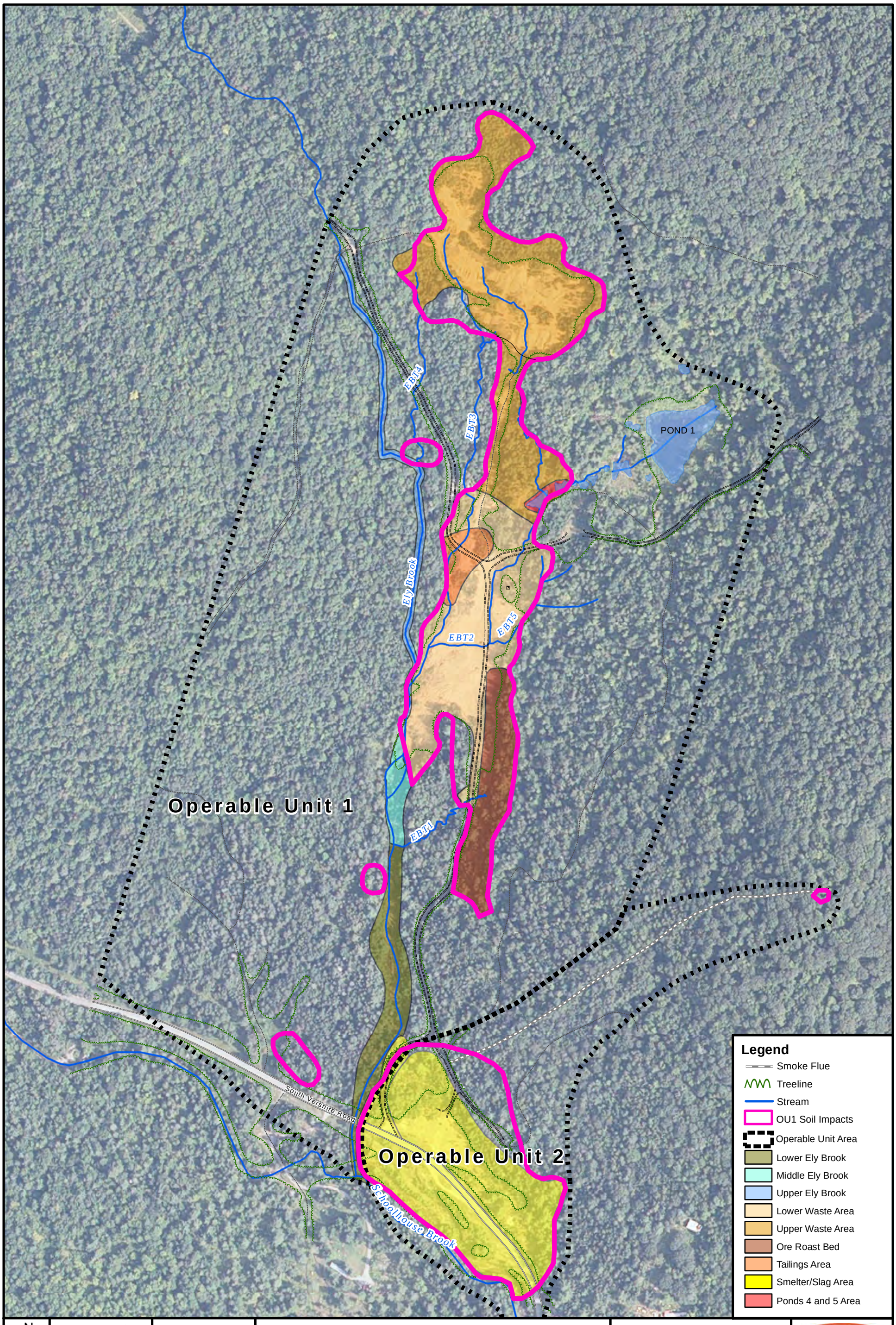
Path: R:\80000 Task Orders\80024 Ely Copper Mine\Technical Data (TD)\GIS\Maps\FS\NEW1-7_ShallowBdRx_PiezoSurface_Aug2009.mxd



Path: R:\80000 Task Orders\80024 Ely Copper Mine\Technical Data (TD)\GIS\Maps\FS\NEW\1-8 HHRA-based Soil Impacts.mxd

N

Drawn By: JRS	Checked By: AJB
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APPROXIMATE SCALE
0 150 300 600 Feet

Preliminary Remediation Goal (PRG)

Cobalt	24	mg/kg
Copper	629	mg/kg
Iron	44,800	mg/kg

FIGURE 1-8
HHRA-based
OU1 Soil Impacts
Ely Copper Mine
Vershire, Vermont

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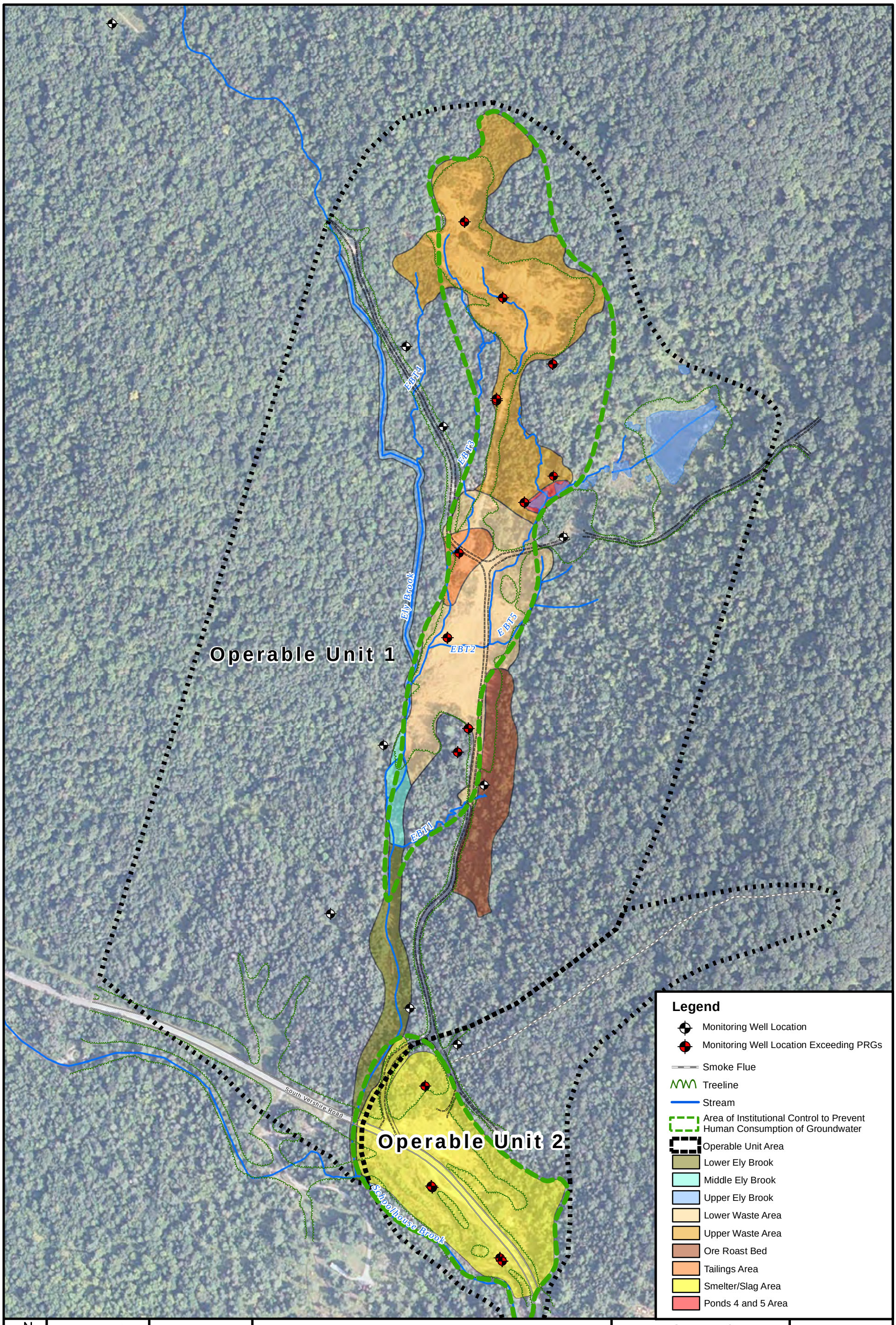

N

Drawn By: JRS	Checked By: AJB
June 24, 2011	Revision No. 00

APPROXIMATE SCALE
0 150 300 600 Feet

NOTE:
Limit of Groundwater Exceedances based on Total/Dissolved Metal Exceedances From 2009 Groundwater Sampling by Nobis Engineering, Inc.

FIGURE 1-9
HHRA-based OU1 Groundwater Impacts
Ely Copper Mine
Vershire, Vermont

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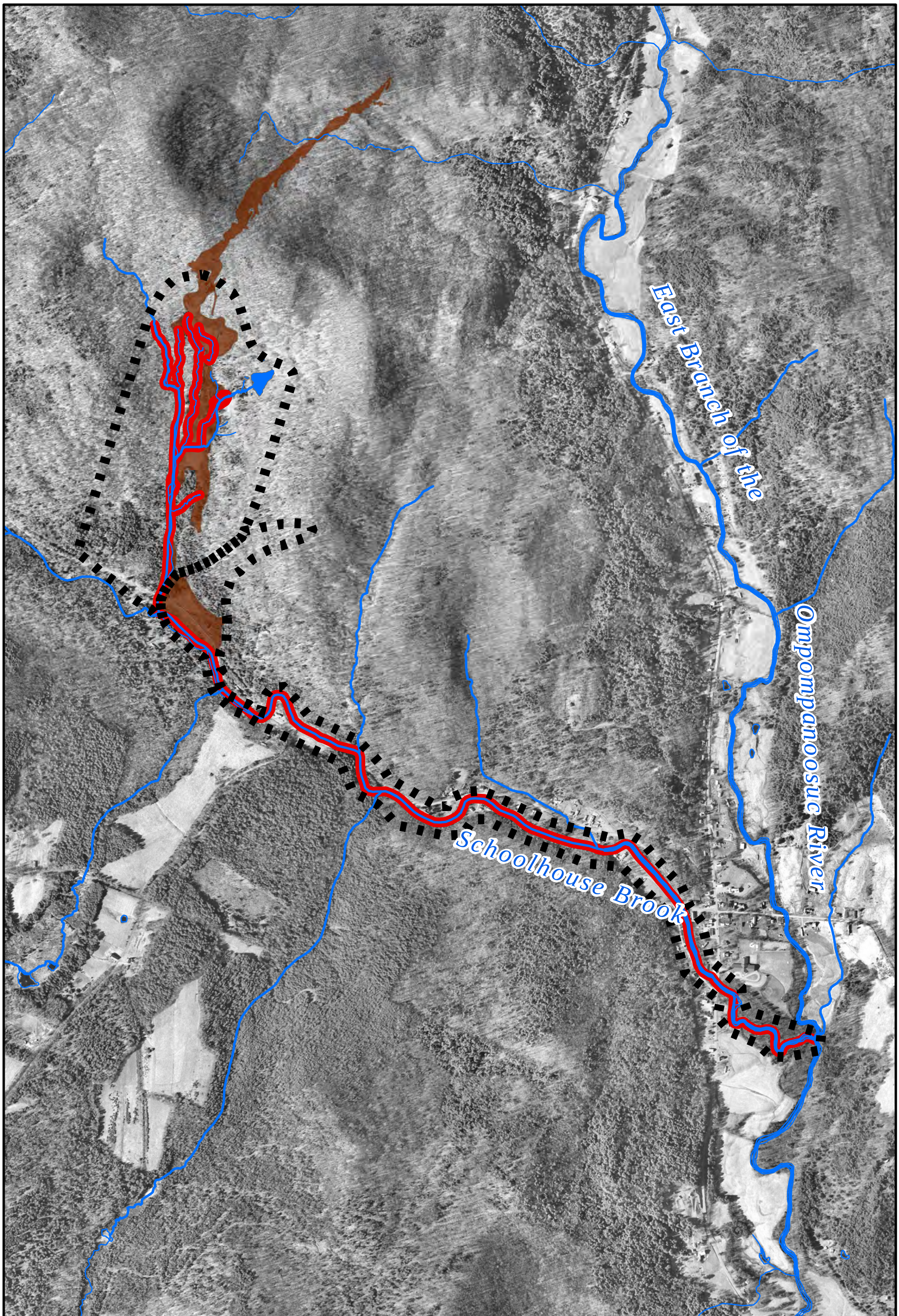
Path: R:\80000 Task Orders\80024 Ely Copper Mine\Technical Data (TD)\GIS\Maps\FS\NEW\1-9 HHRA-based Groundwater Impacts.mxd



N

Drawn By: JRS | Checked By: AJB

June 24, 2011 | Revision No. 00

APPROXIMATE SCALE
0 500 1,000 2,000 Feet

Areas of Aquatic Ecological Impairment
Surface Water
Site Area

FIGURE 1-10
Areas of Aquatic Ecological Impairment
Ely Copper Mine
Vershire, Vermont

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Concord, NH 03301
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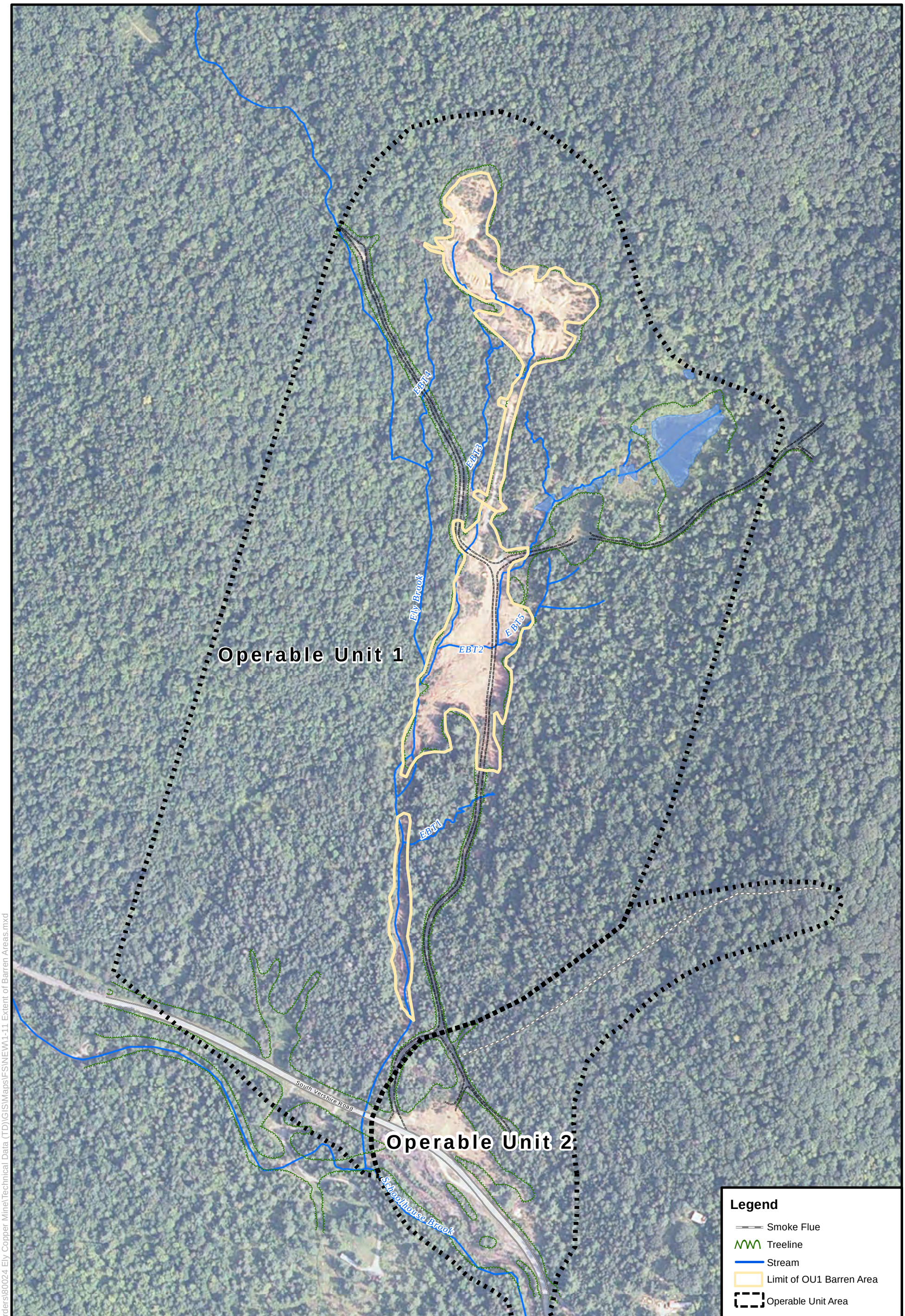
Path: R:\80000 Task Orders\80024 Ely Copper Mine\Technical Data (TD)\GIS\Maps\FS\NEW\1-10 Areas of Aquatic Ecological Impairment1.mxd



N

Drawn By: JRS	Checked By: AJB
June 24, 2011	Revision No. 00

APPROXIMATE SCALE
0 150 300 600 Feet

NOTE:
Barren land extent was created based on a 2009 areial photo of the site.

FIGURE 1-11

Extent of Barren Areas
Ely Copper Mine
Vershire, Vermont

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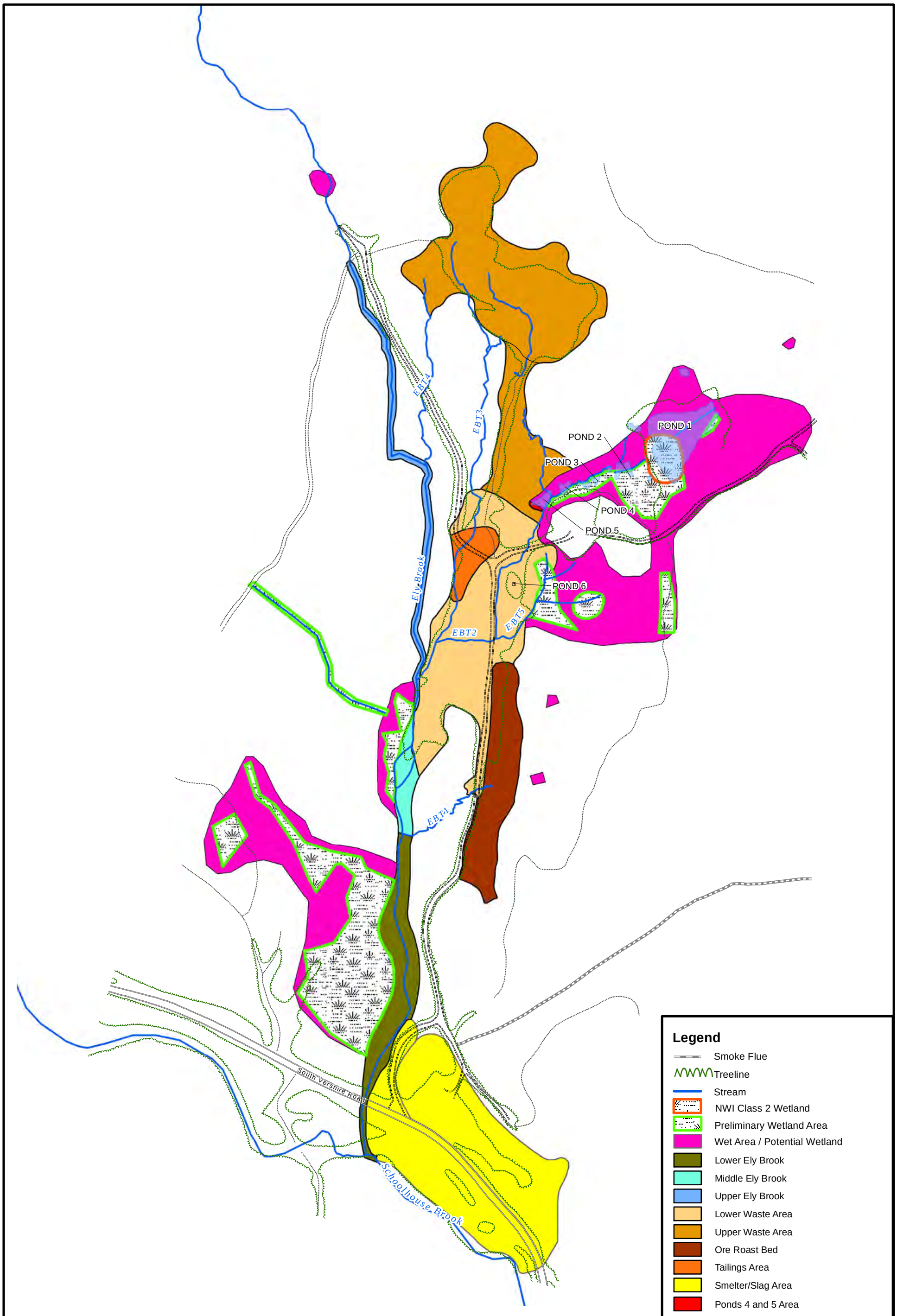
(603) 224-4182

Path: R:\80000 Task Orders\80024 Ely Copper Mine\Technical Data (TD)\GIS\Maps\FS\NEW\1-11 Extent of Barren Areas.mxd



N

Drawn By: JRS	Checked By: AJB
June 24, 2011	Revision No. 00

APPROXIMATE SCALE
0 150 300 600 Feet

NOTE:
Preliminary Wetland Area is based on field observations and GPS data collected April 2011 by Nobis Engineering, Inc

FIGURE 2-1

Site Wetland Areas
Ely Copper Mine
Vershire, Vermont

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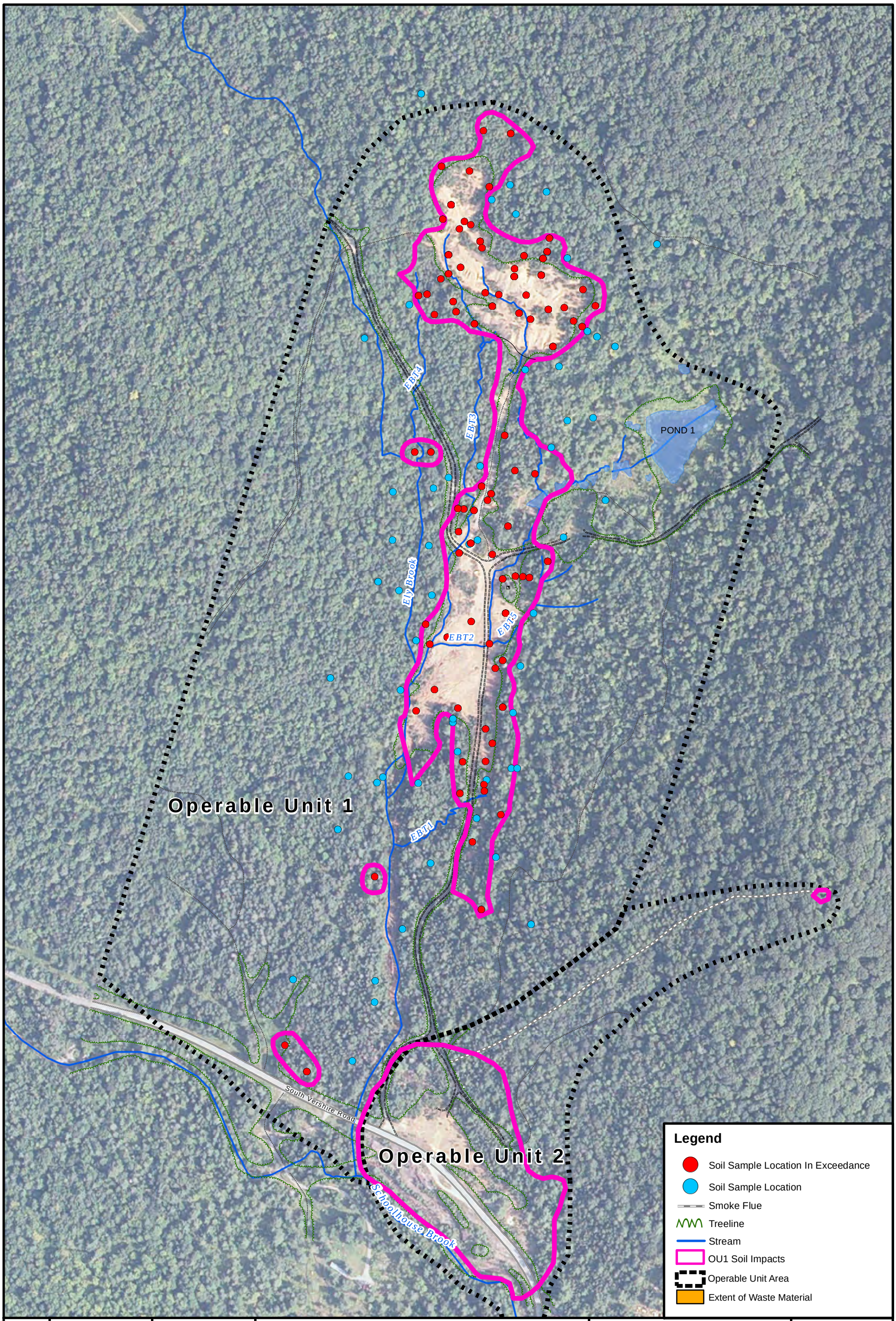
Path: R:\80000 Task Orders\80024 Ely Copper Mine\Technical Data (TD)\GIS\Maps\FS\NEW\2-1 Site Wetland Areas.mxd



N

Drawn By: JRS	Checked By: AJB
June 24, 2011	Revision No. 00

APPROXIMATE SCALE
0 150 300 600 Feet

Preliminary Remediation Goal (PRG)

Cobalt	24	mg/kg
Copper	629	mg/kg
Iron	44,800	mg/kg

FIGURE 2-2

OU1 Extent of Waste Material and Soil Metals Exceedances
Ely Copper Mine
Vershire, Vermont

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18 Chenell Drive
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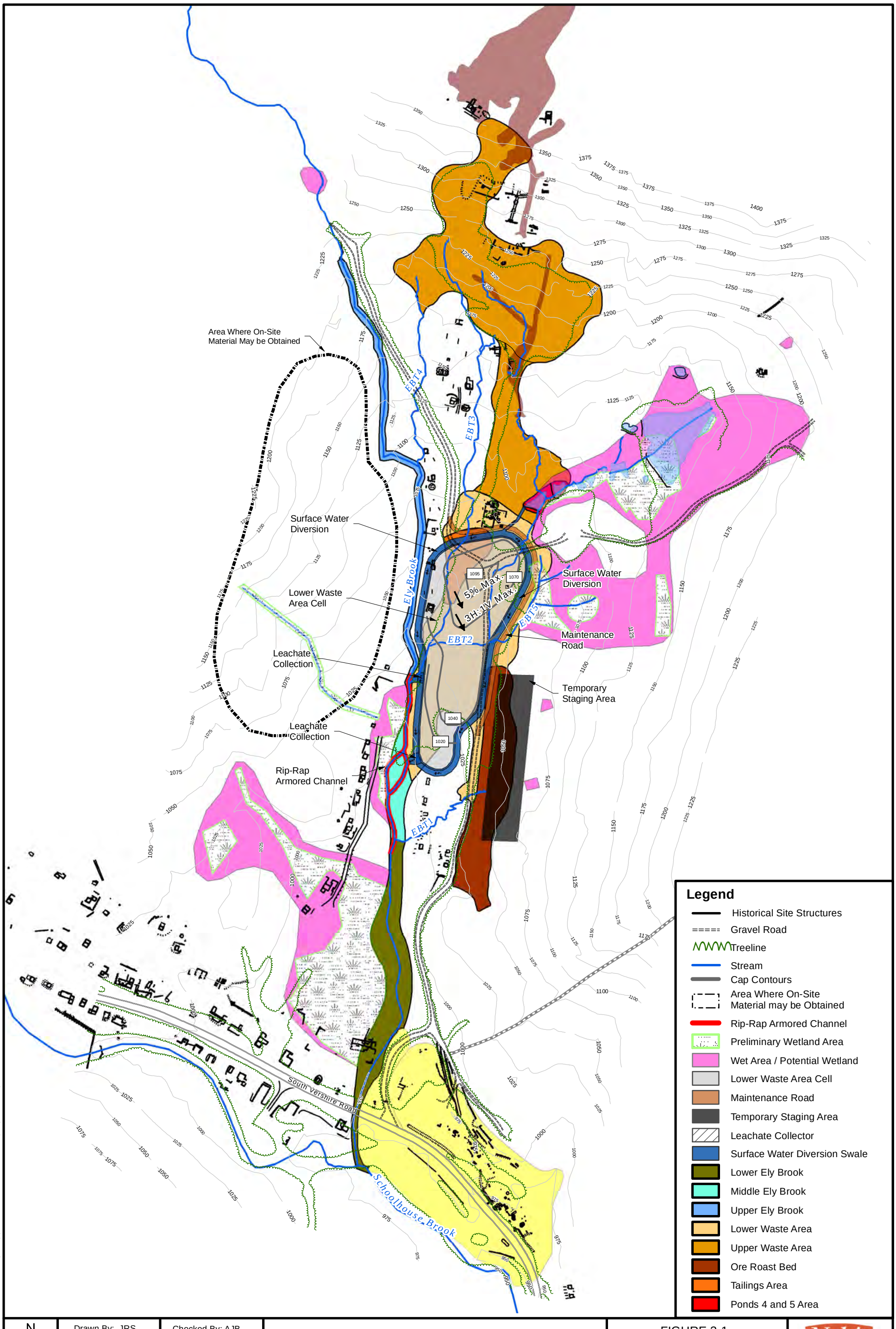
Path: R:\80000 Task Orders\80024 Ely Copper Mine\Technical Data (TD)\GIS\Maps\FS\NEW\2-2 OU1 Extent of Waste Material.mxd



N

Drawn By: JRS	Checked By: AJB
June 24, 2011	Revision No. 00

APPROXIMATE SCALE
0 75 150 300 450 600 Feet

NOTE: Elevations shown are feet above mean sea level (FT-AMSL).

FIGURE 3-1
LWA Cell Location - Alternative SC2
Ely Copper Mine
Vershire, Vermont

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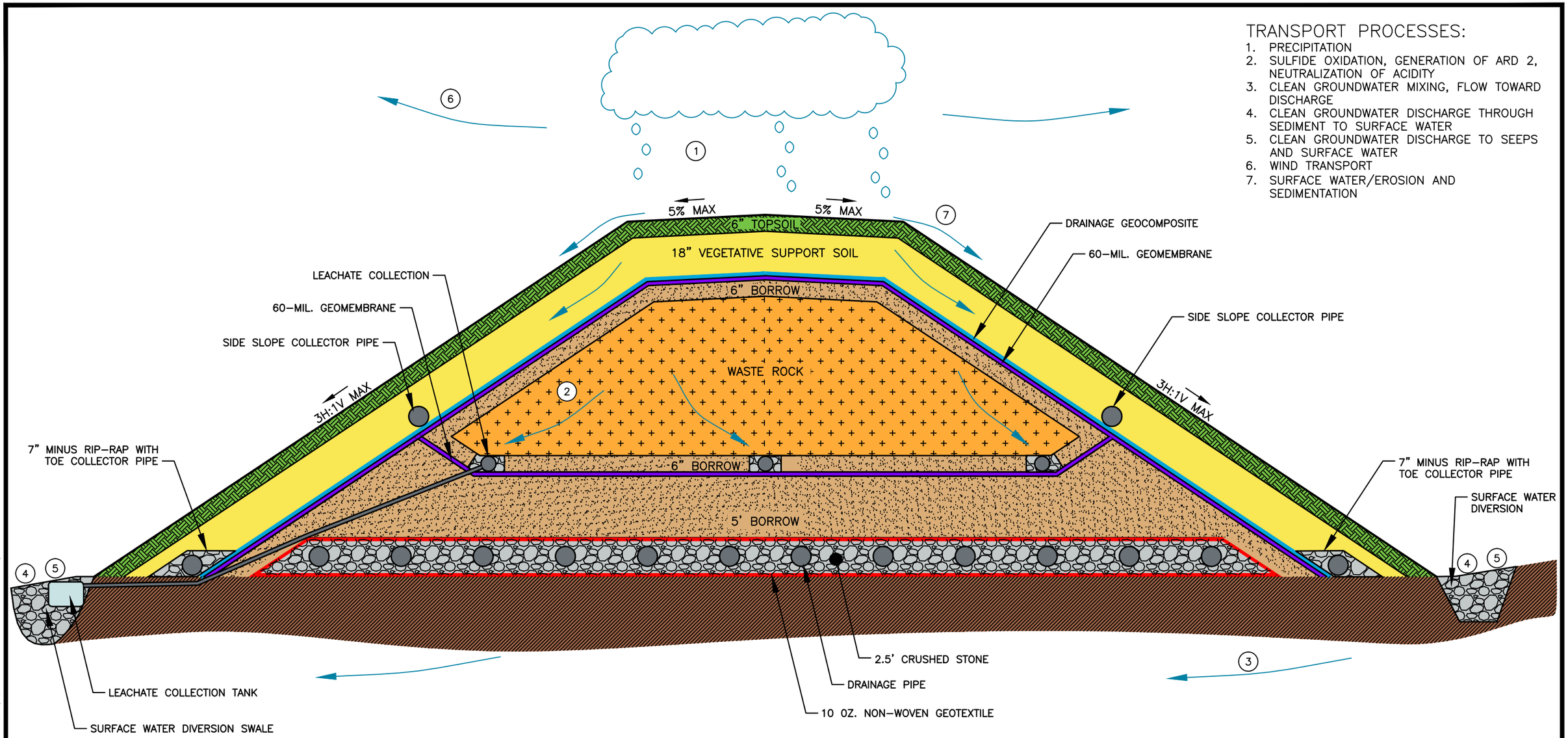
Path: R:\80000 Task Orders\80024 Ely Copper Mine\Technical Data (TD)\GIS\Maps\FS\NEW\3-1 LWA Cell Location - Alternative SC2.mxd

TRANSPORT PROCESSES:

1. PRECIPITATION
2. SULFIDE OXIDATION, GENERATION OF ARD 2, NEUTRALIZATION OF ACIDITY
3. CLEAN GROUNDWATER MIXING, FLOW TOWARD DISCHARGE
4. CLEAN GROUNDWATER DISCHARGE THROUGH SEDIMENT TO SURFACE WATER
5. CLEAN GROUNDWATER DISCHARGE TO SEEPS AND SURFACE WATER
6. WIND TRANSPORT
7. SURFACE WATER/EROSION AND SEDIMENTATION



METAL RETENTION MECHANISMS:

A. FORMATION OF METAL OXIDES INSIDE WASTE ROCK PILES
B. PRECIPITATION MECHANISMS OPERATING WITHIN WASTE ROCK PILE
C. MINERAL PRECIPITATES IN SURFACEWATER/SEEP DISCHARGE AREAS
D. METALS IN GROUNDWATER; DISCHARGED TO AND RETAINED BY SEDIMENTS
E. METALS RETAINED IN "MINE WASTE" LAYER SEDIMENT

NOT TO SCALE

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Concord, New Hampshire 03301
Tel (603) 224-4182
Fax (603) 224-2507
www.nobiseng.com

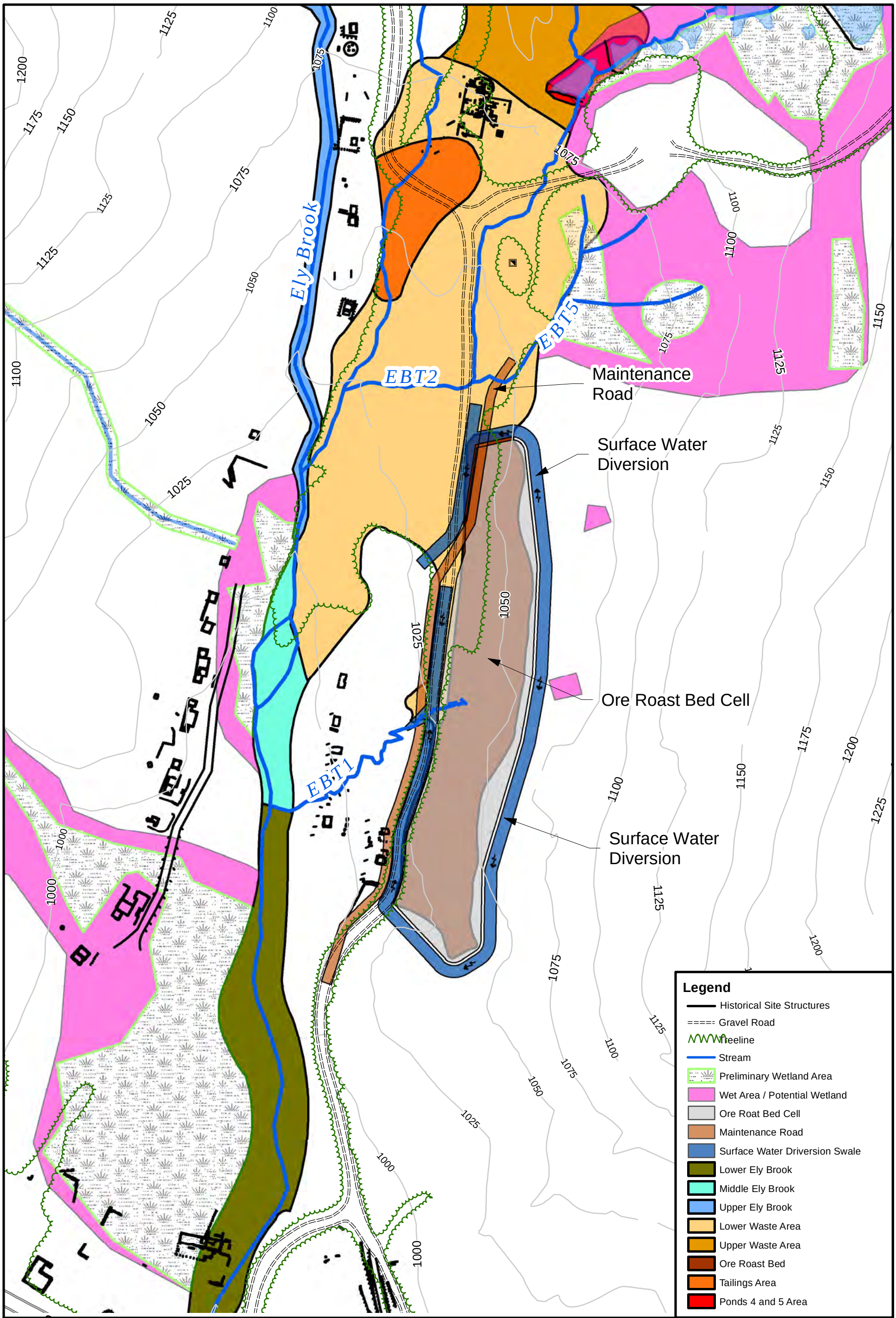
FIGURE 3-2

LWA CELL SYSTEM PROCESS MODEL

ELY COPPER MINE
VERSHIRE, VERMONT

DRAWN BY:	ML	APPROVED BY:	AB
PROJECT:	80024.11	JUNE 24, 2011	

R:\80000 Task Orders\80024 Ely Copper Mine\CAD\dwg\80024-ALTERNATIVE-WR2.dwg



Drawn By: JRS | Checked By: AJB

June 24, 2011 | Revision No. 00

NOTE: Elevations shown are feet above mean sea level (FT-AMSL).

FIGURE 3-3
Ore Roast Bed Cap System Location
Ely Copper Mine
Vershire, Vermont

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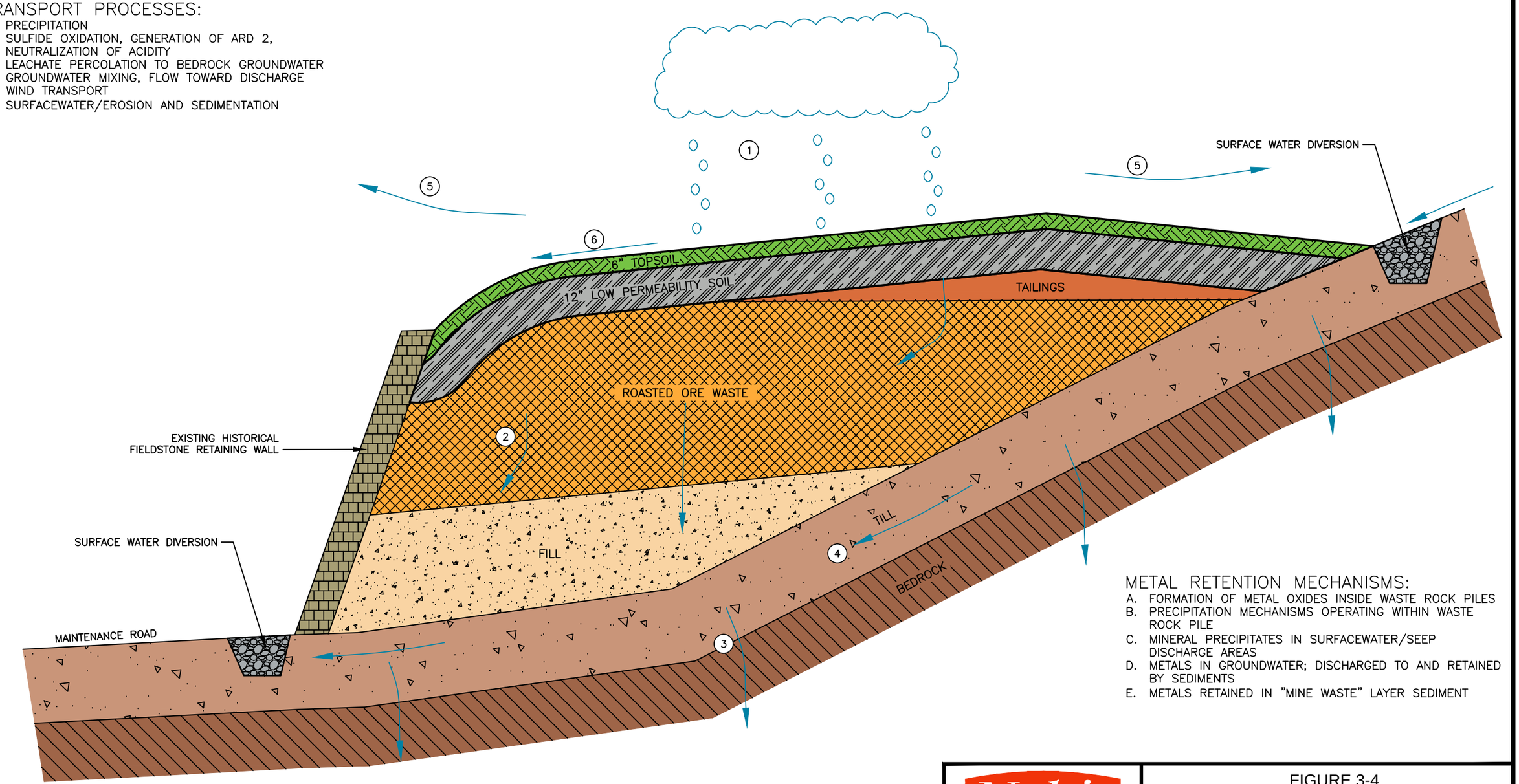
(603) 224-4182

Path: R:\80000 Task Orders\80024 Ely Copper Mine\Technical Data (TD)\GIS\Maps\FS\NEW\3-3 Cap System Location - Ore Roast Bed.mxd

TRANSPORT PROCESSES:

1. PRECIPITATION
2. SULFIDE OXIDATION, GENERATION OF ARD 2, NEUTRALIZATION OF ACIDITY
3. LEACHATE PERCOLATION TO BEDROCK GROUNDWATER
4. GROUNDWATER MIXING, FLOW TOWARD DISCHARGE
5. WIND TRANSPORT
6. SURFACEWATER/EROSION AND SEDIMENTATION



METAL RETENTION MECHANISMS:

A. FORMATION OF METAL OXIDES INSIDE WASTE ROCK PILES
B. PRECIPITATION MECHANISMS OPERATING WITHIN WASTE ROCK PILE
C. MINERAL PRECIPITATES IN SURFACEWATER/SEEP DISCHARGE AREAS
D. METALS IN GROUNDWATER; DISCHARGED TO AND RETAINED BY SEDIMENTS
E. METALS RETAINED IN "MINE WASTE" LAYER SEDIMENT

NOT TO SCALE

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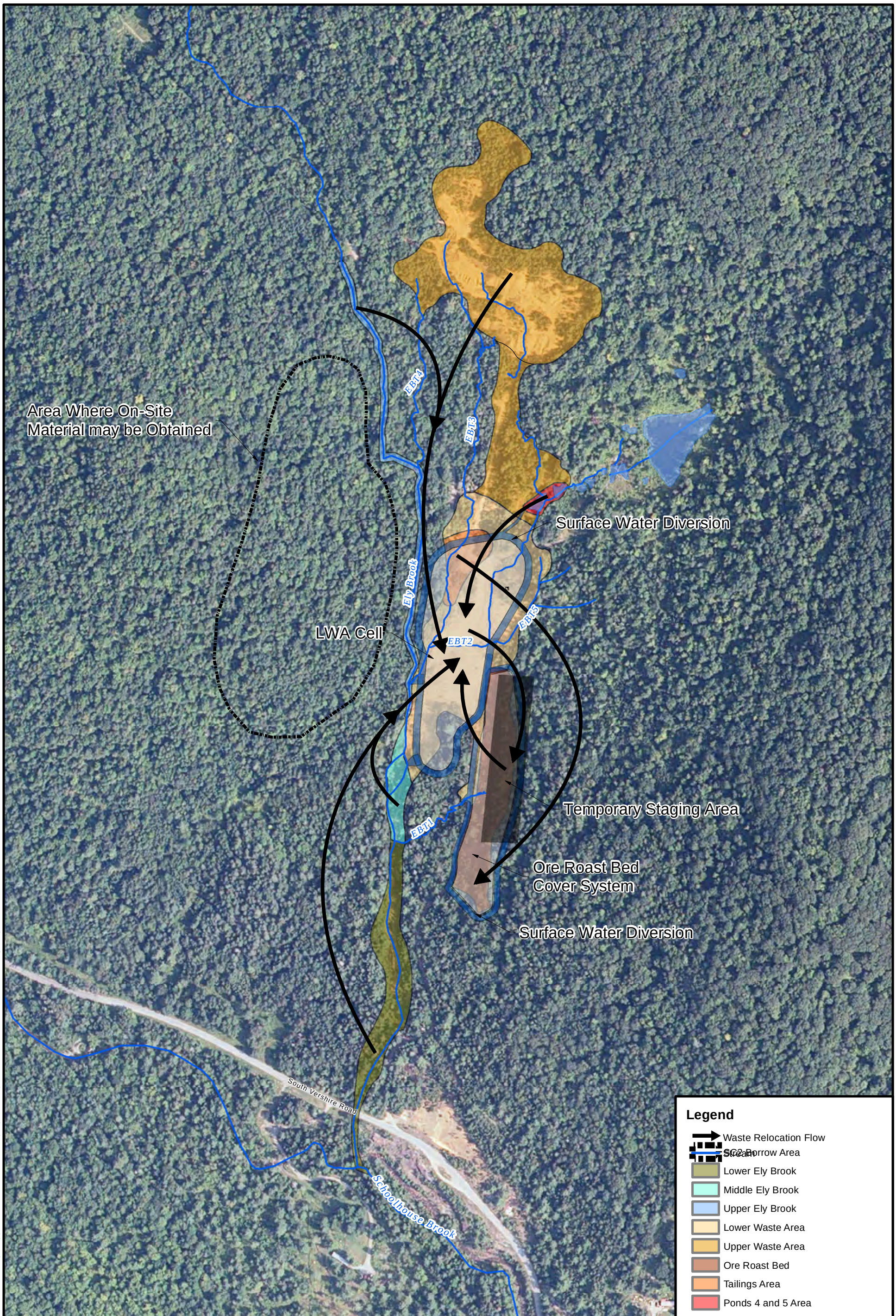
FIGURE 3-4

ORB CAP SYSTEM PROCESS MODEL

ELY COPPER MINE
VERSHIRE, VERMONT

DRAWN BY:	ML	APPROVED BY:	AJB
PROJECT:	80024.11		JUNE 24, 2011

R:\80000 Task Orders\80024 Ely Copper Mine\CAD\dwg\80024-WASTE-CONSOLIDATION-ORE-ROAST-BED.dwg



N

Drawn By: JRS	Checked By: AJB
June 24, 2011	Revision No. 00

APPROXIMATE SCALE
0 150 300 600 Feet

FIGURE 3-5

Alternative Remedy Map - Alternative SC2
Ely Copper Mine
Vershire, Vermont

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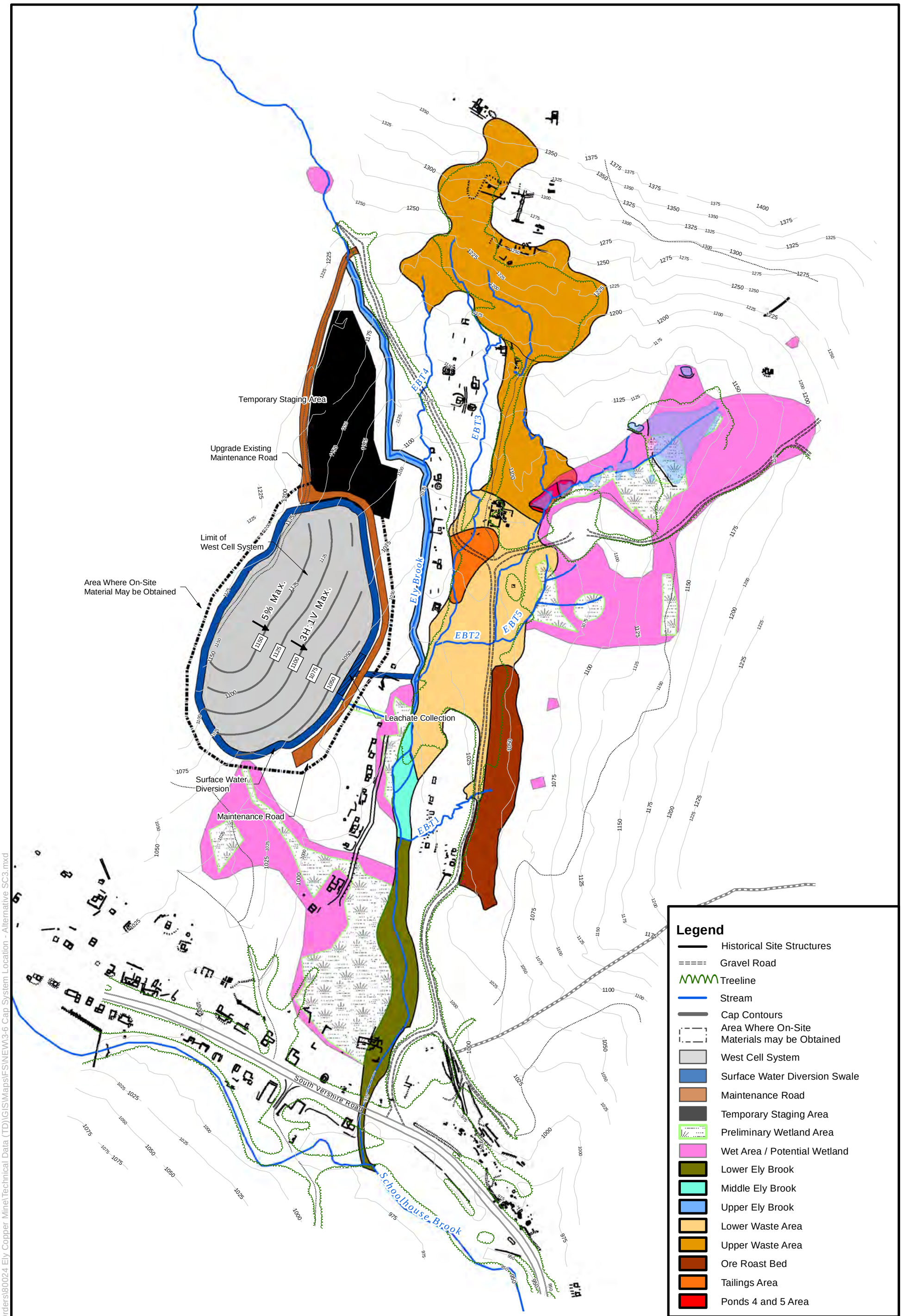
(603) 224-4182

Path: R:\80000 Task Orders\80024 Ely Copper Mine\Technical Data (TD)\GIS\Maps\FS\NEW\3-5 Alternative Remedy Map - Alternative SC2.mxd



N

Drawn By: JRS	Checked By: AJB
June 24, 2011	Revision No. 00

APPROXIMATE SCALE
0 75 150 300 450 600 Feet

NOTE: Elevations shown are feet above mean sea level (FT-AMSL).

FIGURE 3-6

West Cell Location - Alternative SC3
Ely Copper Mine
Vershire, Vermont

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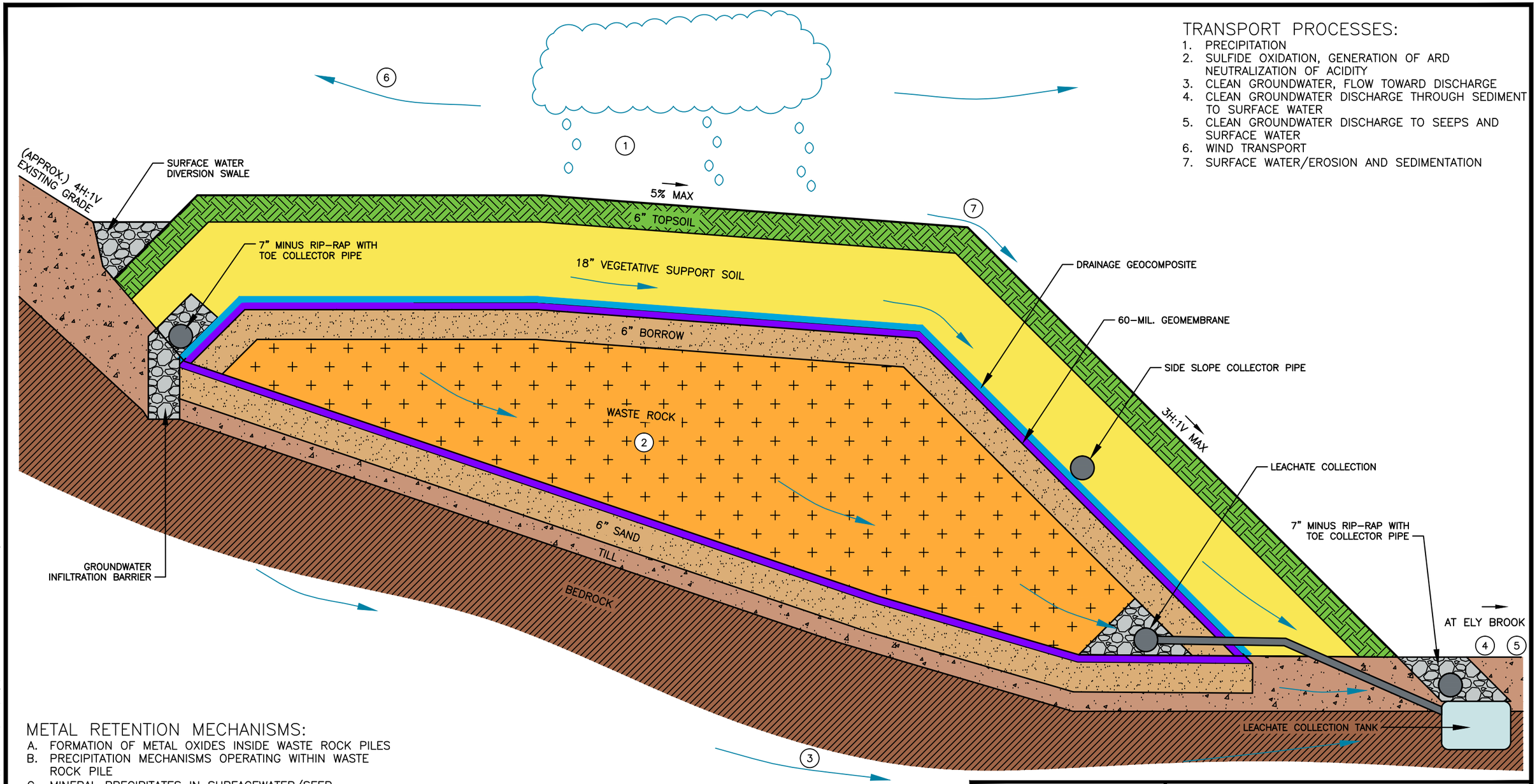
(603) 224-4182

Path: R:\80000 Task Orders\80024 Ely Copper Mine\Technical Data (TD)\GIS\Maps\FS\NEW3-6 Cap System Location - Alternative SC3.mxd



TRANSPORT PROCESSES:

1. PRECIPITATION
2. SULFIDE OXIDATION, GENERATION OF ARD NEUTRALIZATION OF ACIDITY
3. CLEAN GROUNDWATER, FLOW TOWARD DISCHARGE
4. CLEAN GROUNDWATER DISCHARGE THROUGH SEDIMENT TO SURFACE WATER
5. CLEAN GROUNDWATER DISCHARGE TO SEEPS AND SURFACE WATER
6. WIND TRANSPORT
7. SURFACE WATER/EROSION AND SEDIMENTATION

METAL RETENTION MECHANISMS:

A. FORMATION OF METAL OXIDES INSIDE WASTE ROCK PILES
B. PRECIPITATION MECHANISMS OPERATING WITHIN WASTE ROCK PILE
C. MINERAL PRECIPITATES IN SURFACEWATER/SEEP DISCHARGE AREAS
D. METALS IN GROUNDWATER; DISCHARGED TO AND RETAINED BY SEDIMENTS
E. METALS RETAINED IN "MINE WASTE" LAYER SEDIMENT

NOT TO SCALE

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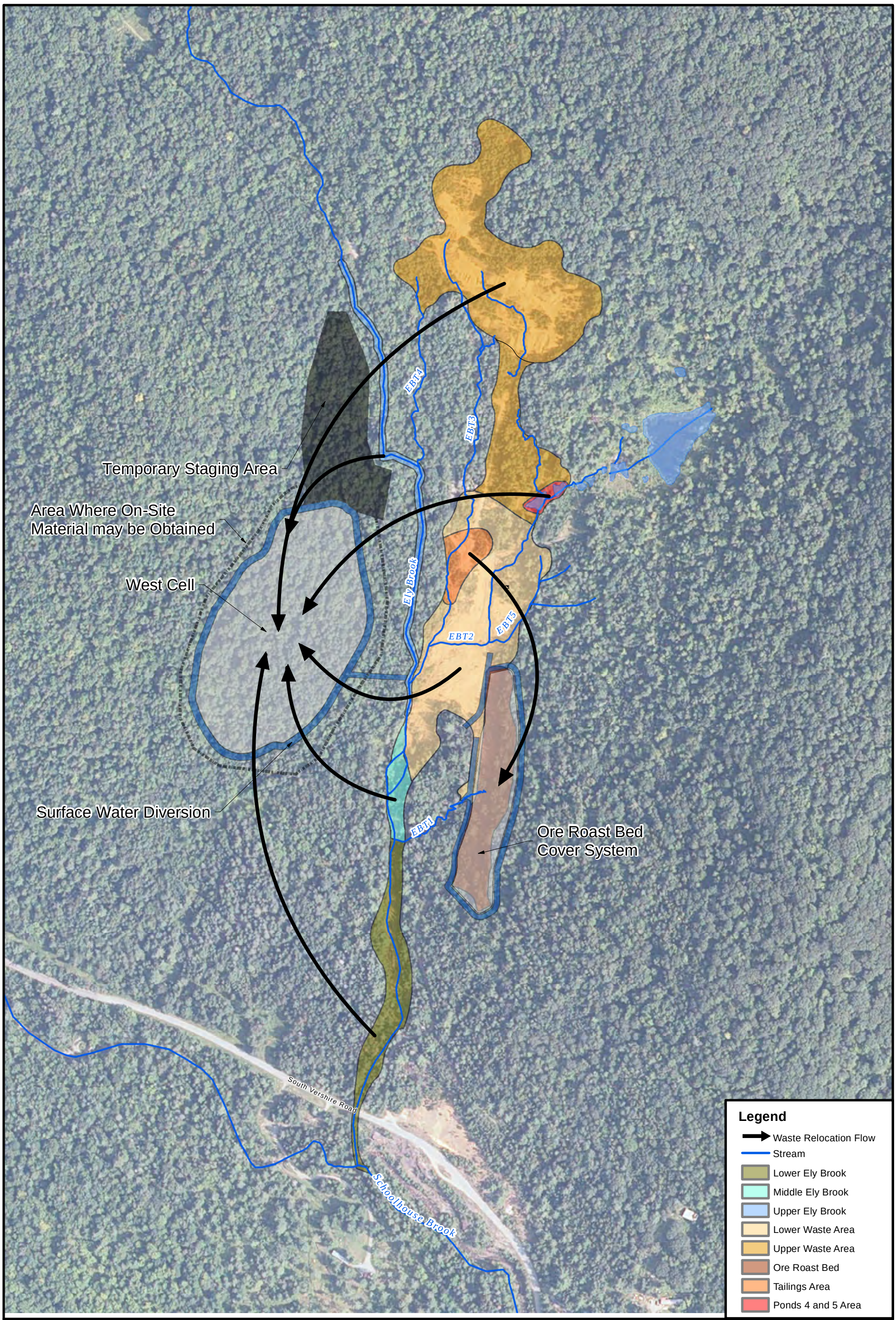
FIGURE 3-7

WEST CELL SYSTEM PROCESS MODEL

ELY COPPER MINE
VERSHIRE, VERMONT

DRAWN BY:	ML	APPROVED BY:	AJB
PROJECT:	80024.11		JUNE 24, 2011

R:\80000 Task Orders\80024 Ely Copper Mine\CAD\dwg\80024-ALTERNATIVE-WR3.dwg



N

Drawn By: JRS	Checked By: AJB
June 24, 2011	Revision No. 00

APPROXIMATE SCALE
0 150 300 600 Feet

FIGURE 3-8
Alternative Remedy Map
Alternative SC3
Ely Copper Mine
Vershire, Vermont

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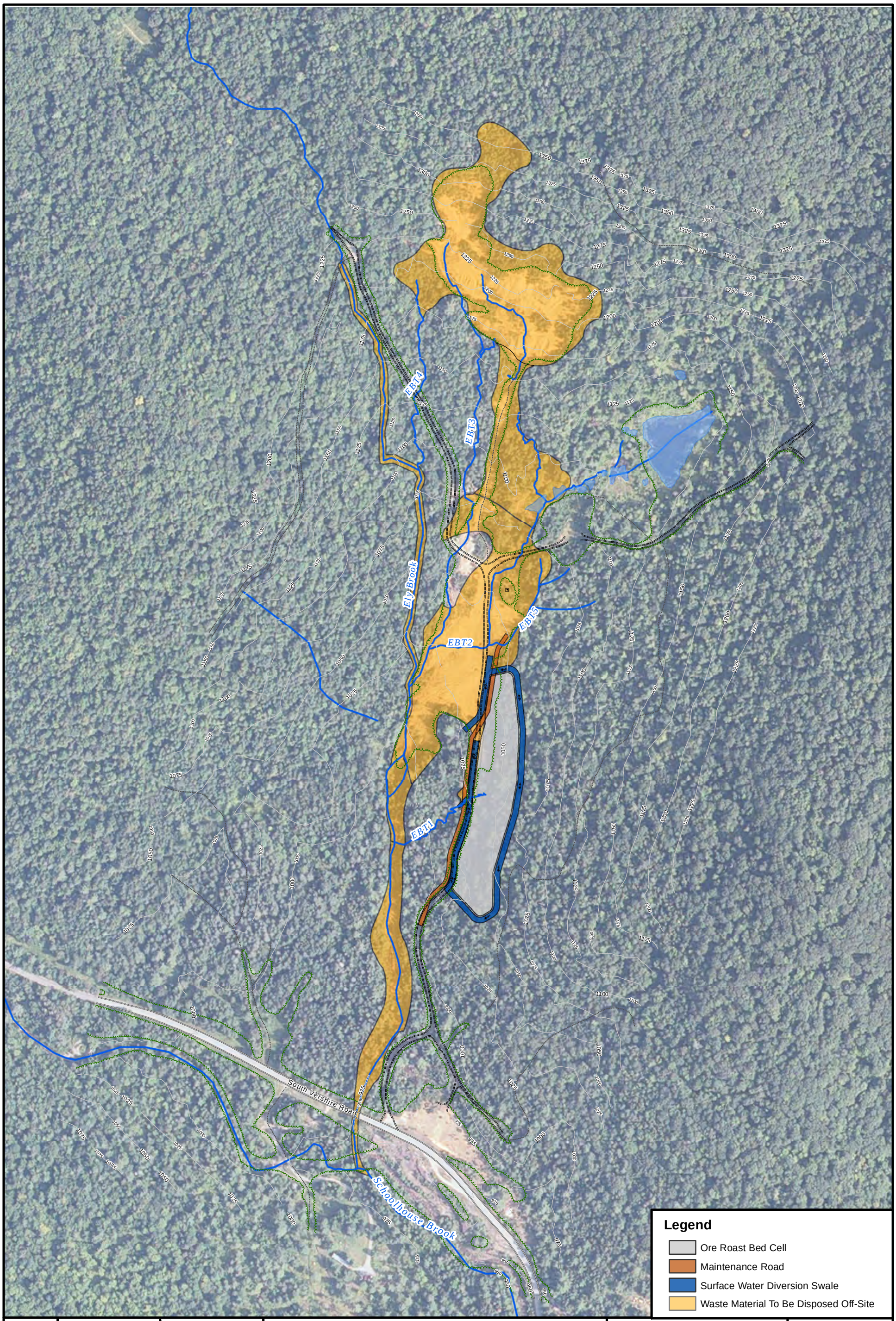
Path: R:\80000 Task Orders\80024 Ely Copper Mine\Technical Data (TD)\GIS\Maps\FS\NEW\3-8 Alternative Remedy Map - Alternative SC3.mxd



N

Drawn By: JRS	Checked By: AJB
June 24, 2011	Revision No. 00

APPROXIMATE SCALE
0 150 300 600 Feet

NOTE: Elevations shown are feet above mean sea level (FT-AMSL).

FIGURE 3-9
Waste Areas
Alternative SC4
Ely Copper Mine
Vershire, Vermont

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Path: R:\80000 Task Orders\80024 Ely Copper Mine\Technical Data (TD)\GIS\Maps\FS\NEW\3-9 Alternative SC4 Waste Areas.mxd

N

Drawn By: JRS	Checked By: AJB
June 24, 2011	Revision No. 00

APPROXIMATE SCALE
0 150 300 600 Feet

FIGURE 3-10
Alternative Remedy Map - Alternative SC4
Ely Copper Mine
Vershire, Vermont

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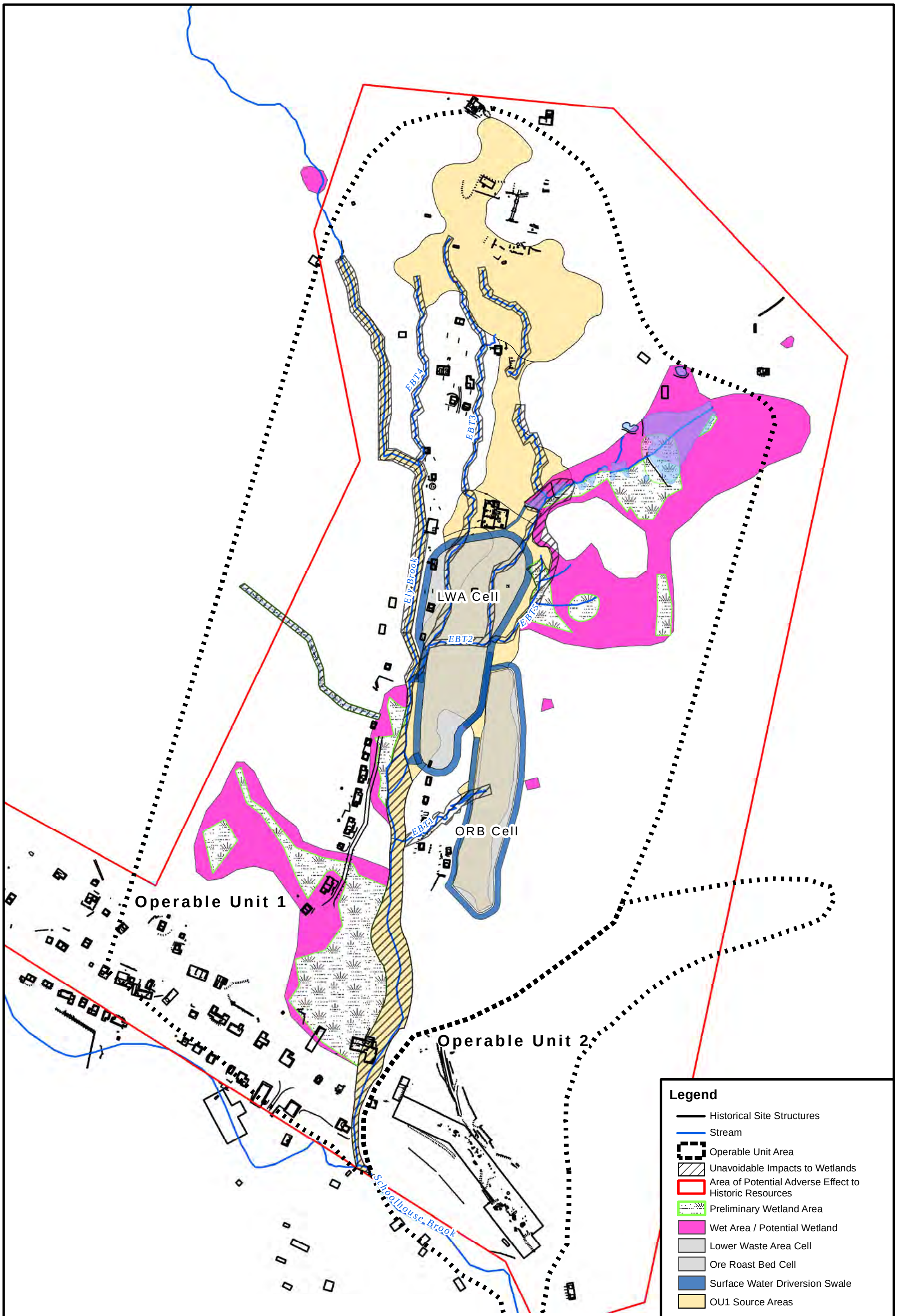
Path: R:\80000 Task Orders\80024 Ely Copper Mine\Technical Data (TD)\GIS\Maps\FS\NEW\3-10 Alternative Remedy Map - Alternative SC4.mxd



N

Drawn By: JRS	Checked By: AJB
June 24, 2011	Revision No. 00

APPROXIMATE SCALE
0 150 300 600 Feet

FIGURE 4-1
SC2 Area of Potential Impact
Ely Copper Mine
Vershire, Vermont

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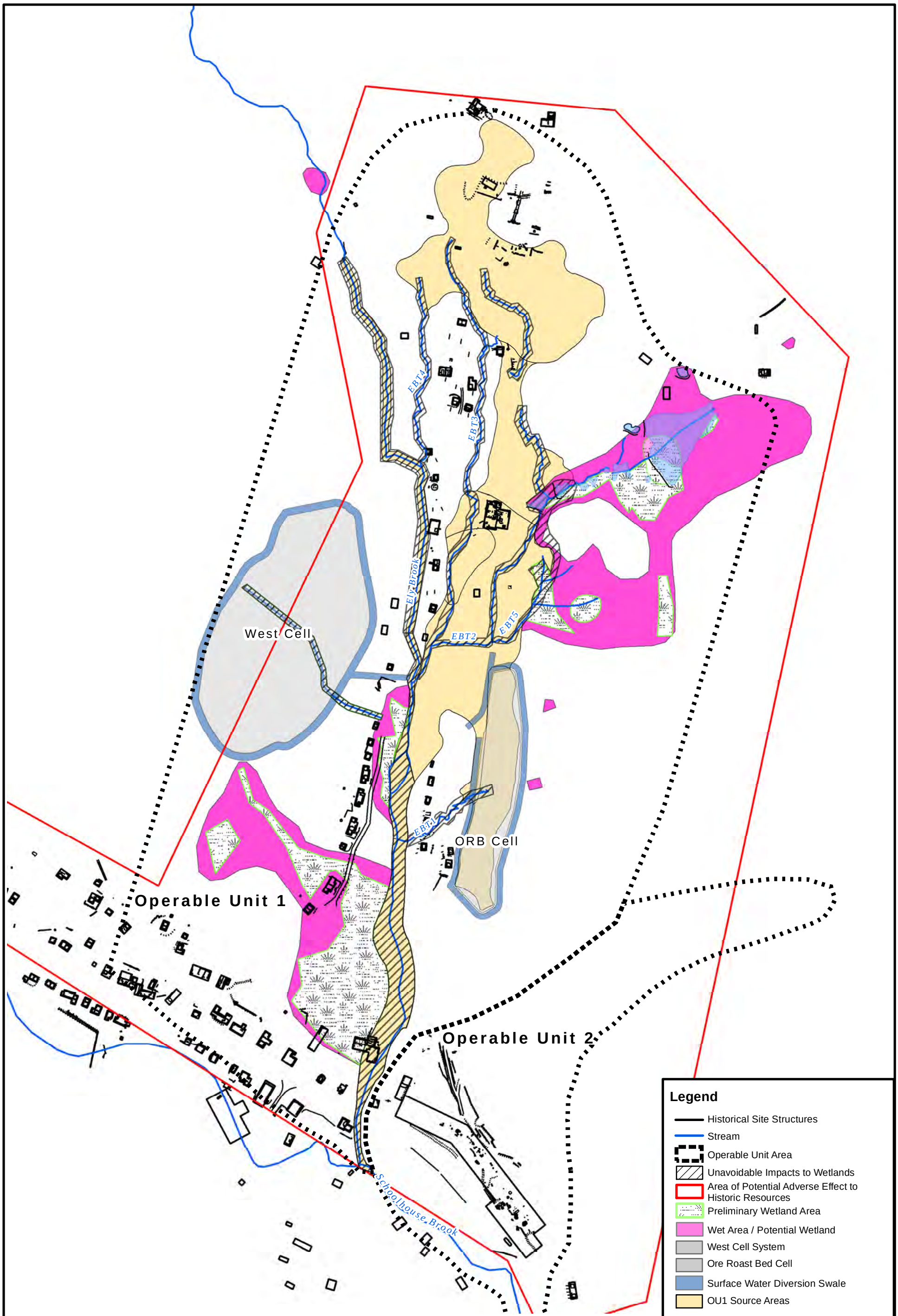
(603) 224-4182

Path: R:\80000 Task Orders\80024 Ely Copper Mine\Technical Data (TD)\GIS\Maps\FS\NEW\4-1 Area of Potential Impacts - Alternative SC2.mxd



N

Drawn By: JRS | Checked By: AJB

June 24, 2011 | Revision No. 00

APPROXIMATE SCALE
0 150 300 600 Feet

FIGURE 4-2
SC3 Area of Potential Impact
Ely Copper Mine
Vershire, Vermont

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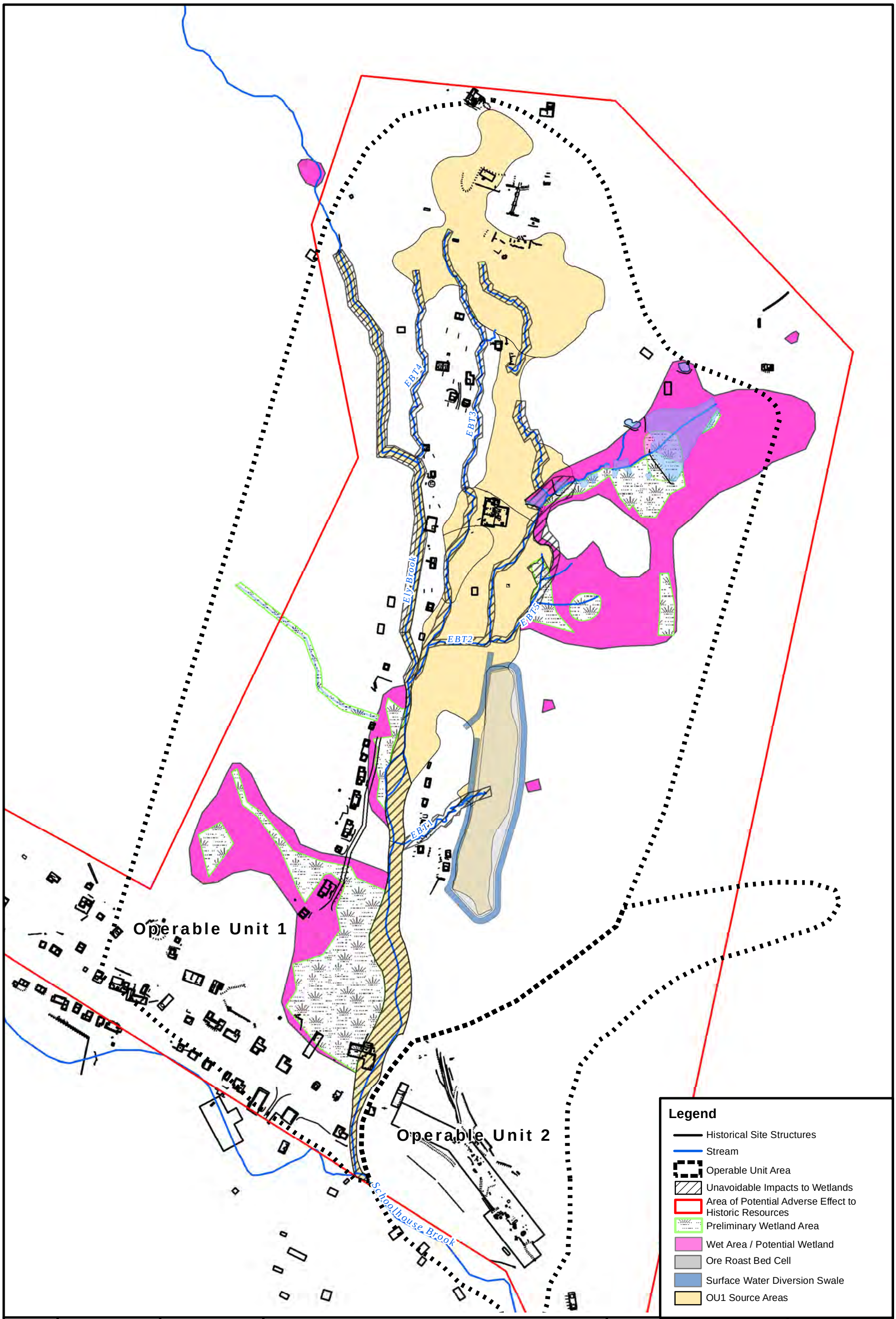
(603) 224-4182

Path: R:\80000 Task Orders\80024 Ely Copper Mine\Technical Data (TD)\GIS\Maps\FS\NEW\4-2 Area of Potential Impacts - Alternative SC3.mxd



N

Drawn By: JRS	Checked By: AJB
June 24, 2011	Revision No. 00

APPROXIMATE SCALE
0 150 300 600 Feet

FIGURE 4-3
SC4 Area of Potential Impact
Ely Copper Mine
Vershire, Vermont

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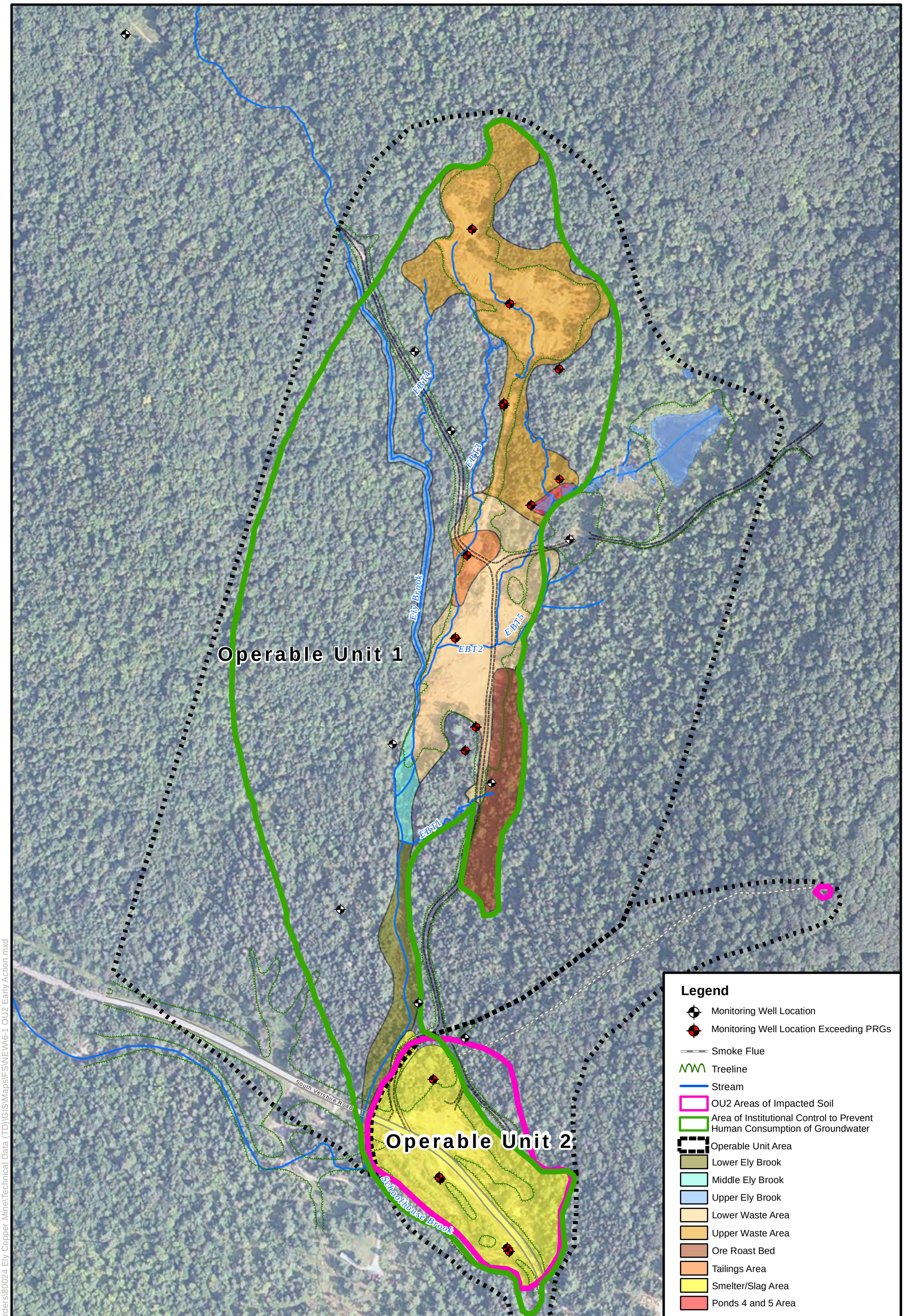
Nobis Engineering, Inc.
18 Chenell Drive
Concord, NH 03301
(603) 224-4182

Path: R:\80000 Task Orders\80024 Ely Copper Mine\Technical Data (TD)\GIS\Maps\FS\NEW\4-3 Area of Potential Impacts - Alternative SC4.mxd



N

Drawn By: JRS	Checked By: AJB
June 24, 2011	Revision No. 00

APPROXIMATE SCALE
0 150 300 600 Feet

NOTE:
Limit of Groundwater Exceedances based on Total/Dissolved Metal Exceedances From 2009 Groundwater Sampling by Nobis Engineering, Inc.
Soil Impact areas are based on sample results in exceedance of the site soil PRGs

FIGURE 6-1

OU2 Early Action
Ely Copper Mine
Vershire, Vermont

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Nobis Engineering, Inc.
18 Chenell Drive
Concord, NH 03301
(603) 224-4182

Path: R:\80000 Task Orders\80024 Ely Copper Mine\Technical Data (TD)\GIS\Maps\FS\NEW\6-1 OU2 Early Action.mxd

APPENDIX A

ALTERNATIVE SC2: EXCAVATION OF UWA, LWA, SEDIMENTS FROM ELY BROOK, TRIBUTARIES AND PONDS 4 AND 5, AND CONSOLIDATION INTO CELL WITHIN LWA, EXCAVATION OF TAILINGS AREA PILE AND CONSOLIDATION WITHIN A CAPPED CLOSURE ON THE ORB

Site: Ely Mine Site
Location: Vershire, Vermont
Phase: Feasibility Study (-30% to +50%)
Base Year: 2011
Date: June 2011

Description: Excavate the UWA, LWA, sediments from Ely Brook and its tributaries, and Ponds 4 and 5, and consolidate the waste/sediment material into a 5-acre constructed cell located in the LWA. The engineered cell will include: an underdrain (piping, 2.5' stone, 5' borrow), a 60-mil geomembrane liner and cap (with drainage geocomposite) over a 6" cushion, a subsurface drainage system, 1.5' of cover material and 0.5' of topsoil, toe details that incorporate cap system drainage and surface water diversions. A surface water diversion swales will be constructed surrounding the cell boundary. Prior to capping, the waste material will be dried to reduce leachate. Includes the excavation of TA and consolidation within capped closure on the ORB.

Description	Qty.	Units	Unit Cost	Cost	Sediment component	Revised total	Notes
Capital Costs							
Pre-Design Studies	1	ls	$ 266,000	$ 266,000	$ 95,000	$ 361,000	
Temporary Facilities	1	ls	$ 95,000	$ 95,000	$ 47,500	$ 142,500	
Haulage Way Construction	1	ls	$ 171,000	$ 171,000	$ 95,000	$ 266,000	
Mobilization / Demobilization	1	ls	$ 95,000	$ 95,000	$ 57,000	$ 152,000	
Upgrade of Existing Access Roads	5,280	ft	$ 19	$ 100,320	$ 47,500	$ 147,820	
Erosion and Sediment Control	1	ls	$ 95,000	$ 95,000	$ 95,000	$ 190,000	
Staging Area							
Clearing - Staging and Stockpile Area	2.0	acre	$ 9,000	$ 18,000		$ 18,000	
Staging Area and Temporary Liner/Leachate Collection System	1	ls	$ 125,000	$ 125,000		$ 125,000	
Passive Leachate Buffering with Limestone Checkdams	1	ls	$ 25,000	$ 25,000		$ 25,000	
Surface Water Diversions							
Ely Brook and Tributaries	490	lf	$ 570	$ 279,300		$ 279,300	
Upper Ely Brook							
Hydraulic Extraction or Flushing	1,700	lf	$ 95	$ 161,500		$ 161,500	
Middle Ely Brook							
Surface Water Diversion and Management	1	ls	$ 95,000	$ 95,000		$ 95,000	
Sediment Excavation, Transport, and Stockpiling	580	cy	$ 60	$ 34,800		$ 34,800	
Stream Channel Reconstruction (Rip-Rap)	650	lf	$ 475	$ 308,750		$ 308,750	
Lower Ely Brook and Tributaries							
Surface Water Diversion and Management	1	ls	$ 190,000	$ 190,000		$ 190,000	
Sediment Excavation, Transport, and Stockpiling	3,950	cy	$ 60	$ 237,000		$ 237,000	
Stream Channel Reconstruction (low-energy)	1,200	lf	$ 475	$ 570,000		$ 570,000	
Ponds 4 & 5							
Surface Water Diversion and Management	1	ls	$ 47,500	$ 47,500		$ 47,500	
Sediment Excavation, Transport, and Stockpiling	378	cy	$ 30	$ 11,340		$ 11,340	
Stream Channel Reconstruction (Rip-Rap)	615	lf	$ 190	$ 116,850		$ 116,850	
Waste Material Excavation, Transport, and Stockpiling							
UWA	69,400	cy	$ 14	$ 971,600		$ 971,600	
LWA	26,000	cy	$ 14	$ 364,000		$ 364,000	
TA	3,600	cy	$ 14	$ 50,400		$ 50,400	
UWA, LWA, TA Tribs and Seeps							
Surface Water Diversion and Management	1	ls	$ 47,500	$ 47,500		$ 47,500	
Sediment Excavation, Transport, and Stockpiling	3,221	cy	$ 14	$ 45,094		$ 45,094	
Stream Channel Reconstruction (7")	1,000	lf	$ 120	$ 120,000		$ 120,000	
Containment Cell Construction							
Temporary Surface Water Diversion for Cell Construction	1	ls	$ 200,000	$ 200,000		$ 200,000	
Subgrade Preparation	217,880	sf	$ 0.5	$ 108,940		$ 108,940	
Underdrain Separation Layer (pipe, 2.5' stone and 5' borrow)	60,000	cy	$ 34	$ 2,040,000		$ 2,040,000	
Waste Placement	103,529	cy	$ 5.50	$ 569,410		$ 569,410	

Appendix A
Cost Detail
Alternative SC2
Ely Copper Mine Superfund Site
Vershire, Vermont

Description	Qty.	Units	Unit Cost	Cost	Sediment component	Revised total	Notes
Cover System Drainage Collection System	2500	lf	$ 23	$ 57,500		$ 57,500	
Surface Water Diversions and Toe Details	2100	lf	$ 82	$ 172,200		$ 172,200	
LLDPE Liner System and Leachate Collection	217,880	sf	$ 2.50	$ 544,700		$ 544,700	
LLDPE and DGC Cover System	289,124	sf	$ 2	$ 578,248		$ 578,248	
Cushion and Vegetative Support System	32,125	cy	$ 8.60	$ 276,275		$ 276,275	6" cushion, 18" borrow, 6" topsoil)
Leachate Generation - Treatment	1	ls	$ 200,000	$ 200,000		$ 200,000	
Cap Construction Ore Roast Bed with Tailings							
Subgrade Preparation	130,680	sf	$ 0.95	$ 124,146		$ 124,146	
Tailings LLDPE Cover and Anchor	1,800	sf	$ 2.00	$ 3,600		$ 3,600	
Cover System and Drainage	130,680	sf	$ 4.75	$ 620,730		$ 620,730	
UWA Restoriation							
0.5' Base Fill with Lime Amendment	8,500	cy	$ 29	$ 242,250		$ 242,250	
Restoration and Revegetation	10.4	acre	$ 7,600	$ 78,802		$ 78,802	
LWA Restoriation							
0.5' Base Fill with Lime Amendment	0	cy	$ 29	$ -		$ -	
Restoration and Revegetation	0.0	acre	$ 7,600	$ -		$ -	
Staging Area							
Restoration and Revegetation	2.0	acre	$ 7,600	$ 15,200		$ 15,200	
Cultural/Historical Monitoring and Mitigation	1	ls	$ 100,000	$ 100,000	$ 95,000	$ 195,000	
Wetland and Habitat Mitigation	1	ls	$ 76,000	$ 76,000	$ 190,000	$ 266,000	
Institutional Controls	1	ls	$ 47,500	$ 47,500	$ 47,500	$ 95,000	
Long-Term Monitoring Plan	1	ls	$ 28,500	$ 28,500	$ 28,500	$ 57,000	
Monitoring Well Installations (6 overburden-shallow bedrock pairs)	1	ls	$ 80,000	$ 80,000	$ -	$ 80,000	
Total Before Contingency and other factors				$ 10,804,955		$ 11,602,955	
Contingency (30%)	30	%		$ 3,241,486		$ 3,480,886	
SUBTOTAL				**$ 14,046,441**		**$ 15,083,841**	
Engineering, Design, and Regulatory Support	10	%		$ 1,404,644		$ 1,508,384	
Project Management	5	%		$ 702,322		$ 754,192	
Construction Management	7	%		$ 983,251		$ 1,055,869	
Total Capital Costs:				**$ 17,136,658**		**$ 18,402,286**	

Annual O&M Costs			
Site Inspections, Sampling, Reporting	1	LS	$ 36,000
Routine Site Maintenance, Repairs, etc.	1	LS	$ 24,000
Annualized Five-Year Review Cost	1	LS	$ 7,000
Contingency (10%) and Project Management (5%)	1	LS	$ 10,050
SUBTOTAL			**$ 77,050**
Total Annual O&M Cost			**$ 77,050**

Notes:
Annual O&M Costs shown are average annualized costs over the period 0-30 years. See Appendix B for yearly O&M cost detail.

Cost type	Year	Total Cost	Total Cost per Year	Discount Factor (7%)	Present Value
Present Value Analysis					
Capital Cost	0	$ 18,402,286			$ 18,402,286
Annual O&M Cost	1-30	$ 2,311,500	$ 77,050	0.444	$ 1,026,221
					$ 19,428,508

ALTERNATIVE SC3: EXCAVATION OF UWA, LWA, SEDIMENTS FROM ELY BROOK, TRIBUTARIES AND PONDS 4 AND 5, AND CONSOLIDATION INTO CELL WEST OF ELB BROOK, EXCAVATION OF TAILINGS AREA PILE AND CONSOLIDATION WITHIN A CAPPED CLOSURE ON THE ORB

Site: Ely Mine Site
Location: Vershire, Vermont
Phase: Feasibility Study (-30% to +50%)
Base Year: 2011
Date: June 2011

Description: Excavate the UWA, LWA, sediments from Ely Brook and its tributaries, and Ponds 4 and 5, and consolidate the waste/sediment material into an 8.5 acre constructed cell located to the west of Ely Brook. The engineered cell will include: a 60-mil geomembrane liner and cap (with drainage geocomposite) over a 6" cushion, a subsurface drainage system, 1.5' of cover material and 0.5' of topsoil, toe details that incorporate cap system drainage and surface water diversions. A groundwater/surface water infiltration trench will be constructed on the updradient cell boundary and a surface water diversion will be constructed on the side-gradient and downgradient boundary. Prior to capping, the waste material will be dried to reduce leachate. Includes the excavation of TA and consolidation within capped closure on the ORB.

Description	Qty.	Units	Unit Cost	Cost	Sediment component	Revised total	Notes
Capital Costs							
Pre-Design Studies	1	ls	$ 190,000	$ 190,000	$ 95,000	$ 285,000	
Temporary Facilities	1	ls	$ 95,000	$ 95,000	$ 47,500	$ 142,500	
Haulage Way Construction	1	ls	$ 270,000	$ 270,000	$ 95,000	$ 365,000	
Mobilization / Demobilization	1	ls	$ 95,000	$ 95,000	$ 57,000	$ 152,000	
Upgrade of Existing Access Roads	5,280	ft	$ 19	$ 100,320	$ 47,500	$ 147,820	
Erosion and Sediment Control	1	ls	$ 95,000	$ 95,000	$ 95,000	$ 190,000	
Staging Area							
Clearing - Staging and Stockpile Area	3.6	acre	$ 9,000	$ 32,400		$ 32,400	
Surface Water Diversions							
Ely Brook and Tributaries	490	lf	$ 570	$ 279,300		$ 279,300	
Upper Ely Brook							
Hydraulic Extraction or Flushing	1,700	lf	$ 95	$ 161,500		$ 161,500	
Middle Ely Brook							
Surface Water Diversion and Management	1	ls	$ 95,000	$ 95,000		$ 95,000	
Sediment Excavation, Transport, and Stockpiling	580	cy	$ 60	$ 34,800		$ 34,800	
Stream Channel Reconstruction (Rip-Rap)	650	lf	$ 475	$ 308,750		$ 308,750	
Lower Ely Brook and Tributaries							
Surface Water Diversion and Management	1	ls	$ 190,000	$ 190,000		$ 190,000	
Sediment Excavation, Transport, and Stockpiling	3,950	cy	$ 60	$ 237,000		$ 237,000	
Stream Channel Reconstruction (low-energy)	1,200	lf	$ 475	$ 570,000		$ 570,000	
Ponds 4 & 5							
Surface Water Diversion and Management	1	ls	$ 47,500	$ 47,500		$ 47,500	
Sediment Excavation, Transport, and Stockpiling	378	cy	$ 30	$ 11,340		$ 11,340	
Stream Channel Reconstruction (Rip-Rap)	615	lf	$ 190	$ 116,850		$ 116,850	
Waste Material Excavation, Transport, and Stockpiling							
UWA	69,400	cy	$ 14	$ 971,600		$ 971,600	
LWA	26,000	cy	$ 14	$ 364,000		$ 364,000	
TA	3,600	cy	$ 14	$ 50,400		$ 50,400	
UWA, LWA, TA Tribs and Seeps							
Surface Water Diversion and Management	1	ls	$ 47,500	$ 47,500		$ 47,500	
Sediment Excavation, Transport, and Stockpiling	3,221	cy	$ 14	$ 45,094		$ 45,094	
Stream Channel Reconstruction (7")	1,000	lf	$ 120	$ 120,000		$ 120,000	
Containment Cell Construction							
Clearing - Containment Cell Area	8.5	acre	$ 9,000	$ 76,500		$ 76,500	
Subgrade Preparation	370,969	sf	$ 0.75	$ 278,227		$ 278,227	
Waste Placement	103,529	cy	$ 5.50	$ 569,410		$ 569,410	
Cover System Drainage Collection System	2625	lf	$ 23	$ 60,375		$ 60,375	3-875' segments
Groundwater Infiltration Trench	1025	lf	$ 150	$ 153,750		$ 153,750	

Appendix A
Cost Detail
Alternative SC3
Ely Copper Mine Superfund Site
Vershire, Vermont

Description	Qty.	Units	Unit Cost	Cost	Sediment component	Revised total	Notes
Surface Water Diversions and Toe Details	1480	lf	$ 82	$ 121,360		$ 121,360	
LLDPE Liner System and Leachate Collection	370,969	sf	$ 2.00	$ 741,938		$ 741,938	
LLDPE and DGC Cover System	408,066	sf	$ 2.00	$ 816,132		$ 816,132	
Cushion and Vegetative Support System	45,341	cy	$ 8.60	$ 389,933		$ 389,933	6" cushion, 18" borrow, 6" topsoil)
Leachate Generation - Treatment	1	ls	$ 200,000	$ 200,000		$ 200,000	
Cap Construction Ore Roast Bed with Tailings							
Subgrade Preparation	130,680	sf	$ 1	$ 124,146		$ 152,646	
Tailings LLDPE Cover and Anchor	1,800	sf	$ 2	$ 3,600		$ 3,600	
Cover System and Drainage	130,680	sf	$ 5	$ 620,730		$ 620,730	
UWA Restoriation							
0.5' Base Fill with Lime Amendment	8,500	cy	$ 29	$ 242,250		$ 242,250	
Restoration and Revegetation	10.4	acre	$ 7,600	$ 78,802		$ 78,802	
LWA Restoriation							
0.5' Base Fill with Lime Amendment	4,000	cy	$ 29	$ 114,000		$ 114,000	
Restoration and Revegetation	4.9	acre	$ 7,600	$ 37,113		$ 37,113	
Staging Area							
Restoration and Revegetation	4.0	acre	$ 7,600	$ 30,400		$ 30,400	
Cultural/Historical Monitoring and Mitigation	1	ls	$ 100,000	$ 100,000	$ 95,000	$ 195,000	
Wetland Mitigation	1	ls	$ 76,000	$ 100,000	$ 190,000	$ 290,000	
Institutional Controls	1	ls	$ 47,500	$ 47,500	$ 47,500	$ 95,000	
Long-Term Monitoring Plan	1	ls	$ 28,500	$ 28,500	$ 28,500	$ 57,000	
Monitoring Well Installations (6 overburden-shallow bedrock pairs)	1	ls	$ 80,000	$ 80,000	$ -	$ 80,000	
Total before contingency and other factors				$ 9,543,019		$ 10,369,519	
Contingency (30%)	30	%		$ 2,862,906		$ 3,110,856	
SUBTOTAL				**$ 12,405,924**		**$ 13,480,374**	
Engineering, Design, and Regulatory Support	10	%		$ 1,240,592		$ 1,348,037	
Project Management	5	%		$ 620,296		$ 674,019	
Construction Management	7	%		$ 868,415		$ 943,626	
Total Capital Costs:				**$ 15,135,228**		**$ 16,446,057**	

Annual O&M Costs

Site Inspections, Sampling, Reporting	1	LS	$ 36,000
Routine Site Maintenance, Repairs, etc.	1	LS	$ 24,000
Annualized Five-Year Review Cost	1	LS	$ 7,000
Contingency (10%) and Project Management (5%)	1	LS	$ 10,050
SUBTOTAL			**$ 77,050**
Total Annual O&M Cost			**$ 77,050**

Notes:
Annual O&M Costs shown are average annualized costs over the period 0-30 years. See Appendix B for yearly O&M cost detail.

Cost type	Year	Total Cost	Total Cost per Year	Discount Factor (7%)	Present Value
Present Value Analysis					
Capital Cost	0	$ 16,446,057			$ 16,446,057
Annual O&M Cost	1-30	$ 2,311,500	$ 77,050	0.444	$ 1,026,221
					$ 17,472,278

ALTERNATIVE SC4: EXCAVATION OF UWA, LWA, SEDIMENTS FROM ELY BROOK, TRIBUTARIES, PONDS 4 AND 5, AND TRANSPORTATION AND OFF-SITE DISPOSAL AT A LICENSED LANDFILL FACILITY AND EXCAVATION OF TAILINGS AREA PILE AND CONSOLIDATION WITHIN A CAPPED CLOSURE ON THE ORB

Site: Ely Mine Site
Location: Vershire, Vermont
Phase: Feasibility Study (-30% to +50%)
Base Year: 2011
Date: June 2011

Description: Excavate the UWA, LWA, sediments from Ely Brook and its tributaries, and Ponds 4 and 5 and transportation and off-site disposal at a licensed landfill facility and excavation of TA and consolidation within capped closure on the ORB.

Description	Qty.	Units	Unit Cost	Cost	Sediment component	Revised total	Notes
Capital Costs							
Pre-Design Studies	1	ls	$ 100,000	$ 100,000	$ 50,000	$ 150,000	
Temporary Facilities	1	ls	$ 95,000	$ 95,000	$ 47,500	$ 142,500	
Haulage Way Construction	1	ls	$ 170,000	$ 170,000	$ 95,000	$ 265,000	
Mobilization / Demobilization	1	ls	$ 50,000	$ 50,000	$ 57,000	$ 107,000	
Upgrade of Existing Access Roads	5,280	ft	$ 19	$ 100,320	$ 47,500	$ 147,820	
Erosion and Sediment Control	1	ls	$ 50,000	$ 50,000	$ 95,000	$ 145,000	
Off-Site Road Improvements	1	ls	$ 500,000	$ 500,000	$ -	$ 500,000	
Surface Water Diversions							
Ely Brook and Tributaries	490	lf	$ 570	$ 279,300		$ 279,300	
Site Clearing							
Staging and Stockpile Area	9	acre	$ 19,000	$ 171,000		$ 171,000	
Containment Cell Area	0	acre	$ 19,000	$ -		$ -	
Upper Ely Brook							
Hydraulic Extraction or Flushing	1,700	lf	$ 95	$ 161,500		$ 161,500	
Middle Ely Brook							
Surface Water Diversion and Management	1	ls	$ 95,000	$ 95,000		$ 95,000	
Sediment Excavation, Transport, and Stockpiling	580	cy	$ 60	$ 34,800		$ 34,800	
Stream Channel Reconstruction (Rip-Rap)	650	lf	$ 475	$ 308,750		$ 308,750	
Lower Ely Brook and Tributaries							
Surface Water Diversion and Management	1	ls	$ 190,000	$ 190,000		$ 190,000	
Sediment Excavation, Transport, and Stockpiling	3,950	cy	$ 60	$ 237,000		$ 237,000	
Stream Channel Reconstruction (low-energy)	1,200	lf	$ 475	$ 570,000		$ 570,000	
Ponds 4 & 5							
Surface Water Diversion and Management	1	ls	$ 47,500	$ 47,500		$ 47,500	
Sediment Excavation, Transport, and Stockpiling	378	cy	$ 30	$ 11,340		$ 11,340	
Stream Channel Reconstruction (Rip-Rap)	615	lf	$ 190	$ 116,850		$ 116,850	
Waste Material Excavation, Transport, and Stockpiling							
UWA	69,400	cy	$ 14	$ 971,600		$ 971,600	
LWA	26,000	cy	$ 14	$ 364,000		$ 364,000	
TA	3,600	cy	$ 14	$ 50,400		$ 50,400	
Ore Roast Bed	10,300	cy	$ 14	$ 144,200		$ 144,200	
Waste Pile Tribs and Seeps							
Surface Water Diversion and Management	1	ls	$ 47,500	$ 47,500		$ 47,500	
Sediment Excavation, Transport, and Stockpiling	3,221	cy	$ 14	$ 45,094		$ 45,094	
Stream Channel Reconstruction (7")	1,000	lf	$ 120	$ 120,000		$ 120,000	

Appendix A
Cost Detail
Alternative SC4
Ely Copper Mine Superfund Site
Vershire, Vermont

Description	Qty.	Units	Unit Cost	Cost	Sediment component	Revised total	Notes
Waste Pile & Sediments - T&D							
UWA, LWA, Ely Brook, and Ponds 4 & 5	103,729	cy					
Transportation	155,594	ton	$ 10	$ 1,555,935		$ 1,555,935	
Off-Site Disposal	155,594	ton	$ 63	$ 9,802,391		$ 9,802,391	
Analytical Testing for Disposal Acceptance	1	ls	$ 58,000	$ 58,000		$ 58,000	
Cap Construction Ore Roast Bed with Tailings							
Subgrade Preparation	130,680	sf	$ 1	$ 124,146		$ 124,146	
Tailings LLDPE Cover and Anchor	1,800	sf	$ 2	$ 3,600		$ 3,600	
Cover System and Drainage	130,680	sf	$ 5	$ 620,730		$ 620,730	
Upper Waste Pile Area Restoriation							
0.5' Base Fill with Lime Amendment	8,500	cy	$ 29	$ 242,250		$ 242,250	
Restoration and Revegetation	10.4	acre	$ 7,600	$ 78,802		$ 78,802	
Lower Waste Pile Area Restoriation							
0.5' Base Fill with Lime Amendment	4,000	cy	$ 29	$ 114,000		$ 114,000	
Restoration and Revegetation	4.9	acre	$ 7,600	$ 37,113		$ 37,113	
Staging Area							
Restoration and Revegetation	9.0	acre	$ 7,600	$ 68,400		$ 68,400	
Cultural/Historical Monitoring and Mitigation	1	ls	$ 100,000	$ 100,000	$ 95,000	$ 195,000	
Wetland Mitigation	1	ls	$ 38,000	$ 38,000	$ 190,000	$ 228,000	
Institutional Controls	1	ls	$ 47,500	$ 47,500	$ 47,500	$ 95,000	
Long-Term Monitoring Plan	1	ls	$ 9,500	$ 9,500	$ 9,500	$ 19,000	
Monitoring Well Installations	1	ls	$ 95,000	$ 95,000	$ -	$ 95,000	
Total before contingency and other factors				$ 18,026,521		$ 18,760,521	
Contingency (30%)	30	%		$ 5,407,956		$ 5,628,156	
SUBTOTAL				**$ 23,434,477**		**$ 24,388,677**	
Engineering, Design, and Regulatory Support	10	%		$ 2,343,448		$ 2,438,868	
Project Management	5	%		$ 1,171,724		$ 1,219,434	
Construction Management	7	%		$ 1,640,413		$ 1,707,207	
Total Capital Costs:				**$ 28,590,062**		**$ 29,754,186**	

Annual O&M Costs

Site Inspections, Sampling, Reporting	1	LS	$ 11,133
Routine Site Maintenance, Repairs, etc.	1	LS	$ 6,000
Annualized Five-Year Review Cost	1	LS	$ 7,000
Contingency (10%) and Project Management (5%)	1	LS	$ 3,620
SUBTOTAL			**$ 27,753**
Total Annual O&M Cost			**$ 27,753**

Notes:
Annual O&M Costs shown are average annualized costs over the period 0-30 years. See Appendix B for yearly O&M cost detail.

Cost type	Year	Total Cost	Total Cost per Year	Discount Factor (7%)	Present Value
Present Value Analysis					
Capital Cost	0	$ 29,754,186			$ 29,754,186
Annual O&M Cost	1-30	$ 832,600	$ 27,753	0.444	$ 369,644
					$ 30,123,830

APPENDIX B

Appendix B
Present Value of Annual and Periodic Costs - Years 1 through 30
Alternative SC1
Ely Copper Mine Superfund Site
Vershire, Vermont

Year (t)	GW Monitoring	Lab	Maitenance	Site Inspections	Annual Reporting	Five-Year Reviews	Contingency (@ 10%)	PM (@ 5%)	Total Non-Discounted Cost	Total Present Value
0										
1	$ -	$ -	$ -	$ -	$ -	$ 7,000	$ 700	$ 350	$ 8,050	$ 7,523
2	$ -	$ -	$ -	$ -	$ -	$ 7,000	$ 700	$ 350	$ 8,050	$ 7,031
3	$ -	$ -	$ -	$ -	$ -	$ 7,000	$ 700	$ 350	$ 8,050	$ 6,571
4	$ -	$ -	$ -	$ -	$ -	$ 7,000	$ 700	$ 350	$ 8,050	$ 6,141
5	$ -	$ -	$ -	$ -	$ -	$ 7,000	$ 700	$ 350	$ 8,050	$ 5,740
6	$ -	$ -	$ -	$ -	$ -	$ 7,000	$ 700	$ 350	$ 8,050	$ 5,364
7	$ -	$ -	$ -	$ -	$ -	$ 7,000	$ 700	$ 350	$ 8,050	$ 5,013
8	$ -	$ -	$ -	$ -	$ -	$ 7,000	$ 700	$ 350	$ 8,050	$ 4,685
9	$ -	$ -	$ -	$ -	$ -	$ 7,000	$ 700	$ 350	$ 8,050	$ 4,379
10	$ -	$ -	$ -	$ -	$ -	$ 7,000	$ 700	$ 350	$ 8,050	$ 4,092
11	$ -	$ -	$ -	$ -	$ -	$ 7,000	$ 700	$ 350	$ 8,050	$ 3,824
12	$ -	$ -	$ -	$ -	$ -	$ 7,000	$ 700	$ 350	$ 8,050	$ 3,574
13	$ -	$ -	$ -	$ -	$ -	$ 7,000	$ 700	$ 350	$ 8,050	$ 3,340
14	$ -	$ -	$ -	$ -	$ -	$ 7,000	$ 700	$ 350	$ 8,050	$ 3,122
15	$ -	$ -	$ -	$ -	$ -	$ 7,000	$ 700	$ 350	$ 8,050	$ 2,918
16	$ -	$ -	$ -	$ -	$ -	$ 7,000	$ 700	$ 350	$ 8,050	$ 2,727
17	$ -	$ -	$ -	$ -	$ -	$ 7,000	$ 700	$ 350	$ 8,050	$ 2,548
18	$ -	$ -	$ -	$ -	$ -	$ 7,000	$ 700	$ 350	$ 8,050	$ 2,382
19	$ -	$ -	$ -	$ -	$ -	$ 7,000	$ 700	$ 350	$ 8,050	$ 2,226
20	$ -	$ -	$ -	$ -	$ -	$ 7,000	$ 700	$ 350	$ 8,050	$ 2,080
21	$ -	$ -	$ -	$ -	$ -	$ 7,000	$ 700	$ 350	$ 8,050	$ 1,944
22	$ -	$ -	$ -	$ -	$ -	$ 7,000	$ 700	$ 350	$ 8,050	$ 1,817
23	$ -	$ -	$ -	$ -	$ -	$ 7,000	$ 700	$ 350	$ 8,050	$ 1,698
24	$ -	$ -	$ -	$ -	$ -	$ 7,000	$ 700	$ 350	$ 8,050	$ 1,587
25	$ -	$ -	$ -	$ -	$ -	$ 7,000	$ 700	$ 350	$ 8,050	$ 1,483
26	$ -	$ -	$ -	$ -	$ -	$ 7,000	$ 700	$ 350	$ 8,050	$ 1,386
27	$ -	$ -	$ -	$ -	$ -	$ 7,000	$ 700	$ 350	$ 8,050	$ 1,295
28	$ -	$ -	$ -	$ -	$ -	$ 7,000	$ 700	$ 350	$ 8,050	$ 1,211
29	$ -	$ -	$ -	$ -	$ -	$ 7,000	$ 700	$ 350	$ 8,050	$ 1,132
30	$ -	$ -	$ -	$ -	$ -	$ 7,000	$ 700	$ 350	$ 8,050	$ 1,058
TOTAL	$ -	$ -	$ -	$ -	$ -	$ 210,000	$ 21,000	$ 10,500	$ 241,500	$ 99,893
									Discount Factor	0.414
Total before applied costs						$ 210,000				

PV Discount Rate (i)
0.070

PV = non-discounted cost X 1/((1+i)t)

Appendix B
Present Value of Annual and Periodic Costs - Years 1 through 30
Alternative SC2
Ely Copper Mine Superfund Site
Vershire, Vermont

Year (t)	GW Monitoring	Lab	Maitenance	Site Inspections	Annual Reporting	Five-Year Reviews	Contingency (@ 10%)	PM (@ 5%)	Total Non-Discounted Cost	Total Present Value
0										
1	$ 20,000	$ 20,000	$ 24,000	$ 15,000	$ 6,000	$ 7,000	$ 9,200	$ 4,600	$ 105,800	$ 98,879
2	$ 20,000	$ 20,000	$ 24,000	$ 15,000	$ 6,000	$ 7,000	$ 9,200	$ 4,600	$ 105,800	$ 92,410
3	$ 20,000	$ 20,000	$ 24,000	$ 15,000	$ 6,000	$ 7,000	$ 9,200	$ 4,600	$ 105,800	$ 86,364
4	$ 20,000	$ 20,000	$ 24,000	$ 15,000	$ 6,000	$ 7,000	$ 9,200	$ 4,600	$ 105,800	$ 80,714
5	$ 20,000	$ 20,000	$ 24,000	$ 15,000	$ 6,000	$ 7,000	$ 9,200	$ 4,600	$ 105,800	$ 75,434
6	$ 2,000	$ 8,000	$ 24,000	$ 15,000	$ 6,000	$ 7,000	$ 6,200	$ 3,100	$ 71,300	$ 47,510
7	$ 2,000	$ 8,000	$ 24,000	$ 15,000	$ 6,000	$ 7,000	$ 6,200	$ 3,100	$ 71,300	$ 44,402
8	$ 2,000	$ 8,000	$ 24,000	$ 15,000	$ 6,000	$ 7,000	$ 6,200	$ 3,100	$ 71,300	$ 41,497
9	$ 2,000	$ 8,000	$ 24,000	$ 15,000	$ 6,000	$ 7,000	$ 6,200	$ 3,100	$ 71,300	$ 38,782
10	$ 2,000	$ 8,000	$ 24,000	$ 15,000	$ 6,000	$ 7,000	$ 6,200	$ 3,100	$ 71,300	$ 36,245
11	$ 2,000	$ 8,000	$ 24,000	$ 15,000	$ 6,000	$ 7,000	$ 6,200	$ 3,100	$ 71,300	$ 33,874
12	$ 2,000	$ 8,000	$ 24,000	$ 15,000	$ 6,000	$ 7,000	$ 6,200	$ 3,100	$ 71,300	$ 31,658
13	$ 2,000	$ 8,000	$ 24,000	$ 15,000	$ 6,000	$ 7,000	$ 6,200	$ 3,100	$ 71,300	$ 29,587
14	$ 2,000	$ 8,000	$ 24,000	$ 15,000	$ 6,000	$ 7,000	$ 6,200	$ 3,100	$ 71,300	$ 27,651
15	$ 2,000	$ 8,000	$ 24,000	$ 15,000	$ 6,000	$ 7,000	$ 6,200	$ 3,100	$ 71,300	$ 25,842
16	$ 2,000	$ 8,000	$ 24,000	$ 15,000	$ 6,000	$ 7,000	$ 6,200	$ 3,100	$ 71,300	$ 24,152
17	$ 2,000	$ 8,000	$ 24,000	$ 15,000	$ 6,000	$ 7,000	$ 6,200	$ 3,100	$ 71,300	$ 22,572
18	$ 2,000	$ 8,000	$ 24,000	$ 15,000	$ 6,000	$ 7,000	$ 6,200	$ 3,100	$ 71,300	$ 21,095
19	$ 2,000	$ 8,000	$ 24,000	$ 15,000	$ 6,000	$ 7,000	$ 6,200	$ 3,100	$ 71,300	$ 19,715
20	$ 2,000	$ 8,000	$ 24,000	$ 15,000	$ 6,000	$ 7,000	$ 6,200	$ 3,100	$ 71,300	$ 18,425
21	$ 2,000	$ 8,000	$ 24,000	$ 15,000	$ 6,000	$ 7,000	$ 6,200	$ 3,100	$ 71,300	$ 17,220
22	$ 2,000	$ 8,000	$ 24,000	$ 15,000	$ 6,000	$ 7,000	$ 6,200	$ 3,100	$ 71,300	$ 16,093
23	$ 2,000	$ 8,000	$ 24,000	$ 15,000	$ 6,000	$ 7,000	$ 6,200	$ 3,100	$ 71,300	$ 15,041
24	$ 2,000	$ 8,000	$ 24,000	$ 15,000	$ 6,000	$ 7,000	$ 6,200	$ 3,100	$ 71,300	$ 14,057
25	$ 2,000	$ 8,000	$ 24,000	$ 15,000	$ 6,000	$ 7,000	$ 6,200	$ 3,100	$ 71,300	$ 13,137
26	$ 2,000	$ 8,000	$ 24,000	$ 15,000	$ 6,000	$ 7,000	$ 6,200	$ 3,100	$ 71,300	$ 12,278
27	$ 2,000	$ 8,000	$ 24,000	$ 15,000	$ 6,000	$ 7,000	$ 6,200	$ 3,100	$ 71,300	$ 11,474
28	$ 2,000	$ 8,000	$ 24,000	$ 15,000	$ 6,000	$ 7,000	$ 6,200	$ 3,100	$ 71,300	$ 10,724
29	$ 2,000	$ 8,000	$ 24,000	$ 15,000	$ 6,000	$ 7,000	$ 6,200	$ 3,100	$ 71,300	$ 10,022
30	$ 2,000	$ 8,000	$ 24,000	$ 15,000	$ 6,000	$ 7,000	$ 6,200	$ 3,100	$ 71,300	$ 9,366
TOTAL	$ 150,000	$ 300,000	$ 720,000	$ 450,000	$ 180,000	$ 210,000	$ 201,000	$ 100,500	$ 2,311,500	$ 1,026,221
									Discount Factor	0.444
Total before applied costs						$ 2,010,000				

PV Discount Rate (i)
0.070

PV = non-discounted cost X 1/((1+i)t)

Appendix B
Present Value of Annual and Periodic Costs - Years 1 through 30
Alternative SC4
Ely Copper Mine Superfund Site
Vershire, Vermont

Year (t)	GW Monitoring	Lab	Maitenance	Site Inspections	Annual Reporting	Five-Year Reviews	Contingency (@ 10%)	PM (@ 5%)	Total Non-Discounted Cost	Total Present Value
0										
1	$ 20,000	$ 20,000	$ 24,000	$ 15,000	$ 6,000	$ 7,000	$ 9,200	$ 4,600	$ 105,800	$ 98,879
2	$ 20,000	$ 20,000	$ 24,000	$ 15,000	$ 6,000	$ 7,000	$ 9,200	$ 4,600	$ 105,800	$ 92,410
3	$ 20,000	$ 20,000	$ 24,000	$ 15,000	$ 6,000	$ 7,000	$ 9,200	$ 4,600	$ 105,800	$ 86,364
4	$ 20,000	$ 20,000	$ 24,000	$ 15,000	$ 6,000	$ 7,000	$ 9,200	$ 4,600	$ 105,800	$ 80,714
5	$ 20,000	$ 20,000	$ 24,000	$ 15,000	$ 6,000	$ 7,000	$ 9,200	$ 4,600	$ 105,800	$ 75,434
6	$ 2,000	$ 8,000	$ 24,000	$ 15,000	$ 6,000	$ 7,000	$ 6,200	$ 3,100	$ 71,300	$ 47,510
7	$ 2,000	$ 8,000	$ 24,000	$ 15,000	$ 6,000	$ 7,000	$ 6,200	$ 3,100	$ 71,300	$ 44,402
8	$ 2,000	$ 8,000	$ 24,000	$ 15,000	$ 6,000	$ 7,000	$ 6,200	$ 3,100	$ 71,300	$ 41,497
9	$ 2,000	$ 8,000	$ 24,000	$ 15,000	$ 6,000	$ 7,000	$ 6,200	$ 3,100	$ 71,300	$ 38,782
10	$ 2,000	$ 8,000	$ 24,000	$ 15,000	$ 6,000	$ 7,000	$ 6,200	$ 3,100	$ 71,300	$ 36,245
11	$ 2,000	$ 8,000	$ 24,000	$ 15,000	$ 6,000	$ 7,000	$ 6,200	$ 3,100	$ 71,300	$ 33,874
12	$ 2,000	$ 8,000	$ 24,000	$ 15,000	$ 6,000	$ 7,000	$ 6,200	$ 3,100	$ 71,300	$ 31,658
13	$ 2,000	$ 8,000	$ 24,000	$ 15,000	$ 6,000	$ 7,000	$ 6,200	$ 3,100	$ 71,300	$ 29,587
14	$ 2,000	$ 8,000	$ 24,000	$ 15,000	$ 6,000	$ 7,000	$ 6,200	$ 3,100	$ 71,300	$ 27,651
15	$ 2,000	$ 8,000	$ 24,000	$ 15,000	$ 6,000	$ 7,000	$ 6,200	$ 3,100	$ 71,300	$ 25,842
16	$ 2,000	$ 8,000	$ 24,000	$ 15,000	$ 6,000	$ 7,000	$ 6,200	$ 3,100	$ 71,300	$ 24,152
17	$ 2,000	$ 8,000	$ 24,000	$ 15,000	$ 6,000	$ 7,000	$ 6,200	$ 3,100	$ 71,300	$ 22,572
18	$ 2,000	$ 8,000	$ 24,000	$ 15,000	$ 6,000	$ 7,000	$ 6,200	$ 3,100	$ 71,300	$ 21,095
19	$ 2,000	$ 8,000	$ 24,000	$ 15,000	$ 6,000	$ 7,000	$ 6,200	$ 3,100	$ 71,300	$ 19,715
20	$ 2,000	$ 8,000	$ 24,000	$ 15,000	$ 6,000	$ 7,000	$ 6,200	$ 3,100	$ 71,300	$ 18,425
21	$ 2,000	$ 8,000	$ 24,000	$ 15,000	$ 6,000	$ 7,000	$ 6,200	$ 3,100	$ 71,300	$ 17,220
22	$ 2,000	$ 8,000	$ 24,000	$ 15,000	$ 6,000	$ 7,000	$ 6,200	$ 3,100	$ 71,300	$ 16,093
23	$ 2,000	$ 8,000	$ 24,000	$ 15,000	$ 6,000	$ 7,000	$ 6,200	$ 3,100	$ 71,300	$ 15,041
24	$ 2,000	$ 8,000	$ 24,000	$ 15,000	$ 6,000	$ 7,000	$ 6,200	$ 3,100	$ 71,300	$ 14,057
25	$ 2,000	$ 8,000	$ 24,000	$ 15,000	$ 6,000	$ 7,000	$ 6,200	$ 3,100	$ 71,300	$ 13,137
26	$ 2,000	$ 8,000	$ 24,000	$ 15,000	$ 6,000	$ 7,000	$ 6,200	$ 3,100	$ 71,300	$ 12,278
27	$ 2,000	$ 8,000	$ 24,000	$ 15,000	$ 6,000	$ 7,000	$ 6,200	$ 3,100	$ 71,300	$ 11,474
28	$ 2,000	$ 8,000	$ 24,000	$ 15,000	$ 6,000	$ 7,000	$ 6,200	$ 3,100	$ 71,300	$ 10,724
29	$ 2,000	$ 8,000	$ 24,000	$ 15,000	$ 6,000	$ 7,000	$ 6,200	$ 3,100	$ 71,300	$ 10,022
30	$ 2,000	$ 8,000	$ 24,000	$ 15,000	$ 6,000	$ 7,000	$ 6,200	$ 3,100	$ 71,300	$ 9,366
TOTAL	$ 150,000	$ 300,000	$ 720,000	$ 450,000	$ 180,000	$ 210,000	$ 201,000	$ 100,500	$ 2,311,500	$ 1,026,221
									Discount Factor	0.444
Total before applied costs						$ 2,010,000				

PV Discount Rate (i)
0.070

PV = non-discounted cost X 1/((1+i)t)

Appendix B
Present Value of Annual and Periodic Costs - Years 1 through 30
Alternative SC4
Ely Copper Mine Superfund Site
Vershire, Vermont

Year (t)	GW Monitoring	Lab	Maitenance	Site Inspections	Annual Reporting	Five-Year Reviews	Contingency (@ 10%)	PM (@ 5%)	Total Non-Discounted Cost	Total Present Value
0										
1	$ 10,000	$ 12,000	$ 6,000	$ 6,000	$ 6,000	$ 7,000	$ 4,700	$ 2,350	$ 54,050	$ 50,514
2	$ 10,000	$ 12,000	$ 6,000	$ 6,000	$ 6,000	$ 7,000	$ 4,700	$ 2,350	$ 54,050	$ 47,209
3	$ 2,000	$ 8,000	$ 6,000	$ 6,000	$ 6,000	$ 7,000	$ 3,500	$ 1,750	$ 40,250	$ 32,856
4	$ 2,000	$ 8,000	$ 6,000	$ 6,000	$ 6,000	$ 7,000	$ 3,500	$ 1,750	$ 40,250	$ 30,707
5	$ 2,000	$ 8,000	$ 6,000	$ 6,000	$ 6,000	$ 7,000	$ 3,500	$ 1,750	$ 40,250	$ 28,698
6	$ -	$ -	$ 6,000	$ 6,000	$ 2,000	$ 7,000	$ 2,100	$ 1,050	$ 24,150	$ 16,092
7	$ -	$ -	$ 6,000	$ 6,000	$ 2,000	$ 7,000	$ 2,100	$ 1,050	$ 24,150	$ 15,039
8	$ -	$ -	$ 6,000	$ 6,000	$ 2,000	$ 7,000	$ 2,100	$ 1,050	$ 24,150	$ 14,056
9	$ -	$ -	$ 6,000	$ 6,000	$ 2,000	$ 7,000	$ 2,100	$ 1,050	$ 24,150	$ 13,136
10	$ -	$ -	$ 6,000	$ 6,000	$ 2,000	$ 7,000	$ 2,100	$ 1,050	$ 24,150	$ 12,277
11	$ -	$ -	$ 6,000	$ 6,000	$ 2,000	$ 7,000	$ 2,100	$ 1,050	$ 24,150	$ 11,473
12	$ -	$ -	$ 6,000	$ 6,000	$ 2,000	$ 7,000	$ 2,100	$ 1,050	$ 24,150	$ 10,723
13	$ -	$ -	$ 6,000	$ 6,000	$ 2,000	$ 7,000	$ 2,100	$ 1,050	$ 24,150	$ 10,021
14	$ -	$ -	$ 6,000	$ 6,000	$ 2,000	$ 7,000	$ 2,100	$ 1,050	$ 24,150	$ 9,366
15	$ -	$ -	$ 6,000	$ 6,000	$ 2,000	$ 7,000	$ 2,100	$ 1,050	$ 24,150	$ 8,753
16	$ -	$ -	$ 6,000	$ 6,000	$ 2,000	$ 7,000	$ 2,100	$ 1,050	$ 24,150	$ 8,180
17	$ -	$ -	$ 6,000	$ 6,000	$ 2,000	$ 7,000	$ 2,100	$ 1,050	$ 24,150	$ 7,645
18	$ -	$ -	$ 6,000	$ 6,000	$ 2,000	$ 7,000	$ 2,100	$ 1,050	$ 24,150	$ 7,145
19	$ -	$ -	$ 6,000	$ 6,000	$ 2,000	$ 7,000	$ 2,100	$ 1,050	$ 24,150	$ 6,678
20	$ -	$ -	$ 6,000	$ 6,000	$ 2,000	$ 7,000	$ 2,100	$ 1,050	$ 24,150	$ 6,241
21	$ -	$ -	$ 6,000	$ 6,000	$ 2,000	$ 7,000	$ 2,100	$ 1,050	$ 24,150	$ 5,833
22	$ -	$ -	$ 6,000	$ 6,000	$ 2,000	$ 7,000	$ 2,100	$ 1,050	$ 24,150	$ 5,451
23	$ -	$ -	$ 6,000	$ 6,000	$ 2,000	$ 7,000	$ 2,100	$ 1,050	$ 24,150	$ 5,094
24	$ -	$ -	$ 6,000	$ 6,000	$ 2,000	$ 7,000	$ 2,100	$ 1,050	$ 24,150	$ 4,761
25	$ -	$ -	$ 6,000	$ 6,000	$ 2,000	$ 7,000	$ 2,100	$ 1,050	$ 24,150	$ 4,450
26	$ -	$ -	$ 6,000	$ 6,000	$ 2,000	$ 7,000	$ 2,100	$ 1,050	$ 24,150	$ 4,159
27	$ -	$ -	$ 6,000	$ 6,000	$ 2,000	$ 7,000	$ 2,100	$ 1,050	$ 24,150	$ 3,886
28	$ -	$ -	$ 6,000	$ 6,000	$ 2,000	$ 7,000	$ 2,100	$ 1,050	$ 24,150	$ 3,632
29	$ -	$ -	$ 6,000	$ 6,000	$ 2,000	$ 7,000	$ 2,100	$ 1,050	$ 24,150	$ 3,395
30	$ -	$ -	$ 6,000	$ 6,000	$ 2,000	$ 7,000	$ 2,100	$ 1,050	$ 24,150	$ 3,173
TOTAL	$ 26,000	$ 48,000	$ 180,000	$ 180,000	$ 80,000	$ 210,000	$ 72,400	$ 36,200	$ 832,600	$ 390,642
									Discount Factor	0.469
Total before applied costs						$ 724,000				

PV Discount Rate (i)
0.070

PV = non-discounted cost X 1/((1+i)t)