ATTACHMENT 2

CHAIN-OF-CUSTODY RECORD

Chain of Custody and Analytical Request Record

ENERGY LABORATORIES

Page _____ of _____

PLEASE PRINT- Provide as much information as possible.

Company Name:	Project Name, PWS, Permit, Etc.	Sample Origin State:	EPA/State Compliance: Yes ☐ No ☐
Report Mail Address:	Contact Name: Phone/Fax:	Email:	Sampler: (Please Print)
Invoice Address:	Invoice Contact & Phone:	Purchase Order:	Quote/Bottle Order:

Special Report/Formats – ELI must be notified prior to sample submittal for the following:

☐ DW
☐ GSA
☐ POTW/WWTP
☐ State: __________
☐ Other: __________
☐ A2LA
☐ EDD/EDT(Electronic Data)
Format:__________
☐ LEVEL IV
☐ NELAC

Number of Containers
Sample Type: A W S V B O
Air Water Soils/Solids
Vegetation Bioassay Other

ANALYSIS REQUESTED

SEE ATTACHED

Normal Turnaround (TAT)

R U S H

Contact ELI prior to **RUSH** sample submittal for charges and scheduling – See Instruction Page

Comments:

Shipped by:

Cooler ID(s):

Receipt Temp
________ °C

On Ice:
Yes No

Custody Seal	Y	N
Intact	Y	N
Signature Match	Y	N

SAMPLE IDENTIFICATION (Name, Location, Interval, etc.)	Collection Date	Collection Time	MATRIX													LABORATORY USE ONLY
1																
2																
3																
4																
5																
6																
7																
8																
9																
10																

Custody Record MUST be Signed

Relinquished by (print):	Date/Time:	Signature:	Received by (print):	Date/Time:	Signature:
Relinquished by (print):	Date/Time:	Signature:	Received by (print):	Date/Time:	Signature:
Sample Disposal: Return to Client: ________	Lab Disposal: ________		**Received by Laboratory:**	Date/Time:	Signature:

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.

PLEASE read and remove before completing the attached Chain of Custody (COC) form. PLEASE read and remove before completing the attached Chain of Custody (COC) form.

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Cell: 775.750.0956

BEFORE COMPLETING THE ATTACHED CHAIN OF CUSTODY (COC) FORM:

If you wish to request RUSH Turn Around Time (TAT), contact the lab PRIOR to sample submittal to confirm that RUSH analysis is available for your request. Verify date required. Additional charges will apply for RUSH Turn Around Time (TAT).

Please contact ELI PRIOR to sample submittal if services are other than standard.

It is important to complete the attached Chain Of Custody(COC) form with as much detailed information as possible. This information is required so that the appropriate analytical services, reporting and invoicing can be provided for your project.

Quote Number or Bottle Order Number:
ELI provides quotes for project specific sampling requirements. It is very important to provide the ELI quote number or bottle order number to assure that you receive the quoted pricing for your project.

Select the types of services you need:
If services other than standard are required for your analytical project, contact ELI PRIOR to sample submittal.

Sample Disposal:
ELI, when applicable, will dispose of all non-hazardous samples. Routinely, hazardous samples will be returned to the client. If requested, ELI will dispose of hazardous samples at client's expense.

Chain of Custody and Analytical Request Record

ENERGY LABORATORIES — Page 1 of 1

PLEASE PRINT- Provide as much information as possible.

Company Name: ABC Corporation	Project Name, PWS#, Permit #, Etc. Rockport Reclamation Project	Sample Origin State: Montana	EPA/State Compliance: Yes ☐ No ☒
Report Mail Address: 1234 Main St, Anywhere, MT 59101	Contact Name: John Smith; Phone/Fax: 605-444-1234	Email: anyone@email.com	Sampler: (Please Print) SAME
Invoice Address: P. O. Box 222, City, ST 11111	Invoice Contact & Phone #: Jane Doe 406-555-1212	Purchase Order #: A98765	Quote/Bottle Order #: HO1-172

Special Report/Formats – ELI must be notified prior to sample submittal for the following:

- ☐ DW
- ☐ GSA
- ☐ POTW/WWTP
- ☐ State: ________
- ☐ Other: ________
- ☐ A2LA
- ☐ EDD/EDT (Electronic Data) Format: ________
- ☐ LEVEL IV
- ☐ NELAC

ANALYSIS REQUESTED

	SAMPLE IDENTIFICATION (Name, Location, Interval, etc.)	Collection Date	Collection Time	MATRIX (Number of Containers, Sample Type: A W S V B O, Air Water Soils/Solids Vegetation Bioassay Other)	Radium 226	Ammonia	Nitrate	SEE ATTACHED	Normal Turnaround (TAT)	RUSH
1	MW-1	08/01/01	13:10	3-W	X	X	X			X
2	Soil From Pad	08/02/01	09:47	1-S	X	X	X			X
3										
4										
5										
6										
7										
8										
9										
10										

Example

Contact ELI prior to RUSH sample submittal for charges and scheduling – See Instruction Page

Comments: Spoke to Joe RE: Rush TAT

Shipped by: / Cooler ID(s): / Receipt Temp ____ °C / On Ice: Yes No / Custody Seal Y N / Intact Y N / Signature Match Y N

LABORATORY USE ONLY

Custody Record MUST be Signed

Relinquished by (print): John Smith	Date/Time: 08/09/04 14:15	Signature: John Smith	Received by (print): Mary Cook	Date/Time: 08/09/04 14:15	Signature: Mary Cook
Relinquished by (print):	Date/Time:	Signature:	Received by (print):	Date/Time:	Signature:
Sample Disposal: Return to Client:		Lab Disposal:	Received by Laboratory:	Date/Time:	Signature:

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.

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PLEASE read and remove before completing the attached Chain of Custody (COC) form. PLEASE read and remove before completing the attached Chain of Custody (COC) form.

ATTACHMENT 3

CUSTODY SEAL

Lynn Peavey Co.
1-800-255-6499

LAB SAMPLE
DO NOT TAMPER

DATE ____________

INITIALS ____________

STANDARD OPERATING PROCEDURES PRE-DESIGN STUDIES CHURCH ROCK MINE AND MILL SITE	SOP-07 Revision: 0
SOIL SAMPLING	Date: July 2013

STANDARD OPERATING PROCEDURE 7
SOIL SAMPLING

TABLE OF CONTENTS

1.0 SCOPE AND APPLICABILITY

This standard operating procedure (SOP) presents the soil sampling procedures to be used during Pre-Design studies at the Church Rock Mine and Mill site. This guideline focuses on methods and equipment that are readily available and typically applied. It is not intended to provide an all-inclusive discussion of soil sampling methods. Sample types, samplers, and sampling methods are discussed.

2.0 SOIL SAMPLING

2.1 TYPES OF SAMPLES

Four basic types of samples are collected in site investigation work: bulk samples, representative samples, "undisturbed" samples, and composite samples.

2.1.1 Bulk Samples

Bulk samples are generally a shovelful or trowelful of material taken from cuttings. There is usually significant uncertainty regarding which interval the cuttings represent. Bulk samples are typically collected from test pits, trenches, or drill cuttings.

2.1.2 Representative Samples

Representative samples are collected with a drive or push tube. They do not represent undisturbed conditions but do represent all the constituents that exist at a certain interval.

2.1.3 Undisturbed Samples

"Undisturbed" samples are high-quality samples collected under strictly controlled conditions to minimize the structural disturbance of the sample. Undisturbed samples should be collected when all the presampling relationships need to be preserved. Every effort is made to avoid altering the sample during the sampling process. Undisturbed samples are generally required for geotechnical work and are rarely necessary to assess environmental quality.

2.1.4 Composite Samples

Composite samples are a blend or mix of sample material, usually combined from two or more stratigraphic intervals mixed in such a way as to represent the total borehole. Homogenized samples are samples that are composited over a discreet interval. For example, if a sample represented the 10- to 11.5-foot interval, the material from that interval would be mechanically blended before being put into the appropriate sample container. VOC samples are never composited or homogenized.

2.2 SAMPLING METHODS

2.2.1 Solid-Barrel Samplers

The length of the solid barrel sampler is 1 to 6 inches and the length is between 12 and 60 inches. The sampler is usually made out of steel or stainless steel and can be used with thin-walled liners that can be slid into or out of the sampler barrel. Liners may be made of brass, aluminum, stainless steel, or synthetic materials. Allowable liner materials are based on the types of materials, tests, and analyses performed.

2.2.2 Split-Spoon Samplers

Split-spoon samplers are the most commonly used sampler for monitoring and geotechnical work and can be applied to a variety of drilling methods. Split-spoon samplers are usually made out of steel or stainless steel. They are tubular in shape and are split longitudinally into two semi-cylindrical halves. They may be lined or unlined. Liners are made of brass, aluminum, stainless steel, or various synthetic materials. Split-spoon samplers are generally available in 2-, 2.5-, 3-, 3.5-, and 4-inch outside diameters (OD). Lengths range between 12 and 60 inches. The 18-inch long sampler is the most commonly used. Three 6-inch liners are commonly used with this sampler. Sixty-inch samplers are commonly used when continuous coring is necessary.

Driving (hammering) is the most common method of obtaining split-spoon samples up to 2.5 feet in length. For most sampling a 140-pound hammer is used. The hammer may either be at the ground surface or in-hole. A standard penetration test should be conducted in accordance with American Society for Testing and Materials (ASTM) D1586. Samples are collected from the split-spoon sampler by driving the sampler into undisturbed material beneath the bottom of the casing or borehole with a weighted hammer. The number of blow counts per 6-inch increment of total drive are recorded. An estimate of the density and consistency of the subsurface soils can be made from the relationships among the hammer weight, drop, and number of blows required to advance the split spoon in 6-inch increments.

If the sampler cannot be advanced 6 inches with a reasonable number of blows (usually about 50) than sampler refusal occurs and the sampling effort at that particular interval is terminated. If "auger refusal" has not occurred, the hole is advanced to the next sampling interval where another attempt at sample retrieval is made.

After the split spoon is removed, it is opened for visual inspection and classification. If an adequate sample volume has not been retrieved, additional sample shall be collected from a second sampler from the interval immediately below the preceding interval.

If volatile organic compounds (VOCs) are to be analyzed, the sample is to be immediately transferred into the appropriate sampling jars upon retrieval of the split spoon from the borehole. Following sample description the contents of the samples for non-VOC analyses shall be emptied into a stainless steel bowl and the sample shall be thoroughly blended before transfer into the sample jars. Care shall be taken to ensure that the sample collected is representative of the sample interval, and not slough material. All slough material shall be discarded. A representative sample shall be retained in an archive box.

2.2.3 Thin-Walled Tube Samplers

The thin-walled tube (Shelby tube) sampler is a 30- or 36-inch-long, thin-walled steel, aluminum, brass, or stainless steel tube equipped with a connector head. It is primarily used in soft or clayey formations where it will provide more sample recovery than a split-spoon sampler and when relatively undisturbed samples are desired. The most commonly used sampler has a 3-inch OD and a 2.81-inch cutting diameter, and is 30 inches long.

Pressing or pushing without rotation is the normal mode of advance for the thin-walled sampler. If the tube cannot be advanced by pressing, it may become necessary to drive the sample with drill rods and hammers without rotation. The tubes are generally allowed to stay in the hole 10 to 15 minutes to allow the buildup of skin friction prior to removal. The tube is then rotated to separate it from the soil beneath it, prior to being brought to the surface.

After removal, the sample is inspected to ensure an adequate sample volume has been collected. If an inadequate volume has been collected, the above sampling procedure shall be repeated.

Upon retrieval, the soil core shall be described and recorded in the logbook and any disturbed soil shall be removed from the end of the tube. VOC samples shall be removed and placed in the appropriate sample containers immediately upon sample retrieval. Thin-walled tubes shall be capped with nonreactive material for transport.

2.2.4 Continuous Coring

Continuous coring is usually performed with a 60-inch split-spoon sampler that is advanced by pressing without rotating while the drill bit is rotating. The sampling tube is lowered into and retrieved from the augers or drill stem using a wireline or drill rods.

The sampling tube is locked into place so that the sampler protrudes slightly ahead of the drill bit. As the bit is advanced, the auger is pressed into the formation. After the hole has been advanced the length of the sampling tube, the full sampler is retrieved and an empty sampler is put down the hole. Sampling procedures will follow those described in Section 2.2.2.

STANDARD OPERATING PROCEDURES PRE-DESIGN STUDIES CHURCH ROCK MINE AND MILLSITE	SOP-08 Revision: 0
TRENCHING AND TEST PITS	Date: July 2013

STANDARD OPERATING PROCEDURE 8
TRENCHING AND TEST PITS

TABLE OF CONTENTS

1.0 SCOPE AND APPLICABILITY

This standard operating procedure (SOP) describes the methods and equipment to be used for conducting trench and test pit excavations during Pre-Design studies at the Church Rock Mine and Mill sites. Shallow test pits and trench excavations are used to: 1) permit both lateral and vertical examination of subsurface conditions, 2) provide access for collecting shallow soil and groundwater samples, and 3) provide a means of determining the orientation of discontinuities in the subsurface.

2.0 TRENCHING AND TEST PIT PROCEDURES

2.1 EQUIPMENT

Trench and test pit excavations are typically carried out by motorized equipment such as rubber tires backhoes and track mounted excavators. Operators of excavating equipment shall be skilled and experienced in safe use of the equipment. A typical backhoe with an extending arm can excavate to a depth of approximately 15 feet. If investigations are required to extend beyond 15 feet, test pits may not be the most appropriate method of investigation and the use of other methods (e.g., soil borings) should be considered.

2.2 SAFETY REQUIREMENTS AND PROCEDURES

Safety is perhaps the most critical consideration in any excavation project. This SOP does not address compliance with the regulations of the Occupational Safety and Health Administration (OSHA). Those issues shall be addressed in project-specific health and safety plans. Prior to all excavations, the sampling team must confirm that any underground utilities (electric, gas, telephone, water, etc.) in the general vicinity have been clearly identified.

During excavation activities, standard hand signals shall be used for rapid and efficient communication between the backhoe operator and the ground crew. Before approaching the test pit or excavating machine, the ground crew must ascertain that the equipment operator has noted their presence and has stopped operation of the equipment.

Upon locating the area for excavation, the field sampling personnel shall determine wind direction and position the excavator upwind of the pending excavation. The backhoe operator shall outline the area of investigation by extending the bucket arm to its maximum length, and tracing a 180-degree outline around the area to be excavated to create the exclusion zone. The support crew shall cordon off the exclusion zone with barricades and brightly colored "caution" tape.

Once the equipment has been appropriately positioned, excavation can begin. If the area of investigation is beneath vegetative cover or surface debris, the backhoe operator shall scrape the initial 6 inches of topsoil to allow a clear and safe working area. In areas without ground cover, any excavated fill material shall be stockpiled away from the immediate edge and away from the native soil to be excavated and sampled. The excavated native soil will be placed on clean plastic or native soil in 2-foot lifts. Both fill material and native soil shall be placed away from the trench to prevent excavated soil from re-entering the trench or pit, and to reduce pressure on the sidewalls. Sidewalls of the excavation may be sloped in loose soils to stabilize the sidewalls and prevent caving.

Excavated soil shall be stockpiled downwind of the ground crew and the equipment operator. Shifting winds may cause the equipment operator and ground crew to periodically move in order to remain upwind, or to curtail further activities. The support crew shall regularly monitor the equipment operator and ground crew's airspace.

Material brought to the surface and handled shall be disposed of in accordance with procedures outlined in the project-specific work plan.

Entry of personnel into pits or trenches is strictly prohibited unless specifically approved by the site-specific health and safety plan, and special precautions and accommodations are provided. Strict adherence to state and federal Occupational Safety and Health Administration (OSHA) trenching guidelines (29 CFR 1926.650) shall be observed. Under this standard, when personnel are required to enter an excavation 5 feet deep or more, adequate means of exit such as ladders, steps, ramps, and other full lateral support of the sidewalls must be provided and be within 25 feet of lateral travel. In addition, personnel entering the trench may be exposed to toxic, explosive, or oxygen-deficient atmospheres. If these atmospheres are anticipated, air monitoring shall be performed before and during entry, and appropriate respiratory gear and protective clothing can be worn, if necessary. Caution must be exercised at all times and at least two people must be present at the immediate site (OSHA, 1990).

Care shall be taken to ensure that personnel do not stand too close to the edge of the trench, especially during sampling or depth measurements. The added weight of a person adjacent to the pit can increase the risk of sidewall failure.

Depending on the desired depth of excavation, the trench may require shoring (lateral support) to prevent the sides from collapsing. Lateral support may be provided by a portable aluminum frame system that uses a hydraulic pump to apply pressure to the sidewalls and that can be quickly inserted or extracted, or the sides benched to an appropriate angle. Only skilled personnel shall install timber supports or any other alternative support required in excavations.

Although personnel shall normally not be required to enter the excavation, it is important to know the possible behavior of the various soil types and conditions that may be encountered. Excavations in fill are generally more unstable than those in native soil. Table 1 below indicates maximum allowable slopes for different soil types (Federal register, Rules and Regulations, Vol. 84, October 1989).

Table 1. MAXIMUM ALLOWABLE SLOPES

Soil or Rock Type	Maximum Allowable Slope (H:V) for Excavations Less Than 20 Feet
Stable Rock	Vertical (90 degrees)
Type A	3/4:1 (53 degrees)
Type B	1:1 (45 degrees)
Type C	1-1/2:1 (34 degrees)

The numbers shown above in parentheses, next to the maximum allowable slopes (MAS), are angles measured from the horizontal. In addition, a short-term MAS of 1/2:1 (63 degrees) is allowed in excavations in Type A soil that are 12 feet or less in depth. Short-term MAS for excavations in Type A soil greater than 12 feet in depth are ¾:1 (53 degrees). Sloping or benching for excavations greater than 20 feet in depth shall be designed by a registered professional engineer.

Excavations in very soft, normally consolidated clay should stand vertically, without support, to depths of approximately 12 feet in the short term only. This critical depth increases as the clays increase in consistency. Long-term stability is dependent on a combination of factors including the soil type, pore water pressures, and other forces acting within the soil. Fissured clays can fail along well-defined shear planes and, therefore, their long-term stability is not dependent on their shear strength and is difficult to predict.

Dry sands and gravels can stand at slopes equal to their natural angle of repose regardless of the depth of the excavation (angles can range from approximately 28 to 46 degrees depending on the angularity of grains and relative density).

Moist sands and gravels possess some cohesion and can stand vertically for a short period of time. However, the stability of water-bearing sands is very difficult to predict in open excavations. If they are cut steeply, as in trench excavation, seepage of water from the face will result in erosion at the toe followed by collapse of the upper part of the face until a stable angle of approximately 15 to 20 degrees is obtained.

Dry silts should stand unsupported vertically, especially if slightly cemented. Saturated silt is the most difficult material to excavate. Seepage of water into excavations in silt leads to slumping and undermining with subsequent collapse, eventually reaching a very shallow angle of repose.

It should not be assumed that excavations in rock will stand with vertical slopes unsupported. Their stability depends on the soundness, angle of bedding planes or joints, and the degree of fracturing. Unstable conditions can occur if bedding planes or joints slope steeply towards the excavation, especially in the presence of groundwater.

2.3 FIELD RECORDING AND SAMPLING TECHNIQUES

The field record shall include a field form giving the location, dimensions, and orientation of the pit or excavation, together with dimensioned sections of the sidewalls, description of the strata encountered, and details of any sampling or testing performed. Working from the ground surface, the technician or other designated personnel shall prepare a visual log of the strata/soil profile and decide the sampling interval. If possible, a photographic record of the excavation, with an appropriate scale, shall be obtained.

Soil samples from excavations can be either disturbed or undisturbed. Soil sample collection methods and procedures are described in SOP-07. Details of sample collection shall be provided in site-specific sampling plans.

2.4 BACKFILLING

Test pits or trenches shall be backfilled immediately upon completion of the excavation and soil sampling, or at a time determined by the Project Manager. Excavated material, including fill material, will be placed back into the excavation in the order it was removed. During backfilling, the excavated material will be compacted in one or two foot lifts with the backhoe or excavator bucket. The backfilled material will be compacted to prevent settling of soil.

3.0 REFERENCES

U.S. Department of Labor, Occupational Safety and Health Administration (OSHA), 1990 (Revised). Excavations.

Federal Register, Rules and Regulations, Vol. 84, No. 209, October 1989.

STANDARD OPERATING PROCEDURES PRE-DESIGN STUDIES CHURCH ROCK MINE AND MILL SITE	SOP-14 Revision: 0
SURVEYING	Date: July 2013

STANDARD OPERATING PROCEDURE 10
SURVEYING

TABLE OF CONTENTS

1.0 INTRODUCTION

This Standard Operating Procedure (SOP) provides a description of the general types of surveys and requirements for performing the various surveys. This document will describe the applicability and operation of control, land, topographic, and aerial surveys along with precision and accuracy required for each. This document is intended for the project manager to help develop work plans and manage resources.

2.0 SURVEY GUIDELINES

The following sections provide guidelines to the performance of several types of surveys and the precision and accuracy required for each. Emphasis is placed on the application of surveying techniques to geoenvironmental investigations. With the exception of recording some locations using hand-held GPS equipment, the surveys will be performed by a licensed professional surveyor, under subcontract to MWH.

2.1 PERFORMING SURVEYS

The following sections briefly describe the various types of surveys that may be performed at the site, what information may be required to perform the survey, and when each survey may be appropriate. In general, survey will be used on the project to record the locations of sample collection, and soil borings and to document the existing site features and topography, as well as the as-built features upon completion of construction.

2.1.1 Establishing Control (Monuments, Baselines, etc.)

Prior to initiating any type of survey, control must be established. The type of control needed depends on the order (first, second, or third) of accuracy that is required. Established control points are based on the National Geodetic Survey which publishes specifications for first-, second-, and third-order horizontal and vertical control surveys. These specifications provide a starting point for establishing standards on most projects that required basic control surveys.

Accuracy refers to the closeness between measurements and expectations or true values. The farther a measurement is from its expected value, the less accurate it is. Observations may be accurate but not precise if they are well distributed about the expected value but are significantly disbursed from one another. Accuracy is often referred to in terms of its order (i.e., first, second, or third order accuracy). The order of accuracy refers to the error of closure allowed; guidelines for each order of accuracy are as follows:

Order of Accuracy	Maximum Error
1st	1/25,000
2nd	1/10,000
3rd	1/5,000
4th	1/3,000
5th	1/1,000
Lowest	1/500

The surveying contractor should be familiar with established control points near the site to be surveyed. From these control points the Surveyor will measure angles and distances to the site to be surveyed to establish local control at the site. Based on the project requirements, monuments can be set at the site that can be used in future site-surveys as a control point. Care must be taken when establishing new control points and elevations from other agencies' vertical control points that all the old control bench marks are on the same datum or reference plane. The monument will be stamped with the state plane coordinates and the elevation (feet above mean sea level) such that it will serve as a reference point for additional surveys. This can save time in future surveys as the surveying contractor will not have to survey new locations from distant established control points.

For boundary surveys, the Bureau of Land Management keeps a file on property survey data related to public lands. State, county, city and town engineering and surveyors offices may also be consulted for useful survey data on private property. This information is used by the Surveyor to locate property boundaries based on existing markers, monuments, angles and distances.

2.1.2 Control Survey

This is the most common type of survey performed in a geoenvironmental investigation. It is used to establish the horizontal and vertical positions of points such as soil borings or monitoring wells. Control is typically established horizontally from a theodolite and electronic distance measurement instrument or using a transit and stadia as part of a three-dimensional traverse. The traverse is used to measure the distance and direction from a known point and the elevation with reference to a known monument. Horizontal and vertical data are then plotted and elevation data interpolated. This type of survey should be used for small areas and for locating particular points.

2.1.3 Topographic Survey

A topographic survey is made to secure data from which a map can be made indicating the configuration of the terrain and location of natural and man-made objects. This type of survey can be performed either using established control monuments or by aerial photography using a digital terrain model (DTM) or digital elevation model (DEM). Contour intervals should be determined before measurement and specified such that enough detail of the site topography is provided. The field surveying methods employed will be determined by the scale to which the map is drawn. The topographic survey is used to identify high and low spots at a site as well as natural drainage patterns. Topographic surveys can be performed on a site of any size but contour intervals will dictate the time and cost of the survey.

2.1.4 Aerial Survey

An aerial survey is performed by a high-precision camera mounted in an aircraft. Photographs are taken in an organized manner as the aircraft flies over the terrain. Aerial surveys are commonly used for larger sites where boundaries and topography are to be defined. Ground surveys are also required in conjunction with aerial surveys to establish control points for the aerial survey.

The main advantages of aerial surveys over ground methods include the following: 1) speed of compilation; 2) reduction in the amount of control surveying required to control the mapping; 3) high accuracy of the locations of planimetric features; 4) faithful reproduction of the configuration of the ground by continuously-traced contour lines; 5) not restricted due to inaccessible terrain; and 6) can be designed for a map scale ranging from 1 inch = 20 feet to 1 inch = 20,000 feet with as small as 0.5-foot contour intervals.

The disadvantages associated with aerial surveys include: 1) difficulties in plotting areas with heavy ground cover (high grass, timber, and underbrush); 2) high cost per acre of mapping areas smaller than 5 acres; 3) difficulties in locating positions of contour lines in flat terrain; and 4) editing requirements to include road classifications, boundary lines, drainage classification, and names of places, roads, and other map features.

2.1.5 Boundary Survey

A boundary, land, or property survey is performed to determine the length and direction of land lines and to establish the position of these lines on the ground. The area of the tract bounded by the lines can also be determined. This type of survey is made using established control monuments and establishing angles and distances from those monuments based on a legal description of the property.

2.1.6 As-Built Survey

An as-built survey is a post-construction survey that shows the exact final location and layout of civil engineering works. This type of survey provides positional verification and records that include design changes.

2.2 REQUIRED ACCURACY AND PRECISION

The required survey accuracy and precision depends on the intended purpose of the survey work. Such requirements could range from gross estimation of a sampling station for inclusion on a small-scale vicinity map to the determination of top of casing elevations to 0.01 feet to establish groundwater gradients. In general, no more than third order accuracy is required for sampling station location and elevation measurements performed in environmental investigations. However, higher accuracies may be required for boundary surveys, topographic surveys, etc. The following sections discuss accuracy and precision requirements for specific survey types.

2.2.1 Geoenvironmental Investigations

For environmental investigations, surveying activities generally consist of obtaining horizontal and vertical coordinates of sampling locations to assess the migration and extent of contaminants in the soil and/or groundwater. The following sections describe precision and accuracy requirements for various field investigation activities.

2.2.1.1 Borings, CPT, and Test Pits

Boring and test pit locations will be located (and laid out) using either hand-held GPS or survey methods depending on the location. The borings, CPT, and test pit locations will be marked with stakes upon completion, so that the completed locations can be recorded by a surveyor.

Surveyed horizontal locations and ground surface elevations for borings and test pits are used to graphically indicate locations on site maps and are often included in boring logs and test pit logs. The surveyed locations are also used to construct geologic sections or profiles. Horizontal locations should be staked out to ± 1.0 foot, and ground surface elevations measured to ± 0.1 feet.

Typically, locations of borings/test pits are surveyed after completion, and care must be taken to measure the original surface elevation as accurately as possible (e.g., a mound or depression may remain in the trench area). The location and outline of the trench/test pit must be adequately staked to permit the required surveying, and stakes should be used to facilitate locating the trench. Stakes can also be used to make boring locations readily visible.

2.2.1.2 Monitoring Wells, Pumping Wells and Piezometers

Horizontal location and ground surface and top of casing elevation criteria for wells and piezometers are generally similar to those of test pits or borings. However, vertical precision in the elevation measurements is essential due to the groundwater elevation measurements that will be collected subsequent to the well installation.

All surveying data, including horizontal location, ground surface elevation, and the elevation of the top of the inner casing will be surveyed after well installation. The accuracy of the horizontal plane survey should be ± 1 foot (unless greater accuracy is desired) and is measured to any point on the well casing cover. The vertical plane survey measurements at the ground surface and on the north side of the top of the inner casing must be accurate to ± 0.01 feet. The point at which the elevation was measured on the inner casing should be scribed so that water level measurements may be taken at the same location. The inner casing shall be inscribed appropriately by the field team and directions will be provided to the Surveying Contractor to collect vertical measurements from the correct location. This procedure is used for both above ground and flush-mounted monitoring well completions.

2.2.1.3 Surface Water Sampling Locations

When grab samples are obtained from the edges of surface water bodies, the sampler can often estimate and mark the approximate location and elevation directly on a site topographic map. Typically, such sampling locations do not require great location accuracy (within several feet), since they are usually only indicated graphically on the site map. However, depending on the accuracy required for the project, a location stake at the shoreline may be installed that marks the sampling location with the station number, coordinates, and water surface elevation.

When samples are to be taken within the surface water body away from the shoreline, better horizontal control is usually required. Sampling locations are determined by the sampler using on-shore baselines or ranges.

2.2.1.4 Surface Soil Sampling Locations

The measurement and layout requirements for obtaining a single grab sample of surface soil are comparable to those for obtaining surface water grab samples from the shoreline. Where a composited sample is to be collected from a sampling grid, the surveyors should stake out the grid and indicate the station number(s), coordinates or orientation of the grid, and ground elevation(s) on the stakes. Generally, a precision of 1.0 foot for location and 0.1 feet for elevation will suffice for grab or grid surface sampling.

2.2.1.5 Air Sampling Stations

Air sampling stations generally need no more layout precision than grab sampling. Therefore, horizontal and vertical plane survey accuracy should be within 1.0 and 0.1 feet, respectively.

2.2.1.6 Other Sampling Locations

Other sampling points can be located using methods similar to those described above. For example, biological sampling stations can be established with the same surveying methods and precision as for the air, water, or soil grab sampling. For unusual or unique sampling methods, appropriate surveying requirements must be developed in consideration of the specific intentions and site conditions. For sampling man-made facilities such as drums, tanks, and pipelines, it is usually most convenient if the sampler identifies these locations at the time of sampling, directly on a topographic map of these facilities.

2.2.2 Topographic Surveys

The results of topographic surveys are usually only represented graphically on maps. Thus, the required accuracy and precision of the field survey is dependent upon the required accuracy and precision for the map as determined by the map scale. Typically, when the scale of 1 inch = 100 feet is to be used, horizontal distances can be plotted to the nearest 1 or 2 feet, while if the scale is 1 inch = 1,000 feet, the plotting will be to the nearest 10 or 20 feet and the field measurements can be correspondingly less precise. For most purposes, horizontal measurements in the field need be no more than third order accuracy and to a precision of the nearest foot. Vertical field survey measurements are depicted on maps graphically as contour lines, and numerically as spot elevations. For most purposes, such vertical field measurements can be performed to no more than third order accuracy and to a precision of 0.1 feet. Commonly, maps showing contour intervals of one foot or more indicate spot elevations between or beyond contour lines to the nearest tenth of a foot.

2.2.3 Aerial Surveys

The standards to be followed in using aerial photography in preparing topographic maps are dependent upon the specific equipment and techniques used in obtaining the photographs and preparing the map.

2.2.4 As-Built Surveys

As-built surveys will show locations of all buildings, channels, utilities, roads, or other structures constructed at the site. Locations should be referenced to base lines or to at least two other fixed points with an accuracy to the nearest 1.0 foot.

2.2.5 Boundary Surveys

Accuracies for boundary maps are usually determined by State or Municipal law. Generally, second order accuracy is required for the survey so that property boundaries can be established to a precision of one second in their bearing and 0.01 feet in their length. In addition to being graphically plotted to scale on the boundary map, the results of the boundary survey are also numerically recorded on the map as the actual bearing and length of each site border.

5.0 REFERENCES

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STANDARD OPERATING PROCEDURE 14
FIELD DOCUMENTATION

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1.0 INTRODUCTION

This guideline is a general reference for the required documentation to be completed by personnel during field investigations. Documentation in the form of field logbooks, reports, and forms should be completed for every activity in the field. Records should be maintained on a daily basis as the work progresses. All field documentation should be accurate and legible because it is part of the client's product and may potentially serve as a legal document.

2.0 FIELD DOCUMENTATION GUIDELINES

Field documentation serves as the primary foundation for all field data collected that will be used to evaluate the project site. Field activities will be documented in field logbooks and task-specific logs and forms. All field documentation should be accurate, legible and written in indelible ink. Absolutely no pencils or erasures are to be used. Mistakes written in the field books, logs, or on forms that need to be deleted should be crossed out with one line, initialed, and dated. Skipped pages or blank sections at the end of a page should be crossed out with an "X" covering the entire page or blank section; "No Further Entries," initials, and date should be written by the person making the correction. The responsible field team member should write his/her signature, date, and time after each day's last entry. To further assist in the organization of the field books, logs, or forms, it is important to write the date on top of each page and the significant activity description (e.g., boring or well number). In addition, all original field documentation should be submitted to the project files.

The descriptions of field data/documentation given below serve as a guideline; individual projects will vary in documentation needs.

2.1 FIELD LOGBOOKS

The field logbook is a bound, weatherproof book with numbered pages that serves primarily as a daily log of the activities carried out during the investigation. All entries should be made in indelible ink. A field logbook should be completed for each operation undertaken during the investigation. The logbook should serve as a diary of the events of the day.

Field activities will vary from project to project; however, the concept and general information that should be recorded will remain similar. A detailed description of the general information that should be recorded in all logbooks is provided below, followed by a listing of task-specific information that may also be recorded.

2.1.1 General Logbook Information

The following general information should be recorded in each logbook:

- Project and site name
- Date
- Weather conditions
- Personnel and subcontractors on the site and time spent on the site
- Site visitors
- Record of tailgate meetings
- General field observations
- Health and safety activities including calibration records for health and safety equipment, personnel contamination prevention and decontamination procedures, and record of daily tailgate safety meetings

2.1.2 Supervisory Activities

Supervisory responsibilities include general supervision, support, assistance, and coordination of the various field investigation activities. In addition to the general information listed above, records of supervisory activities should be maintained in a logbook and will include:

- Field operations and personnel assigned to each activities
- Log of supervisory activities including time spent supervising each operation and summary of daily operations as provided by field team members
- Problems encountered and related corrective actions
- Deviations from the sampling plan
- Records of communications with the client, subcontractors, field team members, and Project Manager
- Information on addresses and contacts
- Record of invoices signed and other billing information

2.1.3 Drilling and Soil Sampling Activities

In addition to the general information listed above, personnel involved in drilling and soil sampling are responsible for recording the following information:

- Site name and well or soil boring number
- Sample location (sketch)
- Drilling method and equipment used
- Name of drilling company or excavation contractor
- Name of name of contractor personnel including driller and helpers
- Calibration of field equipment
- Drilling activities:
    - Borehole diameter
    - Drill cuttings disposal/containerization (number of drums, roll off-bins, etc.)
    - Type and amount of drilling fluids used (mud, water, etc.)
    - Depth and time at which first groundwater was encountered, depth to water at completion of drilling, and the stabilized depth to water. The absence of water in the boring should also be noted.
    - Total drilling depth of well or soil boring
    - Type and amount of materials used for well installation
    - Well construction details [depth of grout (mixture, weight), bentonite seal, filter pack, etc. [include type and amount used, calculate estimated amount that should be used]
    - Type and amount of material used to backfill soil borings
    - Time and date of drilling, completion, and backfilling
- Sampling information including date and time of sample collection, sample interval, and number of samples collected
- Equipment decontamination procedures

- Disposal of contaminated wastes (PPE, paper towels, visqueen, etc.)
- Problems encountered and corrective action taken
- Deviations from the sampling plan

2.1.4 Groundwater Sampling/Development Activities

In addition to the general information listed above, the groundwater sampling and development team members are responsible for recording the following information:

- Calibration of field equipment
- Disposal of contaminated wastes (PPE, paper towels, visqueen, etc.)
- Site name, well number
- Water levels and product levels [time and datum that water levels are measured (i.e. top of casing)]. Purging of the well (include calculations, well volumes) with the following information:
    - Measured field parameters (temperature, pH, conductivity, odor, color, cloudiness, etc.)
    - Amount of water purged
    - Purge method: indicate bailer/pump, diameter and length of bailer, material that the bailer is composed of, type of pump, new nylon rope, etc.
- Purge water disposal/containment (Baker tank/drums, number used, identification, etc.)
- Well sampling including number of samples collected, type of containers used, date and time of sample collection, QA/QC samples collected; names given to blind samples
- Equipment decontamination procedures
- Problems encountered and corrective actions taken
- Deviations from the sampling plan

2.2 TASK-SPECIFIC LOGS AND FORMS

In addition to field logbooks, task-specific logs and forms will be used to record pertinent field information. These are provided in the applicable SOP for each task type. The following are common types of logs and forms and a listing of the information that must be recorded. Other task-specific forms may be used, depending on project needs.

2.2.1 Boring Logs

The preparation of drill logs is the responsibility of the field team members assigned to the drill rig. A detailed description of well logging is provided in the SOP for that subject. The exact format is dependent upon the job and the client; however, the following basic information should be recorded on the log regardless of the format:

- Project and site name
- Date and weather conditions

- Name of driller and drilling company
- Well/soil boring ID and location (sketch)
- Drilling and backfilling dates and times
- Reference elevation for all depth measurements
- Total depth of completed soil boring/well
- Depth of grouting, sealing, and grout mixes
- Signature of the logger
- Detailed description of all materials encountered (see Soil Logging SOP)
- Stratigraphic/lithologic changes; depths at which changes occur
- Depth intervals at which sampling was attempted and amount of sample recovered
- Blow counts
- Depth intervals from which samples are retained
- Depth at which first groundwater was encountered, depth to water at completion of drilling, and the stabilized depth to water. The absence of water in the boring should also be noted.
- Loss and depth of drilling fluids, rate of loss, and total volume of loss
- Use of drilling fluids
- Drilling and sampling problems
- PID readings

2.2.2 Well Construction Diagrams

The preparation of well construction diagrams is also the responsibility of field team members assigned to the drilling operations. The exact format of the diagram is dependent on the job and the client; however, the following basic information should be recorded and/or illustrated on the diagram regardless of the format:

- Project and site name
- Well identification number
- Name of driller and drilling company
- Depth and type of well casing
- Description of well screen and blank
- Borehole diameter
- Any sealing off of water-bearing strata
- Static water level upon completion of the well and after development
- Drilling and installation dates
- Type and amount of annulus materials used; depth measurements of annulus materials
- Other construction details (filter pack type and interval, location of centralizers, etc.)
- Surface elevation and reference elevation of all depth measurements

2.2.3 Groundwater Sampling/Development Logs

The groundwater sampling/development documented any time that a well is developed or sampled. The following information should be recorded on the log:

- Project name and site
- Well identification number
- The date and time of sampling/development
- The water level and reference elevation
- Volume of water to be purged
- Pertinent well construction information (total depth, well diameter, etc.)
- Measurement of field parameters such as pH, turbidity, conductivity, and temperature, as well as the times at which the readings were taken
- Type of purging and sampling equipment used
- Type of samples collected
- Sampler's initials

2.2.4 Aquifer Testing Logs

The aquifer testing team is responsible for setting up, collecting, tracking, and organizing data. The information listed below is a partial listing of required information.

- Well number/identification (data logger identification)
- Data logger information/parameter setup
- Water level (include date, time, and measurement reference (such as top of casing)
- Type of aquifer test (slug, step-drawdown, pump test, etc.)
- Slug test (include length and diameter of slug for volume calculations)
- Start time of test
- Duration of test
- Pump tests (include disposal/containment of water information)
- Field observations and problems
- Tester's name

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STANDARD OPERATING PROCEDURE 17
SOIL LOGGING

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ATTACHMENTS

1.0 INTRODUCTION

This standard operating procedure (SOP) is applicable to logging soils at all sites requiring soil investigation by MWH Americas, Inc. (MWH). The SOP is based on the Unified Soils Classification System (USCS) and the American Society for Testing and Materials (ASTM) Standard D2488-00 Standard Practice for Description and Identification of Soils (Visual-Manual Procedure) (ASTM, 2000). Variance from the logging procedures described herein shall be warranted only if specifically required in writing by a particular client or regulatory agency. A solid working knowledge of this SOP is important for MWH field personnel to standardize logging procedures and to enable subsequent correlations between borings at a site, allowing for accurate and thorough site characterization.

The information in this SOP is summarized in two soil logging field guides (attached). Laminated copies of these guides are available for field personnel; use of the field guides is strongly recommended. Other field guidance references may also be used according to personal preference, however; such references should be based on the USCS. Note that many references (for example, AGI Data Sheet grain-size scales) base soil classifications on the Wentworth Scale. Such scales may vary significantly from the USCS and may lead to inaccurate or inconsistent soil descriptions.

2.0 DEFINITIONS

Use of the USCS requires familiarity with the grain-size ranges that define a particular type of soil, as well as several other physical characteristics. The grain size definitions and physical characteristics upon which soil descriptions are based are presented below. This information is also presented in tabular format on the field guides.

2.1 GRAIN SIZES

USCS grain sizes are based on U.S. standard sieve sizes, which are named as follows:

- Standard sieves with larger openings are named according to the size of the openings in the sieve mesh. For example, a "3-inch" sieve contains openings that are 3 inches square.
- Standard sieves with smaller openings are given numbered designations that indicate the number of openings per inch. For example, a "No. 4" sieve contains 4 openings per inch.

The following grain size definitions are paraphrased from the ASTM Standard D2488-00. Field personnel should familiarize themselves with the grain size definitions and refer to the appropriate field guide for a visual reference.

Boulders: Particles of rock that will not pass a 12-inch (300-mm) square opening.

Cobbles: Particles of rock that will pass a 12-inch (300-mm) square opening and be retained on a 3-inch (75-mm) sieve.

Gravel: Particles of rock that will pass a 3-inch (75-mm) sieve and be retained on a No. 4 (4.75-mm) sieve with the following subdivisions:

- Coarse gravel passes a 3-inch (75-mm) sieve and is retained on a 3/4-inch (19-mm) sieve.
- Fine gravel passes a 3/4-inch (19-mm) sieve and is retained on a No. 4 (4.75-mm) sieve.

Sand: Particles of rock that will pass a No. 4 (0.19-inch or 4.75-mm) sieve and be retained on a No. 200 (0.003-inch or 75-µm) sieve with the following subdivisions:

- Coarse sand passes a No. 4 (0.19-inch or 4.75-mm) sieve and is retained on a No. 10 (0.08-inch or 2-mm) sieve.
- Medium sand passes a No. 10 (0.08-inch or 2-mm) sieve and is retained on a No. 40 (0.017-inch or 425-µm) sieve.

– Fine sand passes a No. 40 (0.017-inch or 425-μm) sieve and is retained on a No. 200 (0.003-inch or 75-μm) sieve.

Silt: Soil passing a No. 200 (0.003-inch or 75-μm) sieve that is non-plastic or very slightly plastic and that exhibits little or no strength when air dried. Individual silt particles are not visible to the naked eye.

Clay: Soil passing a No. 200 (0.003 inch or 75-μm) sieve that can be made to exhibit plasticity within a range of water contents and that exhibits considerable strength when air-dried. Individual clay particles are not visible to the naked eye.

2.2 PHYSICAL CHARACTERISTICS

The following physical characteristics are used in the USCS classification for fine-grained soils. A brief definition of each physical characteristic is presented below. Tables 1 through 4 present descriptions of field tests that may be performed to estimate these properties in a field sample. However, with the exception of plasticity, the tests are generally too time-consuming to perform regularly in the field. A determination of the type of fine-grained soil present in the sample can generally be made on the basis of plasticity, as described in Section 4.1.2.

Dry Strength: The ease with which a dry lump of soil crushes between the fingers (Table 1).

Dilatancy Reaction: The speed with which water appears in a moist pat of soil when shaking in the hand, and disappears while squeezing (Table 2).

Toughness: The strength of a soil, moistened near its plastic limit, when rolled into a 1/8-inch diameter thread (Table 3).

Plasticity: The extent to which a soil may be rolled into a 1/8-inch thread, and re-rolled when drier than the plastic limit (Table 4).

TABLE 1. CRITERIA FOR DESCRIBING DRY STRENGTH

Description	Criteria
None	The dry specimen crumbles into powder with mere pressure of handling.
Low	The dry specimen crumbles into powder with some finger pressure.
Medium	The dry specimen breaks into pieces or crumbles with considerable finger pressure.
High	The dry specimen cannot be broken with finger pressure. Specimen will break into pieces between thumb and a hard surface.
Very High	The dry specimen cannot be broken between the thumb and a hard surface.

TABLE 2. CRITERIA FOR DESCRIBING DILATANCY

Description	Criteria
None	No visible change in the specimen.
Slow	Water appears slowly on the surface of the specimen during shaking and does not disappear or disappears slowly upon squeezing.
Rapid	Water appears quickly on the surface of the specimen during shaking and disappears quickly upon squeezing.

TABLE 3. CRITERIA FOR DESCRIBING TOUGHNESS

Description	Criteria
Low	Only slight pressure is required to roll the thread near the plastic limit. The thread and the lump are weak and soft.
Medium	Medium pressure is required to roll the thread to near the plastic limit. The thread and the lump have medium stiffness.
High	Considerable pressure is required to roll the thread to near the plastic limit. The thread and the lump have very high stiffness.

TABLE 4. CRITERIA FOR DESCRIBING PLASTICITY

Description	Criteria
Non-plastic	A 1/8-inch (3-mm) thread cannot be rolled at any water content.
Low	The thread can barely be rolled and the lump cannot be formed when drier than the plastic limit.
Medium	The thread is easy to roll and not much time is required to reach the plastic limit. The thread cannot be re-rolled after reaching the plastic limit. The lump crumbles when drier than the plastic limit.
High	It takes considerable time rolling and kneading to reach the plastic limit. The thread can be re-rolled several times after reaching the plastic limit. The lump can be formed without crumbling when drier than the plastic limit.

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3.0 SOIL LOGGING PROCEDURES

The following aspects of a project must be considered before sampling and soil logging commences. This information is generally summarized in a project-specific work plan or field sampling plan, which should be thoroughly reviewed by field personnel prior to the initiation of work.

- Purpose of the soil logging (e.g., initial investigation, subsequent investigation, remediation);
- Known or anticipated hydrogeologic setting including: lithology (consolidated/unconsolidated, depositional environment, presence of fill material), physical characteristics of the aquifer (porosity/permeability), type of aquifer (confined/unconfined), recharge/discharge conditions, aquifer thickness and ground water/surface water interrelationships;
- Drilling conditions;
- Previous soil boring or borehole geophysical logs;
- Soil sampling and geotechnical testing program;
- Characteristics of potential chemical release(s) (chemistry, density, viscosity, reactivity, and concentration);
- Health and Safety protection requirements;
- Regulatory requirements;

The procedures used to determine the correct soil sample classification are described below. These procedures are presented in tabular and flow chart form on the field guides.

3.1 FIELD CLASSIFICATION OF SOILS

The following soil classification procedures are based on the ASTM Standard D2488-00 for visual-manual identification of soils (ASTM, 2000). The flow chart is Attachment 1 to this SOP and presented in the field guide can be used to assign the appropriate soil group name and symbol. . When naming soils, the proper USCS soil group name is given, followed by the group symbol. For clarity, it is recommended that the group symbol be placed in parentheses after the written soil group name.

Soil identification using the visual-manual procedures is based on naming the portion of the soil sample that will pass a 3-inch (75-mm) sieve. Therefore, before classifying a soil, any particles larger than 3 inches (cobbles and boulders) should be removed, if possible. Estimate and note the percentage of cobbles and boulders.

Using the remaining soil, the next step is to estimate the percentages, by dry weight, of the gravel, sand, and fine fractions (particles passing a No. 200 sieve). The percentages are to be estimated to the closest 5 percent. In general, the soil is *fine-*

grained (e.g., a silt or a clay) if it contains 50 percent or more fines, and *coarse-grained* (e.g., a sand or a gravel) if it contains less than 50 percent fines. If one of the components is present but estimated to be less than 5 percent, its presence is indicated by the term *trace*. For example, "trace of fines" would be added as additional information following the formal USCS soil description.

3.1.1 Procedure for Identifying Coarse-Grained Soils

Coarse-grained soil contains less that 50 percent fines. If it has been determined that the soil contains less than 50 percent fines, the soil is a *gravel* if the percentage of gravel is estimated to be more than the percentage of sand. The soil is a *sand* if the percentage of gravel is estimated to be equal to or less than the percentage of sand.

If the soil is predominantly sand or gravel but contains an estimated 15 percent or more of the other coarse-grained constituent, the words "with gravel" or "with sand" is added to the group name. For example: "gravel with sand (GP)." If the sample contains any cobbles or boulders, the words "with cobbles" or "with cobbles and boulders" are added to the group name. For example: "silty gravel with cobbles (GM)."

Five Percent or Less Fines

The soil is a "clean gravel" or "clean sand" if the percentage of fines is estimated to be 5 percent or less. "Clean" is not a formal USCS name, but rather a general descriptor for implying little to no fines. Clean sands and gravels are given the USCS designation as either *well-graded* or *poorly-graded*, as described below.

Identify the soil as a *well-graded gravel* (GW) or as a *well-graded sand* (SW) if it has a wide range of particle sizes and substantial amounts of the intermediate particle sizes. Identify the soil as a *poorly-graded gravel* (GP) or as a *poorly-graded sand* (SP) if it consists predominantly of one grain size (uniformly graded), or has a wide range of sizes with some intermediate sizes obviously missing (gap- or skip-graded).

Note: When using the USCS designation, keep in mind the difference between grading and sorting. The term grading is used to indicate the range of particles contained in the sample. For example, a poorly-graded sand containing predominantly one grain size would be considered well-sorted, and vice-versa. One notable exception to this general rule is a skip-graded (bimodally distributed) sample; a sand containing two distinct grain sizes would be considered both poorly-sorted and poorly-graded. The USCS uses only the *grading* descriptor in soil naming, not the sorting descriptor.

Greater than or equal to 15 Percent Fines

The soil is a *silty* or *clayey gravel* or a *silty* or *clayey sand* if the percentage of fines is estimated to be 15 percent or more. For example, identify the soil as *clayey gravel* (GC) or a *clayey sand* (SC) if the fines are clayey. Identify the soil as a *silty gravel* (GM) or a *silty sand* (SM) if the fines are silty. The coarse grained descriptor "poorly-graded" or "well-graded" is not included in the soil name, but rather, should be included as additional information following the formal USCS soil description.

Greater than 5 Percent but less than 15 Percent Fines

If the soil is estimated to contain greater than 5 percent but less than 15 percent fines, give the soil a dual identification using two group symbols. The first group symbol corresponds to a clean gravel or sand (GW, GP, SW, SP) and the second symbol corresponds to a clayey/silty gravel or sand (GC, GM, SC, SM). The group name corresponds to the first group symbol, and include the words "poorly-graded" or "well-graded" plus the words "with clay" or "with silt" to indicate the character of the fines. For example, "poorly-graded gravel with silt (GP-GM)."

3.1.2 Procedure for Identifying Fine-Grained Soils

Fine-grained soil contains 50 percent or more fines. The USCS classifies inorganic fine-grained soils according to their degree of plasticity (no or low plasticity, indicated with an "L"; or high plasticity, indicated with an "H") and other physical characteristics (defined in Section 2.2 and Tables 1 through 4). As indicated in Section 2.2, the field tests used to determine dry strength, dilatancy, and toughness are generally too time consuming to be performed on a routine basis. Field personnel should be familiar with the definitions of the physical characteristics and the concepts of the field tests; however, field classifications will generally be based primarily on plasticity. If precise engineering properties are necessary for the project (i.e., construction, modeling, etc.), geotechnical samples should be collected for laboratory testing. The results of the laboratory tests should be compared to the field logging results. Soil classifications based on plasticity are as follows:

- Lean clay (CL) soil has medium to high dry strength, no or slow dilatancy, and medium toughness and plasticity.
- Fat clay (CH) soil has high to very high dry strength, no dilatancy, and high toughness and plasticity.
- Silt (ML) soil has no to low dry strength, slow to rapid dilatancy, and low toughness and plasticity, or is nonplastic.
- Elastic silt (MH) soil has low to medium dry strength, no to slow dilatancy, and low to medium toughness and plasticity. They will air dry more quickly than lean clay and have a smooth, silky feel when dry.
- Organic soil (OL or OH) soil contains enough organic particles to influence the soil properties. Organic soils usually have a dark brown to black color and may have an organic odor. Organic soils will often change color, from black to brown for example, when exposed to the air. Organic soils normally will not have a high toughness or plasticity.

3.1.3 Other Modifiers for Use with Fine-Grained Soils

15 percent to 25 percent coarse-grained material

If the soil is estimated to have 15 percent to 25 percent sand, gravel, or both, the words "with sand" or "with gravel" (whichever is predominant) is added to the group name. For example: "lean clay with sand (CL)" or "silt with gravel (ML)". If the percentage of sand is equal to the percentage of gravel; use "with sand."

Greater than 30 percent coarse-grained material

If the soil is estimated to have 30 percent or more sand, gravel, or both, the words "sandy" or "gravelly" is added to the group name. Add the word "sandy" if there appears to be the same or more sand than gravel. Add the word "gravelly" if there appears to be more gravel than sand. For example: "sandy silt (ML)" or "gravelly fat clay (CH)."

3.1.4 Procedure for Identifying Borderline Soils

To indicate that the soil may fall into one of two possible basic groups, a borderline symbol may be used with the two symbols separated by a slash. For example, a soil containing an estimated 50 percent silt and 50 percent fine grained sand may be assigned a borderline symbol "SM/ML". Borderline symbols should not be used indiscriminately. Every effort should be made to first place the soil into a single group and then to estimate percentages following the USCS soil description.

3.2 DESCRIPTIVE INFORMATION FOR SOILS

After the soil name and symbol are assigned; (1) the soil color, (2) consistency/density, and (3) moisture content are to be described <u>in that order</u>. Other information is presented later in the description, as applicable.

3.2.1 Color

Color is an important property in identifying organic soils, and may also be useful in identifying materials of similar geologic or depositional origin in a given location. The Munsell Soil Color Charts (Munsell Color, 1992) should be used, if possible.

When using the Munsell Soil Color Charts, a general color (such as brown, gray, or red) is assigned to the soil, etc. Once the general color is assigned, go to the correct area in the charts and assign the applicable color name and Munsell symbol. The ability to detect minor color differences varies among people, and the chance of finding a perfect color match in the charts is rare. Keeping this in mind should help field personnel avoid spending unnecessary time and confusion going through the chart pages. In addition, attempting to describe detail beyond the reasonable accuracy of field observations could lead to making poorer soil descriptions than by simply expressing the dominant colors.

If the color charts are not being used or are unavailable, attempt to assign general colors to soils. Comparing a particular soil sample to samples from different locations in the borehole will help keep the eye "calibrated." For example, by holding two soils together, it may become evident that one is obviously greenish-brown, while another is reddish.

3.2.2 Consistency/Density

For intact, fine-grained soil, describe consistency as very soft, soft, medium stiff, stiff, very stiff, or hard, based on the blows per foot using a 140-pound hammer dropped 30 inches (Table 5). If blow counts are not available, perform the field test described in Table 6 to determine consistency.

For coarse-grained soils, describe density based on blows per foot as very loose, loose, medium dense, dense, and very dense (Table 5). If blow counts are not available, attempt to estimate the soil density by observation, since a practical field test is not available. Be sure to clearly indicate on the field boring log if blow counts could not be obtained.

TABLE 4. DENSITY/CONSISTENCY BASED ON BLOW COUNTS

Density (Sand and Gravel) Blows/ft[a]				Consistency (Silt and Clay) Blows/ft[a]			
Term	**1.4" ID**	**2.0" ID**	**2.5" ID**	**Term**	**1.4" ID**	**2.0" ID**	**2.5" ID**
Very Loose	0 – 4	0 – 5	0 – 7	Very Soft	0 – 2	0 – 2	0 – 2
Loose	4 – 10	5 – 12	7 – 18	Soft	2 – 4	2 – 4	2 – 4
Medium Dense	10 – 29	12 – 37	18 – 51	Medium Stiff	4 – 8	4 – 9	4 – 9
Dense	29 – 47	37 – 60	51 – 86	Stiff	8 – 15	9 – 17	9 – 18
Very Dense	>47	>60	>86	Very Stiff	15 – 30	17 – 39	18 – 42
				Hard	30 – 60	39 – 78	42 – 85
				Very Hard	>60	>78	>85

[a] 140 lb. Hammer dropped 30 inches

TABLE 5. CRITERIA FOR DESCRIBING CONSISTENCY

Description	Criteria
Very Soft	Thumb will penetrate soil more than 1 inch (25 mm)
Soft	Thumb will penetrate soil about 1 inch (25 mm)
Firm	Thumb will indent soil about ¼ inch (6 mm)
Hard	Thumb will not indent soil but readily indented with thumbnail
Very Hard	Thumbnail will not indent soil

3.2.3 Moisture

Describe the moisture condition of the soil as dry (absence of moisture, dusty, dry to the touch), moist (damp but no visible water), or wet (visible free water, saturated).

2.3 DECONTAMINATION PRIOR TO FINAL RELEASE FROM THE SITE

All sampling equipment including drill rigs, drill augers, excavators, small equipment, and support vehicles will be decontaminated and inspected prior to leaving the site. This work will take place under the direction of the site Radiation Safety Officer (RSO) and will include, at a minimum:

1. At the last sampling location prior to leaving the site, thoroughly clean all equipment according to the procedures in Section 2.1 above.
2. Inspect all equipment to ensure all visible soil and debris has been removed. Pressure washing may be necessary to thoroughly clean the equipment.
3. Scan the equipment using the methods and equipment specified by the site RSO.

2.0 PROCEDURES

2.1 DECONTAMINATION OF GEOTECHNICAL SAMPLING EQUIPMENT

All geotechnical soil sampling equipment that may directly contact samples will be decontaminated on site prior to use at each sampling location. The following decontamination procedures will be observed:

1. Remove all visible soil and debris from the surface of the equipment with brushes or scrapers.
2. Rinse with clean water to remove all visible debris.
3. For large equipment such as excavator buckets and drilling augers, a pressure washer may be necessary to thoroughly remove all material.
4. For smaller equipment such as split-spoon samplers or shovels, a bucket may be used to rinse the equipment.
5. If the equipment has only come in contact with cover material or clean borrow material, all decontamination debris and rinse water may be discharged to the ground surface at the sampling location.
6. If the equipment has come into contact with tailings or other contaminants, all decontamination debris and rinse water will be directed down the auger hole, CPT hole, or test pit, as applicable. Plastic sheeting will be used if necessary to prevent the debris and rinse water from contacting clean material.
7. Decontamination will take place at each sampling location prior to moving to the next location.

2.2 DECONTAMINATION OF CHEMICAL SAMPLING EQUIPMENT

To decontaminate equipment used to collect samples for chemical analysis, the following additional procedures will be observed:

1. Wash and scrub the equipment with detergent (laboratory grade, non-phosphate detergent)
2. Rinse with tap water
3. Rinse twice with deionized water
4. Air dry
5. Protect the cleaned equipment from fugitive dust

1.0 SCOPE AND APPLICABILITY

This standard operating procedure (SOP) presents the decontamination procedures to be used during Pre-Design studies at the Church Rock Mine and Mill Site. The purpose of these decontamination procedures is to prevent foreign contamination of the samples and cross-contamination between sites and material types during excavation, drilling, and sampling.

This document focuses on methods and equipment that are readily available and typically applied during geotechnical soil sampling activities. It is not intended to provide an all-inclusive discussion of decontamination methods. This SOP does not replace any site-specific decontamination procedures, nor does it address all the requirements for equipment decontamination prior to release from the site.

STANDARD OPERATING PROCEDURE 31
EQUIPMENT DECONTAMINATION

TABLE OF CONTENTS

STANDARD OPERATING PROCEDURES PRE-DESIGN STUDIES CHURCH ROCK MINE AND MILL SITE	SOP-31 Revision: 0
EQUIPMENT DECONTAMINATION	Date: July 2013

Boring #: MW#: Project: Sheet of

PID/OVA	Sample Interval	Recovered (in.)	Blow Counts / 6 in.	Retained for Analysis.	Casing Type & Size	Annulus Filler	Depth (Feet)	USCS Soil Type	Soil Description	Estimated % Of				
											Sand			
										Gravel	Coarse	Med.	Fine	Silt/Clay
							2							
							3							
							4							
							5							
							6							
							7							
							8							
							9							
							0							
							1							
							2							
							3							
							4							
							5							
							6							
							7							
							8							
							9							
							0							
							1							
							2							

QA/QC

BORING LOG NUMBER:

SHEET ___ OF ___

LOCATION SKETCH

LOC. ID:		ELEVATION:	DATUM:
PROJECT NAME.:			DRILL DATE:
INCLINATION:	AZIMUTH:	HAMMER WEIGHT:	DATE FINISHED:

DEPTH (UNITS)	BORING METHOD	SOIL PROFILE SOIL DESCRIPTION	GRAPHIC LOG	SAMPLES USCS	NUMBER	TYPE	BLOW COUNT/6"	RECOVERY	ADDITIONAL COMMENTS
0									
5									
10									
15									
20									
25									
30									
35									
40									
45									

DEPTH UNITS: ______________

DRILLING CONTRACTOR: ______________

DRILLER: ______________

LOGGED BY: ______________

CHECKED BY: ______________

REV. No.	REVISIONS	REV. DATE	DESIGN BY	DRAWN BY	REVIEWED AND SIGNED BY

SOIL BORING LOG FORM

MWH

PROJECT No.:

AutoCAD FILE:

SCALE: FIGURE No.:

ATTACHMENT 2

EXAMPLE MWH BORING LOG FORMS

5 MOISTURE CONTENT

Term Field	Test
Dry Absence of moisture	, dusty, dry to the touch
Moist Damp b	ut no visible water
Wet Visib	le free water

6 GRAIN SIZE

Term Sie	ve size Gr	ain size Appro	ximate size
Boulders 12 inches	>12 inches	Larger than bask	etball-size
Cobbles 3-12 inches	3-12 inches	Fist-siz	e to basketball-size
Gravel - Coarse 3/4-3 inches	3/4-3 inches	Thumb-siz	e to fist-size
Fine #4-3/4 inches	0.19-0.75 inches	P	ea-size to thumb-size
Sand - Coarse #10-#4	0.079-0.19 inches	Roc	k salt-size to pea-size
Medium #40-#10	0.017-0.079 inches	Sugar-siz	e to rock salt-size
Fine #200-#40	0.0029-0.017 inches	Flour-siz	e to sugar-size
Fines P	assing #200 <0.0029 inches	Flour-siz	e and smaller

7 CEMENTATION

Term Field	Test
Weak Cr	umbles or breaks with handling or slight finger pressure
Moderate Cr	umbles or breaks with considerable finger pressure
Strong Will not cr	umble or break with finger pressure

PLASTICITY

Nonplastic A1/8 inch (3mm) thread cannot be rolled at an y water content

Low The thread can barely be rolled and the lump cannot be formed when drier than the plastic limit

Medium The thread is easy to roll and not m uch time is required to reach the plastic limit. The thread cannot be rerolled after reaching the plastic limit. The lump crumbles when drier than the plastic limit

High It tak es considerable time rolling and kneading to reach the plastic limit. The thread can be rerolled se veral times after reaching the plastic limit. The lump can be formed without cr umbling when drier than the plastic limit

ROCK CLASSIFICATION

Rock name Color W eathering F racturing Competency Miner alogy Miscellaneous

CONVERSIONS

Multiply b	y to Obtain
in 2.54	cm
ft 0.3048	m
mi 1760	yd
mi 5280	ft
mi 1.6093	km
cm 0.3937	in
cm 3.2808 E-2	ft
m 3.2808	ft
km 0.6214	mi
cu ft 2.8317 E-2	cu m
gal 3.7850 E-3	cu m
cu ft 7.4813	gal
quart 0.9464	liter
gal 3.7854	liter
liter 0.2642	gal

Sch 40 PVC CASING VOLUMES

Diameter (in) V	olume (gal/ft)
2 0.17	
4 0.66	
6 1.50	

BORING VOLUMES

Hole dia. (in) V	olume (gal/ft)
7.25 2.14	
7.75 2.45	
8.25 2.78	
10.25 4.29	
12.25 6.1	3

WELL VOLUME CALCULATION EXAMPLE

Well volume = Annular volume + Casing volume

Annular volume = (Boring volume - Casing volume x Sand pack porosity

EXAMPLE

Assume 10.25 in dia hole 4 in dia casing

30% sand pack porosity, 8 ft water column

Annular volume = (4.29 gal/ft - 0.66 gal/ft) x .30 x 8 8.71 gal/ft 2

Casing volume = 0.66 gal/ft x 8 ft = 5.28 gal/ft2

One well volume = 8.71 gal = 5.28 gal = 13.99 gal

MWH
MONTGOMERY WATSON HARZA

INCHES (tenths) 1 2 3 4 5 6 7
(Add 1 inch)

FIELD GUIDE

MWH
MONTGOMERY WATSON HARZA

ORDER OF DESCRIPTION

1. Soil group name 2. USCS symbol 3. Color 4. Density/Consistency 5. Moisture
6. Grain size (sands and gravels) 7. Cementation 8. Odor 9. Miscellaneous

EXAMPLE DESCRIPTION

Poorly-graded sand with gravel (SP), light brown, loose, moist, predominantly fine sand, trace medium sand, 20% fine g ravel, hydrocarbon odor and staining

UNIFIED SOIL CLASSIFICATION SYSTEM

1				2
COARSE-GRAINED SOILS <50% passes #200 sieve	GRAVELS <50% coarse fraction passes #4 sieve	GRAVELS with little or no fines	Well-graded gravels, gravel-sand mixtures, little or no fines	GW
			Poorly-graded gravels, gravel-sand mixtures, little or no fines	GP
		GRAVELS with 15 fines	Silty gravels, poorly-graded gravel-sand-silt mixtures	GM
			Clayey gravels, poorly-graded gravel-sand-clay mixture	GC
	SANDS 50% coarse fraction passes #4 sieve	SANDS with little or no fines	Well-graded sands, gravelly sands, little or no fines	SW
			Poorly-graded sands, gravelly sands, little or no fines	SP
		SANDS with 15% fines	Silty sands, poorly-graded sand-gravel-silt mixtures	SM
			Clayey sands, poorly-graded sand-gravel-clay mixtures	SC
FINE-GRAINED SOILS 50% passes #200 sieve	SILTS AND CLAYS liquid limit <50		Inorganic silts and very fine sands, silty or clayey fine sands, silts with slight plasticity	ML
			Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	CL
			Organic silts and clays of low plasticity	OL
	SILTS AND CLAYS liquid limit >50		Inorganic silts, micaceous or diatomaceous fine sand or silt	MH
			Inorganic clays of high plasticity, fat clays	CH
			Organic silts and clays of medium-to-high plasticity	OH
	HIGHLY ORGANIC SOILS		Peat, humus, swamp soils with high organic content	PT

NOTE: W ell-graded (wide range of grain size) = poorly sorted; poorly-graded (predominantly one grain size) = well sorted

3 **COLOR** Assign color using Munsell Soil Color Chart (1992) if possible

4 **DENSITY** (Sands and gravels)

Term Blo 1.4"ID	w/ft* 2.0"ID	2.5"ID
very loose 0-4	0-5	0-7
loose 4-10	5-12	7-18
medium dense 10-29	12-37	18-51
dense 29-47	37-60	51-86
very dense >47	>60	>86

SOIL TYPE MODIFIERS

Sand/Gr Term	avel % fines	Silt/Cla T	y erm % fines
trace	<5	tr	ace <5
with	5-15	with	15-30
clayey/silty	15	sandy/g ravelly	30

CONSISTENCY (Silts and clays)

Term Blo 1.4"ID	w/ft* 2.0"ID	2.5"ID	Field Test (when b low counts not available)
very soft 0-2	0-2	0-2	Easily penetrated several inches by thumb; exudes between thumb and finger when squeezed
soft 2-4	2-4	2-4	Easily penetr ated one inch by thumb; molded by light finger pressure
medium stiff 4-8	4-8	4-8	Penetrated over 1/2 inch by thumb with moderate effort; molded by strong finger pressure
stiff 8-15	9-17	9-18	Indented b y 1/2 inch by thumb but penetrated only with great effort
very stiff 15-30	17-39	18-42	Readily indented b y thumbnail
hard 30-60	39-78	42-85	Indented with difficuty b y thumbnail
very hard >60	>78	>85	

* = 140 pound hammer dropped 30 inches

MISCELLANEOUS

Plasticity (if applicable) Degree of rounding/angularity Loss of dr illing fluid
Organics, carbon, vegetation Str atigraphic unit (if known) Ca ving/sloughing
Structure (e.g., layering) Dr illing rate ▽ Depth to first w ater (time and date)
Coloration (staining, oxidation, mottling) Rig beha viour
Lithology (e.g., quartz) Hea ving sands ▼ Depth to w ater after drilling (time and date)

GeoFldGd QA-QC 09-01

ATTACHMENT 1

MWH FIELD CLASSIFICATION GUIDES

4.0 REFERENCES

ASTM, 2000. Standard D2488-00 Standard Practice for Description and Identification of Soils (Visual-Manual Procedure).

Munsell Color, 1992. Munsell Soil Color Charts, Revised Edition. Macbeth, Division of Kollmorgen Instruments Corp., Newburgh, New York.

Soil sample information should include the depth interval that was sampled, the blow counts per six inches, the amount of soil recovered, and the portion submitted for analysis or testing, if any. The sample identification number may also be noted on the log.

The degree to which soil samples are collected during a field effort depends on the overall scope and purpose of the investigation, which should be clearly defined before the field effort commences. Additional soil samples may need to be collected if, for example, soils are very heterogeneous or unexpected conditions such as perched water zones or zones of contamination are encountered.

If groundwater is encountered during drilling, the depth to water and the time and date of the observation should be recorded. If the first water encountered is a perched zone, the depth, time, and date that any additional groundwater zones are encountered should also be recorded. Depth to water after drilling, the measuring point, and the date and time of the measurement(s) must be noted. Additional measurements of depth to groundwater, including depth and time, may be beneficial.

If a monitoring well is installed, the construction details such as casing material type, screen length and slot size should be noted on the boring log. The annulus fill material (sand pack, bentonite, grout, etc.) should also be recorded.

If the soil boring is abandoned, the backfill material used (e.g., grout, bentonite, etc.) and volume used, should be recorded on the boring log.

imported fill material, every effort should be made to identify the contact between fill and native soils. If a soil is suspected to be fill, this should be clearly indicated on the log following the soil description. Stratigraphic units and their contacts should be noted wherever possible.

3.2.11 Bedrock Descriptions

If the soil boring penetrates bedrock, the boring log should indicate the rock type, color, weathering, fracturing, competency, mineralogy, age (if known), and any other miscellaneous information available. Definitions of these terms are not included in this SOP, because only a small percentage of drilling activities conducted by MWH penetrate bedrock. If bedrock drilling is planned, the field team leader, with the concurrence of the project manager, makes arrangements to provide the field team with appropriate definitions and indicate the types with information that should be collected.

3.3 ADDITIONAL BORING LOG INFORMATION

The boring log form included in Attachment 2 should be used. Information in the log heading should be complete and accurate. In addition to soil descriptions, the following information should be included, at a minimum:

- Boring or monitoring well number
- Project name and job number
- Site name
- Name of individual who logged the boring
- Name of boring log reviewer
- Drilling contractor
- Drill rig type and method of drilling (for example, "CME 75, hollow stem auger")
- Name of drilling company
- Name of driller and helper
- Borehole diameter and drill bit type
- Type of soil sampler (for example, Modified California, continuous core, etc.)
- Time and date that drilling started and finished
- Time and date that the well was completed, or the soil boring backfilled, as appropriate
- Method of borehole abandonment
- Sketch map of boring or well location with estimated distances to major site features such as property lines or buildings, and north arrow

3.2.7 Angularity

The angularity of the sand (coarse sizes only), gravel, cobbles, and boulders, as angular, subangular, subrounded, or rounded are described in accordance with the following criteria:

- Angular particles have sharp edges and relatively planar sides with unpolished surfaces.
- Subangular particles are similar to angular description but have rounded edges.
- Subrounded particles have nearly plane sides but have well-rounded corners and edges.
- Rounded particles have smoothly curved sides and no edges.

A range of angularity may be stated, such as "subrounded to rounded."

3.2.8 Structure

Describe the structure of intact soils in accordance with the criteria in Table 7.

TABLE 7. CRITERIA FOR DESCRIBING STRUCTURE

Description	Criteria
Stratified	Alternating layers of varying materials or color with layers at least 6 mm thick; note thickness
Laminated	Alternating layers of varying materials or color with the layers less than 6 mm thick; note thickness
Fissured	Breaks along definite planes of fracture with little resistance to fracturing
Slickensided	Fracture planes appear polished or glossy, sometimes striated
Blocky	Cohesive soil that can be broken down in small angular lumps that resist further breakdown
Lensed	Inclusion of small pockets of different soils, such as small lenses of sand scattered through a mass of clay; note thickness
Homogenous	Same color and appearance throughout

3.2.9 Lithology

Describe the lithology (rock or mineral type) of the sand, gravel, cobbles, and boulders, if possible. It may be difficult to determine the lithology of fine and medium-grained sand or particles that have undergone alteration.

3.2.10 Additional Comments

Additional comments may include the presence of roots or other vegetation, fossils or organic debris, staining, mottling, oxidation, difficulty in drilling, and caving or sloughing of the borehole walls. Also, when drilling in an area known or suspected to contain

3.2.4 Grain Size

Describe the maximum particle size found in the sample in accordance with the following information:

- Sand Size – Describe as fine, medium, or coarse (see Section 2.1 for sand size definitions)
- Gravel Size – Describe the diameter of the maximum particle size in inches
- Cobble or Boulder Size – Describe the maximum dimension of the largest particle

For gravel and sand components, describe the range of particle sizes within each component. For example, "about 20 percent fine to coarse gravel, about 40 percent fine to coarse sand."

3.2.5 Odor

Due to health and safety concerns, **NEVER** intentionally smell the soil. This could result in exposure to volatile contaminants that may be present in the soil. If, however, an odor is noticed, it should be described if organic or unusual (e.g., petroleum product or chemical). Soils containing a significant amount of organic material usually have a distinctive odor of decaying vegetation (sometimes a hydrogen sulfide [rotten egg] smell). Organic vapor readings from a photoionization detector or similar instrument should be noted on the field boring log. The project-specific health and safety plan should then be consulted to determine the appropriate level of protection necessary to continue field work.

3.2.6 Cementation

Describe the cementation of intact coarse-grained soils as weak, moderate, or strong, in accordance with the following criteria:

- Weak – Crumbles or breaks with handling or little finger pressure
- Moderate – crumbles or breaks with considerable finger pressure
- Strong – Will not crumble or break with finger pressure

The presence of calcium carbonate may be confirmed on the basis of effervescence with dilute hydrochloric acid (HCl) if calcium carbonate or caliche is believed to be present in the soil. Proper health and safety precautions must be followed when mixing, handling, storing, or transporting HCl.