

FINAL

**Phase II - Reclamation Work Plan
Lilly/Orphan Boy Mine
Powell County, Montana**

Prepared for:

Montana Department of Environmental Quality

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September 24, 2010

Table of Contents

Section 1.0 INTRODUCTION	1
1.1 Purpose of the Phase II Reclamation Work Plan	1
1.2 Organization of Phase II Reclamation Work Plan	2
1.3 Project Team	3
1.4 Project Schedule	4
Section 2.0 ENVIRONMENTAL SETTING	5
2.1 Setting and Climate	5
2.2 Geology and Soils	5
2.3 Hydrogeology	6
2.4 Hydrology	6
2.5 Vegetation and Wildlife	6
2.6 Land Use and Population	7
Section 3.0 DESCRIPTION OF THE PROPERTY	10
3.1 Lilly/Orphan Boy Mine Site History	10
3.2 Description of the Current Property	11
3.2.1 Waste Characteristics	11
3.2.2 Significant Historical and Cultural Features	11
3.3 Ownership Information	12
Section 4.0 WORK PLAN COMPONENTS	13
4.1 Hydrogeology Investigation Plan	13
4.2 Mine Investigation Plan	14
4.2.1 Proposed Components	16
4.2.2 Surface Activities	20
4.2.2.1 Platforms in the Shaft	20
4.2.2.2 Mine dewatering	21
4.2.2.3 Monitoring Wells and Piezometers	21
4.2.3 Underground Activities	21
4.2.4 Project Sequence of Operations	22
4.2.5 Roles and responsibilities:	24
4.3 Projected Reclamation Investigation Costs	26
Section 5.0 REFERENCES CITED	28

List of Figures

Figure 1.	Site Location Map.....	8
Figure 2.	Existing Topographic Site Map	9
Figure 3.	1950 Mine Workings Map	15
Figure 4.	Site Layout Plan.....	18
Figure 5.	Site Layout Plan with Land Application System.....	19

List of Tables

Table 1.	Project Team	3
Table 2.	Project Schedule.....	4
Table 3.	Selected Phase II Reclamation Investigation Costs	27

Appendices

Appendix A	SAP/QAPP	A
Appendix B	HASP	B
Appendix C	Crane Subcontractor Cost Estimates	C
Appendix D	Driller Subcontractor Cost Estimates	D
Appendix E	Rain for Rent Cost Estimate	E
Appendix F	Mining Subcontractor Cost Estimate	F
Appendix G	Analytical Laboratory Cost Estimates.....	G
Appendix H	Subcontractor Cost Estimates.....	H
Appendix I	Technical Memorandums	I

Acronyms and Abbreviations

amsl	above mean sea level
ARD	acid rock drainage
DEQ	Montana Department of Environmental Quality
DOE	US Department of Energy
EEE/CA	Expanded Engineering Evaluation and Cost Analysis
EPA	US Environmental Protection Agency
GPS	global positioning system
HASP	Health and Safety Plan
lbs/cf	pounds per cubic foot
LOB	Lilly/Orphan Boy
MWCB	Mine Waste Cleanup Bureau
QAPP	Quality Assurance Project Plan
QC	quality control
RI	Reclamation Investigation
RWP	Reclamation Investigation Work Plan
SAP	Sampling and Analysis Plan
TerraGraphics	TerraGraphics Environmental Engineering, Inc.
Tetra Tech	Tetra Tech EM, Inc.
USGS	United States Geological Survey

Section 1.0 INTRODUCTION

TerraGraphics Environmental Engineering, Inc. (TerraGraphics) received Task Order No. 12 from the Montana Department of Environmental Quality, Mine Waste Cleanup Bureau (DEQ/MWCB), under DEQ Contract No. 407041. Under Task Order 12, TerraGraphics prepared a memorandum, dated February 9, 2010 which reviewed the Lilly/Orphan Boy Reclamation Investigation (RI) Report by Tetra Tech EM, Inc, dated March 2009. The TerraGraphics memorandum identified data gaps in the Tetra Tech EM, Inc. RI and identified additional investigation necessary to support the preparation of the Expanded Engineering Evaluation and Cost Analysis (EEE/CA). Task Order 12 was subsequently modified (Modification C) to prepare a Phase II Reclamation Work Plan (Phase II RWP) to support additional field investigation and the preparation of a Phase II RI and ultimately the preparation of an EEE/CA for the Lilly/Orphan Boy Mine (PAD #39-006) located in Powell County, Montana.

This Phase II RWP also includes the Hydrogeology Investigation Plan, prepared as a stand alone document, for the installation of wells and monitoring of groundwater and the Mine Investigation Plan for the analysis of the mine workings. A Sampling and Analysis Plan / Quality Assurance Control Plan (SAP/QAPP) and a Health and Safety Plan (HASP) have also been prepared as separate stand-alone documents. The SAP/QAPP addresses soil and water sampling that will occur and sampling protocols to be performed during the field investigation activities. A copy of the SAP/QAPP is included in Appendix A and a copy of the HASP is included in Appendix B.

The Lilly/Orphan Boy Mine was a historical producer of lead, zinc, copper, silver, and gold. The Lilly/Orphan Boy Mine is located approximately 10.5 miles south of Elliston, Montana near the headwaters of Telegraph Creek (Figure 1). The Lilly/Orphan Boy Mine Site is an abandoned hard rock mine located within the Elliston Mining District listed on the DEQ/MWCB priorities sites. The mine is situated at an elevation of approximately 6,800 feet above mean sea level (amsl) and is composed of approximately 1½ acres of land contaminated by metal mining along Telegraph Creek. Characteristics of the site include a second generation wooden headframe, a steel support frame constructed by MSE for their sulfate reducing bacteria research at the site from 1994 to 2005, a 250-foot deep shaft; three collapsed adits; and three waste rock piles.

1.1 Purpose of the Phase II Reclamation Work Plan

The purposes of the investigative efforts included in this Work Plan are to conduct field work and collect data to:

- Characterize the spatial extent of tailings and waste rock material;
- Characterize surface water and mine water;
- Characterize the mine workings to support a detailed evaluation of discharge source control alternatives by performing the following:

- Verify the validity of the 1950 mine map to establish the physical layout of the mine where possible;
- Locate and describe obstructions in the mine workings;
- Map the geology (sulfide and non-sulfide zones), general rock stability, and rock quality in the adit and shaft on the mine map;
- Perform a hydrologic analysis of and description of the mine workings and native material around the mine;
- Location and estimate flow rate of water infiltrating into the mine workings; and
- Estimate the effect of reclamation on the groundwater system at the mine area.

Other activities that will be addressed in the Phase II RI Report, but not anticipated to be performed as part of the field work, include the following:

- Identify potential borrow sources for cover and topsoil; and
- Identify potential repository sites.

These potential sources for cover and topsoil and repository sites shall be characterized by land ownership and estimated area available and estimated distance from the subject site. These other activities shall be performed through a GIS review of readily available aerial photographs, USGS topographic quadrangles, and land ownership within a 10-mile radius of the site.

1.2 Organization of Phase II Reclamation Work Plan

The existing Reclamation Investigation and historic data available for the Lilly/Orphan Boy Mine Site have been reviewed and a summarized in a Memorandum to DEQ from TerraGraphics, dated February 9, 2010. The Phase II RWP is organized into four sections and satisfies Task 2 and 4 under Task Order No. 12, Modification C. 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 Phase II RWP for the Lilly/Orphan Boy Mine Site, including (1) preliminary reclamation objectives and goals; (2) the Hydrogeology Investigation Plan; (3) the Mine Investigation Plan; and (4) estimated RI costs.

1.3 Project Team

The successful completion of this project requires the continual cooperation between DEQ/MWCB and TerraGraphics personnel. The DEQ/MWCB and TerraGraphics personnel working on this project are shown in Table 1.

Table 1. Project Team

Agency/Firm	Personnel	Project Title	Contact Information
Montana Department of Environmental Quality/Mine Waste Cleanup Bureau	John Koerth	Section Supervisor	841-5026
	Pebbles Clark	Lilly/Orphan Boy Mine Site Project Manager	841-5028
TerraGraphics Environmental Engineering	Tom Bourque	Project Manager	441-5441
	Tom Smith	Project Lead	
	Susan Firor	Quality Assurance Manager	
	Jeremy Mickey	Field Manager	
	Jamie Mongoven	Technical Support Team Member	
	Matt Culpo	Technical Support Team Member	

The responsibilities of the TerraGraphics project team members are presented below.

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

Project Lead - The TerraGraphics project lead will oversee project field activities and work products. The project lead will keep the field team informed of all project activities. The project lead will also perform the in-mine mapping activities with the field manager.

Quality Assurance Manager - The quality assurance manager will review all work products for technical quality and consistency.

Field Manager - The field manager will oversee field analytical activities, field sampling activities, coordinate data review, validation, and auditing requirements and coordinate the Project Manager to schedule and complete all field activities. The field manager will also perform the in-mine hydrogeology activities with the project lead.

Technical Support Team Members - The technical support team members will assist the TerraGraphics project manager to complete all work products.

1.4 Project Schedule

The preliminary project schedule is presented in Table 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. 12, Modification C are March 26, 2010 through December 31, 2010.

Table 2. Project Schedule

Document Submittal and Task	Anticipated Dates
Draft Reclamation Work Plan	August 20, 2010
Final Reclamation Work Plan	September 8, 2010
Phase II Reclamation Investigation Field Work	October 2010
Draft Phase II Reclamation Investigation Report	November 2010
Final Phase II Reclamation Investigation Report	December 2010

Section 2.0 ENVIRONMENTAL SETTING

The environmental setting section and subsections of the Lilly/Orphan Boy Mine Site are provided below and were generally copied from the Final Reclamation Work Plan for the Lilly/Orphan Boy Mine Site, Powell County, Montana (Tetra Tech 2008). Some details were modified since more information about the site has become available since 2008. The environmental setting of the Lilly/Orphan Boy Mine Site is provided in the following sections (Section 2.1 through 2.6).

2.1 Setting and Climate

The Lilly/Orphan Boy Mine Site is located on the western edge of the Boulder Mountains, in Powell County, approximately seven miles south of Elliston, Montana (Figure 1). The Lilly/Orphan Boy Mine is situated at an elevation of approximately 6,800 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 (Figure 2). According to the Newman family, the last miners to operate at the site, the Lilly/Orphan Boy are not connected mines but are actually two separate mines. The Lilly mine is situated on the Lilly claim (the subject site) and the Orphan Boy mine is situated on the adjacent Orphan Boy claim. In the mid-1900s, as the mines were being inspected for purchase, mine inspectors grouped the two mines together as the Lilly/Orphan Boy mine and the name has remained.

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.

2.2 Geology and Soils

The geology in the area of the Lilly/Orphan Boy Mine Site 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, LOB-3, installed by MSE Technology Applications in 1995 for the purpose of monitoring water flowing through the Lilly tunnel. At a depth of approximately 17 ft bgs, the top of the Lilly tunnel was encountered. The floor of the tunnel was measured at a depth of approximately 26 ft bgs and no obstructions were observed. 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 sub-watershed 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

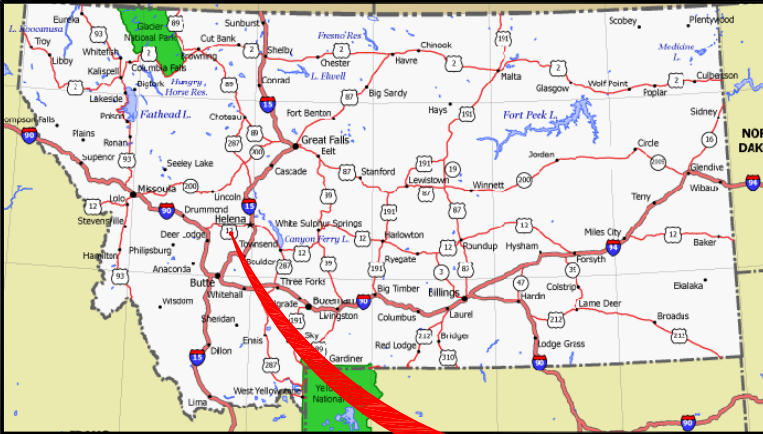
The Lilly/Orphan Boy Mine Site is characterized by native and introduced species of vegetation. These include plants growing on undisturbed areas around the site; little or no vegetation is currently growing on the waste rock piles. Dominant trees on site include Lodgepole pine (*Pinus contorta*), Douglas 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.

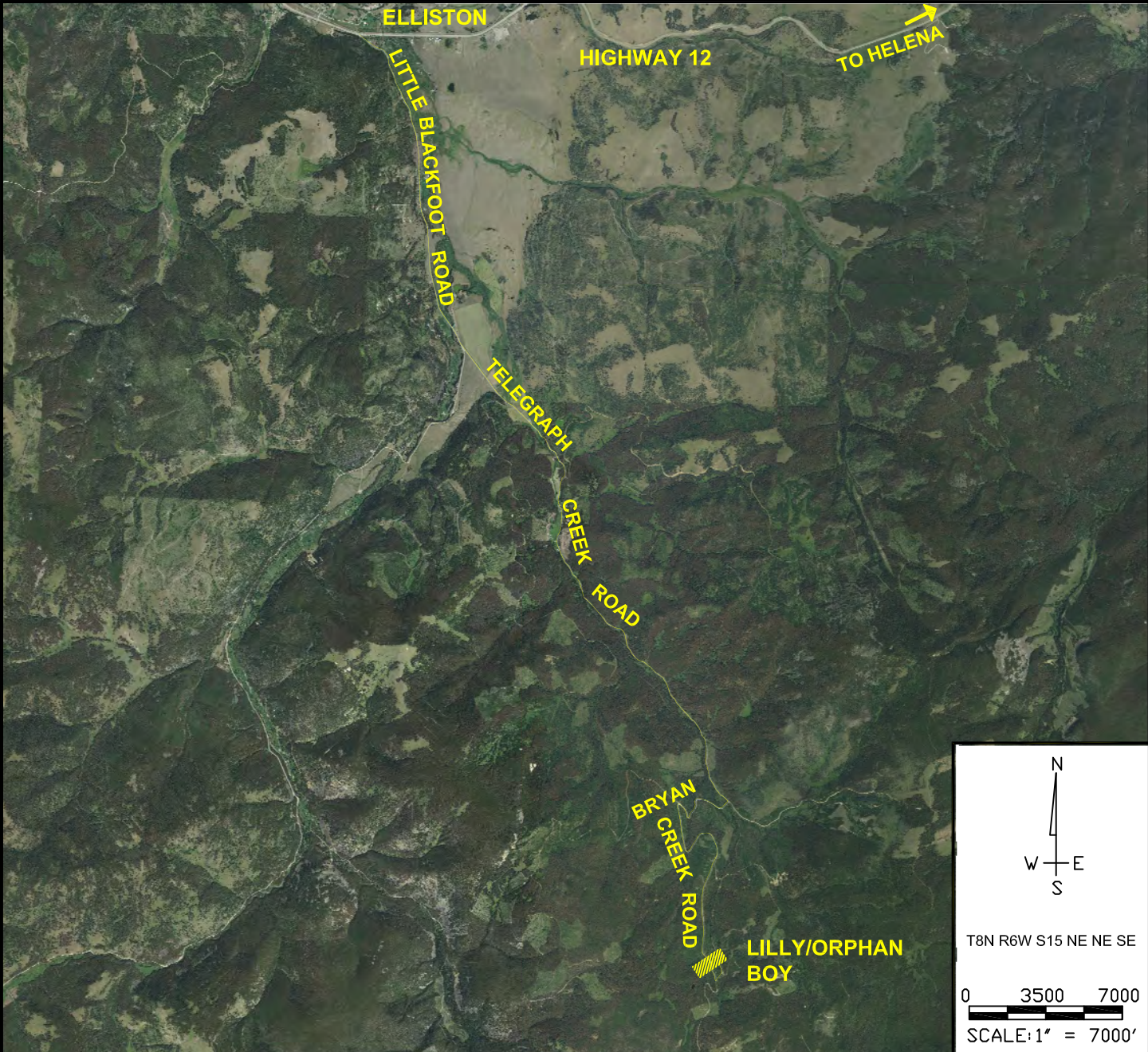
2.6 Land Use and Population

The Lilly/Orphan Boy Mine Site is located on patented (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 cabins located within a half-mile radius of the site, only one is known to be served with electricity. 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 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.

SITE LOCATION MAP



PROJECT LOCATION



T8N R6W S15 NE NE SE



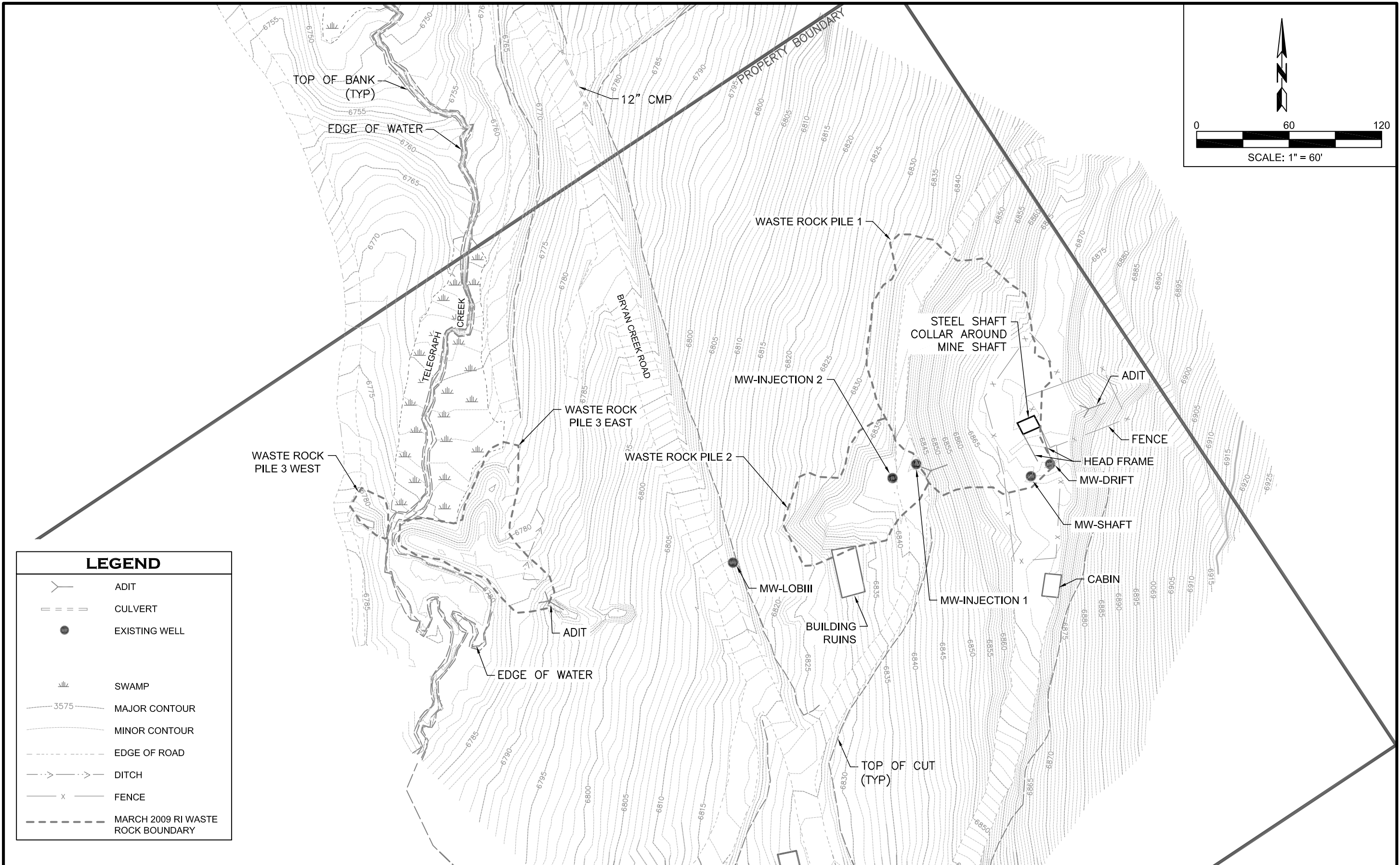
SCALE: 1" = 7000'



SCALE:	As shown
DRAWN BY:	TS
ENGINEER:	TS

PROJECT:
LILLY/ORPHAN BOY MINE
Powell County, Montana

PROJECT NO:	09210
DATE:	5/14/2010
FIGURE:	1



LEGEND	
	ADIT
	CULVERT
	EXISTING WELL
	SWAMP
	MAJOR CONTOUR
	MINOR CONTOUR
	EDGE OF ROAD
	DITCH
	FENCE
	MARCH 2009 RI WASTE ROCK BOUNDARY

DRAWN:	TLS	PROJECT NO.:	09210
ENGINEER:	TLS	SCALE:	AS SHOWN
CHECKED:	JM	APPROVED:	TLS
		DATE:	8/19/10



EXISTING TOPOGRAPHIC
SITE MAP

LILLY/ORPHAN BOY
ABANDONED MINE SITE

FIGURE:	2
DATE:	8/20/2010

Section 3.0 DESCRIPTION OF THE PROPERTY

The description of the property section and subsections of the Lilly/Orphan Boy Mine Site are provided and copied directly from the Final Reclamation Work Plan for the Lilly/Orphan Boy Mine Site, Powell County, Montana (Tetra Tech 2008). Sections 3.2.1 and 3.3 were modified to reflect the current characterization work performed on the site to date and land ownership.

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.

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 headframe and main shaft, two injection wells were drilled vertically into the main adit, and one “tunnel” well was installed down-gradient 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 6,800 feet in Section 15, Township 8 North, Range 6 West. 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 downstream, near Telegraph Creek's confluence with the Little Blackfoot River. The shaft, adits, and waste rock piles are confined to the Lilly claim, as shown on Figure 2, 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

A hazardous materials inventory (HMI) was performed on the site in 1993. Soil, sediment, surface water and groundwater samples were collected and analyzed. Additional soil, sediment, surface water groundwater, and mine water samples obtained and analyzed as part of the Reclamation Investigation Report dated March 2009. The recreational risk analysis included in the 2009 RI states that arsenic, lead and manganese are chemicals of concern for human health with elevated concentrations of arsenic, cadmium, copper, lead, and zinc observed in the surface water that “pose an unacceptable risk to the environment” (Tetra Tech, 2009). The acid discharge coming from the collapsed adit above Waste Rock Pile 3 contains elevated levels of arsenic, cadmium, copper, iron, lead, manganese, nickel, and zinc that exceed DEQ-7 human health and aquatic life standards.

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 with 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.

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 owner of the Lilly/Orphan Boy Mine Site is Lindsey Chaquette of Sherwood, OR (NRIS 2010).

Section 4.0 WORK PLAN COMPONENTS

4.1 Hydrogeology Investigation Plan

Enclosed is the Hydrogeology Investigation Plan. This plan has been prepared as a stand alone document that can be used with the SAP/QAPP and HASP to perform the field work necessary to install the monitoring wells, piezometers, and perform the surface water and groundwater sampling. The mine water sampling and observations shall be performed in conjunction with the Mine Investigation Plan.

Final

Hydrogeology Investigation Plan for Phase II Reclamation Investigation Work Plan (RWP) of Lilly/Orphan Boy Mine, Powell County, Montana

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August 18, 2010

Table of Contents

Section 1.0 Introduction.....	1
1.1 Background.....	1
1.2 Project Personnel	3
Section 2.0 Investigation Work Items.....	4
Section 3.0 Hydrogeology Investigation Methods.....	5
3.1 Soil Borings	5
3.2 Groundwater Sampling and Analysis Methods	6
3.2.1 Monitoring Well Installation.....	7
3.2.2 Monitoring Well Development	7
3.2.3 Well Surveying	7
3.2.4 Well Depth and Static Water Level Measurement.....	9
3.2.5 Monitoring Well Purging Procedure.....	9
3.2.6 Monitoring Well Sampling	9
3.2.7 Disposal of Purge Water	9
3.2.8 Sampling Equipment Decontamination Procedure	9
3.2.9 Transducer Installation.....	9
3.2.10 Piezometer Installation.....	10
3.2.11 Groundwater Data Uses	10
3.3 Subsurface Mine Investigation	10
3.3.1 Hydrogeology Inspection of Mine Workings	10
3.3.2 Data Collection from Mine Workings and Uses.....	11
3.3.3 Mine Water Data Uses	11
Section 4.0 Documentation and Records	11
Section 5.0 References.....	12

List of Figures

Figure 1. Site Location Map.....	2
Figure 2. Monitoring Well Locations.....	8

Appendices

Appendix A Sample Boring Log	A
Appendix B Sample Well Log.....	B
Appendix C Sample Well Development Log	C

Acronyms and Abbreviations

amsl	above mean sea level
ARD	acid rock drainage
COC	contaminant of concern
DEQ	Montana Department of Environmental Quality
DOE	US Department of Energy
EEE/CA	Expanded Engineering Evaluation and Cost Analysis
EPA	US Environmental Protection Agency
GPS	global positioning system
MWCB	Mine Waste Cleanup Bureau
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
RWP	Reclamation Investigation Work Plan
SAP	Sampling and Analysis Plan
SRB	sulfate-reducing bacteria
TerraGraphics	TerraGraphics Environmental Engineering, Inc.
USGS	US Geological Survey

Section 1.0 Introduction

TerraGraphics Environmental Engineering, Inc. (TerraGraphics) has prepared this Hydrogeology Investigation Plan on behalf of the Montana Department of Environmental Quality (DEQ) Mine Waste Cleanup Bureau to partially fulfill the requirements of a Phase II Reclamation Investigation Work Plan (RWP) for the Lilly/Orphan Boy Mine Site. The RWP consists of multiple plans developed by TerraGraphics to define the investigation work items necessary to support the completion of an Expanded Engineering Evaluation and Cost Analysis (EEE/CA) for the site. The purpose of this investigation effort is to conduct field work and collect data necessary to accomplish the following:

- Determine the hydrogeologic connection of the underground mine workings with the bedrock;
- Compare quality of groundwater in the bedrock and water within the mine workings;
- Measure location and estimate flow at seepage zones within the mine workings;
- Estimate the impacts of surface water infiltration into the mine workings; and
- Support an analysis of reclamation alternatives for reducing or stopping discharge from the adit.

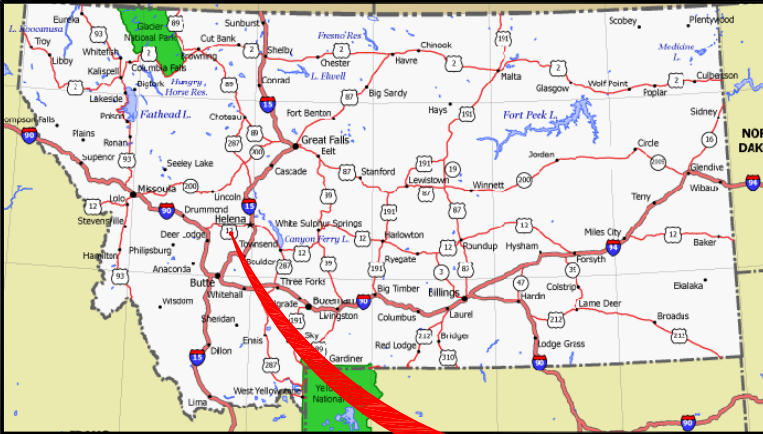
The data collected will be used to determine whether mine water infiltration is occurring through the shallow aquifer, bedrock aquifer, or a combination thereof. The mine water data will be used to prepare a map of infiltration zones within accessible portions of the mine. The geology and water quality will be compiled in an effort to delineate the infiltration zones and to characterize the water quality from each zone. Delineating these zones will provide information that can be used in the closure reclamation designs to segregate the zones and keep mineral-rich water from oxidizing, creating additional ARD and possibly allowing clean water to return to the surface as springs. The information will also be evaluated to determine if cutoff zones may be useful. Overall, this information is anticipated to provide guidance for preparing preliminary designs of viable closure alternatives to be included in the EEE/CA.

This Hydrogeology Investigation Plan has been prepared as part of the RWP to identify and describe the activities necessary to: i) perform a hydrogeologic analysis of the mine workings and native material around the mine, and ii) estimate the effects of reclamation on the groundwater system in the local area. Where it creates efficiencies to do so, this plan will reference other components of the RWP such as the SAP/QAPP and Mine Investigation Plan.

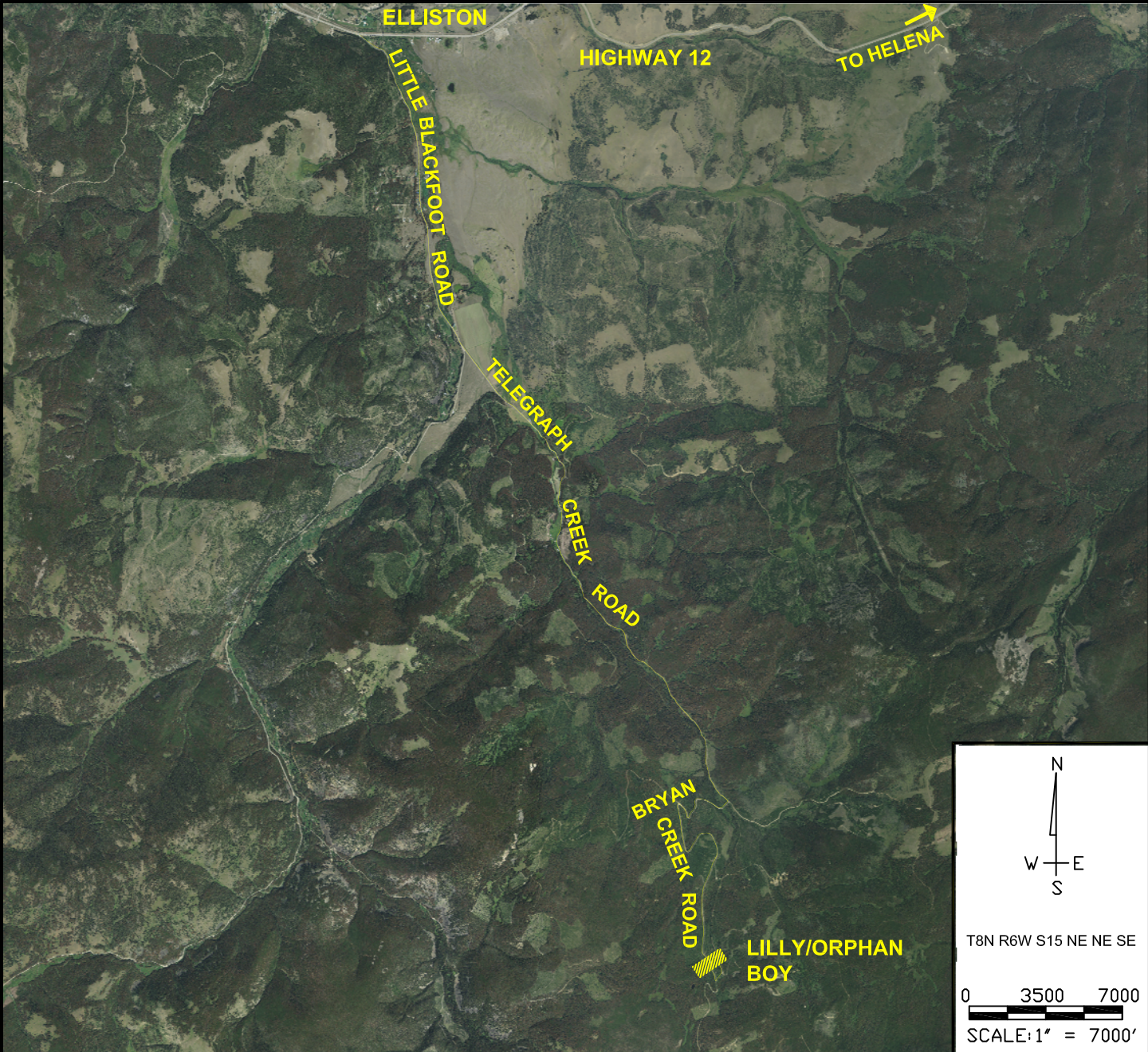
1.1 Background

The project site is located at an elevation of approximately 6,800 feet above mean sea level (amsl) within the Elliston Mining District, near the headwaters of Telegraph Creek (Figure 1). The Problem Definition/Background section of the Sampling and Analysis Plan/Quality Assurance Project Plan (SAP/QAPP) contains a summary of the history surrounding the Lilly/Orphan Boy Mine Site (TerraGraphics 2010).

SITE LOCATION MAP



PROJECT LOCATION



T8N R6W S15 NE NE SE



SCALE: 1" = 7000'



SCALE:	As shown
DRAWN BY:	TS
ENGINEER:	TS

PROJECT:
LILLY/ORPHAN BOY MINE
Powell County, Montana

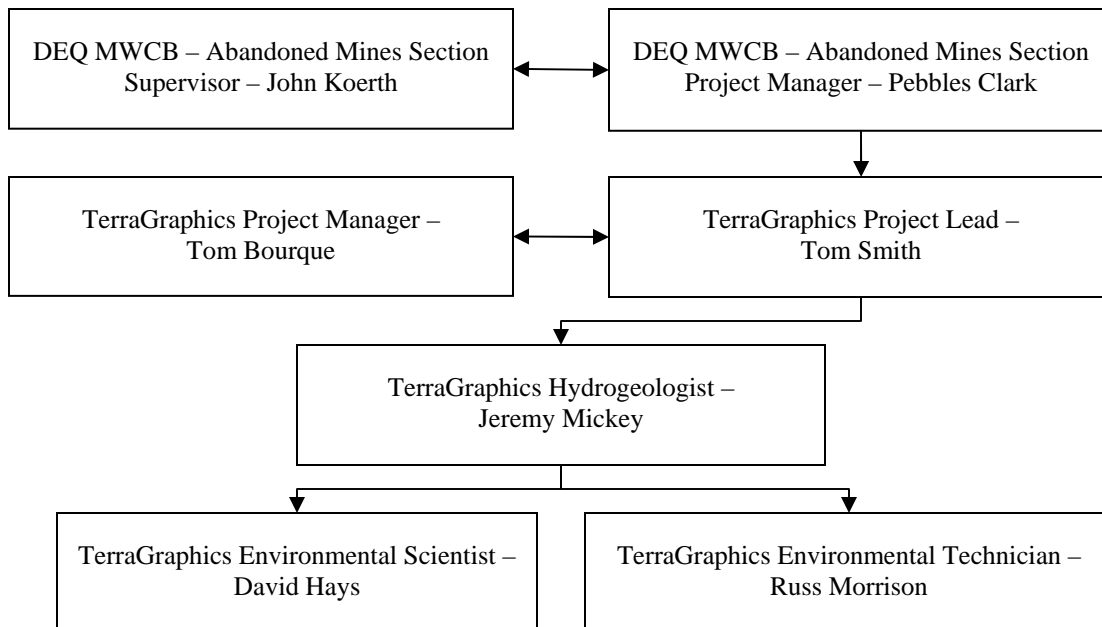
PROJECT NO:	09210
DATE:	5/14/2010
FIGURE:	1

In August 1994, MSE Technology Applications (MSE) began an 11-year field demonstration for the US Environmental Protection Agency (EPA) and the US Department of Energy (DOE) at the Lilly/Orphan Boy Mine Site to treat and control the discharge of heavy metals and arsenic contaminated water by introducing organic material into the workings to promote the growth of sulfate-reducing bacteria (SRB). The study was concluded in July 2005. As part of the technical study, five monitoring wells were installed at the Lilly/Orphan Boy Mine Site: two angled wells were constructed near the headframe and main shaft (neither were drilled into the workings); two injection wells were drilled vertically into the Lilly tunnel; and one “tunnel” well was installed downgradient of the injection wells to monitor treated water prior to its discharge at the collapsed portal. Water filling the mine workings was presumed to be groundwater by MSE during their investigation (MSE 2008).

Other site characteristics include a steel support frame, a wood headframe, a 250-foot deep shaft, three collapsed adits, and three waste rock piles. The known water contaminants of concern (COCs) at the site are: arsenic, cadmium, copper, lead, and zinc. These COCs have been found in the surface water and mine water at the site. The waste rock piles onsite also contain elevated concentrations of the COCs. One waste rock pile, WR-3, is in direct contact with surface water in Telegraph Creek and the acid rock drainage (ARD) originating from the collapsed adit above Telegraph Creek.

1.2 Project Personnel

Project Team Members, their affiliations, and their roles during the Hydrogeology Investigation are as shown in the following chart.



Section 2.0 Investigation Work Items

In order to complete the hydrogeologic analysis component of the Phase II RWP, TerraGraphics will perform the field activities proposed herein to collect the data necessary to characterize the groundwater system at the mine site, its connection to the mine workings, and to predict the effects of reclamation on the system in order to prepare closure alternatives for the EEE/CA. Information obtained during the investigation will be utilized to complete the Phase II Reclamation Investigation Report. Quality Assurance/Quality Control (QA/QC) procedures described in the SAPP/QAPP will be integrated throughout all phases of work to ensure that all data acquisition requirements are met.

The proposed work items listed below have been identified by TerraGraphics as key components of the Hydrogeology Investigation that must be addressed in order to achieve the objectives of the RWP.

1. Conduct a subsurface investigation of the local aquifer(s) by installing shallow piezometers in the surficial soil and weathered bedrock and monitoring wells into the bedrock to observe the existing groundwater setting and water quality (in the monitoring wells only) and to estimate the expected equilibrium elevation of the re-established groundwater system.
2. Gather analytical and hydrogeologic data for the evaluation of groundwater quality, quantity, and flow direction at the site.
3. Monitor the groundwater level with transducers in the new wells, shaft, and existing well MW-LOBIII during mine dewatering operations to determine the connection of the mine workings with the bedrock.
4. Perform a visual site inspection searching for historical expressions of groundwater at the surface on and adjacent to the site (springs/seeps).
5. Test water flowing into the workings at different locations to identify the sources and estimate quantities of metals and dissolved oxygen entering the system from the various sources.
6. Visually identify areas within the workings where “clean” water may be entering and mixing with contaminated water from the mineralized zone(s).
7. If the landowner provides consent, drain the pond above the site to determine hydraulic connectivity of surface water to the workings and estimate the effect of the pond on the shallow surficial aquifer.
8. Gather physical baseline information about the surficial aquifer in an effort to estimate the water contribution to the mine workings.

9. Gather analytical and physical data to characterize the mine water chemistry in the underground mine workings located at the site. Sampling and analysis of the mine water is discussed in Section 1.4 of SAP/QAPP (TerraGraphics 2010).

Section 3.0 Hydrogeology Investigation Methods

An investigation consisting of water quality sampling, spring and seep surveys, monitoring well installation, and piezometer installations will be conducted in an effort to evaluate the existing hydrogeology and estimate the pre-mining groundwater system and what might be expected by closing the discharging adit and shaft. Information obtained from these efforts will be used to perform a preliminary groundwater evaluation of the site in order to complete the hydrogeologic analysis component of the Phase II RWP. The results of this groundwater system characterization will be presented and discussed in the Phase II Reclamation Investigation Report.

During the preparation of this Hydrogeology Investigation Plan, the most current information regarding previous remedial investigation work performed at the site has been summarized from the *Final Reclamation Investigation Report, Lilly/Orphan Boy Mine Site, Powell County, Montana* (Tetra Tech 2009) and *Final Report – In Situ Source Control of Acid Generation Using Sulfate-Reducing Bacteria* (MSE 2008).

This section describes the hydrogeology investigation methods to be used during the field activities that will be performed at the Lilly/Orphan Boy Mine Site. The purpose of these activities is to collect the information necessary to complete the investigation work items identified in Section 2.0 of this plan. The field activities proposed for the site consist of the following:

- Drill five borings at the Lilly/Orphan Boy Mine Site to investigate and describe the soil and bedrock at the drilling locations.
- Install monitoring wells in the borings to evaluate groundwater gradient and quality.
- Install a weir at the discharging adit to calculate and document the amount of water exiting the portal.
- Install pressure transducers in each of the 5 new monitoring wells, in the shaft and in MW-LOBIII, an existing Lilly tunnel monitoring well during dewatering to monitor water levels in the workings and adjacent aquifers. A barometric transducer is also recommended for correcting the depths measured by each transducer. These data will be used to monitor and predict the extent of groundwater connectivity in the bedrock to the underground workings.
- Install shallow piezometers within the colluvium/weathered bedrock to further investigate surface water infiltration and the connectivity of the shallow groundwater with the underground workings.

3.1 Soil Borings

In order to use the groundwater monitoring wells for data collection during mine dewatering, it is currently proposed to drill the pilot borings and install the associated wells during the beginning

phases of field work. Information collected from the soil borings and monitoring wells may be useful in the final design and performance of the mine investigation, particularly with respect to the dewatering phase of the investigation.

Five boring locations are proposed for the Lilly/Orphan Boy Mine site. The borings/monitoring wells will be located throughout the site mainly for the evaluation of the site's groundwater system and estimate the connection with the mine workings. Upon completion of each boring, a monitoring well will be installed.

The borings will be approximately 6 inches in diameter, or larger, and will be advanced using hollow stem augers, air rotary, or other suitable drilling methods. The boring/monitoring well locations are shown on Figure 2. The proposed monitoring well locations have been located along existing roads that can be accessed by the drilling rig and support vehicle(s). Access from Dan Newman, owner of the adjacent Orphan Boy claim, or other neighbors may be necessary.

Soil samples will be collected from the borehole cuttings at 5-foot intervals or at visible lithology changes, then placed and sealed in 1-gallon Ziploc® bags. Bedrock samples will be obtained from the air rotary cuttings or other drilling method and placed in chip trays.

TerraGraphics personnel will monitor drilling of the borings and will log the samples and cuttings to describe the lithology and any groundwater units encountered. This information will be recorded on a borehole log or in the field book. A sample boring log is included in Appendix A. Each borehole log will have a unique borehole identifier and the borehole location. The log will also list the drilling equipment and methods, depth to soil and bedrock unit interfaces, groundwater, sampling information, soil and rock descriptions, and monitoring well construction details.

Earth materials encountered during boring advancement will be classified using the Unified Soil Classification System (USCS) as specified by ASTM D2487. TerraGraphics personnel will also observe the drilling operations to estimate the hardness of rock based on the drilling load required to advance the boring. This information will be included on the borehole log.

Drill Cutting Disposal

In general, since drill cuttings will not be considered a Resource Conservation and Recovery Act (RCRA) hazardous waste as defined by USEPA, drill cuttings will be land applied in the vicinity of each monitoring well.

3.2 Groundwater Sampling and Analysis Methods

Groundwater data will be collected from five monitoring wells installed at the Lilly/Orphan Boy Mine site. The approximate well locations are shown on Figure 2 and are subject to change at the time of drilling depending on field conditions such as terrain, snow cover, road access to the proposed locations, and tree cover. Field tasks will include staking well locations, measuring static water levels in each well, purging each well, field measurement of chemical/physical parameters, and collecting groundwater samples for laboratory analysis according to the constituents identified in Table 1 of the SAP/QAPP (TerraGraphics 2010).

3.2.1 Monitoring Well Installation

PVC-cased monitoring wells will be installed and groundwater sampling will be collected during the site characterization process at the Lilly/Orphan Boy Mine site. Four of the monitoring wells will have 2-inch diameter wells installed and one will have a 4-inch or 6-inch diameter well installed, as shown in Figure 2. The five new monitoring wells will be used to determine local aquifer characteristics such as groundwater table, or potentiometric surface, elevations, flow direction, and how it relates to the water level in the mine workings. Groundwater samples collected from the wells will be used to measure chemical and physical parameters for the purposes of: i) obtaining current baseline information regarding groundwater chemistry, and ii) comparing to corresponding values obtained from the mine water.

Standard monitoring wells will be installed in general accordance with State of Montana requirements. TerraGraphics personnel will monitor the installation of the wells and will prepare a field log. This information will be recorded on a well log or in the field book. A sample well log is included in Appendix B.

3.2.2 Monitoring Well Development

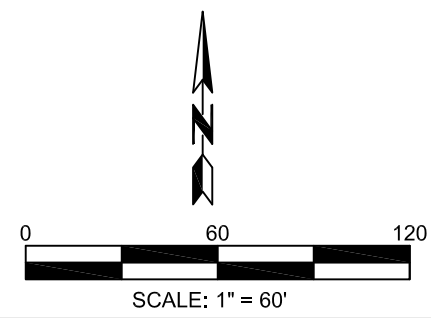
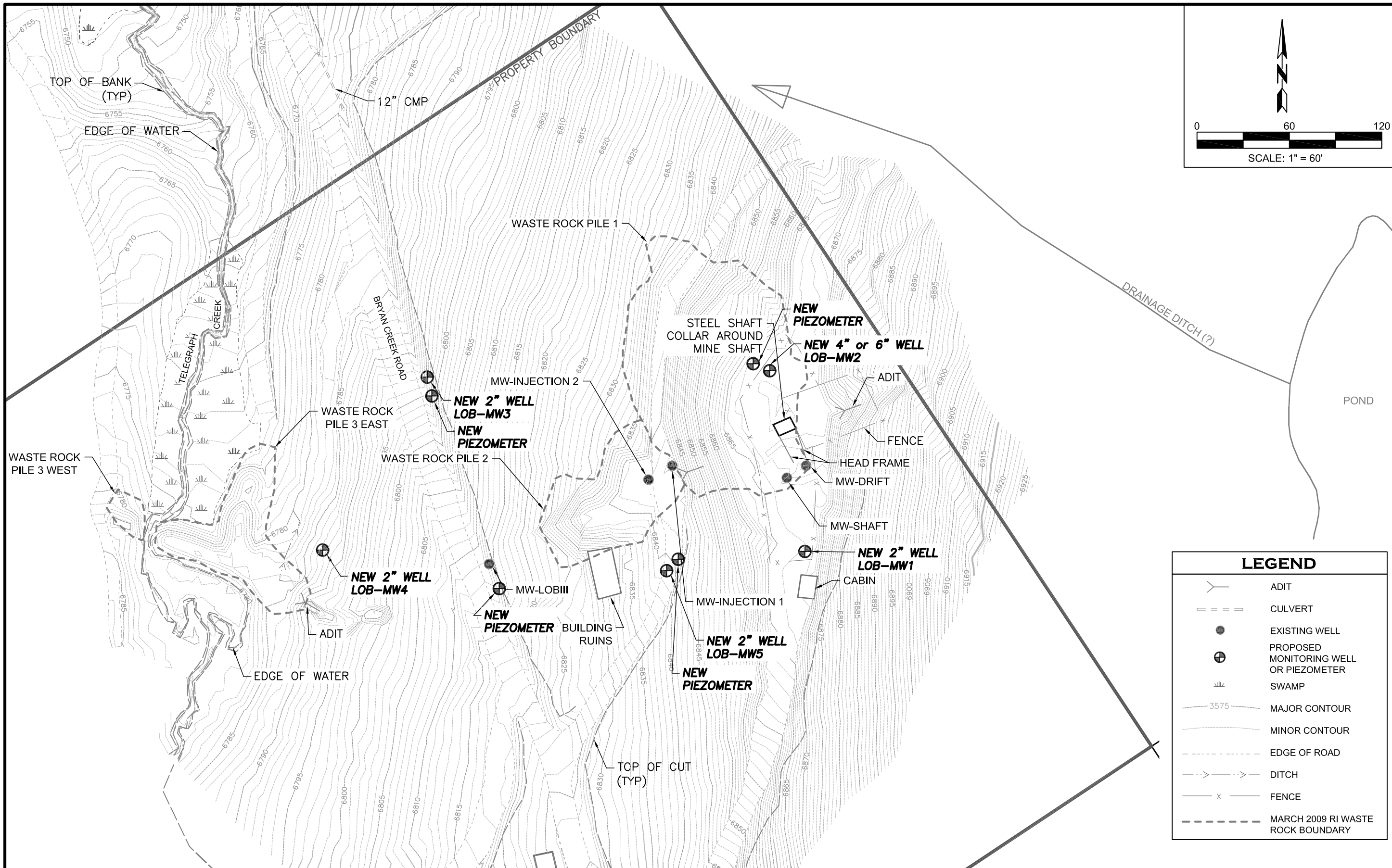
Monitoring wells will be developed to ensure connectivity with the local aquifer. Groundwater pumped to the surface during well development will be disposed of on site and will not be directed to flow directly into Telegraph Creek.

Well development methods will be performed by the drilling contractor and will depend on site conditions, but will likely include over-pumping and surging. Field parameters including pH, specific conductance, temperature, dissolved oxygen, and turbidity will be recorded on the Well Development Field Sheet throughout the development process. Well development will be considered complete upon stabilization of these parameters within the criteria listed at the bottom of the Well Development Log shown in Appendix C.

3.2.3 Well Surveying

For staking purposes, a sub-meter real-time handheld Global Positioning System (GPS) will be used to locate the drilling locations. Due to unforeseen field conditions, some drilling locations may be adjusted during staking in the field. If sites are moved, new locations will be recorded with the GPS. The final monitoring well locations will be included in the Phase II Reclamation Investigation Report on a site map.

Once the monitoring wells have been constructed, the top of casing of each monitoring well will be marked either with indelible ink or a small vertical cut made into the PVC casing on the northern side to mark the groundwater measuring reference point. The measuring point elevations will be surveyed by TerraGraphics with a level or total station. The measuring points will be measured from the on-site control points installed by DJ&A during their 2009 site survey.



LEGEND	
	ADIT
	CULVERT
	EXISTING WELL
	PROPOSED MONITORING WELL OR PIEZOMETER
	SWAMP
	MAJOR CONTOUR
	MINOR CONTOUR
	EDGE OF ROAD
	DITCH
	FENCE
	MARCH 2009 RI WASTE ROCK BOUNDARY

DRAWN:	TLS	PROJECT NO.:	09210
ENGINEER:	TLS	SCALE:	AS SHOWN
CHECKED:	JM	APPROVED:	TLS
		DATE:	8/13/10



**NEW MONITORING WELL &
PIEZOMETER LOCATIONS
SITE MAP**

**LILLY/ORPHAN BOY
ABANDONED MINE SITE**

FIGURE:	2
DATE:	8/19/2010

3.2.4 Well Depth and Static Water Level Measurement

Depth to groundwater will be measured in the five new monitoring wells following the procedure described below.

The static water level will be measured using a water level meter by slowly inserting the water level indicator probe into the well casing. As the probe enters the water, a buzzer and indicator light is activated. The depth to water is indicated at the point at which the water level buzzer and light activate. The graduation mark on the water level tape adjacent to the north rim of the well casing represents the depth to water. This measurement will be recorded in the field log book and on the groundwater sampling form to a precision of 0.01 foot. The probe and attached tape will be thoroughly washed with a solution of laboratory-grade detergent and distilled water at the beginning of each sampling event and triple-rinsed with distilled water prior to use in each well.

3.2.5 Monitoring Well Purging Procedure

The monitoring well purging procedure is described in section 2.1.2.1 of the SAP/QAPP.

3.2.6 Monitoring Well Sampling

Samples will be collected in general accordance with the sampling plan described in section 2.1 of the SAPP/QAPP. All sample handling procedures will follow the guidelines for handling and documentation discussed in section 2.6 of the SAPP/QAPP. Samples will be analyzed for the parameters included in Table 1 of the SAP/QAPP. Procedures for collecting QA/QC samples are described in Section 2.3 of the SAP/QAPP (TerraGraphics 2010).

3.2.7 Disposal of Purge Water

Purge water generated during site characterization activities will be disposed of on site and will not be directed to flow directly into Telegraph Creek.

3.2.8 Sampling Equipment Decontamination Procedure

The procedures for decontamination of sampling equipment is described in section 2.1.6.2 of the SAP/QAPP (TerraGraphics 2010).

3.2.9 Transducer Installation

Transducers will be programmed and deployed in each of the five new monitoring wells. The transducers will be installed to a depth that is just above the base of the well screen in each well. The transducers will be programmed to record water level readings every 4 hours until the mine dewatering operations begin. Prior to mine dewatering, the transducers will be re-programmed to record water levels on a logarithmic cycle. Once the mine investigation is completed, the dewatering will be stopped and mine workings allowed to fill with water. The transducers will continue recording on a logarithmic cycle until the water level in the mine has returned to its pre-dewatering level. Then the transducers will be removed, data downloaded, and data compiled in a spreadsheet for evaluation.

3.2.10 Piezometer Installation

If shallow groundwater is encountered in the colluvium/weathered bedrock, TerraGraphics proposes to install 2-inch diameter, PVC piezometers in selected locations that can be accessed with a mini-excavator. Some piezometers may be nested with the monitoring wells. These piezometers will be used to investigate and monitor the depth to groundwater within the weathered bedrock region to evaluate the potential surface water interaction with the mine workings. The PVC will be slotted using a hack-saw and the slots will be placed from the bottom of the piezometer to a depth of 2 feet above the soil horizon indicating the presence of groundwater. The base of the piezometers will be capped with a 2-inch PVC slip cap.

Once the piezometers have been constructed, the top of casing of each piezometer will be marked either with indelible ink or a small vertical cut made into the PVC casing on the northern side to mark the groundwater measuring reference point. The measuring point elevations will be surveyed by TerraGraphics with a level or total station. The measuring points will be measured from the on-site control points installed by DJ&A during their 2009 site survey.

3.2.11 Groundwater Data Uses

The transducer data and water quality data gathered from the groundwater evaluation will be compiled to show the existing hydrogeologic setting, evaluate the hydrogeologic connection with the mine workings and estimate the potentiometric surface of each closure alternative evaluated in the EEE/CA. The purpose of these data is to determine whether mine water infiltration is occurring through the shallow aquifer, bedrock aquifer, or a combination thereof. This information is anticipated to provide guidance for effective closure options to be included in the EEE/CA.

3.3 Subsurface Mine Investigation

If the Mine Investigation determines that the mine can be entered safely, hydrogeologic data will be obtained from the dewatered mine workings through a combination of visual observation and physical sample collection. This section describes the procedures that will be used to investigate the groundwater system(s) present within the mine workings. The procedures described are designed to provide a thorough record of events surrounding the collection of each sample, and to ensure, as far as can be accomplished in the field, that data collected are usable.

This section describes the subsurface mine investigation methods to be used during the field activities that will be performed at the Lilly/Orphan Boy Mine Site. The purpose of these activities is to collect the information necessary to complete the investigation work items identified in Section 2.0 of this plan. The field activities proposed for the site are presented in the following subsections.

3.3.1 Hydrogeology Inspection of Mine Workings

1. Visually locate groundwater infiltration zones within the workings to construct a map of infiltration areas and estimate the flow at these locations.
2. Measure physiochemical field parameters (pH, dissolved oxygen, oxygenation reduction potential, conductivity, temperature) from the infiltration zones to characterize the quality of groundwater flowing into the workings.

3.3.2 Data Collection from Mine Workings and Uses

Entries into the logbook or other relevant sampling forms for sampling events may include, but are not limited to, the following:

- The name of the project and sampling personnel;
- The date, time, number, and medium of the sample;
- The sample preservation and the analyses requested;
- Type and quantity of containers used for each sample;
- A cross-reference of numbers for field duplicates and blank samples;
- A sketch and description of the geographical location of the sample in reference to site facilities or structures (e.g. mine level, taped distance from shaft, emanating from the floor or height on the wall, or ceiling, etc.);
- The method of sampling, including procedures, equipment, and any departure from the procedures specified in the SAP/QAPP;
- The results of field measurements (e.g., water quality measurements);
- Weather conditions at the time of sampling and other factors that may influence the representative nature of a sample. At a minimum, include the temperature and sky cover;
- Descriptions of photographs including: why it was taken, the date and time it was taken, the location and compass direction of the picture, and photograph number;
- Disposition of the sample (i.e., where it is being analyzed); and
- Shipping number, when applicable.

Each collected sample will have a unique identification code that will catalog the sample site, the sample type, and the sampled depth. The field sample ID number will be recorded on the sample tag and coded as described in Section 1.5.1.1 of the SAP/QAPP (TerraGraphics 2010).

3.3.3 Mine Water Data Uses

The mine water data will be used to prepare a map of infiltration zones within the mine that are accessible. The geology and water quality will be compiled in an effort to delineate zones of infiltration with good water quality and poor water quality. Delineating these zones will provide information that can be used in the closure reclamation designs to separate these zones and keep mineral-rich water from oxidizing, creating additional ARD and possibly allowing clean water to return to the surface as springs. The information will also be evaluated to determine if cutoff zones may be useful.

Section 4.0 Documentation and Records

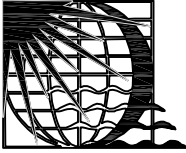
Documentation and records for this effort are described section 1.5 of the SAP/QAPP (TerraGraphics 2010).

Section 5.0 References

- MSE Technology Applications, Inc. (MSE). 2008. Final Report – *In Situ Source Control of Acid Generation Using Sulfate-Reducing Bacteria*. June.
- TerraGraphics Environmental Engineering, Inc. (TerraGraphics). 2010. Sampling and Analysis Plan (SAP)/Quality Assurance Project Plan (QAPP) for Phase II Reclamation Investigation of Lilly/Orphan Boy Mine, Powell County, Montana. July.
- Tetra Tech EM, Inc. (Tetra Tech). 2009. Final Reclamation Investigation Report, Lilly/Orphan Boy Mine Site, Powell County, Montana. March.

Appendix A
Sample Boring Log

Appendix B
Sample Well Log



TerraGraphics

Environmental Engineering, Inc.

WELL NUMBER _____

PAGE ____ OF ____

PROJECT NUMBER _____	DATE STARTED _____
PROJECT NAME _____	DATE COMPLETED _____
LOCATION _____	CASING TYPE/DIAMETER _____
DRILLING METHOD _____	SCREEN TYPE/SLOT/LENGTH _____
SAMPLING METHOD _____	GRAVEL PACK TYPE _____
GROUND ELEVATION _____	GROUT TYPE/QUANTITY _____
TOP OF CASING _____	DEPTH TO WATER _____
LOGGED BY _____	GROUND WATER ELEVATION _____
REMARKS _____	

SAMPLE ID.	EXTENT DEPTH (ft. BGL)	U.S.C.S.	GRAPHIC LOG	LITHOLOGIC DESCRIPTION	CONTACT DEPTH	WELL DIAGRAM
	5 10 15 20 25 30					

Appendix C
Sample Well Development Log



Well Development Log

Site Name:	Initial Well Depth:	Final Well Depth:
Well ID:	Well Diameter:	Screen Length:
Developers:	Static Water Level:	Total Purged Volume:
Start Date: End Date:	Weather Conditions:	
General Comments (e.g., presence of NAPLS):		General Development Method(s):

Date	Time	Method	Pumping Rate (gal/min)	Volume Purged (gal)	Temp. (°C)	Spec. Cond. (µS/cm)	pH	Turbidity (NTU)	Other	Comments (e.g., clarity of water and success of development)

Field Parameter and Stability Guidance: pH (±0.1 standard units); Temperature (±1 °C); specific conductance (±3%, µS/cm); turbidity (10% when turbidity is ≤10 NTU); dissolved oxygen (± 0.3 mg/L); oxidation-reduction potential (± 3%)

NTU- nephelometric unit, µS/cm- microsiemens per centimeter

End of
Hydrogeology Investigation Plan

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4.2 Mine Investigation Plan

This section describes the components, sequence of operations, and roles and responsibilities of the Mine Investigation Plan for the Lilly/Orphan Boy mine workings. The mine was last worked sometime in the mid 1950's and since then, little has been performed to maintain the underground workings of the mine. The opening (adit) to the Lilly tunnel has collapsed, the mine is flooded up to the 74-foot level, and the man ways and ladders have been removed; therefore, access in its current state is not feasible.

The purpose of the Mine Inspection Plan is to create access and evaluate the underground mine workings for delineating suitable reclamation alternatives. Addressing the geology, hydrogeology and stability of the workings will provide valuable information for delineating reclamation approaches to address the mine water discharge from the collapsed Lilly adit. The general geology will be mapped to delineate ore zones, which are sources of potential acid generation, and barren bedrock (quartz monzonite not containing any metalliferous minerals). The hydrogeology will be evaluated to locate and estimate flow at infiltration areas in the workings, and general stability evaluated and mapped to highlight stable zones and fractured zones. All of this mapping will be compiled onto the existing mine map, as shown in Figure 3, where tight areas (relatively solid rock with few fractures making little to no water) and poor quality areas can be delineated and serve as a basis for which preliminary design of viable closure alternatives can be prepared and included in the EEE/CA.

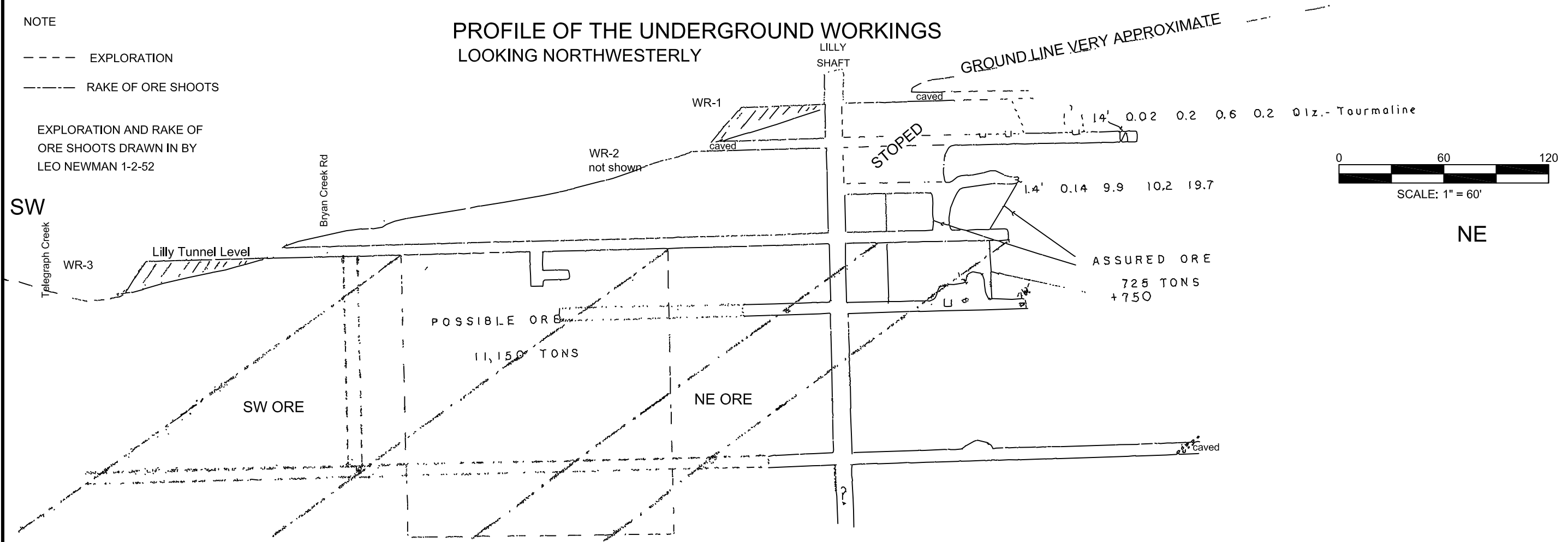
To gain access to the workings through the shaft there are two main obstacles to address; the first are a pair of platforms installed in the shaft and the second is the water in the mine. The platforms were installed by MSE for a study in 1994 using substrate (manure, straw, and wood chips) to reduce the acid and metal content of the mine water. The platforms were reportedly installed at the 125' level below the collar of the shaft, and then approximately 60 cubic yards of compacted substrate placed on top of the platforms. Without removal of the platforms and substrate, the workings cannot be accessed below the suspended substrate. Dewatering of the shaft and the subsequent workings will have to be completed prior to inspecting the workings. Meeting Circular DEQ-7 water quality standards was not economical so alternative water handling methods were evaluated that did not contribute metal loading to Telegraph Creek. Based on our analysis submitted in our revised Water Handling technical memorandum, dated August 18, 2010, the cheapest proposed viable method for handling the mine water that does not increase metal loading to Telegraph Creek is pH adjustment with land application. Once dewatering of the workings is underway or is dewatered, work can begin to restore access to the workings through the shaft by the mine subcontractor. TerraGraphics personnel, escorted by the mine subcontractor, can perform the mine inspection and locate infiltration areas within the workings.

NOTE

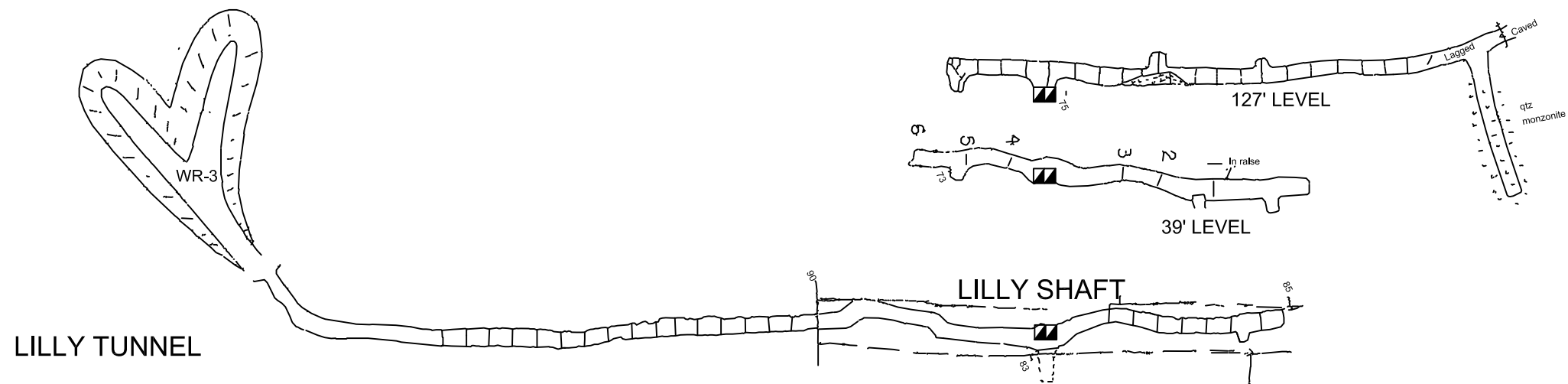
- - - - EXPLORATION
- · - · RAKE OF ORE SHOOTS

EXPLORATION AND RAKE OF
ORE SHOOTS DRAWN IN BY
LEO NEWMAN 1-2-52

PROFILE OF THE UNDERGROUND WORKINGS LOOKING NORTHWESTERLY



PLAN VIEW OF THE UNDERGROUND WORKING LEVELS



REFERENCE: Lilly Mine Geological & Assay Plan, July 1950, M.W. Rankin

DRAWN:	TLS	PROJECT NO.:	09210
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CHECKED:	TLS	APPROVED:	TLS
		DATE:	8/16/10



1950 MINE WORKINGS MAP
MAP PROVIDED BY DAVE NEWMAN

LILLY/ORPHAN BOY
ABANDONED MINE SITE

FIGURE:	3
DATE:	8/20/2010

To determine if the adit flow can be stopped, a simplified groundwater “model” will be developed. No computer modeling will be performed. Water levels in the monitoring wells will be evaluated over the investigation period to estimate pre-mining groundwater elevations. Without characterizing the groundwater and bedrock around the workings, there is no method to determine the extent of the groundwater connection with the workings and its impact on reclamation alternatives.

All of these items are interconnected and are anticipated to provide additional information for preparing an EEE/CA. This Mine Investigation Plan includes proposed components, surface activities, underground activities, project sequence of operations, roles and responsibilities, and proposed reclamation investigation costs.

4.2.1 Proposed Components

The proposed components of the Mine Investigation Plan are divided into two groups of activities, surface and underground, and are composed of the following.

Surface Activities:

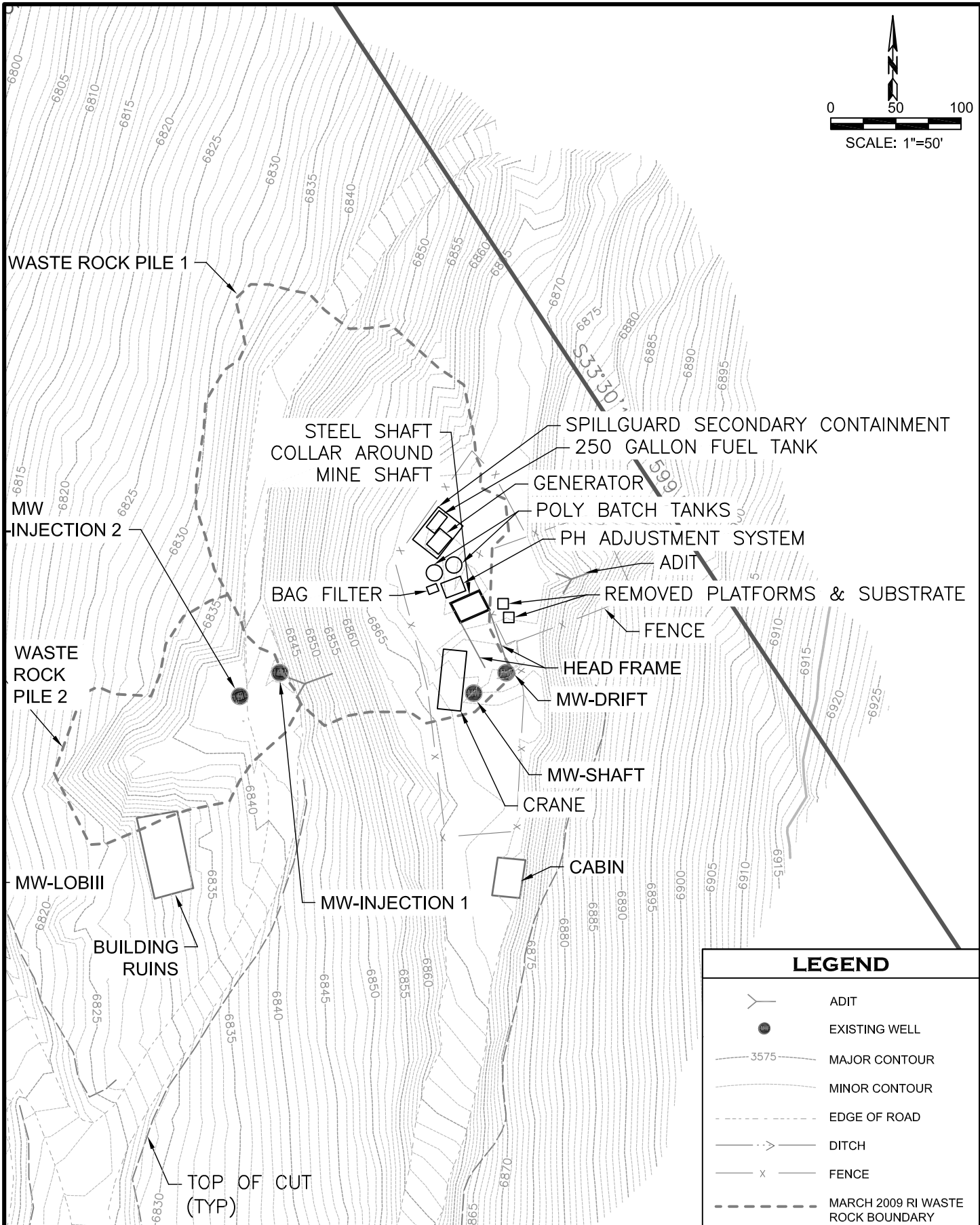
- Crane subcontractor shall attempt to remove the platforms from the shaft and set on the surface to the east of the shaft and headframe. If the platforms cannot be removed, they shall be lowered to the bottom of the shaft. If lowering fails, the platforms shall be re-suspended from the steel support frame at the surface.
- Drilling subcontractor shall drill and install five (5) monitoring wells at selected locations on site. TerraGraphics shall develop the wells and sample according to the SAP, included in Appendix A.
- Dewatering and water handling program (pH adjustment system and land application) is composed of the following items:
 - Water treatment subcontractor, Rain for Rent, shall supply pH adjustment system and land application equipment.
 - Subcontract with Tom’s Crane Service for unloading of water handling system from delivery truck; set the pump and pipe into the shaft; adjust the pump level as needed. Once pumping is completed, remove the pump and pipe from shaft and load the water handling system onto the delivery truck. This item is not covered in the Rain for Rent equipment rental agreement.
 - TerraGraphics shall manage the land application system on site.
 - TerraGraphics shall sample the mine water for laboratory analysis to monitor water quality and changes while dewatering.
 - TerraGraphics shall order and purchase fuel and oil for operation of the generator (separate from Rain for Rent equipment rental agreement).
- TerraGraphics shall hold a site orientation meeting with the mine subcontractor, upon their arrival on site, on the general orientation of the mine layout with respect to the known site surface hazards.

- Surface water and soil sampling by TerraGraphics and analysis by DEQ contracted analytical laboratory.
- Waste management of:
 - Water treatment byproducts (reject water and sludge to be mixed with Quikrete or Portland cement on site and left to solidify on Waste Rock Pile 1).
 - Substrate recovery (leave on site).
 - Other waste (garbage) shall be removed from site once all activities are completed and properly disposed at the Helena Transfer Station.
- Land application pipe protection and shallow excavation for road crossings to protect pipe.

Underground Activities:

- Mine subcontractor shall perform the following:
 - Evaluate air quality with air monitoring equipment and begin air ventilation of the workings. Monitoring and ventilation shall be performed during all underground activities;
 - Assess the shaft for safe access;
 - Rehabilitate the shaft as needed;
 - Construct man way with ladders and landings, as needed;
 - Determine depths of accessible workings;
 - Inspect the Lilly tunnel from the shaft as access allows; and
 - Identify obstructions and remove if possible.
- TerraGraphics personnel will be escorted by the mine subcontractor for the following tasks:
 - The tape survey of accessible mine workings to estimate volumes and record dimensions of the workings.
 - Map geology in shaft and accessible areas of mine.
 - Locate and map water infiltration areas and estimate flow rates (discussed in the Hydrogeology Investigation Plan).
- Mine subcontractor shall regulate access into the shaft with the existing shaft covers and locks during investigation field activities.

At this time, accessing the underground workings is proposed to be performed through the shaft. The mine subcontractor shall be supplying the equipment and materials required to access the shaft and other mine levels. The equipment, personnel, material, and safety requirements to access the working are listed in the Draft proposal and cost estimate from Blue Range Engineering (See Appendix F). Accessing the Lilly tunnel at or uphill of the collapsed adit is not recommended. The risk with re-opening the Lilly adit is considerably more than accessing through the shaft. The tunnel as it approaches the adit becomes less stable and will require timber replacement or installation of steel square sets to shore the surrounding ground. The additional airflow introduced to the mine workings will have a negative affect on the water



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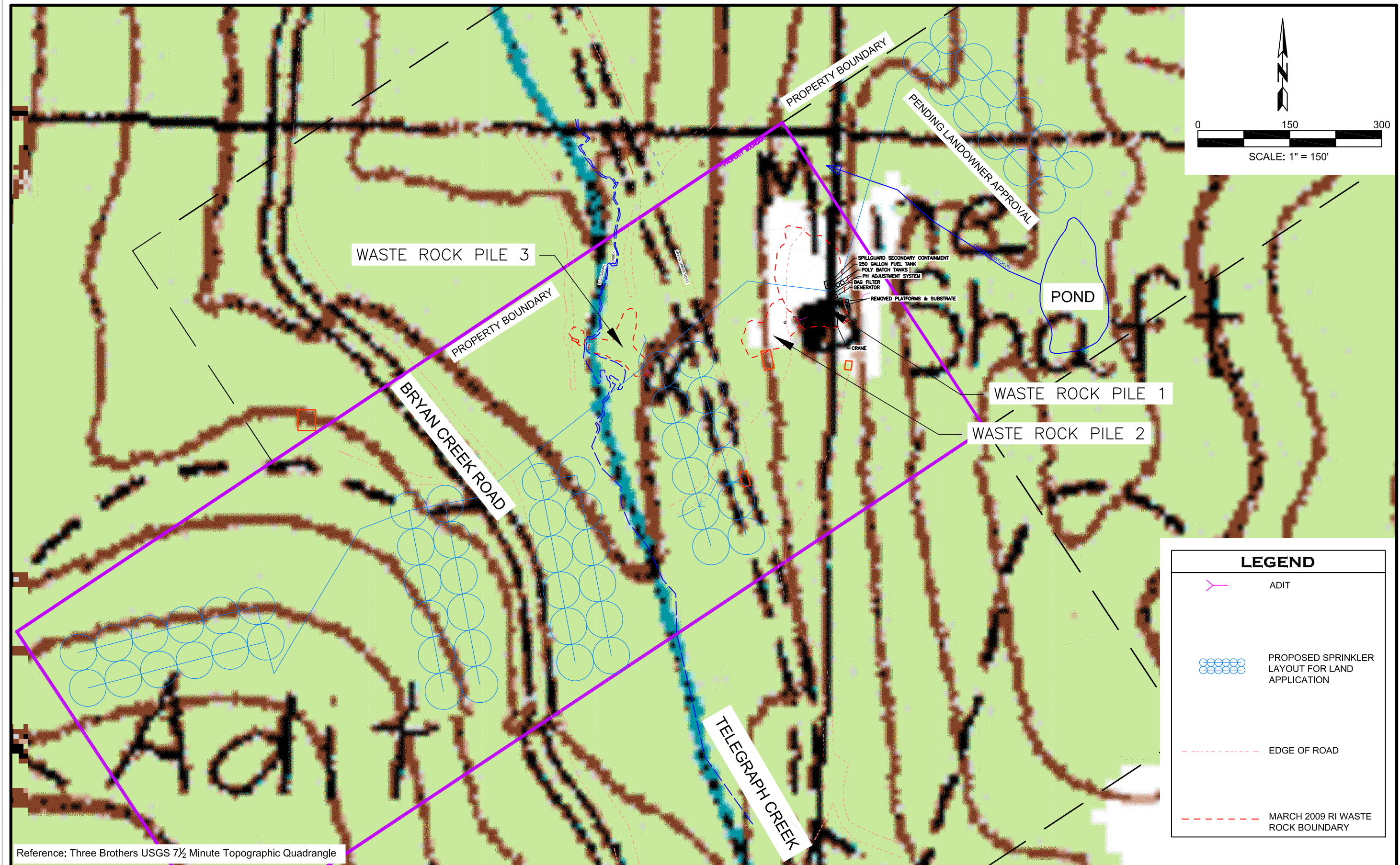
	ADIT
	EXISTING WELL
	MAJOR CONTOUR
	MINOR CONTOUR
	EDGE OF ROAD
	DITCH
	FENCE
	MARCH 2009 RI WASTE ROCK BOUNDARY



DRAWN BY: TS
 PROJECT NO: 09210
 DATE: 9/3/2010

FIGURE 4:

**SITE LAYOUT PLAN
 LILLY/ORPHAN BOY MINE**



Reference: Three Brothers USGS 7½ Minute Topographic Quadrangle

DRAWN:	TLS	PROJECT NO.:	09210
ENGINEER:	TLS	SCALE:	AS SHOWN
CHECKED:	JM	APPROVED:	9/3/10
		DATE:	9/3/10



SITE LAYOUT PLAN WITH
LAND APPLICATION SYSTEM
SITE MAP

LILLY/ORPHAN BOY
ABANDONED MINE SITE

FIGURE:	5
DATE:	9/3/2010

quality where the water oxidizes more of the metals and therefore produce more concentrated ARD. Ground disturbance in the areas close to the tunnel may allow for additional surface water infiltration and could translate into a relatively large surge of AMD into Telegraph Creek if the collapsed material at the adit is blown out. Upon closure of the access to the tunnel, a closure plan would have to be developed and implemented.

Security of the working will be accomplished by using the existing shaft cover panels. Locks supplied by DEQ will be used to secure the panels in place at the end of each working day. The locks will be left to secure the panels once the investigations have been completed.

4.2.2 Surface Activities

Surface activities to be performed as part of the Mine Investigation Plan include the items listed in Section 4.2.1. The general site layout plans are shown in Figures 4 and 5.

4.2.2.1 Platforms in the Shaft

Reviewing the MSE June 7, 1994 Request for Proposal for construction services at the site, a minimum crane capacity of 10 tons is specified. Reviewing the construction photos provided by MSE, two cranes were used for constructing the steel support structure above the shaft and installing the platforms. A Pettibone 30 crane (15 ton capacity) and a crane from Otto's Crane and Rigging (approximate capacity of 60 tons) are shown in the photographs.

The August 14, 2009 submittal letter from MSE states "that 60 cubic yards of [compacted] substrate were placed on the platforms within the shaft". With this volume of substrate and an estimated unit weight of material slightly heavier than water (62.4 lbs/cf) of 65 pounds per cubic foot ($60 \text{ cy} \times 27 \text{ cf/cy} \times 65 \text{ lbs/cf} \div 2,000 \text{ lbs/ton} = 52.65 \text{ total tons}$) at least a 30-ton crane appears to be required for removing the platforms if the volume is split evenly between the platforms. Crane contractors were contacted about the subject site and provided with a scope of work to prepare their cost estimates in general accordance with DEQ-MWCB procurement guidelines. Four crane contractors have been contacted; however, only two cost estimates were received. One estimate was received from H&H Crane Service and the other from Montana Crane Service. The lowest cost estimate was received from H&H Crane Service. One of the crane operators, Tom's Crane Service, does not have a crane with sufficient capacity to remove the cranes but would be an economical and local source for unloading and loading the water handling equipment from the delivery truck and setting the pump and pipe into the shaft. The cost estimates and scope of work are included in Appendix C.

The platforms were reportedly installed at the 125-foot level in the Lilly shaft are to be removed by the crane subcontractor. If the platforms cannot be removed, then the platforms can either be lowered to the bottom of the shaft or left hanging on the steel support frame. If the platforms cannot be removed, then the extent of the mine investigation becomes limited to the areas that can be accessed. This will limit the mapping of the mineralized zones and water producing zones in the mine.

4.2.2.2 Mine dewatering

4.2.2.2.1 pH Adjustment and Land Application System

Water treatment contractors and alternatives evaluated for water handling are discussed in our technical memorandum dated August 18, 2010 and is included in Appendix I. The pH adjustment system proposed by Rain for Rent along with land application on the Lilly claim (the site) is the preferred alternative, based on a cost analysis, for handling and disposal of the mine water. The system includes a pump, generator, bag filter, portable water quality monitoring system, 2,400 gallon poly batch tanks, secondary containment, hoses, valves, adapters, sprinklers, and sodium hydroxide. The only items not covered in the Rain for Rent cost estimate is a means of unloading and loading of the system from the delivery vehicle and fuel to operate the generator. This system and estimated rental cost are included in Appendix E. This system includes risks that some of the mine water may reach Telegraph Creek; however, we propose installing at least 3 groups of 12 sprinklers each that will be rotated to allow infiltration and drying to occur to minimize overloading of the site soils and bedrock. A potential system layout around the shaft is included in Figure 4. A potential site layout of the land application system is included in Figure 5.

4.2.2.2.2 Water Discharge Quality

Discharge water quality will be monitored with the Rain for Rent portable water quality monitoring system that is included as part of the pH adjustment system. The pH of the mine water will be treated to a range of 5 to 6. If the pH of the discharge is below a level of 5, then the system recirculates the water until it meets a pH of at least 5, similar to rain water, then releases the water to discharge through the land application system. The system also reportedly logs the pH and can be downloaded and will be included in the Phase II RI report.

4.2.2.3 Monitoring Wells and Piezometers

Drilling contractors were contacted about the subject site and provided with a scope of work to prepare their cost estimates in general accordance with DEQ-MWCB procurement guidelines. The scope of work is included in Appendix D. Five subcontractors were contacted and three cost estimates received. The lowest cost estimate was provided by Boland Drilling.

Five monitoring wells are proposed at the locations shown on Figure 2 of the Hydrogeology Investigation Plan. These monitoring wells are proposed to be installed in the bedrock around the workings. The monitoring wells are to be installed and water levels monitored during the dewatering of the mine. Four piezometers are also proposed to be installed in the surficial soil and weathered bedrock to provide water level information, as discussed in section 3 of the Hydrogeology Investigation Plan.

4.2.3 Underground Activities

Underground activities to be performed as part of the Mine Investigation Plan include the items listed in Section 4.2.1. Professional mine development contractors were contacted about the

subject site and provided with a scope of work to prepare their cost estimates in general accordance with DEQ-MWCB procurement guidelines. The scope of work is included in Appendix F. Four subcontractors were contacted with two unable to prepare a cost estimate due to their current heavy work loads. Two cost estimates were received; one from Blue Range Engineering and one from New Millennium Mining and Contracting. The lowest cost estimate was provided by Blue Range Engineering and they are tentatively selected, pending DEQ approval, to perform the underground activities listed in section 4.2.1.

In our scope of work, information was requested regarding the subcontractor approach to the mine investigation that was based on the requirements listed in Task Order 12 Modification C. The items include the following:

- All equipment necessary for entering the workings;
- Methods for determining if the mine can be safely entered;
- Personnel responsible for accessing mine safety, determining the structural integrity of the mine, and determining if the mine can be safely entered;
- Personnel responsible for entering the mine and performing investigation activities;
- Methods for stabilization of the mine entrance;
- Methods to monitor air quality and provide fresh air to mine workings;
- Methods for securing the mine to prevent unauthorized entry;
- Methods for closing the mine after completion of investigation activities;
- Map showing the proposed locations for all investigation activities, and
- Storage of equipment, placement of excavated materials, and other significant uses of the Site.

These items have only been addressed in the Blue Range Engineering cost estimate submittal and is included in Appendix F. The mine dewatering items listed in Task Order 12 Modification C are addressed in section 4.2.2.2. Other items are not included as the access into the workings is proposed to be performed through the shaft rather than opening the collapsed adit into the Lilly tunnel, as discussed in section 4.2.1. These items are listed below:

- Location and installation of potential sedimentation basins.
- Areas for placement of excavated material.
- Methods for handling water discharge from the mine.

4.2.4 Project Sequence of Operations

Due to the complexity of the site, subcontractors will be necessary to complete the specialized work proposed in this Work Plan. The proposed subcontractors and possible simplified sequence of operations include:

1. TerraGraphics to notify DEQ of start date of field operations and regularly inform them on progress and schedule.
2. Crane subcontractor to attempt to remove the platforms from the shaft or lower them to the bottom of the shaft. If the platforms cannot be removed then the platforms shall be

re-suspended and the investigation will focus primarily on the accessible portions of the Lilly tunnel and open shaft.

- a) If platforms can be removed, they will be placed on the eastern side of the headframe so as to be out of the way of other activities.
 - b) Substrate shall be allowed to spill onto Waste Rock Pile 1, on which the shaft is situated. If needed, the substrate will be dozed to the east of the shaft or allowed to spread over Waste Rock Pile 1.
3. General subcontractor to perform the following work:
 - a) Temporarily remove portions of the chain link fence around the shaft to allow access, if necessary, then replace the fence once the investigations are completed;
 - b) Create drill pads for the drill rig at drilling sites for drilling and installing the monitoring wells;
 - c) Construct the road crossing(s) to protect the discharge pipe; and
 4. Drilling subcontractor will drill and install the monitoring wells.
 5. TerraGraphics will develop the new monitoring wells, rent the transducers, and program them. Water level transducers to be installed per the Hydrogeology Investigation Plan;
 6. Transducers shall record some baseline data prior to the start of the dewatering effort;
 7. Water handling subcontractor will supply the dewatering system; which includes pumps, generator, chemicals, and land application system to discharge the water on site and dewater the underground workings.
 - a) Subcontractor shall train TerraGraphics personnel on use of the system;
 - b) Install land application system; and
 - c) TG shall program the transducers to record logarithmically with the start of pumping.
 8. TerraGraphics shall collect soil and surface water samples as described in the SAP. (See Appendix A).
 9. TerraGraphics shall construct a weir at the entrance to the collapsed Lilly adit and remove the existing weir. TerraGraphics will rent a mini-excavator for this task and install the 4 shallow piezometers per the Hydrogeology Investigation Plan.
 10. Ship soil and water samples to analytical laboratory for evaluations included in the SAP.
 11. Once dewatering has progressed approximately half way, the mine subcontractor can be brought on site to begin their operations.
 12. The mine subcontractor will assess the site hazards associated with safely entering the workings, monitor air quality, ventilate the mine, rehabilitate the shaft, secure the site, and close the site after investigation of the workings is completed.
 - a) Mine subcontractor shall supply their own equipment for monitoring air quality, ventilating the shaft and workings, and rehabilitating the shaft for access.
 - b) Mine subcontractor is also responsible for maintaining a safe work area for the mine investigation activities.
 - c) Mine subcontractor shall escort TerraGraphics personnel on the underground general mapping activities and hydrogeology investigation and sampling in the workings.

13. Once mine investigation activities are completed,
 - a) Stop pumping and recover pump and pipe, and
 - b) Reprogram transducers to record water recovery logarithmically.
14. General subcontractor will perform site cleanup and reclamation when all work is completed.
 - a) If water treatment sludge/reject water volume is relatively large, mix with Quikrete and spread on top of Waste Rock Pile 1; if volume is relatively low, spread over Waste Rock Pile 1;
 - b) Disposal of all trash;
 - c) Reclaim drill pads;
 - d) Reclaim road disturbances, and
 - e) Recover land application hoses and sprinklers.

TerraGraphics will need to coordinate with all the subcontractors to ensure scheduling and operations will take place at the appropriate times. Safety is critical during all aspects of the investigation and subcontractors shall follow their Health and Safety Plans. Daily tailgate safety meetings shall be performed prior to start of work each day.

4.2.5 Roles and responsibilities:

TerraGraphics has prepared scopes of work for each subcontractor type and gathered preliminary cost estimates. DEQ will solicit bids, or DEQ will direct Terragraphics to solicit bids, for all subcontractors. Subcontracted services will follow DEQ procurement requirements. The following subcontractors will perform:

- General Subcontractor;
 - Shall prepare access for the drilling subcontractor and perform any required site improvements required for other activities.
 - Construct road crossing for waterlines, which includes installing conduit or a small diameter culvert large enough to insert up to a 4" waterline.
 - Will dispose of any waste generated during dewatering operations.
 - Will reclaim the disturbances once work is completed, and other items as directed.
- Drilling Subcontractor;
 - Will drill, install, and develop the monitoring wells/piezometers.
- Crane Subcontractor;
 - Shall attempt to remove the platforms from the shaft.
 - Assist dewatering subcontractor in setting pumps and adjusting pumps in the mine.

- Dewatering subcontractor;
 - Shall supply and maintain pump(s), generator, and storage tank(s);
 - Install dewatering system, equipment, and supplies.
 - Supply and install land application system.
 - To pump, treat and discharge water throughout work.
- Mine Subcontractor;
 - Shall perform air quality monitoring and ventilate the workings.
 - Shall access and rehabilitate the shaft to allow access.
 - Shall manage the underground workings while investigations are occurring.
 - Shall Install ladder man-way, and ventilation system.
 - Shall accompany TerraGraphics personnel in the workings for performing the Hydrogeology Investigation.
- TerraGraphics;
 - Shall coordinate with subcontractors and DEQ.
 - Will review all submittals.
 - Install piezometers and develop monitoring wells.
 - Shall map mine, general geology, and water infiltration areas (Hydrogeology Investigation). Measure field parameters of infiltrating water and submit selected samples for analysis.
 - Shall construct new weir and remove old weir.
 - Shall obtain soil and surface water samples.
 - Shall operate pH adjustment and land application system.
 - Shall order fuel and oil and have delivered to site.
 - Shall program and install transducers, monitor ground/surface water,
 - Shall obtain mine water samples during dewatering.
 - Compile and evaluate data and prepare the Phase II RI Report.
 - Sample surface water on a quarterly basis for 4 quarters.

4.3 Projected Reclamation Investigation Costs

The costs associated with completing and implementing the Work Plan consists of;

- Preparing the Work Plan,
- Preparing the SAP,
- Preparing the QAPP,
- Preparing the HASP,
- Preparing the Mine Investigation Plan,
- Preparing the Hydrogeology Plan,
- Gathering cost estimates,
- Site investigation and mapping,
- Field sampling, and
- Analyzing field samples and data.

The selected approximate costs for TerraGraphics and subcontractors are presented in Table 3.

Table 3. Selected Phase II Reclamation Investigation Costs

Contractor	Task Description	Lowest Cost Estimate
TerraGraphics	Identification of Additional Work Items & Prepare Reclamation Work Plan (Task Order 12)	\$73,705.54
Pace Analytical	Analyze Field Samples Collected During RI	\$ 7,522.00
General Subcontractor	See section 4.2.4	up to \$5,000.00
Crane Subcontractor	See section 4.2.4	\$12,500.00
Drilling Subcontractor	See section 4.2.4	\$14,325.00
Dewatering Subcontractor	See section 4.2.4	\$ 61,277.00
Small Crane Subcontractor	Unloading dewatering equipment, setting pump in the shaft, & reloading dewatering equipment onto delivery vehicle	\$4,000.00
Mine Subcontractor	See section 4.2.4	\$18,000.00
Approximate Total		\$196,329.54

Costs provided in Table 3 for TerraGraphics include the total ceiling cost including modification A through D for Task Order No. 12. Additional costs for completing the Phase II Reclamation Investigation include field work oversight and preparing the Phase II RI Report. These costs are being addressed in subsequent task orders. Laboratory costs will be direct-billed to DEQ/MWCB by Pace Analytical. A general cost estimate from Pace for samples submitted as part of the SAP is provided in Appendix G. Their estimate is based on the work described in the SAP (Appendix A).

Section 5.0 REFERENCES CITED

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