FINAL

RECLAMATION WORK PLAN

LILLY/ORPHAN BOY MINE SITE
POWELL COUNTY, MONTANA

DEQ CONTRACT NO. 407026
TASK ORDER NO. 33

September 30, 2008

Prepared for:
Montana Department of Environmental Quality
Mine Waste Cleanup Bureau – Abandoned Mines Section

Prepared by:

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LILLY/ORPHAN BOY MINE SITE
POWELL COUNTY, MONTANA

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ACRONYM LIST

amsl	above mean sea level
CECRA	Comprehensive Environmental Cleanup and Responsibility Act
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CY	Cubic yards
DEQ/MWCB	Montana Department of Environmental Quality, Mine Waste Cleanup Bureau
DOE	Department of Energy
EEE/CA	Expanded Engineering Evaluation and Cost Analysis
EPA	U.S. Environmental Protection Agency
FHC	Frontier Historical Consultants
FSP	Field Sampling Plan
ft bgs	Feet below ground surface
GWIC	Groundwater Information Center
HASP	Health and Safety Plan
HMI	Hazardous Materials Inventory
LAP	Laboratory Analytical Plan
MBMG	Montana Bureau of Mines and Geology
MNHP	Montana Natural Heritage Service
MSE	MSE Technology Applications, Inc.
NRHP	National Register of Historic Places
QAPP	Quality Assurance Protocol Plan
RI	Reclamation Investigation
RWP	Reclamation Work Plan
SHPO	State Historic Preservation Office
USCB	U.S. Census Bureau
USDA-NRCS	United States Dept. of Agriculture, Natural Resource Conservation Service
WRCC	Western Region Climate Center
XRF	X-ray fluorescence

1.0 INTRODUCTION

Tetra Tech EM Inc. (Tetra Tech) received Task Order No. 33 from the Montana Department of Environmental Quality, Mine Waste Cleanup Bureau (DEQ/MWCB), under DEQ Contract No. 407026. The purpose of this task order is to complete an initial site inspection, prepare a Phase I Reclamation Work Plan (RWP), collect field and laboratory data as part of a Reclamation Investigation (RI), and prepare a Phase I RI Report for the Lilly/Orphan Boy Mine Site. The Lilly/Orphan Boy Mine was a historical producer of lead, zinc, copper, and some precious metals. The mine resides approximately 15 miles southwest of Helena, Montana in Powell County and is bordered to the west by Telegraph Creek.

1.1 PURPOSE OF RECLAMATION WORK PLAN REPORT

The Lilly/Orphan Boy Mine Site consists of approximately one and a half acres of metal mining impacted lands. Three distinct waste areas and four potentially contaminated media (surface water, soil, sediment, and groundwater) are present at this site. Based on the Abandoned Mine Reclamation Bureau Hazardous Material Inventory (HMI) completed by Pioneer Technical Services on behalf of the Montana Department of Environmental Quality, Mine Waste Cleanup Bureau (DEQ/MWCB 1993), approximately 2,600 cubic yards (CY) of decomposed quartz monzonite waste rock and gangue ore are located within the site boundary, including a waste rock pile spanning Telegraph Creek. A 250-foot shaft and three adits are also present on the site. Water is discharging from the lower adit and flowing into Telegraph Creek. Contaminated sediments were also identified downstream from the mine site.

As part of the HMI, soil, groundwater (water discharging from the adit was classified as groundwater for the HMI), and surface water samples were collected at the Lilly/Orphan Boy Mine Site. Arsenic, iron, lead and zinc were found at levels of potential concern in several of the soil samples analyzed. In addition, the concentration of dissolved arsenic, iron, lead, manganese, and zinc in a groundwater sample collected from the discharging adit (GW-1) was found to be higher than the Montana water quality standards for human health (DEQ 2008). Based on these samples and other considerations, the DEQ/MWCB decided to prepare a RWP to identify the potential environmental impacts associated with the present mine waste and to present a plan for completing a reclamation investigation at the Lilly/Orphan Boy Mine Site. A copy of the HMI report is included in Appendix A.

This RWP has been prepared as a functional guide for conducting a full-scale RI at the Lilly/Orphan Boy Mine Site. The reclamation activities proposed for the project site were developed as part of a comprehensive reclamation procedure (Figure 1-1).

1.2 ORGANIZATION OF INVESTIGATION

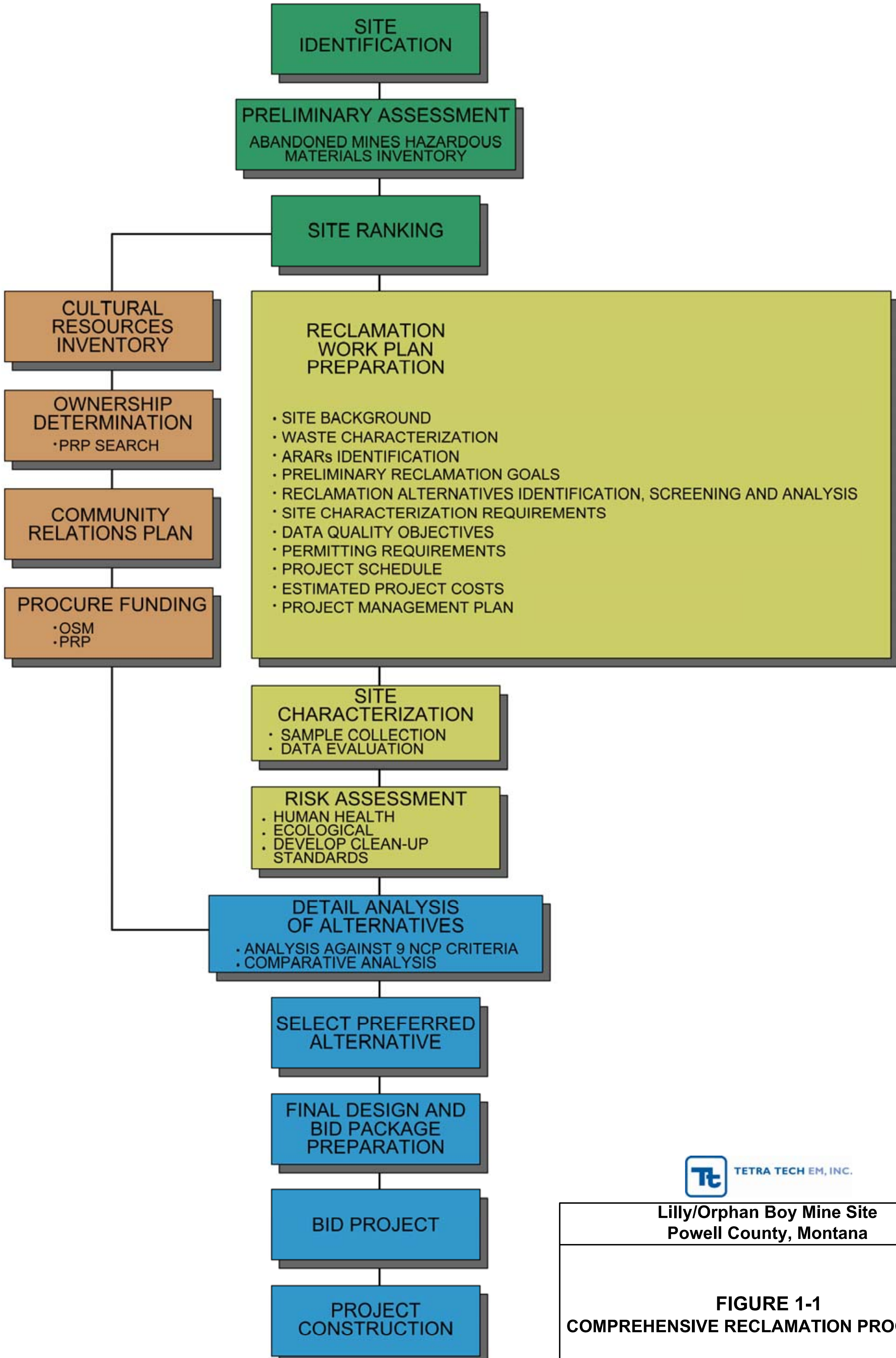
Existing data available for the Lilly/Orphan Boy Mine Site have been evaluated and permission from the owner to access the property has been obtained by DEQ/MWCB. The RWP is organized into four sections and satisfies Task 3 under Task Order No. 33. The references are presented at the end of each section, which document the publications and materials used in the preparation of these sections. The contents of each section are briefly described below.

Section 1.0 Introduction - This section outlines task order requirements and presents the purpose, organization, and management of the Lilly/Orphan Boy Mine Site investigation.

Section 2.0 Environmental Setting - This section describes the location of the Lilly/Orphan Boy Mine Site, including (1) climatic, geologic, and hydrologic characteristics of the site; (2) the biological setting such as the wildlife resources and the vegetation indigenous to the area; and (3) present land uses and local population.

Section 3.0 Description of Property - This section presents a summary of past metal mining activities and the results of any past sampling and characterization at the site. The estimated types, volumes, and contaminant concentrations from existing data are provided. Ownership information and cultural issues are also provided in this section.

Section 4.0 Reclamation Work Plan - This section presents the RWP for the Lilly/Orphan Boy Mine Site, including (1) preliminary reclamation objectives and goals; (2) the field sampling plan (FSP); (3) the quality assurance protocol plan (QAPP); (4) the laboratory analytical plan (LAP); (5) the health and safety plan (HASP); (6) permitting requirements; and (7) estimated RI costs.



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Lilly/Orphan Boy Mine Site
Powell County, Montana

FIGURE 1-1
COMPREHENSIVE RECLAMATION PROCEDURE

Figure 1-1_Comprehensive Relcamation Procedure.dwg - DWH - 09/19/2008

1.3 PROJECT MANAGEMENT

The DEQ/MWCB and Tetra Tech team of professionals working on the investigation and evaluation of the Lilly/Orphan Boy Mine Site is presented in Section 1.3.1. The preliminary schedule for completing tasks and submitting plans and reports is presented in Section 1.3.2.

1.3.1 Project Team

The successful completion of this project requires the continual cooperation between DEQ/MWCB and Tetra Tech personnel. The DEQ/MWCB and Tetra Tech personnel working on this project are presented in Table 1-1.

TABLE 1-1

PROJECT TEAM
LILLY/ORPHAN BOY MINE SITE

<table>
<tr><th>Agency/Firm</th><th>Personnel</th><th>Project Title</th><th>Contact Information</th></tr>
<tr><td rowspan="2">Montana Department of Environmental Quality/Mine Waste Cleanup Bureau</td><td>John Koerth</td><td>Section Supervisor</td><td>841-5026</td></tr>
<tr><td>Pebbles Clark</td><td>Lilly/Orphan Boy Mine Site Project Manager</td><td>841-5028</td></tr>
<tr><td rowspan="8">Tetra Tech EM Inc.</td><td>Jessica Allewalt</td><td>Project Manager
Field Team Leader</td><td rowspan="8">442-5588</td></tr>
<tr><td>Gary Sturm, P.E.</td><td>Project Liaison
Program Manager
Project Engineer</td></tr>
<tr><td>Chris Reynolds</td><td>Quality Assurance Manager
Field Laboratory Supervisor
Field Team Member</td></tr>
<tr><td>Colin McCoy</td><td>Field Team Member</td></tr>
<tr><td>Dan Shaffer</td><td>Field Team Member</td></tr>
<tr><td>Josh Abrahamson</td><td>Field Team Member</td></tr>
<tr><td>Aaron Cade</td><td>Technical Support Team Member</td></tr>
<tr><td>Linda Daehn</td><td>Technical Support Team Member</td></tr>
</table>

The responsibilities of the DEQ/MWCB and Tetra Tech project team members are presented below.

<u>Mine Waste Cleanup Bureau Personnel Responsibilities</u>:

- **Section Supervisor -** The Section Supervisor oversees all DEQ/MWCB activities.
- **Project Manager -** The DEQ/MWCB project manager will monitor the performance of the contractor, review and approve QA measures, and provide direction to the Tetra Tech project liaison, project manager, and field team leader, as well as coordinate all site activities with the property owner.

<u>Tetra Tech EM Inc. Personnel Responsibilities</u>:

Program Manager - The program manager will administer all project activities, staffing, and budgets.

- **Quality Assurance Manager -** The quality assurance manager will review all work products for technical quality and consistency.
- **Project Liaison -** The project liaison will coordinate project activities with the DEQ/MWCB project manager.
- **Project Manager -** The Tetra Tech project manager will oversee project field activities and work products. The project manager/project liaison will keep the field team informed of all project activities.
- **Field Laboratory Supervisor -** The field laboratory supervisor will oversee field analytical activities and will coordinate with the project manager and field team leader to complete the field activities. The field laboratory supervisor will also coordinate data review, validation, and auditing requirements.
- **Field Team Leader -** The field team leader will oversee the field sampling activities and coordinate with the DEQ/MWCB Project Manager schedule all field activities.
- **Field Team Members -** The field team members will assist the field team leader and field laboratory supervisor to complete the field activities.
- **Project Engineer –** The project engineer will have primary responsibility for completing the engineering evaluation and the development and screening of reclamation alternatives during the Expanded Engineering Evaluation and Cost Analysis (EEE/CA) phase.
- **Technical Support Team Members -** The technical support team members will assist the Tetra Tech project manager to complete all work products.

1.3.2 Project Schedule

The preliminary project schedule is presented in Table 1-2. This schedule assumes that the work assignments and agency review proceed in a steady and continuous manner. The effective dates of Task Order No. 33 are September 17, 2008 through March 13, 2009.

TABLE 1-2

PROJECT SCHEDULE
LILLY/ORPHAN BOY MINE SITE

Document Submittal and Task	Date
Draft Reclamation Work Plan	September 19, 2008
Final Reclamation Work Plan	September 30, 2008
Reclamation Field Activities	October 2008
Draft Reclamation Investigation Report	December 1, 2008
Final Reclamation Investigation Report	February 13, 2009

1.4 REFERENCES CITED

Montana Department of Environmental Quality (DEQ). 2008. Montana Numeric Water Quality Standards (Circular DEQ-7). February.

DEQ – Mine Waste Cleanup Bureau (DEQ/MWCB), 1993. Abandoned Hard Rock Mine Priority Site Investigation and Hazardous Materials Inventory and Site Investigation Log Sheet. Lilly/Orphan Boy Mine Site, Powell County, PA 39-006. Completed by Pioneer Technical Services.

2.0 ENVIRONMENTAL SETTING

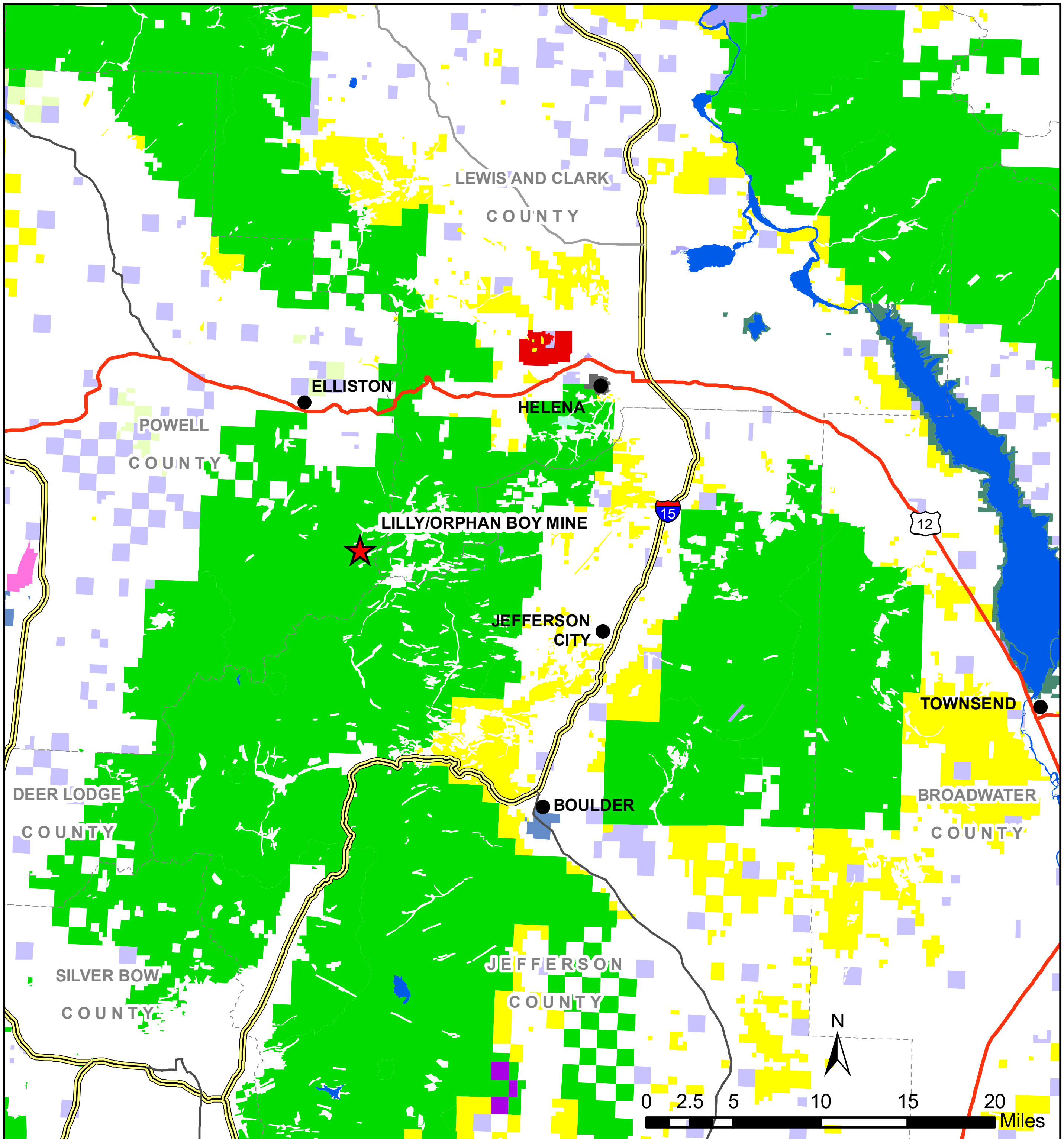
The environmental setting of the Lilly/Orphan Boy Mine Site is provided in the following sections (Section 2.1 through 2.7). The references cited in Section 2.0 are presented in Section 2.8.

2.1 SETTING AND CLIMATE

The Lilly/Orphan Boy Mine Site is located on the western edge of the Elkhorn Mountains, in Powell County, approximately seven miles south of Elliston, Montana (Figure 2-1). The Lilly/Orphan Boy Mine is situated at an elevation of approximately 7,000 feet above mean sea level (amsl) in Section 15, Township 8 North, Range 6 West, Montana principle meridian (Latitude North 46° 26’ 36.5”; Longitude West 112° 20’ 24”). The Lilly/Orphan Boy Mine Site is comprised of approximately one and a half acres of metal mining impacted land along Telegraph Creek. A topographic view of the site is presented in Figure 2-2 and an aerial site map of the project area is provided in Figure 4-1 (see Section 4).

The lower half of the site lies directly in the Telegraph Creek drainage, which flows north to the Little Blackfoot River. The surrounding area consists of relatively steep mountain slopes, moderately sloped hillsides, and rounded boulder terrain. The climate of the Lilly/Orphan Boy Mine Site area is a modified continental climate similar to that of the Helena Valley.

Climate information was obtained from the Western Regional Climate Center (WRCC) located at the Helena, Montana airport. Average monthly temperatures range from a high of 85°F to a low of 53°F in July and a high of 30°F to a low of 10°F in January. Average annual precipitation is 12 inches. Average monthly precipitation exceeds 3 inches during May and June which are the wettest months of the year. Precipitation is mostly in the form of snow in the winter months, snow and rain in the spring and fall, and rain in the summer.



Legend

- ★ Mine Location
- US Bureau of Land Management
- US Forest Service
- State of Montana Lands
- Water

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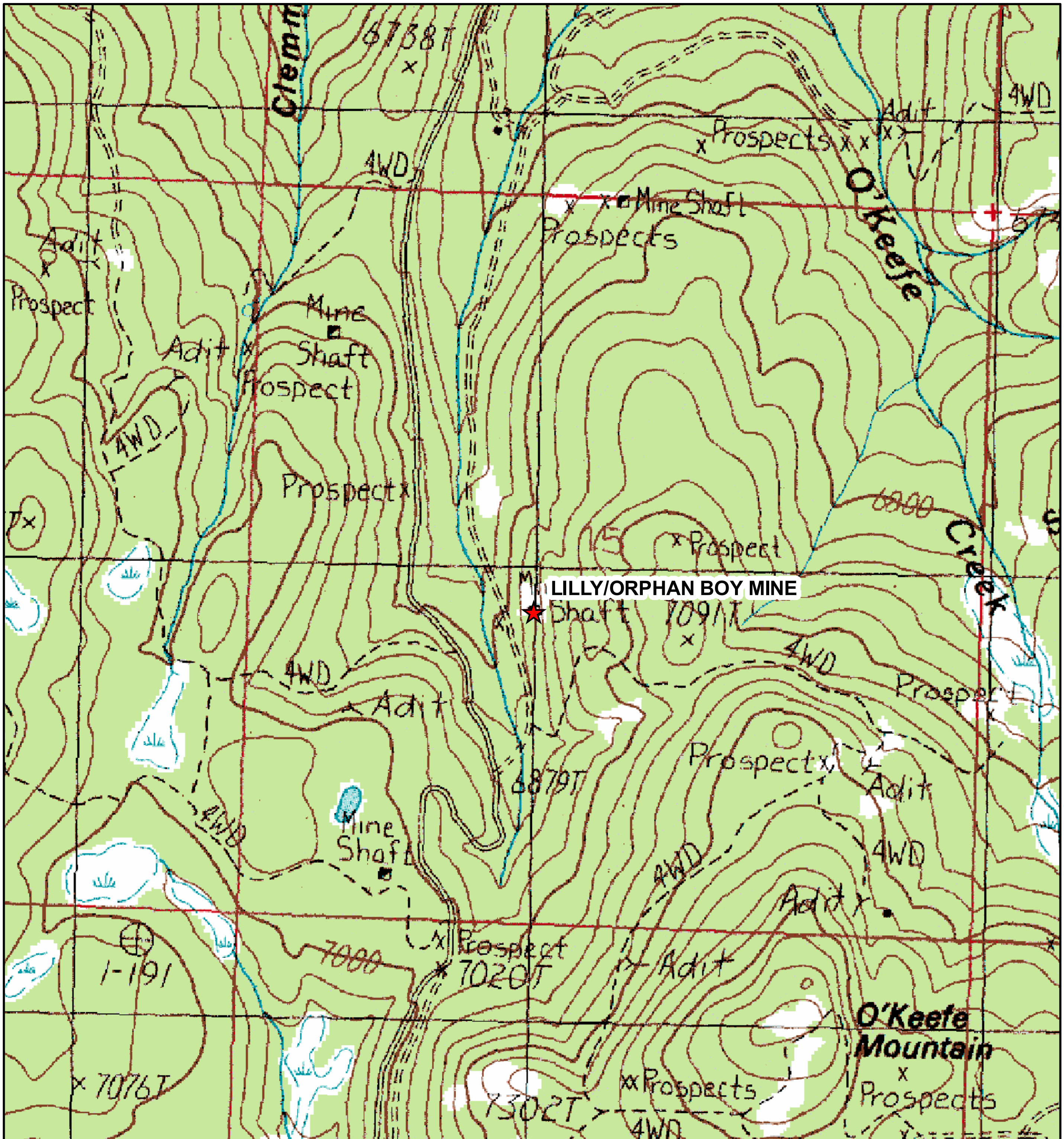
Lilly/Orphan Boy Mine Site
Powell County, Montana

FIGURE 2-1
LILLY/ORPHAN BOY MINE SITE LOCATION

lilly-orphan boy_sitemap_091508.mxd GIS map by Ed Madej - HE_TTEMI



Legend

★ Mine Location

US Forest Service

Water

N

0 — 0.3 Miles

TETRA TECH EM, INC.

Lilly/Orphan Boy Mine Site
Powell County, Montana

FIGURE 2-2
LILLY/ORPHAN BOY MINE SITE TOPOGRAPHIC MAP

2.2 GEOLOGY AND SOILS

The Lilly/Orphan Boy Mine Site is located in the upper drainage of the Little Blackfoot River on the east side of Telegraph Creek. The geology in the area consists of Cretaceous granodiorite and andesite intermixed with younger (Eocene) rhyolitic volcanic rocks (MBMG 1998). The mine exploited east trending high angle veins in intrusive quartz monzonite. The main ore minerals were galena, pyrite, sphalerite, arsenopyrite, and tetrahydrite (Frontier Historical Consultants [FHC] 2002, MSE Technology Applications 2008).

The soil mapped at the Lilly/Orphan Boy Mine Site is a combination of Typic Cryoboralfs and Typic Cryochrepts (USDA-NRCS 2008). Both types of soil are located on 25 to 50 percent slopes in elevations ranging from 5,500 to 7,500 feet amsl. Typic Cryoboralf soils are derived from moraines and glacial till and are typically defined as cobbly loams or cobbly clay loams. Typic Cryochrept soils are derived from granitic mountain slopes or weathered granite and are defined as very gravelly sandy loams (USDA-NRCS 2008). Soils in the immediate vicinity of the headframe and shaft are classified as Typic Cryochrepts.

2.3 HYDROGEOLOGY

The Montana Bureau of Mines and Geology Groundwater Information Center (GWIC) database lists two well logs within a five-mile radius of the Lilly/Orphan Boy Mine Site. One of these wells is a domestic well with a depth of 200 feet and a reported static water level of 40 feet below ground surface (ft bgs). The other is a monitoring well installed by MSE Technology Applications in 1995 for the purpose of monitoring water flowing through the Lilly/Orphan Boy Mine workings. The well has a depth of 25 feet and a reported static water level of 19.5 ft bgs (GWIC 2008). Several other monitoring wells were also drilled during the investigation conducted by MSE Technology Applications on the Lilly/Orphan Boy Mine Site (MSE Technology Applications 2008) that have not yet been incorporated into GWIC.

2.4 HYDROLOGY

The Lilly/Orphan Boy Mine Site is located within the subwatershed of Telegraph Creek, which is contained within the headwaters of the Little Blackfoot River. Telegraph Creek flows north approximately seven miles to its confluence with the Little Blackfoot River. Winter snowmelt and storm water runoff combined with spring and seep flows provide enough water to Telegraph Creek to qualify the creek at the mine site as a perennial stream.

2.5 VEGETATION AND WILDLIFE

The Lilly/Orphan Boy Mine Site is characterized by native and introduced species of vegetation. These include plants growing on undisturbed areas around the site; little or no vegetation is currently growing on the waste rock piles. Dominant trees on site include Lodgepole pine (*Pinus contorta*), Douglas fir (*Pseudotsuga menziesii*), and some Engelmann spruce (*Picea engelmannii*). Shrubs and other vegetative species include grouse whortleberry (*Vaccinium scoparium*), snowberry (*Symphoricarpos* sp.), Phlox (*Phlox* sp.), and several grasses in the meadows areas around Telegraph Creek (MNHP 2008). Other trees, shrubs, and forbs are found across and around the site in lower densities.

The habitat type supports a variety of wildlife – deer, elk, bobcat, black bear, potentially lynx and wolverine, and miscellaneous smaller mammals such as rabbits, squirrels, mice, and voles (MNHP 2008). Many species of birds are found around the site throughout the year including various songbirds, owls, and raptors. Telegraph Creek provides habitat for amphibians, fish, and other aquatic organisms and serves as a water source for other wildlife (MNHP 2008). The DEQ/MWCB project manager for the Lilly/Orphan Boy Mine Site will request data from the Montana Natural Heritage Program (MNHP) on the status and likelihood of endangered species or species of concern present in the vicinity of the site.

2.6 LAND USE AND POPULATION

The Lilly/Orphan Boy Mine Site is located on private land that is encompassed within the Helena National Forest. The primary land use in the vicinity of the site is recreational and residential. There are two houses located within a half-mile radius of the site, which are served by electrical and telephone utilities. The estimated population per square mile within a one-mile radius from the site is less than two people (USCB 2000). Although the Lilly/Orphan Boy Mine Site is located on private property with a fence surrounding the original headframe and main shaft, there are no fences or gates preventing access to the waste rock piles and other remains of the Lilly/Orphan Boy Mine Site.

2.7 REFERENCES CITED

DEQ – Mine Waste Cleanup Bureau (DEQ/MWCB), 1993. Abandoned Hard Rock Mine Priority Site Investigation and Hazardous Materials Inventory and Site Investigation Log Sheet. Lilly/Orphan Boy Mine Site, Powell County, PA 39-006. Completed by Pioneer Technical Services.

Groundwater Information Center (GWIC). 2008. Well Log List in T8N, R6W, Section 15, with a 5-Mile Buffer. Accessed on September 15, 2008 using the Montana Natural Resource Information System (NRIS) website. On-Line Address: http://maps2.nris.state.mt.us

Montana Bureau of Mines and Geology (MBMG). 1998. Geologic map of the Butte 1 x 2 degree quadrangle. Open File Report 363, 16 p. 1:250,000. http://www.mbmg.mtech.edu/

Montana Natural Heritage Program (MNHP). 2008. Montana Field Guide (http://fieldguide.mt.gov/) and TRACKER (http://nhp.nris.mt.gov/Tracker/NHTMap.aspx) web pages. Accessed from MNHP website: http://nhp.nris.mt.gov/). September 17.

MSE Technology Applications, Inc. 2008. Final Report – In Situ Source Control of Acid Generation Using Sulfate-Reducing Bacteria. June.

U.S. Census Bureau (USCB). 2000. 2000 U.S. Census Estimate.

U.S. Department of Agriculture, Natural Resources Conservation Service (USDA-NRCS). 2008. Web Soil Survey. Accessed on September 15, 2008. On-Line Address: http://websoilsurvey.nrcs.usda.gov/app/

Western Regional Climate Center (WRCC). 2008. “Elliston, Montana Period of Record Monthly Climate Summary.” Accessed on September 15, 2008. On-Line Address: http://www.wrcc.dri.edu/summary/lcd.html

Frontier Historical Consultants (FHC). 2002. Cultural Resource Inventory and Assessment for the Lilly/Orphan Boy Mine. November.

3.0 DESCRIPTION OF THE PROPERTY

The Lilly/Orphan Boy Mine Site is comprised of approximately one and a half acres of land that has been impacted by past metal mining. It is a privately-owned patented mining claim. The history of the Lilly/Orphan Boy Mine Site is provided in Section 3.1. Section 3.2 presents a description of the current property, including site waste characteristics and historical features. Section 3.3 presents information about the current owner of the Lilly/Orphan Boy Mine Site. The references cited in Section 3.0 are provided in Section 3.4.

3.1 LILLY/ORPHAN BOY MINE SITE HISTORY

The Lilly and the adjacent Orphan Boy lodes were likely discovered in the early summer of 1890 by a group of four men with the Grand Republic Mining Company. They presumably had the intent to develop the Lilly and Orphan locations along with a few other lode locations on what is now known as O'Keefe Mountain. In 1891 the Lilly was noted in a report by the Montana Inspector of Mines as a mine "held in high estimation" whose ores were treated at a local arrastra during in the year (FHC 2002).

In late 1893 the Lilly/Orphan Boy and other mines owned by the Grand Republic Mining Company were acquired by Empire State Mining Company of New York. Development work at the Lilly/Orphan Boy mines presumably started soon thereafter, but it wasn't until nearly three years later that the Empire State Mining requested and received permission from Montana officials to conduct business in the state (FHC 2002).

In November 1899, the courts ordered the Lilly/Orphan Boy Mine Site property to be sold at public auction to satisfy a mortgage debt held by the Empire State Mining Company. The president of the company, T. H. Teall, obtained ownership of the Lilly/Orphan Boy Mine Site and received a sheriff’s deed in December 1900. Ownership of the mine remained under his name until 1927 when the taxes on the claims became delinquent. Powell County received a tax deed to the property early the following year (FHC 2002).

A rise in the price of metals soon after the onset of the Great Depression rejuvenated active interest in the Lilly/Orphan Boy Mine Site. A new lease was issued by Powell County to a Butte miner named Ed Linquist around 1934. In 1943, Powell County entered into a new lease agreement on the Lilly/Orphan Boy Mine Site with Dave and Leo Newman, who had been mining at other properties in the Telegraph Creek area for the previous several years. It is reported that during the period from 1934 to 1951, the mine produced a total of 1,228 tons of ore, yielding 333 ounces of gold; 12,520 ounces of silver; 2,753 pounds of copper; 85,377 pounds of lead; and 39,899 pounds of zinc (FHC 2002). The last production of ore from the Lilly/Orphan Boy Mine Site was a 50-ton shipment of ore that occurred in either 1954 or 1955 (DEQ Correspondence 2008).

In August of 1994, MSE Technology Applications began an 11-year field demonstration for the U.S. Environmental Protection Agency (EPA) and the U.S. Department of Energy (DOE) at the Lilly/Orphan Boy Mine Site to treat and control the acid rock drainage of metal-contaminated water using sulfate-reducing bacteria. The study was concluded in July of 2005. As part of the technical study, five monitoring wells were installed on the Lilly/Orphan Boy Mine Site. Two angled wells were constructed near the head frame and main shaft, two injection wells were drilled vertically into the main adit, and one "tunnel" well was installed downgradient of the injection wells to monitor treated water prior to its discharge at the end of the adit. Water filling the mine workings (lower shaft and main adit) was presumed groundwater by MSE during their investigation (MSE Technology Applications 2008).

3.2 DESCRIPTION OF THE CURRENT PROPERTY

The Lilly/Orphan Boy Mine Site is on the north slope of O'Keefe Mountain in the Elliston Mining District, Powell County, Montana at an elevation of nearly 7,000 feet in Section 15, Township 8 North, Range 6 West (Figure 2-2). Telegraph Creek flows north through one of the waste rock piles at the Lilly/Orphan Boy Mine Site. The small community of Elliston is about 7 miles upstream, near Telegraph Creek's confluence with the Little Blackfoot River. The shaft, adits, and waste rock piles are confined to the Lilly claim, one of two lode locations that historically comprised the Lilly/Orphan Boy Mine group. Underground workings extend into the adjoining Orphan Boy claim. Recent investigations at the site have found three collapsed adits, a shaft with a headframe, and several waste rock dumps. The site also contains the remains of hoist machinery, two load outs, and four collapsed buildings (RTI 2002).

3.2.1 Waste Characteristics

Pioneer Technical Services, Inc. completed a site inspection and HMI for DEQ/MWCB in 1993 (Appendix A). As part of this inspection and inventory, two composite soil samples, two sediment samples, one groundwater sample and two surface water samples were collected at the Lilly/Orphan Boy Mine Site. The composite soil samples were collected from waste rock piles 1 and 2. The sediment and surface water samples were collected at the same locations; one from upstream of waste rock pile 2 and one from 200 feet downstream of waste rock pile 2. The groundwater sample was taken from collapsed adit 1 (see the site and sampling location map in the HMI report in Appendix A). The soil samples were analyzed by an off-site laboratory for total metals and analyzed in the field using x-ray fluorescence (XRF). The sediment, surface water, and groundwater samples were analyzed for total metals at an off-site laboratory. The results of the metals analyses from the laboratory are presented in Table 3-1. XRF analytical results can be viewed in Table 3-2. Approximately 2,600 cubic yards of waste rock was estimated within the site. The waste rock sample with the highest concentration of metals was WR-2 collected from waste rock pile 2. Contaminants of concern from the sampling include arsenic, iron, manganese, lead, antimony and zinc (DEQ/MWCB 1993).

For the purpose of the RWP and RI activities, three waste rock piles have been identified on the Lilly/Orphan Boy Mine Site. Waste rock pile 1 is situated underneath and around the headframe and main shaft, the farthest upgradient waste rock pile from Telegraph Creek on the east side of the claim. Waste rock pile 2 is located below waste rock pile 1 to the west. Waste rock pile 3 is situated downgradient of other two piles and spans Telegraph Creek.

3.2.2 Significant Historical and Cultural Features

A historic inventory and assessment was conducted by Frontier Historical Consultants (FHC) at the Lilly/Orphan Boy Mine Site in 2002. In order for a site to be assessed as being significant and therefore eligible for inclusion on the National Register of Historic Places it must retain integrity and meet any of the following criteria:

Criteria A: The site was associated with events that have been made a significant contribution to the broad patterns of our history.

Criteria B: The site was associated wit the lives of persons significant in our past.

Criteria C: The site embodied the distinctive characteristics of a type, period, or method of construction, or that represented the work of a master, or that possess high artistic values, or that represented a significant and distinguishable entity whose components may lack individual distinction.

Criteria D: The site has yielded or may be likely to yield information important in prehistory or history.

Based on the assessment, the Lilly/Orphan Boy Mine Site was considered historic and is recommended to be eligible for the National Register of Historic Places (NRHP) under criteria A and C (FHC 2002). The Lilly/Orphan Boy Mine produced enough ore to be a major part of the Elliston Mining District and strongly contributes to the local mining history, which satisfies the requirements of criterion A.

TABLE 3-1

HISTORIC LABORATORY ANALYTICAL RESULTS
LILLY/ORPHAN BOY MINE

Field ID	As	Ba	Cd	Co	Cr	Cu	Fe	Hg	Mn	Ni	Pb	Sb	Zn
Soil Samples	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg
SE-1	4450	283	38.4	118	4.1 U	440	61800	0.106 J	14200	86	550	15 UJ	1200
SE-2	104	62.8	0.5 U	15.5	3.5	11.5	18300	0.018 U	1570	13	65	4 UJ	164
WR-1	13000	43.7	5.9	7	1.9	78.3	29900	0.861 J	1310	9	9720	254 J	612
WR-2	21500	15.1	0.4 U	11.2	1.7	125	71800	0.289 J	43	1 U	9850	164 J	251
Water Samples	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
GW-1	881	14.5	342 J	42.1 JX	5 U	620	19200	0.038 U	5410	32.6	398	36.7	22500
SW-1	20.5	15.7	7.3 J	7.33 JX	7.93	11.7	1900	0.038 U	226	11	4.77	18.3 U	635
SW-2	4.3	8.87	2.55 J	5.99 UX	7	1.57	552	0.042	41.5	8.78 U	1.38	18.3 U	23.4

Notes:

ft	feet
mg/Kg	milligrams per kilogram
ug/L	milligrams per liter
J	Estimated Quantity
U	Not Detected
X	Outlier for Quality or Precision

Mine Name: Lily/Orphan Boy PA# 39-006
XRF Field Analyses
Results in PPM

XRF SAMPLE ID	CrHI	K	Ca	Ti	CrLO	Mn	Fe	Co	Cu	Zn	As	Sr
39-006-WR1-A		13965.4	2287.84	749.519		262.763 *	43657.8		60.5887 *	309.985	17548.5	205.04
39-006-WR1-B		19283.5	4371.29	3148.56		3148.04	34503.7			1428.4	1061.79	169.293
39-006-WR1-C		4350.1	3029.27	542.669		317.798 *	59544		49.351 *	301.823	31702	222.079
39-006-WR1-C-DUP		4909.11	2964.29	559.589			66076.1		75.7018 *	346.775	36868.4	240.65
39-006-WR1-D		23245.9	1831.44	1960.22			51385.6			506.194	8022.5	157.674
39-006-WR2-A		1786.88	1158.7	108.526 *			84451			188.639	61596.3	42.752
39-006-WR2-B		22486.6	1001.7	816.023			25438.7		92.6674 *	339.019	2967.85	193.375
39-006-WR2-C		26976.4	1645.41	1269.5	147.63 *		41965.9			477.161	1309.01	70.8407
39-006-WR-1-COMP		16487.8	2132.91	1089.94		862.873	41898.2			469.532	14305.2	154.523
39-006-WR-2-COMP		19680.2	1419.15	871.15			55601.3		88.5916 *	359.889	27542	123.301

XRF SAMPLE ID	Zr	Hg	Mo	Pb	Rb	Cd	Sb	Ba	Ag	U	Th
39-006-WR1-A	90.5607		5.39493 *	10180.8	63.0951		523.908	103.61	570.199 *		
39-006-WR1-B	148.826		4.35081 *	936.052	149.443			464.034	416.378 *		19.1646 *
39-006-WR1-C	50.6557		7.60684 *	12080.8	22.0543 *		1163.65	29.0721 *	914.871 *		29.7971 *
39-006-WR1-C-DUP	58.4592		6.86486 *	13870.4	28.7668 *		1426.93	45.9585 *	1530.36 *		29.3403 *
39-006-WR1-D	141.613		4.01685 *	2983.11	192.419			377.651			23.6327 *
39-006-WR2-A	28.3761		6.06659 *	4843.66			416.647		876.303 *		
39-006-WR2-B	101.628		3.46234 *	4916.72	101.68		147.938 *	166.402	405.883 *		
39-006-WR2-C	122.019			2637.41	147.316		61.6884 *	175.41			12.9537 *
39-006-WR-1-COMP	87.1029			11248.5	98.4474		461.926	172.433	552.243 *		27.494 *
39-006-WR-2-COMP	100.63			5432.01	105.24		222.337 *	163.683	540.11 *		12.4362 *

* – Estimated Quantity
$ – Unvalidated Data

In, addition, sufficient historic features and structures remain at the Lilly/Orphan Boy Mine Site to satisfy the standards set forth under criteria C. The DEQ/MWCB has acknowledged the historic significance of the Lilly/Orphan Boy Mine Site and will work with the Montana State Historic Preservation Office (SHPO) to provide for historical features should the Lilly/Orphan Boy Mine Site advance to the reclamation stage.

3.3 OWNERSHIP INFORMATION

The current owners of the Lilly/Orphan Boy Mine Site are Lindsey and Jesse Chaquette of Yakima, WA (NRIS 2008).

3.4 REFERENCES CITED

DEQ – Mine Waste Cleanup Bureau (DEQ/MWCB), 1993. Abandoned Hard Rock Mine Priority Site Investigation and Hazardous Materials Inventory and Site Investigation Log Sheet. Lilly/Orphan Boy Mine Site, Powell County, PA 39-006. Completed by Pioneer Technical Services.

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MSE Technology Applications, Inc. 2008. Final Report – In Situ Source Control of Acid Generation Using Sulfate-Reducing Bacteria. June.

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4.0 RECLAMATION WORK PLAN

The Montana DEQ/MWCB has instructed Tetra Tech to prepare a Phase I RWP that includes a field sampling plan (FSP), a quality assurance protocol plan (QAPP), a laboratory analytical plan (LAP), and a health and safety plan (HASP). This RWP has been prepared as a functional guide for conducting full-scale reclamation at the Lilly/Orphan Boy Mine Site. The four supporting plans are presented in Sections 4.2 through 4.5. The references cited in Section 4.0 are presented in Section 4.6.

4.1 PRELIMINARY RECLAMATION OBJECTIVES AND GOALS

The preliminary reclamation objectives and goals for the Lilly/Orphan Boy Mine Site are discussed in the following sections.

4.1.1 Preliminary Reclamation Objectives

The overall objective of the Lilly/Orphan Boy Mine Site reclamation project is to protect human health and the environment. Specifically, site reclamation should limit human and ecological exposure to mineral processing-related contaminants and reduce the mobility of those contaminants through associated solid media, sediment, and surface water exposure pathways. The final reclamation objectives, including the specific amount of contaminant exposure and mobility reduction required, will be determined after site characterization, risk assessment, and analysis of the applicable or relevant and appropriate requirements are completed.

4.1.2 Preliminary Reclamation Goals

Preliminary reclamation goals (PRGs) are contaminant-specific and media-specific numbers that reflect potential cleanup (reclamation) levels at contaminated sites and are established to guide investigation activities and to identify areas and media that may require reclamation. They are based on Federal and/or State water quality standards, soil and sediment screening values, or on risk-based concentration values. The following sections present the PRGs for surface water, groundwater, soil, and sediment for the Lilly/Orphan Boy Mine Site.

Surface Water and Groundwater

PRGs for surface water and groundwater at the Lilly/Orphan Boy Mine Site are based on Montana state water quality standards and include human health standards (HHS) for water, freshwater chronic aquatic life standards (CALS), and maximum contaminant levels (MCL)(DEQ 2008). Surface water on the Lilly/Orphan Boy Mine Site is found in Telegraph Creek, which flows along the western edge of the site. Some surface water has pooled behind the waste rock pile spanning Telegraph Creek in a shallow wetland area. In addition, water discharging from the lower adit flows across the ground to the east of Telegraph Creek. Groundwater is presumed to have filled the underground mine workings of the Lilly/Orphan Boy Mine Site and is discharging from the lower adit.

Metal analyses conducted as part of the HMI in 1993 demonstrated elevated arsenic, iron, lead, and manganese concentrations in a surface water sample (SW-1) collected downstream from the waste rock pile in Telegraph Creek. In addition, a water sample collected from the adit discharge (GW-1) also contained elevated levels of the aforementioned metals, with the addition of zinc (DEQ/MWCB 1993). Arsenic and lead are human health contaminants of concern. The water sampling results from the HMI are presented in Section 3.2.1. Table 4-1 presents the surface water and groundwater PRGs for metals of concern at the Lilly/Orphan Boy Mine Site.

TABLE 4-1

PRELIMINARY RECLAMATION GOALS FOR SURFACE WATER AND GROUNDWATER (µg/L)

Contaminant	CALS [a]	HHS [b]
Arsenic	150	10
Iron	1,000	300 [c]
Lead	0.545 [d]	15
Manganese	None	50
Zinc	37 [d]	2,000

Notes:

[a] CALS - Freshwater Chronic Aquatic Life Standards, Circular DEQ-7, Montana Numeric Water Quality Standards (DEQ 2008)

[b] HHS - Human Health Standards for Water, Circular DEQ-7, Montana Numeric Water Quality Standards (DEQ 2008)

[c] Secondary Maximum Contaminant Level, Circular DEQ-7 Montana Numeric Water Quality

[d] CALS assume water hardness of 25 mg/L for lead and zinc

Soil and Sediment

PRGs for soil (which includes mineral processing wastes) at the Lilly/Orphan Boy Mine Site are based on EPA Region 9 Regional Screening Levels (RSLs) for residential soil (EPA 2008). For sediment, the PRGs are based on freshwater sediment quality values published by the Washington State Department of Ecology derived from the probable apparent effects thresholds (PAET) from bioassay studies in Oregon and Washington State. The EPA RSLs and Washington State Dept. of Ecology values will be used for the Lilly/Orphan Boy Mine Site since there are currently no promulgated standards for metals concentrations in soil or sediment in Montana.

Analysis of soil and sediment collected during the HMI in 1993 revealed concentrations of arsenic, iron, manganese, and lead at levels of potential concern. The previous solid matrix sampling results are presented in Section 3.2.1. Table 4-2 presents the soil and sediment PRGs for metals of concern at the Lilly/Orphan Boy Mine Site.

TABLE 4-2
PRELIMINARY RECLAMATION GOALS FOR SOIL AND SEDIMENTS
(mg/Kg)

Contaminant	EPA RSLs [a]	Washington State Dept. of Ecology Freshwater Sediment Quality PAET Values [b]
Arsenic	0.39 (40) [c]	19
Iron	55,000	None
Lead	400	240
Manganese	1800	1400

Notes:
mg/Kg milligrams per Kilogram
a EPA RSL – Regional Screening Level Table, Residential Soil Values (EPA 2008)
b Probable Apparent Effects Threshold (PAET) Values; (Washington State Dept. of Ecology 1997)
c 0.39 is the arsenic residential soil RSL for the carcinogenic endpoint. The Montana DEQ uses a soil screening value of 40 mg/Kg for arsenic based on background arsenic values for Montana soils (DEQ 2005).

4.2 FIELD SAMPLING PLAN

This field sampling plan (FSP) has been prepared as a guide for conducting the RI of the Lilly/Orphan Boy Mine Site. The FSP presents sampling objectives and procedures, field analytical procedures, sample documentation and custody procedures, sample preservation and handling requirements, and decontamination procedures.

The purpose of the RI is to collect the information necessary to perform the risk assessments, to complete a future Expanded Engineering Evaluation and Cost Analysis (EEE/CA), and to select a reclamation alternative. Once the reclamation alternative has been selected, site- and alternative-specific engineering data may need to be collected to support design efforts. Data collected to support the human health and ecological risk assessments will include:

- the magnitude and extent of soil contamination
- the magnitude and extent of sediment contamination
- the magnitude of surface and groundwater contamination
- metals concentration in background soil

Data collected to support the development and evaluation of reclamation alternatives during the RI and EEE/CA will include:

- accurate estimates of the area and volume of solid waste material requiring reclamation
- data to determine if waste material is classified as a Resource Conservation and Recovery Act (RCRA) hazardous waste
- data to determine reclamation requirements for disturbed areas including soil texture and grain size, liming requirements, fertilizer requirements, percent organic matter, and identification of native species
- location and characterization of potential repository sites
- location of potential cover soil borrow area

4.2.1 Sampling Objectives

Soil, sediment, and water samples will be collected from the Lilly/Orphan Boy Mine Site as part of the RI. Table 4-3 lists the sample type, analysis, approximate number of samples, and number of contingency samples that will be required to fulfill the sampling objectives. Figure 4-1 shows the proposed sampling locations. The sampling objectives for the Lilly/Orphan Boy Mine Site are:

- Determine the nature and extent of soil contamination. Samples will be collected to further define the locations of the contaminated materials that were identified during the site inspection and hazardous materials inventory by DEQ/MWCB in 1993.
- Further define the distribution of metal-contaminated sediments in Telegraph Creek and determine the potential for contaminated sediments behind waste rock pile 3 and around the adit discharge.
- Determine the quality of surface water in Telegraph Creek and in the adit discharge water.
- Collect additional data on metals contamination in groundwater present in the shaft, adit, and related mine workings to determine current concentrations in anticipation of a future investigation to determine whether the discharging adit can be properly sealed off.

4.2.2 Soil Sampling Procedures

<u>Soil</u>

For the purpose of the RQP and RI activities, three waste rock piles have been identified at the Lilly/Orphan Boy Mine Site (see Section 3.2.1 and Figure 4-1). Sample locations will be selected to further characterize the demarcation between the visually observable (contaminated) waste rock materials and the uncontaminated soil located a short distance away from the visual wastes. Sample locations used to characterize the waste materials will be selected based on visible characteristics including soil texture, iron staining, topography, and lack of vegetative cover. Additional sampling locations may be identified during the RI. Twelve solid matrix grab samples will be collected within or near visually identified edges of the three waste rock piles (five samples from waste rock pile 1, four from waste rock pile 2, and three from waste rock pile 3). Up to two additional opportunistic soil grab samples will be collected if necessary.

TABLE 4-3

PROPOSED SOIL, SEDIMENT, SURFACE WATER, AND GROUNDWATER SAMPLES LILLY/ORPHAN BOY MINE SITE

Sample Type	Analysis	Number of Samples	Number of Contingency and Duplicate Samples	Total Number of Samples Per Media Type
Soil (0-3")	TAL Metals	12	3 (2 contingency, 1 duplicate)	-----
	Particle size (texture)	3	0	-----
	CEC	3	0	-----
	Complete Agricultural (pH; conductivity; N-P-K; OM; lime and fertilizer requirement)	3	0	15 Soil
Background Soil (0-3")	TAL Metals	3	0	-----
	Complete Agricultural (pH; conductivity; N-P-K; OM; lime and fertilizer requirement)	1	0	3 Background Soil
Sediment (0-3")	TAL Metals	5	1 [a]	6 Sediment
Surface Water	TAL Metals	3	1	-----
	Water Quality Parameters (pH, conductivity, hardness, chloride, sulfate)	3	1	4 Surface Water
Groundwater	TAL Metals	3	2 (1 contingency, 1 duplicate)	----
	Water Quality Parameters (pH, conductivity, hardness, chloride, sulfate)	3	1	5 Groundwater

Notes:

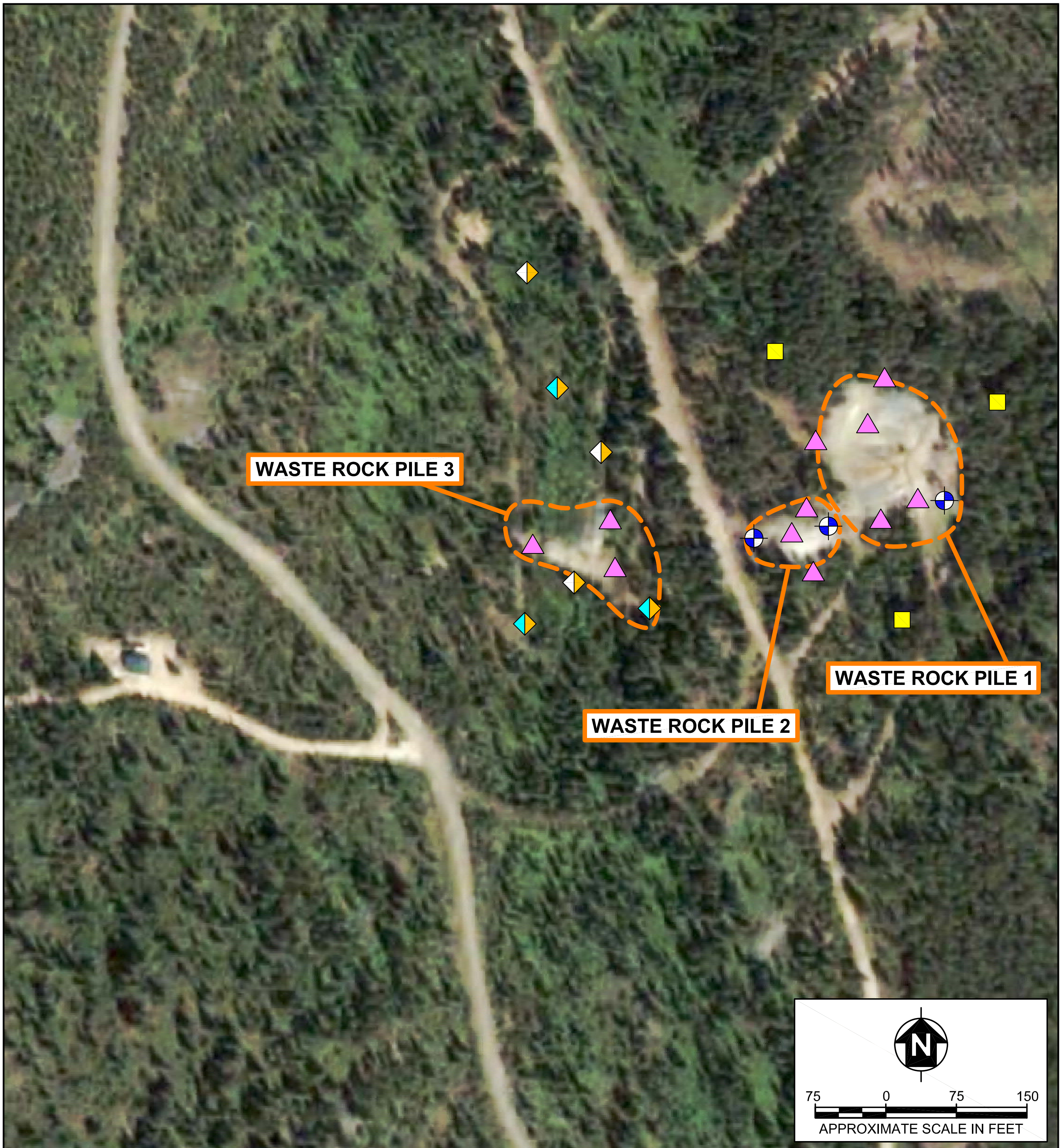
[a] One sediment sample location is dependent upon receiving permission to access the adjacent property.

TAL Target analyte list (antimony, arsenic, barium, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, silver, and zinc)

CEC Cation exchange capacity

N-P-K Nitrogen, phosphorus, potassium

OM Organic matter



LEGEND

- BACKGROUND SAMPLE
- MONITORING WELL
- SURFACE SOIL SAMPLE
- SEDIMENT SAMPLE
- SURFACE WATER / SEDIMENT SAMPLE

TETRA TECH EM, INC.

Lilly/Orphan Boy Mine Site
Powell County, Montana

FIGURE 4-1
PROPOSED SAMPLING LOCATION MAP

Figure 4-1_Proposed Sampling Location Map.dwg - DWH - 09/19/2008

The soil samples will be obtained from a depth between 0 and 3 inches below ground surface (bgs) and will be collected using a trowel. Soil samples will be placed in quart-size or larger Ziploc bags and labeled with sample number, location, time, date, and other required information (see following sections). Samples will be cooled to 4 degrees Celsius (^{o}C) following collection. The soil samples will be analyzed for 13 target analyte list (TAL) metals including: antimony, arsenic, barium, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, silver, and zinc. The samples will be sent to an off-site DEQ approved laboratory for total metals analysis (ICP-AES methods). Selected samples will also be analyzed for particle size (texture), cation exchange capacity (CEC) and complete agricultural (includes pH; conductivity; nitrogen-phosphorus-potassium; organic matter; lime recommendation; and fertilizer recommendation) because of the probability that the soil may be reclaimed in place if the total metals concentrations are below the PRG values.

Table 4-3 lists the approximate number of samples that will be collected to characterize the extent of soil contamination. Figure 4-1 outlines the proposed sampling locations. Soil sampling locations will be staked and marked in the field and will be included in the site topographic survey.

Background Soil Samples

Three soil samples will be collected outside of the mining-impacted area to establish background metals concentrations. All soil samples will be collected from 0 to 3 inches bgs using the same methods used to collect the other soil samples. The background sampling locations will also be staked and marked in the field and included in the site topographic survey.

4.2.3 Sediment Sampling Procedures

The potential environmental/health risks and reclamation alternatives associated with sediment contamination at the Lilly/Orphan Boy Mine Site will be evaluated by collecting grab samples at three additional locations in Telegraph Creek and at three other locations in and around waste rock pile 3 and the adit discharge for a total of six sediment samples. Two of the sediment samples will be collected from the creek bed; one upstream and one downstream from the waste material spanning Telegraph Creek (waste rock pile 3), similar to the locations used in the HMI (DEQ/MWCB 1993, see Appendix A). A third sediment location is proposed further downstream (north) of the Lilly/Orphan Boy Mine Site, but is dependent upon receiving permission to access the land. One sediment sample will be collected from behind waste rock pile 3 (sediment underlying the ponded water behind waste rock pile 3) and the remaining two sediment samples will be collected from areas near the adit discharge.

The sediment grab samples will be collected using a stainless steel trowel to collect sediments to a depth of about 3 inches. Care will be taken to ensure that a sufficient volume of the finer sediment fraction is collected for analysis. All sediment samples will be decanted of excess water and placed in glass jars. The samples will be cooled to 4°C following collection and sent to an offsite DEQ approved laboratory for total metals analysis. The proposed sediment sampling locations are shown on Figure 4-1.

4.2.4 Surface Water Sampling Procedures

The risk to potential receptors will be evaluated using the previous surface water data and the additional RI water quality data. Three surface water samples (two of which will be co-located with sediment sample locations) are proposed to be collected. The third surface water sample will be collected from the adit discharge. Up to one additional opportunistic surface water samples will be collected if necessary. The proposed surface water sampling locations are shown on Figure 4-1.

Surface water samples in Telegraph Creek will be collected by dipping the sample container into the water with the container mouth pointed upstream. Surface water samples will not be filtered. Three separate sample containers will be filled; one for metals analysis, one for nitrate/nitrite analysis, and one for hardness, chloride, and sulfate determinations. Triple rinsing the surface water containers is not necessary since sample bottles received from the laboratory are pre-cleaned. The sample bottle designated for metals analysis will be preserved with nitric acid, the sample bottle designated for nitrate/nitrite will be preserved with sulfuric acid, and the sample bottle for hardness, chloride, and sulfate will not be preserved. All samples will be cooled to 4°C.

4.2.5 Groundwater Sampling Procedures

Three groundwater samples will be collected from the existing monitoring wells on the Lilly/Orphan Boy Mine Site in anticipation of a future investigation to determine whether the discharging adit can be properly sealed off. One sample will be obtained from a well near the headframe and main shaft above waste rock pile 1. Another sample will be collected from one of the injection wells near waste rock pile 2, and a third will be taken from the "tunnel" monitoring well that intersects the main adit downgradient of where MSE injected organic material as part of their investigation (MSE Technology Applications 2008). Up to one additional opportunistic groundwater sample will be collected if necessary.

Prior to sampling the wells, a depth to groundwater will be collected. In addition to providing groundwater elevation information, the depth to groundwater will determine the type of sampling pump that can be used. If the groundwater depth is within the operating limits for a submersible pump, then a pump will be used. If not, a bailer will be used to retrieve groundwater samples. If a pump is used, water will be allowed to run for approximately five minutes before collecting the water sample by directly filling the sample bottle. Water quality parameters such as pH, oxidation-reduction potential (ORP), and specific conductivity will be measured as part of the sampling process (see Section 4.2.6). The groundwater samples will be preserved with nitric acid and submitted to an off-site DEQ approved laboratory for total metals analysis. Three sample bottles will be filled, one for metals analysis, one for nitrate/nitrite analysis, and one for total dissolved solids, hardness, and sulfate analyses in the manner described above for surface water samples.

4.2.6 Field Analytical Procedures

Field analysis will be conducted on water sampling locations within Lilly/Orphan Boy Mine Site. Field measurements will be recorded in the field logbook at each of the proposed co-located sediment and surface water locations and for the groundwater samples. The water quality parameters that will be measured in the field include pH, specific conductance, ORP, and temperature and will be gathered using a field portable meter. The instrument will be calibrated using the manufacturer's recommended procedures. The probes will be inserted into the water and the pH, specific conductance, ORP, and temperature readings will be recorded. Before every sample, a check standard will be measured to verify instrument calibration. Before every second sample, a series of three measurements will be made to check instrument response and precision.

4.2.7 Sample Documentation and Custody

The possession and handling of each sample will be properly documented to promote timely, correct, and complete analysis for all required parameters. To promote sample integrity, each sample will be traceable from the point of collection through analysis and final disposition.

The field records and documentation control measures to be used during sample collection, identification, handling, and shipping include the following:

- Sample labels
- Custody seals
- Field sample data and chain-of-custody record

The Tetra Tech field team leader is responsible for obtaining these items and distributing them to field personnel. All paperwork will be completed using indelible ink.

Sample Designation

A sample numbering scheme has been developed that allows each sample to be uniquely identified and provides a means of tracking the sample from collection through analysis. The numbering scheme indicates the sample type, location, and depth (or interval depth). The unique sample number will be entered on sample labels, field tracking sheets, chain-of-custody forms, and other records documenting sampling activities. The following sample numbering system will be used for this investigation:

X-Y-Z

where:

X = Abbreviated Site Name (i.e. Lilly/Orphan Boy = LOB)

Y = Sample Type (SS = surface soil sample; SD = sediment sample; BG = background soil sample; GW = groundwater sample; and SW = surface water sample)

Z = Sample Location

for example: LOB-SS-06 would be a Lilly/Orphan Boy Mine Site surface soil sample collected from the sixth soil sampling location.

Field Logbook

Daily field activities will be documented through journal entries in a bound field logbook, dedicated to the Lilly/Orphan Boy Mine Site. Logbook entry and custody procedures will follow National Enforcement Investigation Center policies and procedures (EPA 1986). The logbook will be water-resistant, and all entries will be made in indelible ink. The logbook contains all pertinent information about sampling activities, site conditions, field methods used, general observations, and other pertinent technical information. Examples of typical logbook entries include the following:

- Personnel present
- Daily temperature and other climatic conditions
- Field measurements, activities, and observations
- Referenced sampling location description (in relation to a stationary landmark) and map
- Media sampled
- Sample collection methods and equipment
- Date and time of sample collection
- Types of sample containers used
- Sample identification and cross-referencing
- Sample types and preservatives used

- Analytical parameters
- Sampling personnel, distribution, and transporters
- Site sketches
- Instrument calibration procedures and frequency
- Visitors to the site

The Tetra Tech field team leader or designee will be responsible for the daily maintenance of all field records. Each page of the logbook will be numbered, dated, and signed by the person making the entry. Corrections to the logbook will be made by using a single strike mark through the entry to be corrected, then recording and initialing the correct entry. For corrections made at a later date, the date of the correction will be noted.

Color photographs taken during the sampling activities will be numbered to correspond to logbook entries. The name of the photographer, date, time, site location, and photograph description will be entered sequentially in the logbook as photographs are taken.

Chain-Of-Custody Record

A chain-of-custody record establishes the documentation necessary to trace sample possession from time of collection through sample analysis and disposition. A sample is in the custody of a person if any of the following criteria are met:

- The sample is in a person's physical possession.
- The sample is in a person's view after being in his or her physical possession.
- The sample was in a person's physical possession and was then locked up or sealed to prevent tampering.
- The sample is kept in a secured area.

The sample collector will complete a chain-of-custody record to accompany each sample delivery container (cooler) and will be responsible for hand delivering or shipping samples to the laboratory. The sample collector will provide the project number and the sample collector's signature as header information on the chain-of-custody record. For each sample location, the sample collector will indicate the date, time, sample location, number of containers, analytical parameters, and designated sample numbers. When shipping or delivering the samples, the sample collector will sign the bottom of the form and enter the date and time (military) that the samples were relinquished. If shipping the samples, the sample collector will enter the carrier name and air bill number on the form. The original signature copy of the chain-of-custody record will be enclosed in a plastic bag and secured to the inside of the cooler lid. A copy of the chain-of-custody record will be retained for Tetra Tech files and a copy will be included in the Final RI Report.

Sample Shipment

Samples collected at the Lilly/Orphan Boy Mine Site are scheduled for hand-delivery at Energy Laboratories, Inc. in Helena, Montana. If for some reason another laboratory will be used that requires sample shipment, the following process will be used. All samples will be packaged and labeled for shipment in compliance with current regulations. Only metal or plastic ice chests will be used for shipping samples. The samples will be placed in the cooler and padded with bubble wrap to absorb shock. The chain-of-custody form will then be placed in a sealed plastic bag and taped to the inside of the cooler lid. The ice chest will be securely taped shut and the custody seals and shipping airbill will be attached.

4.2.8 Sample Preservation and Handling

The preservation and holding time requirements for the samples and analysis described in Sections 4.2.1 through 4.2.5 are listed in Table 4-4.

4.2.9 Decontamination Procedures

Decontamination will be required for all sampling equipment, personal protective gear, and field monitoring equipment used during field activities. Sampling equipment will be decontaminated between collection of each sample. Liquinox or Alconox cleaning solutions and distilled water rinses will be used for all sampling equipment and tools. Decontamination procedures for specific equipment used in association with field activities are described in the following sections.

Sampling Equipment

All non-disposable sampling equipment will be decontaminated before and after use. Disposable equipment will have gross contamination removed and then will be placed in a garbage bag and disposed of in the municipal trash. Sampling equipment may include shovels, sediment sampler, and hand trowels. Laboratory-supplied sample containers are provided pre-cleaned and will not require decontamination.

TABLE 4-4

SAMPLE COLLECTION, PRESERVATION, AND HOLDING TIME REQUIREMENTS
LILLY/ORPHAN BOY MINE SITE

Matrix	Analyte	Preservation	Holding Time	Sample Size	Bottle
Soil	EPA 6010 TAL Metals[a]	Cool to 4°C	180 days; Hg 28 days	4 oz.	4-ounce glass jar or quart size Ziploc bag
Soil	Particle Size[a]	None	None	4 oz.	4-ounce glass jar or quart size Ziploc bag
Soil	Cation Exchange Capacity[a]	None	None	4 oz.	4-ounce glass jar or quart size Ziploc bag
Soil	Complete agricultural (pH; conductivity; N-P-K; OM; lime and fertilizer requirement) [a]	Cool to 4°C	None	4 oz.	4-ounce glass jar or quart size Ziploc bag
Sediment	EPA 6010 TAL Metals	Cool to 4°C	180 days; Hg 28 days	4 oz.	4-ounce glass jar
Water	EPA 6010 TAL Metals	Cool to 4°C, HNO_3 to pH <2	180 days; Hg 28 days	250 ml	250-ml polyethylene
Water	Total Dissolved Solids[b]	Cool to 4°C	7 days	500 ml	500-ml polyethylene
Water	Hardness[b]		28 days		
Water	Alkalinity/Acidity[b]		7 days		
Water	Sulfate[b]		28 days		
Water	Chloride[b]		28 days		
Water	Nitrate/Nitrite	Cool to 4°C H_2SO_4 to pH < 2	28 days	250 ml	250-ml polyethylene

Notes:

[a] Analytes can be analyzed from the same 4-ounce sample bottle
[b] Analytes can be analyzed from the same 1-liter sample bottle

TAL Target analyte list
H_2SO_4 Sulfuric acid
°C Degree Celsius
oz. ounces
HNO_3 Nitric acid
EPA Environmental Protection Agency
ml milliliters

In general, the following procedures will be used for sampling equipment decontamination:

- Scrub the sampling equipment in a bucket using a stiff brush and Liquinox or Alconox solution with potable water.
- Triple-rinse the sampling equipment with potable water.
- Final rinse the sampling equipment with distilled water and allow to air dry in a clean dust-controlled area.
- Store the equipment in clean plastic bags until the next sampling event.

4.3 QUALITY ASSURANCE PROTOCOL PLAN

This quality assurance protocol plan (QAPP) has been prepared to support the RWP and FSP and describes the quality assurance (QA) for the RI of the Lilly/Orphan Boy Mine Site. This QAPP presents the data quality objectives (DQOs); quality assurance (QA) objectives; QA sample collection procedures; sample documentation and custody; equipment operation, maintenance, and calibration; analytical procedures; data reduction, validation, and reporting; and corrective action procedures. A copy of this QAPP will be provided to the project laboratory for compliance.

4.3.1 Data Quality

DQOs are qualitative and quantitative statements that specify the quality of the data required to support the RI activities. The data quality objectives for the project and the type, analytical level, and use of the data are presented below.

Data Quality Objectives

DQOs were prepared using EPA guidance for the data quality objectives process (EPA 2006). The EPA guidance (2006) presents the DQOs as a seven-step process:

Step 1 - State the Problem. Concisely describe the problem to be studied.

Step 2 - Identify the Decision. Identify what questions the study will attempt to resolve and what actions may result.

Step 3 - Identify the Inputs to the Decision. Identify the information that needs to be obtained and the measurements that need to be taken to resolve the decision statement.

Step 4 - Define the Study Boundaries. Specify the time periods and spatial area to which the decisions will apply.

Step 5 - Develop a Decision Rule. Define the statistical parameter of interest, specify the action level, and integrate the previous DQO outputs into a single statement that describes the logical basis for choosing among alternative actions.

Step 6 - Specify Tolerable Limits on Decision Errors. Define the decision maker's tolerable decision error rates based on a consideration of the consequences of making an incorrect decision.

Step 7 - Optimize the Design. Evaluate information from the previous steps and generate alternative data collection designs.

The following paragraphs describe each step, as listed above, and how it pertains to the investigation of the Lilly/Orphan Boy Mine Site.

Step 1: Stating the Problem

The Lilly/Orphan Boy Mine is an abandoned mine site located southeast of Elliston, Montana. Mine waste rock residing at this site contains elevated concentrations of arsenic, iron, lead, and manganese. A previous HMI (Appendix A) at the site shows that the waste rock poses a risk to surface water, groundwater, soil, and sediment receptors, as well as human recreational users. The objective for the project is to protect human health and the environment.

Step 2: Identify the Decision

Previous data and inspections of the site revealed waste rock and sediment samples with elevated levels of arsenic, iron, manganese, and lead. These materials may cause adverse impacts to human health and the environment. The following decisions will be made: What reclamation action is necessary at the site to protect human health and the environment? What is the areal extent and volume of waste rock and metal contaminated soil and sediment? How will the characteristics of the mine waste rock and underlying soil impact revegetation of the site? How will the physiography of the site affect reclamation alternatives? Are there suitable repository sites and soil borrow areas near the site?

Step 3: Identify the Inputs to the Decision

The areal extent of waste rock and metal contaminated soil and sediments, and the characteristics of soil underlying the wastes will be determined by analyzing soil, sediment, surface water, and groundwater samples for metals and reclamation parameters. The volume of wastes and the physiography of the site will be determined by completing a survey of site topography and site features.

Step 4: Define the Study Boundaries

The disturbed area at the Lilly/Orphan Boy Mine Site covers approximately one and a half acres in the NE1/4 of the SW1/4 of Section 15, Township 8 North, Range 6 West, in Powell County, Montana.

Step 5: Develop a Decision Rule

The potential receptors at the site include recreational users, terrestrial wildlife, vegetation, and aquatic life. Reclamation of the site will be necessary if levels of contaminants in soil samples exceed the PRGs and pose unacceptable risks to human health and the environment. Reclamation may include, but is not limited to, mine waste removal and reclamation-in-place actions.

Step 6: Specify Tolerable Limits on Decision Errors

In general, environmental data may be strongly indicative of site conditions, but data are not absolutely definitive; therefore, decisions based upon the data could be in error. This is known as the decision error. This section discusses the limits on decision errors for this investigation.

Sampling error and measurement error are associated with environmental data collection and may lead to decision error. Sampling error occurs because it is impossible for a sampling effort to measure conditions at every point of a site or at every point in time. Sampling error occurs when the sample is not representative of the true state of the environment at a site. Measurement error occurs because of random and systematic errors associated with sample collection, handling, preparation, analysis, data reduction, and data handling. The two types of errors may lead to incorrect decisions or recommendations. In general, decision errors are controlled by adopting a scientific approach that uses hypothesis testing to minimize the potential for decision errors. EPA guidance (2006) suggests the following steps to identify and control decision errors:

- Define the possible range of the parameter of interest,
- Define both types of decision errors and the consequences of each, and
- Specify a range of parameter values for which the consequences of decision errors are relatively minor.

Decision errors are evaluated through hypothesis testing. The reclamation may result in members of the public coming into contact with site wastes. Therefore, the null hypothesis for recreational use is that the site waste contains concentrations of contaminants above the risk-based recreation cleanup levels. The site may also have terrestrial wildlife, vegetation, and aquatic life that are exposed to site wastes and contaminated sediments and surface water runoff. Therefore, the null hypothesis for vegetation, terrestrial wildlife, and aquatic receptors is that site wastes materials, sediments, and surface water runoff are contaminated.

There are two types of decision errors:

> **False Negative Error.** A false negative decision error occurs when the hypothesis is rejected although it is true. In the case of this project, the decision-maker would determine that the site does not contain mineral processing wastes, soil, surface water, sediment, or groundwater that require additional reclamation although concentration levels do require additional reclamation. The consequences of a false negative error would be that contaminated soil and groundwater are left in place instead of being reclaimed.
>
> **False Positive Error.** A false positive decision error occurs when the hypothesis is not rejected although it is false. In the case of this project, the decision-maker would determine that the site contains mineral processing wastes, soil, surface water, sediment, and groundwater that require reclamation (based on the results of the analytical data), although the concentrations of contaminants in the wastes, soil, surface water, sediment, or groundwater do not require reclamation. The consequences of a false positive error would be that unnecessary resources may be spent to perform additional reclamation to address contamination that does not exist at levels exceeding action levels or acceptable risk levels.

Limits on decision errors due to sampling error will be minimized by using the analytical results from the site inspection and HMI (DEQ/MWCB 1993), other previously collected and reported data from the site (MSE Technology Applications 2008), and visual observations to identify contaminated areas. The sampling approach will be to collect enough data to define the areal and vertical extent of contamination.

Step 7: Optimize the Design

The collection of soil samples should be adequate to accept or reject the null hypothesis for recreational exposure. Visual examination of the site together with incorporation of previous site analytical data will be used to bias the collection of samples. The analytical results will be used to locate and characterize the extent of contamination, risk assessment, and reclamation design.

The collection of surface water, groundwater, and sediment samples should be sufficient to accept or reject the null hypothesis for exposure of aquatic organisms.

Data Type, Analytical Level, and Use

Table 4-5 presents data quality objectives, including data analysis or measurement, location of that measurement, analytical method, analytical support level, sample media, and the data use.

The analytical support levels are the analytical options available to support data collection activities. There are five general levels that are distinguished by the types of technology, documentation use, and degree of sophistication, which are:

- Level V - Nonstandard methods. Analyses that may require method modification and development.
- Level IV - This level is characterized by rigorous QA protocols and documentation and provides qualitative and quantitative analytical data. The documentation includes all information required to complete the full data validation as defined in the National Functional Guidelines for Inorganic Data Review.
- Level III - This level is used primarily in support of engineering studies using standard EPA-approved procedures. Some procedures may be equivalent to Level IV analysis without the requirements for documentation.
- Level II - Field analysis. This level is characterized by the use of portable analytical instruments on site or in mobile laboratories stationed near the site. Examples of field screening instruments include portable X-ray fluorescence spectrometers, gas-chromatographs, and water quality meters.
- Level I - Field screening. This level is characterized by the use of portable instruments that can provide real-time data to assist in optimizing sampling point locations and for health and safety support. Examples of Level I analysis include photoionization detector (PID), explosive atmosphere, and oxygen content measurements.

Analytical levels to be implemented during the Lilly/Orphan Boy Mine Site activities are Levels II and III, unless directed by DEQ/MWCB to perform Level IV.

TABLE 4-5

SUMMARY OF DATA QUALITY OBJECTIVES
LILLY/ORPHAN BOY MINE SITE

Analysis	Location	Analysis Method	Analytical Support Level	Media	Data Use
TAL Metals	Laboratory	EPA 6010B	IV	SS, SW, GW	SC, RA, EA, ED
Particle Size	Laboratory	ASA15-5	III	SS	SC
Cation Exchange Capacity	Laboratory	EPA 6010B	III	SS	SC
Complete and Partial Agricultural Analysis	Laboratory	ASA and USDA	III	SS	SC
Hardness	Laboratory	A2340 B	III	SW, GW	SC, RA, EA, ED
Sulfate	Laboratory	EPA 300.0	III	SW, GW	SC, RA, EA, ED
Chloride	Laboratory	EPA 300.0	III	SW, GW	SC, RA, EA, ED
Specific Conductivity, Temperature	Field	Manufacturer's Instructions	II	SW, GW	SC
pH, ORP, Dissolved Oxygen	Field	Manufacturer's Instructions	II	SW, GW	SC

Notes:

ASA	American Society of Agronomy (ASA 1996)
EA	Evaluation of Alternatives
ED	Engineering Design
EPA	Environmental Protection Agency
GW	Groundwater
RA	Risk Assessment
SC	Site Characterization
SS	Soil or sediment
SW	Surface water
TAL	Target analyte list includes: Ag, As, Ba, Cd, Cr, Cu, Fe, Hg, Mn, Ni, Pb, Sb, and Zn
USDA	U.S. Department of Agriculture

4.3.2 Quality Assurance Objectives

The overall QA objective for the Lilly/Orphan Boy Mine Site is to produce well-documented data of known quality. Meeting this objective involves establishing and meeting goals for precision, accuracy, completeness, representativeness, comparability, and target reporting limits for the analytical methods. The Tetra Tech QA manager for the Lilly/Orphan Boy Mine Site project will be responsible for communicating QA objectives and expectations with the project laboratory and working with the DEQ/MWCB project manager to meet designated QA standards.

If analytical data fail to meet the QA objectives described in this section, Tetra Tech will explain in the RI report why the data failed to meet the objectives (for example, because of matrix interferences), and will describe the limitations and usability of the data. The following corrective actions may be taken for data that do not meet QA objectives: (1) verify that the analytical measurement system was in control, (2) thoroughly check all calculations, (3) use data qualifiers, and (4) assuming a sufficient quantity of sample is available, reanalyze the affected samples, if authorized by the Montana DEQ Lilly/Orphan Boy Mine Site project manager. Corrective actions for internal QA and quality control (QC) are presented in detail in Section 4.3.7.

The data precision, accuracy, and completeness requirements are listed in Table 4-6 and Table 4-7 lists the target reporting limits (TRL) for all analytes of concern by each analytical method. The quantitative and qualitative QA objectives are presented below.

Quantitative QA Objectives

Quantitative QA objectives that will be evaluated for the laboratory data include completeness, accuracy, precision, and method detection limits. The following sections discuss the calculation of each QA objective.

TABLE 4-6

PRECISION, ACCURACY, AND COMPLETENESS REQUIREMENTS
LILLY/ORPHAN BOY MINE SITE

Analyte	Matrix	Precision	Accuracy	Completeness
Metals	Soil Sediment	<35% RPD between homogenized sample aliquots	Calibration, LCS to CLP data validation functional guideline criteria Matrix Spike Recovery 75% to 125%	90%
	Water	<20% RPD between duplicate samples	Calibration, LCS to CLP data validation functional guideline criteria Matrix Spike Recovery 75% to 125%	90%
Particle Size	Soil	<35% RPD between homogenized sample aliquots	Method-specified calibration	90%
Cation Exchange Capacity	Soil	<35% RPD between homogenized sample aliquots	Method-specified calibration	90%
Hardness	Water	<20% RPD between duplicate samples	Method-specified calibration	90%
Sulfate	Water	<20% RPD between duplicate samples	Method-specified calibration	90%
Chloride	Water	<20% RPD between duplicate samples	Method-specified calibration	90%
Field Parameters	Water	<10% RPD between replicate measurements	Method-specified calibration	90%

Notes:

CLP Contract Laboratory Program
LCS Laboratory check sample
MS Matrix spike
MSD Matrix spike duplicate
RPD Relative percent difference
% Percent
< Less than

TABLE 4-7

TARGET REPORTING LIMITS FOR SOIL, SEDIMENT, AND WATER METAL ANALYSIS LILLY/ORPHAN BOY MINE SITE

Analyte Type	Method	Analyte	Reporting Limit Soil (mg/Kg)	Reporting Limit Water (µg/L)
TAL Metals	EPA 6010B, 6010.20, SW7471, 200.2, and 245.1,	Antimony	5	5
		Arsenic	5	5
		Barium	5	100
		Cadmium	1	1
		Chromium	5	10
		Copper	5	10
		Iron	5	30
		Lead	5	10
		Manganese	5	10
		Mercury	0.5	1
		Nickel	5	10
		Silver	5	5
		Zinc	5	10

Notes:

µg/L	Micrograms per liter
mg/kg	Milligrams per kilogram
TAL	Target analyte list
EPA	Environmental Protection Agency

Precision and Accuracy

Precision and accuracy are indicators of data quality. Generally, precision is a measure of the variability of a group of measurements compared to their mean value. Laboratory analytical precision is estimated by calculating the relative percent difference (RPD) between the analytical results from the matrix spike (MS) and matrix spike duplicate (MSD) samples for low-level samples and laboratory duplicate samples for high-level samples.

The RPD between the analyte levels measured in the MS and MSD sample (or sample duplicates) will be calculated using the following equation.

$$RPD = \frac{|MS - MSD|}{0.5\ (MS + MSD)} \ x\ 100\%$$

Where:

RPD = Relative percent difference
MS = Matrix spike
MSD = Matrix spike duplicate

Accuracy is a measure of the bias in a measurement system. Sampling accuracy is assessed by analyzing field and equipment blanks. The blanks are used to determine if the ambient air, sample containers, or sample preservatives are contaminating the sample. Analytical accuracy for laboratory data is assessed by evaluating matrix spike sample percent recovery, instrument calibration data, and laboratory control sample results.

Accuracy will be estimated by calculating the percent recovery of laboratory MS samples using the following equation.

$$\%R = \frac{(C_j - C_o)}{C_t} \ x\ 100\%$$

Where:

%R = Percent recovery
C_j = Measured concentration in spiked sample aliquot
C_o = Measured concentration in unspiked sample aliquot
C_t = Actual concentration of spike added

Precision and accuracy goals depend on the types of samples and analysis to be performed and the ultimate use of the analytical data. The project laboratory is responsible for calculating precision and accuracy for the Lilly/Orphan Boy Mine Site samples. These values will be reviewed by the Tetra Tech QA manager to determine if the values are within the specified project data quality objectives.

Completeness

Completeness is defined as an assessment of the amount of valid analytical data obtained from a measurement system compared to the amount of analytical data needed to achieve a particular statistical level of confidence. The percent completeness is calculated by dividing the number of samples with acceptable data by the total number of samples planned to be collected, and multiplying the result by 100. For this project, the QA objective for degree of completeness for the laboratory is 90 percent. If completeness is less than 90 percent, Tetra Tech will provide documentation explaining why this objective was not met, and the impact, if any, of a lower percentage on the project. Completeness will be reported as the percentage of all measurements judged valid. The following equation will be used to determine completeness:

$$\%C = (V/T) \times 100\%$$

Where:

%C	=	Percent completeness
V	=	Number of measurements judged valid
T	=	Total number of measurements

The completeness target for this project is 90 percent.

Target Reporting Limits

The target reporting limits (TRL) for soil and water metals analyses are listed in Table 4-7. The TRL is defined as the lowest concentration that needs to be reported for undiluted samples to obtain project objectives. The laboratory will try to achieve the lowest reporting limits possible for all measurements and will notify the Tetra Tech QA manager if the detection limits for the samples exceed the TRLs. If samples are diluted to qualify constituents present at high concentration levels or to reduce matrix interferences, the reporting limit will be calculated as the reporting limit for the particular matrix multiplied by the dilution factor. The actual matrix reporting limits for each sample will vary depending on the concentration of analytes present and the presence of any interference.

Qualitative QA Objectives

Qualitative QA objectives that will be evaluated include sample representativeness and comparability. The following sections present an analysis of the representativeness and comparability for each matrix to be sampled.

Representativeness

Representativeness is the degree to which sample data represent characteristics of a population, variation at a sample point, or an environmental condition. Sampling locations will be selected to obtain representative soil and groundwater samples. Representative data will also be obtained through the proper collection and handling of samples. The QA objective is to obtain a statistically adequate number of samples that represent the various process matrices at the time samples are collected.

Comparability

Comparability expresses the confidence with which one data set can be compared to another. Comparability will be maximized by using standard EPA methods and standard sampling techniques. Tetra Tech will document all sample locations, conditions, and field sampling methods. All results will be reported in standard units or, for field parameters, as defined in the method. All laboratory calibrations will be performed with standards traceable to the National Institute for Standards and Technology or to EPA-approved sources.

4.3.3 QA Sample Collection Procedures

Various types of QA/QC samples will be collected during the field investigation activities: MS, MSD, and laboratory sample duplicates.

MS, MSD, and Duplicate Samples

The RI field team will collect one MS and MSD sample, as well as one duplicate sample of each media type (water and solid matrix) from the Lilly/Orphan Boy Mine Site to be analyzed for metals. Soil samples do not require the collection of additional sample volume for MS and MSD analysis. For water samples requiring MS and MSD analyses, three times the amount of sample required for routine analysis will be collected. In the laboratory, two (for MS and MSD) aliquots of this sample will be spiked to allow determination of percent recoveries and RPD for the MS compounds.

4.3.4 Sample Documentation and Custody

The possession and handling of each sample will be properly documented to promote timely, correct, and complete analysis for all required parameters. To promote sample integrity, each sample will be traceable from the point of collection through analysis and final disposition. Sample documentation and custody procedures are presented in Section 4.2.7.

4.3.5 Equipment Operation, Maintenance, Calibration, and Standardization

The procedures and frequency for field instrument operation, initial and continuing calibration verification, and maintenance requirements are described in the analytical methods or instrument manufacturer's calibration procedures. Calibration data will be recorded in the field logbook as will the source and method of preparation of the standard solutions used. Tetra Tech will calibrate all field analytical equipment before it is shipped to the field, and daily, before and after use. All calibration standards will be prepared from commercially available (Supelco or equivalent) NIST, EPA-traceable, or EPA-certified standards. The laboratory instrument operation, calibration, and maintenance procedures are described in the analytical method.

4.3.6 Analytical Procedures

The field and laboratory analytical methods that will be used are listed in Table 4-5. Laboratory analysis of samples collected during the RI will be completed by Energy Laboratories Inc. (ELI) in Helena, Montana. ELI has established QA protocols that meet or exceed EPA guidelines. EPA methods will be used whenever they are available for the target analyte.

4.3.7 Data Reduction, Validation, and Reporting

Procedures must be used to ensure that all laboratory data generated and processed are scientifically valid, defensible, and comparable. The following sections describe the data reduction, validation, and reporting procedures that will be used in this RI. This information will be provided with ELI to ensure data quality objectives are met.

Data Reduction

In accordance with standard document control procedures, ELI will maintain on file the original copies of all data sheets and logbooks containing raw data, signed and dated by the responsible analyst. Separate instrument logs will also be maintained by the laboratory to enable a reconstruction of the run sequences for individual instruments.

The laboratory will store all residual samples until disposal is authorized by the Montana DEQ. For the first 60 days after the laboratory receives the samples, samples and sample extracts will be stored in a refrigerator at 4°C. After that time, they may be stored at room temperature.

Data Validation

Tetra Tech and the laboratory will validate all laboratory data by comparing the QC data to the criteria listed in the analytical method or in the National Functional Guidelines for Inorganic Data Review (EPA 1994). Analytical outlier data are defined as QC data lying outside a specific QA objective range for precision or accuracy for a given analytical method. If QC data are outside control limits, corrective action procedures will be applied to determine the probable causes of the problem. If necessary, the sample will be reanalyzed, and only the reanalyzed results reported. If the problem is with the matrix, both initial and reanalyzed results will be reported and identified in the laboratory report. If reanalysis is not feasible, the initial analysis results will be reported and the results will be flagged and identified in the laboratory report.

The laboratory project manager and QA coordinator will be responsible for laboratory data validation. The Tetra Tech project manager and Tetra Tech QA manager will be responsible for post-laboratory data validation of all data generated by the laboratory. The soil, sediment, and water metal data will be validated using the procedures described in National Functional Guidelines for Inorganic Data Review (EPA 1994).

Reporting

A flow chart depicting the overall data handling and reporting scheme is given in Figure 4-2. Data will be reported in standard units as described in the analytical methods.

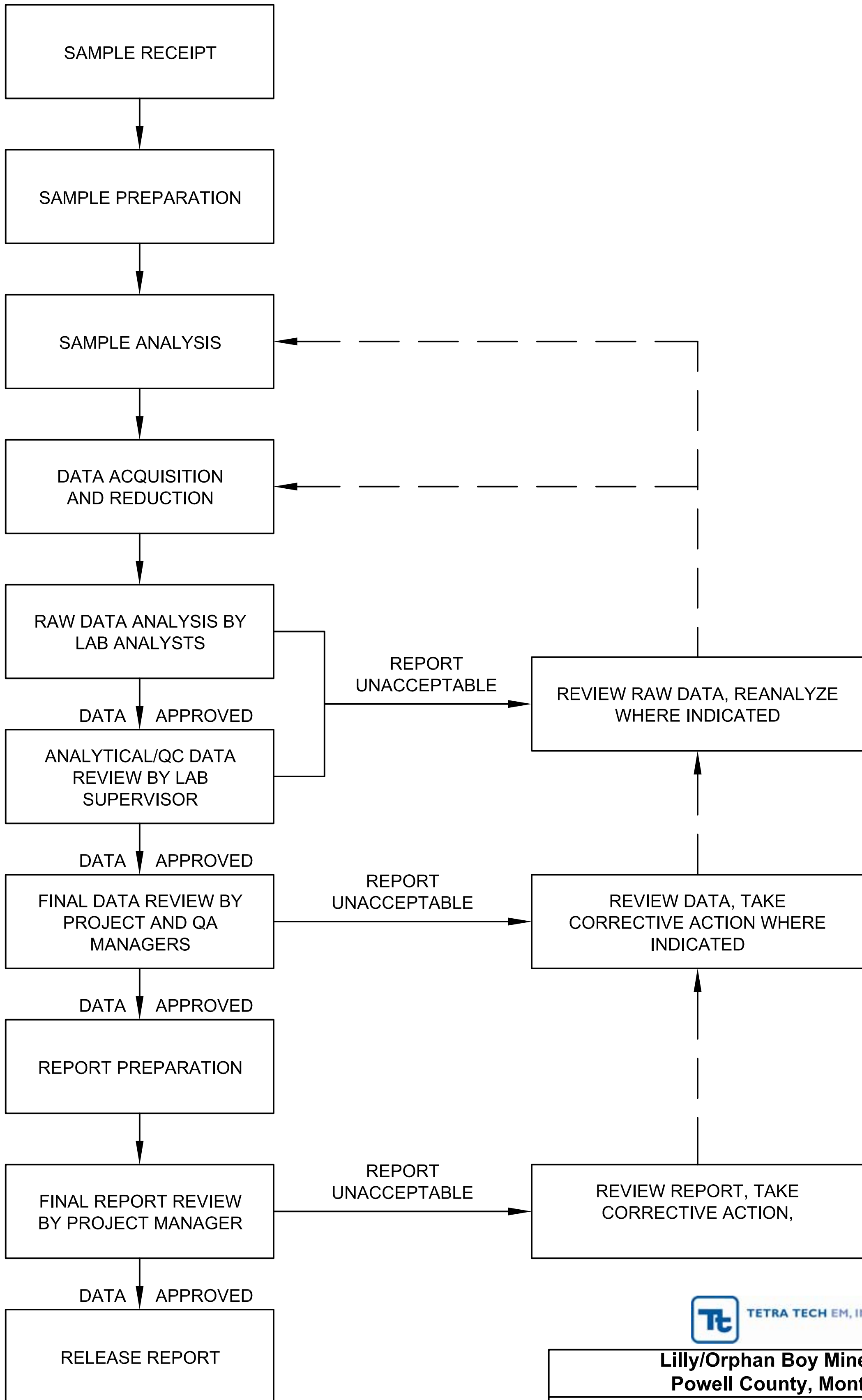
The laboratory project manager will be responsible for reviewing the laboratory report. The completed laboratory report will be approved by the laboratory project manager. The laboratory will provide all raw data necessary to fully validate the data. Each data package will include the following items:

- Case narrative including a statement of samples received, description of any deviation from standard procedures, explanation of any data qualifiers used, and any problems encountered during analysis
- A QC summary report including applicable surrogate recoveries, MS and MSD, recoveries, method blank results, and laboratory control sample recoveries. This report must identify all QC outliers and describe their impact on data quality and useability
- Chain-of-custody records
- Reporting limits
- Analytical instrument run logs
- Analytical instrument raw data for samples, blanks, and standards
- Initial calibration information
- Continuing calibration information
- Laboratory accuracy and precision limits
- All values below reporting limits and above method detection limits
- Date of analysis

The final report will contain a QA/QC summary that discusses whether the final data meet the original project QA objectives. If the QA objectives are not met, the report will contain an explanation of the impact on the evaluation of the project objectives.

4.3.8 Corrective Action Procedures

Corrective actions will be taken when any problems are identified in the program that affects product quality. The laboratory project manager and the Tetra Tech QA manager, or their designees, are responsible for identifying the causes of the problems and developing a solution.



TETRA TECH EM, INC.

Lilly/Orphan Boy Mine Site
Powell County, Montana

FIGURE 4-2
DATA REDUCTION, VALIDATION, AND REPORTING SCHEME

The cause of the problem must first be determined so that the effect of the problem on the overall program can be identified. The field team (and if necessary, the DEQ/MWCB project manager) will then develop a plausible corrective action. The effects of the action will be examined to determine whether the problem is addressed.

If the corrective action is initially successful, the laboratory project manager, or designee, will prepare a corrective action memorandum describing the corrective action, how and when it will be implemented, and the expected results. A copy of the memorandum will be sent to the Tetra Tech project manager and QA manager and then to the DEQ/MWCB project manager. The laboratory project manager, or designee, will be responsible for implementing the corrective action and assessing its effectiveness. Procedures are presented below for correcting (1) problems detected during audits, (2) laboratory problems, and (3) data outside control limits.

Laboratory Corrective Actions

The laboratory QA manager will review laboratory procedures to identify conditions or procedures that may have an adverse impact on data quality. The QA manager will then assess the impact on the quality of the associated data, and then identify the corrective actions to be implemented. All conditions or procedures that may have an adverse impact on data quality will be included in the laboratory reports.

Data Outside Control Limits

The manner in which data outside of control limits are handled will depend on where the nonconformance is discovered. During data review in the laboratory, if QC checks fail to meet acceptance criteria, either the data will be flagged in accordance with standard EPA-defined data flags, or the nonconformance will be discussed in the case narrative. During the post-laboratory data validation, the data will be reviewed and assigned to one of the following three categories:

1. **Valid-unqualified** - This category is used for all data that meet all QC criteria without any qualifier. These data are useful for any purpose, and are not flagged.
2. **Valid-qualified** - Data placed in this category are valid, but their usefulness may be limited in certain situations. These data may be qualified as "estimated," which is indicated by use of a "J" flag, or by the use of a specific flag that conveys information about the limitations of the data.
3. **Invalid or Rejected** - Data are considered to be invalid in cases such as failure to properly ice samples that require storage at 4°C during shipment. These data are flagged with an "R" and are considered to be unusable for any purpose.

Data will be validated using EPA guidance documents and the specific requirements of this QAPP. If certain data appear to be borderline between two categories, the data validator may seek the advice of the individuals cited in Section 1.3.1 as having a QA function.

4.4 LABORATORY ANALYTICAL PLAN

This LAP describes laboratory requirements for conducting the RI at the Lilly/Orphan Boy Mine Site. Analysis of the solid matrix samples (soils and sediments), surface water, and groundwater samples will be conducted during the RI. All analytical work is to follow the requirements listed in this LAP for the duration of the project. This LAP contains four sections including sample collection requirements, laboratory requirements, quality assurance requirements, and analytical methods.

4.4.1 Sample Collection Requirements

Samples will be collected from soils, sediments, surface water, and groundwater at the Lilly/Orphan Boy Mine Site. The number and type of samples are specified in Table 4-3 (Section 4.2.1).

The matrix, analyte, required preservation, holding time, sample size, and containers to be used during the Lilly/Orphan Boy Mine Site RI are specified in Table 4-5 (Section 4.2.8 of the FSP). Whenever possible, standard EPA protocols will be used.

4.4.2 Laboratory Requirements

The primary laboratory will be contracted by Montana DEQ for all total metals, particle size (texture), CEC, and agricultural analyses. The primary laboratory may use a separate laboratory for certain physical and chemical analyses. All analyses performed by the project laboratories should follow the analytical methods listed in Table 4-5, which includes the applicable reference for each method.

Qualifications and Experience

The laboratory shall designate and use key personnel meeting the minimum requirements, as specified below, and comply with all terms and conditions of the contract. Experience is defined as more than 50 percent of the person's productive work time in active participation on a given task and includes the following:

1. The Inductively Coupled Plasma (ICP) emission spectroscopist responsible for work under this contract must have at least one year of experience in the operation of the ICP on soil and water samples.
2. The Furnace Atomic Absorption (AA) spectroscopist responsible for the work on this contract must have at least one year of experience in the operation of a furnace AA on soil and water.
3. The Hydride Generation AA and Cold Vapor AA (CVAA) spectroscopist responsible for work on this contract must have specific training in hydride applications and at least one year of experience in the operation of hydride AA and CVAA.
4. The inorganic sample preparation expert performing sample preparation for this contract must have at least three months of experience in the preparation of environmental samples for ICP and AA analysis.
5. The analyst or technician responsible for determining soil pH on the contract must have at least six months of experience in the technique and instrumentation.
6. The sample custodian, who is responsible for receiving, logging, and tracking the samples for the laboratory must have at least three months experience. This requirement is necessary because of the large number of samples and complexity of the project.

The laboratory shall have in place an acceptable QA plan. The plan shall designate key QA individuals by name and shall define their responsibilities. The plan shall detail the mechanisms for checking whether laboratory procedures are within control, and shall detail the corrective actions and responsibilities for out-of-control conditions.

Subcontracting

Subcontracting portions of this work by the primary laboratory is acceptable for special analysis, but subcontracting must be approved by the DEQ/MWCB Lilly/Orphan Boy Mine Site project manager, Ms. Pebbles Clark. All laboratories in this project must abide by the LAP and the QAPP.

Confidentiality

Analytical results are to be held in the strictest of confidence and will be discussed with only those individuals approved by the DEQ/MWCB Lilly/Orphan Boy Mine Site project manager, Ms. Pebbles Clark.

Reporting Times

Analytical results are to be reported within 30 working days of sample receipt by the laboratory. If at all possible, holding, analysis, and reporting times should be minimized.

Reporting Format

The data report package for the target analyte list (TAL) metals will not initially include a standard EPA Contract Laboratory Program (CLP) package, but the laboratory must save all the run data on magnetic media in order to generate a CLP package on request for a period of two years following completion of the analysis. The laboratory should obtain written permission from the Montana DEQ/MWCB prior to disposing of any archived data support packages.

The data support package provided as a deliverable should include the following:

1. Cover letter documenting analytical protocols used.
2. Copies of completed chain-of-custody forms.
3. Cross-reference table of contractor and laboratory identification numbers.
4. Data summary tables (hard copy and electronic media in format to be negotiated between Tetra Tech and the laboratory.
5. QA/QC summaries including laboratory control samples (LCS), spikes, duplicates, and preparation blank results.

The physical parameters and other specialized chemical analyses, such as particle size, cation exchange capacity (CEC), and fertilizer and lime requirements, should comply with the above five components, when applicable.

Report Transmittal

All data reports are to be sent directly to DEQ/MWCB, P.O. Box 200901, Helena, Montana 59620, in care of Ms. Pebbles Clark and to Tetra Tech, Power Block Building, 7 West 6th Avenue, Suite 612, Helena, Montana 59601, in care of Ms. Jessica Allewalt.

4.4.3 Quality Assurance Requirements

The mechanism used to monitor the precision and accuracy of environmental data is the analysis of field and laboratory QC samples. The required field QC types and frequency are provided in the QAPP. The required laboratory QC requirements are specified in this LAP when the CLP statement of work (SOW) for inorganics (EPA 1992), or the analytical method does not define the QC requirement. Laboratory QC includes method blanks, duplicates, matrix spikes, and LCS. These QC requirements are to be performed at a frequency of 1 per 20 samples except for particle size analysis, components of the lime requirement, and CEC. The CEC will only have duplicates performed. The ranges for precision (duplicates) and accuracy (matrix spikes) acceptability are presented in the QAPP. The method blank should have a reported value within the method detection limit of the instrument detection limit.

4.4.4 Analytical Methods

Analytical methods are summarized in Table 4-5 with the appropriate reference document(s). The project laboratories should contact Ms. Pebbles Clark or Ms. Jessica Allewalt for permission to deviate from the listed analytical methods for the project analyses.

Detection Limits

The instrumentation used must be sensitive enough to meet the required detection limits. Instruments for target analyte analyses are ICP, AA, and CVAA. The detection limits for the parameters presented in Tables 4-4 (Section 4.2.8) and 4-5 are included in the analytic reference methods.

Storage Requirements

The contracted laboratory is required to have a secured sample bank for storage of samples, digestates, and extracts. Original samples will be stored in the sample bank for a standard six month interval. All other forms of the sample to be analyzed will be stored in this area for the standard six month interval after analysis or to the end of the analyte holding time, which ever comes first. This will provide the Montana DEQ and Tetra Tech ample time to review data and request reanalysis if necessary. At the end of six months time, the laboratory will be responsible for sample disposal.

Chain-Of-Custody

A sample is physical evidence collected from a facility or from the environment. An essential part of hazardous waste investigations is that samples and data may be used as evidence in legal proceedings. Laboratories performing analyses will use document control and chain-of-custody procedures as specified in Exhibit F for the CLP SOW for inorganics (EPA 1992).

Sample Stream

In accordance with EPA procedures, field QC samples (i.e. duplicates) will be treated in the same manner as the natural samples. This provides external QC checks of laboratory data.

4.5 HEALTH AND SAFETY PLAN

The health and safety plan for RI activities at the Lilly/Orphan Boy Mine Site is attached as an Appendix to this RWP (Appendix B).

4.6 PERMITTING REQUIREMENTS

Permits will not be required in order to complete the RI or to conduct the site survey. Federal and state permits maybe required to complete reclamation activities in and around Telegraph Creek. These requirements will be determined as part of the RI and will be presented in the Final RI Report.

4.7 PROJECTED RECLAMATION INVESTIGATION COSTS

The costs associated with completing the RI consist of preparing the RWP, site surveying and mapping; field sampling, analyzing field samples, and generating a RI Report. Tetra Tech personnel will complete all tasks with the exception of the analysis of field samples, which will be conducted by ELI in Helena, Montana. The projected costs for both Tetra Tech and ELI are presented in Table 4-8 below.

Costs provided in Table 4-8 for Tetra Tech include both direct and indirect costs and project administration fees, but does not include profit. This is the approximate value that was included in the original cost estimate provided to DEQ/MWCB with Task Order 33. Laboratory costs will be direct-billed to DEQ/MWCB by ELI. A general cost estimate from ELI for samples submitted as part of the RI is provided in Appendix C. The estimate is based on 15 soil samples (12 site soils plus 3 background soil samples), 6 sediment samples, 3 surface water samples, and 3 groundwater samples analyzed in accordance to Table 4-3. It does not include the price for analyzing contingency and duplicate samples. In total, the projected RI costs would be approximately $33,214.

TABLE 4-8

PROJECTED RECLAMATION INVESTIGATION COSTS
LILLY/ORPHAN BOY MINE SITE

Contractor	Task Description	Cost
Tetra Tech	Prepare Reclamation Work Plan	$6,851
	Conduct Site Survey and Mapping	$2,552
	Conduct On Site Reclamation Investigation	$5,122
	Prepare Reclamation Investigation Report	$13,640
	Subtotal	*$28,165*
Energy Laboratory Inc.	Analyze Field Samples Collected During RI	$5,049
	Total	**$33,214**

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APPENDIX A

1993 HAZARDOUS MATERIALS INVENTORY REPORT

APPENDIX B

HEALTH AND SAFETY PLAN (HASP)

APPENDIX C

LABORATORY COST ESTIMATE