ATTACHMENT 2

WORK PLAN
MARYSVILLE ROAD/SILVER CREEK
ROAD ALIGNMENT SURVEYING
AND ROADBED SAMPLING
LEWIS AND CLARK COUNTY, MONTANA

To: CENWO-ED-GG Lead Driller

CENWO-ED-GG Field Geologist

CENWO-ED-GG File

WORK PLAN
MARYSVILLE ROAD/SILVER CREEK
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Introduction

This Work Plan provides the surveying and drilling instructions for control point surveying and roadbed soil sampling along the Marysville Road. Marysville, Montana is about 20 miles northwest of Helena, Montana. Control surveys will encompass the full length of the Marysville Road, route L2590, from its intersection with Montana Hwy 279 (Lincoln Road) at RP 0, west to Marysville at RP 6.15, then continues on Ottawa Gulch Road, route L2550, at RP 0 to its junction with Belmont Drive at RP 1.7±, on the west side of Marysville. Control surveys will be done in accordance with Montana Department of Transportation Specifications. Drilling for road base sampling will encompass the stretch of road from the Montana Hwy 279 west to the Drumlummon Mine and Mill Site on the east side of Marysville. The roadbed fill will be continuously sampled from the surface to a maximum depth of ten feet, or refusal on rock, at twenty-one locations

Background

The Montana Department of Transportation (MDT) requested the US Army Corps of Engineers install control survey points and sample the roadbed fill in preparation for widening and paving the Marysville Road. Marysville Road is a gravel road which is narrow and winding in places, more so in the upper portion near Marysville. **Should a location for a soil boring appear unsafe due to lack of visibility by on coming traffic or the narrowness of the road, that location may be relocated or deleted with the concurrence of the USACE – Omaha District Chief of Geology.** The concern with the roadbed fill is that contaminated spoil from mining and milling may have been used to construct the roadbed. The intent of this sampling effort is to identify possible areas of concern. Of particular concern/interest is the possibility of mercury contamination in the soil. Geologists and drillers should be on the look out for obvious signs of mercury contamination (silvery liquid droplets) in soil cuttings and samples. A Jerome Meter shall be used to monitor for harmful levels of mercury vapors at the work site. Monitoring details are include in the site specific

portion of the Health and Safety Plan. **If mercury is detected in the sample or in drill cuttings, drilling and sampling will be discontinued at that boring location for safety reasons**. Other possible contaminants include other heavy metals, strongly acidic soil conditions and residual cyanide. If this investigation reveals significant contamination, additional sampling to delineate areas for treatment or removal would have to be undertaken at a later date. MDOT is interested in documenting information on any historic sites encountered along the road, principally a location and a brief general description and any other aspects of the historical site that may affect the road construction.

The Jerome Meter (rented from Total Safety) and the sampling jars and supplies form the laboratory are being shipped to the Federal Express Office at 3171 Bozeman Ave., Helena, MT. as a hold for pickup shipment.

Scope of Work

Control Surveys

The USACE Omaha District Survey Crew will install control points and survey in their locations in accordance with MDT specifications. Control stations will be placed on backslopes so stations are intervisible. A typical station will be a standard MDT disk drilled into rock outcropping. Horizontal coordinates will be determined by postprocessing GPS data collected by four Trimble receivers. Vertical control will be established by differential levels using a Wild Diglev. Control standards will meet requirements of the National Map Accuracy Standards.

1. Connection to three NGS HARN marks is required. The project control should be within a triangle formed by the three HARN marks. Dual frequency receivers are required for the GPS observations associated with the connection to the HARN.
2. "Leapfrog" of receivers without a change in the antenna heights is to be avoided.
3. Project control marks.
    a. Establish throughout the project.
    b. MDT 51 mm aluminum caps and 30" (0.762 meter) rebar.
    c. MDT witness post with a decal will be set near all control marks. The location of the witness post in relationship to the monument will be described in the field notes and included in the final abstract.
    d. Control marks along the project should be 300-500 meters apart.
    e. Set outside the estimated construction limits.
    f. Stamped per the Survey Manual (mile post and letter).
    g. Adjacent control marks are to be visible.
    h. Mark name in all files will be equal to the stamping on the cap. For example 0A, 0B, 2B, etc.

i. Include observations to the nearest NGS benchmark in the network.

4. Static or Fast Static observations are to be used for all project control marks. One network adjustment will be done that includes all control marks occupied with GPS.
5. It is not necessary to include the boring locations as part of the control survey since these locations will be marked with a wooden stake. The coordinates of the boring locations can be determined after the control network is adjusted.
6. NAVD88 elevations of the control marks are to be based on differential levels. A check run should be made between two adjacent NGS benchmarks. One on these should be the benchmark per item 3.i. above.
7. Trivial baselines should not be included in the final constrained adjustment.
8. GPSurvey file name or TGO file name will be the control number (4983).
9. The final data will be a fully constrained 3D adjustment using GPSurvey (version 2.35 Web Patch 2.35a) or TGO Version 1.5. The adjustment will constrain the latitude and longitude of all HARN marks (not the state plane coordinates). The vertical will be constrained as deemed necessary. This final adjustment will then be archived using GPSurvey backup (everything) routine, and provided to survey on CD. If TGO is used then all project files should be copied to a CD using WinZip. Do not send floppy disks.
    a. Horizontal-NAD83(1999).
    b. Vertical-NAVD88.
    c. Generally the network reference factor should pass the Chi Square Test with a GPS scalar in the vicinity of 4-6 for the fully constrained adjustment.
    d. Centering errors and HI errors should be estimated in the vicinity of 0.002m.
10. All original survey notes will be included with the GPS submittal.
11. Provide a space delineated coordinate text file (metric state plane-NAD83/1999) that includes all marks occupied with GPS. The horizontal coordinates will be shown to four places and elevations to three places.
12. Provide a text file that includes the locations and description of all marks occupied by GPS.

Butte District requested a MDT representative be present during the setting of the control marks. In addition, it is understood that some surveying has been conducted by DEQ. In order to utilize the existing survey it will have to be tied, at some point in time, to the GPS control survey.

Soil Boring Surveying

The USACE Omaha District Survey Crew will stake the boring locations for the roadbed fill sampling at the same time they install and survey control points along the road. Soil boring locations will be staked offset, just off the north edge of the road. The borings will be drilled by the USACE drill crew in the road (on the north side),

after measuring back on to the road from the staked location off the north edge. Boring locations will be staked using a 2X2 wood stake, marked with the boring number. A lath, painted orange/red fluorescent on top or tied with similar colored flagging, should be installed adjacent to the survey stake if the area is in tall vegetation or otherwise difficult to visually locate. Boring locations shall be in the Montana State Plane Coordinate System NAD 83 datum. (No elevations are required for the soil boring locations.)

Soil Borings and Sampling

Twenty-one soil borings numbered MR02-01 through MR02-21 shall be continuously sampled from the road surface to a maximum depth of ten feet below ground surface (bgs) or refusal for soil logging, geotechnical bag sampling, splitspoon blow counts and composite analytical sampling. Three boring locations (MR02-02, MR02-16 and MR02-17, in areas assumed to be uncontaminated) will be sampled at 0 to 1.5, 1.5 to 3.0 and 3.0 to 4.5 feet bgs with a 2-inch O.D. splitspoon, with blow counts recorded for each 6-inchs of drive. The remainder of those borings and the full depth of all other borings shall be sampled using a (carbon steel) 5-foot continuous soil core sampler. For Drilling and sampling equipment details see SOPs A2 (Drilling Equipment and Procedures) and A3 (Subsurface Soil/Rock Sampling Equipment and Procedures). Equipment decontamination shall follow SOP a12 (Equipment Decontamination Procedures). There shall be twenty–one (21) primary analytical composite samples (one sample composited from the full depth of each boring), with two (2) QC split samples, two (2) TCLP samples and approximately three to four (3-4) 16-ounce geotechnical bag samples (for visual inspection only by the Geotechnical Engineer – Gordon Lewis). The TCLP samples shall be selected by the field geologist from among those composite samples, which are believed to be the most contaminated, based on appearance in the field. In general, it is expected that the TCLP samples will be taken in the areas of soil borings MR02-07 to MR02-08 (Goldsil millsite and tailings) MR02-10 to MR02-13 (Drumlummon tailings dam) and/or MR02-18 to MR02-21 (Drumlummon mine and millsite). **If mercury is detected in the sample or in drill cuttings, drilling and sampling will be discontinued at that boring location for safety reasons**. The geotechnical bag samples shall be representative samples of all the significant soil types encountered during drilling. Recovered samples shall be described and logged according to SOPs A5 (Lithologic Description of Surface and Subsurface Soil (and rock) Samples and A6 (Boring Log Completion). An exception to this shall be that the log form (attached) will have a dual English-foot/Metric scale on the left side. However, logging and field notes will continue to be in the English-foot system. The core shall be photographed, showing the boring identification, top and bottom footage depths of each core, and the date and time, on a backboard or by other means. The sub-sample for chemical analysis shall be composited according to SOP A4 (Soil/Rock Homogenization Equipment and Procedures) by taking a sample at the surface and at each foot in depth, to the total boring depth. Sample handling and labeling shall follow SOP A13 (Sample Handling, Documentation, and Tracking

Procedures), with the exception that the sample number shall read similar to MR-SB01-10 for the sample from boring MR02-01. (There are no [sub] sampling area locations associated with this project at this time, therefore there will be no Designation of Sampling Area Location [VVVV] in the sample ID.) General field documentation, in addition to boring logs and sample labels and custody forms, shall follow SOP A14 (Field documentation). The USACE shall obtain utility clearances for all boring locations, prior to drilling at each location.

Analytical Sampling and Analysis The twenty-one composite soil samples with two QC samples and two TCLP samples shall be submitted for analysis. The samples shall be sent to:

Samples for ABA Accounting analysis:

Energy Laboratory
1120 So 27 th St
Billings, Montana 59101

Point of Contact: John Standish
Telephone: (800) 735-4489

Samples for all other Analysis and Geotechnical Bag Samples:

US Army Corps of Engineers
Environmental Chemistry Branch Laboratory
Attn: CEWES-EE-Q (Sample Custodian)
420 South 18 th Street
Omaha, NE 68102-2501

Point of Contact: Laura Percifield
Telephone: (402) 444-4314

The **LIMS # 6683** shall be attached to each sample and Chain-of-custody sent to the laboratory.

The sample shall be analyzed as given below.

Analysis of composite soil samples

Sample Type and Number	Analyses	Method
21 Soil Samples & 2 QC Samples	Metals (Ag, As, Ba, Cd, Cr, Cu, Fe, Hg, Mn,	6010B/7471

	Ni, Pb, Sb, & Zn	
	pH (soil)	USDA 8C
	Total Cyanide	9012
	Acid-Base Accounting*	**
2 Soil Samples 1311/6010B/7471	TCLP Metals***	

* This analysis shall be denoted as Acid-Base Accounting (ABA), Sulfur forms, Exchangeable Acidity and SMP buffer
** Analysis method by Energy Laboratory, Billings Montana
*** RCRA 8 analysis

Samples to be obtained (see table in this section)

Sample Type	Analyses	Container
23 Soil Samples ** ***Metals*	8 oz glass container	
	pH*	
	Total Cyanide	4 oz glass container
	Acid-Base Accounting	16 oz glass container or plastic bag container can be used
2 Soil Samples	TCLP Metals*	

* These three analyses can be obtained from the same 8 oz container
** From two of these samples an MS/MSD pair of samples shall be obtained which requires another sample container.
*** Duplicate samples shall be obtained from two of these samples.

There are no set holding times for these soil samples, however the samples must be kept in a known place so sample tracking and security can be assured. (Sample coolers should have security seals when not in the physical presence and control or the sampler.) The samples may be batched (held on site) before shipping, but should be sent to their respective laboratories at least once a week. ABA Accounting Analysis samples do not need to be stored with iced/refrigerated or shipped with ice to Energy Laboratory. The pH and Total Cyanide samples (along with Metals and TCLP if from the same jar) will need to be stored with ice/refrigerated and shipped with iced to the Environmental Chemistry Branch Laboratory. The sample/samples shall be analyzed

and the sensitivity and quality control samples acceptance criteria shall meet that set by the Environmental Chemistry Branch Laboratory criteria and/or as per the Draft General Work Plan, Restoration of Abandoned Mine Sites, June 2002.

Total Samples Required and Containers

Method	Field Samples	QC Samples	MS/MSD Samples	Total Samples	Sample Containers
Metals, (*) TCLP Metals pH	21	2	2	25	8 oz
Tot Cyanide	21	2	2	25	4 oz
ABA	21	2	2	25	16 oz glass or plastic bag
Geotech (**)	3 to 4			3 to 4	16 oz bag

(*) All three analyses performed on the one 8 oz container must be given on the container label. TCLP Metals analysis for only two of twenty-one samples.
(**) Geotechnical Samples for visual examination by Geotechnical Engineer (Lewis). Samples to be sent to Environmental Chemistry Branch Laboratory with the analytical samples but marked "Geotech samples only-not for chemical analysis. Attention: Gordon Lewis"

IDW Disposal

IDW Disposal shall in general follow SOP A7 (Investigative derived Waste Procedures). It is desired to return as much of the soil and rock cuttings back to the boring from which it came, especially any material, which may appear to be contaminated. It is also desirable to insure that borings do not settle and leave a hole in the road in the future. Therefore, the cuttings shall be used to back fill the boring from which they came from total depth to three feet below the surface. The top three feet of each boring shall then be backfilled with cement grout to insure the hole remains sealed at the surface

Site Safety Considerations/Procedures

In addition to the presence of mercury, discussed in the Background section above, a key safety concern will be traffic control while drilling along Marysville Road. Current estimated traffic load is about 400 vehicles per day. Roadway width varies from 19 feet to 26 feet. Appropriate traffic control in accordance with the "Manual of Uniform Traffic Control Devices" shall be followed throughout the drilling portion of this project. Work zone control (flagmen, cones for lane restriction and signage) will follow a MDT and USACE-Omaha approved Traffic Safety Plan. The USACE Contractor, Tabbert Construction/Traffic Control of Helena, Montana, will supply the plan, flagmen, cones and signage for this project. The Contractor will set up, man, and

move the work zone controls for the USACE Drill Crew, as work progresses. The primary point of contact at Tabbert is Mike Wriggs Cell Phone (406) 439-7130, Fax (406) 457-0520 and the secondary contact is Bobbi Halvorson Phone (406) 594-2517. (A copy of the Traffic control plan showing the work zone layout with signage and flaggers is attached.) **Should a location for a soil boring appear unsafe due to lack of visibility by on coming traffic or the narrowness of the road, that location may be relocated or deleted with the concurrence of the USACE - Omaha District Chief of Geology.** Appropriate signing traffic control shall also be used during the Surveying portion of the project, as well.

Reporting Requirements

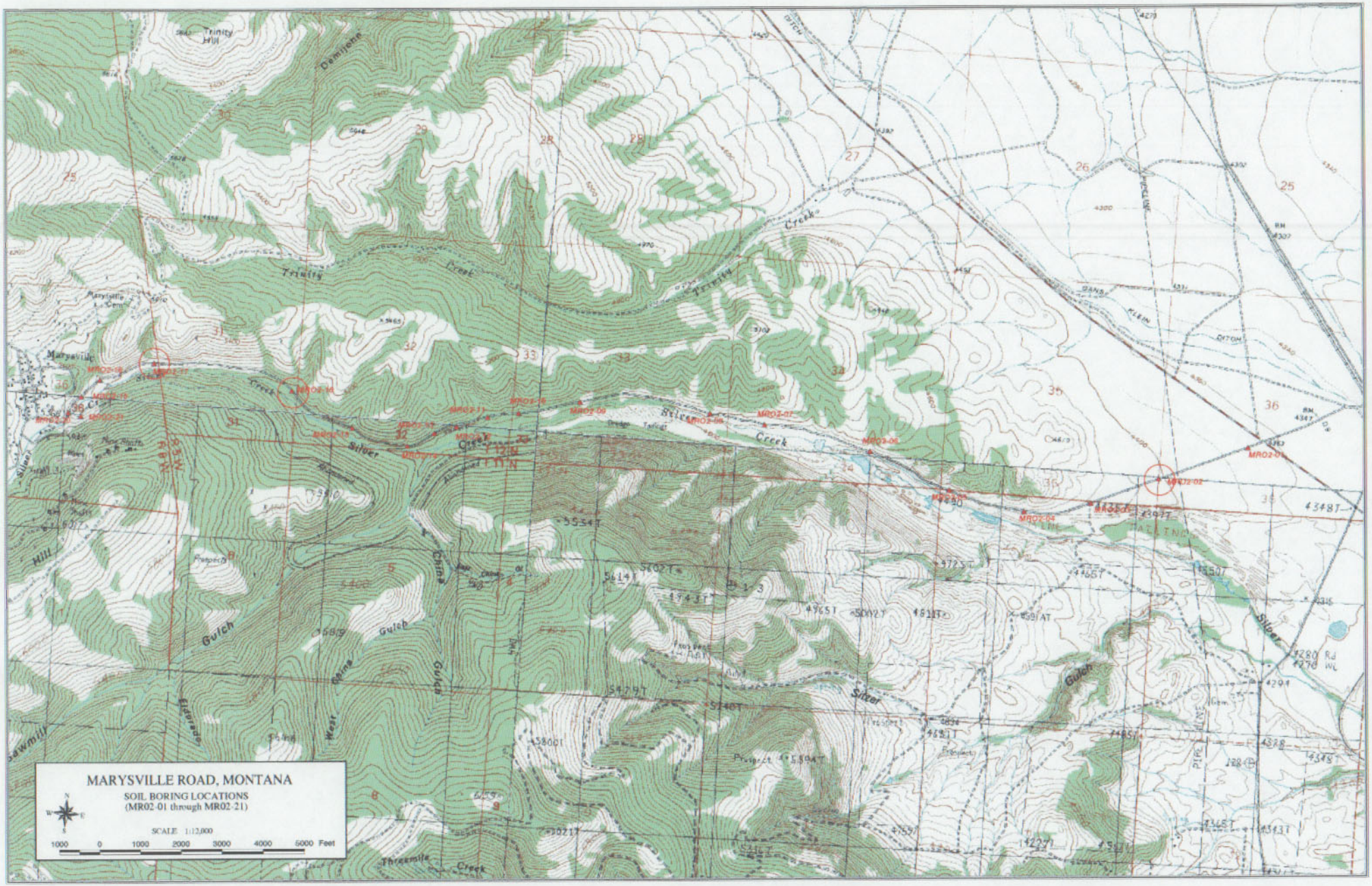
The field Geologist shall maintain a field notebook to document daily activates. Daily Quality Control Reports (attached) and a daily Tailgate Safety Meeting Documentation sheet (attached to the Safety Plan) for each days work, Sample Transmittal (attached) or Custody forms for all Geotechnical and Analytical samples, and HTRW Drilling logs (attached) for each boring shall also be completed and submitted. A brief and concise field report (the Site Information Sheet, attached) shall be completed and submitted with copies of all the other project documentation within 7 days of completion of the work.

Additional Contacts

If there are any questions regarding this work you may contact the Project Geologist, Tom Liefer at (402) 221-7777; the Project Manager, Kim Mulhern at (402) 7735; or the Chief of Geology, Tim Skeen at (402)221-7766

Encls.

Timothy Skeen
Chief, Geology Section
Geotechnical Engineering and Sciences Branch


MARYSVILLE ROAD, MONTANA
SOIL BORING LOCATIONS
(MR02-01 through MR02-21)
SCALE 1:12,000
1000 0 1000 2000 3000 4000 5000 Feet
Trinity Hill
Demijohn
Trinity Creek
Marysville
Silver Creek
Silver Gulch
Chinn Gulch
Sawmill Gulch
Threemile Creek
T12N
T11N
R3W
R2W
MR02-01
MR02-02
MR02-03
MR02-04
MR02-05
MR02-06
MR02-07
MR02-08
MR02-09
MR02-10
MR02-11
MR02-12
MR02-13
MR02-14
MR02-15
MR02-16
MR02-17
MR02-18
MR02-19
MR02-20
MR02-21

APPENDIX A
STANDARD OPERATING PROCEDURES

A1	N.A.
A2	Drilling Equipment and Procedures
A3	Subsurface Soil/Rock Sampling Equipment and Procedures
A4	Soil/Rock Homogenization Equipment and Procedures
A5	Lithologic Description of Surface and Subsurface Soil Samples
A6	Boring Log Completion
A7	Investigative Derived Waste Procedures
A8	N.A.
A9	N.A.
A10	N.A.
A11	N.A.
A12	Equipment Decontamination Procedures
A13	Sample Handling, Documentation, and Tracking Procedures
A14	Field Documentation
A15	N.A.
A16	N.A.
A17	N.A.
A18	N.A.
A19	N.A.

A2

DRILLING EQUIPMENT AND PROCEDURES

Equipment Needs

Drill Rig or direct-push drill rig capable of:

a. Advancing borings with either 4.25 or 6.25-inch Inner Diameter (I.D.) hollow-stem augers to the appropriate depth,
b. Providing standard penetration test information for soils where appropriate, and
c. Completing monitoring well installation

Non-metallic tape of adequate length to measure depth of boring, calibrated to 0.01 foot
Electronic water level indicator of adequate length (100 feet), calibrated to 0.01 foot
Generator, steam cleaner, and related equipment (see ***SOP A12***)
Tap water and deionized water (see ***SOP A12***)
Personal Protective Equipment in accordance with the Site Safety and Health Plan
HTW boring logs (see ***SOP A6***) and data forms (see ***SOP A14***)
Field Log book (see ***SOP A14***)
Indelible marking pen and black ink pen
Copies of other applicable SOPs and/or ASTMs

Drilling Procedures

Boreholes will be drilled in accordance with applicable state regulations.

All drill pipe, drilling tools, etc. will be free of potentially contaminating materials (e.g., grease, oil, paint, etc.). The rig will be free of leaks that could contaminate the boreholes or drill cuttings (e.g., hydraulic fluid, oil, gas, etc.).

Upon arrival at the site and prior to use at each sample location, the drill rig, drilling tools and sampling equipment will be decontaminated to minimize the potential for cross-contamination. Decontamination will consist of steam-cleaning the drill rig and drilling tools. Sampling equipment (e.g., the split-spoon sampler or soil core barrel) will be decontaminated prior to use at each sampling location and also will be decontaminated between all sampling intervals (see ***SOP A12***).

Split-spoon soil samples (***ASTM D 1586***) will be obtained at 2.0-foot intervals or with a 5-foot stainless steel or carbide steel, continuous soil core barrel to the designated depth (see ***SOP A3***).

Soil samples for off-site laboratory analysis will be obtained from the sample intervals designated in the site-specific addendum to the work plan. If insufficient sample volume is obtained at the designated interval, additional soils for laboratory analysis will be obtained from

the interval immediately below or above the designated interval. These soils generally will be analyzed for inorganic parameters.

If auger refusal is encountered during the first 10 feet during borehole advancement, the auger will be removed and a new borehole will be advanced approximately 10 feet from the original location or at a greater distance based on field judgment. If refusal occurs at the second borehole, at approximately the same depth, it will be assume that refusal is due to the presence of shallow bedrock.

Upon completion of the boring to the groundwater table, the water table depth will be measured with the electronic water level indicator and will be noted on the HTW boring log (see ***SOP A6***). If groundwater is not encountered, the depth of the boring will be measured with a non-metallic tape, and the depth will be logged. Sampling intervals also will be measured with the non-metallic tape and recorded on the HTW boring log. Any other information considered important by the sampler will be entered on the HTW boring log and in the field log book (see ***SOP A14***).

Boreholes not completed with a monitoring well will be abandoned according to the state requirements. If there are no state borehole abandonment requirements, 30% solids bentonite grout will be placed to within 3 feet of the ground surface. The top 3 feet will be filled with native material.

Investigative Derived Wastes (IDW)

All investigative derived waste will be handled in accordance with ***SOP A7***.

A3

SUBSURFACE SOIL/ROCK SAMPLING EQUIPMENT AND PROCEDURES

Equipment Needs

Drill rig and equipment (see ***SOP A2***)
Stainless steel 3-inch split-spoons (2)
Stainless or carbide steel 5-foot soil core barrel
Stainless steel bowl/tray
Stainless steel spoon/spatula
Sample containers for chemical analysis
Decontamination equipment (see ***SOP A12***)
PPE in accordance with the Site Safety and Health Plan
Field forms and field log book (see ***SOP A6*** and ***SOP A14***)
Indelible pens
Cooler
Ice
Zipperlock-type baggies
Aluminum foil
Liquinox® detergent (see ***SOP A12***)
Copies of other applicable SOPs and/or ASTMs

Soil Sampling Procedure

Disturbed soil samples will be collected with either split-spoon soil samples (ASTM D 1586) at intervals designated in the work plan addendum or with a 5-foot stainless steel, continuous soil core barrel or a 5-foot carbide steel, continous soil core barrel. Samples collected with the carbide steel core barrel will be peeled to ensure that none of the analytical sample has come into contact with the carbon steel. The soil will be extruded onto aluminum foil. The retrieved soils will then be thoroughly homogenized as outlined in ***SOP A4***.

Samples for HTW laboratory analyses will be collected from the sample intervals identified in the site-specific addendum. If insufficient sample volume is obtained at the designated interval, additional soils for laboratory analysis will be obtained from the interval immediately below or above the designated interval.

Soil samples will be visually classified using the Unified Soil Classification System (USCS) following methods outlined in ***ASTM D 2488***, and descriptions will be entered into the HTW boring log (see ***SOP A6***).

Investigative Derived Waste (IDW)

All investigative derived waste will be handled in accordance with ***SOP A7***.

Air Monitoring Procedures

Air Monitoring Procedures will be used during all intrusive activities to meet the safety requirements of the Site Safety and Health Plan.

A4

SOIL/ROCK HOMOGENIZATION EQUIPMENT AND PROCEDURES

Equipment Needs

Aluminum Foil
Disposable spoon or spatula
Sample containers
Disposable nitrile gloves
Copies of other applicable SOPs and/or ASTMs

Procedure

The soil/rock for the sample interval will be placed on aluminum foil and thoroughly mixed using a disposable spoon or spatula. The soil or sediment in the pan will be scraped from the sides, corners, and bottom of the pan, rolled to the middle of the pan, and initially mixed. The sample then will be quartered and moved to the four corners of the pan or bowl, and each quarter of the sample will be mixed individually. The soils then will be rolled to the center of the container, and the entire sample mixed again. This procedure will be continued to ensure that all parts of the sample are mixed and that the sample is as homogenous as possible before being placed in the sample containers. An assessment of the completeness of homogenization will be based on the uniformity of color and texture of the entire sample.

Investigative Derived Waste (IDW)

All investigative derived waste will be handled in accordance with ***SOP A7***.

A5

LITHOLOGIC DESCRIPTION OF SURFACE AND SUBSURFACE SOIL/ROCK SAMPLES

Equipment Needs

Pocket knife or small spatula
Hand lens
Camera and film
Field forms
Field log book
Indelible pens
Copies of other applicable SOPs and/or ASTMs

Procedures

Soil samples will be classified according to the Unified Soil Classification System (USCS), following methods outlined in ***ASTM D 2488*** (Standard Practice for Description and Identification of Soils, Visual-Manual Procedure) and the Standard Nomenclature for Description of Soils of the U.S. Army Corps of Engineers, Omaha District.

The field geologist will describe and classify soil materials based on field observations using methods discussed above and will enter the lithologic classifications into the boring log (see ***SOP A6***). Final boring logs will be prepared using observations of the field geologist and the driller. Laboratory analyses will not be used to confirm or modify the visual-manual classifications.

The field geologist will subdivide materials into stratigraphic units of practical thickness based on significant lithologic changes, measure depth intervals to the nearest 0.1 foot, and record the readings on the boring log. Very thin intervals may be described as lenses, laminae, or beds within a larger stratigraphic unit, with the depth intervals noted.

Field soil classifications will be based on estimated grain-size distribution in reference to ASTM flow charts for identifying fine-grained and coarse-grained soils. The order of descriptive terminology on the boring log generally will follow the USACE Standard Nomenclature for Description of Soils. The order is as follows:

1. USCS Classification -- determined from flow charts in ***ASTM D 2488***, e.g. silty sand (SM), lean clay (CL), etc.,
2. Density -- for dominantly coarse-grained materials (silt, sand, gravel), based on blow counts in Standard Penetration Tests (SPTs) in ***ASTM D 1586*** (see table below), or
3. Consistency -- for dominantly fine-grained materials, based on blow counts in SPTs in ***ASTM D 1586*** (see table below),

4. Plasticity -- described as non-plastic, low, medium, or high, based on field test described in ***ASTM D 2488***,
5. Cementation -- described as high, moderate, or weak, according to field test in ASTM D 2488,
6. Moisture -- generally described as dry, moist, wet, or saturated.
7. Color -- for moist samples, determined by visual description such as brown, gray, olive, etc.,
8. Grain Size -- estimated percentages of grain size categories, e.g. 10% silt, 50% fine sand, 40% medium sand,
9. Grain Shape -- for coarse-grained materials, generally described as angular, subangular, subrounded, or rounded,
10. Other features -- includes any other notable identifying characteristics, such as fractures, structures, bedding, fossil content, nature of contents with overlying or underlying strata, etc., and
11. Depositional Type -- e.g., alluvium, outwash, till, etc., if it can be determined.

Rock materials shall be described in the sequence outlined below and in accordance with ***ASTM C 294*** and other standard geologic nomenclature including:

- Rock type,
- Relative hardness,
- Density,
- Texture,
- Color,
- Weathering,
- Bedding,
- Fractures, joints, bedding planes, and cavities, including any filling material and whether open or closed,
- Rock Quality Designation (RQD), and
- Other descriptive features (fossils, pits, crystals, etc.).

If standard penetration tests are performed, the blow counts from each 0.5-foot interval will be recorded in column g and will be used to determine the density/consistency of the soil in that interval. The N value (see table) will be entered in column h. The following table permits adjustment for different split-spoon samplers:

Standard Penetration Test (SPT)

Standard Penetration Tests are made by driving a standard split-spoon sampler with a 140-pound hammer falling 30 inches and counting the number of blows required to advance the sampler a distance of 12 inches (blows per foot). The N value is the sum of the blow counts for the second and third 0.5-foot intervals.

Density (Sand and Gravel)		
Spoon Diameter (O.D.) -- Inches		
Description	**2.0**	**2.5**
Very Loose	0-4	0-7
Loose	4-10	7-18
Medium Dense	10-30	18-51
Dense	30-50	51-86
Very Dense	>50	>86

Consistency (Silt and Clay)		
Spoon Diameter (O.D.) -- Inches		
Description	**2.0**	**3.0**
Very Soft	0-2	0-2
Soft	2-4	2-4
Medium Stiff	4-8	4-9
Stiff	8-15	9-18
Very Stiff	15-30	18-42
Hard	>30	>42

A6

BORING LOG COMPLETION

Equipment Needs

HTW Drilling Log Forms
Indelible Pens
Straight Edge
Non-metallic Tape Measure
Copies of other applicable SOPs and/or ASTMs

Procedures

Logs will be prepared on the HTW Drilling Log form that accompanies this SOP. Examples of a completed form and blank form are provided at the end of this SOP. Logs will be prepared in the field by a qualified, experienced geologist or geotechnical engineer as borings are drilled. Each log will be signed by the preparer.

All log entries will be printed. Photo reproductions will be clear and legible. Illegible or incomplete logs are not acceptable. Survey coordinates will be completed at a later date and will be included on the final computer-drafted copies of the boring log. One legible copy of each field log will be completed and sent/mailed with Daily Quality Control Reports (DQCRs) on a weekly basis.

Borehole depths and sample intervals will be measured to 0.1 foot.

All relevant information blanks in the log heading and log body will be completed. If surveyed horizontal control is not available at the time of drilling, location sketches, referenced by measured distances from prominent surface features, will be shown on the first page of the log.

Logs will identify the depth at which water is first encountered and the depth to water prior to installing the monitoring well or grouting the boring. The absence of water in borings also shall be indicated. The time between encountering the groundwater and the last measurement of the depth to groundwater will be noted on the log

Column b
Log scale will be 1 inch = 1 foot unless otherwise specified in the site-specific addendum.

Column c

Every material type encountered will be described in column "c" of the log form. Unconsolidated materials will be as described in SOP A5.

Stratigraphic/lithologic changes will be identified in column "c" by a solid horizontal line at the appropriate scale depth on the log that corresponds to the measured borehole depths at which changes occur. Stratigraphic/lithologic changes will be measured to the nearest 0.1 foot. Gradational transitions will be identified by a horizontal dashed line at the appropriate scale depth based on the best judgment of the logger. All lines will be drawn with a straight edge, not free hand.

Column d

If air monitoring is required by the Site Safety and Health Plan, the calibration information for the monitoring equipment will be written at the top of the column on the first page, along with the background level in appropriate units. For each sample interval, the breathing zone reading in appropriate units will be provided in column "d".

Columns e and f

Logs will clearly show, in columns "e" and "f", the depth intervals from which all samples for off-site analysis were obtained, including depth intervals for duplicate samples. Soil sampling intervals will be shown in column "e", including depths from which attempts were made and length of sample recovered from each attempt.

Column g

The blow counts for each 0.5-foot interval will be recorded at the appropriate depth in column "g". A line drawn with a straight edge will extend across column "g" to indicate each 0.5-foot interval.

Column h

Soil sample information with the split-spoon samplers will be recorded in column "h" and will include the following:

1. N value -- the sum of the blow counts from the second and third half-foot intervals in column "g",
2. Recovery -- in feet, and
3. Time of sample collection.

Soil sample information with the continuous soil core barrel will be recorded in consecutively numbered runs in column "h" and will include the following:

1. Start and stop time of each sample run,
2. Depth to top and bottom of each sample run,
3. Length of sample recovered from each run, and
4. Measured depth to the bottom of the hole after sample is removed from each run.

Logs will include all other information relevant to a particular investigation in column "h", including but not limited to:

1. Odors,
2. Staining,
3. Drilling difficulties and how resolved,
4. Monitoring equipment measurements or other field screening or test results, if required, and
5. Any other observations.

Logs will show the total depth of penetration and sampling. The bottom of the hole will be clearly identified on the log with a continuous double line across the width of the log and with the notation "Bottom of Hole = xxx feet".

Logs will identify any intervals of hole instability, and will show depths and types of any temporary casing used. Any drilling or sampling problems will be recorded on logs, including descriptions of problem resolution.

Boring logs will be included as appendices to the Project Report and will be computer generated.

A7

INVESTIGATIVE DERIVED WASTE PROCEDURES

Equipment Needs

Plastic Garbage Bags
55-gallon drums
Copies of other applicable SOPs and/or ASTMs

Procedures

Rock/Soils

All excess surface and subsurface rock and soils obtained for samples and/or logging will be disposed by spreading on the ground surface adjacent to the sampling location. Composite samples will be spread on the ground surface in the general area of the grab sample locations.

Sediments

All excess sediments will be disposed by spreading on the stream bank adjacent to the sampling location.

Surface Water

All excess surface water will be gently poured back into the stream at the sampling location.

Groundwater

Groundwater from well development and/or purging will be disposed of based upon pH. Groundwater with a pH of 5.0 to 9.0 will be disposed to the ground surface approximately 20 feet away from the monitoring well. Groundwater with high or low pH will be containerized in 55-gallon drums and permitted to evaporate if possible. If evaporation does not occur due to unsuitable weather conditions, analytical results will be used to develop an IDW Disposal Plan.

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A12

EQUIPMENT DECONTAMINATION PROCEDURES

Equipment Needs

Plastic sheeting
Wash and rinse tubs/troughs
Liquinox®
Tap water
Deionized water
Scrub brushes
Paper towels
Squirt bottles
Disposable nitrile gloves/Disposal latex gloves
Copies of other applicable SOPs and/or ASTMs

Disposable equipment will be used whenever available to minimize the need for equipment decontamination.

Procedures for Drilling Equipment

Prior to arrival on-site, all drilling equipment will be steam-cleaned. The drill rig and all support equipment will be free from grease, oils, or caked-on soils from previous work. Equipment which leaks fuel, coolant, or lubricants will be removed from the site and repaired prior to use. Decontaminated drilling equipment (excluding the drill rig) not immediately utilized will be placed on plastic sheeting. Decontamination activities will be performed at a convenient location at least 20 feet downwind from any soil sampling locations. Drilling equipment will be decontaminated before any drilling begins at the site, between each hole, and upon completion of sampling at the site.

Procedures for Surface/Subsurface Soil Sampling Equipment

Split spoon sampling equipment, soil core barrels, shallow hand soil augers, and other hand sampling and mixing equipment will be decontaminated between sample locations and sample intervals using the following procedure:

1. Remove all soil and solids from sampling equipment and spread on the ground surface,
2. Scrub all sampling equipment with a Liquinox® and tap water wash,
3. Rinse equipment in tap water, and
4. Double rinse equipment with deionized or distilled water, as indicated in the SSA.

Deionized or distilled water will be stored in labeled plastic pump sprayers.

Decontaminated equipment will be kept on plastic sheeting until required for the next sampling event. If equipment is to be stored or transported, it will be wrapped completely with aluminum foil, shiny side out, to prevent contamination. No rinseate samples will be collected or analyzed for soil sampling devices.

Equipment cleaning will take place in an area away from sampling locations. Personnel will wear latex or nitrile gloves during all decontamination procedures.

Procedures for Well Development and Water Sampling Equipment

The pump used for well development will be disassembled prior to decontamination. All parts of the pumps that were in contact with the groundwater, which have the potential to contact groundwater, which entered the well casing, or which have the potential to enter the well casing will be thoroughly decontaminated prior to development of the well (if not previously completed) and following the development of the well.

The decontamination of the development pump will consist of the following procedures:

1. Disassemble all parts of each pump which must be decontaminated,
2. Scrub all the parts of the equipment with a Liquinox® and tap water wash,
3. Rinse equipment in tap water, and
4. Double rinse equipment with deionized water.

Deionized water will be stored in labeled plastic pump sprayers.

Decontaminated equipment will be kept on plastic sheeting until required for the next sampling event.

Equipment cleaning will take place in an area away from sampling locations. Personnel will wear latex or nitrile gloves during all decontamination procedures.

Water level measuring equipment and other appropriate items will be decontaminated using the same procedure.

Investigative Derived Waste (IDW)

All investigative derived waste will be handled in accordance with ***SOP A7***.

A13

SAMPLE HANDLING, DOCUMENTATION, AND TRACKING PROCEDURES

Equipment Needs

Chain of Custody forms
Field Log Book
Ice
Coolers
Shipping Peanuts
Bubble Wrap
Strapping Tape, 1 inch
Custody seals
Address labels
Environmental Sample jar labels
"Fragile" labels
"This Side Up" labels
Federal Express forms
Zipper-lock bags of appropriate sizes
Clear tape, 2 inch
Indelible pens
Copies of other applicable SOPs and/or ASTMs

Sample Labels

Sample labels will be prepared prior to initiation of field work. The labels will be affixed to the sample bottle in the field and covered with clear tape after entering information on the label. Information written on the labels prior to arrival in the field will include:

- Name of the collector,
- Laboratory LIMS number,
- Place of collection (site name, location number),
- Sample ID number, which includes location, depth, matrix
- Analysis required
- Preservatives added (if any)

The date, time, and sampler's name will be added in the field during sample collection. Additionally, any additions to the sample ID number (e.g., the sample depth) will be made.

Sample ID Scheme

Samples will be uniquely identified using the following system:

UU-VVVV-XXXX-YY-ZZ

where:

UU = Project Designation/Name

VVVV = Designation of Sampling Area Location.

XXXX = 4 Character Designation for Sample Type/Location, where the first two X-characters indicate sample type:

MW = Monitoring Well
SB = Soil Boring
SD = Sediment
SS = Surface Sample
SW = Surface Water
TB = Trip Blank
WB = Water Blank

the next two X-characters, 01 through 99, further define the sample location based on the boring or sampling site number.

Trip blanks will be marked with a monitoring well (MW) or surface water (SW) designation to prevent preferential treatment by the laboratory.

YY = 2 Character Designation for Sample Depth, using the bottom depth of the soil sample interval, such as using -04, for the 2 to 4-foot interval.

Water samples (MW, TB, WB, and SW) will not require a YY designation.

ZZ = 2 Character Designation for Samples, where:

01 = Normal Field Sample
02 = QC Duplicate
03 = Trip Blank
04 = Confirmation Sample
05 = Water Supply Blank

Packaging Requirements

All samples will be shipped as low concentration samples. All samples will be prepared as follows:

1. On the previously-completed adhesive sample label complete the date, time, and sampler's name, attach the label to the sample container, and cover the label with 2" clear tape.
2. Place sample container in an appropriately-sized zipper-lock bag and seal. Place the sample container in a second appropriately-sized zipper-lock bag and seal.
3. Temporarily place samples in an iced cooler until samples can be prepared for shipment. Samples will be kept at a temperature of 4°C or less in this cooler or a refrigerator, if held overnight.
4. Select an appropriately-sized cooler, tape the drain plugs on the outside with duct tape,
5. Wrap the glass sample bottles with bubble wrap.
6. Place the sample bottles in the cooler.
7. Put packaging material under and around the samples to minimize the possibility of breakage.
8. Place a completed Chain-of-Custody Form (white and yellow copies) listing the contents of the cooler in a zipperlock-type bag and tape it to the underside of the cooler lid.
9. Place double-bagged zipperlock-type ice packs on top and around the samples. A sufficient amount of ice needs to be used to maintain a 4°C sample temperature.
10. Close the cooler and tape shut with strapping tape in at least two locations.
11. Place completed Chain-of-Custody seals whose serial numbers were recorded on the Chain-of-Custody Form in the cooler at the side of the left back and front right of cooler so the seals will break if the cooler is opened. Cover the seals with clear tape.
12. The sides of the cooler must be marked with "This End Up" labels, and arrows should be drawn accordingly. "Fragile" labels are needed on the cooler lid if glass bottles/jars are contained in the cooler.
13. Weigh the cooler. Weight should not exceed 75 pounds.

Chain-of-Custody

Each cooler will have a chain-of-custody form for the samples contained in that cooler. Examples of these forms are included at the end of this SOP. These forms will be placed in a plastic zipperlock-type plastic bag and taped to the inside of the lid. The lab will complete the Chain-of-Custody form upon sample log-in.

Sample Shipment

All samples will be shipped by overnight delivery to the appropriate laboratory within 24 hours of collection of the samples, if possible.

The laboratory will be notified by the USACE Project Chemist or Project Manager approximately one week prior to the arrival of the first sample shipment. Thereafter, field personnel will call the laboratories on the day of sample shipment to tell them the number of coolers/samples being shipped. Field personnel will confirm that all samples shipped from the field were received by the lab within the expected time frame. Saturday sample arrival will be cleared with the laboratory in advance. The samples will be sent via overnight delivery to:

U.S. Army Corps of Engineers
Environmental Chemistry Branch Laboratory
ATTN: CEWES-EE-Q (Sample Custodian)
420 South 18th Street
Omaha, NE 68102-2501

Point of Contact at the lab is Laura Percifield at (402) 444-4314.

USACE Chemical Quality Data Management

QC (Quality Control) samples consist of duplicates of field samples and help the laboratory identify and diagnose problems related to sampling and analysis.

The Project ID "LIMS # " will be added to the labels and chain-of-custody records for all QC samples shipped to the laboratory throughout the duration of this project.

QC Laboratory Turnaround Time

The laboratory will provide a maximum turnaround time of 30 days (from receipt of the samples) on all laboratory analyses of QC samples.

Quality Control Review

If it can be demonstrated that chemical quality control contract requirements were not met by the laboratory at any time during this project, the Project Manager will direct the laboratory to take appropriate corrective action(s). The procedures to be performed by the USACE during the ongoing USACE Quality Assurance review process include inspection of the QC samples and data comparison, as described below.

Inspection of QC Samples

The laboratory will inspect QC samples to ensure that sampling and shipping procedures correspond to the work plans with regard to sample containers, preservation, labeling, chain of custody, etc.

Data Comparison

The USACE will analyze all QC samples and compare analytical results obtained with those obtained by the USACE laboratory from original samples.

A14

FIELD DOCUMENTATION

Several types of documentation will be prepared in the field to record information concerning soil borings, well installation and sampling related activities. These will include field log books, daily quality control reports, instrument calibration forms, and those forms presented in previous SOPs.

Boring Logs

A complete and accurate log entry for each soil boring will be prepared and entered onto a separate boring log. These boring logs will be considered the primary location to record all information obtained during drilling. Each log will include the name of the project, hole number, location of boring, type of sampling device, diameter of boring, location and number of each sample, types of sampling equipment, ground-water information, and description of materials. Sediment samples will be entered in the field log book at each site in lieu of a separate boring log. Soil materials will be visually classified using the USCS. Soil descriptions will follow ***ASTM D 2488***, etc. Descriptions will be based on visual inspection of the material in the field (refer to ***SOP A5***). In addition, well construction diagrams and borehole abandonment forms will be prepared and submitted for soil borings and monitoring wells. Examples of these forms are provided in ***SOP A8***.

Field Log Book

Field observations and readings will be recorded by the field geologist in a bound notebook with pre-numbered pages. This will be done so that the logic of decisions may be traced, or data comparisons may be accomplished once off-site analytical results become available. In addition, the log book is the legal document for field activities. Indelible ink will be used for all entries. Each page must be signed and dated by the preparer. A brief listing of pertinent data to be recorded in the field notebook includes, but is not limited to the following:

1. Date/time,
2. Sample location,
3. Weather information,
4. Instrument calibration data,
5. Brief descriptions of sample matrices, including any observations,
6. The number of samples obtained, ID numbers, number and type of containers used, preservation methods used, sampler's name and initials, and
7. Comments, remarks about field activities.

Field/Well Surveying

After soil sampling activities, the location of the boring will be surveyed and marked by the installation of a wooden stake. Soil sample locations will be surveyed to the nearest 0.1 foot. The elevations of soil borings will not be determined. This information will be noted in the Field Log Book and other appropriate forms. The locations of the soil borings will be presented in tabular form, and will be shown on a drawing in draft and final reports.

Following well installation, each well location, as well as ground surface and top of pipe elevation, will be surveyed and referenced to the 1983 National Geodetic Vertical Datum (NGVD). The survey point on the top of the riser will be marked by cutting notches into the riser on both sides of the survey point. Monitoring wells will be surveyed to the nearest 0.01 foot for top of casing adjusted elevations, and the locations of the wells will be determined to the nearest 0.1 foot. Water elevations will be adjusted from top of casing elevation minus depth to water. These data and other well information will be noted in the field log book (refer to ***SOP A8***).

Surveying notes will be sent to the Project Manager and the Project Geologist at the completion of the project.

Daily Quality Control Reports

During the field investigation, each field team will be responsible for completing a Daily Quality Control Report (DQCR). This report will include a description of any problems encountered and any corrective actions taken. These reports also will include information about personnel and equipment at the site, work performed (including samples obtained), weather conditions, safety levels and equipment, and quality control activities. An example of a Daily Quality Control Report form is provided at the end of this SOP. These reports will be compiled and sent to the Project Geologist on a daily basis. If problems arise, the Field Team Leader will immediately notify the Project Geologist. Each day, all personnel at the site, plus any visitors to the site, will be listed on the DQCR.

Instrument Calibration

Field instruments will be calibrated on a daily basis according to the manufacturers instructions, as stated in the work plan. Calibration documentation will be completed in the field log book.