

RPT-5006
Rev. 0

**Repository Investigation Report
for the Broken Hill Mine Site,
Sanders County, Montana**

Applicability: Broken Hill Mine Site	Effective Date: 9/30/10	Owner: Alan Dreesbach
For most recent revision or additional information: https://www.portageinc.com/PortageNet/PDCS		Signature: 



REPOSITORY INVESTIGATION REPORT FOR THE BROKEN HILL MINE SITE, SANDERS COUNTY, MONTANA	Identifier: RPT-5006 Revision: 0 Page: 1 of 21
---	--

History of Revisions

Revision	Issue Date	Action	Description

REPOSITORY INVESTIGATION REPORT FOR THE BROKEN HILL MINE SITE, SANDERS COUNTY, MONTANA	Identifier: RPT-5006 Revision: 0 Page: 2 of 21
---	--

Table of Contents

1.	Introduction	5
1.1	Purpose and Scope.....	5
1.2	Project Location.....	5
1.3	Project Understanding	8
2.	Site Background	8
2.1	Climate	8
2.2	Geology, Geomorphology, and Topography	8
2.3	Seismicity and Faults.....	9
2.4	Soils	9
2.5	Hydrology.....	9
2.6	Hydrogeology	9
3.	Field Methods, Procedures, and Observations	10
3.1	Site Reconnaissance	10
3.2	Test Pits	10
3.3	Photographic Log	13
3.4	General Field Observations Pertaining to Soils.....	13
3.5	Groundwater	13
3.6	Bedrock	13
4.	Laboratory Testing Summary.....	14
4.1	Soil Classification.....	14
4.2	Soil Moisture/Density Relationship	14
4.3	Agronomic Tests	16
5.	Conclusions and Recommendations	18
5.1	Repository Siting Summary	18



REPOSITORY INVESTIGATION REPORT FOR THE BROKEN HILL MINE SITE, SANDERS COUNTY, MONTANA	Identifier: RPT-5006 Revision: 0 Page: 3 of 21
---	--

5.2	General Recommendations.....	19
5.2.1	Site Preparation	19
5.2.2	Excavation and Backfill	20
5.2.3	Hydrologic Barrier Materials	20
5.2.4	Dewatering and Stormwater Management.....	20
6.	Report Limitations.....	20
7.	References	21

Figures

Figure 1.	Project location.....	6
Figure 2.	Potential repository site locations.....	7

Tables

Table 1.	Test pit data summary.....	10
Table 2.	Gradation and classification of selected soil samples.....	15
Table 3.	Standard Proctor test results.....	17
Table 4.	Topsoil analytical results.....	19
Table 5.	Background metals concentrations in BHMS soil.....	19
Table 6.	Background metals concentrations in repository site soils.....	20
Table 7.	Fertilizer recommendation.....	20

Appendixes

APPENDIX A – TEST PIT LOGS

APPENDIX B – PHOTOGRAPHIC RECORD AND REPORT ELECTRONIC COPY

APPENDIX C – LABORATORY DATA SHEETS

APPENDIX D – TEST PIT LOCATIONS

ACRONYMS

AMS	Abandoned Mine Section
ASTM	ASTM International
BHMS	Broken Hill Mine Site
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
EEE/CA	expanded engineering evaluation/cost analysis
famsl	feet above mean sea level
FR	Forest Road
GPS	Global Positioning System
GWIC	Groundwater Information Center
MBMG	Montana Bureau of Mines and Geology
DEQ	(Montana) Department of Environmental Quality
MWCB	Mine Waste Cleanup Bureau
PMM	Principal Montana Meridian
RI	remedial investigation
USCS	Unified Soil Classification System
USFS	United States Forest Service

**REPOSITORY INVESTIGATION REPORT
FOR THE BROKEN HILL MINE SITE,
SANDERS COUNTY, MONTANA**

Identifier: RPT-5006
Revision: 0
Page: 5 of 21

1. INTRODUCTION

This document provides information relevant to the geotechnical investigation for the Broken Hill Mine Site (BHMS) repository siting investigation. The investigation was performed for the Montana Department of Environmental Quality (DEQ), Abandoned Mine Section (AMS), to support an expanded engineering evaluation/cost analysis (EEE/CA) on behalf of the AMS. The work was performed under Contract No. 407025, Task Order 8, between DEQ and Portage, Inc.

1.1 Purpose and Scope

The purpose of the geotechnical investigation was to collect, interpret, and report geotechnical information relevant to constructing a mine waste rock repository on National Forest lands near Heron, Montana. The geotechnical investigation scope of work included identifying sites for a potential repository, conducting field surveys, collecting samples, testing representative materials, interpreting test results, and stating pertinent recommendations.

Two sites were initially identified for study through discussions with AMS and United States Forest Service (USFS) staff. During site reconnaissance, USFS personnel stationed in the Kootenai National Forest recommended two additional sites near the BHMS.

The field survey consisted of two components. The first involved demarcating the approximate boundaries of each repository site, based on the estimated acreage required for waste rock encapsulation. The second involved excavating backhoe test pits at each potential repository site location, recording subsurface observations, and collecting representative samples. Throughout the field survey, potential haul routes were evaluated, general site reconnaissance was done, and photographs were taken. After the field investigation was complete, representative soil samples were submitted for laboratory testing.

1.2 Project Location

The project is located near Heron, Montana, northeast of Montana State Highway 200 in the East Fork of Blue Creek drainage. A total of four potential repository sites were investigated. The legal descriptions of the sites are as follows:

- Fatman Saddle in the SE1/4 of the NW1/4 of Section 15, Township 27N, Range 34W, Principal Montana Meridian (PMM), Sanders County, Montana. Fatman Saddle is a prominent saddle off the northeastern flank of Fatman Mountain approximately 1 mile south of the BHMS at an elevation of approximately 3,480 feet above mean sea level (famsl).
- East Fork of Blue Creek Bench in the NW1/4 of the SE1/4 of Section 9, Township 27N, Range 34W, PMM, Sanders County, Montana. The bench is located in the valley floor approximately 1 mile southwest of the BHMS at an elevation of approximately 2,660 famsl.
- Unnamed ridge (Road Bench Site #1) near the BHMS in the SE1/4 of the NW1/4 of Section 15, Township 27N, Range 34W, PMM, Sanders County, Montana. Road Bench Site #1 is located adjacent to Forest Road (FR) 2290 approximately $\frac{3}{4}$ mile south of the BHMS at an elevation of approximately 3,740 famsl.
- Unnamed ridge (Road Bench Site #2) near the BHMS in the SE1/4 of the NW1/4 of Section 15, Township 27N, Range 34W, PMM, Sanders County, Montana. Road Bench Site #2 is located adjacent to FR 2290 approximately $\frac{1}{4}$ mile southwest of the BHMS at an elevation of approximately 3,920 famsl.

**REPOSITORY INVESTIGATION REPORT
FOR THE BROKEN HILL MINE SITE,
SANDERS COUNTY, MONTANA**

Identifier: RPT-5006
Revision: 0
Page: 6 of 21

Figure 1 shows the location of the BHMS within Montana, and Figure 2 shows potential repository site locations in relation to the BHMS.

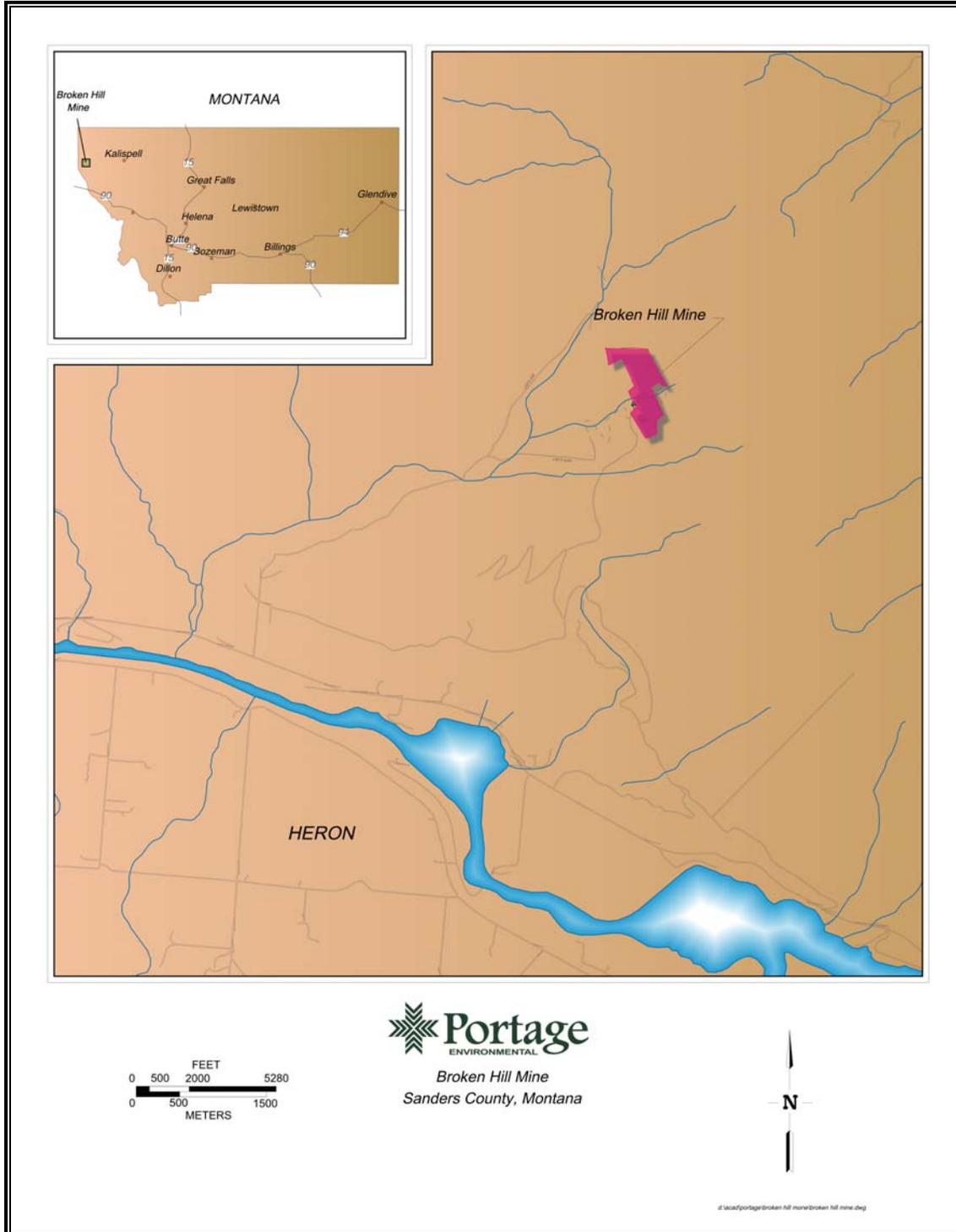


Figure 1. Project location.

(Base Map: 1:24,000 Scale Digital Format Map, Heron, Montana, United States Geological Survey 1983)

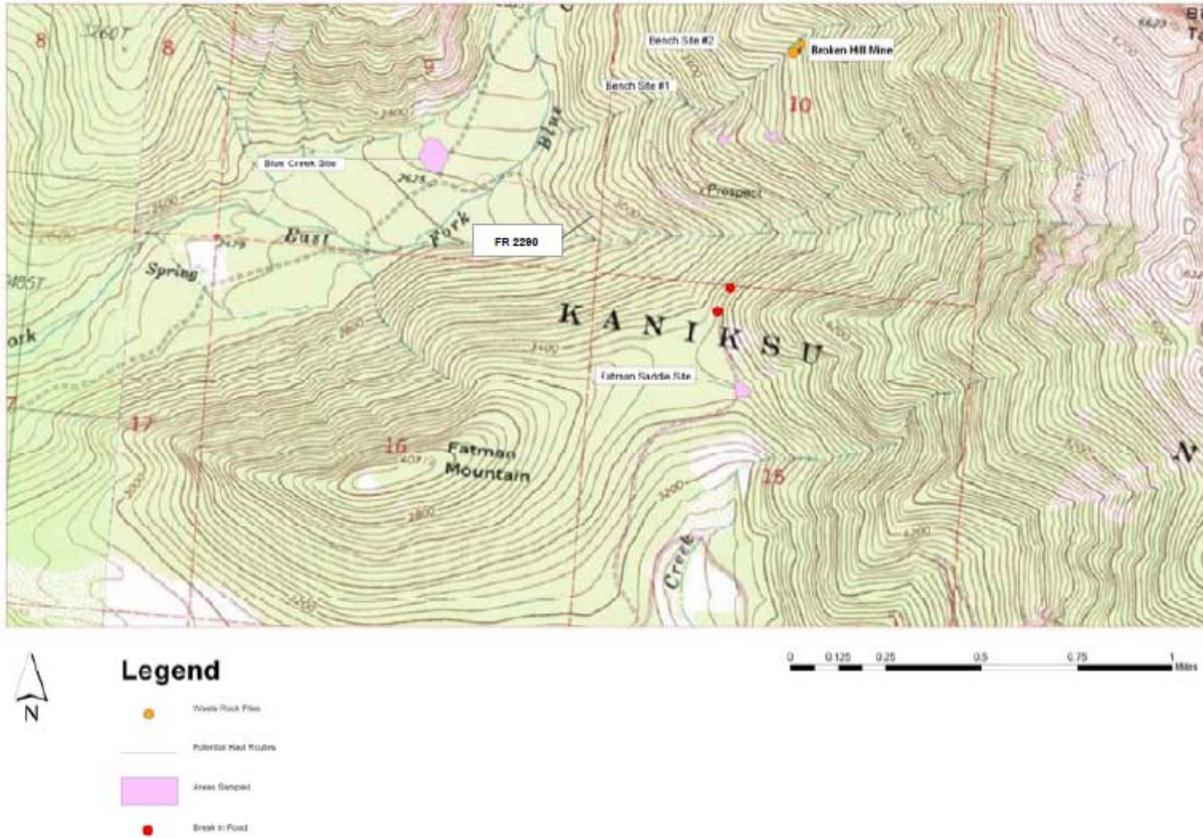


Figure 2. Potential repository site locations.
(Base Map: 1:24,000 Scale Digital Format Map, Heron, Montana, United States Geological Survey 1983)

1.3 Project Understanding

This geotechnical site investigation was performed to support siting of a mine waste rock repository on USFS property near Heron, Montana. The total site waste rock volume is approximately 4,100 yd³, with approximately 3,100 yd³ of the waste located on USFS property and the remaining 1,000 yd³ located on private land.

2. SITE BACKGROUND

This section provides relevant background information of the Heron, Montana, area from readily available sources.

2.1 Climate

The climate of the BHMS is based on the nearest climate station at Heron, Montana. Average monthly temperatures range from an average high of 82.9°F in July to an average low of 18.4°F in January. The average annual high temperature is 56.4°F and the average annual low temperature is 32.0°F. Average annual total precipitation is 33.6 in. per year with the majority of precipitation occurring as snow between the months of November and April. Average annual snowfall is 85.7 in. (Western Regional Climate Center 2010). The BHMS is located in mountainous terrain at an elevation approximately 1,000 ft higher than Heron, which may increase total annual precipitation and total precipitation as snowfall.

2.2 Geology, Geomorphology, and Topography

During the Proterozoic Era, a shallow subsiding marine basin formed in northwestern Montana where great thicknesses of homogeneous sand, silt, clay, and carbonate sediments accumulated. Low-grade regional metamorphism later indurated these sediments into a mixture of resistant quartzites, siltites, argillites, and limestones; this thick sequence of fine-grained, quartzite-rich calcareous and non-calcareous rocks is the Belt Series. The Belt Series is subdivided into four general groups in ascending order: Lower Belt or Pre-Ravalli, Ravalli, Middle Belt Carbonate, and Missoula Groups (Montana Agricultural Experiment Station and United States Department of Agriculture 1980). The BHMS is in the Ravalli Group. The Montana Bureau of Mines and Geology (MBMG) reported that selected dump samples at the BHMS contained pyrite, pyrrhotite, sphalerite, galena, chalcopyrite, and arsenopyrite. They are present in a gangue of quartz, tourmaline, and tremolite.

The BHMS and three of the repository sites investigated are significantly elevated above the valley floor and associated alluvial deposits. The repository site investigated near the East Fork of Blue Creek is at the lowest elevation (of the sites investigated) and is located on a bench bounded by the East Fork of Blue Creek to the southeast and apparent ephemeral drainage to the northwest. The bench subsurface consists of alluvial outwash associated with the East Fork of Blue Creek and the narrow canyon draining its headwaters.

Site topography is characterized by steep mountainous terrain rising from a narrow valley floor draining the East Fork of Blue Creek. FR 2290 begins at an elevation of 2,625 famsl at its junction with FR 409 and terminates at an elevation of approximately 3,320 famsl near the BHMS. Billiard Table Mountain is a prominent peak northeast of the BHMS at an elevation of 6,622 famsl.

2.3 Seismicity and Faults

The dominant geologic feature of the district is the Hope fault, a large northwest-trending transverse fault that extends from at least Hope, Idaho, to Heron, Montana (MBMG 1963). The nearest Quaternary fault shown in current geological literature is the Bull Lake Fault. The Bull Lake Fault is a generally west-east-trending normal fault with the east end located near the Bull River approximately 3 mi north-northeast of the BHMS (Stickney et al. 2000).

2.4 Soils

Hard, fine-grained Belt Series rocks typically weather to fine sandy or loamy soils with high percentages of coarse fragments. Most soils are weakly developed. These Sharrott series soils consist of shallow residual or colluvial soils developed on the moderately-sloping-to-steep ridges and mountain slopes of hard thinly-bedded argillite at an elevation of 3,000 to 4,500 ft. They are well-drained soils with medium runoff and moderate permeability ranging from 0.6 to 2.0 in./hour. Depth to bedrock is typically 4 to 20 in., and coarse fragment content is 50 to 80%. Clay content is usually 5 to 20%. They are slightly sticky (after pressure, soil adheres to both thumb and finger and tends to stretch somewhat before pulling apart) to slightly plastic (moderate pressure is required to deform soil mass) when wet. Soils may be classified as a loamy-skeletal, mixed Lithic Ustocrept (Montana Agricultural Experiment Station and United States Department of Agriculture 1980).

2.5 Hydrology

The BHMS is located within the watershed of an unnamed, ephemeral tributary to the East Fork of Blue Creek. The unnamed tributary lies 100 ft to the north of the BHMS and reaches its confluence with the East Fork of Blue Creek approximately 0.75 mile downstream from the BHMS. The unnamed tributary begins approximately 4,000 ft upstream from the BHMS (United States Geological Survey 1997).

The East Fork of Blue Creek reaches its confluence with Blue Creek 2 mi from its confluence with the unnamed tributary. Blue Creek empties into Cabinet Gorge Reservoir of the Clark Fork River 0.5 mi from the confluence of the East Fork with Blue Creek proper.

2.6 Hydrogeology

The MBMG Groundwater Information Center (GWIC) database lists one well log within a 1-mile radius of the BHMS. The well is located 1 mile to the northwest in Section 2 of Township 27 North and Range 34 West. The well has a static water level of 92 ft below ground surface and a yield of five gallons per minute and is used for domestic purposes (MBMG 2010). There are no lithologic details available for this well. The GWIC database lists 35 well logs within a 4-mi radius of the BHMS (MBMG 2010).

3. FIELD METHODS, PROCEDURES, AND OBSERVATIONS

This section describes methods and procedures used in the field to collect relevant geotechnical investigation data. The field investigation was conducted May 4–7, 2010, and monitored by Ray Schwaller, P.E. (Portage), and Jacqueline Janosko, E.I. (Portage).

3.1 Site Reconnaissance

Visual reconnaissance of the project area was conducted. Potential geotechnical concerns such as bedrock, seeps, slumps, boggy areas, peat, unstable areas, or excessive erosion were sought and noted if encountered. Further discussion and recommendations regarding general site considerations are addressed in later sections of this report. Prior to the geotechnical investigation, Portage surveyed approximate repository site boundaries and locations for test pits within the boundaries using the Global Positioning System (GPS).

3.2 Test Pits

A total of 29 test pits were excavated on May 4–7, 2010, within the proposed repository site areas. Test pits were excavated with a Bobcat 442 tracked excavator equipped with a 3-ft-wide bucket. The equipment operator was Quentin Jensen, Owner, BBQ Excavation, of Heron, Montana. Table 1 contains a summary of test pit subsurface conditions, and Appendix A contains individual logs describing the subsurface conditions and soils encountered while excavating test pits.

Table 1. Test pit data summary.

TP No.	Location	Total Depth (ft)	Depth (ft) / Material Description
TP-01	SW part of Fatman Saddle Site	19.0	0.0 – 1.0 topsoil 1.0 – 19.0 angular rocky soil
TP-02	NW corner of Fatman Saddle Site	12.0	0.0 – 1.5 topsoil 1.5 – 12.0 angular rocky soil large rock (possibly bedrock) at 12.0
TP-03	NE corner of Fatman Saddle Site	5.0	0.0 – 1.5 topsoil 1.5 – 5.0 angular rocky soil bedrock at 5.0
TP-04	north-center of Fatman Saddle Site	8.0	0.0 – 3.5 topsoil 3.5 – 8.0 angular rocky soil bedrock at 8.0
TP-05	north-center of Fatman Saddle Site	9.5	0.0 – 2.0 topsoil 2.0 – 9.5 angular rocky soil bedrock at 9.5

**REPOSITORY INVESTIGATION REPORT
FOR THE BROKEN HILL MINE SITE,
SANDERS COUNTY, MONTANA**

Identifier: RPT-5006
Revision: 0
Page: 11 of 21

Table 1. (continued).

TP No.	Location	Total Depth (ft)	Depth (ft) / Material Description
TP-06	center of Fatman Saddle Site	7.0	0.0 – 2.0 topsoil 2.0 – 7.0 angular rocky soil bedrock at 7.0
TP-07	approx. center of Fatman Saddle Site	9.0	0.0 – 2.0 topsoil 2.0 – 9.0 angular rocky soil bedrock at 9.0
TP-08	west-center of Fatman Saddle Site	11.0	0.0 – 2.0 topsoil 2.0 – 11.0 angular rocky soil bedrock at 11.0
TP-09	east-center of Fatman Saddle Site	10.0	0.0 – 2.0 topsoil 2.0 – 10.0 angular rocky soil bedrock at 10.0
TP-10	south-center of Fatman Saddle Site	12.0	0.0 – 1.5 topsoil 1.5 – 12.0 angular rocky soil
TP-11	east corner of Blue Creek Bench Site	8.5	0.0 – 1.5 topsoil 1.5 – 8.5 sub-rounded rocky soil rock (possibly bedrock) at 8.5
TP-12	north corner of Blue Creek Bench Site	8.0	0.0 – 2.0 topsoil 2.0 – 8.0 sub-rounded rocky soil rock (possibly bedrock) at 8.0
TP-13	west corner of Blue Creek Bench Site	9.5	0.0 – 1.5 topsoil 1.5 – 9.5 sub-rounded rocky soil
TP-14	approx. center of Blue Creek Bench Site	10.5	0.0 – 2.0 topsoil 2.0 – 10.5 sub-rounded rocky soil large rocks at bottom of test pit
TP-15	south corner of Blue Creek Bench Site	11.0	0.0 – 1.5 topsoil 1.5 – 11.0 sub-rounded rocky soil large rocks at bottom of test pit
TP-16	west corner of Road Bench Site #1	5.5	0.0 – 1.0 topsoil 1.0 – 5.5 fractured angular rock hard bedrock at 5.5

**REPOSITORY INVESTIGATION REPORT
FOR THE BROKEN HILL MINE SITE,
SANDERS COUNTY, MONTANA**

Identifier: RPT-5006
Revision: 0
Page: 12 of 21

Table 1. (continued).

TP No.	Location	Total Depth (ft)	Depth (ft) / Material Description
TP-17	west center of Road Bench Site #1	9.0	0.0 – 1.0 topsoil 1.0 – 5.0 angular rock and silt 5.0 – 9.0 friable shale bedrock at 9.0
TP-18	north corner of Road Bench Site #1	8.0	0.0 – 1.5 topsoil 1.5 – 5.5 angular rock and silt 5.5 – 8.0 silty clay
TP-19	SW corner of Road Bench Site #1	3.5	0.0 – 0.5 topsoil 0.5 – 3.5 angular rock and silt bedrock at 3.5
TP-20	approx. center of Road Bench Site #1	4.0	0.0 – 1.0 topsoil 1.0 – 4.0 angular rock and silt bedrock at 4.0
TP-21	SW center of Road Bench Site #1	7.0	0.0 – 1.0 topsoil 1.0 – 7.0 angular rock and silt bedrock at 7.0
TP-22	SW corner of Road Bench Site #1	7.0	0.0 – 1.0 topsoil 1.0 – 7.0 angular rock and silt bedrock at 7.0
TP-23	east center of Road Bench Site #1	5.5	0.0 – 1.0 topsoil 1.0 – 5.5 angular rock and silt bedrock at 5.5
TP-24	east corner of Road Bench Site #1	4.5	0.0 – 1.0 topsoil 1.0 – 4.5 angular rock and silt bedrock at 4.5
TP-25	east corner of Road Bench Site #2	12.0	0.0 – 1.0 topsoil 1.0 – 12.0 angular rock and silty sand
TP-26	north corner of Road Bench Site #2	9.0	0.0 – 2.0 topsoil 2.0 – 9.0 angular rock and silt

REPOSITORY INVESTIGATION REPORT FOR THE BROKEN HILL MINE SITE, SANDERS COUNTY, MONTANA	Identifier: RPT-5006 Revision: 0 Page: 13 of 21
---	---

Table 1. (continued).

TP No.	Location	Total Depth (ft)	Depth (ft) / Material Description
TP-27	north corner of Road Bench Site #2	9.0	0.0 – 2.0 topsoil 2.0 – 9.0 angular rock and silt
TP-28	approx. center of Road Bench Site #2	7.0	0.0 – 1.0 topsoil 1.0 – 7.0 angular rock and silt hard rock (possibly bedrock) at 7.0
TP-29	west corner of Road Bench Site #2	10.0	0.0 – 2.0 topsoil 2.0 – 10.0 angular rock and silt

3.3 Photographic Log

A photographic record of test pit profiles, representative soil materials, and other relevant site information was made during the field reconnaissance and when collecting soils information. Photographs are provided separately on compact disk (digital format), which are attached in Appendix B.

3.4 General Field Observations Pertaining to Soils

Some general observations regarding the overall soil and subsurface conditions are as follows:

- There is, on average, at least 1 ft of topsoil suitable for site reclamation purposes at each potential repository site.
- The earth materials (above bedrock) were generally excavated without difficulty when digging test pits at each potential repository site.
- Residual soils at each potential repository site, at depth, typically consist of angular rock with some fines. The shear strength and bearing capacity of this material is expected to be relatively high.

3.5 Groundwater

Groundwater or seeps were not encountered within test pits during this investigation. Also, saturated soils or other evidence of seasonally high groundwater was not observed in test pits. All subsurface materials appeared well drained.

3.6 Bedrock

Fractured bedrock was encountered within the test pits at varying depths at each potential repository site during this investigation. Hard bedrock was found at depths ranging from 3.5 ft at Road

Bench Site 2 to over 19.0 ft at Fatman Saddle, with the average expected depth to lie within the range of 5 ft to 10 ft at many locations onsite.

4. LABORATORY TESTING SUMMARY

Upon completion of the field investigation, soil samples and field logs were examined to determine representative and appropriate materials for testing. Because subsurface conditions were relatively uniform across all sites, the samples submitted for analysis were not from each individual site, but were representative of the different material groupings observed across all sites. This section describes laboratory tests that were conducted on the samples selected. The samples were tested by Pioneer Technical Services (Helena, Montana) for geotechnical properties and by Energy Laboratories (Helena, Montana) for agronomic properties. Tables 2 and 3 summarize the geotechnical test results; laboratory data sheets are found in Appendix C.

4.1 Soil Classification

Ten representative soil samples were submitted to the laboratory for engineering classification tests under the Unified Soil Classification System (USCS). Particle size distribution and Atterberg limits tests conforming to ASTM International (ASTM) standards (ASTM D422 and D4318) were performed to determine the soil classification under the USCS.

Classification provides general information regarding the suitability of the soil for various engineering purposes. Engineering properties include (but are not limited to) shear strength, compressibility, hydraulic conductivity, and susceptibility to frost or erosion. Additionally, empirical relationships can be used to estimate saturated hydraulic conductivity based on particle size distribution. Finally, particle size distribution provides data necessary for determining soil filter criteria for compatibility with drainage media.

For each sample, only the fraction passing the 3-in. sieve was used for laboratory analysis (i.e., cobbles and boulders are not included). Table 2 summarizes the soil sample gradation and classification test results.

4.2 Soil Moisture/Density Relationship

Three representative soil samples were submitted for testing the soil moisture/density relationship per the standard Proctor Test (ASTM D698 and D4718). Standard Proctor, specific gravity, and moisture content data are used to calculate void ratio and porosity of soils compacted to a specified density. From these parameters, the hydrologic properties and performance of proposed final cover materials can be evaluated. Also, the soil moisture/density relationship and initial moisture content are important geotechnical information (and have cost implications) for contractors bidding on construction projects.

All samples submitted to the laboratory were tested for field moisture content, representing conditions at the time of collection. Table 3 summarizes standard Proctor test results for the three soil samples. The results show maximum dry density and optimum moisture content, both corrected for oversize (+ ¾-in.) material.



**REPOSITORY INVESTIGATION REPORT
FOR THE BROKEN HILL MINE SITE,
SANDERS COUNTY, MONTANA**

Identifier: RPT-5006
Revision: 0
Page: 15 of 21

Table 2. Gradation and classification of selected soil samples.

Sample ID No.	Repository Location	Location / Depth	Percent Gravel	Percent Sand	Percent Fines	Atterberg Limits	USCS Classification
TP-01-B	Fatman Saddle Site	TP-01 / 1.0 - 19.0	67.4	29.2	3.4	LL=23, PI=18	GW
TP-02-A	Fatman Saddle Site	TP-02 / 0.0 - 0.5	21.8	19.9	58.3	LL=71, PI=65	MH
TP-02-B	Fatman Saddle Site	TP-02 / 0.5 - 1.5	28.2	20.4	51.4	NP	ML
TP-12-A	Blue Creek Bench Site	TP-12 / 0.0 - 2.0	27.7	28.9	43.3	NP	SM
TP-12-B	Blue Creek Bench Site	TP-12 / 2.0 - 12.0	51.7	43.8	4.6	NP	GP
TP-18-A	Road Bench Site #1	TP-18 / 0.0 - 1.5	19.7	19.0	61.3	NP	ML
TP-18-B	Road Bench Site #1	TP-18 / 1.5 - 8.0	38.8	29.2	32.0	LL=25, PI=22	GM
TP-25-A	Road Bench Site #2	TP-25 / 0.0 - 1.0	13.9	26.5	59.6	NP	ML
TP-25-B	Road Bench Site #2	TP-25 / 1.0 - 12.0	40.6	31.1	28.3	NP	GM
TP-29-B	Road Bench Site #2	TP-29 / 2.0 - 10.0	64.3	21.4	14.3	LL=22, PI=20	GM

LL = liquid limit, PI = plasticity index, NP = non plastic

- GW = well-graded gravels, gravel-sand mixtures, little or no fines
- GP = poorly-graded gravels, gravel-sand mixtures, little or no fines
- GM = silty gravels, gravel-sand mixtures
- SM = silty sands, sand-silt mixtures
- ML = inorganic silts, and very fine sands, rock flour, silty or clayey fine sands, or clayey silts with slight plasticity
- MH = inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.

Table 3. Standard Proctor test results.

Sample ID No.	Repository Location	Location / Depth	Material Description	Specific Gravity	Maximum Dry Density (pcf)	Optimum Moisture Content (%)	Field Moisture Content (%)
TP-01-B	Fatman Saddle Site	TP-01 / 1.0 - 19.0	well-graded gravel with sand	2.76	136.6	7.8	6.1
TP-18-B	Road Bench Site #1	TP-18 / 1.5-8.0	silty gravel with sand	2.73	124.7	9.5	12.8
TP-25-B	Road Bench Site #2	TP-25 / 1.0-12.0	silty gravel with sand	2.63	121.3	9.7	15.0

REPOSITORY INVESTIGATION REPORT FOR THE BROKEN HILL MINE SITE, SANDERS COUNTY, MONTANA	Identifier: RPT-5006 Revision: 0 Page: 16 of 21
---	---

4.3 Agronomic Tests

Agronomic tests were performed on six topsoil samples. Agronomic tests are performed on soils proposed for use as topsoil during site reclamation. The agronomic tests classify soils per United States Department of Agriculture standards, aiding in selection of suitable species for vegetative cover on the repository and surroundings. The tests can also be used to determine the appropriate concentration and type of fertilizer or other soil amendments, if needed.

Topsoil was found at each site, ranging in depths from 0.5 ft to 3.5 ft, with typically at least 1.0 ft present in many locations. In many locations, the topsoil occurs in two distinct layers that are easily segregated by color. The upper topsoil layer is very dark (nearly black) in color and consists of a silt loam soil with substantial amounts of roots and plant matter present. The lower topsoil layer has a light-brown-to-reddish-brown color and consists of a silt loam soil with lesser amounts of roots and other plant matter. Topsoil at all of the potential repository sites was substantially vegetated.

For testing purposes, the two samples identified as TP-02-A and TP-02-B, Fatman Saddle Site, represent the two distinct topsoil layers. The remaining samples tested for agronomic purposes consist of a composite of both topsoil layers. The laboratory test data are attached in Appendix C.

Table 4 presents the analytical results of topsoil testing compared to the requirements of DEQ Standard Specification 310.02 (DEQ 2003) for topsoil. Based on this comparison, topsoil at all sites should be suitable for use as repository cover material and growth medium once recommended fertilizer amendments have been performed. The analytical data show that soil at all sites is acidic with relatively low neutralization potential. However, soils at all sites have very low acid potential, and the acid/base potential is positive (non acid producing) at each site. With the exception of pH, all analytical parameters are within the requirements of DEQ Standard Specification 310.02.

Table 5 shows the analytical results of background metals sampling at the BHMS performed during the remedial investigation (RI) of the site (Portage 2010). The RI results indicate highly mineralized topsoil in and around the BHMS. Arsenic, lead, manganese, and zinc all exceeded the requirements of DEQ Standard Specification 310.02 for topsoil. Based on this result, Portage submitted representative topsoil samples from all four potential repository sites to the contract analytical laboratory for arsenic, lead, manganese, and zinc analysis. Table 6 shows the results of these analyses. As shown in Table 6, manganese exceeds the requirements of DEQ Standard Specification 310.02 for topsoil at each potential repository site. The elevated manganese is apparently background for area soils and therefore Portage does not recommend using alternative sources of topsoil that meet the standard. Each site was well vegetated, indicating that area soils can support a mix of native vegetation that would be established on reclaimed surfaces after repository construction.

Table 7 presents the fertilizer amendment recommendation based on the laboratory test results for potassium, nitrate, phosphorus, ammonia, zinc, and sulfur. Fertilizer amendments reported by the contract laboratory are for grasses and may be modified based on the seed mix specified by the USFS for reclamation.



**REPOSITORY INVESTIGATION REPORT
FOR THE BROKEN HILL MINE SITE,
SANDERS COUNTY, MONTANA**

Identifier: RPT-5006
Revision: 0
Page: 17 of 21

Table 4. Topsoil analytical results.

Sample ID No.	Repository Location	% Sand	% Silt	% Clay	% Gravel	Soil pH	% Organic Content	Electrical Conductance (mmhos/cm)	Acid/Base Potential (t/kt)
TP-02-A	Fatman Saddle Site	24	66	10	0	4.9	4.92	0.13	6
TP-02-B	Fatman Saddle Site	24	68	8	0	4.9	2.70	0.06	3
TP-12-A	Blue Creek Bench	30	60	10	0	4.8	4.99	0.10	5
TP-18-A	Road Bench Site #1	24	70	6	0	5.3	3.31	0.09	5
TP-25-A	Road Bench Site #2	22	70	8	0	5.8	2.77	0.14	5
TP-29-A	Road Bench Site #2	26	66	8	0	5.2	3.06	0.10	3
DEQ Specification 310.02		70 (max)	70 (max)	40 (max)	20 (total Sample)	5.5 – 8	1 – 20	<4	Not acid forming

Table 5. Background metals concentrations in BHMS soil (mg/kg).

Analyte	DEQ Specification 310.02	Mean Background	BHMS-BG-1 Background	BHMS-BG-2 Background	BHMS-BG-3 Background
Arsenic	30	44	28	67	36
Cadmium	4	1	1	1	1
Copper	100	13	12	14	24
Lead	100	560	350	309	1,020
Manganese	250	1,720	2,510	1,430	1,220
Zinc	250	257	205	162	404

REPOSITORY INVESTIGATION REPORT FOR THE BROKEN HILL MINE SITE, SANDERS COUNTY, MONTANA	Identifier: RPT-5006 Revision: 0 Page: 18 of 21
---	---

Table 6. Background metals concentrations in repository site soils (mg/kg).

Analyte	DEQ Specification 310.02	Mean	TP-01-A (Fatman Saddle)	TP-11-A (Blue Creek Bench)	TP-16-A (Road Bench Site #1)	TP-28-A (Road Bench Site #2)	TP-29-A (Road Bench Site #2)
Arsenic	30	7.4	7	13	5	7	5
Lead	100	11.8	12	15	11	11	10
Manganese	250	624.4	766	367	896	736	357
Zinc	250	56.8	48	46	56	60	74

Table 7. Fertilizer recommendation (lb/acre).

Sample ID No.	Repository Location	Total Nitrogen	Phosphorus (P ₂ O ₅)	Potassium (K ₂ O)	Zinc
TP-02-A	Fatman Saddle Site	25	20	30	0
TP-02-B	Fatman Saddle Site	25	30	40	3
TP-12-A	Blue Creek Bench	25	50	20	2
TP-18-A	Road Bench Site #1	25	50	0	3
TP-25-A	Road Bench Site #2	25	0	0	0
TP-29-A	Road Bench Site #2	25	50	20	2

5. CONCLUSIONS AND RECOMMENDATIONS

This section discusses the conclusions and recommendations relevant to constructing a repository for the BHMS waste rock.

5.1 Repository Siting Summary

In consideration of the geotechnical observations and data, each of the four sites would be suitable for constructing a waste rock repository. From a geotechnical engineering perspective, the soil types and subsurface conditions were not significantly different among the four sites investigated. The main exception to this is that the rocks found at the Blue Creek Bench Site were alluvial, and therefore more rounded than the angular (residual or colluvial) rocks found at the other sites.

Bedrock depths are generally great enough to accommodate the engineering design of balanced cut/fill earthwork, with cut materials utilized as general fill for shaping the repository and surroundings. A sufficient quantity of topsoil is available at each site to cover and reclaim the surface upon completion.

A hydrogeologic investigation was not conducted as part of the geotechnical investigation but, as noted, no groundwater was encountered during test pit excavation and no seasonal groundwater influence was evident at the point of excavator refusal (bedrock).

REPOSITORY INVESTIGATION REPORT FOR THE BROKEN HILL MINE SITE, SANDERS COUNTY, MONTANA	Identifier: RPT-5006 Revision: 0 Page: 19 of 21
---	---

The topography of Road Bench Sites #1 and #2 provides the most opportunity for creation of a naturally appearing land feature for repository construction. This is because each of these sites is located on a sloping ridge into which the repository cut and fill can be contoured into the slope. At the Blue Creek Bench Site and to a lesser extent the Fatman Saddle Site, the repository would be a mounded landform.

Haul distance is the least to Road Bench Site #2 (approximately ¼ mi) and potentially farthest to the Fatman Saddle Site. FR 2290, which could potentially connect the BHMS to Fatman Saddle, is discontinuous because of rock outcroppings and steep terrain. Significant road improvements would be required to use FR 2290 as a haul route. Steep grades and switchbacks on FR 2290 also create a challenging haul to the Blue Creek Bench Site.

Each site has sufficient area for repository construction (at least ¾ acres) with Road Bench Site #2 having the least usable acreage and the Blue Creek Bench Site having the most useable acreage. Potential geotechnical concerns such as exposed or excessively shallow bedrock, seeps, slumps, boggy areas, peat, unstable areas, or excessive erosion were not encountered during site investigations.

Because no one site has an advantage over another based on geotechnical considerations, the choice of a preferred repository site is based on factors which affect cost (haul distance), environmental concerns, visual impact, and others. These factors will be fully analyzed in the BHMS EEE/CA for each repository site. Based on the results of this investigation, however, Portage recommends Road Bench Site #2 as the preferred repository site. This recommendation is supported by the following:

- Road Bench Site #2 is nearest the BHMS and will involve the shortest haul, reducing project construction costs and environmental impacts from truck traffic.
- Road Bench Site #2 is likely to be more hydrologically isolated than either the Blue Creek Bench or Fatman Saddle sites because it is higher in elevation and farther away from surface water.
- Road Bench Site #2 will have less visual impact than other sites because of the following: the repository can be shaped into the topography of the bench, the site will require the least clearing and grubbing, and the site will require minimal road improvements.

5.2 General Recommendations

The following sections provide general recommendations with respect to the soil/subsurface conditions and intended site use.

5.2.1 Site Preparation

Each of the sites requires clearing and grubbing before earthwork can proceed. Large root balls and thick brush should be removed from the work area, but smaller roots, branches, and other vegetative matter may be included in the topsoil. It is recommended that, within the repository excavation limits, topsoil be stripped down to the rocky subsoil and stockpiled for later use. Given the relatively shallow bedrock and rocky subsoils, the subgrade bearing capacity likely exceeds 5,000 psf and settlement from the repository is expected to be imperceptible.



REPOSITORY INVESTIGATION REPORT FOR THE BROKEN HILL MINE SITE, SANDERS COUNTY, MONTANA	Identifier: RPT-5006 Revision: 0 Page: 20 of 21
---	---

5.2.2 Excavation and Backfill

It is recommended that excavated slopes are kept to 1.5:1 (H:V) or flatter. To minimize settlement and maintain stable final slopes, backfill should be placed in loose lifts not exceeding 8 in. in thickness and uniformly compacted to a minimum of 95% of maximum dry density per standard Proctor (ASTM D 698), within 2% of optimum moisture content. Generally, the rocky soils are expected to make suitable backfill materials; however, any geosynthetic and/or any piping installed in the repository must be isolated and protected from rocks $\frac{3}{4}$ in. or greater in size.

5.2.3 Hydrologic Barrier Materials

Earth materials suitable for use as hydrologic barriers in the waste repository were not found in significant quantities during the site investigations. Soil containing larger quantities of fines (silt or clay) was found in a few test pits, but no extensive source of this material was observed (excluding topsoil). It is recommended that hydrologic barriers be constructed of geosynthetic materials, imported soils, or selected soils from onsite that are screened to remove rocks and blended with an appropriate amendment (i.e., granulated bentonite).

5.2.4 Dewatering and Stormwater Management

Based on the observed subsurface conditions (no springs or seeps observed in May 2010), dewatering during the repository construction is not anticipated. However, stormwater management, including construction of the run-on control berm and the use of best management practices are recommended during construction and while vegetation is re-established.

6. REPORT LIMITATIONS

This geotechnical report does not address any special considerations for waste materials management, environmental compliance, or worker health and safety. Such issues, while important, are outside the scope of this report.

This report has been prepared in accordance with generally accepted geotechnical engineering practices in this area within project budget constraints. Preliminary recommendations submitted in this report are based upon data obtained from a limited number of test pits. Conclusions and recommendations presented in this report assume that site conditions do not substantially differ from those exposed during the subsurface investigations.

The earthwork phases of construction should be monitored by a qualified Professional Engineer. This is to assure that subsurface conditions are compatible with those used to develop geotechnical engineering analyses and recommendations.

This report should be made available to prospective contractors for information on factual data only, and not as a warranty of subsurface conditions. Additional investigation by bidders and contractors is encouraged for developing bids and confirming subsurface conditions for construction purposes.

REPOSITORY INVESTIGATION REPORT FOR THE BROKEN HILL MINE SITE, SANDERS COUNTY, MONTANA	Identifier: RPT-5006 Revision: 0 Page: 21 of 21
---	---

7. REFERENCES

- Montana Agricultural Experiment Station and United States Department of Agriculture, 1980, "Geologic Parent Materials of Montana Soils," Bulletin 721, Montana Agricultural Experiment Station and U.S. Department of Agriculture, November 1980.
- MBMG (Montana Bureau of Mines and Geology), 1963, "Mines and Mineral Deposits of Sanders County, Montana," Bulletin 34, F.A. Crowley, Montana Bureau of Mines and Geology, May 1963.
- MBMG, 2010, GWIC Web site, <http://mbmggwic.mtech.edu/>.
- MDEQ (Montana Department of Environmental Quality), 2003, Standard Specification 310.02.
- Portage, Inc., 2010, *Reclamation Investigation Report for the Broken Hill Mine Site*, Sanders County, Montana, January 2010.
- Stickney, Haller, Machette, 2000, *Map of Quaternary Faults and Seismicity in Western Montana*, Special Publication No. 114, Montana Bureau of Mines and Geology.
- United States Geological Survey, 1983, Base Map: 1:24,000 Scale Digital Format Map, Heron, Montana, Montana Natural Resources Information System Web Site:
<http://nris.state.mt.us/nsdi/drgpages/tif100utm.html>.
- United States Geological Survey, 1997, 7.5 Minute Quadrangle Map, Heron, Montana.
- Western Regional Climate Center, 2010, Web Site: <http://www.wrcc.dri.edu/cgi-bin/cliMAIN.pl?mt4084>, Historical Climate Information for Heron 2 NW, Montana (244084).



**REPOSITORY INVESTIGATION REPORT
FOR THE BROKEN HILL MINE SITE,
SANDERS COUNTY, MONTANA**

Identifier: RPT-5006
Revision: 0
Page: A-1 of A-30

**APPENDIX A
TEST PIT LOGS**

REPOSITORY INVESTIGATION REPORT FOR THE BROKEN HILL MINE SITE, SANDERS COUNTY, MONTANA	Identifier: RPT-5006 Revision: 0 Page: A-2 of A-30
---	--

**Broken Hill Mine Reclamation Project
Potential Repository Site Investigations
Geotechnical Test Pit Log**

Test Pit Excavation Date: May 4, 2010
Logged By: Ray Schwaller, P.E.
Equipment: Bobcat 442 tracked excavator w/36-in.-wide bucket
Test Pit Number: TP-01
General Location: Southwest part of southeast Fatman Saddle site

Depth (ft)	Materials/Observations	Comments
Surface	Very sparse vegetation	Next to roadway
0.0 – 1.0	Silty topsoil; medium-dark brown; moist	Topsoil layer varies from 6 to 18 in. thick.
1.0 – 19.0 T.D. = 19.0	Angular rock and coarse sand with a trace of fines; tan to reddish brown; moist to very moist. Some layers with greater amounts of clayey fines. Relatively easy digging.	No groundwater or seeps present in the test pit.



REPOSITORY INVESTIGATION REPORT FOR THE BROKEN HILL MINE SITE, SANDERS COUNTY, MONTANA	Identifier: RPT-5006 Revision: 0 Page: A-3 of A-30
---	--

**Broken Hill Mine Reclamation Project
Potential Repository Site Investigations
Geotechnical Test Pit Log**

Test Pit Excavation Date: May 4, 2010
Logged By: Ray Schwaller, P.E.
Equipment: Bobcat 442 tracked excavator w/36-in.-wide bucket
Test Pit Number: TP-02
General Location: Northwest corner of Fatman Saddle site

Depth (ft)	Materials/Observations	Comments
Surface	Forested land	Next to roadway
0.0 – 1.0	Silty topsoil; medium-dark brown; moist	Topsoil layers vary from 6 to 18 in. thick.
1.0-1.5	Silt with few coarse rocks; light brown to reddish brown; moist	Topsoil layers vary from 6 to 18 in. thick.
1.5 – 12.0 T.D. = 12.0 (possible bedrock)	Angular rock and very coarse sand with a trace of fines; tan to reddish brown; moist to very moist. Some layers with greater amounts of clayey fines. Relatively easy digging.	No groundwater or seeps present in the test pit.



REPOSITORY INVESTIGATION REPORT FOR THE BROKEN HILL MINE SITE, SANDERS COUNTY, MONTANA	Identifier: RPT-5006 Revision: 0 Page: A-4 of A-30
---	--

**Broken Hill Mine Reclamation Project
Potential Repository Site Investigations
Geotechnical Test Pit Log**

Test Pit Excavation Date: May 4, 2010
Logged By: Ray Schwaller, P.E.
Equipment: Bobcat 442 tracked excavator w/36-in.-wide bucket
Test Pit Number: TP-03
General Location: Northeast corner of Fatman Saddle site

Depth (ft)	Materials/Observations	Comments
Surface	Forested land/Thin layer of black topsoil	On bedrock side-slope
0.0 – 1.5	Silty topsoil; medium-reddish brown; moist	Topsoil layers vary from 6 to 18 in. thick.
1.5 – 5.0 T.D. = 5.0 (bedrock)	Angular rock and coarse sand with a trace of fines; tan to reddish brown; moist to very moist. Some layers with greater amounts of clayey fines. Relatively easy digging.	No groundwater or seeps present in the test pit.



REPOSITORY INVESTIGATION REPORT FOR THE BROKEN HILL MINE SITE, SANDERS COUNTY, MONTANA	Identifier: RPT-5006 Revision: 0 Page: A-5 of A-30
---	--

**Broken Hill Mine Reclamation Project
Potential Repository Site Investigations
Geotechnical Test Pit Log**

Test Pit Excavation Date: May 4, 2010
Logged By: Ray Schwaller, P.E.
Equipment: Bobcat 442 tracked excavator w/36-in.-wide bucket
Test Pit Number: TP-04
General Location: Northern center of Fatman Saddle site

Depth (ft)	Materials/Observations	Comments
Surface	Forested land	Next to bedrock side-slope
0.0 – 3.5	Silty topsoil; medium-reddish brown; moist	
1.5 – 8.0 T.D. = 8.0 (bedrock)	Angular rock and coarse sand with a trace of fines; tan to reddish brown; moist to very moist. Some layers with greater amounts of clayey fines. Relatively easy digging.	No groundwater or seeps present in the test pit.



REPOSITORY INVESTIGATION REPORT FOR THE BROKEN HILL MINE SITE, SANDERS COUNTY, MONTANA	Identifier: RPT-5006 Revision: 0 Page: A-6 of A-30
---	--

**Broken Hill Mine Reclamation Project
Potential Repository Site Investigations
Geotechnical Test Pit Log**

Test Pit Excavation Date: May 4, 2010
Logged By: Ray Schwaller, P.E.
Equipment: Bobcat 442 tracked excavator w/36-in.-wide bucket
Test Pit Number: TP-05
General Location: Northern center of Fatman Saddle site

Depth (ft)	Materials/Observations	Comments
Surface	Forested land/Thin layer of black topsoil	Next to bedrock side-slope
0.0 – 2.0	Silty topsoil; reddish brown; moist	
2.0 – 9.5 T.D. = 9.5 (bedrock)	Angular rock and very coarse sand; tan to reddish brown; moist; some layers with traces of clayey fines. Relatively easy digging.	No groundwater or seeps present in the test pit.

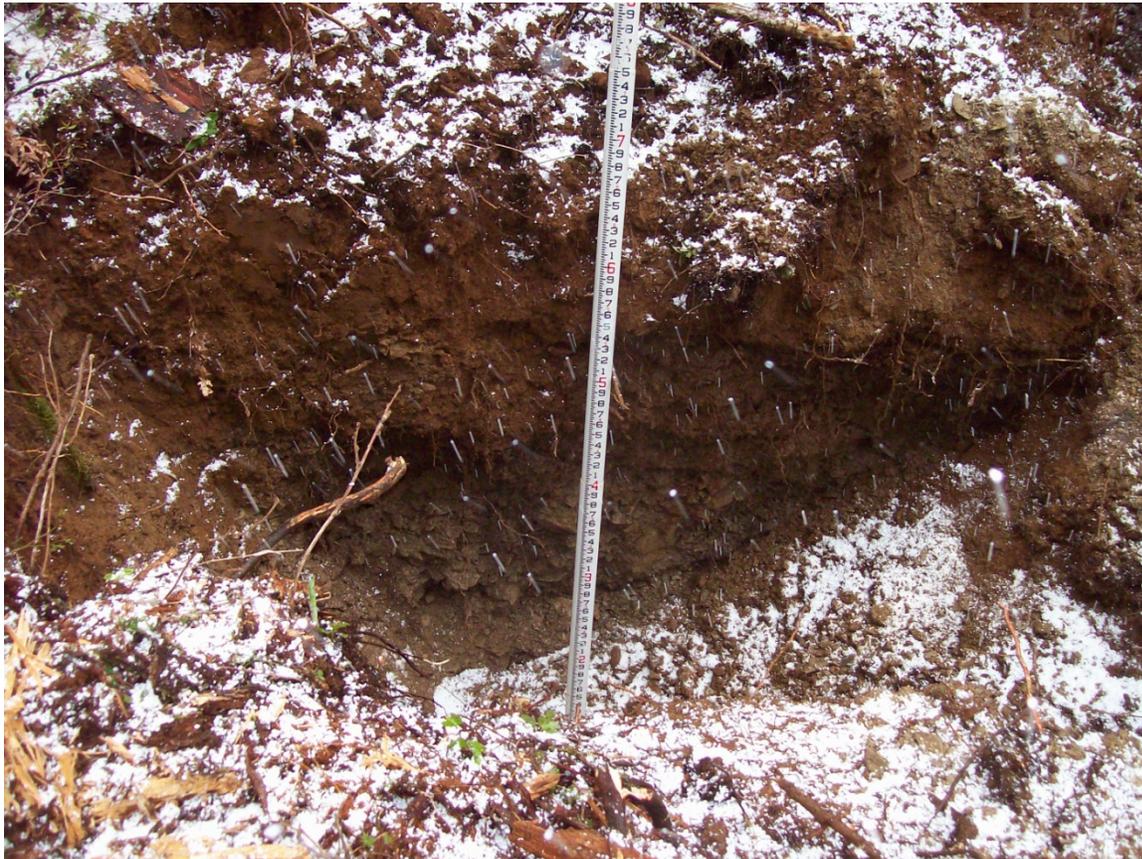


REPOSITORY INVESTIGATION REPORT FOR THE BROKEN HILL MINE SITE, SANDERS COUNTY, MONTANA	Identifier: RPT-5006 Revision: 0 Page: A-7 of A-30
---	--

**Broken Hill Mine Reclamation Project
Potential Repository Site Investigations
Geotechnical Test Pit Log**

Test Pit Excavation Date: May 4, 2010
Logged By: Ray Schwaller, P.E.
Equipment: Bobcat 442 tracked excavator w/36-in.-wide bucket
Test Pit Number: TP-06
General Location: Approximate center of Fatman Saddle site

Depth (ft)	Materials/Observations	Comments
Surface	Forested land/Thin layer of black topsoil	Next to bedrock side-slope
0.0 – 2.0	Silty topsoil; reddish brown; moist	
2.0 – 7.0 T.D. = 7.0 (bedrock)	Angular rock and very coarse sand; tan to reddish brown; moist; some layers with traces of clayey fines. Relatively easy digging.	No groundwater or seeps present in the test pit.



REPOSITORY INVESTIGATION REPORT FOR THE BROKEN HILL MINE SITE, SANDERS COUNTY, MONTANA	Identifier: RPT-5006 Revision: 0 Page: A-8 of A-30
---	--

**Broken Hill Mine Reclamation Project
Potential Repository Site Investigations
Geotechnical Test Pit Log**

Test Pit Excavation Date: May 4, 2010
Logged By: Ray Schwaller, P.E.
Equipment: Bobcat 442 tracked excavator w/36-in.-wide bucket
Test Pit Number: TP-07
General Location: Approximate center of Fatman Saddle site

Depth (ft)	Materials/Observations	Comments
Surface	Forested land/Thin layer of black topsoil	Next to bedrock side-slope
0.0 – 2.0	Silty topsoil; reddish brown; moist	
2.0 –9.0 T.D. = 9.0 (bedrock)	Angular rock and very coarse sand; tan to reddish brown; moist; some layers with traces of clayey fines. Relatively easy digging.	No groundwater or seeps present in the test pit.



REPOSITORY INVESTIGATION REPORT FOR THE BROKEN HILL MINE SITE, SANDERS COUNTY, MONTANA	Identifier: RPT-5006 Revision: 0 Page: A-9 of A-30
---	--

**Broken Hill Mine Reclamation Project
Potential Repository Site Investigations
Geotechnical Test Pit Log**

Test Pit Excavation Date: May 4, 2010
Logged By: Ray Schwaller, P.E.
Equipment: Bobcat 442 tracked excavator w/36-in.-wide bucket
Test Pit Number: TP-08
General Location: West center of Fatman Saddle site

Depth (ft)	Materials/Observations	Comments
Surface	Forested land/Thin layer of black topsoil	Center of site, just off main road
0.0 – 2.0	Silty topsoil; reddish brown; moist	
2.0 – 11.0 T.D. = 11.0 (bedrock)	Angular rock and very coarse sand; tan to reddish brown; moist; some layers with traces of clayey fines. Relatively easy digging.	No groundwater or seeps present in the test pit.



REPOSITORY INVESTIGATION REPORT FOR THE BROKEN HILL MINE SITE, SANDERS COUNTY, MONTANA	Identifier: RPT-5006 Revision: 0 Page: A-10 of A-30
---	---

**Broken Hill Mine Reclamation Project
Potential Repository Site Investigations
Geotechnical Test Pit Log**

Test Pit Excavation Date: May 5, 2010
Logged By: Ray Schwaller, P.E.
Equipment: Bobcat 442 tracked excavator w/36-in.-wide bucket
Test Pit Number: TP-09
General Location: East center of Fatman Saddle site

Depth (ft)	Materials/Observations	Comments
Surface	Forested land/Thin layer of black topsoil	On bedrock side-slope
0.0 – 2.0	Silty topsoil; reddish brown; moist	
2.0 –10.0 T.D. = 10.0 (bedrock)	Angular rock and very coarse sand; tan to reddish brown; moist; some layers with traces of clayey fines. Relatively easy digging.	No groundwater or seeps present in the test pit.



REPOSITORY INVESTIGATION REPORT FOR THE BROKEN HILL MINE SITE, SANDERS COUNTY, MONTANA	Identifier: RPT-5006 Revision: 0 Page: A-11 of A-30
---	---

**Broken Hill Mine Reclamation Project
Potential Repository Site Investigations
Geotechnical Test Pit Log**

Test Pit Excavation Date: May 5, 2010
Logged By: Ray Schwaller, P.E.
Equipment: Bobcat 442 tracked excavator w/36-in.-wide bucket
Test Pit Number: TP-10
General Location: South center of Fatman Saddle site

Depth (ft)	Materials/Observations	Comments
Surface	Forested land/Thin layer of black topsoil	Near bedrock side-slope
0.0 – 1.5	Silty topsoil; reddish brown; moist	
1.5 –12.0 T.D. = 12.0	Angular rock and coarse sand; tan to reddish brown; moist to very moist; Some layers with traces of clayey fines. Relatively easy digging.	No groundwater or seeps present in the test pit.



REPOSITORY INVESTIGATION REPORT FOR THE BROKEN HILL MINE SITE, SANDERS COUNTY, MONTANA	Identifier: RPT-5006 Revision: 0 Page: A-12 of A-30
---	---

**Broken Hill Mine Reclamation Project
Potential Repository Site Investigations
Geotechnical Test Pit Log**

Test Pit Excavation Date: May 5, 2010
Logged By: Jacqueline Janosko, E.I.
Equipment: Bobcat 442 tracked excavator w/36-in.-wide bucket
Test Pit Number: TP-11
General Location: East corner of Blue Creek site

Depth (ft)	Materials/Observations	Comments
Surface	Forested land/Thin layer of black topsoil	Area has received 3+ in. of rain within the last week.
0.0 – 1.5	Silty topsoil; dark brown; very moist	
1.5 – 8.5 T.D. = 8.5 (possible bedrock)	Sub-angular/Sub-rounded rock and coarse sand; dark- medium reddish brown; moist to very moist. Relatively easy digging.	No groundwater or seeps present in the test pit.



**REPOSITORY INVESTIGATION REPORT
FOR THE BROKEN HILL MINE SITE,
SANDERS COUNTY, MONTANA**

Identifier: RPT-5006
Revision: 0
Page: A-13 of A-30

**Broken Hill Mine Reclamation Project
Potential Repository Site Investigations
Geotechnical Test Pit Log**

Test Pit Excavation Date: May 5, 2010
Logged By: Jacqueline Janosko, E.I.
Equipment: Bobcat 442 tracked excavator w/36-in.-wide bucket
Test Pit Number: TP-12
General Location: North corner of Blue Creek site

Depth (ft)	Materials/Observations	Comments
Surface	Forested land/Thin layer of black topsoil	Area has received 3+ in. of rain within the last week.
0.0 – 2.0	Silty topsoil; dark brown; very moist.	
2.0 – 8.0 T.D. = 8.0 (possible bedrock)	Sub-angular/Sub-rounded rock and coarse sand; trace of silty fines; dark-medium reddish brown; moist to very moist. Relatively easy digging.	No groundwater or seeps present in the test pit.



REPOSITORY INVESTIGATION REPORT FOR THE BROKEN HILL MINE SITE, SANDERS COUNTY, MONTANA	Identifier: RPT-5006 Revision: 0 Page: A-14 of A-30
---	---

**Broken Hill Mine Reclamation Project
Potential Repository Site Investigations
Geotechnical Test Pit Log**

Test Pit Excavation Date: May 5, 2010
Logged By: Jacqueline Janosko, E.I.
Equipment: Bobcat 442 tracked excavator w/36-in.-wide bucket
Test Pit Number: TP-13
General Location: West corner of Blue Creek site

Depth (ft)	Materials/Observations	Comments
Surface	Forested land/Thin layer of black topsoil	Area has received 3+ in. of rain within the last week.
0.0 – 1.5	Very rocky topsoil; dark brown silt-sand; very moist	
1.5 –9.5 T.D. = 9.5	Sub-angular/Sub-rounded rock and coarse sand; trace of silty fines; dark-medium reddish brown; moist to very moist. Relatively easy digging.	No groundwater or seeps present in the test pit.



REPOSITORY INVESTIGATION REPORT FOR THE BROKEN HILL MINE SITE, SANDERS COUNTY, MONTANA	Identifier: RPT-5006 Revision: 0 Page: A-15 of A-30
---	---

**Broken Hill Mine Reclamation Project
Potential Repository Site Investigations
Geotechnical Test Pit Log**

Test Pit Excavation Date: May 5, 2010
Logged By: Jacqueline Janosko, E.I.
Equipment: Bobcat 442 tracked excavator w/36-in.-wide bucket
Test Pit Number: TP-14
General Location: Approximate center of Blue Creek site

Depth (ft)	Materials/Observations	Comments
Surface	Forested land/Thin layer of black topsoil	Area has received 3+ in. of rain within the last week.
0.0 – 2.0	Very rocky topsoil; dark brown silt-sand; very moist	
2.0 –10.5 T.D. = 10.5 (large rocks)	Sub-angular/Sub-rounded rock and coarse sand; trace of silty fines; dark-medium reddish brown; moist to very moist. Relatively easy digging.	No groundwater or seeps present in the test pit.



REPOSITORY INVESTIGATION REPORT FOR THE BROKEN HILL MINE SITE, SANDERS COUNTY, MONTANA	Identifier: RPT-5006 Revision: 0 Page: A-16 of A-30
---	---

**Broken Hill Mine Reclamation Project
Potential Repository Site Investigations
Geotechnical Test Pit Log**

Test Pit Excavation Date: May 6, 2010
Logged By: Jacqueline Janosko, E.I.
Equipment: Bobcat 442 tracked excavator w/36-in.-wide bucket
Test Pit Number: TP-15
General Location: South corner of Blue Creek site

Depth (ft)	Materials/Observations	Comments
Surface	Forested land/Thin layer of black topsoil	Area has received 3+ in. of rain within the last week; just off the main road.
0.0 – 1.5	Very rocky topsoil; dark brown silt-sand; very moist	
1.5 –11.0 T.D. = 11.0 (large rocks)	Sub-angular/Sub-rounded rock and coarse sand; trace of silty fines; dark-medium reddish brown; moist to very moist. Relatively easy digging.	No groundwater or seeps present in the test pit.



REPOSITORY INVESTIGATION REPORT FOR THE BROKEN HILL MINE SITE, SANDERS COUNTY, MONTANA	Identifier: RPT-5006 Revision: 0 Page: A-17 of A-30
---	---

**Broken Hill Mine Reclamation Project
Potential Repository Site Investigations
Geotechnical Test Pit Log**

Test Pit Excavation Date: May 6, 2010
Logged By: Ray Schwaller, P.E.
Equipment: Bobcat 442 tracked excavator w/36-in.-wide bucket
Test Pit Number: TP-16
General Location: West corner of Road Bench #1 site

Depth (ft)	Materials/Observations	Comments
Surface	Forested land	
0.0 – 1.0	Black silty topsoil overlying reddish-brown silty topsoil; very moist	
1.0 – 5.5 T.D. = 5.5 (hard bedrock)	Angular fractured rock (in place); weathered residual bedrock with silty medium-reddish brown soil in fill; moist to very moist. Relatively easy digging.	No groundwater or seeps present in the test pit.



REPOSITORY INVESTIGATION REPORT FOR THE BROKEN HILL MINE SITE, SANDERS COUNTY, MONTANA	Identifier: RPT-5006 Revision: 0 Page: A-18 of A-30
---	---

**Broken Hill Mine Reclamation Project
Potential Repository Site Investigations
Geotechnical Test Pit Log**

Test Pit Excavation Date: May 6, 2010
Logged By: Ray Schwaller, P.E.
Equipment: Bobcat 442 tracked excavator w/36-in.-wide bucket
Test Pit Number: TP-17
General Location: West center of Road Bench #1 site

Depth (ft)	Materials/Observations	Comments
Surface	Forested land	
0.0 – 1.0	Dark brown topsoil and roots	
1.0-5.0	Angular rock and silt	
5.0 –9.0 T.D. = 9.0 (bedrock)	Friable shale; light greenish-brown; moist to very moist. Relatively easy digging.	No groundwater or seeps present in the test pit.



REPOSITORY INVESTIGATION REPORT FOR THE BROKEN HILL MINE SITE, SANDERS COUNTY, MONTANA	Identifier: RPT-5006 Revision: 0 Page: A-19 of A-30
---	---

**Broken Hill Mine Reclamation Project
Potential Repository Site Investigations
Geotechnical Test Pit Log**

Test Pit Excavation Date: May 6, 2010
Logged By: Ray Schwaller, P.E.
Equipment: Bobcat 442 tracked excavator w/36-in.-wide bucket
Test Pit Number: TP-18
General Location: North corner of Road Bench #1 site

Depth (ft)	Materials/Observations	Comments
Surface	Forested land/ Thin layer of black topsoil	
0.0 – 1.5	Reddish-brown silty topsoil	
1.5-5.5	Angular rock and silt; moist	
5.5 –8.0 T.D. = 8.0	Grayish light brown silty clay; low plasticity; moist to very moist. Relatively easy digging.	No groundwater or seeps present in the test pit.



REPOSITORY INVESTIGATION REPORT FOR THE BROKEN HILL MINE SITE, SANDERS COUNTY, MONTANA	Identifier: RPT-5006 Revision: 0 Page: A-20 of A-30
---	---

**Broken Hill Mine Reclamation Project
Potential Repository Site Investigations
Geotechnical Test Pit Log**

Test Pit Excavation Date: May 6, 2010
Logged By: Ray Schwaller, P.E.
Equipment: Bobcat 442 tracked excavator w/36-in.-wide bucket
Test Pit Number: TP-19
General Location: Southwest corner of Road Bench #1 site

Depth (ft)	Materials/Observations	Comments
Surface	Forested land/ Thin layer of black topsoil	
0.0 – 0.5	Black and reddish-brown silty topsoil	
0.5-3.5 T.D. = 3.5 (bedrock)	Fractured bedrock with silt infiltration	No groundwater or seeps present in the test pit.



REPOSITORY INVESTIGATION REPORT FOR THE BROKEN HILL MINE SITE, SANDERS COUNTY, MONTANA	Identifier: RPT-5006 Revision: 0 Page: A-21 of A-30
---	---

**Broken Hill Mine Reclamation Project
Potential Repository Site Investigations
Geotechnical Test Pit Log**

Test Pit Excavation Date: May 6, 2010
Logged By: Ray Schwaller, P.E.
Equipment: Bobcat 442 tracked excavator w/36-in.-wide bucket
Test Pit Number: TP-20
General Location: Approximate center of Road Bench #1 site

Depth (ft)	Materials/Observations	Comments
Surface	Forested land/ Thin layer of black topsoil	
0.0 – 1.0	Black and reddish-brown silty topsoil	
1.0 – 4.0 T.D. = 4.0 (bedrock)	Fractured bedrock with silt infiltration	No groundwater or seeps present in the test pit.



REPOSITORY INVESTIGATION REPORT FOR THE BROKEN HILL MINE SITE, SANDERS COUNTY, MONTANA	Identifier: RPT-5006
	Revision: 0
	Page: A-22 of A-30

**Broken Hill Mine Reclamation Project
Potential Repository Site Investigations
Geotechnical Test Pit Log**

Test Pit Excavation Date: May 6, 2010
Logged By: Ray Schwaller, P.E.
Equipment: Bobcat 442 tracked excavator w/36-in.-wide bucket
Test Pit Number: TP-21
General Location: Southwest center of Road Bench #1 site

Depth (ft)	Materials/Observations	Comments
Surface	Forested land/ Thin layer of black topsoil	
0.0 – 1.0	Black and reddish-brown silty topsoil	
1.0 – 7.0 T.D. = 7.0 (bedrock)	Fractured bedrock with silt infiltration	No groundwater or seeps present in the test pit.



REPOSITORY INVESTIGATION REPORT FOR THE BROKEN HILL MINE SITE, SANDERS COUNTY, MONTANA	Identifier: RPT-5006 Revision: 0 Page: A-23 of A-30
---	---

**Broken Hill Mine Reclamation Project
Potential Repository Site Investigations
Geotechnical Test Pit Log**

Test Pit Excavation Date: May 6, 2010
Logged By: Ray Schwaller, P.E.
Equipment: Bobcat 442 tracked excavator w/36-in.-wide bucket
Test Pit Number: TP-22
General Location: Southwest corner of Road Bench #1 site

Depth (ft)	Materials/Observations	Comments
Surface	Forested land/ Thin layer of black topsoil	
0.0 – 1.0	Black and reddish-brown silty topsoil	
1.0 – 7.0 T.D. = 7.0 (bedrock)	Fractured bedrock with silt infiltration	No groundwater or seeps present in the test pit.



REPOSITORY INVESTIGATION REPORT FOR THE BROKEN HILL MINE SITE, SANDERS COUNTY, MONTANA	Identifier: RPT-5006 Revision: 0 Page: A-24 of A-30
---	---

**Broken Hill Mine Reclamation Project
Potential Repository Site Investigations
Geotechnical Test Pit Log**

Test Pit Excavation Date: May 6, 2010
Logged By: Ray Schwaller, P.E.
Equipment: Bobcat 442 tracked excavator w/36-in.-wide bucket
Test Pit Number: TP-23
General Location: East center of Road Bench #1 site

Depth (ft)	Materials/Observations	Comments
Surface	Forested land/ Thin layer of black topsoil	
0.0 – 1.0	Black and reddish-brown silty topsoil	
1.0 – 5.5 T.D. = 5.5 (bedrock)	Fractured bedrock with silt infiltration	No groundwater or seeps present in the test pit.



REPOSITORY INVESTIGATION REPORT FOR THE BROKEN HILL MINE SITE, SANDERS COUNTY, MONTANA	Identifier: RPT-5006 Revision: 0 Page: A-25 of A-30
---	---

**Broken Hill Mine Reclamation Project
Potential Repository Site Investigations
Geotechnical Test Pit Log**

Test Pit Excavation Date: May 6, 2010
Logged By: Ray Schwaller, P.E.
Equipment: Bobcat 442 tracked excavator w/36-in.-wide bucket
Test Pit Number: TP-24
General Location: East corner of Road Bench #1 site

Depth (ft)	Materials/Observations	Comments
Surface	Forested land/ Thin layer of black topsoil	
0.0 – 1.0	Black and reddish-brown silty topsoil	
1.0 – 4.5 T.D. = 4.5 (bedrock)	Fractured bedrock with silt infiltration	No groundwater or seeps present in the test pit.



REPOSITORY INVESTIGATION REPORT FOR THE BROKEN HILL MINE SITE, SANDERS COUNTY, MONTANA	Identifier: RPT-5006 Revision: 0 Page: A-26 of A-30
---	---

**Broken Hill Mine Reclamation Project
Potential Repository Site Investigations
Geotechnical Test Pit Log**

Test Pit Excavation Date: May 6, 2010
Logged By: Ray Schwaller, P.E.
Equipment: Bobcat 442 tracked excavator w/36-in.-wide bucket
Test Pit Number: TP-25
General Location: East corner of Road Bench #2 site

Depth (ft)	Materials/Observations	Comments
Surface	Forested land/ Thin layer of black topsoil	
0.0 – 1.0	Black and reddish-brown silty topsoil	
1.0 – 12.0 T.D. = 12.0	Colluvium; angular rocks and silty sand; light brown rocks; slightly moist	No groundwater or seeps present in the test pit.



REPOSITORY INVESTIGATION REPORT FOR THE BROKEN HILL MINE SITE, SANDERS COUNTY, MONTANA	Identifier: RPT-5006 Revision: 0 Page: A-27 of A-30
---	---

**Broken Hill Mine Reclamation Project
Potential Repository Site Investigations
Geotechnical Test Pit Log**

Test Pit Excavation Date: May 7, 2010
Logged By: Ray Schwaller, P.E.
Equipment: Bobcat 442 tracked excavator w/36-in.-wide bucket
Test Pit Number: TP-26
General Location: North corner of Road Bench #2 site

Depth (ft)	Materials/Observations	Comments
Surface	Forested land/ Thin layer of black topsoil	
0.0 – 2.0	Black topsoil overlying medium brown silty topsoil	
2.0 – 9.0 T.D. = 9.0	Angular rock and silt – light brown; moist to very moist. Relatively easy excavating.	No groundwater or seeps present in the test pit.

No photo for TP-26

REPOSITORY INVESTIGATION REPORT FOR THE BROKEN HILL MINE SITE, SANDERS COUNTY, MONTANA	Identifier: RPT-5006 Revision: 0 Page: A-28 of A-30
---	---

**Broken Hill Mine Reclamation Project
Potential Repository Site Investigations
Geotechnical Test Pit Log**

Test Pit Excavation Date: May 7, 2010
Logged By: Ray Schwaller, P.E.
Equipment: Bobcat 442 tracked excavator w/36-in.-wide bucket
Test Pit Number: TP-27
General Location: North corner of Road Bench #2 site

Depth (ft)	Materials/Observations	Comments
Surface	Forested land/ Thin layer of black topsoil	
0.0 – 2.0	Black topsoil overlying medium brown silty topsoil	
2.0 – 9.0 T.D. = 9.0	Angular rock and silt – light brown; moist to very moist. Relatively easy excavating.	No groundwater or seeps present in the test pit.



REPOSITORY INVESTIGATION REPORT FOR THE BROKEN HILL MINE SITE, SANDERS COUNTY, MONTANA	Identifier: RPT-5006 Revision: 0 Page: A-29 of A-30
---	---

**Broken Hill Mine Reclamation Project
Potential Repository Site Investigations
Geotechnical Test Pit Log**

Test Pit Excavation Date: May 7, 2010
Logged By: Ray Schwaller, P.E.
Equipment: Bobcat 442 tracked excavator w/36-in.-wide bucket
Test Pit Number: TP-28
General Location: Approximate center of Road Bench #2 site

Depth (ft)	Materials/Observations	Comments
Surface	Forested land/ Thin layer of black topsoil	
0.0 – 1.0	Black topsoil overlying medium reddish-brown silty topsoil	
1.0 – 7.0 T.D. = 7.0 (hard rock)	Fractured rock with silty soil in fill; moist to very moist. Difficult excavating with depth.	No groundwater or seeps present in the test pit.



REPOSITORY INVESTIGATION REPORT FOR THE BROKEN HILL MINE SITE, SANDERS COUNTY, MONTANA	Identifier: RPT-5006 Revision: 0 Page: A-30 of A-30
---	---

**Broken Hill Mine Reclamation Project
Potential Repository Site Investigations
Geotechnical Test Pit Log**

Test Pit Excavation Date: May 7, 2010
Logged By: Ray Schwaller, P.E.
Equipment: Bobcat 442 tracked excavator w/36-in.-wide bucket
Test Pit Number: TP-29
General Location: West corner of Road Bench #2 site

Depth (ft)	Materials/Observations	Comments
Surface	Forested land/ Thin layer of black topsoil	
0.0 – 2.0	Black topsoil overlying medium reddish-brown silty topsoil; moist	
2.0 – 10.0 T.D. = 10.0	Fractured angular rock with medium brown silty sand (colluvium); rock and clayey soil in fill at greater depth; moist to very moist. Relatively easy excavating.	No groundwater or seeps present in the test pit.





REPOSITORY INVESTIGATION REPORT FOR THE BROKEN HILL MINE SITE, SANDERS COUNTY, MONTANA	Identifier: RPT-5006 Revision: 0 Page: B-1
---	--

**APPENDIX B
PHOTOGRAPHIC RECORD AND REPORT ELECTRONIC COPY**

[provided separately on compact disk]



**REPOSITORY INVESTIGATION REPORT
FOR THE BROKEN HILL MINE SITE,
SANDERS COUNTY, MONTANA**

Identifier: RPT-5006
Revision: 0
Page: C-1

**APPENDIX C
LABORATORY DATA SHEETS**



ANALYTICAL SUMMARY REPORT

September 27, 2010

Pebbles Clark
MT DEQ
PO Box 200901
Helena, MT 59620-0901

Workorder No.: H10090144

Project Name: BHMS

Energy Laboratories Inc received the following 5 samples for MT DEQ on 9/9/2010 for analysis.

Sample ID	Client Sample ID	Collect Date	Receive Date	Matrix	Test
H10090144-001	TP-01-A	05/04/10 0:00	09/09/10	Soil	Metals by ICP/ICPMS, Total Digestion, Total Metals
H10090144-002	TP-11-A	05/05/10 17:00	09/09/10	Soil	Same As Above
H10090144-003	TP-16-A	05/06/10 17:00	09/09/10	Soil	Same As Above
H10090144-004	TP-28-A	05/07/10 17:00	09/09/10	Soil	Same As Above
H10090144-005	TP-29-A	05/07/10 17:00	09/09/10	Soil	Same As Above

This report was prepared by Energy Laboratories, Inc., 3161 E. Lyndale Ave., Helena, MT 59604. Any exceptions or problems with the analyses are noted in the Laboratory Analytical Report, the QA/QC Summary Report, or the Case Narrative.

The results as reported relate only to the item(s) submitted for testing.

If you have any questions regarding these test results, please call.

Report Approved By:



LABORATORY ANALYTICAL REPORT

Client: MT DEQ
Project: BHMS
Workorder: H10090144

Report Date: 09/27/10
Date Received: 09/09/10

Sample ID	Client Sample ID	Analysis		As-T	Mn-T	Pb-T	Zn-T
		Units		mg/kg	mg/kg	mg/kg	mg/kg
		Up	Low	Results	Results	Results	Results
H10090144-001	TP-01-A	0	0	7	766	12	48
H10090144-002	TP-11-A	0	0	13	367	15	46
H10090144-003	TP-16-A	0	0	5	896	11	56
H10090144-004	TP-28-A	0	0	7	736	11	60
H10090144-005	TP-29-A	0	0	5	357	10	74



QA/QC Summary Report

Client: MT DEQ
Project: BHMS

Report Date: 09/27/10
Work Order: H10090144

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: E200.7								Analytical Run: ICP1-HE_100917B		
Sample ID: ICV	4	Initial Calibration Verification Standard								09/17/10 09:24
Arsenic		0.784	mg/L	0.10	98	90	110			
Lead		0.764	mg/L	0.050	96	90	110			
Manganese		3.76	mg/L	0.010	94	90	110			
Zinc		0.842	mg/L	0.010	105	90	110			
Sample ID: ICSA	4	Interference Check Sample A								09/17/10 09:42
Arsenic		0.0370	mg/L	0.10		0	0			
Lead		0.0425	mg/L	0.050		0	0			
Manganese		0.0256	mg/L	0.010		0	0			
Zinc		-0.00850	mg/L	0.010		0	0			
Sample ID: ICSAB	4	Interference Check Sample AB								09/17/10 09:46
Arsenic		1.07	mg/L	0.10	107	80	120			
Lead		1.02	mg/L	0.050	102	80	120			
Manganese		0.465	mg/L	0.010	93	80	120			
Zinc		1.01	mg/L	0.010	101	80	120			
Sample ID: ICSA	4	Interference Check Sample A								09/17/10 20:39
Arsenic		0.0207	mg/L	0.10		0	0			
Lead		0.0250	mg/L	0.050		0	0			
Manganese		0.0201	mg/L	0.010		0	0			
Zinc		-0.00970	mg/L	0.010		0	0			
Sample ID: ICSAB	4	Interference Check Sample AB								09/17/10 20:42
Arsenic		1.00	mg/L	0.10	100	80	120			
Lead		0.969	mg/L	0.050	97	80	120			
Manganese		0.419	mg/L	0.010	84	80	120			
Zinc		0.931	mg/L	0.010	93	80	120			

Qualifiers:

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.

QA/QC Summary Report

Client: MT DEQ
Project: BHMS

Report Date: 09/27/10
Work Order: H10090144

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: SW6010B Batch: 9856										
Sample ID: MB-9856	4	Method Blank								
										Run: ICP1-HE_100917B 09/17/10 13:25
Arsenic		ND	mg/kg	0.5						
Lead		ND	mg/kg	0.4						
Manganese		0.2	mg/kg	0.1						
Zinc		ND	mg/kg	0.1						
Sample ID: LFB-9856	4	Laboratory Fortified Blank								
										Run: ICP1-HE_100917B 09/17/10 13:28
Arsenic		46.6	mg/kg	5.0	93	70	130			
Lead		45.0	mg/kg	5.0	90	70	130			
Manganese		230	mg/kg	5.0	92	70	130			
Zinc		50.0	mg/kg	5.0	100	70	130			
Sample ID: LCS-9856	4	Laboratory Control Sample								
										Run: ICP1-HE_100917B 09/17/10 13:37
Arsenic		158	mg/kg	25	92	80.9	119			
Lead		112	mg/kg	12	91	81.5	119			
Manganese		236	mg/kg	5.0	91	81.5	118			
Zinc		160	mg/kg	5.0	96	79	121			
Sample ID: H10090107-005ADUP	3	Sample Duplicate								
										Run: ICP1-HE_100917B 09/17/10 14:27
Arsenic		10.5	mg/kg	25						30
Lead		11.4	mg/kg	12						30
Zinc		48.7	mg/kg	5.0				7		30
Sample ID: H10090144-005AMS	4	Sample Matrix Spike								
										Run: ICP1-HE_100917B 09/17/10 20:26
Arsenic		47.6	mg/kg	9.9	89	75	125			
Lead		49.8	mg/kg	5.0	78	75	125			
Manganese		652	mg/kg	5.0	120	75	125			
Zinc		128	mg/kg	5.0	109	75	125			
Sample ID: H10090144-005AMSD	4	Sample Matrix Spike Duplicate								
										Run: ICP1-HE_100917B 09/17/10 20:30
Arsenic		45.4	mg/kg	9.9	85	75	125	4.7		20
Lead		48.6	mg/kg	5.0	76	75	125	2.4		20
Manganese		722	mg/kg	5.0	147	75	125	10		20 S
Zinc		132	mg/kg	5.0	119	75	125	3.7		20
Method: SW6010B Batch: 9856										
Sample ID: H10090107-005ADUP		Sample Duplicate								
										Run: ICP1-HE_100923B 09/23/10 20:27
Manganese		327	mg/kg	5.0				20		30

Qualifiers:

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.

S - Spike recovery outside of advisory limits.

Workorder Receipt Checklist



H10090144

Login completed by: Tracy L. Lorash

Reviewed by: BL2000\sdull

Reviewed Date: 9/12/2010

Date Received: 9/9/2010

Received by: wjj

Carrier name: Hand Del

- | | | | |
|---|---|--|--|
| Shipping container/cooler in good condition? | Yes <input checked="" type="checkbox"/> | No <input type="checkbox"/> | Not Present <input type="checkbox"/> |
| Custody seals intact on shipping container/cooler? | Yes <input type="checkbox"/> | No <input type="checkbox"/> | Not Present <input checked="" type="checkbox"/> |
| Custody seals intact on sample bottles? | Yes <input type="checkbox"/> | No <input type="checkbox"/> | Not Present <input checked="" type="checkbox"/> |
| Chain of custody present? | Yes <input checked="" type="checkbox"/> | No <input type="checkbox"/> | |
| Chain of custody signed when relinquished and received? | Yes <input checked="" type="checkbox"/> | No <input type="checkbox"/> | |
| Chain of custody agrees with sample labels? | Yes <input type="checkbox"/> | No <input checked="" type="checkbox"/> | |
| Samples in proper container/bottle? | Yes <input checked="" type="checkbox"/> | No <input type="checkbox"/> | |
| Sample containers intact? | Yes <input checked="" type="checkbox"/> | No <input type="checkbox"/> | |
| Sufficient sample volume for indicated test? | Yes <input checked="" type="checkbox"/> | No <input type="checkbox"/> | |
| All samples received within holding time? | Yes <input checked="" type="checkbox"/> | No <input type="checkbox"/> | |
| Container/Temp Blank temperature: | 15.2°C Soil | | |
| Water - VOA vials have zero headspace? | Yes <input type="checkbox"/> | No <input type="checkbox"/> | No VOA vials submitted <input checked="" type="checkbox"/> |
| Water - pH acceptable upon receipt? | Yes <input type="checkbox"/> | No <input type="checkbox"/> | Not Applicable <input checked="" type="checkbox"/> |

Contact and Corrective Action Comments:

Sample bags have depths on them - COC does not. No collection times on bags or COC - estimated time in lab.
Additional analysis for these samples is associated with work order H10050192. TI 9/9/10.



Chain of Custody and Analytical Request Record

PLEASE PRINT (Provide as much information as possible.)

Company Name: **Portage** Project Name, PWS, Permit, Etc.: **BHMS** Sample Origin: **MA** EPA/State Compliance: Yes No

Report Mail Address: **Pubblw Clark / DEa** Contact Name: **Alan Dressbach** Phone/Fax: **990 5135** Email: **alan.dressbach@portageinc.com** Sampler: (Please Print) **Roy Schynell**

Invoice Address: **Pubblw Clark / DEa** Invoice Contact & Phone: **Pubblw Clark / DEa** Purchase Order: Quote/Bottle Order:

Special Report/Formats: DW POT/WWTP State: LEVEL IV NELAC EDD/EDT (Electronic Data) Format: LEVEL IV NELAC

SAMPLE IDENTIFICATION (Name, Location, Interval, etc.)	Collection Date	Collection Time	MATRIX	ANALYSIS REQUESTED		Standard Turnaround (TAT)	Contact EI prior to RUSH sample submittal for charges and scheduling - See Instruction Page	Shipped by: Handdel. Cooler ID(s):
				Number of Containers	Sample Type: A W S V B O DW			
1 TP-02-A	5/4/10		S					Receipt Temp: 15.2°C On Ice: Y
2 TP-11-A	5/5/10		S					Custody Seal: Y On Bottle: Y On Cooler: Y
3 TP-16-A	5/6/10		S					Intact: Y Signature Match: Y
4 TP-28-A	5/12/10		S					Signature: H10090144
5 TP-29-A	5/17/10		S					
6								
7								
8								
9								
10								

Relinquished by (print): **Alan Dressbach** Date/Time: **9/9/10** Signature: *[Signature]*

Relinquished by (print): Date/Time: Signature:

Received by (print): Date/Time: Signature:

Received by (print): **Ward** Date/Time: **9-9-10 14:18** Signature: *[Signature]*

Received by Laboratory: **Ward** Date/Time: **9-9-10 14:18** Signature: *[Signature]*

Sample Disposal: Return to Client: Lab Disposal:

Custody Record MUST be Signed

In certain circumstances, samples submitted to Energy Laboratories, Inc. may be subcontracted to other certified laboratories in order to complete the analysis requested. This serves as notice of this possibility. All sub-contract data will be clearly notated on your analytical report. Visit our web site at www.energylab.com for additional information, downloadable fee schedule, forms, and links.

ANALYTICAL SUMMARY REPORT

June 21, 2010

Pebbles Clark
MT DEQ
PO Box 200901
Helena, MT 59620-0901

Workorder No.: H10050192 Quote ID: H475 - Soil Sampling

Project Name: Broken Hill Mine Reclamation Project

Energy Laboratories Inc received the following 6 samples for MT DEQ on 5/14/2010 for analysis.

Sample ID	Client Sample ID	Collect Date	Receive Date	Matrix	Test
H10050192-001	TP-02-A	05/04/10 17:00	05/14/10	Soil	DPTA extractable metals Acid/Base Potential Conductivity Potassium Nitrate as N, CaCL2 Extract Organic Matter-Walkley/Black Saturated Paste pH Phosphorus-Olsen NH4AC Soil Extraction CaCl2 Hot Water Soil Extraction DTPA extraction for metals Lime Percentage NaHCO3 Soil Extract Particle Size Analysis / Texture Prep Saturated Paste Extraction Total Organic Matter Prep Particle Size Analysis / Texture Sulfur Forms Particle Size Analysis / Texture
H10050192-002	TP-02-B	05/04/10 17:00	05/14/10	Soil	Same As Above
H10050192-003	TP-12-A	05/05/10 17:00	05/14/10	Soil	Same As Above
H10050192-004	TP-18-A	05/06/10 17:00	05/14/10	Soil	Same As Above
H10050192-005	TP-25-A	05/06/10 17:00	05/14/10	Soil	Same As Above
H10050192-006	TP-29-A	05/07/10 17:00	05/14/10	Soil	Same As Above

This report was prepared by Energy Laboratories, Inc., 3161 E. Lyndale Ave., Helena, MT 59604. Any exceptions or problems with the analyses are noted in the Laboratory Analytical Report, the QA/QC Summary Report, or the Case Narrative.

The results as reported relate only to the item(s) submitted for testing.

If you have any questions regarding these test results, please call.

Report Approved By:

TO: Montana DEQ
ADDRESS:

LAB NO.: H10050192-001-006
DATE: 6/22/10

Broken Hill Mine Reclamation Project FERTILIZER RECOMMENDATIONS

Fertilizer Suggested in Actual Pounds per Acre

FIELD	TP-02-A	TP-02-B	TP-12-A	TP-18-A	TP-25-1	TP-29-A
CROP	Grass	Grass	Grass	Grass	Grass	Grass
PROJECTED YIELD	1T	1T	1T	1T	1T	1T
Nitrogen						
Total	25	25	25	25	25	25
Preplant	25	25	25	25	25	25
Sidedress	0	0	0	0	0	0
Phosphorus (P₂O₅)						
Broadcast	20	30	50	50	0	50
Banded						
Potassium (K₂O)						
Broadcast	30	40	20	0	0	20
Banded						
Sulphur (S)	0	0	0	0	0	0
Zinc (Zn)	0	3	2	3	0	2
Iron (Fe)						
Copper (Cu)						
Boron (B)						
Gypsum						

COMMENTS:

PREPARED BY: Neal Fehring, Certified Professional Agronomist, C.C.A., (406) 860-3647.

LABORATORY ANALYTICAL REPORT

Client: MT DEQ
Project: Broken Hill Mine Reclamation Project
Workorder: H10050192

Report Date: 06/23/10
Date Received: 05/14/10

Sample ID	Client Sample ID	Analysis		pH-SatPst	Cond-SatPst	Sand	Silt	Clay	Texture	K-NH4OAc	Sulfur, Total	Sulfur, Sulfate	Sulfur, Pyritic	Sulfur, Organic
		Units		s_u_	mmhos/cm	%	%	%	unitless	mg/kg	%	%	%	%
		Up	Low	Results	Results	Results	Results	Results	Results	Results	Results	Results	Results	Results
H10050192-001	TP-02-A	0	0	4.9	0.13	24	66	10	SiL	109	< 0.01	< 0.01	< 0.01	< 0.01
H10050192-002	TP-02-B	0	0	4.9	0.06	24	68	8	SiL	75	< 0.01	< 0.01	< 0.01	< 0.01
H10050192-003	TP-12-A	0	0	4.8	0.10	30	60	10	SiL	140	< 0.01	< 0.01	< 0.01	< 0.01
H10050192-004	TP-18-A	0	0	5.3	0.09	24	70	6	SiL	179	< 0.01	< 0.01	< 0.01	< 0.01
H10050192-005	TP-25-A	0	0	5.8	0.14	22	70	8	SiL	206	< 0.01	< 0.01	< 0.01	< 0.01
H10050192-006	TP-29-A	0	0	5.2	0.10	26	66	8	SiL	122	< 0.01	< 0.01	< 0.01	< 0.01

LABORATORY ANALYTICAL REPORT

Client: MT DEQ
Project: Broken Hill Mine Reclamation Project
Workorder: H10050192

Report Date: 06/23/10
Date Received: 05/14/10

Sample ID	Client Sample ID	Analysis		OM-WB	Neut Potential	Acid Potential	Acid/Base Potential	P-Olsen	NO3	Zn-DTPA
		Units		%	t/kt	t/kt	t/kt	mg/kg	mg/kg	mg/kg
		Up	Low	Results	Results	Results	Results	Results	Results	Results
H10050192-001	TP-02-A	0	0	4.92	6	0.16	6	9.1	1	0.90
H10050192-002	TP-02-B	0	0	2.70	3	< 0.01	3	7.0	< 1	0.09
H10050192-003	TP-12-A	0	0	4.99	5	0.17	5	3.5	1	0.35
H10050192-004	TP-18-A	0	0	3.31	5	< 0.01	5	4.7	1	0.20
H10050192-005	TP-25-A	0	0	2.77	5	< 0.01	5	14	2	0.86
H10050192-006	TP-29-A	0	0	3.06	3	< 0.01	3	2.8	< 1	0.30



QA/QC Summary Report

Client: MT DEQ
Project: Broken Hill Mine Reclamation Project

Report Date: 06/23/10
Work Order: H10050192

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: ASA10-3								Analytical Run: MISC SOILS_100525G		
Sample ID: CCV_1_100518_1		Continuing Calibration Verification Standard								05/19/10 09:45
Conductivity, sat. paste		1.30	mmhos/cm	0.010	93	90	110			
Sample ID: ICV_1_100518_1		Initial Calibration Verification Standard								05/19/10 09:46
Conductivity, sat. paste		13.0	mmhos/cm	0.010	101	90	110			
Method: ASA10-3								Batch: 8777		
Sample ID: LCS_1_100518_1		Laboratory Control Sample								05/19/10 09:50
Conductivity, sat. paste		2.58	mmhos/cm	0.010	114	70	130			
Sample ID: H10050192-006ADUP		Sample Duplicate								05/19/10 09:53
Conductivity, sat. paste		0.1000	mmhos/cm	0.010				4.4	20	

Qualifiers:

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.

QA/QC Summary Report

Client: MT DEQ
Project: Broken Hill Mine Reclamation Project

Report Date: 06/23/10
Work Order: H10050192

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: ASA13-3								Analytical Run: ICP1-HE_100603A		
Sample ID: CCV	Continuing Calibration Verification Standard									
Potassium, NH4OAc Extractable		9.33	mg/kg	1.0	93	90	110			06/03/10 11:11
Method: ASA13-3								Analytical Run: ICP1-HE_100603B		
Sample ID: ICV	Initial Calibration Verification Standard									
Potassium, NH4OAc Extractable		10.1	meq/l	1.0	101	90	110			06/03/10 13:24
Sample ID: CCV	Continuing Calibration Verification Standard									
Potassium, NH4OAc Extractable		10.0	meq/l	1.0	101	90	110			06/03/10 13:38
Sample ID: CCV	Continuing Calibration Verification Standard									
Potassium, NH4OAc Extractable		9.48	mg/kg	1.0	95	90	110			06/03/10 14:16
Method: ASA13-3								Batch: 8784		
Sample ID: MB-8784	Method Blank									
Potassium, NH4OAc Extractable		6	mg/kg	0.04						Run: ICP1-HE_100603B 06/03/10 13:50
Sample ID: LCS-8784	Laboratory Control Sample									
Potassium, NH4OAc Extractable		176	mg/kg	1.0	103	70	130			Run: ICP1-HE_100603B 06/03/10 13:55
Sample ID: H10050192-004ADIL	Serial Dilution									
Potassium, NH4OAc Extractable		185	mg/kg	2.0		0	0	3.1	10	Run: ICP1-HE_100603B 06/03/10 14:08
Sample ID: H10050192-004AMS	Sample Matrix Spike									
Potassium, NH4OAc Extractable		300	mg/kg	1.0	121	75	125			Run: ICP1-HE_100603B 06/03/10 14:10
Sample ID: H10050192-004AMSD	Sample Matrix Spike Duplicate									
Potassium, NH4OAc Extractable		296	mg/kg	1.0	117	75	125			Run: ICP1-HE_100603B 06/03/10 14:13
Sample ID: H10050192-006Adup	Sample Duplicate									
Potassium, NH4OAc Extractable		119	mg/kg	1.0				2.8	30	Run: ICP1-HE_100603B 06/03/10 14:26

Qualifiers:

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.



QA/QC Summary Report

Client: MT DEQ
Project: Broken Hill Mine Reclamation Project

Report Date: 06/23/10
Work Order: H10050192

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: ASA15-5										Batch: 8789
Sample ID: H10050192-001ADUP	3	Sample Duplicate								Run: MISC SOILS_100521C 05/19/10 13:06
Sand		24	%	1.0				0	30	
Silt		66	%	1.0				0	30	
Clay		10	%	1.0				0	30	
Sample ID: LCS-8789	3	Laboratory Control Sample								Run: MISC SOILS_100521C 05/19/10 13:06
Sand		20	%	1.0	100	70	130			
Silt		50	%	1.0	104	70	130			
Clay		30	%	1.0	94	70	130			
Sample ID: H10050192-001ADUP		Sample Duplicate								Run: MISC SOILS_100521C 05/19/10 13:06
Texture		ND	unitless			90	110			

Qualifiers:

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.



QA/QC Summary Report

Client: MT DEQ
Project: Broken Hill Mine Reclamation Project

Report Date: 06/23/10
Work Order: H10050192

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: ASA24-5								Analytical Run: FIA202-HE_100527A		
Sample ID: ICV	Initial Calibration Verification Standard									
Phosphorus		7.5	mg/kg	0.10	100	90	110			05/27/10 14:04
Sample ID: ICB								Initial Calibration Blank, Instrument Blank		
Phosphorus		0.066	mg/kg	0.10		0	0			05/27/10 14:08
Method: ASA24-5								Batch: 8785		
Sample ID: MB-8785	Method Blank									
Phosphorus		0.4	mg/kg	0.08						Run: FIA202-HE_100527A 05/27/10 14:11
Sample ID: LCS-8785	Laboratory Control Sample									
Phosphorus		7.6	mg/kg	0.10	102	80	120			Run: FIA202-HE_100527A 05/27/10 14:12
Sample ID: H10050124-001AMS	Sample Matrix Spike									
Phosphorus		65	mg/kg	0.10	78	80	120			Run: FIA202-HE_100527A 05/27/10 14:15 S
Sample ID: H10050124-001AMSD	Sample Matrix Spike Duplicate									
Phosphorus		65	mg/kg	0.10	79	80	120	1.1	20	Run: FIA202-HE_100527A 05/27/10 14:16 S
Sample ID: H10050208-001ADUP	Sample Duplicate									
Phosphorus		63	mg/kg	0.10				2.3	30	Run: FIA202-HE_100527A 05/27/10 14:28

Qualifiers:

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.

S - Spike recovery outside of advisory limits.



QA/QC Summary Report

Client: MT DEQ
Project: Broken Hill Mine Reclamation Project

Report Date: 06/23/10
Work Order: H10050192

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: ASA29-3										Batch: 8788
Sample ID: H10050208-001ADUP		Sample Duplicate					Run: MISC SOILS_100527A			05/27/10 07:54
Organic Matter		4.99	%	0.020				0.7	30	
Sample ID: LCS-87881005270754		Laboratory Control Sample					Run: MISC SOILS_100527A			05/27/10 07:54
Organic Matter		1.70	%	0.020	98	70	130			
Sample ID: MBLK-8788100527075		Method Blank					Run: MISC SOILS_100527A			05/27/10 07:54
Organic Matter		ND	%	0.009						

Qualifiers:

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.



QA/QC Summary Report

Client: MT DEQ
Project: Broken Hill Mine Reclamation Project

Report Date: 06/23/10
Work Order: H10050192

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: ASA33-8								Analytical Run: NUTRIENTS_100528A		
Sample ID: ICV-1	Initial Calibration Verification Standard									
Nitrate as N, KCL Extract		0.99	mg/kg	1.0	99	90	110			05/28/10 08:45
Sample ID: ICB	Initial Calibration Blank, Instrument Blank									
Nitrate as N, KCL Extract		ND	mg/kg	1.0		0	0			05/28/10 08:55
Sample ID: CCV-61	Continuing Calibration Verification Standard									
Nitrate as N, KCL Extract		0.50	mg/kg	1.0	100	90	110			05/28/10 10:45
Sample ID: CCV-74	Continuing Calibration Verification Standard									
Nitrate as N, KCL Extract		0.48	mg/kg	1.0	96	90	110			05/28/10 11:11
Method: ASA33-8								Batch: 8782		
Sample ID: MBLK-68	Method Blank									
Nitrate as N, KCL Extract		0.3	mg/kg	0.1					Run: NUTRIENTS_100528A	05/28/10 10:59
Sample ID: LCS-69	Laboratory Control Sample									
Nitrate as N, KCL Extract		5.2	mg/kg	1.0	98	70	130		Run: NUTRIENTS_100528A	05/28/10 11:01
Sample ID: H10050192-004AMS	Sample Matrix Spike									
Nitrate as N, KCL Extract		2.9	mg/kg	1.0	92	80	120		Run: NUTRIENTS_100528A	05/28/10 11:19
Sample ID: H10050192-004AMSD	Sample Matrix Spike Duplicate									
Nitrate as N, KCL Extract		2.8	mg/kg	1.0	91	80	120	0.7	Run: NUTRIENTS_100528A	05/28/10 11:21
Sample ID: H10050208-001ADUP	Sample Duplicate									
Nitrate as N, KCL Extract		18	mg/kg	2.5				7.3	Run: NUTRIENTS_100528A	05/28/10 11:29

Qualifiers:

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.



QA/QC Summary Report

Client: MT DEQ
Project: Broken Hill Mine Reclamation Project

Report Date: 06/23/10
Work Order: H10050192

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: ASAM10-3.2								Analytical Run: MISC SOILS_100525F		
Sample ID: CCV_1_100518_1	Continuing Calibration Verification Standard									
pH, sat. paste		7.00	s.u.	0.10	100	90	110			05/19/10 07:20
Sample ID: ICV_1_100518_1	Initial Calibration Verification Standard									
pH, sat. paste		9.83	s.u.	0.10	98	90	110			05/19/10 07:20
Method: ASAM10-3.2								Batch: 8777		
Sample ID: LCS_1_100518_1	Laboratory Control Sample									
pH, sat. paste		7.44	s.u.	0.10	96	90	110			Run: MISC SOILS_100525F 05/19/10 07:20
Sample ID: H10050192-006ADUP	Sample Duplicate									
pH, sat. paste		5.31	s.u.	0.10				1.7	30	Run: MISC SOILS_100525F 05/19/10 07:27

Qualifiers:

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.



QA/QC Summary Report

Client: MT DEQ
Project: Broken Hill Mine Reclamation Project

Report Date: 06/23/10
Work Order: H10050192

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: E200.7										Analytical Run: ICP1-HE_100524C
Sample ID: ICV		Initial Calibration Verification Standard								05/24/10 14:49
Zinc		0.850	mg/L	0.010	106	90	110			
Sample ID: ICSA		Interference Check Sample A								05/24/10 15:02
Zinc		-0.00950	mg/L	0.010		0	0			
Sample ID: ICSAB		Interference Check Sample AB								05/24/10 15:05
Zinc		1.05	mg/L	0.010	105	80	120			
Sample ID: ICSA		Interference Check Sample A								05/24/10 17:57
Zinc		-0.00930	mg/L	0.010		0	0			
Sample ID: ICSAB		Interference Check Sample AB								05/24/10 18:00
Zinc		0.965	mg/L	0.010	96	80	120			

Qualifiers:

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.



QA/QC Summary Report

Client: MT DEQ
Project: Broken Hill Mine Reclamation Project

Report Date: 06/23/10
Work Order: H10050192

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: E3.2.3										Batch: R62668
Sample ID: H10050192-006A	4	Sample Duplicate					Run: LECO632_100525A			05/25/10 14:04
Sulfur, Total		ND	%	0.010						30
Sulfur, Sulfate		ND	%	0.010						30
Sulfur, Pyritic		ND	%	0.010						30
Sulfur, Organic		ND	%	0.010						30
Sample ID: LCS1005251415		Laboratory Control Sample					Run: LECO632_100525A			05/25/10 14:15
Sulfur, Total		ND	%	0.010		80	120			S

Qualifiers:

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.

S - Spike recovery outside of advisory limits.



QA/QC Summary Report

Client: MT DEQ
Project: Broken Hill Mine Reclamation Project

Report Date: 06/23/10
Work Order: H10050192

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: Sobek Modified										Batch: 8791
Sample ID: LCS-8791		Laboratory Control Sample					Run: MAN-TECH_100519D			05/19/10 12:53
Neutralization Potential		78	t/kt		101	70	130			
Sample ID: H10050192-006ADUP		Sample Duplicate					Run: MAN-TECH_100519D			05/19/10 13:37
Neutralization Potential		2.4	t/kt					3.6	20	
Method: Sobek Modified										Batch: 8791
Sample ID: H10050192-006ADUP	2	Sample Duplicate					Run: MISC SOILS_100525N			05/25/10 00:00
Acid Potential		0.016	t/kt	0.31					20	
Acid/Base Potential		2.4	t/kt					4.2	20	

Qualifiers:

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.



QA/QC Summary Report

Client: MT DEQ
Project: Broken Hill Mine Reclamation Project

Report Date: 06/23/10
Work Order: H10050192

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: SW6010B										Batch: 8790
Sample ID: MB-8790		Method Blank								05/24/10 17:04
Zinc		0.005	mg/kg	0.002						
Sample ID: LCS-8790		Laboratory Control Sample								05/24/10 17:07
Zinc		0.546	mg/kg	0.10	83	70	130			
Sample ID: H10050192-005AMS2		Sample Matrix Spike								05/24/10 17:35
Zinc		4.76	mg/kg	0.10	98	75	125			
Sample ID: H10050192-005AMSD2		Sample Matrix Spike Duplicate								05/24/10 17:38
Zinc		4.64	mg/kg	0.10	95	75	125	2.6	20	

Qualifiers:

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.

Workorder Receipt Checklist



H10050192

Login completed by: Tracy L. Lorash

Date Received: 5/14/2010

Reviewed by: BL2000\wjemmings

Received by: TLL

Reviewed Date: 6/2/2010

Carrier name: Hand Del

- | | | | |
|---|---|--|--|
| Shipping container/cooler in good condition? | Yes <input checked="" type="checkbox"/> | No <input type="checkbox"/> | Not Present <input type="checkbox"/> |
| Custody seals intact on shipping container/cooler? | Yes <input type="checkbox"/> | No <input type="checkbox"/> | Not Present <input checked="" type="checkbox"/> |
| Custody seals intact on sample bottles? | Yes <input type="checkbox"/> | No <input type="checkbox"/> | Not Present <input checked="" type="checkbox"/> |
| Chain of custody present? | Yes <input checked="" type="checkbox"/> | No <input type="checkbox"/> | |
| Chain of custody signed when relinquished and received? | Yes <input checked="" type="checkbox"/> | No <input type="checkbox"/> | |
| Chain of custody agrees with sample labels? | Yes <input type="checkbox"/> | No <input checked="" type="checkbox"/> | |
| Samples in proper container/bottle? | Yes <input checked="" type="checkbox"/> | No <input type="checkbox"/> | |
| Sample containers intact? | Yes <input checked="" type="checkbox"/> | No <input type="checkbox"/> | |
| Sufficient sample volume for indicated test? | Yes <input checked="" type="checkbox"/> | No <input type="checkbox"/> | |
| All samples received within holding time? | Yes <input checked="" type="checkbox"/> | No <input type="checkbox"/> | |
| Container/Temp Blank temperature: | 16.0°C Soil | | |
| Water - VOA vials have zero headspace? | Yes <input type="checkbox"/> | No <input type="checkbox"/> | No VOA vials submitted <input checked="" type="checkbox"/> |
| Water - pH acceptable upon receipt? | Yes <input type="checkbox"/> | No <input type="checkbox"/> | Not Applicable <input checked="" type="checkbox"/> |

Contact and Corrective Action Comments:

Collection times est. in lab. Per Ray, Sample ID is the field ID number on the attached supporting data. Client requested a fertilizer analysis - had to add NPK, Zinc and EC to the requested analysis. See attached email for authorization from Ray. TI



Chain of Custody and Analytical Request Record

PLEASE PRINT - Provide as much information as possible.

Company Name: Portage, Inc. Report Mail Address: 1065 N. Ewing		Project Name, PWS, Permit, Etc.: Broken Hill Mine Reclamation Project.		Sample Origin State: State:		EPA/State Compliance: Yes <input type="checkbox"/> No <input type="checkbox"/>	
Invoice Address: MT DEQ, per transmitted letter		Contact Name: Ray Schwaller 431-5522 Phone/Fax: rschwaller@portageinc.com		Email: rschwaller@portageinc.com		Sampler: (Please Print) RAY SCHWALLER	
Special Report/Formats - ELI must be notified prior to sample submittal for the following: <input type="checkbox"/> DW <input type="checkbox"/> GSA <input type="checkbox"/> POTW/WWTP <input type="checkbox"/> State: <input type="checkbox"/> Other:		ANALYSIS REQUESTED SEE ATTACHED		Contact ELI prior to RUSH sample submittal for charges and scheduling - See instruction Page R U S H		Shipped by: Hand Del.	
<input type="checkbox"/> A2LA <input type="checkbox"/> EDD/EDT (Electronic Data) Format: <input type="checkbox"/> LEVEL IV <input type="checkbox"/> NELAC		Matrix Number of Containers: _____ Sample Type: A W S V B O Vegetation Bioassay Other		Comments:		Receipt Temp: (6.0) °C	
SAMPLE IDENTIFICATION (Name, Location, Interval, etc.) 1 See attached letter 2 3 4 5 6 7 8 9 10		Collection Date Date/Time: 5/14/2010 1055		Collection Time Date/Time:		On Ice: Yes <input checked="" type="checkbox"/> No <input type="checkbox"/>	
Signature: Ray Schwaller		Signature: Ray Schwaller		Received by (print): Ray Schwaller		Date/Time: 5/14/10 10:55	
Signature: Ray Schwaller		Signature: Ray Schwaller		Received by (print): Ray Schwaller		Date/Time: 5/14/10 10:55	
Signature: Ray Schwaller		Signature: Ray Schwaller		Received by (print): Ray Schwaller		Date/Time: 5/14/10 10:55	

LABORATORY USE ONLY

H10050192

Custody Record MUST be Signed

In certain circumstances, samples submitted to Energy Laboratories, Inc. may be subcontracted to other certified laboratories in order to complete the analysis requested. This serves as notice of this possibility. All sub-contract data will be clearly notated on your analytical report. Visit our web site at www.energylab.com for additional information, downloadable fee schedule, forms, and links.

May 25, 2010

Ms. Pebbles Clark
MDEQ – Abandoned Mine Bureau
P.O. 200901
Helena, MT 59620

**RE: Broken Hill Mine Site
Geotechnical Investigation
Pioneer Technical Services Project No. 14637**

Dear Ms. Clark,

On May 14th, ten samples of material from the Broken Hill Mine Site Project were delivered to our ASTM/AASHTO/USACOE accredited materials testing laboratory by Mr. Ray Schwaller, P.E. of Portage Inc. Table 1 presents a list of samples received, the assigned laboratory numbers, and the testing performed.

Table 1 – Sample Summary

Lab Sample Number	Sample Location	Depth (ft)	Moisture Content	Sieve Analysis	Particle Size Analysis of Soils	Liquid and Plastic Limits	Standard Proctor	Specific Gravity of Soils
			ASTM D2216	ASTM C117, C136	ASTM D420	ASTM D4318	ASTM D698	ASTM D854
9214	TP-01-B	1 - 19	x	x		x	x	x
9215	TP-02-A	0 - 0.5	x		x	x		
9216	TP-02-B	0.5 - 1.5	x		x	x		
9217	TP-12-A	0 - 2	x		x	x		
9218	TP-12-B	2 - 8	x	x		x		
9219	TP-18-A	0 - 1.5	x		x	x		
9220	TP-18-B	1.5 - 8	x	x		x	x	x
9221	TP-25-A	0 - 1	x		x	x		
9222	TP-25-B	1 - 12	x	x		x	x	x
9223	TP-29-B	2 - 10	x	x		x		

ANACONDA

307 East Park Street, Suite 421
Anaconda, MT 59711
Phone (406) 563-9371
Fax (406) 563-9372

BUTTE

63 1/2 West Broadway
Butte, MT 59701
Phone (406) 782-5177
Fax (406) 782-5866

BILLINGS

1925 Grand Avenue, Suite 100
Billings, MT 59102
Phone (406) 545-4805
Fax (406) 545-4658

HELENA

201 East Broadway, Suite C
Helena, MT 59601
Phone (406) 457-8252
Fax (406) 442-1158

Moisture Content

Table 2 presents our moisture content testing results. *Standard Test Method for Laboratory Determination of Water Content of Soil and Rock by Mass ASTM D2216.*

Table 2 – Moisture Content

Lab Sample Number	Sample Location	Moisture Content (%)
9214	TP-01-B	6.1
9215	TP-02-A	61.1
9216	TP-02-B	43.6
9217	TP-12-A	51.2
9218	TP-12-B	5.8
9219	TP-18-A	69.2
9220	TP-18-B	12.8
9221	TP-25-A	48.5
9222	TP-25-B	15.0
9223	TP-29-B	10.2

Grain Size Analysis

Table 3 presents our grain size analysis testing results for aggregates and for soils. *Sieve Analysis of Coarse and Fine Aggregate (ASTM C117, C136); Standard Test Method for Particle Size Analysis of Soils ASTM D422.*

Table 3 – Grain Size Analysis

Lab Number:	9214	9215	9216	9217	9218	9219	9220	9221	9222	9223
Test Pit	TP-01-B	TP-02-A	TP-02-B	TP-12-A	TP-12-B	TP-18-A	TP-18-B	TP-25-A	TP-25-B	TP-29-B
Depth (ft)	1-19	0-.5	.5-1.5	0-2	2-8	0-1.5	1.5-8	0-1	1-12	2-10
Sieve Size	Percent Passing									
3" 75 mm	100						100			
2" 50 mm	96				100		99		100	100
1.5" 37.5 mm	93	100	100	100	93	100	97	100	98	95
1" 25 mm	85	99	99	96	84	96	92	98	91	84
3/4" 19 mm	79	96	94	91	80	93	88	97	86	74
1/2" 12.5 mm	64	90	85	83	69	89	79	92	77	58
3/8" 9.5 mm	55	86	80	79	63	85	74	90	71	50
# 4 4.75 mm	33	78	72	72	48	80	61	86	59	36
# 10 2.0 mm	12	74	65	67	35	76	48	80	49	26
# 20 0.85 mm	6	70	61	58	21	72	41	72	43	22
# 40 0.425 mm	5	67	58	53	13	69	38	68	40	20
# 60 0.250 mm	4	65	57	50	9	68	36	66	38	19
# 100 0.150 mm	4	63	56	48	7	66	35	64	34	17
# 200 0.075 mm	3.4	58.3	51.4	43.3	4.6	61.2	32.0	59.7	28.3	14.3

ANACONDA

307 East Park Street, Suite 421
Anaconda, MT 59711
Phone (406) 563-9371
Fax (406) 563-9372

BUTTE

63 1/2 West Broadway
Butte, MT 59701
Phone (406) 782-5177
Fax (406) 782-5866

BILLINGS

1925 Grand Avenue, Suite 100
Billings, MT 59102
Phone (406) 545-4805
Fax (406) 545-4658

HELENA

201 East Broadway, Suite C
Helena, MT 59601
Phone (406) 457-8252
Fax (406) 442-1158

Soil Classification, Atterberg Limits Testing

Table 4 presents our soil classifications with their liquid and plastic limits. *USDA Textural Classification; Classification of Soils for Engineering Purposes ASTM D2487; Classification of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes AASHTO M145; Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils ASTM D4318.*

Table 4 – Soil Classification, Atterberg Limits

Lab Sample Number	Sample Location	USDA Classification	USCS Classification	AASHTO Classification	Liquid Limit	Plastic Limit	Plasticity Index
9214	TP-01-B	----	Well-Graded Gravel with Sand (GW)	A-1-a (0)	23	18	5
9215	TP-02-A	Gravelly Silt Loam	Gravelly Elastic Silt with Sand (MH)	A-5 (0)	71	65	6
9216	TP-02-B	Gravelly Silt Loam	Gravelly Silt with Sand (ML)	A-4 (0)	NP	NP	NP
9217	TP-12-A	Gravelly Silt Loam	Silty Sand with Gravel (SM)	A-4 (0)	NP	NP	NP
9218	TP-12-B	----	Poorly Graded Gravel with Sand (GP)	A-1-a (0)	NP	NP	NP
9219	TP-18-A	Gravelly Silt Loam	Gravelly Silt with Sand (ML)	A-4 (0)	NP	NP	NP
9220	TP-18-B	----	Silty Gravel with Sand (GM)	A-2-4 (0)	25	22	3
9221	TP-25-A	Gravelly Silt Loam	Sandy Silt (ML)	A-4 (0)	NP	NP	NP
9222	TP-25-B	----	Silty Gravel with Sand (GM)	A-2-4 (0)	NP	NP	NP
9223	TP-29-B	----	Silty Gravel with Sand (GM)	A-1-a (0)	22	20	2

ANACONDA

307 East Park Street, Suite 421
Anaconda, MT 59711
Phone (406) 563-9371
Fax (406) 563-9372

BUTTE

63 1/2 West Broadway
Butte, MT 59701
Phone (406) 782-5177
Fax (406) 782-5866

BILLINGS

1925 Grand Avenue, Suite 100
Billings, MT 59102
Phone (406) 545-4805
Fax (406) 545-4658

HELENA

201 East Broadway, Suite C
Helena, MT 59601
Phone (406) 457-8252
Fax (406) 442-1158

Proctor Testing

Table 5 presents our Proctor testing results. *Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort ASTM D698*. The Proctor values were corrected for oversized particles. *Standard Practice for Correction of Unit Weight and Water Content for Soils Containing Oversize Particles ASTM D4718*.

Table 5 – Proctor Moisture/Density Relationships

Lab Sample Number	Sample Location	Corrected Maximum Dry Density (lb/ft ³)	Corrected Optimum Moisture (%)	Percent Oversized Material (+ 3/4-inch)
9214	TP-01-B	136.6	7.8	21.5
9220	TP-18-B	124.7	9.5	11.6
9222	TP-25-B	121.3	9.7	13.8

Specific Gravity

Tables 6 and 7 present our specific gravity results. Table 6 presents the specific gravity results for the samples tested for the specific gravity of soil. *Standard Test Method for Specific Gravity of Soil Solids by Water Pycnometer ASTM D854*.

Table 6 – Specific Gravity of Soil

Lab Sample Number	Sample Location	Specific Gravity of Fine Material (4.75mm Minus)	Fine Material Percent of Total	Specific Gravity of Coarse Aggregate				Coarse Aggregate Percent of Total	Weighted Average Specific Gravity
				Bulk Specific Gravity	Bulk Specific Gravity (SSD)	Apparent Specific Gravity	Absorption (%)		
9214	TP-01-B (1-19")	2.707	33	2.52	2.61	2.78	3.7	67	2.755
9220	TP-18-B (1.5-8')	2.725	61	2.37	2.5	2.72	5.4	39	2.723
9222	TP-25-B (1-12')	2.638	59	2.3	2.43	2.62	5.3	41	2.632

ANACONDA

307 East Park Street, Suite 421
Anaconda, MT 59711
Phone (406) 563-9371
Fax (406) 563-9372

BUTTE

63 1/2 West Broadway
Butte, MT 59701
Phone (406) 782-5177
Fax (406) 782-5866

BILLINGS

1925 Grand Avenue, Suite 100
Billings, MT 59102
Phone (406) 545-4805
Fax (406) 545-4658

HELENA

201 East Broadway, Suite C
Helena, MT 59601
Phone (406) 457-8252
Fax (406) 442-1158

Table 7 presents the specific gravity results on the portion of the samples smaller than 2 mm as required for the hydrometer portion of the *Particle Size Analysis of Soils ASTM D422*.

Table 7 – Specific Gravity of Soil (- 2mm portion)

Lab Sample Number	Sample Location	Specific Gravity (- 2mm)
9215	TP-02-A	2.361
9216	TP-02-B	2.428
9217	TP-12-A	2.398
9219	TP-18-A	2.410
9221	TP-25-A	2.496

The grain size distribution curves, USDA textural chart, Proctor curves, Atterberg limits charts and specific gravity of soils calculation sheets are included with this report. We thank you for using Pioneer Technical Services for your geotechnical and materials testing requirements. If you have any questions regarding these results, please contact Todd Lorenzen or Paul Bushnell at (406) 443-6053.

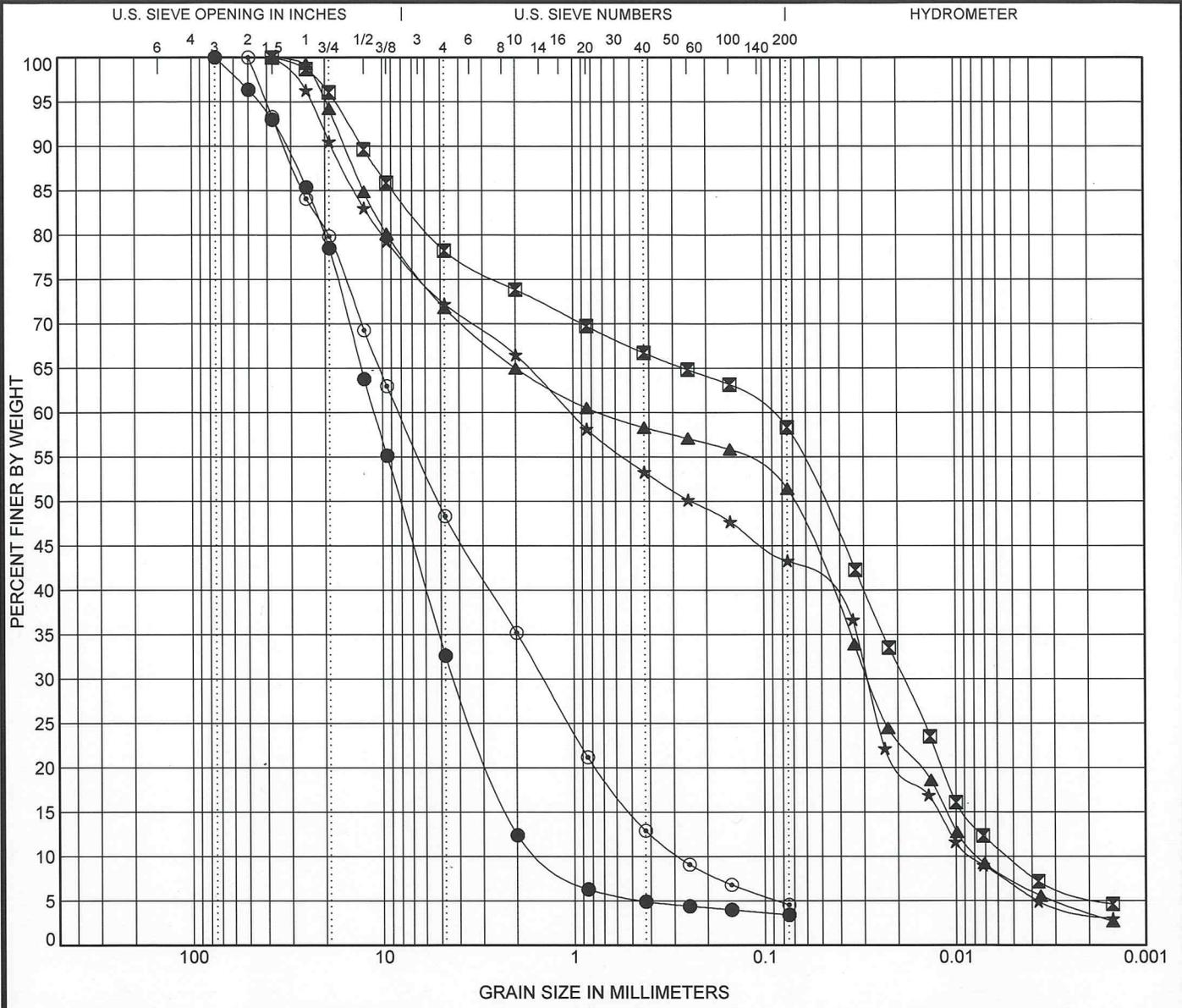
Sincerely,
PIONEER TECHNICAL SERVICES, INC.



Todd Lorenzen, P.E.
Senior Geotechnical Engineer



Paul Bushnell
Materials Testing Supervisor



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	LL	PL	PI	Cc	Cu
● TP-01-B 1.0	(A-1-a)	23	18	5	1.14	7.77
■ TP-02-A 0.0	(A-5)	71	65	6	0.69	17.88
▲ TP-02-B 0.5	(A-4)	NP	NP	NP	0.15	94.34
★ TP-12-A 0.0	(A-4)	NP	NP	NP	0.10	125.69
○ TP-12-B 2.0	(A-1-a)	NP	NP	NP	0.91	29.14

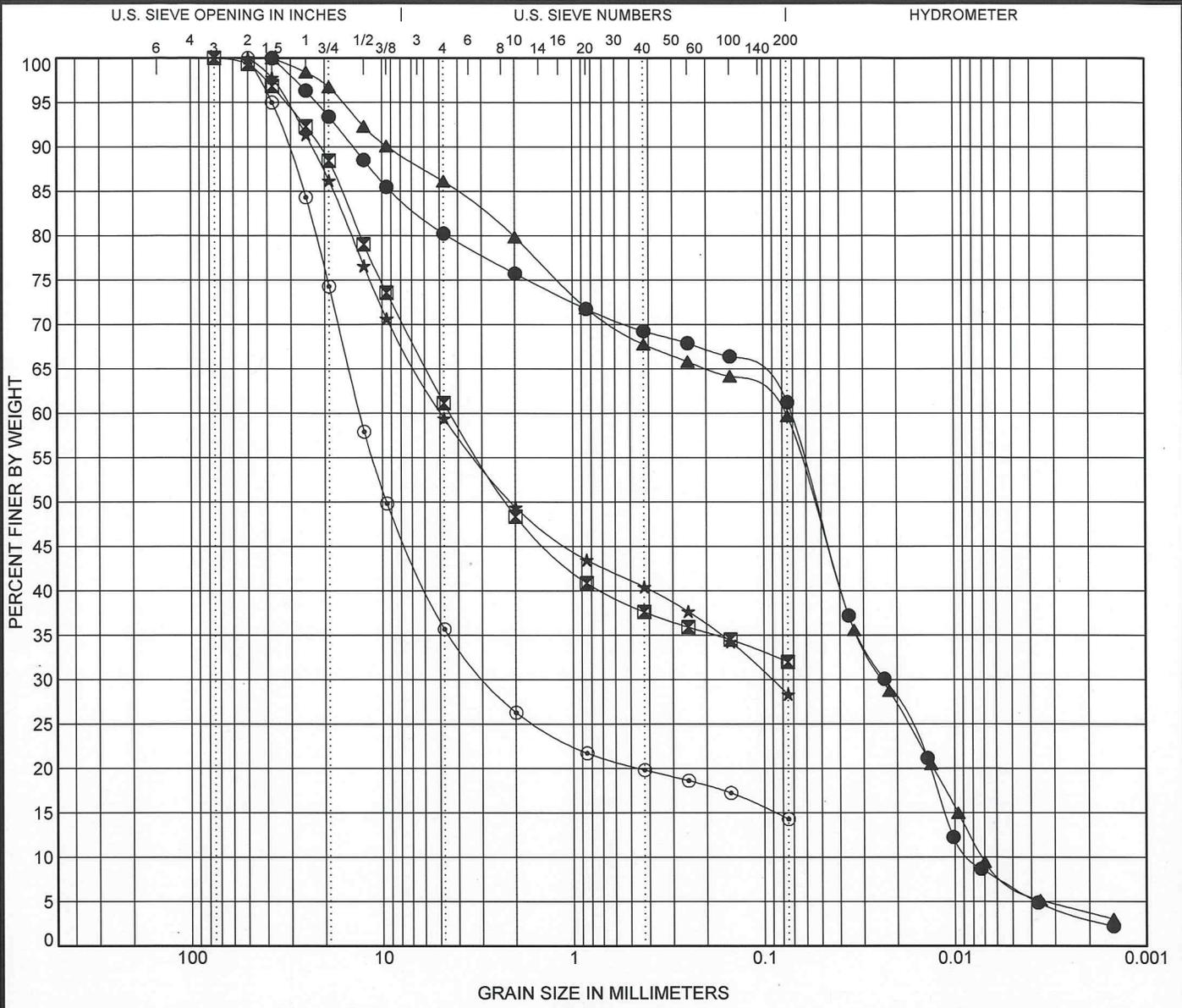
Specimen Identification	D100	D50	D15	D10	%Gravel	%Sand	%Silt	%Clay
● TP-01-B 1.0	75	8.108	2.235	1.427	67.4	29.2	3.4	
■ TP-02-A 0.0	37.5	0.049	0.009	0.005	21.8	19.9	52.9	5.4
▲ TP-02-B 0.5	37.5	0.07	0.011	0.008	28.2	20.4	47.8	3.6
★ TP-12-A 0.0	37.5	0.241	0.012	0.008	27.7	28.9	39.7	3.6
○ TP-12-B 2.0	50	5.138	0.506	0.283	51.7	43.8	4.6	



GRAIN SIZE DISTRIBUTION

Project: Broken Hill Mine Site
 Number: 14637

U.S. GRAIN SIZE_AASHTO_BROKEN HILL MINE SITE - 14637.GPJ PIONEER.GDT 5/24/10



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	LL	PL	PI	Cc	Cu
● TP-18-A 0.0	(A-4)	NP	NP	NP	0.91	8.75
■ TP-18-B 1.5	(A-2-4)	25	22	3		
▲ TP-25-A 0.0	(A-4)	NP	NP	NP	1.00	10.92
★ TP-25-B 1.0	(A-2-4)	NP	NP	NP		
○ TP-29-B 2.0	(A-1-a)	22	20	2		

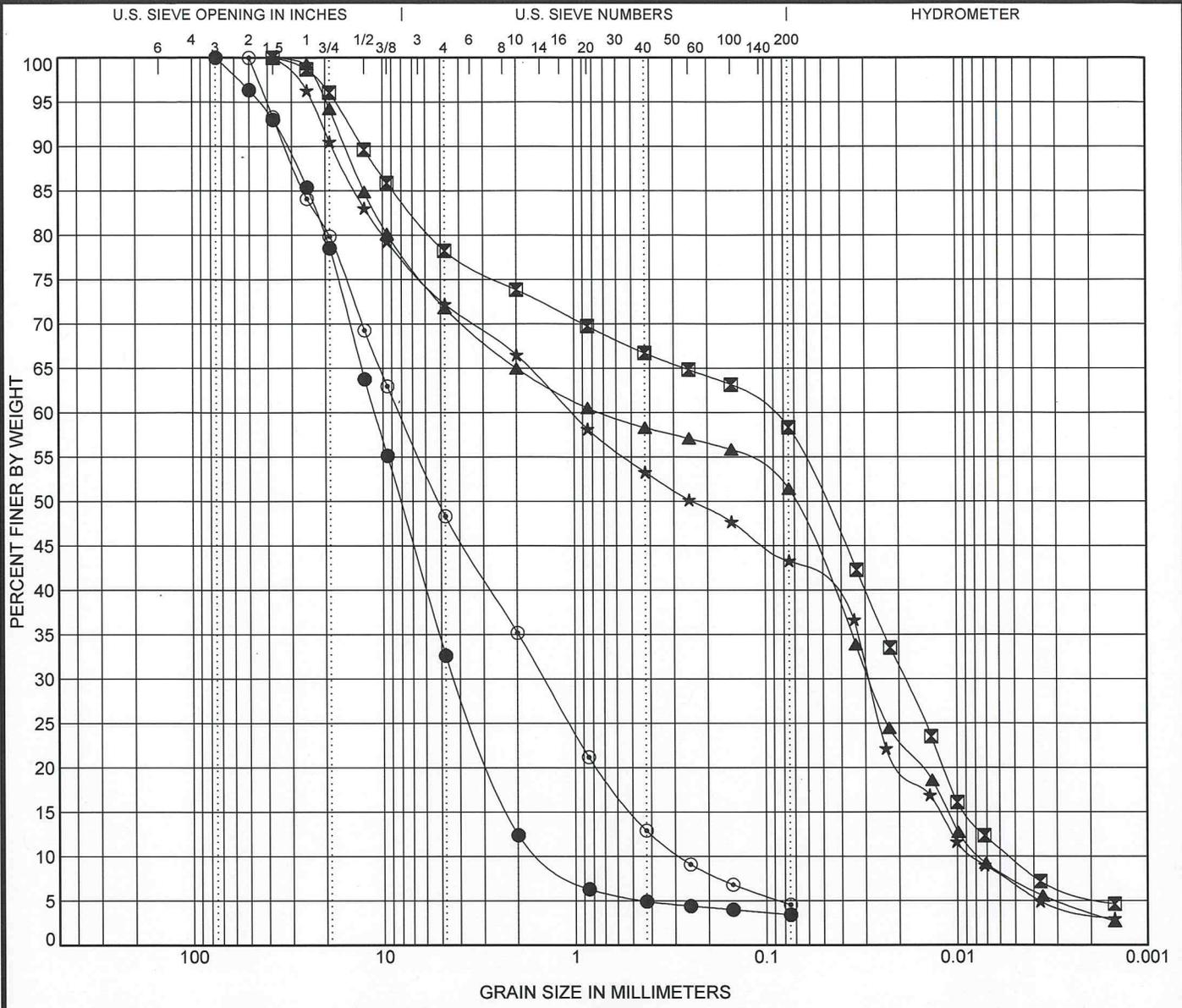
Specimen Identification	D100	D50	D15	D10	%Gravel	%Sand	%Silt	%Clay
● TP-18-A 0.0	37.5	0.053	0.011	0.008	19.7	19.0	58.2	3.1
■ TP-18-B 1.5	75	2.233			38.8	29.2	32.0	
▲ TP-25-A 0.0	37.5	0.054	0.01	0.007	13.9	26.5	55.9	3.7
★ TP-25-B 1.0	50	2.106			40.6	31.1	28.3	
○ TP-29-B 2.0	50	9.55	0.088		64.3	21.4	14.3	



GRAIN SIZE DISTRIBUTION

Project: Broken Hill Mine Site
 Number: 14637

U.S. GRAIN SIZE AASHTO - BROKEN HILL MINE SITE - 14637.GPJ PIONEER.GDT 5/24/10



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	LL	PL	PI	Cc	Cu
● TP-01-B 1.0	WELL-GRADED GRAVEL with SAND(GW)	23	18	5	1.14	7.77
■ TP-02-A 0.0	GRAVELLY ELASTIC SILT with SAND(MH)	71	65	6	0.69	17.88
▲ TP-02-B 0.5	GRAVELLY SILT with SAND(ML)	NP	NP	NP	0.15	94.34
★ TP-12-A 0.0	SILTY SAND with GRAVEL(SM)	NP	NP	NP	0.10	125.69
○ TP-12-B 2.0	POORLY GRADED GRAVEL with SAND(GP)	NP	NP	NP	0.91	29.14

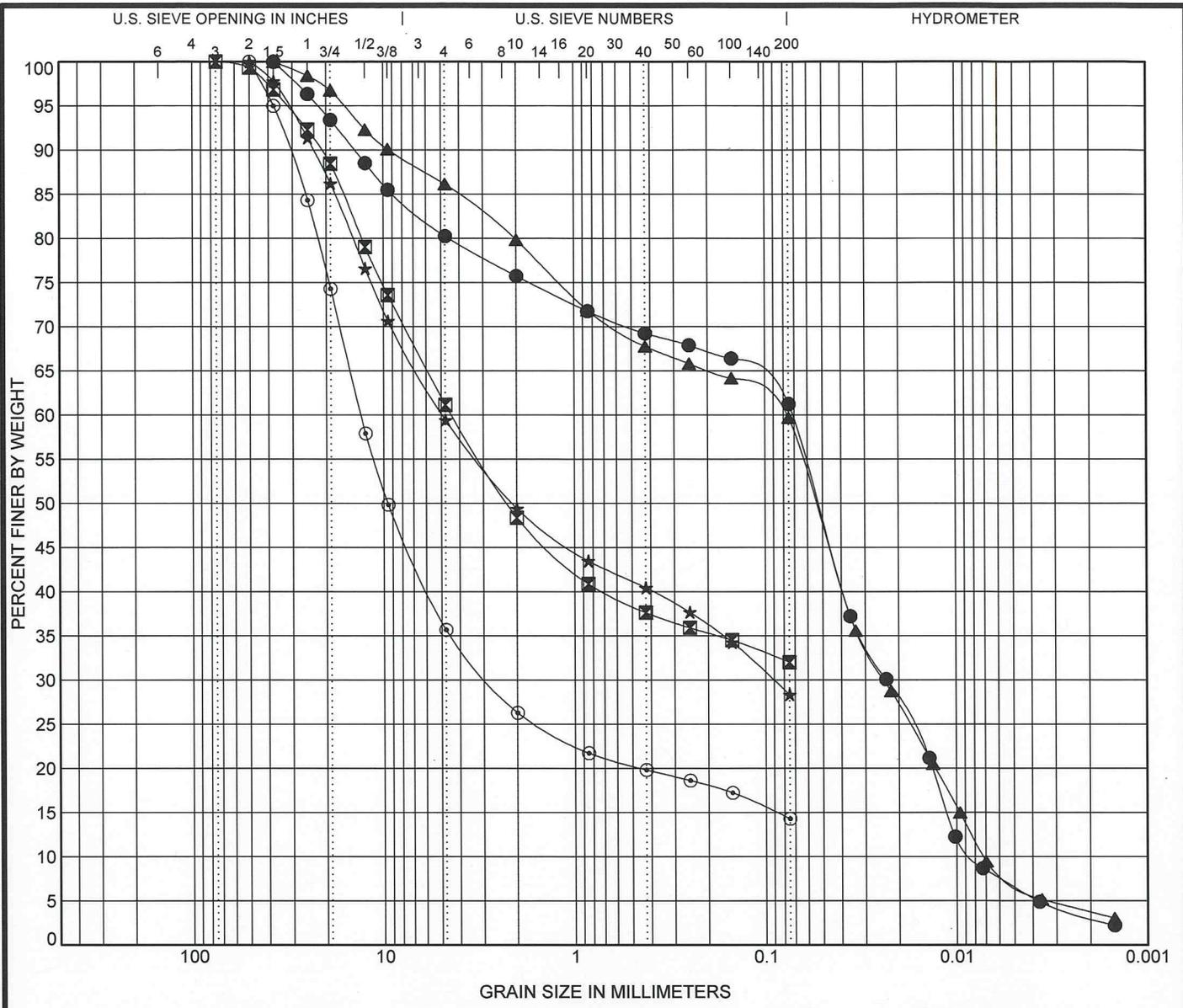
Specimen Identification	D100	D50	D15	D10	%Gravel	%Sand	%Silt	%Clay
● TP-01-B 1.0	75	8.108	2.235	1.427	67.4	29.2	3.4	
■ TP-02-A 0.0	37.5	0.049	0.009	0.005	21.8	19.9	52.9	5.4
▲ TP-02-B 0.5	37.5	0.07	0.011	0.008	28.2	20.4	47.8	3.6
★ TP-12-A 0.0	37.5	0.241	0.012	0.008	27.7	28.9	39.7	3.6
○ TP-12-B 2.0	50	5.138	0.506	0.283	51.7	43.8	4.6	



GRAIN SIZE DISTRIBUTION

Project: Broken Hill Mine Site
 Number: 14637

U.S. GRAIN SIZE ASTM BROKEN HILL MINE SITE - 14637.GPJ PIONEER.GDT 5/24/10



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	LL	PL	PI	Cc	Cu
● TP-18-A 0.0	GRAVELLY SILT with SAND(ML)	NP	NP	NP	0.91	8.75
■ TP-18-B 1.5	SILTY GRAVEL with SAND(GM)	25	22	3		
▲ TP-25-A 0.0	SANDY SILT(ML)	NP	NP	NP	1.00	10.92
★ TP-25-B 1.0	SILTY GRAVEL with SAND(GM)	NP	NP	NP		
○ TP-29-B 2.0	SILTY GRAVEL with SAND(GM)	22	20	2		

Specimen Identification	D100	D50	D15	D10	%Gravel	%Sand	%Silt	%Clay
● TP-18-A 0.0	37.5	0.053	0.011	0.008	19.7	19.0	58.2	3.1
■ TP-18-B 1.5	75	2.233			38.8	29.2	32.0	
▲ TP-25-A 0.0	37.5	0.054	0.01	0.007	13.9	26.5	55.9	3.7
★ TP-25-B 1.0	50	2.106			40.6	31.1	28.3	
○ TP-29-B 2.0	50	9.55	0.088		64.3	21.4	14.3	

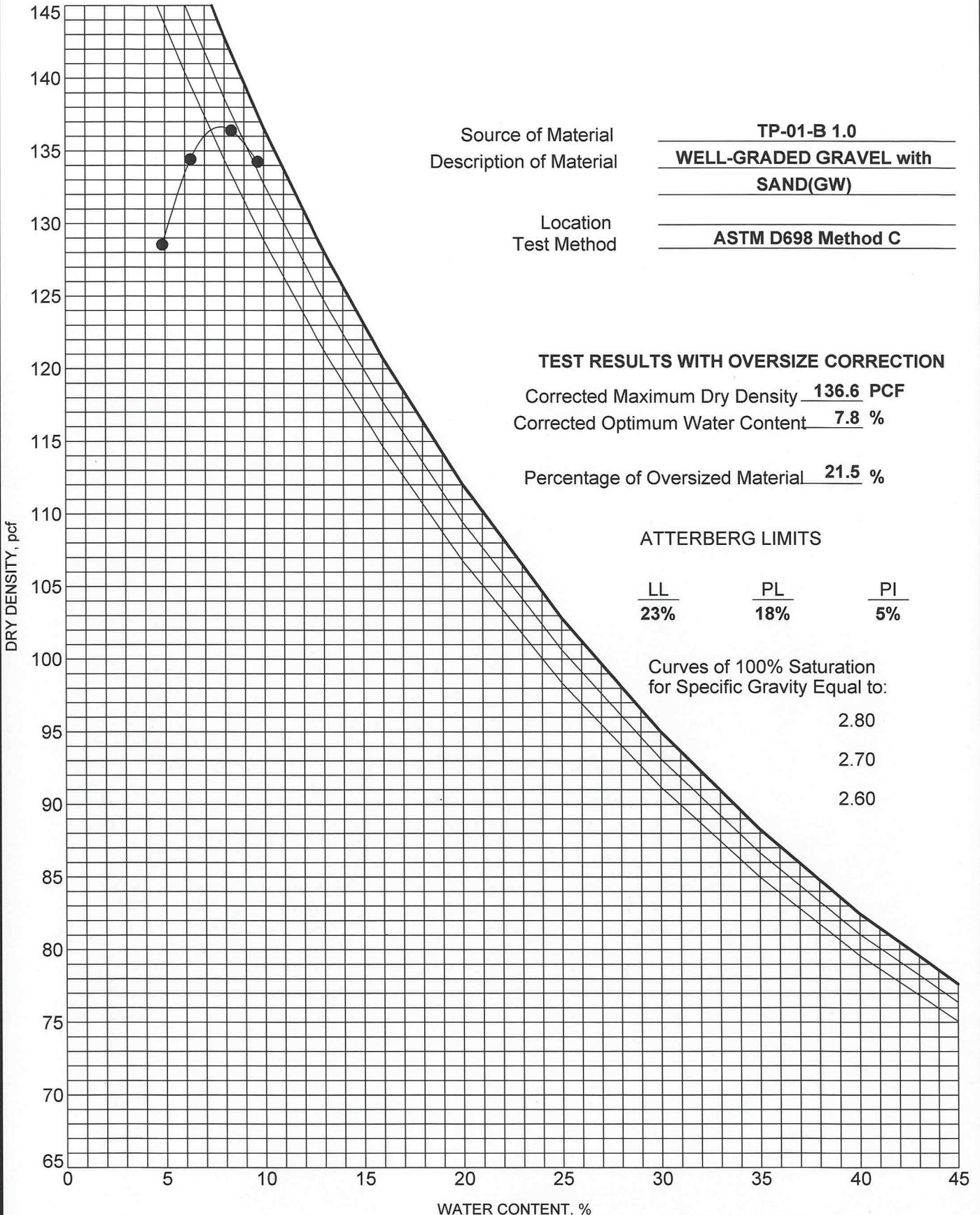


GRAIN SIZE DISTRIBUTION

Project: Broken Hill Mine Site
 Number: 14637

U.S. GRAIN SIZE ASTM BROKEN HILL MINE SITE - 14637.GPJ PIONEER.GDT 5/24/10

COMPACTION ROCK CORRECTION ASTM BROKEN HILL MINE SITE - 14639.GPJ COMPACTION ROCK CORRECTION.GDT 5/24/10



Source of Material
Description of Material

TP-01-B 1.0
WELL-GRADED GRAVEL with
SAND(GW)

Location
Test Method

ASTM D698 Method C

TEST RESULTS WITH OVERSIZE CORRECTION

Corrected Maximum Dry Density 136.6 PCF
Corrected Optimum Water Content 7.8 %
Percentage of Oversized Material 21.5 %

ATTERBERG LIMITS

LL PL PI
23% **18%** **5%**

Curves of 100% Saturation
for Specific Gravity Equal to:

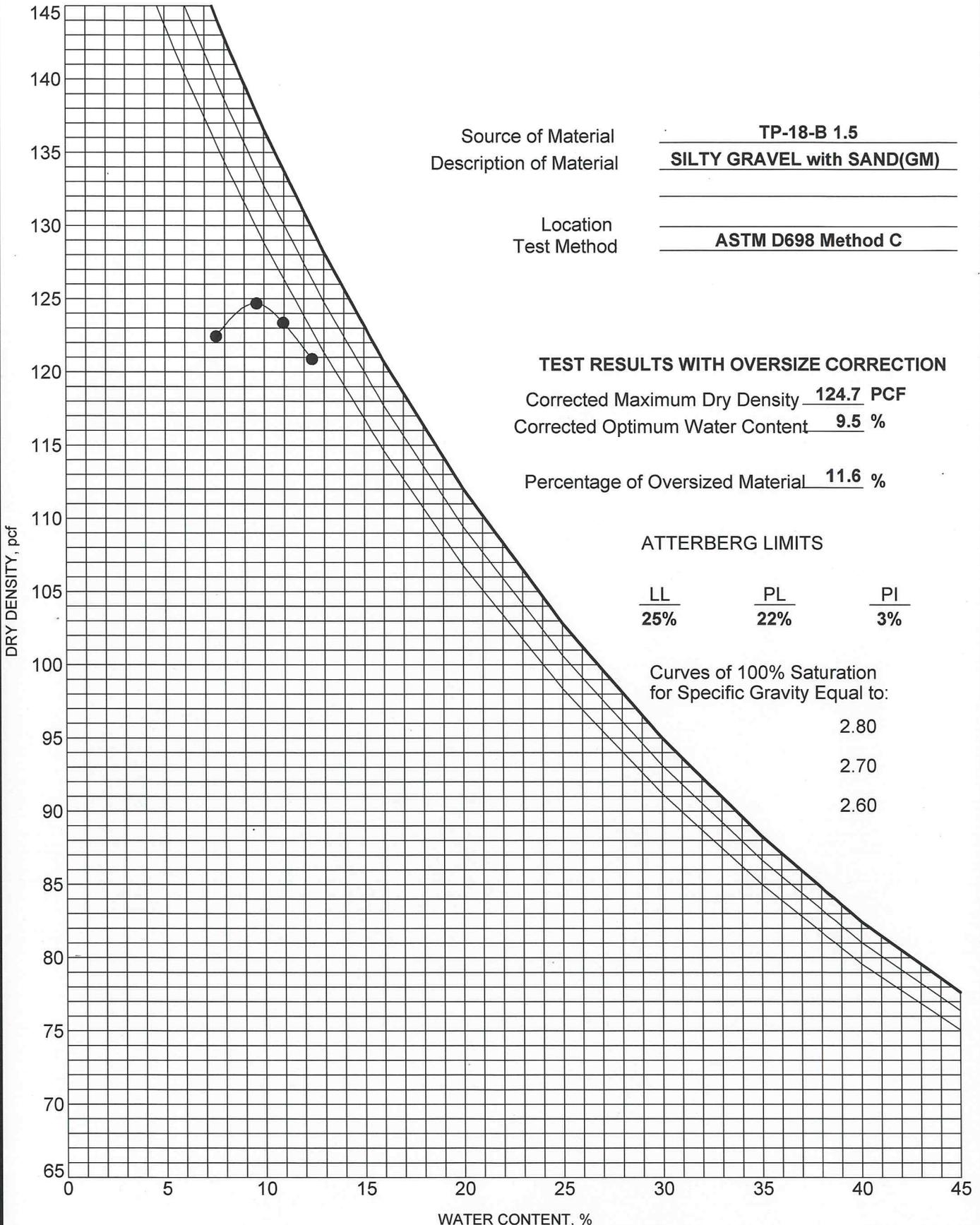
2.80
2.70
2.60



MOISTURE-DENSITY RELATIONSHIP

Project: Broken Hill Mine Site
Number: 14637

COMPACTION ROCK CORRECTION ASTM BROKEN HILL MINE SITE - 14639.GPJ COMPACTION ROCK CORRECTION.GDT 5/24/10



Source of Material
Description of Material

TP-18-B 1.5
SILTY GRAVEL with SAND(GM)

Location
Test Method

ASTM D698 Method C

TEST RESULTS WITH OVERSIZE CORRECTION

Corrected Maximum Dry Density 124.7 PCF
Corrected Optimum Water Content 9.5 %
Percentage of Oversized Material 11.6 %

ATTERBERG LIMITS

LL PL PI
25% **22%** **3%**

Curves of 100% Saturation
for Specific Gravity Equal to:

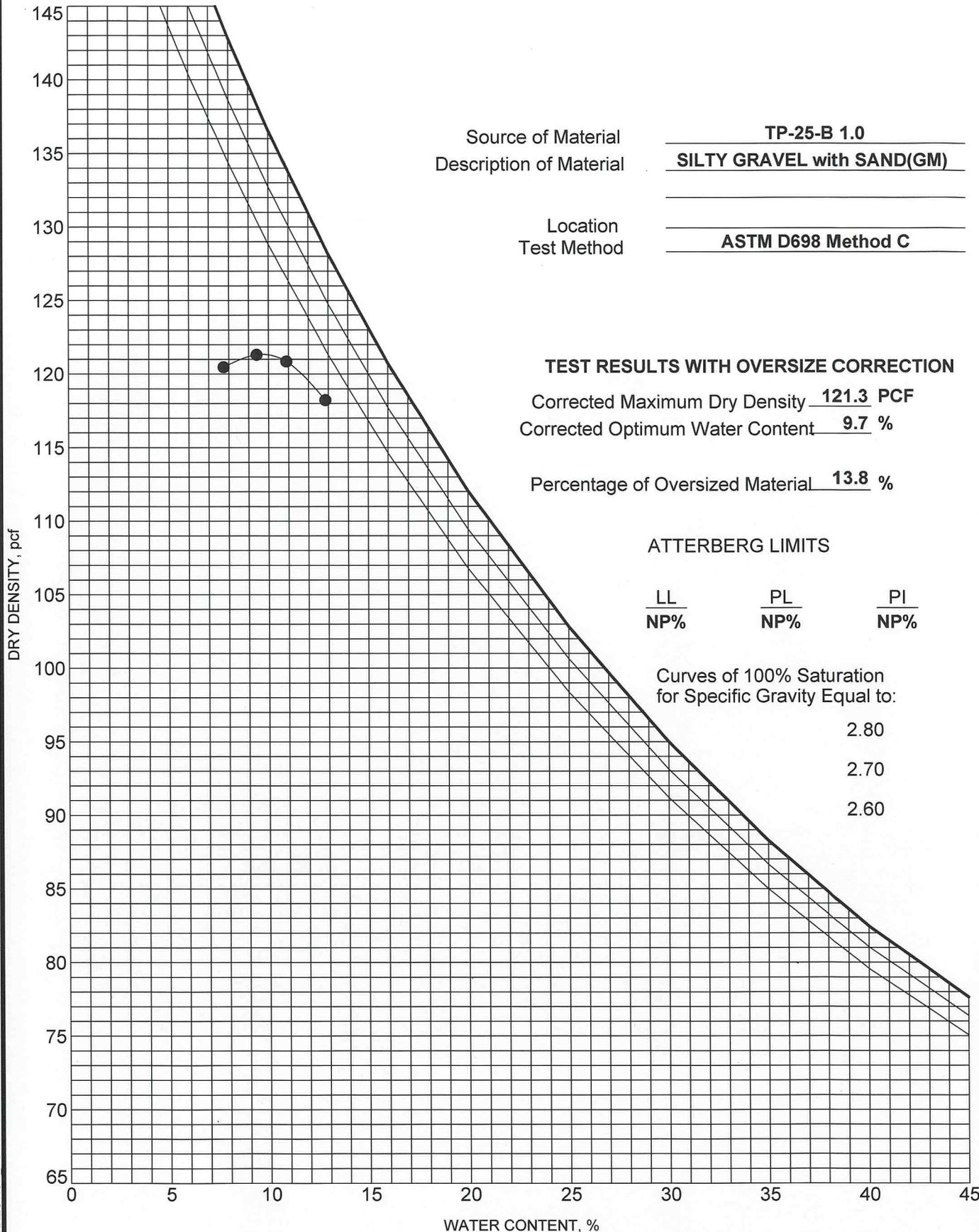
2.80
2.70
2.60

MOISTURE-DENSITY RELATIONSHIP



Project: Broken Hill Mine Site
Number: 14637

COMPACTION ROCK CORRECTION ASTM BROKEN HILL MINE SITE - 14639.GPJ COMPACTION ROCK CORRECTION.GDT 5/24/10



MOISTURE-DENSITY RELATIONSHIP

Project: Broken Hill Mine Site
 Number: 14637



201 East Broadway, Suite C
Helena, Montana 59601
Phone (406)457-8252 Fax (406)442-1158
www.pioneer-technical.com

Specific Gravity of Soils

Project	Broken Hill Mine Site
Project No.	14639
Location	TP-01-B 1'-19'
Lab No.	9214

Specific Gravity of Fine Material (4.75 minus)

Percent of Total	33
------------------	----

Pycnometer Method

Wo	Mass of Sample of oven-dried soil in grams
Wa	Mass of Pycnometer filled with water at Tx in grams
Wb	Mass of Pycnometer filled with water and soil at Tx in grams
Tx	Temperature of pycnometer contents when Wb was determined
Gs	Specific Gravity

Pycnometer No.	Soak Time Start	Soak Time End	Wo	Wa	Wb	Tx	Gs
500 D	5/19/2010 8:00	5/20/2010 9:00	78.8	759.89	809.58	20	2.707

$$Gs, Tx/Tx = Wo / [Wo + (Wa - Wb)]$$

Specific Gravity fine Material 2.707

Specific Gravity and Absorption of Coarse Aggregate

Percent of Total	67
------------------	----

Oven-Dry Weight in Air (grams) (A)	SSD Weight in Air (grams) (B)	Weight in Water (grams) (C)	
10879.7	11287.2	6964.2	
Bulk Specific Gravity = A / (B - C)			2.52
Bulk Specific Gravity (SSD) = B / (B - C)			2.61
Apparent Specific Gravity = A / (A - C)			2.78
% Absorption = ((B - A) / A) X 100			3.7

Specific Gravity of Soils page 2

Project	Broken Hill Mine Site
Project No.	14639
Location	TP-01-B 1'-19'
Lab No.	9214

Weighted Average Specific Gravity

G avg =	Weighted average specific gravity of soils composed of particles larger and smaller than the 4.75-mm sieve.
R1 =	Percent of soil particles retained on the 4.75-mm sieve
P1 =	Percent of soil particles passing the 4.75-mm sieve
G1 =	apparent specific gravity of soil particles retained on the 4.75-mm sieve as determined by ASTM C127
G2 =	Specific gravity of soil particles passing the 4.75-mm sieve as determined by ASTM D854

$$G \text{ avg} = 1 / ((R1 / 100 * G1) + (P1 / 100 * G2))$$

G avg = 2.755



201 East Broadway, Suite C
 Helena, Montana 59601
 Phone (406)457-8252 Fax (406)442-1158
 www.pioneer-technical.com

Specific Gravity of Soils

Project	Broken Hill Mine Site
Project No.	14639
Location	TP-18-B 1.5'-8'
Lab No.	9220

Specific Gravity of Fine Material (4.75 minus)

Percent of Total	61
------------------	----

Pycnometer Method

Wo	Mass of Sample of oven-dried soil in grams
Wa	Mass of Pycnometer filled with water at Tx in grams
Wb	Mass of Pycnometer filled with water and soil at Tx in grams
Tx	Temperature of pycnometer contents when Wb was determined
Gs	Specific Gravity

Pycnometer No.	Soak Time Start	Soak Time End	Wo	Wa	Wb	Tx	Gs
500B	5/19/2010 8:00	5/20/2010 9:00	101.31	750.51	814.64	20	2.725

$G_s, T_x/T_x = W_o / [W_o + (W_a - W_b)]$

Specific Gravity fine Material	2.725
--------------------------------	-------

Specific Gravity and Absorption of Coarse Aggregate

Percent of Total	39
------------------	----

Oven-Dry Weight in Air (grams) (A)	SSD Weight in Air (grams) (B)	Weight in Water (grams) (C)
7843.9	8266.7	4959.3
Bulk Specific Gravity = $A / (B - C)$		2.37
Bulk Specific Gravity (SSD) = $B / (B - C)$		2.50
Apparent Specific Gravity = $A / (A - C)$		2.72
% Absorption = $((B - A) / A) \times 100$		5.4

Specific Gravity of Soils page 2

Project	Broken Hill Mine Site
Project No.	14639
Location	TP-18-B 1.5'-8'
Lab No.	9220

Weighted Average Specific Gravity

G avg =	Weighted average specific gravity of soils composed of particles larger and smaller than the 4.75-mm sieve,
R1 =	Percent of soil particles retained on the 4.75-mm sieve
P1 =	Percent of soil particles passing the 4.75-mm sieve
G1 =	apparent specific gravity of soil particles retained on the 4.75-mm sieve as determined by ASTM C127
G2 =	Specific gravity of soil particles passing the 4.75-mm sieve as determined by ASTM D854

$G_{avg} = 1 / ((R1 / 100 * G1) + (P1 / 100 * G2))$

G avg =	2.723
---------	-------



201 East Broadway, Suite C
Helena, Montana 59601
Phone (406)457-8252 Fax (406)442-1158
www.pioneer-technical.com

Specific Gravity of Soils

Project	Broken Hill Mine Site
Project No.	14639
Location	TP-25-B 1'-12'
Lab No.	9222

Specific Gravity of Fine Material (4.75 minus)

Percent of Total	59
------------------	----

Pycnometer Method

Wo	Mass of Sample of oven-dried soil in grams
Wa	Mass of Pycnometer filled with water at Tx in grams
Wb	Mass of Pycnometer filled with water and soil at Tx in grams
Tx	Temperature of pycnometer contents when Wb was determined
Gs	Specific Gravity

Pycnometer No.	Soak Time Start	Soak Time End	Wo	Wa	Wb	Tx	Gs
500 C	5/19/2010 8:00	5/20/2010 9:00	73.15	759.92	805.34	20	2.638

$G_s, T_x/T_x = W_o / [W_o + (W_a - W_b)]$

Specific Gravity fine Material 2.638

Specific Gravity and Absorption of Coarse Aggregate

Percent of Total	41
------------------	----

Oven-Dry Weight in Air (grams) (A)	SSD Weight in Air (grams) (B)	Weight in Water (grams) (C)
6051.8	6373.2	3745.1
Bulk Specific Gravity = $A / (B - C)$		2.30
Bulk Specific Gravity (SSD) = $B / (B - C)$		2.43
Apparent Specific Gravity = $A / (A - C)$		2.62
% Absorption = $((B - A) / A) \times 100$		5.3

Specific Gravity of Soils page 2

Project	Broken Hill Mine Site
Project No.	14639
Location	TP-25-B 1'-12'
Lab No.	9222

Weighted Average Specific Gravity

G avg =	Weighted average specific gravity of soils composed of particles larger and smaller than the 4.75-mm sieve.
R1 =	Percent of soil particles retained on the 4.75-mm sieve
P1 =	Percent of soil particles passing the 4.75-mm sieve
G1 =	apparent specific gravity of soil particles retained on the 4.75-mm sieve as determined by ASTM C127
G2 =	Specific gravity of soil particles passing the 4.75-mm sieve as determined by ASTM D854

$G_{avg} = 1 / ((R1 / 100 * G1) + (P1 / 100 * G2))$

G avg = 2.632



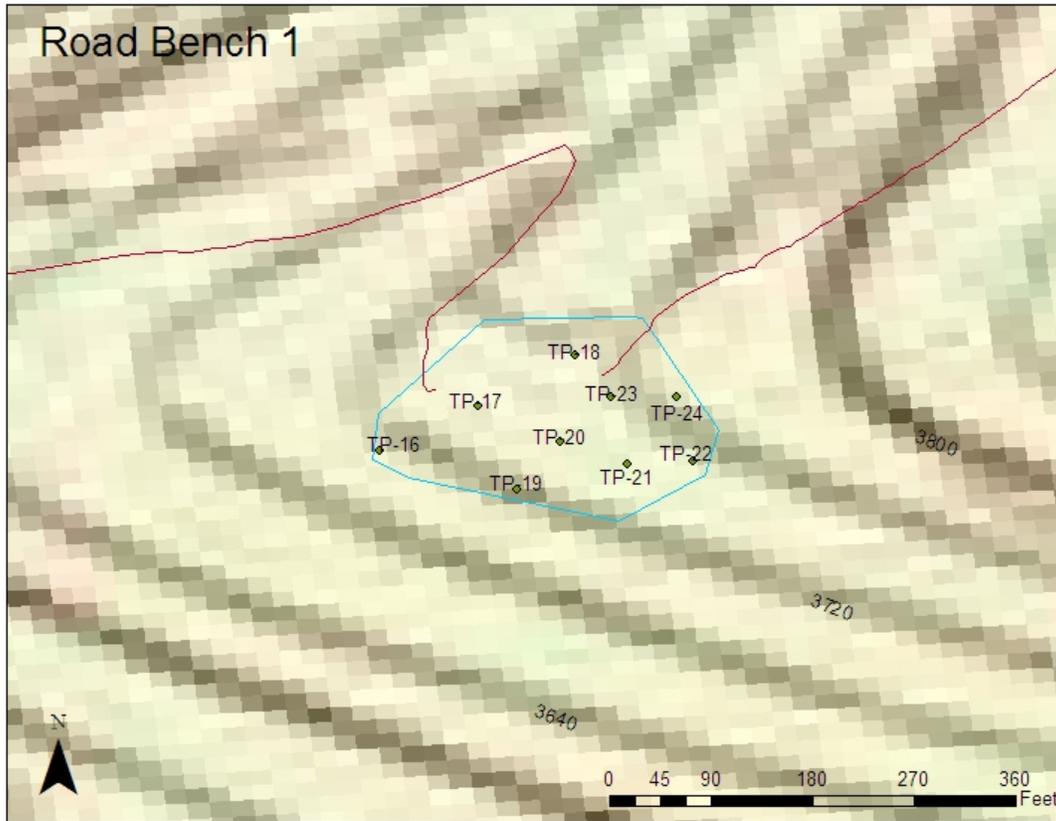
**REPOSITORY INVESTIGATION REPORT
FOR THE BROKEN HILL MINE SITE,
SANDERS COUNTY, MONTANA**

Identifier: RPT-5006
Revision: 0
Page: D-1 of D-5

**APPENDIX D
TEST PIT LOCATIONS**

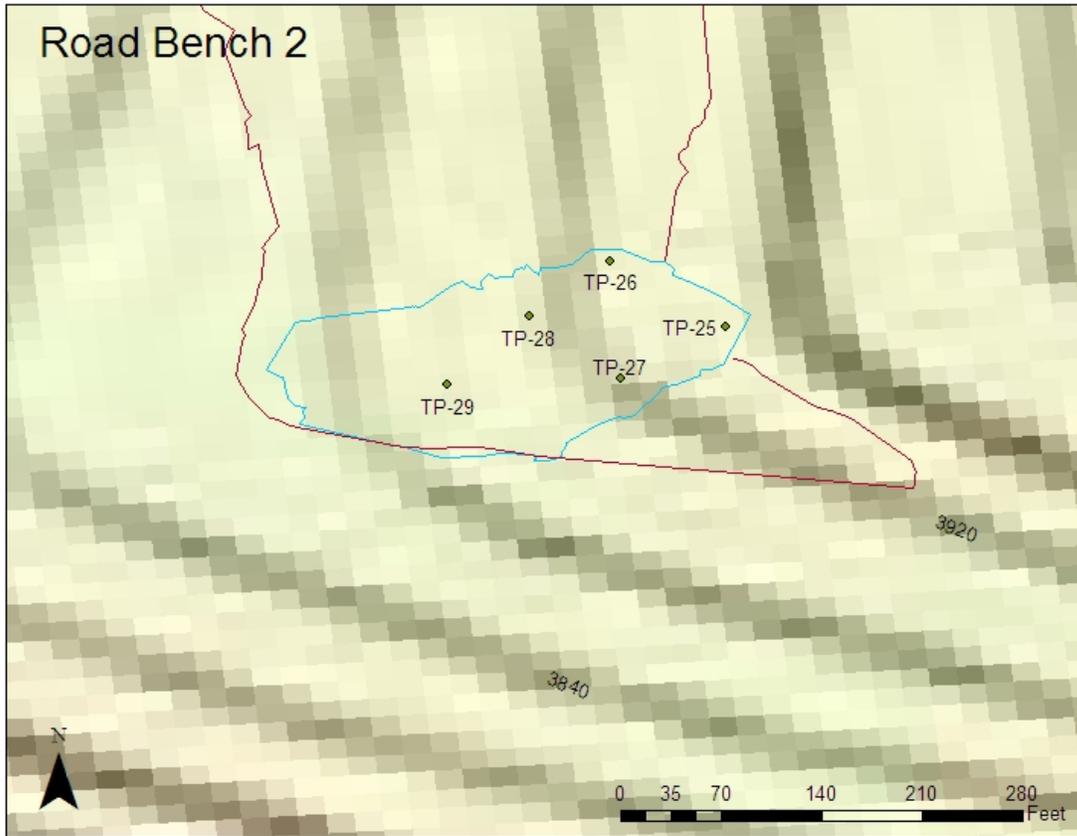
**REPOSITORY INVESTIGATION REPORT
FOR THE BROKEN HILL MINE SITE,
SANDERS COUNTY, MONTANA**

Identifier: RPT-5006
Revision: 0
Page: D-2 of D-5



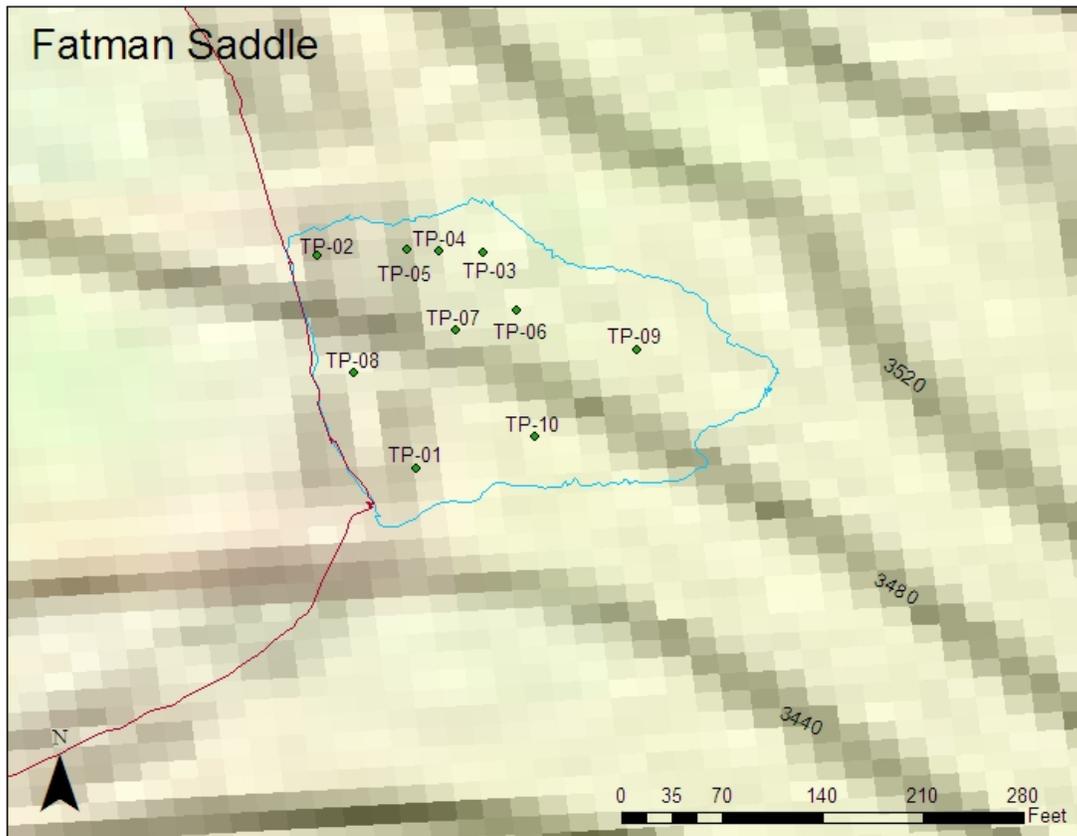
**REPOSITORY INVESTIGATION REPORT
FOR THE BROKEN HILL MINE SITE,
SANDERS COUNTY, MONTANA**

Identifier: RPT-5006
Revision: 0
Page: D-3 of D-5



**REPOSITORY INVESTIGATION REPORT
FOR THE BROKEN HILL MINE SITE,
SANDERS COUNTY, MONTANA**

Identifier: RPT-5006
Revision: 0
Page: D-4 of D-5



**REPOSITORY INVESTIGATION REPORT
FOR THE BROKEN HILL MINE SITE,
SANDERS COUNTY, MONTANA**

Identifier: RPT-5006
Revision: 0
Page: D-5 of D-5

