3R – 448

2008 GW WP

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Prepared for:
Brandon Powell
New Mexico Oil Conservation Division
1000 Rio Brazos Road
Aztec, New Mexico 87410

Prepared on behalf of:
Benson-Montin-Greer Drilling Corporation
4900 College Blvd.
Farmington, New Mexico 87402

SAMPLING AND ANALYSIS PLAN
Highway 537 Llaves Oil Pipeline Spill

Benson Montin Greer
NW¼ NE¼ of Section 18, T25N, R3W
Los Ojitos Canyon, Rio Arriba County,
New Mexico

Date of Spill Discovery: December 31, 2007
Date of Plan: January 23, 2008

Prepared by:
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Appendices

1.0 Introduction

Animas Environmental Services, LLC (AES), on behalf of Benson Montin Greer Drilling Corporation (BMG), submits this Sampling and Analysis Plan (SAP) for BMG's Highway 537 Llaves Pipeline oil spill, which was discovered on December 31, 2007.

2.0 Site Information

2.1 Site Location

The Llaves Pipeline is a 4-inch diameter pipeline that carries crude oil and is located in the southeast portion of the San Juan Basin, Rio Arriba County, New Mexico. Surface ownership in the area where the spill occurred includes private land owned by the Schmitz Ranch. The pipeline transects several small, unnamed tributaries (in the area where the spill occurred) that drain to the Los Ojitos Arroyo and eventually to Largo Canyon.

The spill began on the Schmitz Ranch, on the south side of Highway 537, within the NW ¼ NE ¼ of Section 18, T25N, R3W (latitude and longitude recorded as N36° 24' 214" and W107° 11' 053") and flowed south and southwest through a small unnamed arroyo for a distance of approximately 920 linear feet. The location of the spill is shown on Figure 1.

2.2 Spill History

On December 31, 2007, a Western Refining truck driver discovered the Llaves pipeline leak and immediately contacted BMG. BMG personnel arrived on-site at about 1630 on the same day and confirmed the leak. BMG shut down the Llaves pipeline pumps and also closed a block valve located about one mile upstream. BMG personnel also constructed a small earthen dam across the arroyo to prevent any further surface migration of the oil. Due to the cold ambient temperature, the oil quickly became thick and waxy upon reaching the surface. On January 1, 2008, BMG left Mr. Brandon Powell, New Mexico Oil Conservation Division (NMOCD), a voice mail regarding notification of the spill and BMG's intended remedial response. Also on January 1, 2008, BMG contracted with TNT Excavating to remove the oil that had pooled along the surface of the small arroyo. Approximately 40 barrels (bbls) of oil were recovered.

On January 8, 2008, TNT Excavating uncovered the Llaves pipeline to allow the failed section to be observed and repaired. On January 9, 2008, the pipeline was repaired, and AES inspected the site as part of preparation of the Sampling and Analysis Plan. The Llaves pipeline has not yet been returned to service.

BMG notified the National Response Center of the spill on January 23, 2008. The report was given an identification number of 860429.

3.0 Regional and Local Geology and Hydrogeology

3.1 Geology

Rio Arriba County, New Mexico, is located along the southeastern margin of the San Juan Basin portion of the Colorado Plateau physiographic province. The San Juan Basin is a large, structural depression encompassing approximately 22,000 square miles and contains deep Tertiary fill resting on rocks of Late Cretaceous age. The lithography consists primarily of the Mesa Verde Formation, composed primarily of sandstones. The topography is broad and mostly flat, surrounded by mountains and deep canyons. Major rivers carved deep canyons and mesas, and physical erosion from wind and water chipped and polished the exposed rocks in the canyons.

The regional geology of the Los Ojitos Canyon area is predominately Late Cretaceous coastal plains and shoreline and marine units that were deposited along the western margin of the interior seaway. The shallow inland sea transgressed and regressed over a period of 250 million years, depositing the Dakota Sandstone and Mancos Shale units. The Dakota Sandstone records the alternating rise (shale) and fall (sandstones) of sea level as the shoreline moved back and forth across the area about 98 to 100 million years ago. The long-term rise in sea level deposited rocks of the Mancos Group, which from oldest to youngest, include the Graneros Shale, Greenhorn Limestone, and Carlile Shale. Gradually the sea level dropped again, and the shoreline retreated to the northeast, as deposition of the Mesaverde Group began. The Mesaverde Group consists of alternating sandstones, siltstones, and coal deposited by rivers flowing into the shallow sea.

3.2 Hydrogeology

The Llaves pipeline transects several unnamed washes that lead to the Los Ojitos Canyon Arroyo, which drains southwest to Largo Canyon and ultimately to the San Juan River.

Locally, shallow groundwater is encountered within the valleys and canyons at depths less than 50 feet and is typically associated with arroyos, which can be incised as much as 20 feet below the valley floor. Based on measurements from nearby wells installed by AES in 2007, groundwater underlying the spill site is expected to be at approximately 40 feet below the ground surface (bgs).

4.0 Proposed Scope of Work

Site investigation activities will be initiated in order to delineate the full extent of petroleum hydrocarbon impacted surface and subsurface soils and groundwater. The investigation procedures are designed to be protective of both surface water and groundwater and are based upon protocols outlined in the USEPA documents, *Expedited Site Assessment Tools for Underground Storage Tank Sites*, March, 1997, and *Site Characterization for Subsurface Remediation*, November, 1991.

4.1 Access Agreements

Prior to initiating the field work, AES will obtain a written property access agreement from the Schmitz Ranch.

4.2 *Archaeological Clearances*

In the event that any evidence of human remains or burials is encountered, all work will be ceased immediately, and the State Historic Preservation Office (SHPO) will be contacted. Under Federal and Tribal law, mitigative action will be required before any site investigation activities can be continued.

4.3 *U.S. Army Corps of Engineers Permit*

Prior to initiating the site investigation, AES will consult with the U.S. Army Corps of Engineers (USACE) to obtain, if necessary, a Nation Wide 404 permit.

4.4 *Utilities Notification*

AES will utilize the New Mexico One-Call system to identify and mark all underground utilities at the site before the start of any proposed field activities which could impact buried utilities. Any local utilities not participating in the New Mexico One-Call system will be contacted separately by AES for utility locations.

4.5 *Health and Safety Plan*

AES has a Health and Safety Program in place to ensure the health and safety of all AES employees. The Health and Safety Program defines safety practices and procedures to be instituted in all AES work places, as applicable. The program meets the requirements promulgated by the Occupational Safety and Health Act (OSHA). All AES personnel are appropriately trained in accordance with OSHA 40 CFR 1910.120.

A comprehensive site-specific Health and Safety Plan (HASP) addressing the site investigation and associated sampling will be prepared prior to the start of the field work. An example of the plan that will be utilized for the project is included in Appendix A.

All employees and subcontractors will be required to read and sign the HASP to acknowledge their understanding of the information contained within it. The HASP will be implemented and enforced on site by the assigned Site Safety and Health Officer. Daily tailgate meetings will be held and documented during field activities and will address specific health and safety concerns or issues.

4.6 *Installation of Soil Borings*

AES proposes to install 10 soil borings, of which six will be completed as groundwater monitoring wells, along the route of the spill in order to define the lateral and vertical extent of near surface and subsurface soil contamination. The locations of the soil borings and monitoring wells are shown on Figure 2.

4.6.1 Soil Borings

Soil borings will be advanced with a DT 6620 track-mounted direct push rig, manufactured by Geoprobe®, and equipped with a 2-inch outer diameter (OD) core barrel. Direct push drilling will be provided by Earth Worx, Los Lunas, New Mexico.

4.7 Soil Sampling and Analyses

4.7.1 Soil Sample Collection

Borings to be completed as monitoring wells, near the spill release point, will be advanced to approximately 50 feet below ground surface (bgs), where it is anticipated that groundwater will be encountered at approximately 40 feet bgs. Borings located within the small arroyo will most likely be advanced to 10 to 15 feet below the arroyo base, assuming that the full vertical extent of contaminated soil has been defined.

Each boring will be logged for lithology and sampled continuously for field screening of volatile organic compounds (VOCs) with a photo-ionization detector (PID) organic vapor meter (OVM). A minimum of three soil samples will be collected from each of the deep borings for laboratory analysis; one sample from the surface; one from the depth at which the highest vapor reading was recorded, and one sample from the capillary fringe just above groundwater. A minimum of three soil samples will also be collected from each of the shallow borings for laboratory analysis; one sample from the surface; one from the depth at which the highest vapor reading was recorded, and one sample from the terminal depth or just above groundwater, whichever is first encountered.

For each soil boring, a Soil Boring Log will be completed. These logs will record sample identification, depth collected, and method of collection, as well as observations of soil moisture, color, density, grain size, plasticity, contaminant presence, and overall stratigraphy. An example of the log which will be used is included in Appendix B.

Soil samples will be collected from continuously driven core-barrel samplers during advancement of the soil borings. Discrete samples will be collected based on PID-OVM screening measurements from the core barrel sampler and transferred to appropriately labeled sample containers. Soil sample collection will be completed in strict accordance with the USEPA Environmental Response Team's Standard Operating Procedures (SOPs), which are included in Appendix C.

4.7.2 Field Screening

Samples will be collected at approximate 4-foot intervals from each soil sampling location and field screened for volatile organic vapors utilizing a PID-OVM calibrated with isobutylene gas to obtain preliminary data regarding potential petroleum hydrocarbon-impacted soil.

Once collected, the soil sample to be field screened will be immediately placed in a clean 16 ounce glass jar, filled approximately half full, and sealed with a threaded ring lid and a sheet of aluminum foil. The sample jar will then be placed in a warm water bath where it will be warmed to approximately 80°F. Approximately ten minutes will be allowed for the soil to be heated and for any VOCs in the soil to accumulate in the head space of the jar. During the initial stages of headspace development, the sample will be gently shaken for one minute to promote vapor development and disaggregate the sample. Volatile gases will then be measured by piercing the aluminum foil with the sample probe of the PID-OVM. The highest (peak) measurement will be recorded. PID-OVM readings will be recorded onto the Soil Boring Logs. All field screening will be completed in strict accordance with the USEPA Environmental Response Team's SOP, which is included in Appendix C.

The action level for PID-OVM readings will be considered to be any reading that is above a non-detectable concentration. The extent of soil contamination will continue to be defined in either a vertical and/or horizontal direction until non-detectable field screening concentrations are reached.

4.7.3 Laboratory Analyses - Soil

Analytical samples collected from soil borings will be submitted to an EPA-approved laboratory, Hall Environmental Analysis Laboratory, Albuquerque, New Mexico, or one of its subcontractors for analysis of the following parameters:

Table 1. Soil Analytical Parameters

Soil Boring	***Parameter***	***Analytical Method***	***Analyzing Laboratory***
All Soil Borings	BTEX	EPA Method 8021	Hall Environmental Analysis Laboratory 4901 Hawkins NE, Suite D Albuquerque, NM (505) 345-3975
All Soil Borings	Total Petroleum Hydrocarbons (TPH) (C_6-C_{36})	EPA Method 8015 Modified	Hall Environmental Analysis Laboratory 4901 Hawkins NE, Suite D Albuquerque, NM (505) 345-3975

As described above, three discrete soil samples from each boring will be submitted for laboratory analyses. Additional soil samples will be collected and submitted for laboratory analyses if warranted by field observation. Therefore, based on 10 proposed soil borings, a minimum of 30 soil samples will be submitted for laboratory analyses.

Once collected, sample containers will be packed with ice in insulated coolers and shipped via UPS or Greyhound Bus to the analyzing laboratory. Typical laboratory regular turn around time is 12 to 15 business days.

For all laboratory samples, quality assurance and quality control (QA/QC) procedures, sample preservation, apparatus required, and analyses performed will be in accordance with USEPA Document EPA-600, "Methods for Chemical Analysis for Water and Wastes" dated July 1982; and USEPA document SW-846, 3rd Edition, "Test Methods for Evaluating Solid Waste: Physical Chemical Methods", dated November, 1986.

4.8 Groundwater Monitor Well Installation

4.8.1 Groundwater Monitor Well Installation and Construction

Groundwater monitoring wells may be installed within six of the 10 soil borings. Monitoring well construction will consist of 1.4-inch outside diameter (OD) [0.75-inch inside diameter (ID)] Schedule 40 PVC screen and 1.0-inch blank riser casing. The screened interval will extend 15 feet across the water table. The wells will be constructed of a 1.4-inch OD (0.75-inch ID) pre-packed screen (0.010-inch slot). The screen is factory packed with 20/40 Colorado silica sand. A bentonite seal will be placed above the sand pack, and concrete grout with approximately five percent bentonite will be poured from the top of the bentonite plug up to within a foot of ground surface. An above grade locking steel protective casing, enclosed with a shroud of concrete, will be installed on the well to prevent unauthorized access and damage from runoff and debris within the wash. A proposed monitoring well construction schematic is included on Figure 2. Monitoring wells will be installed in strict accordance with the USEPA Environmental Response Team's SOP, which is included in Appendix C.

4.8.2 Groundwater Monitor Well Development

Following monitor well installation and completion, each well will be developed by a combination of surging and bailing techniques. It is estimated that approximately 2 gallons of water will be generated during development of the 1-inch diameter shallow groundwater monitor wells. Groundwater purged from the wells will be contained in labeled and sealed 55-gallon drums. Development water will remain on-site in a secure location until proper disposal. Monitoring wells will be developed in strict accordance with the USEPA Environmental Response Team's SOP, which is included in Appendix C.

4.8.3 Groundwater Monitor Well Monitoring and Sampling

Upon completion and development, the monitor wells will be allowed to sit undisturbed for a minimum of one week. The groundwater monitor wells will then be gauged to determine water table elevation and direction of groundwater flow. The wells will then be purged of a minimum of three well volumes, and a groundwater sample will be collected from each well.

Groundwater samples will be collected from each well with a new disposable bailer equipped with a low-flow release valve. Purging data, including pH, temperature, conductivity, oxidation-reduction potential, and dissolved oxygen, will be measured with a YSI water quality meter and documented on a Water Sample Collection Form along with purged water volume. All sampling and purging equipment will be thoroughly decontaminated between uses. An example of the Water Sample Collection Form which will be used is included in Appendix B.

Duplicate groundwater samples will be collected from each monitoring well and held in the event that further laboratory analyses are required. All sample collection data, including sample collection depth, will be documented on a Water Sample Collection Form. A Chain of Custody Record will be completed in the field as samples are being collected. Samples will be stored in a chilled, insulated cooler at 6°C until delivered to the analyzing laboratory.

Groundwater monitoring, well installation, well development, and sampling will be completed in strict accordance with the USEPA Environmental Response Team's SOPs, which are included in Appendix C.

4.8.4 Professional Survey

The location and elevation of the top of each well casing will be surveyed to the nearest 0.01 foot with reference to mean sea level by a licensed surveyor in order to accurately determine the local groundwater depth and flow direction beneath the site. Each well will be tied to an existing USGS benchmark. AES will arrange with a New Mexico Licensed Professional Surveyor to complete the survey upon completion of the monitoring well installation.

4.8.5 Laboratory Analyses - Groundwater

All groundwater analytical samples collected from the monitoring wells will be submitted to an EPA-approved laboratory, Hall Environmental Analysis Laboratory, Albuquerque, New Mexico, or one of its subcontractors for analysis of the following parameters:

Table 2. Groundwater Analytical Parameters

Water Sample Location	***Parameter***	***Analytical Method***	***Analyzing Laboratory***
All Monitoring Wells	BTEX	EPA Method 8021	Hall Environmental Analysis Laboratory 4901 Hawkins NE, Suite D Albuquerque, NM (505) 345-3975
All Monitoring Wells	Total Petroleum Hydrocarbons (TPH) (C6-C36)	EPA Method 8015 Modified	Hall Environmental Analysis Laboratory 4901 Hawkins NE, Suite D Albuquerque, NM (505) 345-3975

A travel blank and field blank will be analyzed for BTEX per EPA Method 8021. Once collected, sample containers will be packed with ice in insulated coolers and shipped via UPS or Greyhound Bus to the laboratory. Typical laboratory regular turn around time is 12 to 15 days.

For all laboratory samples, QA/QC procedures, sample preservation, apparatus required, and analyses performed will be per USEPA Document EPA-600, "Methods for Chemical Analysis for Water and Wastes" dated July 1982; and USEPA document SW-846, 3rd Edition, "Test Methods for Evaluating Solid Waste: Physical Chemical Methods", dated November 1986, as amended by Update One, July 1992.

4.9 Equipment Decontamination

In order to prevent cross-contamination between sampling locations, strict decontamination procedures will be employed during the investigation. All direct push equipment will be decontaminated after completing each soil boring, and sampling equipment (i.e. hand auger, spoon sampler, and other hand tools) will be decontaminated following each use at an individual depth or location.

All decontamination of equipment will be completed within 110-gallon plastic tubs, which will contain the effluent. At least two tubs will be used, one designated for direct push core barrels and the other for small sampling equipment. On an as-needed basis, effluent from the tubs will be transferred by small pump or bucket into 55-gallon DOT approved drums, which will then be marked with identification labels and sealed. Decontamination procedures that will be employed are outlined below.

For small equipment such as direct push core barrels, hand augers, hand tools, and spoon samplers:

1. Physical removal of gross contamination and all debris with brushes
2. High pressure wash with non-phosphate detergent
3. Hand wash with non-phosphate detergent and water using brush
4. Rinse with water
5. Second rinse with water
6. Air dry

All decontamination procedures will be completed in strict accordance with the USEPA Environmental Response Team's SOPs, which are included in Appendix C.

4.10 Investigation Derived Waste

4.10.1 Investigation Derived Waste - Soil

Contaminated soils will be managed in accordance with applicable State and Federal regulations. All contaminated drill cuttings will be placed within 55-gallon DOT approved drums, which will then be marked with identification and sealed. These soils will then be disposed of at the TNT Landfarm, an NMOCD approved facility. Disposal manifests will be included within the assessment report.

4.10.2 Investigation Derived Waste - Groundwater

Contaminated water will be managed in accordance with applicable State and Federal regulations. Groundwater obtained from monitoring well development and pre-sample purging will be stored on-site within 55-gallon DOT approved drums, which will then be marked with identification and sealed. This water will then be disposed of at an evaporation pond at the TNT Landfarm. Disposal manifests will be included within the assessment report.

4.10.3 Investigation Derived Waste – Equipment Decontamination Water

All decontamination and rinse water will be managed in accordance with applicable State and Federal regulations. This water will be stored on-site within 55-gallon DOT approved drums, which will then be marked with identification and sealed. Equipment decontamination water will then be disposed of at an evaporation pond at the TNT Landfarm. Disposal manifests will be included within the assessment report.

4.11 Quality Assurance/Quality Control and Chain of Custody Procedures

4.11.1 Quality Control Samples

Field quality control samples will be collected in order to assess variability of the media being sampled and to detect contamination and sampling error in the field. Field QC samples will include field duplicates, trip blanks and if applicable, equipment rinsate blanks.

- One field duplicate sample will be collected for every ten field samples collected for laboratory analysis in order to check for reproducibility of laboratory and field procedures.

- One trip blank sample will be utilized per sampling event to check for contamination of volatile organic samples during handling and shipment from the field to the analyzing laboratory.

- One equipment rinsate blank will be collected per sampling event to check field decontamination procedures if sampling equipment is decontaminated and reused in the field.

Laboratory QC samples will be analyzed by the laboratory and will consist of matrix spike and matrix spike duplicates for organic samples in order to identify, measure, and control the sources of error that may be introduced from the time of sample bottle preparation through analysis.

4.11.2 Sample Quality Assurance Elements

Sample quality assurance elements will include the following:

1. Sample documentation (location, date and time collected, batch, etc.)
2. Complete chain of custody records
3. Initial and periodic calibration of field equipment
4. Determination and documentation of applicable detection limits
5. Analyte(s) identification
6. Analyte(s) quantification

4.11.3 Chain of Custody Record

A Chain of Custody Record will be maintained from the time of sample collection until final deposition. Every transfer of custody will be noted and signed for, and a copy of the record will be kept by each individual who has signed it. The Chain of Custody Record will include the following information:

1. Sample identification
2. Sample location
3. Sample collection date
4. Sample information, i.e., matrix, number of bottles collected, etc.
5. Names and signatures of samplers
6. Signatures of all individuals who have had custody of the samples

When samples are not under direct control of the individual currently responsible for them, they will be stored in a locked container which has been sealed with a Custody Seal.

4.11.4 Custody Seal

Custody seals demonstrate that a sample container has not been opened or tampered with. The individual who has custody of the samples will sign and date the seal and affix it to the container in such a manner that it cannot be opened without breaking the seal.

5.0 Deliverables

Within 60 days of the completing the SAP, a Site Assessment Report (SAR) summarizing the SAP activities will be submitted to the NMOCD, USEPA, and the Schmitz Ranch. The SAR will include the following:

1. A summary of all work conducted in the implementation of the SAP;
2. Maps of all sampling locations, including soil and groundwater contamination plumes;
3. All laboratory data and quality assurance and quality control information; and
4. Recommendations of further sampling which needs to be conducted as a result of the sampling pursuant to the SAP.
5. Recommendations for further remediation measures

6.0 Post-Removal Controls

Measures for post-removal controls will be determined once the extent of horizontal and vertical contamination has been defined, and the contaminated soils and/or groundwater have been mitigated. Post-removal control measures will fall in accordance with 40 CFR 300.415 and OSWER Directive 9360.2-02 and will be presented in the SAR. Control measures may potentially include:

1. Fences, warning signs, or other security or site control precautions where humans or animals have access to the release;

2. Drainage controls;

3. Stabilization of berms, dikes, or impoundments;

4. Excavation, consolidation, or removal of highly contaminated soils from drainage or other areas, where such actions will reduce the spread of, or direct contact with the contamination

7.0 Implementation Schedule

AES proposes the following timeline to implement SAP activities, once written NMOCD approval has been received. This schedule assumes that no inclement weather occurs which could result in a delay in implementing field activities.

Task	***Days from SAP Approval***
1. Army Corps consultation. Schedule direct push rig for soil borings and monitor well installation; provide notification to NMOCD, USEPA, and Schmitz Ranch of scheduled site activities	10
2. Complete installation of soil borings and groundwater monitor wells; collect and submit soil and groundwater samples for laboratory analysis	30
3. Receive laboratory analytical reports for soil and groundwater samples	45
4. Prepare and submit Site Assessment Report (SAR)	90

8.0 Certification

AES has prepared this Sampling and Analysis Plan on behalf of Benson Montin Greer Drilling Corporation to complete an environmental site assessment associated with the Highway 537 Llaves Oil Pipeline spill, which occurred on December 31, 2007.

Respectfully submitted,

Ross Kennemer
Project Manager

Elizabeth D. McNally

Elizabeth McNally, NM PE #15709
Environmental Engineer

9.0 References

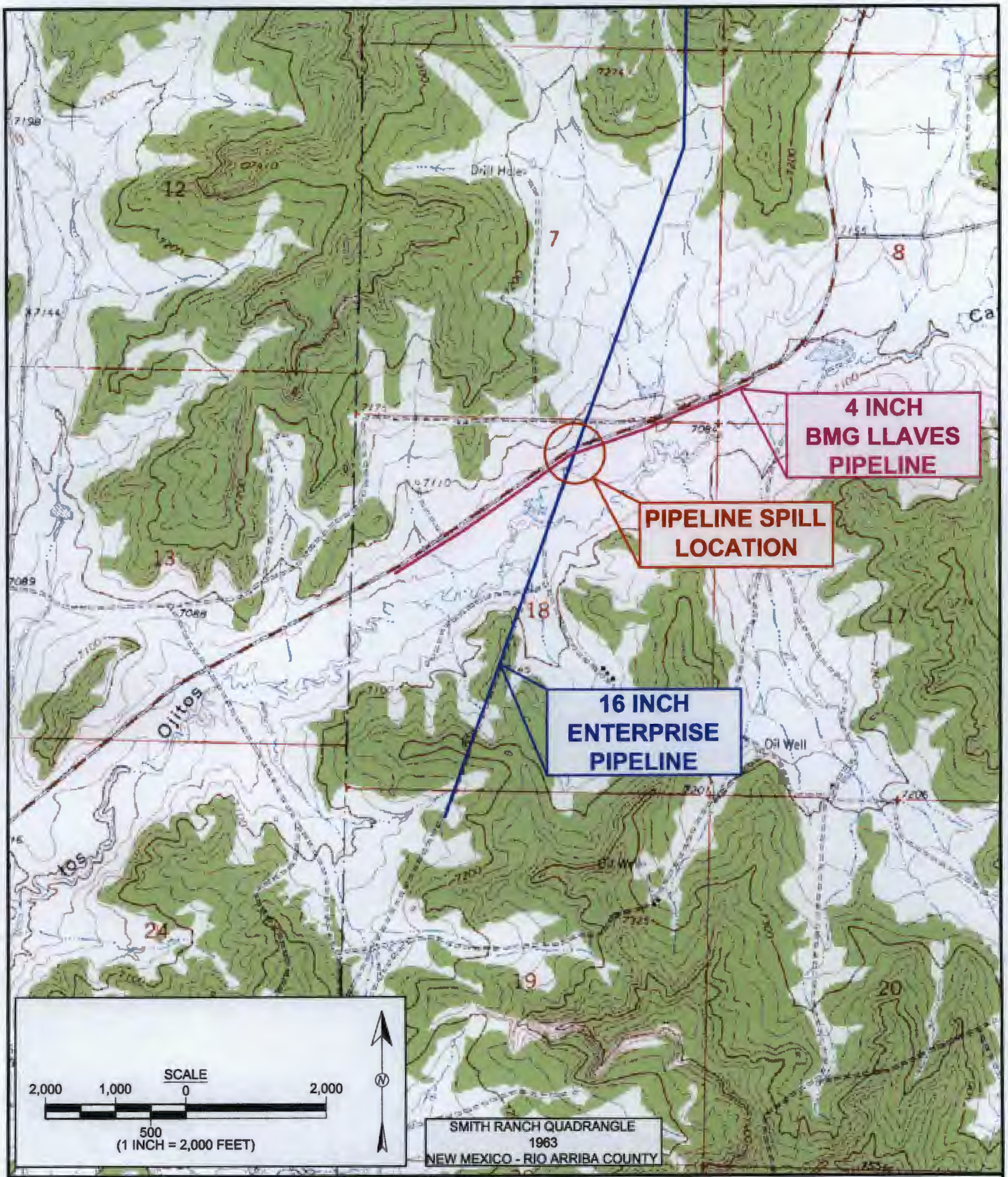
U.S. Environmental Protection Agency (USEPA). 1982. *Methods for Chemical Analysis for Water and Wastes.* Document EPA-600, July, 1982.

USEPA. 1992. SW-846, 3rd Edition, *Test Methods for Evaluating Solid Waste: Physical Chemical Methods*, dated November, 1986, and as amended by Update One, July, 1992.

USEPA. 1991. *Site Characterization for Subsurface Remediation*, EPA 625/4-91-026, November, 1991.

USEPA. 1997. *Expedited Site Assessment Tools for Underground Storage Tank Sites.* OSWER 5403G and EPA 510B-97-001, March, 1997.

USEPA. 2001. Contract Laboratory Program (CLP) Guidance for Field Samplers. OSWER 9240.0-35, EPA 540-R-00-003. June, 2001.



AES

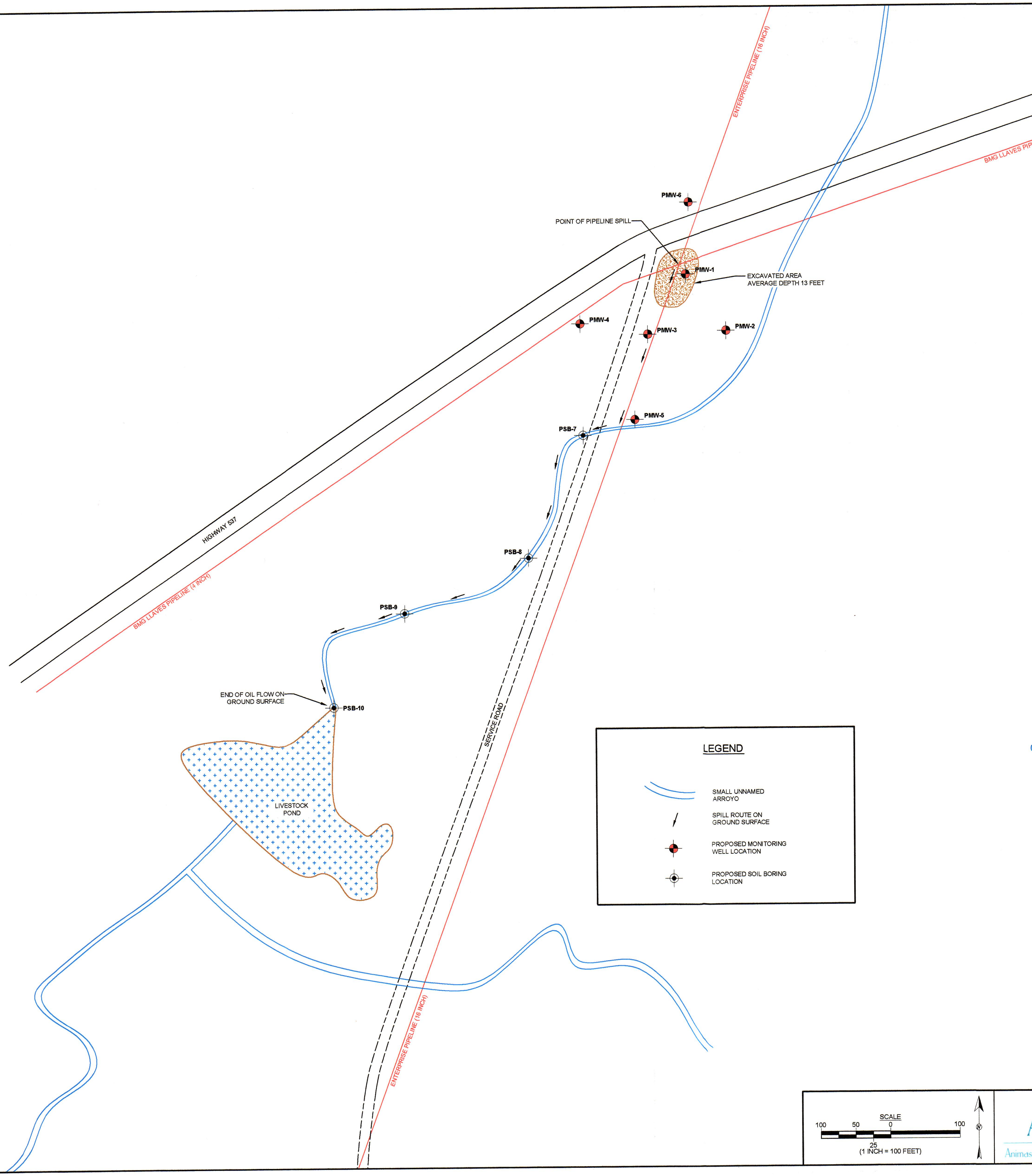
Animas Environmental Services, LLC

DRAWN BY: R. Kennemer	**DATE DRAWN:** January 21, 2008
REVISIONS BY: R. Kennemer	**DATE REVISED:** January 22, 2008
CHECKED BY: L. Cupps	**DATE CHECKED:** January 21, 2008
APPROVED BY: R. Kennemer	**DATE APPROVED:** January 21, 2008

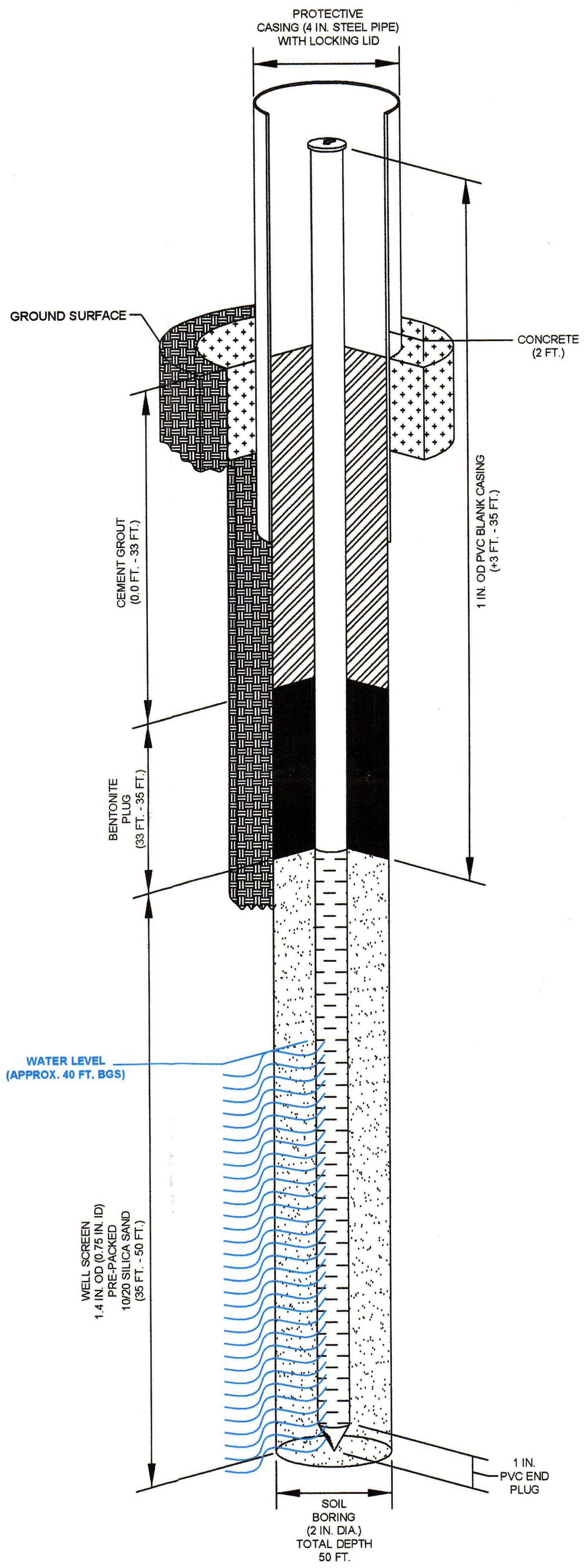
FIGURE 1
TOPOGRAPHICAL SITE LOCATION MAP

BMG
HIGHWAY 537 LLAVES PIPELINE OIL SPILL
NW ¼, NE ¼, SEC. 18, T25N, R3W
SCHMITZ RANCH, RIO ARRIBA COUNTY, NEW MEXICO
N36°24'214", W107°11'053"

S:\ANIMAS 2000\2008 PROJECTS\BMG\HWY. 537 2008 SPILL\MAPS AND DRAWINGS\FIGURE 1 TOPOGRAPHIC LOCATION MAP



PROPOSED GROUNDWATER MONITORING WELL CONSTRUCTION DETAIL



MONITORING WELL
CONSTRUCTION DETAIL
NOT TO SCALE

SCALE
100 50 0 100
25
(1 INCH = 100 FEET)
N

AES
Animas Environmental Services, LLC

DRAWN BY:	DATE DRAWN:
R. KENNEMER	January 22, 2008
REVISIONS BY:	DATE REVISED:
R. KENNEMER	January 23, 2008
CHECKED BY:	DATE CHECKED:
L. CUPPS	January 22, 2008
APPROVED BY:	DATE APPROVED:
E. MCNALLY	January 22, 2008

FIGURE 2
PROPOSED SPILL INVESTIGATION AREA

BMG
HIGHWAY 537 LLAVES PIPELINE OIL SPILL
NW ¼, NE ¼, SEC. 18, T25N, R3W
SCHMITZ RANCH, RIO ARRIBA COUNTY, NEW MEXICO
N36°24'214", W107°11'053"

S:\ANIMAS 2000\2008 PROJECTS\BMG\HWY. 537 2008 SPILL\MAPS AND DRAWINGS\FIGURE 2 PROPOSED SPILL INVESTIGATION AREA

Site Health and Safety Plan
For Site Assessment and Groundwater Monitoring and Sampling Activities

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Site Name:

Benson Montin Greer
December 2007 Highway 537 Pipeline Spill
Rio Arriba County, New Mexico

Date:
January 23, 2008

Prepared By:
Lany Cupps
Project Manager

Animas Environmental Services, LLC.
(505) 564-2281

Material Safety Data Sheet

MSDS ID NO.: 0110MAR019
Revision date: 09/12/2005

1. CHEMICAL PRODUCT AND COMPANY INFORMATION

Product name: Marathon Petroleum Crude Oil
Synonyms: Crude Oil
Chemical Family: Petroleum Hydrocarbon
Formula: Complex mixture

Manufacturer:
Marathon Petroleum Company LLC
539 South Main Street
Findlay OH 45840

Other information: 419-421-3070
Emergency telephone number: 877-627-5463

2. COMPOSITION/INFORMATION ON INGREDIENTS

Petroleum Crude Oil is a complex mixture of paraffinic, cycloparaffinic and aromatic hydrocarbons covering carbon numbers ranging from C1 to C60+. Can contain minor amounts of sulfur, nitrogen and oxygen compounds as well as trace amounts of heavy metals such as nickel, vanadium and lead. Composition varies depending on source of crude.

Product information

Name	CAS Number	Weight %	ACGIH Exposure Limits:	OSHA - Vacated PELs - Time Weighted Ave	Other:
Marathon Petroleum Crude Oil	8002-05-9	100		= 1600 mg/m^3 TWA = 400 ppm TWA	

Component Information

Name	CAS Number	Weight %	ACGIH Exposure Limits:	OSHA - Vacated PELs - Time Weighted Ave	Other:
Petroleum Crude Oil	8002-05-9	98-100		= 1600 mg/m^3 TWA = 400 ppm TWA	
Normal Hexane	110-54-3	0-3	= 1000 ppm STEL = 50 ppm TWA = 500 ppm TWA skin - potential for cutaneous absorption	= 1000 ppm STEL = 180 mg/m^3 TWA = 1800 mg/m^3 TWA = 3600 mg/m^3 STEL = 50 ppm TWA = 500 ppm TWA	
Toluene	108-88-3	0-5	= 50 ppm TWA skin - potential for cutaneous absorption	= 100 ppm TWA = 150 ppm STEL = 375 mg/m^3 TWA = 560 mg/m^3 STEL	
Xylene	1330-20-7	0-5	= 100 ppm TWA = 150 ppm STEL	= 100 ppm TWA = 150 ppm STEL = 435 mg/m^3 TWA = 655 mg/m^3 STEL	
Sulfur Compounds	Mixture	0-3			
Benzene	71-43-2	0-2	= 0.5 ppm TWA = 2.5 ppm STEL skin - potential for cutaneous absorption	= 10 ppm TWA unless specified in 1910.1028 = 25 ppm Ceiling unless specified in 1910.1028 = 50 ppm STEL 10 min, unless specified in 1910.1028	OSHA Exposure Limit as specified in 1910.1028: =1.0 ppm TWA = 5 ppm STEL = 0.5 ppm Action Level
Hydrogen Sulfide	7783-06-4	0-4	= 10 ppm TWA = 15 ppm STEL	= 10 ppm TWA = 14 mg/m^3 TWA = 15 ppm STEL = 21 mg/m^3 STEL	

Notes: The manufacturer has voluntarily elected to reflect exposure limits contained in OSHA's 1989 air contaminants standard in its MSDS's, even though certain of those exposure limits were vacated in 1992.

3. HAZARDS IDENTIFICATION

EMERGENCY OVERVIEW

CRUDE OIL IS AN AMBER TO BLACK IN COLOR DEPENDING ON THE SOURCE. IT POSSESSES A ROTTEN EGG OR SULFUR ODOR. CRUDE OIL IS A VOLATILE AND EXTREMELY FLAMMABLE LIQUID. VAPORS MAY CAUSE FLASH FIRES. KEEP AWAY FROM HEAT, FLAME AND SOURCES OF IGNITION. REPEATED AND LONG TERM SKIN EXPOSURE CONTACT TO COMPONENTS OF THIS PRODUCT HAS CAUSED SYSTEMIC TOXICITY AND CANCER IN LABORATORY ANIMALS. CAN CONTAIN TOXIC LEVELS OF HYDROGEN SULFIDE VAPORS THAT ACCUMULATE IN THE VAPOR SPACES OF STORAGE AND TRANSPORT COMPARTMENTS. H2S VAPORS CAN CAUSE EYE, SKIN, AND RESPIRATORY TRACT IRRITATION AND ASPHYXIATION. THIS PRODUCT MAY CONTAIN BENZENE. BENZENE MAY CAUSE CANCER OR BE TOXIC TO BLOOD-FORMING ORGANS. IF SWALLOWED, THE VOLATILE COMPONENTS OF THIS PRODUCT MAY GET SUCKED INTO THE LUNGS (ASPIRATED) AND CAUSE LUNG DAMAGE OR EVEN DEATH.

OSHA WARNING LABEL:

DANGER!
FLAMMABLE LIQUID.
REPEATED AND LONG TERM SKIN EXPOSURE TO COMPONENTS OF THIS PRODUCT HAS CAUSED SYSTEMIC TOXICITY AND CANCER IN LABORATORY ANIMALS.
MAY VENT HARMFUL CONCENTRATIONS OF HYDROGEN SULFIDE (H2S) GAS WHICH CAN CAUSE RESPIRATORY IRRITATION AND ASPHYXIATION.
CONTAINS BENZENE WHICH MAY CAUSE CANCER OR BE TOXIC TO BLOOD-FORMING ORGANS.
IF SWALLOWED, THE VOLATILE COMPONENTS OF THIS PRODUCT MAY GET SUCKED INTO THE LUNGS (ASPIRATED) AND CAUSE LUNG DAMAGE OR EVEN DEATH.

CONSUMER WARNING LABEL:

A CONSUMER WARNING LABEL IS NOT APPLICABLE FOR THIS PRODUCT.

Inhalation:	Vapors and fumes can cause respiratory and nasal irritation. Significant concentrations of hydrogen sulfide gas can be present in the vapor space of storage tanks and bulk transport compartments (See Sections 7, 8 & 11).
Ingestion:	The volatile components of this product may be toxic by ingestion. Aspiration (inadvertent suction) of liquid into the lungs must be avoided as even small quantities in the lungs can produce chemical pneumonitis, pulmonary edema/hemorrhage and even death.
Skin contact:	Prolonged or repeated liquid contact can cause dermatitis, folliculitis or oil acne.
Eye contact:	Liquid or vapor contact may result in slight eye irritation.

Carcinogenic Evaluation:

Product information

Name	IARC Carcinogens:	NTP Carcinogens:	ACGIH - Carcinogens:	OSHA - Select Carcinogens:
Marathon Petroleum Crude Oil 8002-05-9	NE			

Notes: The International Agency for Research on Cancer (IARC) has determined that there is limited evidence for the carcinogenicity of crude oil in animals. IARC has determined that there is inadequate evidence for the carcinogenicity of crude oil in humans. Crude oil is not classifiable as to its carcinogenicity to humans (Group 3).

Component Information

Name	IARC Carcinogens:	NTP Carcinogens:	ACGIH - Carcinogens:	OSHA - Select Carcinogens:

Toluene 108-88-3			A4 - Not Classifiable as a Human Carcinogen	
Xylene 1330-20-7			A4 - Not Classifiable as a Human Carcinogen	
Benzene 71-43-2	Supplement 7, 1987; Monograph 29, 1982	Known Carcinogen Reasonably Anticipated To Be A Carcinogen	A1 - Confirmed Human Carcinogen	Present

Notes: The International Agency for Research on Cancer (IARC), the National Toxicology Program (NTP), and OSHA have determined that there is sufficient evidence for th carcinogenicity of benzene in humans (Group 1A).

4. FIRST AID MEASURES

Inhalation: If affected, move person to fresh air. If breathing is difficult, administer oxygen. If n breathing or if no heartbeat, give artificial respiration or cardiopulmonary resuscitation (CPR). Immediately call a physician. If symptoms or irritation occur wi any exposure, call a physician.

Skin contact: Wash with soap and large amounts of water. Remove contaminated clothing. If symptoms or irritation occur, call a physician.

Ingestion: Ingestion not likely. If swallowed, do not induce vomiting and do not give liquids. Immediately call a physician.

Eye contact: Flush eyes with large amounts of tepid water for at least 15 minutes. If symptoms o irritation occur, call a physician.

Medical conditions aggravated by exposure: Preexisting skin, eye and respiratory disorders may be aggravated by exposure to components of this product.

5. FIRE FIGHTING MEASURES

Suitable extinguishing media: For small fires, Class B fire extinguishing media such as CO2, dry chemical, foam (AFFF/ATC) or water spray can b used. For large fires, water spray, fog or foam (AFFT/ATC can be used. Fire fighting should be attempted only by thos who are adequately trained and equipped with proper protective equipment.

Specific hazards: This product has been determined to be a flammable liquic per the OSHA Hazard Communication Standard, and shou be handled accordingly. Vapors may travel along the ground or be moved by ventilation and ignited by many sources such as pilot lights, sparks, electric motors, static discharge, or other ignition sources at locations distant fro material handling. Flashback can occur along vapor trail. For additional fire related information see NFPA 30 or Nort American Emergency Response Guide 115.

Special protective equipment for firefighters: Avoid using straight water streams. Water spray and foa (AFFF/ATC) must be applied carefully to avoid frothing an from as far a distance as possible. Avoid excessive water spray application. Water may be ineffective in extinguishin low flash point fires, but can be used to cool exposed surfaces. Keep run-off water out of sewers and water sources.

Flash point: 20-100 F
Autoignition temperature: No data available.
Flammable limits in air - lower (%): No data available.
Flammable limits in air - upper (%): No data available.

NFPA rating:	**HMIS classification:**
Health: 1	Health: 1
Flammability: 3	Flammability: 3
Reactivity: 0	Reactivity: 0
Other: -	Special: *See Section 8 for guidance in selection of personal protective equipment.

6. ACCIDENTAL RELEASE MEASURES

Personal precautions:	Keep public away. Isolate and evacuate area. Shut off source if safe to do so. Advise authorities and National Response Center (800-424-8802) if substance has entered a watercourse or sewer. Notify local health and pollution control agencies, if appropriate. Contain liquid with sand or soil. Recover and return free product to proper containers. Use suitable absorbent materials such as vermiculite, sand, or clay to clean up residual liquids.

7. HANDLING AND STORAGE

Handling:

Comply with all applicable EPA, OSHA, NFPA and consistent state and local requirements. Use appropriate grounding and bonding practices. Store in properly closed containers that are appropriately labeled and in a cool well-ventilated area. Do not expose to heat, open flames, strong oxidizers or other sources of ignition. Do not cut, drill, grind or weld on empty containers since they may contain explosive residues.

Harmful concentrations of hydrogen sulfide (H2S) gas can accumulate in excavations and low-lying areas as well as the vapor space of storage and bulk transport compartments. Stay upwind and vent open hatches before unloading.

Avoid skin contact. Exercise good personal hygiene including removal of soiled clothing and prompt washing with soap and water.

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

PERSONAL PROTECTIVE EQUIPMENT

Engineering measures:	Local or general exhaust required in an enclosed area or when there is inadequate ventilation.
Respiratory protection:	Not required under normal conditions and adequate ventilation. Supplied air respirators should be used if operating conditions create airborne concentrations which exceed exposure limits for any individual components (including H2S). Observe respirator protection factor criteria cited in ANSI Z88.2. Self-contained breathing apparatus should be used for fire fighting.
Skin and body protection:	Neoprene or nitrile gloves to prevent skin contact.
Eye protection:	No special eye protection is normally required. Where splashing is possible, wear safety glasses with side shields.
Hygiene measures:	Use mechanical ventilation equipment that is explosion-proof.

9. PHYSICAL AND CHEMICAL PROPERTIES:

Appearance:	Amber to Black Viscous Liquid
Physical state (Solid/Liquid/Gas):	Liquid
Substance type (Pure/Mixture):	Mixture
Color:	Amber to Black
Odor:	Mild Hydrocarbon or Rotten-egg.

Molecular weight:	Not determined.
pH:	Neutral
Boiling point/range (5-95%):	100-1000 F
Melting point/range:	No data available.
Decomposition temperature:	Not applicable.
Specific gravity:	0.8-1.0
Density:	6.6-8.2 lbs/gal
Bulk density:	No data available.
Vapor density:	No data available.
Vapor pressure:	0-724 mm Hg
Evaporation rate:	No data available.
Solubility:	Not determined
Solubility in other solvents:	No data available.
Partition coefficient (n-octanol/water):	2-6
VOC content(%):	No data available.
Viscosity:	No data available.

10. STABILITY AND REACTIVITY

Stability:	The material is stable at 70 F, 760 mm pressure.
Polymerization:	Will not occur.
Hazardous decomposition products:	Combustion produces carbon monoxide, aldehydes, aromatic and other hydrocarbons.
Materials to avoid:	Strong oxidizers such as nitrates, chlorates, peroxides.
Conditions to avoid:	Excessive heat, sources of igition and open flames.

11. TOXICOLOGICAL INFORMATION

Acute toxicity:

Product information

Name	CAS Number	Inhalation:	Dermal:	Oral:
Marathon Petroleum Crude Oil	8002-05-9	No data available	> 2 ml/kg [Rabbit]	> 5 gm/kg [Rat]

Lifetime skin painting studies in animals with whole crude oils and crude oil fractions have produced tumors in animals following prolonged and repeated skin contact. Repeated dermal application of two different crude oils in rats produced systemic toxicity in blood, liver, thymus and bone marrow. Repeated dermal application to pregnant rats produced maternal toxicity and fetal developmental toxicity.

Summary of health effect data on crude oil components:

Hydrogen sulfide concentrations will vary significantly depending on the source and sulfur content of the crude. Sweet crudes (<0.5% sulfur) may contain toxicologically significant levels of hydrogen sulfide in the vapor spaces of bulk storage tanks and transport compartments. Concentrations of H2S as low as 10 ppm over an 8 hour workshift may cause eye or throat irritation. Prolonged breathing of 50-100 ppm H2S vapors can produce significant eye and respiratory irritation. Sour crudes commonly contain extremely high concentrations of H2S (500-70,000 ppm) in the vapor spaces of bulk storage vessels. Exposure to 250-600 ppm for 15-30 minutes can produce headache, dizziness, nervousness, staggering gait, nausea and pulmonary edema or bronchial pneumonia. Concentrations >1,000 ppm will cause immediate unconsciousness and death through respiratory paralysis. Rats and mice exposed to 80 ppm H2S, 6 hrs/day, 5 days/week for 10 weeks, did not produce any toxicity except for irritation of nasal passages. H2S did not affect reproduction and development (birth defects or neurotoxicity) in rats exposed to concentrations of 75-80 ppm or 150 ppm H2S, respectively. Over the years a number of acute cases of H2S poisonings have been reported. Complete and rapid recovery is the general rule. However, if the exposure was sufficiently intense and sustained causing cerebral hypoxia (lack of oxygen to the brain), neurologic effects such as amnesia, intention tremors or brain damage are possible.

This product may contain benzene at a level of >0.1%. Repeated or prolonged exposure to benzene at concentrations in excess of the TLV may cause serious injury to blood-forming organs. Significant chronic exposure to benzene vapor has been reported to produce various blood disorders ranging from anemia to certain forms of leukemia (cancer) in man. Benzene produced tumors in rats and mice in lifetime chronic toxicity studies, but the response has not been consistent across species, strain, sex or route of exposure. Animal studies on benzene have demonstrated immune toxicity, chromosomal aberrations, testicular effects and alterations in reproductive cycles and embryo/fetotoxicity, but not teratogenicity.

This product may contain hexane at a level of >1.0%. Studies in laboratory animals have produced systemic toxicity in blood, spleen and lungs. Fetotoxicity has been observed at hexane concentrations that produced maternal toxicity. Long term exposure to high concentrations of hexane has been shown to cause testicular effects and nervous system damage.

This product may contain toluene at a level of >1.0%. Deliberate inhalation of high concentrations of toluene has been shown to cause liver, kidney and brain damage and central nervous system effects (incoordination, lassitude and memory loss) in individuals abusing toluene for its euphoric effects.

This product may contain xylene at a level of >1.0%. Gross overexposure or severe poisoning incidents in humans to xylenes has been reported to cause lung, liver, kidney, heart and brain damage as well as neurologic disturbances. Laboratory animals exposed to high doses of xylene showed evidence of effects in the liver, kidneys, lungs, spleen, heart and adrenals. Exposure of pregnant rats, mice and rabbits during gestation to significant concentrations of xylene produced maternal, fetal and developmental toxicity (skeletal retardation, cleft palate, and wavy ribs) generally at maternally toxic doses. These types of fetotoxic effects have been associated with maternal toxicity. Repeated inhalation of high xylene concentrations have shown impairment of performance abilities (behavioral tests) in animals and man. Xylene produced a mid frequency hearing loss in rats subchronically exposed to high concentrations of xylene.

12. ECOLOGICAL INFORMATION

Ecotoxicity effects:	Coating action of oil can kill birds, plankton, algae and fish. Keep out of all bodies of water and sewage drainage systems. Two crude oils were tested in a acute battery of ecotoxicity tests. The 96 hour lethal loading (LL50) values for rainbow trout were 21 and 41 mg/l. LL50s for invertibrate organisms (mysid) were determined to be 2.7 and 4.1 mg/l and EL50s for algae were 122 and 528 ml/kg.

13. DISPOSAL CONSIDERATIONS

Cleanup Considerations:	This product as produced is not specifically listed as an EPA RCRA hazardous waste according to federal regulations (40 CFR 261). However, when discarded or disposed of, it may meet the criteria of an "characteristic" hazardous waste. This product could also contain benzene at >0.5 ppm and could exhibit the characteristics of "toxicity" as determined by the toxicity characteristic leaching procedure (TCLP). This material could become a hazardous waste if mixed or contaminated with a hazardous waste or other substance(s). It is the responsibility of the user to determine if disposal material is hazardous according to federal, state and local regulations.

14. TRANSPORT INFORMATION

49 CFR 172.101:

DOT:

Transport Information:	This material when transported via US commerce would be regulated by DOT Regulations.
Proper shipping name:	Petroleum Crude Oil
UN/Identification No:	UN 1267
Hazard Class:	3
Packing group:	II
DOT reportable quantity (lbs):	Not applicable.

TDG (Canada):

Proper shipping name:	Petroleum Crude Oil
UN/Identification No:	UN 1267
Hazard Class:	3
Packing group:	II
Regulated substances:	Not applicable.

15. REGULATORY INFORMATION

Federal Regulatory Information:

US TSCA Chemical Inventory Section 8(b):	This product and/or its components are listed on the TSCA Chemical Inventory.
OSHA Hazard Communication Standard:	This product has been evaluated and determined to be hazardous as defined in OSHA's Hazard Communication Standard.

EPA Superfund Amendment & Reauthorization Act (SARA):

SARA Section 302: This product contains the following component(s) that have been listed on EPA's Extremely Hazardous Substance (EHS) List:

Name	CERCLA/SARA - Section 302 Extremely Hazardous Substances and TPQs
Petroleum Crude Oil	NA
Normal Hexane	NA
Toluene	NA
Xylene	NA
Sulfur Compounds	NA
Benzene	NA
Hydrogen Sulfide	hydrogen sulfide

SARA Section 304: This product contains the following component(s) identified either as an EHS or a CERCLA Hazardous substance which in case of a spill or release may be subject to SARA reporting requirements:

Name	CERCLA/SARA - Hazardous Substances and their Reportable Quantities
Petroleum Crude Oil	NA
Normal Hexane	= 2270 kg final RQ = 5000 lb final RQ
Toluene	= 0.454 kg final RQ = 1 lb final RQ = 10 lb final RQ = 100 lb final RQ = 1000 lb final RQ = 4.54 kg final RQ = 45.4 kg final RQ = 454 kg final RQ
Xylene	= 100 lb final RQ = 45.4 kg final RQ
Sulfur Compounds	NA
Benzene	= 0.454 kg final RQ = 0.454 kg statutory RQ = 1 lb final RQ = 1 lb statutory RQ = 10 lb final RQ = 10 lb final RQ receives an adjustable RQ of 10 lbs based on potential carcinogenicity in August 14, 1989 final rule = 100 lb final RQ = 4.54 kg final RQ = 4.54 kg final RQ receives an adjustable RQ of 10 lbs based on potential carcinogenicity in August 14, 1989 final rule = 45.4 kg final RQ
Hydrogen Sulfide	= 100 lb final RQ = 45.4 kg final RQ

SARA Section 311/312: The following EPA hazard categories apply to this product:

Acute Health Hazard
Chronic Health Hazard
Fire Hazard

SARA Section 313: This product contains the following component(s) that may be subject to reporting on the Toxic Release Inventory (TRI) From R:

Name	CERCLA/SARA 313 Emission reporting:
Petroleum Crude Oil	= 100 lb Reporting Threshold Chemical Category N590, PBT Chemicals
Normal Hexane	= 1.0 percent de minimis concentration
Toluene	= 1.0 percent de minimis concentration
Xylene	= 1.0 percent de minimis concentration
Sulfur Compounds	None
Benzene	= 0.1 percent de minimis concentration
Hydrogen Sulfide	None

State and Community Right-To-Know Regulations:
The following component(s) of this material are identified on the regulatory lists below:

Petroleum Crude Oil

Louisiana Right-To-Know:	Not Listed
California Proposition 65:	Not Listed
New Jersey Right-To-Know:	sn 2648
Pennsylvania Right-To-Know:	[present]
Massachusetts Right-To Know:	Present
Florida substance List:	Not Listed.
Rhode Island Right-To-Know:	Flammable
Michigan critical materials register list:	Not Listed.
Massachusetts Extraordinarily Hazardous Substances:	Not Listed
California - Regulated Carcinogens:	Not Listed

Pennsylvania RTK - Special Hazardous Substances:	Not Listed
New Jersey - Special Hazardous Substances:	Not Listed
New Jersey - Environmental Hazardous Substances List:	SN 3758; Category Code N590
Illinois - Toxic Air Contaminants	Not Listed
New York - Reporting of Releases Part 597 - List of Hazardous Substances:	Not Listed
Normal Hexane	
Louisiana Right-To-Know:	Not Listed
California Proposition 65:	Not Listed
New Jersey Right-To-Know:	sn 1340
Pennsylvania Right-To-Know:	[present]
Massachusetts Right-To Know:	Present
Florida substance List:	Not Listed.
Rhode Island Right-To-Know:	Toxic, Flammable
Michigan critical materials register list:	Not Listed.
Massachusetts Extraordinarily Hazardous Substances:	Not Listed
California - Regulated Carcinogens:	Not Listed
Pennsylvania RTK - Special Hazardous Substances:	Not Listed
New Jersey - Special Hazardous Substances:	flammable - third degree
New Jersey - Environmental Hazardous Substances List:	SN 1340
Illinois - Toxic Air Contaminants	Present
New York - Reporting of Releases Part 597 - List of Hazardous Substances:	= 1 lb Air RQ = 1 lb Land/Water RQ
Toluene	
Louisiana Right-To-Know:	Not Listed
California Proposition 65:	developmental toxicity; initial date 1/1/91
New Jersey Right-To-Know:	sn 1866
Pennsylvania Right-To-Know:	environmental hazard
Massachusetts Right-To Know:	Present
Florida substance List:	Not Listed.
Rhode Island Right-To-Know:	Toxic, Flammable; skin
Michigan critical materials register list:	Annual usage threshold = 100 pounds
Massachusetts Extraordinarily Hazardous Substances:	Not Listed
California - Regulated Carcinogens:	Not Listed
Pennsylvania RTK - Special Hazardous Substances:	Not Listed
New Jersey - Special Hazardous Substances:	flammable - third degree
New Jersey - Environmental Hazardous Substances List:	SN 1866
Illinois - Toxic Air Contaminants	Present
New York - Reporting of Releases Part 597 - List of Hazardous Substances:	= 1 lb Land/Water RQ = 1,000 lbs Air RQ
Xylene	
Louisiana Right-To-Know:	Not Listed
California Proposition 65:	Not Listed
New Jersey Right-To-Know:	sn 2014
Pennsylvania Right-To-Know:	environmental hazard
Massachusetts Right-To Know:	Present
Florida substance List:	Not Listed.
Rhode Island Right-To-Know:	Toxic, Flammable
Michigan critical materials register list:	Annual usage threshold = 100 pounds (all isomers)

Massachusetts Extraordinarily Hazardous Substances:	Not Listed
California - Regulated Carcinogens:	Not Listed
Pennsylvania RTK - Special Hazardous Substances:	Not Listed
New Jersey - Special Hazardous Substances:	flammable - third degree
New Jersey - Environmental Hazardous Substances List:	SN 2014
Illinois - Toxic Air Contaminants	Present
New York - Reporting of Releases Part 597 - List of Hazardous Substances:	= 1 lb Land/Water RQ = 1,000 lbs Air RQ
Sulfur Compounds	
Louisiana Right-To-Know:	Not Listed
California Proposition 65:	Not Listed
New Jersey Right-To-Know:	Not Listed.
Pennsylvania Right-To-Know:	Not Listed.
Massachusetts Right-To Know:	Not Listed.
Florida substance List:	Not Listed.
Rhode Island Right-To-Know:	Not Listed
Michigan critical materials register list:	Not Listed.
Massachusetts Extraordinarily Hazardous Substances:	Not Listed
California - Regulated Carcinogens:	Not Listed
Pennsylvania RTK - Special Hazardous Substances:	Not Listed
New Jersey - Special Hazardous Substances:	Not Listed
New Jersey - Environmental Hazardous Substances List:	Not Listed
Illinois - Toxic Air Contaminants	Not Listed
New York - Reporting of Releases Part 597 - List of Hazardous Substances:	Not Listed
Benzene	
Louisiana Right-To-Know:	Not Listed
California Proposition 65:	carcinogen; initial date 2/27/87 developmental toxicity; initial date 12/26/97 male reproductive toxicity; initial date 12/26/97
New Jersey Right-To-Know:	sn 0197
Pennsylvania Right-To-Know:	environmental hazard; special hazardous substance
Massachusetts Right-To Know:	Carcinogen; Extraordinarily hazardous
Florida substance List:	Not Listed.
Rhode Island Right-To-Know:	Toxic, Flammable, Carcinogen; skin
Michigan critical materials register list:	Annual usage threshold = 100 pounds
Massachusetts Extraordinarily Hazardous Substances:	carcinogen; extraordinarily hazardous
California - Regulated Carcinogens:	Not Listed
Pennsylvania RTK - Special Hazardous Substances:	[present]
New Jersey - Special Hazardous Substances:	carcinogen; flammable - third degree; mutagen
New Jersey - Environmental Hazardous Substances List:	SN 0197
Illinois - Toxic Air Contaminants	Present
New York - Reporting of Releases Part 597 - List of Hazardous Substances:	= 1 lb Land/Water RQ = 10 lbs Air RQ
Hydrogen Sulfide	
Louisiana Right-To-Know:	Not Listed
California Proposition 65:	Not Listed
New Jersey Right-To-Know:	sn 1017

Pennsylvania Right-To-Know:	environmental hazard
Massachusetts Right-To Know:	Extraordinarily hazardous
Florida substance List:	Not Listed.
Rhode Island Right-To-Know:	Toxic, Flammable
Michigan critical materials register list:	Not Listed.
Massachusetts Extraordinarily Hazardous Substances:	extraordinarily hazardous
California - Regulated Carcinogens:	Not Listed
Pennsylvania RTK - Special Hazardous Substances:	Not Listed
New Jersey - Special Hazardous Substances:	flammable - fourth degree
New Jersey - Environmental Hazardous Substances List:	SN 1017
Illinois - Toxic Air Contaminants	Not Listed
New York - Reporting of Releases Part 597 - List of Hazardous Substances:	= 100 lbs Air RQ = 100 lbs Land/Water RQ

Canadian Regulatory Information:

Canada DSL/NDSL Inventory: This product and/or its components are listed either on the Domestic Substances List (DSL) or the Non Domestic Substance List (NDSL).

Name	Canada - WHMIS: Classifications of Substances:	Canada - WHMIS: Ingredient Disclosure:
Petroleum Crude Oil	B2	
Normal Hexane	B2; D2B	1% (English Item 827, French Item 964) 1% (English Item 828, French Item 965)
Toluene	B2; D2A	1% (English Item 1578, French Item 1622)
Xylene	B2; D2A; D2B	
Benzene	B2; D2A	0.1% (English Item 153, French Item 277)
Hydrogen Sulfide	A; B1; D1A; D2B	1% (English Item 851, French Item 1550)

16. OTHER INFORMATION

Additional Information: The pronounced and easily-recognized rotten egg odor of hydrogen sulfide gas (H2S) can be detected at concentrations as low as 0.003-0.13 ppm. Since higher H2S concentrations (100-200 ppm) cause olfactory fatigue and other hydrocarbon odors can "mask" H2S, the sense of smell cannot be used as a reliable indicator of H2S exposure.

Prepared by: Craig M. Parker Manager, Toxicology and Product Safety

The information and recommendations contained herein are based upon tests believed to be reliable. However, Marathon Petroleum Company LLC (MPC) does not guarantee their accuracy or completeness nor shall any of this information constitute a warranty, whether expressed or implied, as to the safety of the goods, the merchantability of the goods, or the fitness of the goods for a particular purpose. Adjustment to conform to actual conditions of usage maybe required. MPC assumes no responsibility for results obtained or for incidental or consequential damages, including lost profits arising from the use of these data. No warranty against infringement of any patent, copyright or trademark is made or implied.

End of Safety Data Sheet

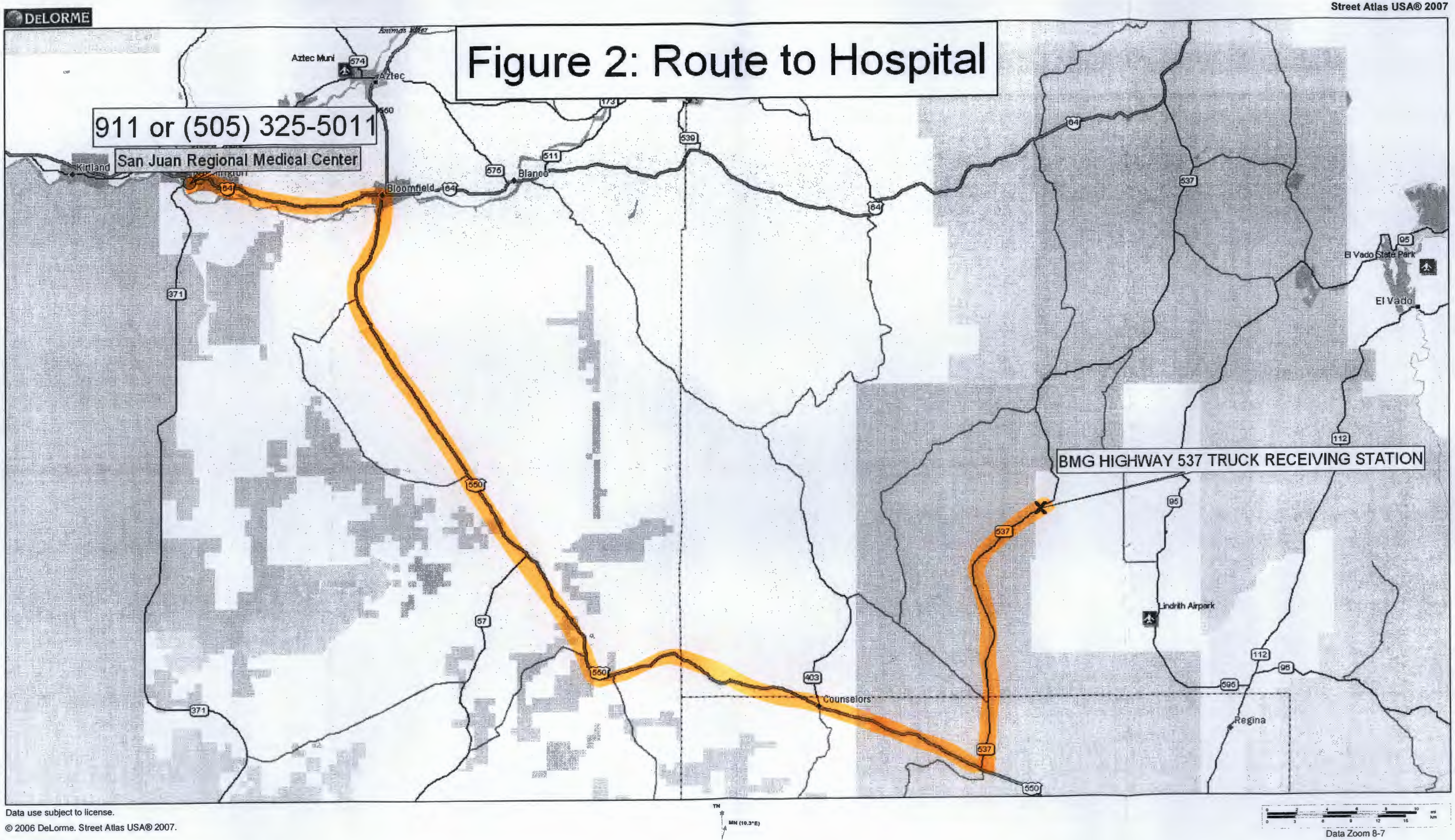


Figure 2: Route to Hospital

Tailgate Safety Meeting Form

Animas Environmental Services
624 E. Comanche, Farmington, NM 87401
Tel. (505) 564-2281 Fax (505) 324-2022

Project: ____________________
Client: ____________________
Location: ____________________
Project Manager: ____________________
Safety Officer: ____________________

Project No.: ____________________
Date: ____________________
Time: ____________________

Site Activities:

Project Duration:

Safety Topics:

Personnel Present	Company	Signature

Soil Boring Log

Soil Boring No:
Monitor Well No:

Animas Environmental Services

624 E Comanche Farmington, NM 87401
Tel. (505) 564-2281 Fax (505) 324-2022

Project:
Client:
Location:
Driller:
Drilling Method:
Depth to Water (ft):
Project No.:
Date:
Elevation:
Datum:
Logged by:
Well Diameter (in.):

Depth (ft)	Soil Description	Soil Type	Odor	OVM (ppm)	Samples	Time	Monitor Well Details

MONITORING WELL SAMPLING RECORD

Monitor Well No: ____________

Animas Environmental Services
624 E. Comanche, Farmington NM 87401
Tel. (505) 564-2281 Fax (505) 324-2022

Site: ____________________
Location: ____________________
Project: ____________________
Sampling Technician: ____________________
Purge / No Purge: ____________________
Well Diameter (in): ____________________
Project No.: ____________
Date: ____________
Arrival Time: ____________
Air Temp: ____________
T.O.C. Elev. (ft): ____________
Total Well Depth (ft): ____________
Initial D.T.W. (ft): ____________ **Time:** ____________ *(taken at initial gauging of all wells)*
Confirm D.T.W. (ft): ____________ **Time:** ____________ *(taken prior to purging well)*
Final D.T.W. (ft): ____________ **Time:** ____________ *(taken after sample collection)*

Water Quality Parameters - Recorded During Well Purging

Time	Temp (deg C)	Conductivity (µS) (mS)	DO (mg/L)	pH	ORP (mV)	PURGED VOLUME (see reverse for calc.)	Notes/Observations

Analytical Parameters (include analysis method and number and type of sample containers)

Disposal of Purged Water: ____________________
Collected Samples Stored on Ice in Cooler: ____________________
Chain of Custody Record Complete: ____________________
Analytical Laboratory: ____________________
Equipment Used During Sampling: Keck Water Level, YSI Water Quality Meter, and New Disposable Bailer

Notes/Comments

revised: 05/23/07

If it is necessary to calculate the volume of the monitoring well to determine what volume of groundwater will need to be purged from the well prior to collecting the samples, use the following equation:

Well Volume = (h)(cf)

where:

h = height of water column (feet)
cf = gallons/foot based on well diameter shown below

The gallons/foot for common size monitoring wells are as follows:

Well Diameter (inches)	2"	3"	4"	6"
Volume (gallons/foot)	0.1632	0.3672	0.6528	1.4688

The well volume is typically tripled to determine the volume to be purged.

Show purge volume calculation below:

revised: 05/23/07

U. S. EPA ENVIRONMENTAL RESPONSE TEAM

STANDARD OPERATING PROCEDURES

SOP: 2012
PAGE: 1 of 13
REV: 0.0
DATE: 02/18/00

SOIL SAMPLING

CONTENTS

SUPERCEDES: SOP #2012; Revision 0.0; 11/16/94; U.S. EPA Contract 68-C4-0022.

1.0 SCOPE AND APPLICATION

The purpose of this standard operating procedure (SOP) is to describe the procedures for the collection of representative soil samples. Sampling depths are assumed to be those that can be reached without the use of a drill rig, direct-push, or other mechanized equipment (except for a back-hoe). Analysis of soil samples may determine whether concentrations of specific pollutants exceed established action levels, or if the concentrations of pollutants present a risk to public health, welfare, or the environment.

These are standard (i.e., typically applicable) operating procedures which may be varied or changed as required, dependent upon site conditions, equipment limitations or limitations imposed by the procedure. In all instances, the actual procedures used should be documented and described in an appropriate site report.

Mention of trade names or commercial products does not constitute U.S. Environmental Protection Agency (EPA) endorsement or recommendation for use.

2.0 METHOD SUMMARY

Soil samples may be collected using a variety of methods and equipment depending on the depth of the desired sample, the type of sample required (disturbed vs. undisturbed), and the soil type. Near-surface soils may be easily sampled using a spade, trowel, and scoop. Sampling at greater depths may be performed using a hand auger, continuous flight auger, a trier, a split-spoon, or, if required, a backhoe.

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE

Chemical preservation of solids is not generally recommended. Samples should, however, be cooled and protected from sunlight to minimize any potential reaction. The amount of sample to be collected and proper sample container type are discussed in ERT/REAC SOP #2003 Rev. 0.0 08/11/94, *Sample Storage, Preservation and Handling*.

4.0 INTERFERENCES AND POTENTIAL PROBLEMS

There are two primary potential problems associated with soil sampling - cross contamination of samples and improper sample collection. Cross contamination problems can be eliminated or minimized through the use of dedicated sampling equipment. If this is not possible or practical, then decontamination of sampling equipment is necessary. Improper sample collection can involve using contaminated equipment, disturbance of the matrix resulting in compaction of the sample, or inadequate homogenization of the samples where required, resulting in variable, non-representative results.

5.0 EQUIPMENT

Soil sampling equipment includes the following:

- Maps/plot plan
- Safety equipment, as specified in the site-specific Health and Safety Plan
- Survey equipment or global positioning system (GPS) to locate sampling points
- Tape measure
- Survey stakes or flags
- Camera and film
- Stainless steel, plastic, or other appropriate homogenization bucket, bowl or pan
- Appropriate size sample containers
- Ziplock plastic bags
- Logbook
- Labels
- Chain of Custody records and custody seals
- Field data sheets and sample labels
- Cooler(s)
- Ice
- Vermiculite
- Decontamination supplies/equipment
- Canvas or plastic sheet
- Spade or shovel
- Spatula
- Scoop
- Plastic or stainless steel spoons
- Trowel(s)
- Continuous flight (screw) auger
- Bucket auger
- Post hole auger
- Extension rods
- T-handle
- Sampling trier
- Thin wall tube sampler
- Split spoons
- Vehimeyer soil sampler outfit
  - Tubes
  - Points
  - Drive head
  - Drop hammer
  - Puller jack and grip
- Backhoe

6.0 REAGENTS

Reagents are not used for the preservation of soil samples. Decontamination solutions are specified in ERT/REAC SOP #2006 Rev. 0.0 08/11/94, *Sampling Equipment Decontamination*, and the site specific work plan.

7.0 PROCEDURES

7.1 Preparation

1. Determine the extent of the sampling effort, the sampling methods to be employed, and the types and amounts of equipment and supplies required.

2. Obtain necessary sampling and monitoring equipment.

3. Decontaminate or pre-clean equipment, and ensure that it is in working order.

4. Prepare schedules and coordinate with staff, client, and regulatory agencies, if appropriate.

5. Perform a general site survey prior to site entry in accordance with the site specific Health and Safety Plan.

6. Use stakes, flagging, or buoys to identify and mark all sampling locations. Specific site factors, including extent and nature of contaminant, should be considered when selecting sample location. If required, the proposed locations may be adjusted based on site access, property boundaries, and surface obstructions. All staked locations should be utility-cleared by the property owner or the On-Scene-Coordinator (OSC) prior to soil sampling; and utility clearance should always be confirmed before beginning work.

7.2 Sample Collection

7.2.1 Surface Soil Samples

Collection of samples from near-surface soil can be accomplished with tools such as spades, shovels, trowels, and scoops. Surface material is removed to the required depth and a stainless steel or plastic scoop is then used to collect the sample.

This method can be used in most soil types but is limited to sampling at or near the ground surface. Accurate, representative samples can be collected with this procedure depending on the care and precision demonstrated by the sample team member. A flat, pointed mason trowel to cut a block of the desired soil is helpful when undisturbed profiles are required. Tools plated with chrome or other materials should not be used. Plating is particularly common with garden implements such as potting trowels.

The following procedure is used to collect surface soil samples:

1. Carefully remove the top layer of soil or debris to the desired sample depth with a pre-cleaned spade.
2. Using a pre-cleaned, stainless steel scoop, plastic spoon, or trowel, remove and discard a thin layer of soil from the area which came in contact with the spade.
3. If volatile organic analysis is to be performed, transfer the sample directly into an appropriate, labeled sample container with a stainless steel lab spoon, or equivalent and secure the cap tightly. Place the remainder of the sample into a stainless steel, plastic, or other appropriate homogenization container, and mix thoroughly to obtain a homogenous sample representative of the entire sampling interval. Then, either place the sample into appropriate, labeled containers and secure the caps tightly; or, if composite samples are to be collected, place a sample from another sampling interval or location into the homogenization container and mix thoroughly. When compositing is complete, place the sample into appropriate, labeled containers and secure the caps tightly.

7.2.2 Sampling at Depth with Augers and Thin Wall Tube Samplers

This system consists of an auger, or a thin-wall tube sampler, a series of extensions, and a "T" handle (Figure 1, Appendix A). The auger is used to bore a hole to a desired sampling depth, and is then withdrawn. The sample may be collected directly from the auger. If a core sample is to be collected, the auger tip is then replaced with a thin wall tube sampler. The system is then lowered down the borehole, and driven into the soil to the completion depth. The system is withdrawn and the core is collected from the thin wall tube sampler.

Several types of augers are available; these include: bucket type, continuous flight (screw), and post-hole augers. Bucket type augers are better for direct sample recovery because they provide a large volume of sample in a short time. When continuous flight augers are used, the sample can be collected directly from the flights. The continuous flight augers are satisfactory when a composite of the complete soil column is desired. Post-hole augers have limited utility for sample collection as they are designed to cut through fibrous, rooted, swampy soil and cannot be used below a depth of approximately three feet.

The following procedure is used for collecting soil samples with the auger:

1. Attach the auger bit to a drill rod extension, and attach the "T" handle to the drill rod.

2. Clear the area to be sampled of any surface debris (e.g., twigs, rocks, litter). It may be advisable to remove the first three to six inches of surface soil for an area approximately six inches in radius around the drilling location.

3. Begin augering, periodically removing and depositing accumulated soils onto a plastic sheet spread near the hole. This prevents accidental brushing of loose material back down the borehole when removing the auger or adding drill rods. It also facilitates refilling the hole, and avoids possible contamination of the surrounding area.

4. After reaching the desired depth, slowly and carefully remove the auger from the hole. When sampling directly from the auger, collect the sample after the auger is removed from the hole and proceed to Step 10.

5. Remove auger tip from the extension rods and replace with a pre-cleaned thin wall tube sampler. Install the proper cutting tip.

6. Carefully lower the tube sampler down the borehole. Gradually force the tube sampler into the soil. Do not scrape the borehole sides. Avoid hammering the rods as the vibrations may cause the boring walls to collapse.

7. Remove the tube sampler, and unscrew the drill rods.

8. Remove the cutting tip and the core from the device.

9. Discard the top of the core (approximately 1 inch), as this possibly represents material collected before penetration of the layer of concern. Place the remaining core into the appropriate labeled sample container. Sample homogenization is not required.

10. If volatile organic analysis is to be performed, transfer the sample into an appropriate, labeled sample container with a stainless steel lab spoon, or equivalent and secure the cap tightly. Place the remainder of the sample into a stainless steel, plastic, or other appropriate homogenization container, and mix thoroughly to obtain a homogenous sample representative of the entire sampling interval. Then, either place the sample into appropriate, labeled containers and secure the caps tightly; or, if composite samples are to be collected, place a sample from another sampling interval into the homogenization container and mix thoroughly.

    When compositing is complete, place the sample into appropriate, labeled containers and secure the caps tightly.

11. If another sample is to be collected in the same hole, but at a greater depth, reattach the auger bit to the drill and assembly, and follow steps 3 through 11, making sure to decontaminate the auger and tube sampler between samples.

12. Abandon the hole according to applicable state regulations. Generally, shallow holes can simply be backfilled with the removed soil material.

7.2.3 Sampling with a Trier

The system consists of a trier, and a "T" handle. The auger is driven into the soil to be sampled and used to extract a core sample from the appropriate depth.

The following procedure is used to collect soil samples with a sampling trier:

1. Insert the trier (Figure 2, Appendix A) into the material to be sampled at a 0° to 45° angle from horizontal. This orientation minimizes the spillage of sample.

2. Rotate the trier once or twice to cut a core of material.

3. Slowly withdraw the trier, making sure that the slot is facing upward.

4. If volatile organic analyses are required, transfer the sample into an appropriate, labeled sample container with a stainless steel lab spoon, or equivalent and secure the cap tightly. Place the remainder of the sample into a stainless steel, plastic, or other appropriate homogenization container, and mix thoroughly to obtain a homogenous sample representative of the entire sampling interval. Then, either place the sample into appropriate, labeled containers and secure the caps tightly; or, if composite samples are to be collected, place a sample from another sampling interval into the homogenization container and mix thoroughly. When compositing is complete, place the sample into appropriate, labeled containers and secure the caps tightly.

7.2.4 Sampling at Depth with a Split Spoon (Barrel) Sampler

Split spoon sampling is generally used to collect undisturbed soil cores of 18 or 24 inches in length. A series of consecutive cores may be extracted with a split spoon sampler to give a complete soil column profile, or an auger may be used to drill down to the desired depth for sampling. The split spoon is then driven to its sampling depth through the bottom of the augured hole and the core extracted.

When split spoon sampling is performed to gain geologic information, all work should be performed in accordance with ASTM D1586-98, "Standard Test Method for Penetration Test and Split-Barrel Sampling of Soils".

The following procedures are used for collecting soil samples with a split spoon:

1. Assemble the sampler by aligning both sides of barrel and then screwing the drive shoe on the bottom and the head piece on top.
2. Place the sampler in a perpendicular position on the sample material.
3. Using a well ring, drive the tube. Do not drive past the bottom of the head piece or compression of the sample will result.
4. Record in the site logbook or on field data sheets the length of the tube used to penetrate the material being sampled, and the number of blows required to obtain this depth.
5. Withdraw the sampler, and open by unscrewing the bit and head and splitting the barrel. The amount of recovery and soil type should be recorded on the boring log. If a split sample is desired, a cleaned, stainless steel knife should be used to divide the tube contents in half, longitudinally. This sampler is typically available in 2 and 3 1/2 inch diameters. A larger barrel may be necessary to obtain the required sample volume.
6. Without disturbing the core, transfer it to appropriate labeled sample container(s) and seal tightly.

7.2.5 Test Pit/Trench Excavation

A backhoe can be used to remove sections of soil, when detailed examination of soil characteristics are required. This is probably the most expensive sampling method because of the relatively high cost of backhoe operation.

The following procedures are used for collecting soil samples from test pits or trenches:

1. Prior to any excavation with a backhoe, it is important to ensure that all sampling locations are clear of overhead and buried utilities.
2. Review the site specific Health & Safety plan and ensure that all safety precautions including appropriate monitoring equipment are installed as required.

3. Using the backhoe, excavate a trench approximately three feet wide and approximately one foot deep below the cleared sampling location. Place excavated soils on plastic sheets. Trenches greater than five feet deep must be sloped or protected by a shoring system, as required by OSHA regulations.

4. A shovel is used to remove a one to two inch layer of soil from the vertical face of the pit where sampling is to be done.

5. Samples are taken using a trowel, scoop, or coring device at the desired intervals. Be sure to scrape the vertical face at the point of sampling to remove any soil that may have fallen from above, and to expose fresh soil for sampling. In many instances, samples can be collected directly from the backhoe bucket.

6. If volatile organic analyses are required, transfer the sample into an appropriate, labeled sample container with a stainless steel lab spoon, or equivalent and secure the cap tightly. Place the remainder of the sample into a stainless steel, plastic, or other appropriate homogenization container, and mix thoroughly to obtain a homogenous sample representative of the entire sampling interval. Then, either place the sample into appropriate, labeled containers and secure the caps tightly; or, if composite samples are to be collected, place a sample from another sampling interval into the homogenization container and mix thoroughly. When compositing is complete, place the sample into appropriate, labeled containers and secure the caps tightly.

7. Abandon the pit or excavation according to applicable state regulations. Generally, shallow excavations can simply be backfilled with the removed soil material.

8.0 CALCULATIONS

This section is not applicable to this SOP.

9.0 QUALITY ASSURANCE/QUALITY CONTROL

There are no specific quality assurance (QA) activities which apply to the implementation of these procedures. However, the following QA procedures apply:

1. All data must be documented on field data sheets or within site logbooks.

2. All instrumentation must be operated in accordance with operating instructions as supplied by the manufacturer, unless otherwise specified in the work plan. Equipment checkout and calibration

activities must occur prior to sampling/operation, and they must be documented.

10.0 DATA VALIDATION

This section is not applicable to this SOP.

11.0 HEALTH AND SAFETY

When working with potentially hazardous materials, follow U.S. EPA, OHSA and corporate health and safety procedures, in addition to the procedures specified in the site specific Health & Safety Plan..

12.0 REFERENCES

Mason, B.J. 1983. Preparation of Soil Sampling Protocol: Technique and Strategies. EPA-600/4-83-020.

Barth, D.S. and B.J. Mason. 1984. Soil Sampling Quality Assurance User's Guide. EPA-600/4-84-043.

U.S. Environmental Protection Agency. 1984 Characterization of Hazardous Waste Sites - A Methods Manual: Volume II. Available Sampling Methods, Second Edition. EPA-600/4-84-076.

de Vera, E.R., B.P. Simmons, R.D. Stephen, and D.L. Storm. 1980. Samplers and Sampling Procedures for Hazardous Waste Streams. EPA-600/2-80-018.

ASTM D 1586-98, ASTM Committee on Standards, Philadelphia, PA.

APPENDIX A
Figures
SOP #2012
February 2000

FIGURE 1. Sampling Augers

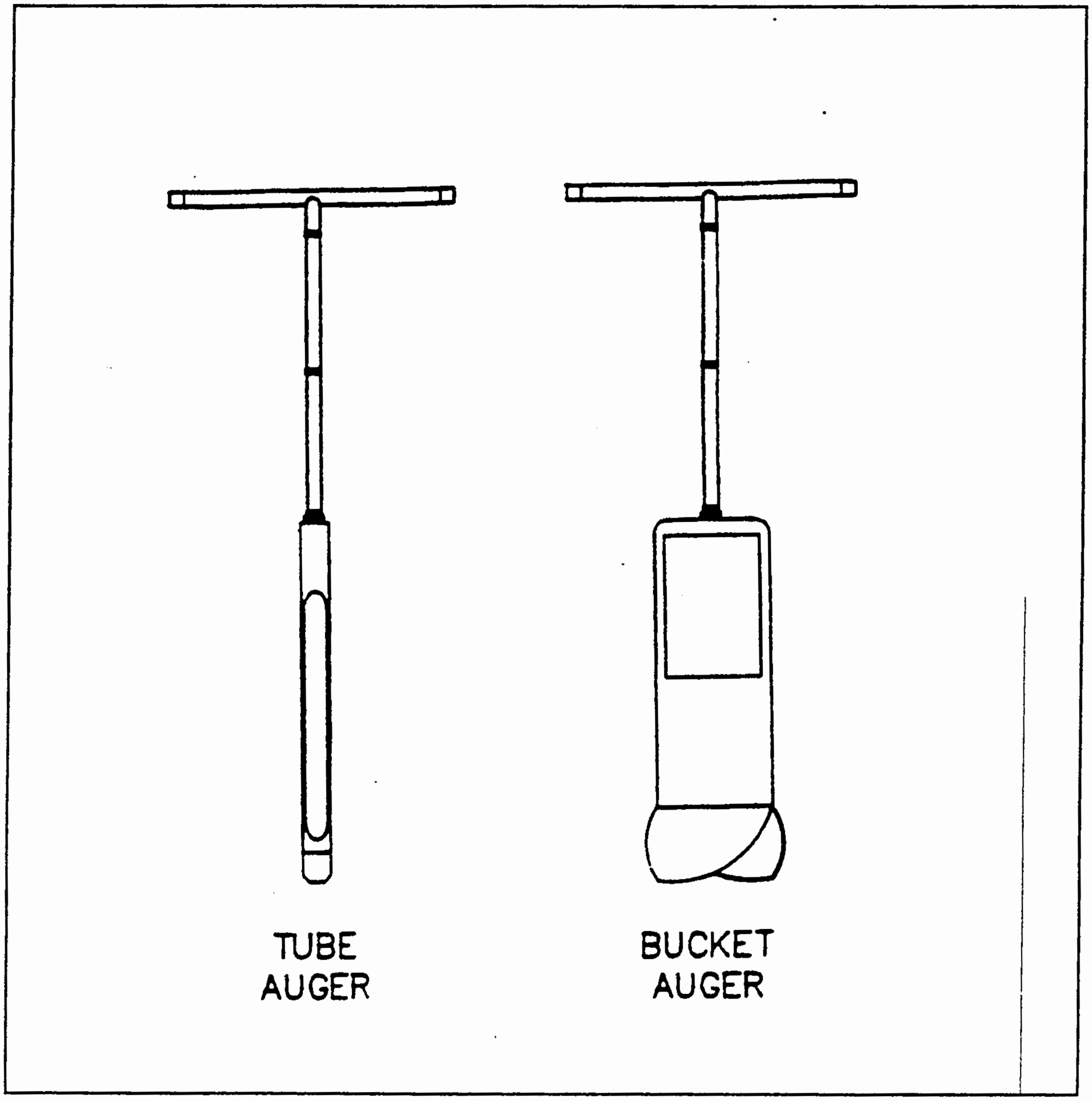
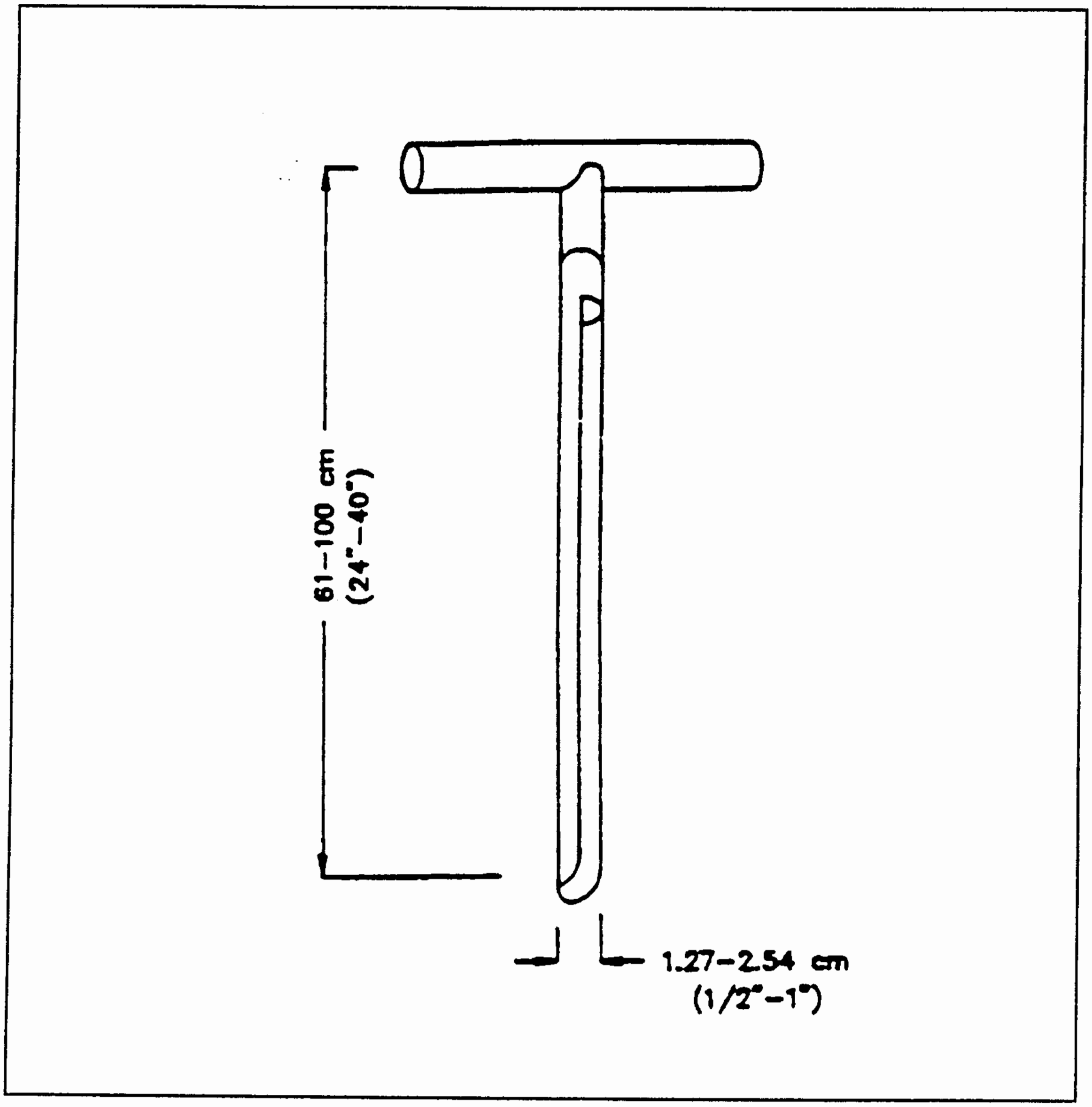


FIGURE 2. Sampling Trier



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PHOTOIONIZATION DETECTOR (PID) HNU

SOP#: 2114
DATE: 10/06/94
REV. #: 0.0

1.0 SCOPE AND APPLICATION

The purpose of this Standard Operating Procedure (SOP) is to describe the procedure for using a photoionization detector (PID). The PID is a portable, nonspecific, vapor/gas detector employing the principle of photoionization to detect a variety of chemical compounds, both organic and inorganic, in air. This procedure is applicable to the HNU PI-101, HNU ISPI-101, and HW-101 used for air monitoring.

These are standard (i.e., typically applicable) operating procedures which may be varied or changed as required, dependent on site conditions, equipment limitations or limitations imposed by the procedure. In all instances, the ultimate procedures employed should be documented and associated with the final report.

Mention of trade names or commercial products does not constitute U.S. Environmental Protection Agency (U.S. EPA) endorsement or recommendation for use.

2.0 METHOD SUMMARY

The PID is a useful general survey instrument at hazardous waste sites. A PID is capable of detecting and measuring real-time concentrations of many organic and inorganic vapors in air. A PID is similar to a flame ionization detector (FID) in application; however, the PID has somewhat broader capabilities in that it can detect certain inorganic vapors. Conversely, the PID is unable to respond to certain low molecular weight hydrocarbons, such as methane and ethane, that are readily detected by FID instruments.

The PID employs the principle of photoionization. The analyzer will respond to most vapors that have an ionization potential less than or equal to that supplied by the ionization source, which is an ultraviolet (UV) lamp. Photoionization occurs when an atom or molecule absorbs a photon of sufficient energy to release an electron and form a positive ion. This will occur when the ionization potential of the molecule in electron volts (eV) is less than the energy of the photon. The sensor is housed in a probe and consists of a sealed ultraviolet light source that emits photons with an energy level high enough to ionize many trace organics, but not enough to ionize the major components of air (e.g., nitrogen, oxygen, carbon dioxide). The ionization chamber exposed to the light source contains a pair of electrodes, one a bias electrode, and the second the collector electrode. When a positive potential is applied to the bias electrode, an electro-magnetic field is created in the chamber. Ions formed by the adsorption of photons are driven to the collector electrode. The current produced is then measured and the corresponding concentration displayed on a meter, directly, in units above background. Several probes are available for the PID, each having a different eV lamp and a different ionization potential. The selection of the appropriate probe is essential in obtaining useful field results. Though it can be calibrated to a particular compound, the instrument cannot distinguish between detectable compounds in a mixture of gases and, therefore, indicates an integrated response to the mixture.

Three probes, each containing a different UV light source, are available for use with the HNU. Energies are 9.5, 10.2, and 11.7 eV. All three detect many aromatic and large molecular hydrocarbons. The 10.2 eV and 11.7 eV probes, in addition, detect some smaller organic molecules and some halogenated hydrocarbons. The 10.2 eV probe is the most useful for environmental response work, as it is more durable than the 11.7 eV probe and detects more compounds than the 9.5 eV probe.

Gases with ionization potentials near to or less than that of the lamp will be ionized. These gases will thus be detected and measured by the analyzer. Gases with ionization potentials higher than that of the lamp will not be detected. Ionization potentials for various atoms, molecules, and compounds are given in

Table 1 (Appendix A). The ionization potential of the major components of air, oxygen, nitrogen, and carbon dioxide, range from about 12.0 eV to about 15.6 eV and are not ionized by any of the three lamps.

Table 2 (Appendix A) illustrates ionization sensitivities for a large number of individual species when exposed to photons from a 10.2 eV lamp. Applications of each probe are included in Table 3 (Appendix A).

While the primary use of the HNU is as a quantitative instrument, it can also be used to detect certain contaminants, or at least to narrow the range of possibilities. Noting instrument response to a contaminant source with different probes can eliminate some contaminants from consideration. For instance, a compound's ionization potential may be such that the 9.5 eV probe produces no response, but the 10.2 eV and 11.7 eV probes do elicit a response.

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE

This section is not applicable to this SOP.

4.0 INTERFERENCES AND POTENTIAL PROBLEMS

4.1 PID Instrument Limitations

1. The PID is a nonspecific total vapor detector. It cannot be used to identify unknown substances; it can only roughly quantify them.

2. The PID must be calibrated to a specific compound.

3. The PID does not respond to certain low molecular weight hydrocarbons, such as methane and ethane. In addition, the HNU does not detect a compound if the probe has a lower energy than the compound's ionization potential.

4. Certain toxic gases and vapors, such as carbon tetrachloride and hydrogen cyanide, have high ionization potentials and cannot be detected with a PID.

5. Certain models of PID instruments are not intrinsically safe. The HNU PI-101 and HW-101 are not designed for use in potentially flammable or combustible atmospheres. Therefore, these models should be used in conjunction with a Combustible Gas Indicator. The ISPI-101 is intrinsically safe, however.

6. Electrical power lines or power transformers may cause interference with the instrument and thus cause measurement errors. Static voltage sources such as power lines, radio transmissions, or transformers may also interfere with measurements.

7. High winds and high humidity will affect measurement readings. The HNU may become unusable under foggy or humid conditions. An indication of this is the needle dropping below zero, or a slow constant climb on the read-out dial.

8. The lamp window must be periodically cleaned to ensure ionization of the new compounds by the probe (i.e., new air contaminants).

9. The HNU measures concentrations from about 1-2000 ppm, although the response is not linear over this entire range. For example, if calibrated to benzene, the response is linear from about 0-600 units above background. This means the HNU reads a true concentration of benzene only between 0 and 600. Greater concentrations are detected at a lower level than the true value.

10. This instrument is not to be exposed to precipitation (rain). The units are not designed for this service.

11. Do not use this instrument for head space analysis where liquids can inadvertently be drawn into the probe.

4.2 Regulatory Limitations

Transport of calibration gas cylinders by passenger and cargo aircraft must comply with International Air Transport Association (IATA) Dangerous Goods

Regulations or the U.S. Code of Federal Regulations, 49 CFR Parts 100-177. A typical calibration gas included with a PID is isobutylene. It is classified as a non-flammable gas, UN #1556 and the proper shipping name is Compressed Gas. It must be shipped by cargo aircraft only.

5.0 EQUIPMENT/APPARATUS

The following equipment is required for PID operation:

C PID (HNU)
C Operating manual
C Probes: 9.5 eV, 10.2 eV, or 11.7 eV
C Battery charger for PID
C Spare batteries
C Jeweler's screwdriver for adjustments
C Tygon tubing
C NBS traceable calibration gas
C "T" valve for calibration
C Field Data Sheets/Site Logbook
C Intake assembly extension
C Strap for carrying PID
C Teflon tubing for downhole measurements
C Plastic bags for protecting the PID from moisture and dirt

Note: Battery charge status - This instrument may be kept on continuous charge without battery damage.

6.0 REAGENTS

C Isobutylene standards for calibration
C Benzene reference standard
C Methanol for cleaning ionization chamber (GC grade)
C Mild soap solution for cleaning unit surfaces
C Specific gas standards when calibrating to a specific compound
C Light source cleaning compound Cat. No. PA101534-A1 (For use only with 9.5 and 10.2 lamps)

The HNU is calibrated in accordance with the operations manual using isobutylene as the calibration standard. The operations manual may also be referred to for alternate calibration to a specific compound.

7.0 PROCEDURES

7.1 Preparation

Check out and ensure the proper operation of the PID, as appropriate, using the equipment checklist provided in Sections 5.0 and 6.0 and the steps listed below.

7.2 Start-Up Procedures

1. Allow the temperature of the unit to equilibrate to its surrounding. This should take about five minutes.

2. Attach the probe to the read-out unit. Match the alignment key, then twist the connector clockwise until a distinct locking is felt. Make sure the microswitch (red button) is depressed by the locking ring.

3. Turn the FUNCTION switch to the battery check position. Check to ensure that the indicator reads within or beyond the green battery arc on the scale plate. If the indicator is below the green arc, or if the red LED comes on, the battery must be charged prior to using.

4. To zero the instrument, turn the FUNCTION switch to the STANDBY position and rotate the ZERO POTENTIOMETER until the meter reads zero. Wait 15-20 seconds to ensure that the zero adjustment is stable; if not, then readjust.

5. Check to see that the SPAN POTENTIOMETER is set at the appropriate setting for the probe being used (i.e., 9.8 for the 10.2 eV probe, 5.0 for the 11.7 eV probe, 1 for the 9.5 eV probe. Note: The setting may vary based on the intensity of the light source).

6. Set the FUNCTION switch to the desired range (i.e., 0-20, 0-200, 0-2000).

7. Listen for the fan operation to verify fan function.

8. Look for ultraviolet light source in the probe to verify function. Do not look at light source from closer than six inches with unprotected eyes, observe only briefly.

9. Check instrument with an organic point source, such as a magic marker, prior to survey to verify instrument function.

10. Routinely during the day, verify the useful battery life by turning the function switch to BATT and schedule the instrument's use accordingly.

7.3 Field Operation

7.3.1 Field Calibration

1. Follow the start-up procedure in Section 7.2.

2. Set the FUNCTION switch to the range setting which includes the concentration of the calibration gas.

3. Attach a regulator to a disposable cylinder of calibration gas. Connect the regulator to the probe of the HNU with a piece of clean tygon tubing. Open the valve on the regulator.

4. After 15 seconds, the meter reading should equal the response value as indicated on the calibration gas cylinder used. If the reading is within ±15% of the response value, then the instrument can be field calibrated to the response value using the external SPAN ADJUSTMENT control. The SPAN ADJUSTMENT control should be adjusted to a lower setting until the correct reading has been obtained. The lower the number on the SPAN ADJUSTMENT conrol, the greater the instrument sensitivity. If the SPAN ADJUSTMENT control has to be adjusted below a setting of 4.00, the unit should be red-tagged and returned for repairs.

5. If the meter reading is greater than ±15% of the response value of the calibration gas used, then the instrument should be red-tagged and returned for re-calibration.

6. Record the following information in the site logbook: the instrument ID number (U.S. EPA decal or serial number if the instrument is a rental), the initial and final span settings, the date and time, concentration and type of calibration gas used, and the name of the person who field calibrated the instrument.

7. If the PID does not start up, check out, or calibrate properly, the instrument should not be used. Under no circumstances is work requiring air monitoring with a PID to be done without a proper functioning instrument.

8. In some field applications, with the exception of the probe's inlet and exhaust, the PID should be wrapped in clear plastic to prevent it from becoming contaminated and to prevent water from getting inside in the event of precipitation.

7.3.2 Operation

1. All readings are to be recorded in the site logbook. Readings should be recorded, following background readings, as "units above background," not ppm.

2. As with any field instrument, accurate results depend on the operator being completely familiar with the operator's manual. The instructions in the operating manual should be followed explicitly in order to obtain accurate results.

3. Position the probe assembly close to the area to be monitored because the low sampling rate allows for only very localized readings. Under no circumstances should the probe tip assembly be immersed in fluid.

4. While taking care to prevent the PID from being exposed to excessive moisture, dirt, or contamination, monitor the work activity as specified in the site Health and Safety Plan. The PID survey should be conducted at a slow to moderate rate of speed and the intake assembly (the probe) slowly swept from side to side. There is a three to five second delay in read-out depending upon the instruments sensitivity to the contaminant.

5. During drilling activities, PID monitoring is performed at regular intervals downhole, at the headspace, and in the breathing zone. In addition, where elevated organic vapor levels are encountered, monitoring may be performed in the breathing zone during actual drilling. When the activity being monitored is other than drilling, readings should emphasize breathing zone conditions.

6. When the activity is completed or at the end of the day, carefully clean the outside of the PID with a damp disposable towel to remove any visible dirt.

7.4 Post Operation

1. Turn FUNCTION Switch to OFF.

2. Return the PID to a secure area and check the calibration (Section 7.3.1.) before charging. Connect the instrument to charger and plug in the charger. The probe must be connected to the readout unit to charge the HNU.

3. Complete logbook entries, verifying the accuracy of entries and signing/initialing all pages. Following completion of a series of "0" readings, verify the instrument is working as in Section 7.3.1.

4. Check the equipment, repair or replace damaged equipment, and charge the batteries.

7.5 Equipment Calibration

1. Follow the start-up procedure in Section 7.2.

2. Set the FUNCTION switch to the range setting which includes the concentration of the calibration gas.

3. Attach a regulator to a cylinder of calibration gas. Connect the regulator to the probe of the NHU with a piece of clean tygon tubing. Open the valve on the regulator.

4. After 15 seconds, the meter reading should equal the response value as indicated on the calibration gas cylinder used. If the reading is greater than ±15% of the actual concentration, an internal calibration is necessary. Unlock the SPAN POTENTIOMETER dial before adjusting it. Adjust the SPAN POTENTIOMETER to the span setting recommended for the probe being used (i.e., 9.8 for the 10.2 eV probe, 5.0 for the 11.7 eV probe, 1 for the 9.5 eV probe). To calibrate the instrument, unscrew the bottom support screw and lift the instrument out of the case. Locate and adjust the trimpot "R-32" (near the top of the printed circuit board) by inserting a small screwdriver and gently turning. When the instrument gives the correct reading for the calibration gas being used, reassemble it.

5. Record the following information in the calibration logbook: the instrument identification number (U.S. EPA barcode number or serial number if the instrument is a rental), the initial and final span settings, the date and time, concentration and type of calibration gas used, and the name of the person who calibrated the instrument. Affix a sticker to the instrument indicating the person who performed the calibration, the date of calibration, and the due date of the next calibration.

6. Turn the FUNCTION switch to OFF and connect the instrument to the charger. The probe must be connected to the readout unit to ensure that the unit accepts a charge.

8.0 CALCULATIONS

The HNU is a direct reading instrument. Readings are interpreted as units above background rather than ppm.

9.0 QUALITY ASSURANCE/ QUALITY CONTROL

There are no specific quality assurance activities which apply to the implementation of these procedures. However, the following general QA procedures apply:

1. All data must be documented on field data sheets or within site logbooks.

2. All instrumentation must be operated in

accordance with operating instructions as supplied by the manufacturer, unless otherwise specified in the work plan. Equipment checkout and calibration activities must occur prior to sampling/operation, and they must be documented.

10.0 DATA VALIDATION

This section is not applicable to this SOP.

11.0 HEALTH AND SAFETY

When working with potentially hazardous materials, follow U.S. EPA, OSHA, or corporate health and safety practices.

The HNU is certified by OSHA standards for use in Class 1, Division 2, Groups A, B, C, and D locations.

12.0 REFERENCES

HNU Systems, Inc. 1975. "Instruction Manual for Model PI-101 Photoionization Analyzer."

U.S. Code of Federal Regulations, 49 CFR Parts 100 to 177, Transportation, revised November 1, 1985.

U.S. Environmental Protection Agency. 1984. "Characterization of Hazardous Waste Sites - A Methods Manual: Volume II, Available Sampling Methods, Second Edition", EPA-600/4-84-076, Environmental Monitoring Systems Laboratory, Office of Research and Development, Las Vegas, Nevada.

International Air Transport Association Dangerous Goods Regulations

APPENDIX A (Cont'd)

Tables

TABLE 1. Ionization Potentials (Continued)

AROMATIC COMPOUNDS

Molecule	IP (eV)	Molecule	IP (eV)
Benzene	9.245	Phenyl isothiocyanate	8.520
Toluene	8.82	Benzonitrile	9.705
Ethyl benzene	3.76	Nitrobenzene	9.92
n-propyl benzene	8.72	Aniline	7.70
i-propyl benzene	8.69	Fluoro-benzene	9.195
n-butyl benzene	8.69	Chloro-benzene	9.07
s-butyl benzene	8.68	Bromo-benzene	8.98
t-butyl benzene	8.68	Iodo-benzene	8.73
o-xylene	8.56	o-dichlorobenzene	9.07
m-xylene	8.56	m-dichlorobenzene	9.12
p-xylene	8.445	p-dichlorobenzene	8.94
Mesitylene	8.40	1-chloro-2-fluorobenzene	9.155
Durene	8.025	1-chloro-3-fluorobenzene	9.21
Styrene	8.47	1-bromo-4-fluorobenzene	8.99
o-methyl styrene	8.35	o-fluorotoluene	8.915
Ethynylbenzene	8.815	m-fluorotoluene	8.915
Napthalene	8.12	p-fluorotoluene	8.785
1-methylnapthalene	7.69	o-chlorotoluene	8.83
2-methylnapthalene	7.955	m-chlorotoluene	8.83
Biphenyl	8.27	p-chlorotoluene	8.70
Phenol	8.50	o-bromotoluene	8.79
Anisole	8.22	m-bromotoluene	8.81
Phenetole	8.13	p-bromotoluene	8.67
Benzaldehyde	9.53	o-iodotoluene	8.62
Acetophenone	9.27	m-iodotoluene	8.61
Benzenethiol	8.33	p-iodotoluene	8.50
Phenyl isocyanate	8.77	Benzotrifluoride	9.68
		o-fluorophenol	8.66

MONITOR WELL INSTALLATION

SOP#: 2048
DATE: 03/18/96
REV. #: 0.0

1.0 SCOPE AND APPLICATION

The purpose of this standard operating procedure (SOP) is to provide an overview of the methods used for groundwater monitor wells. Monitor well installation create permanent access for collection of samples to assess groundwater quality and the hydrogeologic properties of the aquifer in which contaminants may exist. Such wells should not alter the medium which is being monitored.

The most commonly used drilling methods are: the hollow-stem auger, cable tool, and hydraulic rotary. Rotary drilling can utilize mud rotary or air rotary methods.

These are standard (i.e., typically applicable) operating procedures which may be varied or changed as required, depending on site conditions, equipment limitations, or limitations imposed by the procedures themselves. In all instances, the ultimate procedures employed should be documented and described in the final report as well as in logbooks.

2.0 METHOD SUMMARY

There is no ideal monitor well installation method for all conditions therefore, hydrogeologic conditions at the site as well as project objectives must be considered before deciding which drilling method is appropriate.

2.1 Hollow-Stem Augering

Outside diameters of hollow-stem augers generally range from 6 1/4 inches to 22 inches with corresponding inner diameters ranging from 2 1/4 inches to 13 inches. Auger lengths are usually 5 feet which allows easy handling. However, lengths of 10 or 20 feet may be used for deeper holes drilled with machines capable of handling the extended lengths. Formation samples can be taken in a number of ways, depending on the accuracy required. Cuttings may suffice for shallow depths but become less representative with depth, particularly below the water table. The most accurate samples are obtained with various coring devices, such as split spoons or shelby tubes which can be used inside the augers. Continuous cores can also be taken with a thin-walled tube which is inserted into the lowest auger and locked in place. The tube is retracted with a wire line and hoist after the hole has been advanced the length of the auger. A bottom plug in the cutting head or bit prevents cuttings from entering the augers until the first core sample is taken and the plug is knocked out.

In unconsolidated material, the augers serve as a temporary casing and gravel-packed wells can be constructed inside the augers and then the augers withdrawn. Well development is usually less difficult than with wells drilled by the mud rotary method because a bentonite drilling fluid is not normally used.

2.2 Cable Tool Drilling

Cable tool drilling is a percussion method in which a bit, attached to a drilling string, is lifted and dropped. The drilling string, consists (bottom to top) of the bit, drill stem, drilling jars, socket, and wire cable. A walking beam on the drilling rig provides the lifting and dropping motion to the wire cable and hence to the drilling string. The repeated action breaks or loosens the formation material which mixes with formation water or water added to the hole by the operator to form a slurry. The slurry facilitates removal of the cuttings which are periodically removed from the hole with a bailer. In unconsolidated formations, steel casing must be driven or pushed into the ground as the drilling progresses in order to prevent hole collapse. A hardened steel drive shoe on the bottom end of the casing prevents damage during driving. A well may then be constructed inside the steel casing and the casing pulled back. In consolidated formations, the casing may be driven through the weathered zone, and seated in solid rock. The hole below the casing may remain open or may be fitted with a smaller diameter inner casing and screen, depending on the sampling requirements. Depending on formation material, extensive well development may often not be necessary.

2.3 Rotary Drilling

2.3.1 Mud Rotary Method

In the mud rotary method the drill bit is rotated rapidly to cut the formation material and advance the borehole. The drill bit is attached to hollow drilling rods which transfer power from the rig to the bit. In conventional rotary drilling, cuttings are removed by pumping drilling fluid (water, or water mixed with bentonite or other additives) down through the drill rods and bit, and up the annulus between the borehole and the drill rods. The drilling fluid flows into a mud pit where the cuttings settle out and then is pumped back down the drill rods. The drilling fluid also cools the bit and prevents the borehole from collapsing in unconsolidated formations.

Sampling may be done from the cuttings but samples are generally mixed and the amount of fine material may not be accurately represented. Coring may be done through the drill rods and bit if a coring bit (with a center opening big enough to allow passage of the coring tube) is used. When drilling unconsolidated formations, a temporary surface or shallow casing may have to be installed in order to prevent cross-contamination, hole collapse, or wall erosion by the drilling fluid. Casing (riser pipe), screen, and gravel pack are usually installed in the open hole or through the surface casing. Once the well is constructed, extensive well development may be necessary in order to remove drilling fluid from the formation.

2.3.2 Air Rotary Method

The air rotary method uses air as the drilling fluid. Air is forced down the drill rods by an air compressor, escapes out of the bit and returns to the surface in the annular space between the hole wall and the drill string. Cuttings are moved out of the hole by the ascending air and collect around the rig. Cuttings are mixed and may not always be representative of the depth currently being drilled. In the conventional air rotary method, the drill string operates in a manner similar to that described for the mud rotary system. In a "hammer" or "down-the-hole" air rotary method, the bit is pneumatically driven rapidly against the rock in short strokes while the drilling string slowly rotates. The use of air rotary methods are generally limited to consolidated and semi-consolidated formations. Casing is often used in semi-consolidated formations and through the weathered portion of consolidated formations to prevent hole collapse. In environmental work, the air supply must be filtered to prevent introduction of contamination into the borehole.

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE

Often, a primary objective of the drilling program is to obtain representative lithologic or environmental samples. The most common techniques for retrieving samples are:

In unconsolidated formations:

- Split spoon sampling, carried out continuously or at discrete intervals during drilling, as summarized in ASTM Method D-1586-84, Split Barrel Sampling
- Shelby tube sampling when an undisturbed sample is required from clayey or silty soils, especially for geotechnical evaluation or chemical analysis
- Cutting collection when a general lithologic description and approximate depths are sufficient

In consolidated formations:

- Rock coring at continuous or discrete intervals
- Cutting collection when a general lithologic description and approximate depths are sufficient

When collecting environmental samples, the amount of sample to be collected and the proper sample container type (i.e., glass, plastic), chemical preservation, and storage requirements are dependent on the matrix being sampled and the parameter(s) of interest. Sample preservation, containers, handling and storage for air and waste samples are discussed in the specific SOPs for the technique selected.

4.0 INTERFERENCES AND POTENTIAL PROBLEMS

Advantages and disadvantages of the various drilling methods are summarized below.

4.1 Auger Drilling

The advantages of auger drilling are:

C Relatively fast and inexpensive

C Because augers act as temporary casing, drilling fluids are not used resulting in reduced well development

The disadvantages of auger drilling are:

C Very slow or impossible to use in coarse materials such as cobble or boulders

C Cannot be used in consolidated formations and is generally limited to depths of approximately 100 feet in order to be efficient

4.2 Cable Tool Drilling

The advantages of cable tool drilling are:

C Relatively inexpensive with minimum labor requirements

C The water table and water bearing zones are easily identified

C Driven casing stabilizes borehole and minimizes potential for cross-contamination

C Especially successful in drilling caving formations or formations containing boulders

C Accurate formation samples can usually be obtained from cuttings

The disadvantages of cable tool drilling are:

C Extremely slow rate of drilling

C Necessity to drive casing may limit depth in large diameter holes.

4.3 Rotary Drilling

4.3.1 Mud Rotary Drilling

The advantages of mud rotary drilling are:

C Fast, more than 100 feet of borehole advancement per day is common

C Provides an open borehole, necessary for some types of geophysical logging and other tests

The disadvantages of mud rotary drilling are:

C Potential for cross-contamination of water-bearing zones

C Drill cuttings may be mixed and not accurately represent lithologies at a given drilling depth

C Drilling mud may alter the groundwater chemistry

C Water levels can only be determined by constructing wells

C Drilling mud may change local permeability of the formation and may not be entirely removed during well development

C Disposal of large volumes of drilling fluid and cuttings may be necessary if they are contaminated

4.3.2 Air Rotary Drilling

The advantages of air rotary drilling are:

C Fast, more than 100 feet of borehole advancement a day is possible

C Preliminary estimates of well yields and water levels are often possible

C No drilling fluid to plug the borehole

The disadvantages of air rotary drilling are:

C Generally cannot be used in unconsolidated formations

C In contaminated zones, the use of high-pressure air may pose a significant hazard to the drill crew because of transport of contaminated material up the hole

C Introduction of air to the groundwater could reduce concentration of volatile organic compounds

5.0 EQUIPMENT

The following equipment is necessary for the site geologist:

C Metal clipboard box case (container for well logs)
C Ruler
C Depth sounder
C Water level indicator
C All required health and safety gear
C Sample collection jars
C Trowels
C Description aids (Munsell color chart, grain size charts, etc.)
C Geolis® Logbooks (Appendix A)
C Field Logbook

Equipment and tools to install the well are normally provided by the drilling contractor.

6.0 REAGENTS

Reagents are not required for preservation of soil samples. Samples should, however, be cooled to 4° C and protected from sunlight in order to minimize any potential reaction due to the light sensitivity of the sample. Decontamination of drilling equipment should follow the Sampling Equipment Decontamination SOP and the site-specific work plan.

7.0 PROCEDURES

7.1 Preparation

All drilling and well installation programs must be planned and supervised by a professional geologist/hydrogeologist.

The planning, selection and implementation of any monitor well installation program should include the following:

C Review of existing data on site geology and hydrogeology including publications, air photos, water quality data, and existing maps. These may be obtained from local, state or federal agencies

C Assesment of the site to determine potential access problems for drill rig, locate water supply sources, establish equipment storage area, and observe outcrops

C Perform utilities check, note location of underground utilities and of overhead electrical wires

C Preparation of a Site Safety Plan

C Select drilling, sampling and well development methods

C Determination of well construction specifications (i.e., casing and screen materials, casing and screen diameter, screen length and screen interval, filter pack and screen slot size)

C Determination of the need for containing drill cuttings and fluids and their method of disposal

C Preparation of work plan including all of the above

C Preparation of and execute the drilling contract

7.2 Field Preparation

Prior to mobilization, the drill rig and all associated equipment should be thoroughly decontaminated by a steam/pressure washer to remove all oil, grease, mud, etc. Before drilling each boring, all the "down-the-hole" drill equipment should be steam cleaned and rinsed with potable water to minimize cross-contamination. Special attention should be given to the threaded section of the casings, and to the drill rods. All drilling equipment should be steam-cleaned at completion of the project to ensure that no contamination is transported to or from the sampling site.

7.3 Well Construction

The well casing material should not interact with the groundwater. Well casings for environmental projects are usually constructed of polyvinyl chloride (PVC), Teflon^{TM}, fiberglass, or stainless steel. Details of the construction methods are given in Sections 7.3.1 and 7.3.2.

7.3.1 Bedrock Wells

Wells completed in bedrock will be drilled using the air or mud rotary method. Crystalline rock wells are usually drilled most efficiently with the air rotary method while consolidated sedimentary formations are drilled using either the air rotary or mud rotary method. The compressed air supply will be filtered prior to introduction into the borehole to remove oil or other contaminants. Bedrock wells may be completed as an open-hole, providing that borehole cave-in is not a possibility.

Bedrock wells will be advanced with air or mud rotary methods until a minimum of 5 feet of competent rock has been drilled. Minimum borehole diameter will be 8 inches. The drill string will then be pulled from the borehole and 6-inch I.D. Schedule 80 or 40 PVC casing inserted. Portland cement/bentonite grout will be pumped into the hole and up the annular space outside the casing. After the grout has set (minimum of 24 hours), the cement will be drilled out and the borehole advanced to the desired depth. Figure 1 (Appendix B) shows typical construction details for an open-hole bedrock well.

The preferred method of well completion for the bedrock wells will be open-hole. However, if the open borehole is subject to cave-in, the well(s) will be completed as screened and cased sand-packed wells. For details of completion see Section 7.3.2.

7.3.2 Overburden Well Construction

Any of the drilling methods discussed in this SOP can be used to drill or set a well in the overburden. The hollow-stem method is the preferred choice for shallow (<100 ft.) overburden wells because the well can be constructed inside of the augers. Details of the construction are provided below and are shown in Figure 2 (Appendix B).

1. The screen slot size will be determined by the site hydrologist, based upon sand-pack size. The length of screen used will be site-dependent. Casing sections will be flush-threaded. Screw-threaded bottom plugs will be used. To prevent introduction of contaminants into the well, no glue-connected fittings will be used. Each piece of PVC pipe, screen, and the bottom plug will be steam-cleaned before lowering into the borehole. The site hydrogeologist is responsible for the supervision of all steam cleaning procedures.

2. The annular space between the well screen and the borehole wall will be filled with a uniform gravel/sand pack to serve as a filter media. For wells deeper than approximately 50 feet, or when recommended by the site geologist, the sand pack will be emplaced using a tremie pipe. A sand slurry composed of sand and potable water will be pumped through the tremie pipe into the annulus throughout the entire screened interval, and over the top of the screen. Allowance must be made for settlement of the sand pack.

3. The depth of the top of the sand will be determined using the tremie pipe, thus verifying the thickness of the sand pack. Additional sand shall be added to bring the top of the sand pack to approximately 2 to 3 feet above the top of the well screen. Under no circumstances should the sand pack extend into any aquifer other than the one to be monitored. In most cases, the well design can be modified to allow for a sufficient sand pack without threat of crossflow between producing zones through the sand pack.

4. In materials that will not maintain an open hole using hollow-stem augers, the temporary or outer casing will be withdrawn gradually during placement of sand pack/grout. For example, after filling two feet with sand pack, the outer casing should be withdrawn 2 feet. This step of placing more gravel and withdrawing the outer casing should be repeated until the level of the sand pack is approximately 3 feet above the top of the well screen. This ensures that there is no locking of the permanent (inner) casing in the outer casing.

5. A bentonite seal of a minimum 2-foot vertical thickness will be placed in the annular space above the sand pack to separate the sand pack from the cement surface seal. The bentonite will be placed through a tremie pipe or poured directly into the annular space, depending upon the depth and site conditions. The bentonite will be pourable pellets. The hydrogeologist will record the start and stop times of the bentonite seal emplacement, the interval of the seal, the amount of bentonite that was used, and problems that arise. The type of bentonite and the supplier will also be recorded.

   A cap placed over the top of the well casing before pouring the bentonite pellets will prevent pellets from entering the well casing.

6. If a slurry of bentonite is used as annular seal, it is prepared by mixing powdered or granular bentonite with potable water. The slurry must be of sufficiently high specific gravity and viscosity to prevent its displacement by the grout to be emplaced above it. As a precaution (regardless of depth) and depending on fluid viscosity, a few handfuls of bentonite pellets may be added to solidify the bentonite slurry surface.

7. Cement and/or bentonite grout is placed from the top of the bentonite seal to the ground surface.

   Only Type I or II cement without accelerator additives may be used. An approved source of potable water must be used for mixing grouting materials. The following mixes are acceptable:

C Neat cement, a maximum of 6 gallons of water per 94 pound bag of cement

C Granular bentonite, 1.5 pounds of bentonite per 1 gallon of water

C Cement-bentonite, 5 pounds of pure bentonite per 94 pound bag of cement with 7-8 gallons of water

C Cement-bentonite, 6 to 8 pounds of pure bentonite per 94 pound bag of cement with 8-10 gallons of water, if water mixed

C Non-expandable cement, mixed at 7.5 gallons of water to one half (1/2) teaspoon of Aluminum Hydroxide, 94 pounds of neat cement (Type I) and 4 pounds of bentonite

C Non-expandable cement, mixed at 7 gallons of water to one half (1/2) teaspoon of Aluminum Hydroxide, 94 pounds of neat cement (Type I and Type II)

8. Grout is pumped through a tremie pipe (normally a 1.25-inch PVC or steel pipe) to the bottom of the annulus until undiluted grout flows from the annulus at the ground surface

9. In materials that will not maintain an open hole, the temporary steel casing should be withdrawn in a manner that prevents the level of grout from dropping below the bottom of the casing.

10. Additional grout may be added to compensate for the removal of the temporary casing and the tremie pipe to ensure that the top of the grout is at or above ground surface. After the grout has set (about 24 hours), any depression due to settlement is filled with a grout mix similar to that described above.

11. The protective casing should now be set. Casing may be a 5 foot minimum length of black iron or galvanized pipe extending about 1.5 to 3 feet above the ground surface, and set in concrete or cement grout. The protective casing diameter should be 4 inches greater than the well casing. A 0.5-inch drain hole may be installed near ground level. A flush-mount protective casing may also be used in areas of high traffic or where access to other areas would be limited by a well stick-up.

12. A protective steel cap, secured to the protective casing by a padlock, should be installed.

13. Steel guard posts should be installed around the protective casing in areas where vehicle traffic may be a problem. Posts should have a minimum diameter of 3 inches and be a

minimum of 4 feet high.

14. All monitor wells should be labelled and dated with paint or steel tags.

7.4 Well Development

Well development is the process by which the aquifer's hydraulic conductivity is restored by removing drilling fluids, and fine-grained formation material from newly installed wells. Two methods of well development that are commonly used are surging and bailing, and overpumping. A well is considered developed when the pH and conductivity of the groundwater stabilizes and the measured turbidity is <50 nephelometric turbidity units (NTUs).

Surging and bailing will be performed as follows:

1. Measure the total depth (TD) of the well and depth to water (DTW).

2. Using an appropriately sized surge block, surge 5-foot sections of well screen, using 10-20 up/down cycles per section. Periodically remove the surge block and bail accumulated sediment from the well, as required.

3. For open-hole wells, a 6-inch surge block will be used inside the cased portion of the well. Sediments will be bailed periodically, as required. Overpumping may be used in combination with surging and bailing for development of bedrock wells. The method(s) used will be based on field conditions encountered, and will be determined by the site hydrogeologist. However, sediment will initially be removed from the wells by bailing in order to minimize the volume of development water generated.

The pump used must be rated to achieve the desired yield at a given depth. The pump system should include the following:

C A check valve to prevent water from running back into the well when the pump is shut off
C Flexible discharge hose
C Safety cable or rope to remove the pump from the well
C Flow meter monitoring system (measuring bucket or inline flow meter)
C Generator
C Amp meter, to measure electrical current (load)

The amp meter is used to monitor pump performance. If the pump becomes clogged, the current will increase due to stress on the pump. If the water level drops below the intake ports, the current will drop due to decreased resistance on the pump.

8.0 CALCULATIONS

To maintain an open borehole during rotary drilling, the drilling fluid must exert a pressure greater than the formation pore pressure. Typical pore pressures for unconfined and confined aquifers are 0.433 define (psi/ft) and 0.465 psi/ft, respectively.

The relationship for determining the hydrostatic pressure of the drilling fluid is:

Hydrostatic Pressure (psi) = Fluid Density (lb/gal) x Height of Fluid Column (ft) x 0.052

The minimum grout volume necessary to grout a well can be calculated using:

Grout Vol (ft^3) = Vol of Borehole (ft^3) - Vol of Casing (ft^3) = $L\,(r_B^2 - r_C^2)$

where:

L = length of borehole to be grouted (ft)
r_B = radius of boring (ft)
r_C = radius of casing (ft)

9.0 QUALITY ASSURANCE/ QUALITY CONTROL

There are no specific quality assurance activities that apply to the implementation of these procedures. However, the following general QA procedures apply:

1. All data must be documented on standard well completion forms, field data sheets or within field/site logbooks. Descriptive logs, pump tests, and well completion date are entered on Geolis® forms. The Geolis® forms are used to ensure data is collected uniformly by all Site Geologists and provide

input to a standardized computer well file. Appendix A contains examples of Geolis® forms used to record descriptions of geologic samples.

2. All instrumentation must be operated in accordance with operating instructions as supplied by the manufacturer, unless otherwise specified in the work plan. Equipment checkout and calibration activities must occur prior to sampling/operation and must be documented.

10.0 DATA VALIDATION

This section is not applicable to this SOP.

11.0 HEALTH AND SAFETY

Drilling rigs and equipment present a variety of safety hazards. REAC personnel working around drilling rigs should know the position of the emergency "kill" switch. Wirelines and ropes should be inspected and frayed or damaged sections discarded. Swivels and blocks should turn freely. Gages should be operational and controls clearly marked. All underground utilities should be clearly marked, and drillers should be aware of any overhead hazards such as power lines. Avoid drilling in these areas. Ear protection should be worn when working around drilling equipment for extended periods of time, particularly air rotary equipment. Failure to follow safety procedure or wear the proper personal protection gear on the part of either the drilling crew or REAC personnel may result in dismissal from the job.

When working with potentially hazardous materials, follow U.S. EPA, OSHA, and corporate health and safety practices.

12.0 REFERENCES

American Society for Testing and Materials. 1991. Annual Book of ASTM Standards. Designation: D5092-90 Standard Practice for Design and Installation of Groundwater Monitoring Wells in Aquifers. p. 1081-1092. Philadelphia, PA.

Boateng, K., P.C. Evens, and S.M. Testa. 1984. "Groundwater Contamination of Two Production Wells: A Case History." *Groundwater Monitoring Review*, V.4, No. 2, p. 24-31.

Keely, J.F. and Kwasi Boateng. 1987. "Monitoring Well Installation, Purging, and Sampling Techniques - Part 1: Conceptualizations." *Groundwater* V. 25, No. 3, p. 300-313.

Keely, J.F. and Kwasi Boateng. 1987. "Monitoring Well Installation, Purging, and Sampling Techniques - Part 2: Case Histories." *Groundwater* V. 25, No. 4, p. 427-439.

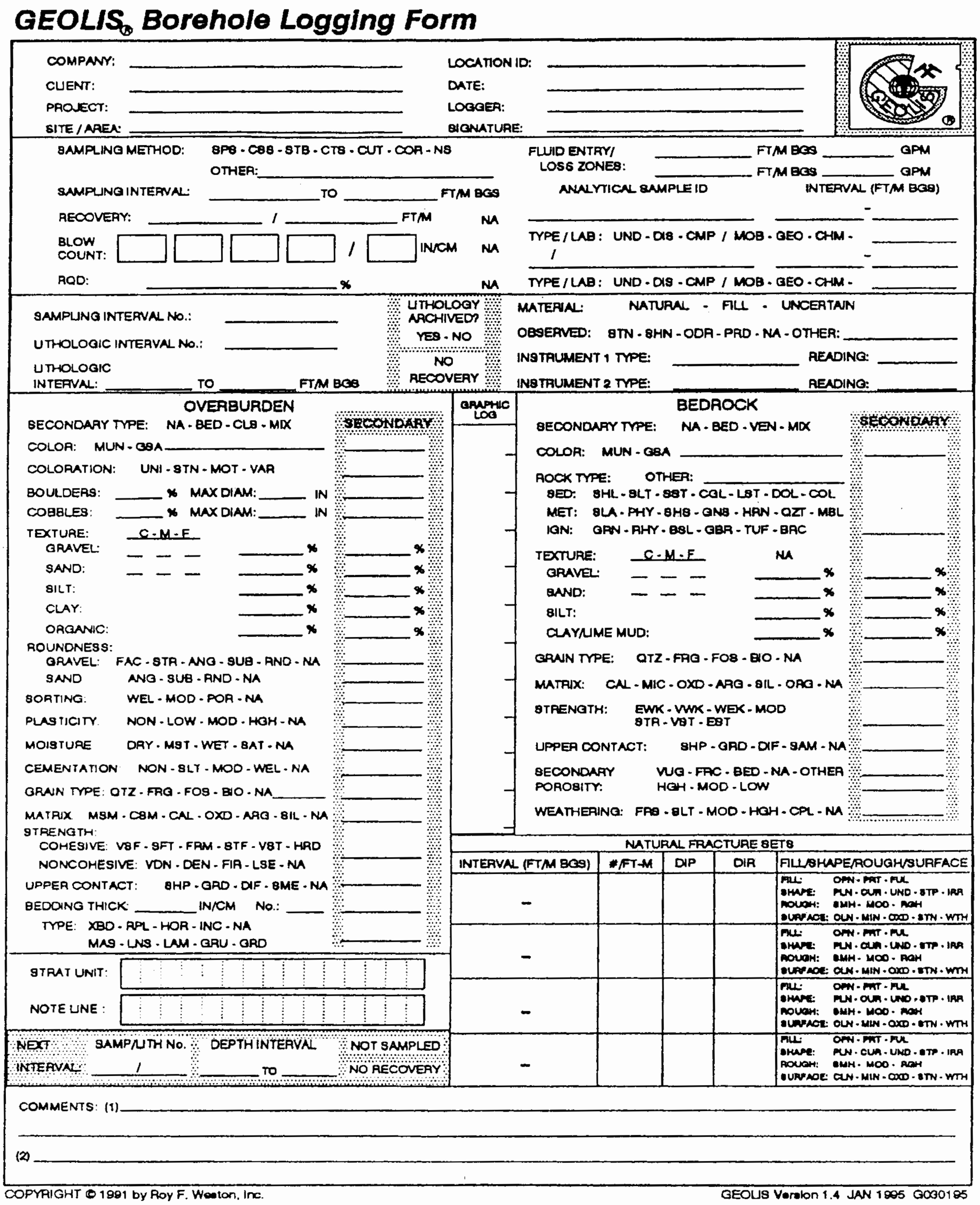
Driscoll, F.G. 1986. *Groundwater and Wells* (2nd ed.): Johnson Division, UOP Inc., St. Paul, MN. p. 1089

U.S. EPA. 1987. A Compendium of Superfund Field Operations Methods. EPA/540/p-87/001 Office of Emergency and Remedial Responses. Washington, DC.

APPENDIX A

Geolis Forms

Form 1. Geolis® Borehole Logging Form



GEOLIS® Borehole Logging Form

COMPANY: ________
CLIENT: ________
PROJECT: ________
SITE / AREA: ________

LOCATION ID: ________
DATE: ________
LOGGER: ________
SIGNATURE: ________

SAMPLING METHOD: SPS - CSS - STB - CTS - CUT - COR - NS
OTHER: ________
SAMPLING INTERVAL: ________ TO ________ FT/M BGS
RECOVERY: ________ / ________ FT/M NA
BLOW COUNT: ☐ ☐ ☐ ☐ / ☐ IN/CM NA
RQD: ________ % NA

FLUID ENTRY/ LOSS ZONES: ________ FT/M BGS ________ GPM
________ FT/M BGS ________ GPM

ANALYTICAL SAMPLE ID ________ INTERVAL (FT/M BGS) ________ - ________
TYPE / LAB: UND - DIS - CMP / MOB - GEO - CHM -
/ ________ ________ - ________
TYPE / LAB: UND - DIS - CMP / MOB - GEO - CHM -

SAMPLING INTERVAL No.: ________
LITHOLOGIC INTERVAL No.: ________
LITHOLOGIC INTERVAL: ________ TO ________ FT/M BGS

LITHOLOGY ARCHIVED? YES - NO
NO RECOVERY

MATERIAL: NATURAL - FILL - UNCERTAIN
OBSERVED: STN - SHN - ODR - PRD - NA - OTHER: ________
INSTRUMENT 1 TYPE: ________ READING: ________
INSTRUMENT 2 TYPE: ________ READING: ________

OVERBURDEN — SECONDARY

SECONDARY TYPE: NA - BED - CLS - MIX
COLOR: MUN - GSA ________ | ________
COLORATION: UNI - STN - MOT - VAR | ________
BOULDERS: ________ % MAX DIAM: ________ IN | ________
COBBLES: ________ % MAX DIAM: ________ IN | ________
TEXTURE: C - M - F
GRAVEL: __ __ __ ________ % | ________ %
SAND: __ __ __ ________ % | ________ %
SILT: ________ % | ________ %
CLAY: ________ % | ________ %
ORGANIC: ________ % | ________ %
ROUNDNESS:
GRAVEL: FAC - STR - ANG - SUB - RND - NA | ________
SAND ANG - SUB - RND - NA | ________
SORTING: WEL - MOD - POR - NA | ________
PLASTICITY: NON - LOW - MOD - HGH - NA | ________
MOISTURE DRY - MST - WET - SAT - NA | ________
CEMENTATION NON - SLT - MOD - WEL - NA | ________
GRAIN TYPE: QTZ - FRG - FOS - BIO - NA ________ | ________
MATRIX MSM - CSM - CAL - OXD - ARG - SIL - NA | ________
STRENGTH:
COHESIVE: VSF - SFT - FRM - STF - VST - HRD | ________
NONCOHESIVE: VDN - DEN - FIR - LSE - NA | ________
UPPER CONTACT: SHP - GRD - DIF - SME - NA | ________
BEDDING THICK: ________ IN/CM No.: ________ | ________
TYPE: XBD - RPL - HOR - INC - NA
MAS - LNS - LAM - GRU - GRD | ________

STRAT UNIT: ☐
NOTE LINE: ☐

GRAPHIC LOG

BEDROCK — SECONDARY

SECONDARY TYPE: NA - BED - VEN - MIX
COLOR: MUN - GSA ________ | ________
ROCK TYPE: OTHER: ________
SED: SHL - SLT - SST - CGL - LST - DOL - COL
MET: SLA - PHY - SHS - GNS - HRN - QZT - MBL
IGN: GRN - RHY - BSL - GBR - TUF - BRC | ________
TEXTURE: C - M - F NA
GRAVEL: __ __ __ ________ % | ________ %
SAND: __ __ __ ________ % | ________ %
SILT: ________ % | ________ %
CLAY/LIME MUD: ________ % | ________ %
GRAIN TYPE: QTZ - FRG - FOS - BIO - NA | ________
MATRIX: CAL - MIC - OXD - ARG - SIL - ORG - NA | ________
STRENGTH: EWK - VWK - WEK - MOD
STR - VST - EST | ________
UPPER CONTACT: SHP - GRD - DIF - SAM - NA | ________
SECONDARY POROSITY: VUG - FRC - BED - NA - OTHER | ________
HGH - MOD - LOW | ________
WEATHERING: FRS - SLT - MOD - HGH - CPL - NA | ________

NATURAL FRACTURE SETS

INTERVAL (FT/M BGS)	#/FT-M	DIP	DIR	FILL/SHAPE/ROUGH/SURFACE
-				FILL: OPN - PRT - FUL SHAPE: PLN - CUR - UND - STP - IRR ROUGH: SMH - MOD - RGH SURFACE: CLN - MIN - OXD - STN - WTH
-				FILL: OPN - PRT - FUL SHAPE: PLN - CUR - UND - STP - IRR ROUGH: SMH - MOD - RGH SURFACE: CLN - MIN - OXD - STN - WTH
-				FILL: OPN - PRT - FUL SHAPE: PLN - CUR - UND - STP - IRR ROUGH: SMH - MOD - RGH SURFACE: CLN - MIN - OXD - STN - WTH
-				FILL: OPN - PRT - FUL SHAPE: PLN - CUR - UND - STP - IRR ROUGH: SMH - MOD - RGH SURFACE: CLN - MIN - OXD - STN - WTH

NEXT INTERVAL: SAMP/LITH No. ________ / ________ DEPTH INTERVAL ________ TO ________ NOT SAMPLED NO RECOVERY

COMMENTS: (1) ________

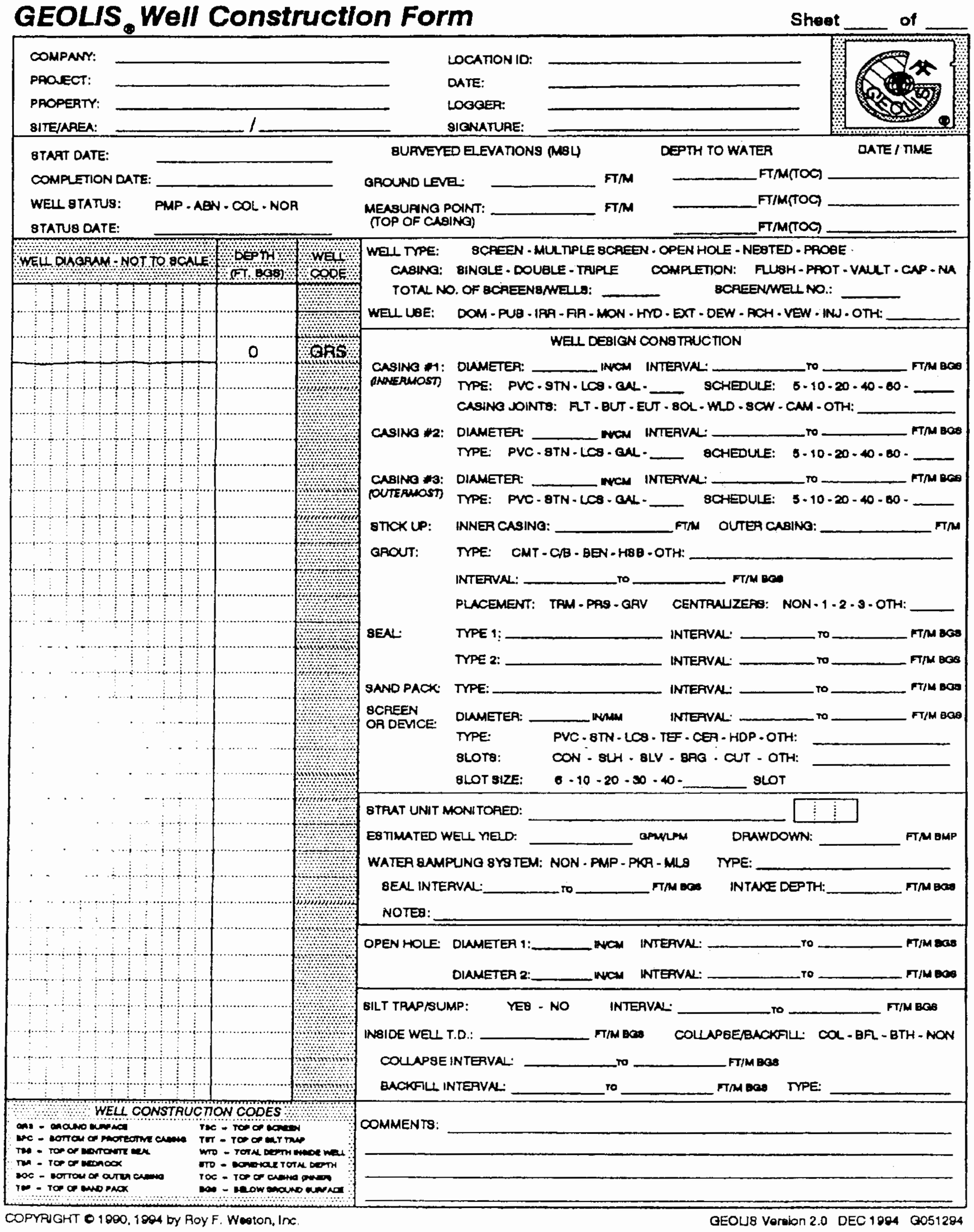
(2) ________

GEOLIS Version 1.4 JAN 1995 G030195

APPENDIX A (Cont'd)

Geolis Forms

Form 2. Geolis® Well Construction Form



GEOLIS® Well Construction Form

Sheet ____ of ____

COMPANY: ____________
PROJECT: ____________
PROPERTY: ____________
SITE/AREA: ______ / ______
LOCATION ID: ____________
DATE: ____________
LOGGER: ____________
SIGNATURE: ____________

START DATE: ____________
COMPLETION DATE: ____________
WELL STATUS: PMP - ABN - COL - NOR
STATUS DATE: ____________

SURVEYED ELEVATIONS (MSL)		DEPTH TO WATER	DATE / TIME
GROUND LEVEL: ________	FT/M	________ FT/M(TOC)	________
MEASURING POINT: ________ (TOP OF CASING)	FT/M	________ FT/M(TOC)	________
		________ FT/M(TOC)	________

WELL DIAGRAM - NOT TO SCALE	DEPTH (FT. BGS)	WELL CODE
	0	GRS

WELL TYPE: SCREEN - MULTIPLE SCREEN - OPEN HOLE - NESTED - PROBE
CASING: SINGLE - DOUBLE - TRIPLE   COMPLETION: FLUSH - PROT - VAULT - CAP - NA
TOTAL NO. OF SCREENS/WELLS: ______   SCREEN/WELL NO.: ______
WELL USE: DOM - PUS - IRR - FIR - MON - HYD - EXT - DEW - RCH - VEW - INJ - OTH: ______

WELL DESIGN CONSTRUCTION

CASING #1: (INNERMOST) DIAMETER: ______ IN/CM INTERVAL: ______ TO ______ FT/M BGS
TYPE: PVC - STN - LCS - GAL - ____ SCHEDULE: 5 - 10 - 20 - 40 - 80 - ____
CASING JOINTS: FLT - BUT - EUT - SOL - WLD - SCW - CAM - OTH: ______

CASING #2: DIAMETER: ______ IN/CM INTERVAL: ______ TO ______ FT/M BGS
TYPE: PVC - STN - LCS - GAL - ____ SCHEDULE: 5 - 10 - 20 - 40 - 80 - ____

CASING #3: (OUTERMOST) DIAMETER: ______ IN/CM INTERVAL: ______ TO ______ FT/M BGS
TYPE: PVC - STN - LCS - GAL - ____ SCHEDULE: 5 - 10 - 20 - 40 - 80 - ____

STICK UP: INNER CASING: ______ FT/M OUTER CASING: ______ FT/M

GROUT: TYPE: CMT - C/B - BEN - HSB - OTH: ______
INTERVAL: ______ TO ______ FT/M BGS
PLACEMENT: TRM - PRS - GRV CENTRALIZERS: NON - 1 - 2 - 3 - OTH: ______

SEAL: TYPE 1: ______ INTERVAL: ______ TO ______ FT/M BGS
TYPE 2: ______ INTERVAL: ______ TO ______ FT/M BGS

SAND PACK: TYPE: ______ INTERVAL: ______ TO ______ FT/M BGS

SCREEN OR DEVICE: DIAMETER: ______ IN/MM INTERVAL: ______ TO ______ FT/M BGS
TYPE: PVC - STN - LCS - TEF - CER - HDP - OTH: ______
SLOTS: CON - SLH - SLV - BRG - CUT - OTH: ______
SLOT SIZE: 6 - 10 - 20 - 30 - 40 - ______ SLOT

STRAT UNIT MONITORED: ______ ☐
ESTIMATED WELL YIELD: ______ GPM/LPM DRAWDOWN: ______ FT/M BMP
WATER SAMPLING SYSTEM: NON - PMP - PKR - MLS TYPE: ______
SEAL INTERVAL: ______ TO ______ FT/M BGS INTAKE DEPTH: ______ FT/M BGS
NOTES: ______

OPEN HOLE: DIAMETER 1: ______ IN/CM INTERVAL: ______ TO ______ FT/M BGS
DIAMETER 2: ______ IN/CM INTERVAL: ______ TO ______ FT/M BGS

SILT TRAP/SUMP: YES - NO INTERVAL: ______ TO ______ FT/M BGS
INSIDE WELL T.D.: ______ FT/M BGS COLLAPSE/BACKFILL: COL - BFL - BTH - NON
COLLAPSE INTERVAL: ______ TO ______ FT/M BGS
BACKFILL INTERVAL: ______ TO ______ FT/M BGS TYPE: ______

COMMENTS: ______

WELL CONSTRUCTION CODES

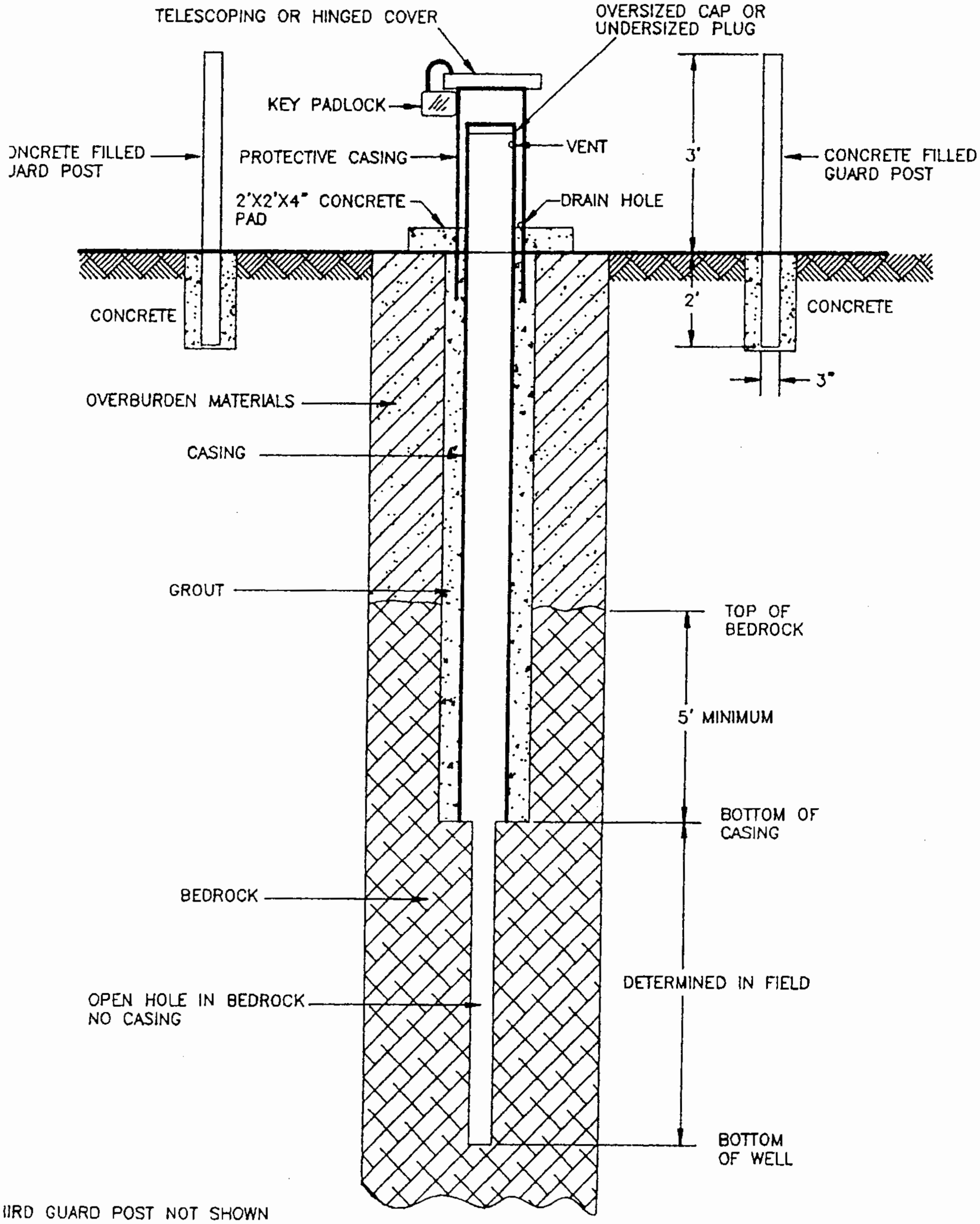
GRS - GROUND SURFACE	TSC - TOP OF SCREEN
BPC - BOTTOM OF PROTECTIVE CASING	TST - TOP OF SILT TRAP
TBS - TOP OF BENTONITE SEAL	WTD - TOTAL DEPTH INSIDE WELL
TBR - TOP OF BEDROCK	BTD - BOREHOLE TOTAL DEPTH
BOC - BOTTOM OF OUTER CASING	TOC - TOP OF CASING (INNER)
TSP - TOP OF SAND PACK	BGS - BELOW GROUND SURFACE

GEOLIS Version 2.0 DEC 1994 G051294

APPENDIX B

Figures

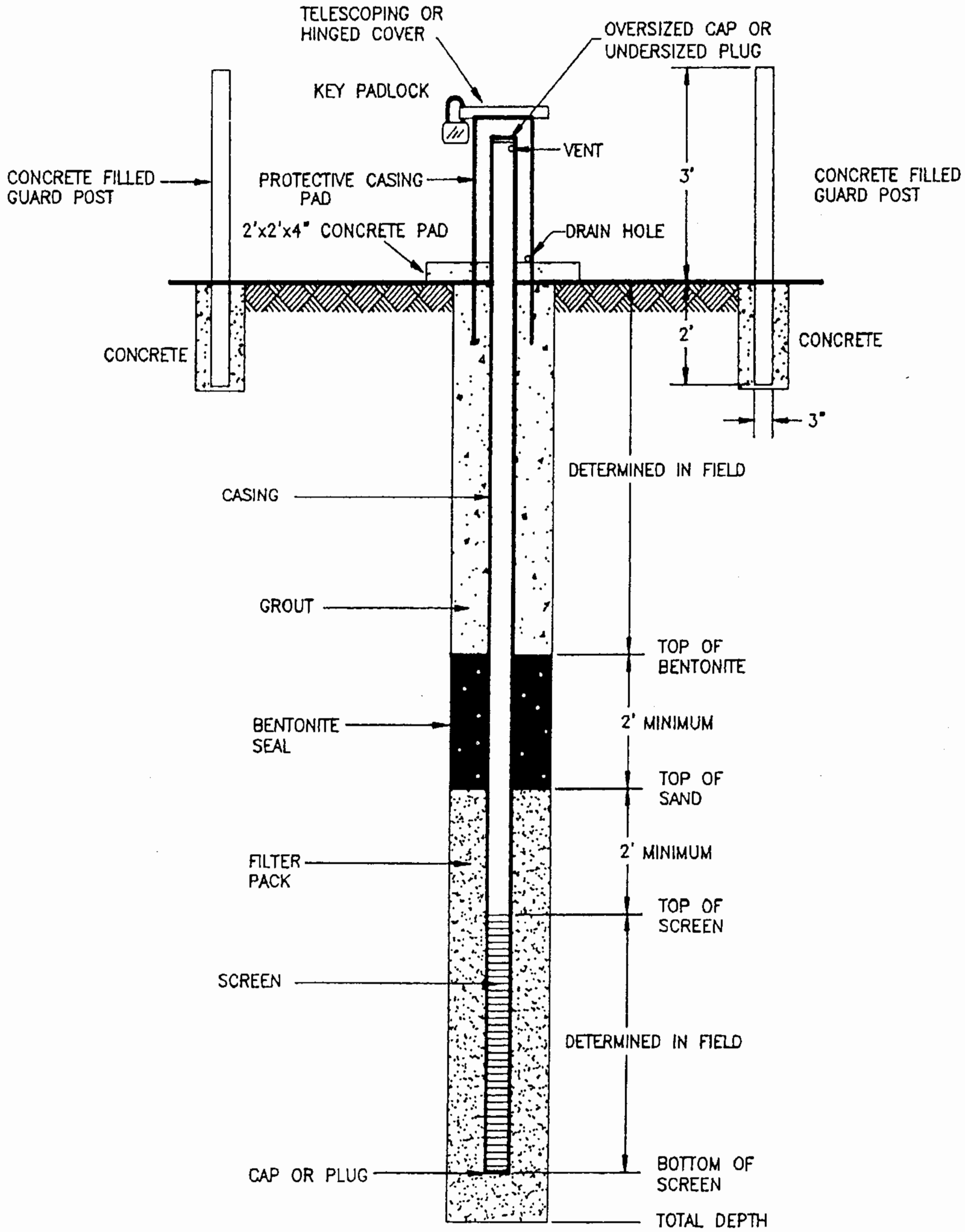
FIGURE 1. Typical Bedrock Well Construction



APPENDIX B (Cont'd)

Figures

FIGURE 2. Typical Overburden Well Construction



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U. S. EPA ENVIRONMENTAL RESPONSE TEAM

STANDARD OPERATING PROCEDURES

SOP:	2044
PAGE:	1 of 8
REV:	0.1
DATE:	10/23/01

MONITOR WELL DEVELOPMENT

CONTENTS

*These sections affected by Revision 0.1.

SUPERCEDES: SOP #2044; Revision 0.0; 2/18/00; U.S. EPA Contract 68-C99-223.

1.0 SCOPE AND APPLICATION

The purpose of this standard operating procedure (SOP) is to provide an overview of monitor well development practices. The purpose of monitor well development is to ensure removal of fine grained sediments (fines) from the vicinity of the well screen. This allows the water to flow freely from the formation into the well, and also reduces the turbidity of the water during sampling. The most common well development methods are: surging, jetting, overpumping, and bailing.

Surging involves raising and lowering a surge block or surge plunger inside the well. The resulting surging motion forces water into the formation and loosens sediment, pulled from the formation into the well. Occasionally, sediments must be removed from the well with a sand bailer to prevent sand locking of the surge block. This method may cause the sand pack around the screen to be displaced to a degree that damages its value as a filtering medium. Channels or voids may form near the screen if the filter pack sloughs away during surging (Keel and Boating, 1987).

Surging with compressed air is done by injecting a sudden charge of compressed air into the well with an air line so that water is forced through the well screen. The air is then turned off so that the water column falls back into the well and the process is repeated. Periodically, the air line is pulled up into a pipe string (educator) and water is pumped from the well using air as the lifting medium (air-lift pumping). The process is repeated until the well is sediment free. Method variations include leaving the air line in the pipe string at all times or using the well casing as the educator pipe.

Jetting involves lowering a small diameter pipe into the well and injecting a high velocity horizontal stream of water or air through the pipe into the screen openings. This method is especially effective at breaking down filter cakes developed during mud rotary drilling. Simultaneous air-lift pumping is usually used to remove fines.

Overpumping involves pumping at a rate rapid enough to draw the water level in the well as low as possible, and then allowing the well to recharge to the original level. This process is repeated until sediment-free water is produced.

Bailing includes the use of a simple manually operated check-valve bailer to remove water from the well. The bailing method, like other methods, should be repeated until sediment free water is produced. Bailing may be the method of choice in a shallow well or well that recharges slowly.

These are standard (i.e., typically applicable) operating procedures which may be varied or changed as required, dependent on site conditions, equipment limitations or limitations imposed by the procedure. In all instances, the ultimate procedures employed should be documented and associated with a final report.

Mention of trade names or commercial products does not constitute United States Environmental Protection

Agency (U.S. EPA) endorsement or recommendation for use.

2.0 METHOD SUMMARY

After installation, development of a well should occur as soon as it is practical. It should not occur any sooner than 48 hours after grouting is completed, especially if a vigorous well development method (i.e. surging) is being used. If a less vigorous method (i.e bailing) is used, it may be initiated shortly after installation. The method used for development should not interfere with the setting of the well seal.

Several activities must take place prior to well development. First, open the monitor well, take initial measurements (i.e., head space air monitoring readings, water level, total depth of the well) and record results in the site logbook. Develop the well by the appropriate method to accommodate site conditions and project objectives. Continue until the development water is clear and free of sediments, or until parameters such as pH, temperature, and specific conductivity stabilize. Containerize all purge water from wells with known or suspected contamination. Record final measurements in the site logbook. Decontaminate equipment as appropriate prior to use in the next well.

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE

This section is not applicable to this SOP.

4.0 INTERFERENCES AND POTENTIAL PROBLEMS

The following problems may be associated with well development:

1. Overpumping is not as vigorous as surging and jetting, and is probably the most desirable method for monitor well development. The possibility of disturbing the filter pack is greatest with surging and jetting well development methods.

2. The introduction of external water or air by jetting may alter the hydro chemistry of the aquifer.

3. Surging with air may produce “air locking” in some formations, preventing water from flowing into the well.

4. The use of surge blocks in formations containing clay may cause plugging of the screen.

5. Small (2-inch nominal diameter) submersible pumps that will fit in 2-inch diameter well casing are especially susceptible to clogging if used in well development applications.

6. Chemicals/reagents used during the decontamination of drilling equipment may complicate well development.

5.0 EQUIPMENT/APPARATUS

The type of equipment used for well development is dependent on the diameter of the well and the development method. For example, the diameter of most submersible pumps is too large to fit into a two-inch inner diameter (I.D.) well, and other development methods should be used. Obtaining the highest possible yield is not usually an objective in developing monitor wells and vigorous development is not always necessary. Many monitor wells are constructed in fine-grained formations that would not normally be considered aquifers. Specifications for the drilling contract should include the necessary well development equipment (air compressors, pumps, air lines, surge blocks, generators).

6.0 REAGENTS

The use of chemicals in developing wells that will be used to monitor groundwater quality should be avoided if possible; however, polyphosphates (a dispersing agent), acids, or disinfectants are often used in general well development. Polyphosphates should not be used in thinly bedded sequences of sands and clays. The use of decontamination solutions may also be necessary. If decontamination of equipment is required at a well, refer to Environmental Response Team/Response Engineering and Analytical Contract (ERT/REAC) SOP #2006, *Sampling Equipment Decontamination* and the site specific work plan.

7.0 PROCEDURES

7.1 Preparation

1. Coordinate site access and obtain keys to well locks.
2. Obtain information on each well to be developed (i.e., drilling method, well diameter, well depth, screened interval, anticipated contaminants).
3. Obtain a water level meter, a depth sounder, air monitoring instruments, materials for decontamination, and water quality instrumentation capable of measuring, at a minimum, pH, specific conductivity, temperature, and turbidity. Dissolved oxygen (DO) and salinity are also useful parameters.
4. Assemble containers for temporary storage of water produced during well development. Containers must be structurally sound, compatible with anticipated contaminants, and easy to manage in the field. The use of truck-mounted or roll-off tanks may be necessary in some cases; alternately, a portable water treatment unit (i.e., activated carbon) may be used to decontaminate the purge water.

7.2 Operation

Development should be performed as soon as it is practical after the well is installed, but no sooner than 48 hours after well completion.

1. Assemble necessary equipment on a plastic sheet surrounding the well.

2. Record pertinent information in the site or personal logbook (personnel, time, location ID, etc.).

3. Open monitor well, take air monitor reading at the top of casing and in the breathing zone as appropriate.

4. Measure depth to water and the total depth of the monitor well. Calculate the water column volume of the well (Equation 1, Section 8.0).

5. Begin development and measure the initial pH, temperature, turbidity, and specific conductivity of the water and record in the site logbook. Note the initial color, clarity, and odor of the water.

6. Continue to develop the well and periodically measure the water quality parameters indicated in step 5 (above). Depending on project objectives and available time, development should proceed until these water quality parameters stabilize, or until the water has a turbidity of less than 50 nephelometric turbidity units (NTUs).

7. All water produced by development of contaminated or suspected contaminated wells must be containerized or treated. Each container must be clearly labeled with the location ID, date collected, and sampling contractor. Determination of the appropriate disposal method will be based on the analytical results from each well.

8. No water shall be added to the well to assist development without prior approval by the appropriate U.S. EPA ERT Work Assignment Manager (WAM) and/or appropriate state personnel. In some cases , small amounts of potable water may be added to help develop a poor yielding well. It is essential that at least five times the amount of water injected must be recovered from the well in order to assure that all injected water is removed from the formation.

9. Note the final water quality parameters in the site or personal logbook along with the following data:

   Well designation (location ID)
   Date(s) of well installation
   Date(s) and time of well development

Static water level before and after development
Quantity of water removed, and initial and completion time
Type and capacity of pump or bailer used
Description of well development techniques

7.3 Post-Operation

1. Decontaminate all equipment;
2. Secure holding tanks or containers of development water;
3. Review analytical results and determine the appropriate water disposal method. Actual disposal of the purge water is generally carried out by the On-Scene Coordinator (OSC).

8.0 CALCULATIONS

To calculate the volume of water in the well, the following equation is used:

$$\textbf{Well Volume (V)} = r^2 h\ (cf) \qquad \textbf{[Equation 1]}$$

where:

= pi (3.14)
r = radius of monitoring well in feet (ft)
h = height of the water column in ft. [This may be determined by subtracting the depth to water from the total depth of the well as measured from the same reference point.]
cf = conversion factor in gallons per cubic foot (gal/ft^3) = 7.48 gal/ft^3. [In this equation, 7.48 gal/ft^3 is the necessary conversion factor.]

Monitor well diameters are typically 2-, 3-, 4-, or 6-inches. A number of standard conversion factors can be used to simplify the above equation using the diameter of the monitor well. The volume, in gallons per linear foot, for various standard monitor well diameters can be calculated as follows:
where:

$$\textbf{V (gal/ft)} = r^2\ (cf) \qquad \textbf{[Equation 2]}$$

= pi
r = radius of monitoring well (feet)
cf = conversion factor (7.48 gal/ft^3)

For example, a two inch diameter well, the volume per linear foot can be calculated as follows:

$$\begin{aligned} \mathbf{V\ (gal/ft)} &= \mathbf{r^2\ (cf)} \quad \textbf{[Equation 2]} \\ &= \mathbf{3.14\ (1/12\ ft)^2\ 7.48\ gal/ft^3} \\ &= \mathbf{0.1631\ gal/ft} \end{aligned}$$

NOTE: The diameter must be converted to the radius in feet as follows:

$$\frac{\textbf{Well Diameter (inches)}}{\mathbf{12}} \mathbf{\times 0.5 = } \textbf{Well Radius (feet)} \quad \textbf{[Equation 3]}$$

The volume in gallons/feet for the common size monitor wells are as follows:

Well diameter (inches)	2	3	4	6
Volume (gal/ft)	0.1631	0.3670	0.6524	1.4680

If you utilize the volumes for the common size wells above, Equation 1 is modified as follows:
where:

$$\textbf{Well volume} = \mathbf{(h)(f)} \qquad \textbf{[Equation 4]}$$

h = height of water column (feet)
f = the volume in gal/ft calculated from Equation 2

9.0 QUALITY ASSURANCE/QUALITY CONTROL

There are no specific quality assurance activities, which apply to the implementation of these procedures. However, the following general quality assurance/quality control (QA/QC) procedures apply:

1. All data must be documented in site and/or personal logbooks.
2. All instrumentation must be operated in accordance with operating instructions as supplied by the manufacturer, unless otherwise specified in the work plan. Equipment checkout and calibration activities must occur prior to sampling/operation and must be documented.

10.0 DATA VALIDATION

This section is not applicable to this SOP.

11.0 HEALTH AND SAFETY

When working with potentially hazardous materials, follow U.S. EPA, Occupational Safety and Health (OSHA), and corporate health and safety practices.

12.0 REFERENCES

Driscoll, F. G. 1986. "Development of Water Wells." In: *Groundwater and Wells.* Second Edition. Chapter 15. Johnson Filtration Division, St. Paul, Minnesota. p. 497-533.

Freeze, Allan R. and John A. Cherry. 1979. *Groundwater*. Englewood Cliffs, NJ: Prentice-Hall, Inc.

Keel, J.F. and Kwasi Boating. 1987. "Monitoring Well Installation, Purging, and Sampling Techniques - Part 1: Conceptualizations". *Groundwater,* 25(3):300-313.

Keel, J.F. and Kwasi Boating. 1987. "Monitoring Well Installation, Purging, and Sampling Techniques - Part 2: Case Histories". *Groundwater*, 25(4):427-439.

13.0 APPENDICES

This section is not applicable to this SOP.

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GROUNDWATER WELL SAMPLING

SOP#: 2007
DATE: 01/26/95
REV. #: 0.0

1.0 SCOPE AND APPLICATION

The objective of this standard operating procedure (SOP) is to provide general reference information on sampling of ground water wells. This guideline is primarily concerned with the collection of water samples from the saturated zone of the subsurface. Every effort must be made to ensure that the sample is representative of the particular zone of water being sampled. These procedures are designed to be used in conjunction with analyses for the most common types of ground water contaminants (e.g., volatile and semi-volatile organic compounds, pesticides, metals, biological parameters).

These are standard (i.e., typically applicable) operating procedures which may be varied or changed as required, dependent upon site conditions, equipment limitations or limitations imposed by the procedure. In all instances, the ultimate procedures employed should be documented and associated with the final report.

Mention of trade names or commercial products does not constitute U.S. Environmental Protection Agency (EPA) endorsement or recommendation for use.

2.0 METHOD SUMMARY

In order to obtain a representative groundwater sample for chemical analysis it is important to remove stagnant water in the well casing and the water immediately adjacent to the well before collection of the sample. This may be achieved with one of a number of instruments. The most common of these are the bailer, submersible pump, non-contact gas bladder pump, inertia pump and suction pump. At a minimum, three well volumes should be purged, if possible. Equipment must be decontaminated prior to use and between wells. Once purging is completed and the correct laboratory-cleaned sample containers have been prepared, sampling may proceed. Sampling may be conducted with any of the above instruments, and need not be the same as the device used for purging. Care should be taken when choosing the sampling device as some will affect the integrity of the sample. Sampling should occur in a progression from the least to most contaminated well, if this information is known.

The growing concern over the past several years over low levels of volatile organic compounds in water supplies has led to the development of highly sophisticated analytical methods that can provide detection limits at part per trillion levels. While the laboratory methods are extremely sensitive, well controlled and quality assured, they cannot compensate for a poorly collected sample. The collection of a sample should be as sensitive, highly developed and quality assured as the analytical procedures.

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE

The type of analysis for which a sample is being collected determines the type of bottle, preservative, holding time, and filtering requirements. Samples should be collected directly from the sampling device into appropriate laboratory cleaned containers. Check that a Teflon liner is present in the cap, if required. Attach a sample identification label. Complete a field data sheet, a chain of custody form, and record all pertinent data in the site logbook.

Samples shall be appropriately preserved, labelled, logged, and placed in a cooler to be maintained at 4EC. Samples must be shipped well before the holding time is up and ideally should be shipped within 24 hours of sample collection. It is imperative that samples be shipped or delivered daily to the analytical laboratory in order to maximize the time available for the laboratory to perform the analyses. The bottles should be shipped with adequate packing and cooling to ensure that they arrive intact.

Sample retrieval systems suitable for the valid collection of volatile organic samples are: positive displacement bladder pumps, gear driven submersible pumps, syringe samplers and bailers (Barcelona, 1984; Nielsen, 1985). Field conditions and other constraints will limit the choice of appropriate systems. The focus of concern must remain to provide a valid sample for analysis, one which has been subjected to the least amount of turbulence possible.

Treatment of the sample with sodium thiosulfate preservative is required only if there is residual chlorine in the water that could cause free radical chlorination and change the identity of the original contaminants. It should not be used if there is no chlorine in the water.

Holding time for volatiles analysis is seven days. It is imperative that the sample be shipped or delivered daily to the analytical laboratory. The bottles must be shipped on their sides to aid in maintaining the airtight seal during shipment, with adequate packing and cooling to ensure that they arrive intact.

For collection of volatile organic samples, refer to the work plan to ensure that 40 mL glass sample vials with Teflon lined septa are ordered and in sufficient numbers. Check sampling supplies; field kit for chlorine, preservatives, Parafilm, foam sleeves and coolers. Due to the extreme trace levels at which volatile organics are detectable, cross contamination and introduction of contaminants must be avoided. Trip blanks are incorporated into the shipment package to provide a check against cross contamination.

4.0 INTERFERENCES AND POTENTIAL PROBLEMS

4.1 General

The primary goal in performing ground water sampling is to obtain a representative sample of the ground water body. Analysis can be compromised by field personnel in two primary ways: (1) taking an unrepresentative sample, or (2) by incorrect handling of the sample. There are numerous ways of introducing foreign contaminants into a sample, and these must be avoided by following strict sampling procedures and utilizing trained field personnel.

4.2 Purging

In a nonpumping well, there will be little or no vertical mixing of the water, and stratification will occur. The well water in the screened section will mix with the ground water due to normal flow patterns, but the well water above the screened section will remain isolated, become stagnant, and may lack the contaminants representative of the ground water. Persons sampling should realize that stagnant water may contain foreign material inadvertently or deliberately introduced from the surface, resulting in an unrepresentative sample. To safeguard against collecting nonrepresentative stagnant water, the following guidelines and techniques should be adhered to during sampling:

1. As a general rule, all monitor wells should be pumped or bailed prior to sampling. Purge water should be containerized on site or handled as specified in the site specific project plan. Evacuation of a minimum of one volume of water in the well casing, and preferably three to five volumes, is recommended for a representative sample. In a high-yielding ground water formation and where there is no stagnant water in the well above the screened section, evacuation prior to sample withdrawal is not as critical. However, in all cases where the monitoring data is to be used for enforcement actions, evacuation is recommended.

2. When purging with a pump (not a bailer), the pump should be set at the screened interval, or if the well is an open-rock well, it should be set at the same depth the sample will be collected. When sampling a screened well, the sample should also be collected from the same depth the pump was set at.

3. The well should be sampled as soon as possible after purging.

4. Analytical parameters typically dictate whether the sample should be collected through the purging device, or through a separate sampling instrument.

5. For wells that can be pumped or bailed to dryness with the equipment being used, the well should be evacuated and allowed to

recover prior to collecting a sample. If the recovery rate is fairly rapid and time allows, evacuation of more than one volume of water is preferred. If recovery is slow, sample the well upon recovery after one evacuation.

6. A non-representative sample can also result from excessive pre-pumping of the monitoring well. Stratification of the leachate concentration in the ground water formation may occur, or heavier-than-water compounds may sink to the lower portions of the aquifer. Excessive pumping can dilute or increase the contaminant concentrations from what is representative of the sampling point of interest.

4.3 Materials

Materials of construction for samplers and evacuation equipment (bladders, pump, bailers, tubing, etc.) should be limited to stainless steel, Teflon^{R}, and glass in areas where concentrations are expected to be at or near the detection limit. The tendency of organics to leach into and out of many materials make the selection of materials critical for trace analyses. The use of plastics, such as PVC or polyethylene, should be avoided when analyzing for organics. However, PVC may be used for evacuation equipment as it will not come in contact with the sample, and in highly contaminated wells, disposable equipment (i.e., polypropylene bailers) may be appropriate to avoid cross-contamination.

Materials of construction (bladders/ pumps, bailers, tubing, etc.) suitable for collecting and handling Volatile Organic Samples should be limited to stainless steel, Teflon and glass in areas which detection limit range concentrations are expected. The tendency of organics to leach into and out of many materials, make the selection of materials critical for these trace analyses. The use of plastics, e.g., PVC etc., should be avoided. There are numerous ways of introducing foreign contaminants into a sample, and these must be avoided by following strict sampling procedures and utlization of trained personnel.

4.4 Advantages/Disadvantages of Certain Equipment

4.4.1 Bailers

Advantages

C Only practical limitations on size and materials

C No power source needed

C Portable

C Inexpensive, so it can be dedicated and hung in a well, thereby reducing the chances of cross contamination

C Minimal outgassing of volatile organics while sample is in bailer

C Readily available

C Removes stagnant water first

C Rapid, simple method for removing small volumes of purge water

Disadvantages

C Time-consuming to flush a large well of stagnant water

C Transfer of sample may cause aeration

C Stoppers at the bottom of the bailer usually leak thus the bailer must be brought to the surface rapidly

C If the bailer is allowed to hit the bottom of the well boring, gravel can displace the ball valve not allowing the bailer to hold water

4.4.2 Submersible Pumps

Advantages

C Portable and can be transported to several wells

C Depending upon the size of the pump and the pumping depths, relatively high pumping rates are possible

C Generally very reliable and does not require priming

Disadvantages

C Potential for effects on analysis of trace organics

C Heavy and cumbersome to deal with, particularly in deeper wells

C Expensive

C Power source needed

C Sediment in water may cause problems with the pumps

C Impractical in low yielding or shallow wells

4.4.3 Non-Contact Gas Bladder Pumps

Advantages

C Maintains integrity of sample

C Easy to use

C Can sample from discrete locations within the monitor well

Disadvantages

C Difficulty in cleaning, though dedicated tubing and bladder may be used

C Only useful to about 100 feet

C Supply of gas for operation, gas bottles and/or compressors are often difficult to obtain and are cumbersome

C Relatively low pumping rates

C Requires air compressor or pressurized gas source and control box

4.4.4 Suction Pumps

Advantages

C Portable, inexpensive, and readily available

Disadvantages

C Restricted to areas with water levels within 20 to 25 feet of the ground surface

C Vacuum can cause loss of dissolved gasses and volatile organics

C Pump must be primed and vacuum is often difficult to maintain during initial stages of pumping

4.4.5 Inertia Pumps

Advantages

C Portable, inexpensive, and readily available

C Offers a rapid method for purging relatively shallow wells

Disadvantages

C Restricted to areas with water levels within 70 feet of the ground surface

C May be time consuming to purge wells with these manual pumps

C Labor intensive

C WaTerra pumps are only effective in 2-inch diameter wells

5.0 EQUIPMENT APPARATUS

5.1 Equipment Checklist

5.1.1 General

C Water level indicator
  - electric sounder
  - steel tape
  - transducer
  - reflection sounder
  - airline
C Depth sounder
C Appropriate keys for well cap locks
C Steel brush
C HNU or OVA (whichever is most appropriate)
C Logbook
C Calculator
C Field data sheets and samples labels

C Chain of custody records and seals
C Sample containers
C Engineer's rule
C Sharp knife (locking blade)
C Tool box (to include at least: screwdrivers, pliers, hacksaw, hammer, flashlight, adjustable wrench)
C Leather work gloves
C Appropriate Health & Safety gear
C 5-gallon pail
C Plastic sheeting
C Shipping containers
C Packing materials
C Bolt cutters
C Ziploc plastic bags
C Containers for evacuation liquids
C Decontamination solutions
C Tap water
C Non phosphate soap
C Several brushes
C Pails or tubs
C Aluminum foil
C Garden sprayer
C Preservatives
C Distilled or deionized water
C Fire extinguisher (if using a generator for your power source)

5.1.2 Bailers

C Clean, decontaminated bailers of appropriate size and construction material
C Nylon line, enough to dedicate to each well
C Teflon coated bailer wire
C Sharp knife
C Aluminum foil (to wrap clean bailers)
C Five gallon bucket

5.1.3 Submersible Pump

C Pump(s)
C Generator (110, 120, or 240 volt) or 12 volt battery if inaccessible to field vehicle - amp meter is useful
C 1" black PVC coil tubing - enough to dedicate to each well
C Hose clamps
C Safety cable
C Tool box supplement
    - pipe wrenches
    - wire strippers
    - electrical tape
    - heat shrink
    - hose connectors
    - Teflon tape
C Winch, pulley or hoist
C Gasoline for generator/gas can
C Flow meter with gate valve
C 1" nipples and various plumbing (i.e., pipe connectors)
C Control box (if necessary)

5.1.4 Non-Gas Contact Bladder Pump

C Non-gas contact bladder pump
C Compressor or nitrogen gas tank
C Batteries and charger
C Teflon tubing - enough to dedicate to each well
C Swagelock fitting
C Toolbox supplements - same as submersible pump
C Control box (if necessary)

5.1.5 Suction Pump

C Pump
C 1" black PVC coil tubing - enough to dedicate to each well
C Gasoline - if required
C Toolbox
C Plumbing fittings
C Flow meter with gate valve

5.1.6 Inertia Pump

C Pump assembly (WaTerra pump, piston pump)
C Five gallon bucket

6.0 REAGENTS

Reagents may be utilized for preservation of samples and for decontamination of sampling equipment. The preservatives required are specified by the analysis to be performed. Decontamination solutions are specified in ERT SOP #2006, Sampling Equipment Decontamination.

7.0 PROCEDURE

7.1 Preparation

1. Determine the extent of the sampling effort, the sampling methods to be employed, and the types and amounts of equipment and supplies needed (i.e, diameter and depth of wells to be sampled).

2. Obtain necessary sampling and monitoring equipment, appropriate to type of contaminant being investigated. For collection of volatile organic samples, refer to the work plan to ensure that 40 mL glass sample vials with Teflon lined septa are ordered and in sufficient numbers. Check sampling supplies; field kit for chlorine, preservatives, Parafilm, foam sleeves and coolers. Due to extreme trace levels at which volatile organics are detectable, cross contamination and introduction of contaminants must be avoided. Trip blanks are incorporated into the shipment package to provide a check against cross contamination.

3. Decontaminate or preclean equipment, and ensure that it is in working order.

4. Prepare scheduling and coordinate with staff, clients, and regulatory agency, if appropriate.

5. Perform a general site survey prior to site entry in accordance with the site specific Health and Safety Plan.

6. Identify and mark all sampling locations.

7.2 Field Preparation

1. Start at the least contaminated well, if known.

2. Lay plastic sheeting around the well to minimize likelihood of contamination of equipment from soil adjacent to the well.

3. Remove locking well cap, note location, time of day, and date in field notebook or appropriate log form.

4. Remove well casing cap.

5. Screen headspace of well with an appropriate monitoring instrument to determine the presence of volatile organic compounds and record in site logbook.

6. Lower water level measuring device or equivalent (i.e., permanently installed transducers or airline) into well until water surface is encountered.

7. Measure distance from water surface to reference measuring point on well casing or protective barrier post and record in site logbook. Alternatively, if no reference point, note that water level measurement is from top of steel casing, top of PVC riser pipe, from ground surface, or some other position on the well head.

   If floating organics are of concern, this can be determined by measuring the water level with an oil/water interface probe which measures floating organics.

8. Measure total depth of well (at least twice to confirm measurement) and record in site logbook or on field data sheet.

9. Calculate the volume of water in the well and the volume to be purged using the calculations in Section 8.0.

10. Select the appropriate purging and sampling equipment.

11. If residual chlorine is suspected, use the Hach Field Test Kit for chlorine to determine if there is residual chlorine in the water to be sampled. If there is, treat the sample vial with a crystal of sodium thiosulfate prior to sample collection.

7.3 Purging

The amount of flushing a well receives prior to sample collection depends on the intent of the monitoring program as well as the hydrogeologic conditions. Programs where overall quality determination of water resources are involved may require long pumping periods to obtain a sample that is representative of a large volume of that aquifer. The pumped volume can be determined prior to sampling so that the sample is a collected after a known volume of the water is evacuated from the aquifer, or the well can be pumped until the stabilization of parameters such as temperature, electrical conductance, pH, or turbidity has occurred.

However, monitoring for defining a contaminant plume requires a representative sample of a small volume of the aquifer. These circumstances require that the well be pumped enough to remove the stagnant water but not enough to induce flow from other areas. Generally, three well volumes are considered effective, or calculations can be made to determine, on the basis of the aquifer parameters and well dimensions, the appropriate volume to remove prior to sampling.

During purging, water level measurements may be taken regularly at 15-30 second intervals. This data may be used to compute aquifer transmissivity and other hydraulic characteristics. The following well evacuation devices are most commonly used. Other evacuation devices are available, but have been omitted in this discussion due to their limited use.

7.3.1 Bailers

Bailers are the simplest purging device used and have many advantages. They generally consist of a rigid length of tube, usually with a ball check-valve at the bottom. A line is used to lower the bailer into the well and retrieve a volume of water. The three most common types of bailer are PVC, Teflon, and stainless steel.

This manual method of purging is best suited to shallow or narrow diameter wells. For deep, larger diameter wells which require evacuation of large volumes of water, other mechanical devices may be more appropriate.

7.3.1.1 Operation

Equipment needed will include a clean decontaminated bailer, Teflon or nylon line, a sharp knife, and plastic sheeting.

1. Determine the volume of water to be purged as described in 8.0, calculations.

2. Lay plastic sheeting around the well to prevent contamination of the bailer line with foreign materials.

3. Attach the line to the bailer and slowly lower until the bailer is completely submerged, being careful not to drop the bailer to the water, causing turbulence and the possible loss of volatile organic contaminants.

4. Pull bailer out ensuring that the line either falls onto a clean area of plastic sheeting or never touches the ground.

5. Empty the bailer into a pail until full to determine the number of bails necessary to achieve the required purge volume.

6. Thereafter, pour the water into a container and dispose of purge waters as specified in the site specific sampling plan.

7.3.2 Submersible Pumps

The use of submersible pumps for sample collection is permissible provided they are constructed of suitably noncontaminating materials. The chief drawback, however, is the difficulty avoiding cross-contamination between wells. Although some units can be disassembled easily to allow surfaces contacted by contaminants to be cleaned, field decontamination may be difficult and require solvents that can affect sample analysis. The use of submersible pumps in multiple well-sampling programs, therefore, should be carefully considered against other sampling mechanisms (bailers, bladder pumps). In most cases, a sample can be collected by bailer after purging with a submersible pump, however, submersible pumps may be the only practical sampling device for extremely deep wells (greater than 300 feet of water). Under those conditions, dedicated pump systems should be installed to eliminate the potential for cross-contamination of well samples.

Submersible pumps generally use one of two types of power supplies, either electric or compressed gas or air. Electric powered pumps can run off a 12 volt DC rechargeable battery, or a 110 or 220 volt AC power supply. Those units powered by compressed air normally use a small electric or gas-powered air compressor. They may also utilize compressed gas (i.e., nitrogen) from bottles. Different size pumps are available for different depth or diameter monitoring wells.

7.3.2.1 Operation

1. Determine the volume of water to be purged as described in 8.0 Calculations.
2. Lay plastic sheeting around the well to prevent contamination of pumps, hoses or lines with foreign materials.
3. Assemble pump, hoses and safety cable, and lower the pump into the well. Make sure the pump is deep enough so all the water is not evacuated. (Running the pump without water may cause damage.)
4. Attach flow meter to the outlet hose to measure the volume of water purged.
5. Use a ground fault circuit interrupter (GFCI) or ground the generator to avoid possible electric shock.
6. Attach power supply, and purge the well until the specified volume of water has been evacuated (or until field parameters, such as temperature, pH, conductivity, etc, have stabilized). Do not allow the pump to run dry. If the pumping rate exceeds the well recharge rate, lower the pump further into the well, and continue pumping.
7. Collect and dispose of purge waters as specified in the site specific sampling plan.

7.3.3 Non-Contact Gas Bladder Pumps

For this procedure, an all stainless-steel and Teflon Middleburg-squeeze bladder pump (e.g., IEA, TIMCO, Well Wizard, Geoguard, and others) is used to provide the least amount of material interference to the sample (Barcelona, 1985). Water comes into contact with the inside of the bladder (Teflon) and the sample tubing, also Teflon, that may be dedicated to each well. Some wells may have permanently installed bladder pumps, (i.e., Well Wizard, Geoguard), that will be used to sample for all parameters.

7.3.3.1 Operation

1. Assemble Teflon tubing, pump and charged control box.
2. Procedure for purging with a bladder pump is the same as for a submersible pump (Section 7.3.2.1).
3. Be sure to adjust flow rate to prevent violent jolting of the hose as sample is drawn in.

7.3.4 Suction Pumps

There are many different types of suction pumps. They include: centrifugal, peristaltic and diaphragm. Diaphragm pumps can be used for well evacuation at a fast pumping rate and sampling at a low pumping rate. The peristaltic pump is a low volume pump that uses rollers to squeeze the flexible tubing thereby creating suction. This tubing can be dedicated to a well to prevent cross contamination. Peristaltic pumps, however, require a power source.

7.3.4.1 Operation

1. Assembly of the pump, tubing, and power source if necessary.
2. Procedure for purging with a suction pump is exactly the same as for a submersible pump (Section 7.3.2.1).

7.3.5 Inertia Pumps

Inertia pumps such as the WaTerra pump and piston pump, are manually operated. They are most appropriate to use when wells are too deep to bail by hand, or too shallow or narrow (or inaccessible) to warrant an automatic (submersible, etc.) pump. These pumps are made of plastic and may be either decontaminated or discarded.

7.3.5.1 Operation

1. Determine the volume of water to be purged as described in 8.0, Calculations.
2. Lay plastic sheeting around the well to prevent contamination of pumps or hoses with foreign materials.
3. Assemble pump and lower to the appropriate depth in the well.
4. Begin pumping manually, discharging water into a 5 gallon bucket (or other graduated vessel). Purge until specified volume of water has been evacuated (or until field parameters such as temperature, pH,

conductivity, etc. have stabilized).

5. Collect and dispose of purge waters as specified in the site specific project plan.

7.4 Sampling

Sample withdrawal methods require the use of pumps, compressed air, bailers, and samplers. Ideally, purging and sample withdrawal equipment should be completely inert, economical to manufacture, easily cleaned, sterilized, reusable, able to operate at remote sites in the absence of power resources, and capable of delivering variable rates for sample collection.

There are several factors to take into consideration when choosing a sampling device. Care should be taken when reviewing the advantages or disadvantages of any one device. It may be appropriate to use a different device to sample than that which was used to purge. The most common example of this is the use of a submersible pump to purge and a bailer to sample.

7.4.1 Bailers

The positive-displacement volatile sampling bailer is perhaps the most appropriate for collection of water samples for volatile analysis. Other bailer types (messenger, bottom fill, etc.) are less desirable, but may be mandated by cost and site conditions.

7.4.1.1 Operation

1. Surround the monitor well with clean plastic sheeting. If using the GPI bailer, insert a vial into the claim and assemble the unit.
2. Attach a line to a clean decontaminated bailer.
3. Lower the bailer slowly and gently into the well, taking care not to shake the casing sides or to splash the bailer into the water. Stop lowering at a point adjacent to the screen.
4. Allow bailer to fill and then slowly and gently retrieve the bailer from the well avoiding contact with the casing, so as not to knock flakes of rust or other foreign materials into the bailer. If using the GPI bailer for collecting volatile organic samples, once at the surface, remove the bailer from the cable. Carefully open the GPI bailer unit and remove the vial. Begin slowly pouring from the bailer, and collect the duplicate samples from the midstream sample.
5. Remove the cap from the sample container and place it on the plastic sheet or in a location where it won't become contaminated. See Section 7.7 for special considerations on VOA samples.
6. Begin slowly pouring from the bailer.
7. Filter and preserve samples as required by sampling plan.
8. Cap the sample container tightly and place prelabeled sample container in a carrier.
9. Replace the well cap.
10. Log all samples in the site logbook and on field data sheets and label all samples.
11. Package samples and complete necessary paperwork.
12. Transport sample to decontamination zone for preparation for transport to analytical laboratory.

7.4.2 Submersible Pumps

Although it is recommended that samples not be collected with a submersible pump due to the reasons stated in Section 4.4.2, there are some situations where they may be used.

7.4.2.1 Operation

1. Allow the monitor well to recharge after purging, keeping the pump just above screened section.
2. Attach gate valve to hose (if not already fitted), and reduce flow of water to a manageable sampling rate.
3. Assemble the appropriate bottles.
4. If no gate valve is available, run the water

down the side of a clean jar and fill the sample bottles from the jar.

5. Cap the sample container tightly and place prelabeled sample container in a carrier.

6. Replace the well cap.

7. Log all samples in the site logbook and on the field data sheets and label all samples.

8. Package samples and complete necessary paperwork.

9. Transport sample to decontamination zone for preparation for transport to the analytical laboratory.

10. Upon completion, remove pump and assembly and fully decontaminate prior to setting into the next sample well. Dedicate the tubing to the hole.

7.4.3 Non-Contact Gas Bladder Pumps

The use of a non-contact gas positive displacement bladder pump is often mandated by the use of dedicated pumps installed in wells. These pumps are also suitable for shallow (less than 100 feet) wells. They are somewhat difficult to clean, but may be used with dedicated sample tubing to avoid cleaning. These pumps require a power supply and a compressed gas supply (or compressor). They may be operated at variable flow and pressure rates making them ideal for both purging and sampling.

Barcelona (1984) and Nielsen (1985) report that the non-contact gas positive displacement pumps cause the least amount of alteration in sample integrity as compared to other sample retrieval methods.

7.4.3.1 Operation

1. Allow well to recharge after purging.

2. Assemble the appropriate bottles.

3. Turn pump on, increase the cycle time and reduce the pressure to the minimum that will allow the sample to come to the surface.

4. Cap the sample container tightly and place prelabeled sample container in a carrier.

5. Replace the well cap.

6. Log all samples in the site logbook and on field data sheets and label all samples.

7. Package samples and complete necessary paperwork.

8. Transport sample to decontamination zone for preparation for transport to analytical laboratory.

9. On completion, remove the tubing from the well and either replace the Teflon tubing and bladder with new dedicated tubing and bladder or rigorously decontaminate the existing materials.

10. Nonfiltered samples shall be collected directly from the outlet tubing into the sample bottle.

11. For filtered samples, connect the pump outlet tubing directly to the filter unit. The pump pressure should remain decreased so that the pressure build up on the filter does not blow out the pump bladder or displace the filter. For the Geotech barrel filter, no actual connections are necessary so this is not a concern.

7.4.4 Suction Pumps

In view of the limitations of these type pumps, they are not recommended for sampling purposes.

7.4.5 Inertia Pumps

Inertia pumps may be used to collect samples. It is more common, however, to purge with these pumps and sample with a bailer (Section 7.4.1).

7.4.5.1 Operation

1. Following well evacuation, allow the well to recharge.

2. Assemble the appropriate bottles.

3. Since these pumps are manually operated,

the flow rate may be regulated by the sampler. The sample may be discharged from the pump outlet directly into the appropriate sample container.

4. Cap the sample container tightly and place prelabeled sample container in a carrier.
5. Replace the well cap.
6. Log all samples in the site logbook and on field data sheets and label all samples.
7. Package samples and complete necessary paperwork.
8. Transport sample to decontamination zone for preparation for transport to the analytical laboratory.
9. Upon completion, remove pump and decontaminate or discard, as appropriate.

7.4.6. Sample Retrieval - Syringe

A limited number of commercial syringe type samplers are available, (IEA, TIMCO, etc.) some are homemade devices. These devices are claimed to provide good quality samples for volatile analysis, but are severly limited in sample volume and are specific to sampling for volatiles. Essentially, they operated with an evacuated chamber that is lowered down the well, and allowed to fill with the pressure of the water. The entire mechanism is then brought to the surface with the sample. The sample may then be transferred to a sample vial, or the entire unit may be sent as the sample container.

1. Evacuate the syringe if necessary, and lower the sampling device to just below the well screen.
2. Remove the constriction from the device and allow the sample to fill the syringe, apply slight suction as necessary.
3. Bring unit to the surface. If necessary, transfer the sample to vials, as outlined in steps 2 through 7 above.

7.5 Filtering

For samples requiring filtering, such as total metals analysis, the filter must be decontaminated prior to and between uses. Filters work by two methods. A barrel filter such as the "Geotech" filter works with a bicycle pump, used to build up positive pressure in the chamber containing the sample which is then forced through the filter paper (minimum size 0.45 µm) into a jar placed underneath. The barrel itself is filled manually from the bailer or directly via the hose of the sampling pump. The pressure must be maintained up to 30 lbs/in^2 by periodic pumping.

A vacuum type filter involves two chambers; the upper chamber contains the sample and a filter (minimum size 0.45 µm) divides the chambers. Using a hand pump or a Gilian type pump, air is withdrawn from the lower chamber, creating a vacuum and thus causing the sample to move through the filter into the lower chamber where it is drained into a sample jar. Repeated pumping may be required to drain all the sample into the lower chamber. If preservation of the sample is necessary, this should be done after filtering.

7.6 Post Operation

After all samples are collected and preserved, the sampling equipment should be decontaminated prior to sampling another well to prevent cross-contamination of equipment and monitor wells between locations.

1. Decontaminate all equipment.
2. Replace sampling equipment in storage containers.
3. Prepare and transport ground water samples to the laboratory. Check sample documentation and make sure samples are properly packed for shipment.

7.7 Special Considerations for VOA Sampling

The proper collection of a sample for volatile organics requires minimal disturbance of the sample to limit volatilization and therefore a loss of volatiles from the sample.

Sample retrieval systems suitable for the valid collection of volatile organic samples are: positive displacement bladder pumps, gear driven submersible pumps, syringe samplers and bailers (Barcelona, 1984; Nielsen, 1985). Field conditions and other constraints will limit the choice of appropriate systems. The focus of concern must be to provide a valid sample for analysis, one which has been subjected to the least amount of turbulence possible.

The following procedures should be followed:

1. Open the vial, set cap in a clean place, and collect the sample during the middle of the cycle. When collecting duplicates, collect both samples at the same time.
2. Fill the vial to just overflowing. Do not rinse the vial, nor excessively overflow it. There should be a convex meniscus on the top of the vial.
3. Check that the cap has not been contaminated (splashed) and carefully cap the vial. Place the cap directly over the top and screw down firmly. Do not overtighten and break the cap.
4. Invert the vial and tap gently. Observe vial for at least ten (10) seconds. If an air bubble appears, discard the sample and begin again. It is imperative that no entrapped air is in the sample vial.
5. Immediately place the vial in the protective foam sleeve and place into the cooler, oriented so that it is lying on its side, not straight up.
6. The holding time for VOAs is seven days. Samples should be shipped or delivered to the laboratory daily so as not to exceed the holding time. Ensure that the samples remain at 4EC, but do not allow them to freeze.

8.0 CALCULATIONS

If it is necessary to calculate the volume of the well, utilize the following equation:

$$\textit{Well volume} \;\; ' \;\; nr^2h\ (cf) \qquad [\textit{Equation } 1]$$

where:

n = pi
r = radius of monitoring well (feet)
h = height of the water column (feet) [This may be determined by subtracting the depth to water from the total depth of the well as measured from the same reference point.]
cf = conversion factor (gal/ft^3) = 7.48 gal/ft^3 [In this equation, 7.48 gal/ft^3 is the necessary conversion factor.]

Monitor well diameters are typically 2", 3", 4", or 6". Knowing the diameter of the monitor well, there are a number of standard conversion factors which can be used to simplify the equation above.

The volume, in gallons per linear foot, for various standard monitor well diameters can be calculated as follows:

$$v(gal/ft) \;\; ' \;\; nr^2\ (cf) \qquad [\textit{Equation } 2]$$

where:

n = pi
r = radius of monitoring well (feet)
cf = conversion factor (7.48 gal/ft^3)

For a 2" diameter well, the volume per linear foot can be calculated as follows:

$$\begin{aligned} vol/linear\ ft \;\; &' \;\; nr^2\ (cf) \qquad [\textit{Equation } 2] \\ &' \;\; \mathbf{3.14\ (1/12}\ ft)^2\ \ \mathbf{7.48}\ gal/ft^3 \\ &' \;\; \mathbf{0.1632}\ gal/ft \end{aligned}$$

Remember that if you have a 2" diameter well, you must convert this to the radius in feet to be able to use the equation.

The conversion factors for the common size monitor wells are as follows:

Well diameter	2"	3"	4"	6"
Volume (gal/ft.)	0.1632	0.3672	0.6528	1.4688

If you utilize the conversion factors above, Equation

1 should be modified as follows:

$$\textit{Well volume} \; ' \; (h)(cf) \qquad [\textit{Equation } 3]$$

where:

h = height of water column (feet)
cf = the conversion factor calculated from Equation 2

The well volume is typically tripled to determine the volume to be purged.

9.0 QUALITY ASSURANCE/ QUALITY CONTROL

There are no specific quality assurance (QA) activities which apply to the implementation of these procedures. However, the following general QA procedures apply:

1. All data must be documented on field data sheets or within site logbooks.
2. All instrumentation must be operated in accordance with operating instructions as supplied by the manufacturer, unless otherwise specified in the work plan. Equipment checkout and calibration activities must occur prior to sampling/operation and they must be documented.
3. The collection of rinsate blanks is recommended to evaluate potential for cross contamination from the purging and/or sampling equipment.
4. Trip blanks are required if analytical parameters include VOAs.

10.0 DATA VALIDATION

This section is not applicable to this SOP.

11.0 HEALTH AND SAFETY

When working with potentially hazardous materials, follow U.S. EPA, OSHA or REAC health and safety guidelines. More specifically, depending upon the site specific contaminants, various protective programs must be implemented prior to sampling the first well. The site health and safety plan should be reviewed with specific emphasis placed on the protection program planned for the well sampling tasks. Standard safe operating practices should be followed such as minimizing contact with potential contaminants in both the vapor phase and liquid matrix through the use of respirators and disposable clothing.

When working around volatile organic contaminants:

1. Avoid breathing constituents venting from the well.
2. Pre-survey the well head-space with an FID/PID prior to sampling.
3. If monitoring results indicate organic constituents, sampling activities may be conducted in Level C protection. At a minimum, skin protection will be afforded by disposable protective clothing.

Physical hazards associated with well sampling:

1. Lifting injuries associated with pump and bailers retrieval; moving equipment.
2. Use of pocket knives for cutting discharge hose.
3. Heat/cold stress as a result of exposure to extreme temperatures and protective clothing.
4. Slip, trip, fall conditions as a result of pump discharge.
5. Restricted mobility due to the wearing of protective clothing.
6. Electrical shock associated with use of submersible pumps is possible. Use a GFCI or a copper grounding stake to avoid this problem.

12.0 REFERENCES

Barcelona, M.J., Helfrich, J.A., Garske, E.E., and J.P. Gibb, Spring 1984. "A Laboratory Evaluation of Groundwater Sampling Mechanisms," Groundwater

Monitoring Review, 1984 pp. 32-41.

Barcelona, M.J., Helfrich, J.A., and Garske, E.E., "Sampling Tubing Effects on Groundwater Samples", Analy. Chem., Vol. 57, 1985 pp. 460-463.

Driscoll, F.G., Groundwater and Wells (2nd ed.) Johnson Division, UOP Inc., St. Paul, Minnesota, 1986, 1089 pp.

Gibb, J.P., R.M. Schuller, and R.A. Griffin,. Monitoring Well Sampling and Preservation Techniques, EPA-600/9-80-010, 1980. March, 1980.

Instrument Specialties Company, (January). Instruction Manual, Model 2100 Wastewater Sampler, Lincoln, Nebraska, 1980.

Keely, J.F. and Kwasi Boateng, Monitoring Well Installation, Purging and Sampling Techniques - Part I: Conceptualizations, Groundwater V25, No. 3, 1987 pp. 300-313.

Keith, Lawrence H., Principles of Environmental Sampling, American Chemical Society, 1988.

Korte, Nic, and Dennis Ealey,. Procedures for Field Chemical Analyses of Water Samples, U.S. Department of Energy, GJ/TMC-07, Technical Measurements Center, Grand Junction Project Office, 1983.

Korte, Nic, and Peter Kearl,. Procedures for the Collection and Preservation of Groundwater and Surface Water Samples and for the Installation of Monitoring Wells: Second Edition, U.S. Department of Energy, GJ/TMC-08, Technical Measurements Center, Grand Junction Projects Office, 1985.

National Council of the Paper Industry for Air and Stream Improvement, Inc.,. A Guide to Groundwater Sampling, Technical Bulletin No. 362, Madison, New York. January, 1982.

Nielsen, David M. and Yeates, Gillian L., Spring. "A Comparison of Sampling Mechanisms Available for Small-Diameter Groundwater Monitoring Wells," Groundwater Monitoring Review, 1985 pp. 83-99.

Scalf, et al. (M.J. Scalf, McNabb, W. Dunlap, R. Crosby, and J. Fryberger),. Manual for Groundwater Sampling Procedures. R.S. Kerr Environmental Research Laboratory, Office of Research and Development. 1980, Ada, OK.

Sisk, S.W. NEIC Manual for Ground/Surface Investigations at Hazardous Waste Sites, EPA-330/9-81-002, 1981.

U.S. Department of the Interior, National Handbook of Recommended Methods for Water-Data Acquisition, Reston, Virginia.

U.S. Environmental Protection Agency, 1977. Procedures Manual for Groundwater Monitoring at Solid Waste Disposal Facilities. EPA-530/SW-611. August, 1977.

U.S. Code of Federal Regulations, 49 CFR Parts 100 to 177, Transportation revised November 1, 1985.

U.S. Environmental Protection Agency, 1982. Handbook for Chemical and Sample Preservation of Water and Wastewater, EPA-600/4-82-029, Washington, D.C.

U.S. Environmental Protection Agency, 1983. Methods for Chemical Analysis of Water and Waste, EPA-600/4-79-020, Washington, D.C.

U.S. Environmental Protection Agency, 1984. Test Methods for Evaluation of Solid Waste, EPA-SW-846, Second Edition, Washington, D.C.

U.S. Environmental Protection Agency, 1981. Manual of Groundwater Quality Sampling Procedures, EPA-600/2-81-160, Washington, D.C.

U.S. Environmental Protection Agency, 1985. Practical Guide for Groundwater Sampling, EPA-600/2-85/104, September, 1985.

U.S. Environmental Protection Agency, 1986. RCRA Groundwater Monitoring Technical Enforcement Guidance Document, OSWER-9950-1, September, 1986.

Weston, 1987. Standard Operations Procedures for Monitor Well Installation. MOUND IGMP/RIP.

U.S. Environmental Protection Agency, 1982. Handbook for Sampling and Sample Preservation of Water and Wastewater, EPA-600/4-82-029, Washington, D.C.

--- 1981. Manual of Groundwater Quality

Sampling Procedures, EPA-600/2-81-160, Washington, D.C.

--- 1985. Practice Guide for Groundwater Sampling, EPA-600/2/85-104, September 1985.

Nielsen, David M. and Yeates, Gillian L., Spring 1985. "A Comparison of Sampling Mechanisms Available for Small-Diameter Groundwater Monitoring Wells," Groundwater Monitoring Review, pp. 83-99.

WESTON, 1987. Standard Operating Procedures for Monitor Well Installation. MOUND IGMP/RIP

Barcelona, M.J. Helfrich, J.A., and Garske, E.E., "Sampling Tubing Effects on Groundwater Samples". 1985, Analy. Chem., Vol. 57, pp. 460-463.

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SAMPLING EQUIPMENT DECONTAMINATION

SOP#: 2006
DATE: 08/11/94
REV. #: 0.0

1.0 SCOPE AND APPLICATION

The purpose of this Standard Operating Procedure (SOP) is to provide a description of the methods used for preventing, minimizing, or limiting cross-contamination of samples due to inappropriate or inadequate equipment decontamination and to provide general guidelines for developing decontamination procedures for sampling equipment to be used during hazardous waste operations as per 29 Code of Federal Regulations (CFR) 1910.120. This SOP does not address personnel decontamination.

These are standard (i.e. typically applicable) operating procedures which may be varied or changed as required, dependent upon site conditions, equipment limitation, or limitations imposed by the procedure. In all instances, the ultimate procedures employed should be documented and associated with the final report.

Mention of trade names or commercial products does not constitute U.S. Environmental Protection Agency (U.S. EPA) endorsement or recommendation for use.

2.0 METHOD SUMMARY

Removing or neutralizing contaminants from equipment minimizes the likelihood of sample cross contamination, reduces or eliminates transfer of contaminants to clean areas, and prevents the mixing of incompatible substances.

Gross contamination can be removed by physical decontamination procedures. These abrasive and non-abrasive methods include the use of brushes, air and wet blasting, and high and low pressure water cleaning.

The first step, a soap and water wash, removes all visible particulate matter and residual oils and grease. This may be preceded by a steam or high pressure water wash to facilitate residuals removal. The second step involves a tap water rinse and a distilled/deionized water rinse to remove the detergent. An acid rinse provides a low pH media for trace metals removal and is included in the decontamination process if metal samples are to be collected. It is followed by another distilled/deionized water rinse. If sample analysis does not include metals, the acid rinse step can be omitted. Next, a high purity solvent rinse is performed for trace organics removal if organics are a concern at the site. Typical solvents used for removal of organic contaminants include acetone, hexane, or water. Acetone is typically chosen because it is an excellent solvent, miscible in water, and not a target analyte on the Priority Pollutant List. If acetone is known to be a contaminant of concern at a given site or if Target Compound List analysis (which includes acetone) is to be performed, another solvent may be substituted. The solvent must be allowed to evaporate completely and then a final distilled/deionized water rinse is performed. This rinse removes any residual traces of the solvent.

The decontamination procedure described above may be summarized as follows:

1. Physical removal
2. Non-phosphate detergent wash
3. Tap water rinse
4. Distilled/deionized water rinse
5. 10% nitric acid rinse
6. Distilled/deionized water rinse
7. Solvent rinse (pesticide grade)
8. Air dry
9. Distilled/deionized water rinse

If a particular contaminant fraction is not present at the site, the nine (9) step decontamination procedure specified above may be modified for site specificity. For example, the nitric acid rinse may be eliminated if metals are not of concern at a site. Similarly, the solvent rinse may be eliminated if organics are not of concern at a site. Modifications to the standard procedure should be documented in the site specific work plan or subsequent report.

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE

The amount of sample to be collected and the proper sample container type (i.e., glass, plastic), chemical preservation, and storage requirements are dependent on the matrix being sampled and the parameter(s) of interest.
More specifically, sample collection and analysis of decontamination waste may be required before beginning proper disposal of decontamination liquids and solids generated at a site. This should be determined prior to initiation of site activities.

4.0 INTERFERENCES AND POTENTIAL PROBLEMS

C The use of distilled/deionized water commonly available from commercial vendors may be acceptable for decontamination of sampling equipment provided that it has been verified by laboratory analysis to be analyte free (specifically for the contaminants of concern).

C The use of an untreated potable water supply is not an acceptable substitute for tap water. Tap water may be used from any municipal or industrial water treatment system.

C If acids or solvents are utilized in decontamination they raise health and safety, and waste disposal concerns.

C Damage can be incurred by acid and solvent washing of complex and sophisticated sampling equipment.

5.0 EQUIPMENT/APPARATUS

Decontamination equipment, materials, and supplies are generally selected based on availability. Other considerations include the ease of decontaminating or disposing of the equipment. Most equipment and supplies can be easily procured. For example, soft-bristle scrub brushes or long-handled bottle brushes can be used to remove contaminants. Large galvanized wash tubs, stock tanks, or buckets can hold wash and rinse solutions. Children's wading pools can also be used. Large plastic garbage cans or other similar containers lined with plastic bags can help segregate contaminated equipment. Contaminated liquid can be stored temporarily in metal or plastic cans or drums.

The following standard materials and equipment are recommended for decontamination activities:

5.1 Decontamination Solutions

C Non-phosphate detergent
C Selected solvents (acetone, hexane, nitric acid, etc.)
C Tap water
C Distilled or deionized water

5.2 Decontamination Tools/Supplies

C Long and short handled brushes
C Bottle brushes
C Drop cloth/plastic sheeting
C Paper towels
C Plastic or galvanized tubs or buckets
C Pressurized sprayers (H_2O)
C Solvent sprayers
C Aluminum foil

5.3 Health and Safety Equipment

Appropriate personal protective equipment (i.e., safety glasses or splash shield, appropriate gloves, aprons or coveralls, respirator, emergency eye wash)

5.4 Waste Disposal

C Trash bags
C Trash containers
C 55-gallon drums
C Metal/plastic buckets/containers for storage and disposal of decontamination solutions

6.0 REAGENTS

There are no reagents used in this procedure aside from the actual decontamination solutions. Table 1 (Appendix A) lists solvent rinses which may be required for elimination of particular chemicals. In general, the following solvents are typically utilized for decontamination purposes:

C 10% nitric acid is typically used for inorganic compounds such as metals. An acid rinse may not be required if inorganics are not a contaminant of concern.
C Acetone (pesticide grade)(1)
C Hexane (pesticide grade)(1)
C Methanol(1)

(1) - Only if sample is to be analyzed for organics.

7.0 PROCEDURES

As part of the health and safety plan, a decontamination plan should be developed and reviewed. The decontamination line should be set up before any personnel or equipment enter the areas of potential exposure. The equipment decontamination plan should include:

C The number, location, and layout of decontamination stations.

C Decontamination equipment needed.

C Appropriate decontamination methods.

C Methods for disposal of contaminated clothing, equipment, and solutions.

C Procedures can be established to minimize the potential for contamination. This may include: (1) work practices that minimize contact with potential contaminants; (2) using remote sampling techniques; (3) covering monitoring and sampling equipment with plastic, aluminum foil, or other protective material; (4) watering down dusty areas; (5) avoiding laying down equipment in areas of obvious contamination; and (6) use of disposable sampling equipment.

7.1 Decontamination Methods

All samples and equipment leaving the contaminated area of a site must be decontaminated to remove any contamination that may have adhered to equipment. Various decontamination methods will remove contaminants by: (1) flushing or other physical action, or (2) chemical complexing to inactivate contaminants by neutralization, chemical reaction, disinfection, or sterilization.

Physical decontamination techniques can be grouped into two categories: abrasive methods and non-abrasive methods, as follows:

7.1.1 Abrasive Cleaning Methods

Abrasive cleaning methods work by rubbing and wearing away the top layer of the surface containing the contaminant. The mechanical abrasive cleaning methods are most commonly used at hazardous waste sites. The following abrasive methods are available:

Mechanical

Mechanical methods of decontamination include using metal or nylon brushes. The amount and type of contaminants removed will vary with the hardness of bristles, length of time brushed, degree of brush contact, degree of contamination, nature of the surface being cleaned, and degree of contaminant adherence to the surface.

Air Blasting

Air blasting equipment uses compressed air to force abrasive material through a nozzle at high velocities. The distance between nozzle and surface cleaned, air pressure, time of application, and angle at which the abrasive strikes the surface will dictate cleaning efficiency. Disadvantages of this method are the inability to control the amount of material removed and the large amount of waste generated.

Wet Blasting

Wet blast cleaning involves use of a suspended fine abrasive. The abrasive/water mixture is delivered by compressed air to the contaminated area. By using a very fine abrasive, the amount of materials removed can be carefully controlled.

7.1.2 Non-Abrasive Cleaning Methods

Non-abrasive cleaning methods work by forcing the contaminant off a surface with pressure. In general, the equipment surface is not removed using non-abrasive methods.

Low-Pressure Water

This method consists of a container which is filled with water. The user pumps air out of the container to create a vacuum. A slender nozzle and hose allow the user to spray in hard-to-reach places.

High-Pressure Water

This method consists of a high-pressure pump, an operator controlled directional nozzle, and a high-pressure hose. Operating pressure usually ranges from 340 to 680 atmospheres (atm) and flow rates usually range from 20 to 140 liters per minute.

Ultra-High-Pressure Water

This system produces a water jet that is pressured from 1,000 to 4,000 atmospheres. This ultra-high-pressure spray can remove tightly-adhered surface films. The water velocity ranges from 500 meters/second (m/s) (1,000 atm) to 900 m/s (4,000 atm). Additives can be used to enhance the cleaning action.

Rinsing

Contaminants are removed by rinsing through dilution, physical attraction, and solubilization.

Damp Cloth Removal

In some instances, due to sensitive, non-waterproof equipment or due to the unlikelihood of equipment being contaminated, it is not necessary to conduct an extensive decontamination procedure. For example, air sampling pumps hooked on a fence, placed on a drum, or wrapped in plastic bags are not likely to become heavily contaminated. A damp cloth should be used to wipe off contaminants which may have adhered to equipment through airborne contaminants or from surfaces upon which the equipment was set.

Disinfection/Sterilization

Disinfectants are a practical means of inactivating infectious agents. Unfortunately, standard sterilization methods are impractical for large equipment. This method of decontamination is typically performed off-site.

7.2 Field Sampling Equipment Decontamination Procedures

The decontamination line is setup so that the first station is used to clean the most contaminated item. It progresses to the last station where the least contaminated item is cleaned. The spread of contaminants is further reduced by separating each decontamination station by a minimum of three (3') feet. Ideally, the contamination should decrease as the equipment progresses from one station to another farther along in the line.

A site is typically divided up into the following boundaries: Hot Zone or Exclusion Zone (EZ), the Contamination Reduction Zone (CRZ), and the Support or Safe Zone (SZ). The decontamination line should be setup in the Contamination Reduction Corridor (CRC) which is in the CRZ. Figure 1 (Appendix B) shows a typical contaminant reduction zone layout. The CRC controls access into and out of the exclusion zone and confines decontamination activities to a limited area. The CRC boundaries should be conspicuously marked. The far end is the hotline, the boundary between the exclusion zone and the contamination reduction zone. The size of the decontamination corridor depends on the number of stations in the decontamination process, overall dimensions of the work zones, and amount of space available at the site. Whenever possible, it should be a straight line.

Anyone in the CRC should be wearing the level of protection designated for the decontamination crew. Another corridor may be required for the entry and exit of heavy equipment. Sampling and monitoring equipment and sampling supplies are all maintained outside of the CRC. Personnel don their equipment away from the CRC and enter the exclusion zone through a separate access control point at the hotline. One person (or more) dedicated to decontaminating equipment is recommended.

7.2.1 Decontamination Setup

Starting with the most contaminated station, the decontamination setup should be as follows:

Station 1: Segregate Equipment Drop

Place plastic sheeting on the ground (Figure 2, Appendix B). Size will depend on amount of equipment to be decontaminated. Provide containers lined with plastic if equipment is to be segregated. Segregation may be required if sensitive equipment or mildly contaminated equipment is used at the same time as equipment which is likely to be heavily contaminated.

Station 2: Physical Removal With A High-Pressure Washer (Optional)

As indicated in 7.1.2, a high-pressure wash may be required for compounds which are difficult to remove by washing with brushes. The elevated temperature of the water from the high-pressure washers is excellent at removing greasy/oily compounds. High pressure washers require water and electricity.

A decontamination pad may be required for the high-pressure wash area. An example of a wash pad may consist of an approximately 1 1/2 foot-deep basin lined with plastic sheeting and sloped to a sump at one corner. A layer of sand can be placed over the plastic and the basin is filled with gravel or shell. The sump is also lined with visqueen and a barrel is placed in the hole to prevent collapse. A sump pump is used to remove the water from the sump for transfer into a drum.

Typically heavy machinery is decontaminated at the end of the day unless site sampling requires that the machinery be decontaminated frequently. A separate decontamination pad may be required for heavy equipment.

Station 3: Physical Removal With Brushes And A Wash Basin

Prior to setting up Station 3, place plastic sheeting on the ground to cover areas under Station 3 through Station 10.
Fill a wash basin, a large bucket, or child's swimming pool with non-phosphate detergent and tap water. Several bottle and bristle brushes to physically remove contamination should be dedicated to this station . Approximately 10 - 50 gallons of water may be required initially depending upon the amount of equipment to decontaminate and the amount of gross contamination.

Station 4: Water Basin

Fill a wash basin, a large bucket, or child's swimming pool with tap water. Several bottle and bristle brushes should be dedicated to this station. Approximately 10-50 gallons of water may be required initially depending upon the amount of equipment to decontaminate and the amount of gross contamination.

Station 5: Low-Pressure Sprayers

Fill a low-pressure sprayer with distilled/deionized water. Provide a 5-gallon bucket or basin to contain the water during the rinsing process. Approximately 10-20 gallons of water may be required initially depending upon the amount of equipment to decontaminate and the amount of gross contamination.

Station 6: Nitric Acid Sprayers

Fill a spray bottle with 10% nitric acid. An acid rinse may not be required if inorganics are not a contaminant of concern. The amount of acid will depend on the amount of equipment to be decontaminated. Provide a 5-gallon bucket or basin to collect acid during the rinsing process.

Station 7: Low-Pressure Sprayers

Fill a low-pressure sprayer with distilled/deionized water. Provide a 5-gallon bucket or basin to collect water during the rinsate process.

Station 8: Organic Solvent Sprayers

Fill a spray bottle with an organic solvent. After each solvent rinse, the equipment should be rinsed with distilled/deionized water and air dried. Amount of solvent will depend on the amount of equipment to decontaminate. Provide a 5-gallon bucket or basin to collect the solvent during the rinsing process.

Solvent rinses may not be required unless organics are a contaminant of concern, and may be eliminated from the station sequence.

Station 9: Low-Pressure Sprayers

Fill a low-pressure sprayer with distilled/deionized water. Provide a 5-gallon bucket or basin to collect water during the rinsate process.

Station 10: Clean Equipment Drop

Lay a clean piece of plastic sheeting over the bottom plastic layer. This will allow easy removal of the plastic in the event that it becomes dirty. Provide aluminum foil, plastic, or other protective material to wrap clean equipment.

7.2.2 Decontamination Procedures

Station 1: Segregate Equipment Drop

Deposit equipment used on-site (i.e., tools, sampling devices and containers, monitoring instruments radios, clipboards, etc.) on the plastic drop cloth/sheet or in different containers with plastic liners. Each will be contaminated to a different degree. Segregation at the drop reduces the probability of cross contamination. Loose leaf sampling data sheets or maps can be placed in plastic zip lock bags if contamination is evident.

Station 2: Physical Removal With A High-Pressure Washer (Optional)

Use high pressure wash on grossly contaminated equipment. Do not use high- pressure wash on sensitive or non-waterproof equipment.

Station 3: Physical Removal With Brushes And A Wash Basin

Scrub equipment with soap and water using bottle and bristle brushes. Only sensitive equipment (i.e., radios, air monitoring and sampling equipment) which is waterproof should be washed. Equipment which is not waterproof should have plastic bags removed and wiped down with a damp cloth. Acids and organic rinses may also ruin sensitive equipment. Consult the manufacturers for recommended decontamination solutions.

Station 4: Equipment Rinse

Wash soap off of equipment with water by immersing the equipment in the water while brushing. Repeat as many times as necessary.

Station 5: Low-Pressure Rinse

Rinse sampling equipment with distilled/deionized water with a low-pressure sprayer.

Station 6: Nitric Acid Sprayers (required only if metals are a contaminant of concern)

Using a spray bottle rinse sampling equipment with nitric acid. Begin spraying (inside and outside) at one end of the equipment allowing the acid to drip to the other end into a 5-gallon bucket. A rinsate blank may be required at this station. Refer to Section 9.

Station 7: Low-Pressure Sprayers

Rinse sampling equipment with distilled/deionized water with a low-pressure sprayer.

Station 8: Organic Solvent Sprayers

Rinse sampling equipment with a solvent. Begin spraying (inside and outside) at one end of the equipment allowing the solvent to drip to the other end into a 5-gallon bucket. Allow the solvent to evaporate from the equipment before going to the next station. A QC rinsate sample may be required at this station.

Station 9: Low-Pressure Sprayers

Rinse sampling equipment with distilled/deionized water with a low-pressure washer.

Station 10 : Clean Equipment Drop

Lay clean equipment on plastic sheeting. Once air dried, wrap sampling equipment with aluminum foil, plastic, or other protective material.

7.2.3 Post Decontamination Procedures

1. Collect high-pressure pad and heavy equipment decontamination area liquid and waste and store in appropriate drum or container. A sump pump can aid in the collection process. Refer to the Department of Transportation (DOT) requirements for appropriate containers based on the contaminant of concern.

2. Collect high-pressure pad and heavy equipment decontamination area solid waste and store in appropriate drum or container. Refer to the DOT requirements for appropriate containers based on the contaminant of concern.

3. Empty soap and water liquid wastes from basins and buckets and store in appropriate

drum or container. Refer to the DOT requirements for appropriate containers based on the contaminant of concern.

4. Empty acid rinse waste and place in appropriate container or neutralize with a base and place in appropriate drum. pH paper or an equivalent pH test is required for neutralization. Consult DOT requirements for appropriate drum for acid rinse waste.

5. Empty solvent rinse sprayer and solvent waste into an appropriate container. Consult DOT requirements for appropriate drum for solvent rinse waste.

6. Using low-pressure sprayers, rinse basins, and brushes. Place liquid generated from this process into the wash water rinse container.

7. Empty low-pressure sprayer water onto the ground.

8. Place all solid waste materials generated from the decontamination area (i.e., gloves and plastic sheeting, etc.) in an approved DOT drum. Refer to the DOT requirements for appropriate containers based on the contaminant of concern.

9. Write appropriate labels for waste and make arrangements for disposal. Consult DOT regulations for the appropriate label for each drum generated from the decontamination process.

8.0 CALCULATIONS

This section is not applicable to this SOP.

9.0 QUALITYASSURANCE/ QUALITY CONTROL

A rinsate blank is one specific type of quality control sample associated with the field decontamination process. This sample will provide information on the effectiveness of the decontamination process employed in the field.

Rinsate blanks are samples obtained by running analyte free water over decontaminated sampling equipment to test for residual contamination. The blank water is collected in sample containers for handling, shipment, and analysis. These samples are treated identical to samples collected that day. A rinsate blank is used to assess cross contamination brought about by improper decontamination procedures. Where dedicated sampling equipment is not utilized, collect one rinsate blank per day per type of sampling device samples to meet QA2 and QA3 objectives.

If sampling equipment requires the use of plastic tubing it should be disposed of as contaminated and replaced with clean tubing before additional sampling occurs.

10.0 DATA VALIDATION

Results of quality control samples will be evaluated for contamination. This information will be utilized to qualify the environmental sample results in accordance with the project's data quality objectives.

11.0 HEALTH AND SAFETY

When working with potentially hazardous materials, follow OSHA, U.S. EPA, corporate, and other applicable health and safety procedures.

Decontamination can pose hazards under certain circumstances. Hazardous substances may be incompatible with decontamination materials. For example, the decontamination solution may react with contaminants to produce heat, explosion, or toxic products. Also, vapors from decontamination solutions may pose a direct health hazard to workers by inhalation, contact, fire, or explosion.

The decontamination solutions must be determined to be acceptable before use. Decontamination materials may degrade protective clothing or equipment; some solvents can permeate protective clothing. If decontamination materials do pose a health hazard, measures should be taken to protect personnel or substitutions should be made to eliminate the hazard. The choice of respiratory protection based on contaminants of concern from the site may not be appropriate for solvents used in the decontamination process.

Safety considerations should be addressed when using abrasive and non-abrasive decontamination equipment. Maximum air pressure produced by abrasive equipment could cause physical injury. Displaced material requires control mechanisms.

Material generated from decontamination activities requires proper handling, storage, and disposal. Personal Protective Equipment may be required for these activities.

Material safety data sheets are required for all decontamination solvents or solutions as required by the Hazard Communication Standard (i.e., acetone, alcohol, and trisodiumphosphate).

In some jurisdictions, phosphate containing detergents (i.e., TSP) are banned.

12.0 REFERENCES

Field Sampling Procedures Manual, New Jersey Department of Environmental Protection, February, 1988.

A Compendium of Superfund Field Operations Methods, EPA 540/p-87/001.

Engineering Support Branch Standard Operating Procedures and Quality Assurance Manual, USEPA Region IV, April 1, 1986.

Guidelines for the Selection of Chemical Protective Clothing, Volume 1, Third Edition, American Conference of Governmental Industrial Hygienists, Inc., February, 1987.

Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities, NIOSH/OSHA/USCG/EPA, October, 1985.

APPENDIX A

Table

Table 1. Soluble Contaminants and Recommended Solvent Rinse

TABLE 1
Soluble Contaminants and Recommended Solvent Rinse

SOLVENT[1]	EXAMPLES OF SOLVENTS	SOLUBLE CONTAMINANTS
Water	Deionized water Tap water	Low-chain hydrocarbons Inorganic compounds Salts Some organic acids and other polar compounds
Dilute Acids	Nitric acid Acetic acid Boric acid	Basic (caustic) compounds (e.g., amines and hydrazines)
Dilute Bases	Sodium bicarbonate (e.g., soap detergent)	Acidic compounds Phenol Thiols Some nitro and sulfonic compounds
Organic Solvents [2]	Alcohols Ethers Ketones Aromatics Straight chain alkalines (e.g., hexane) Common petroleum products (e.g., fuel, oil, kerosene)	Nonpolar compounds (e.g., some organic compounds)
Organic Solvent[2]	Hexane	PCBs

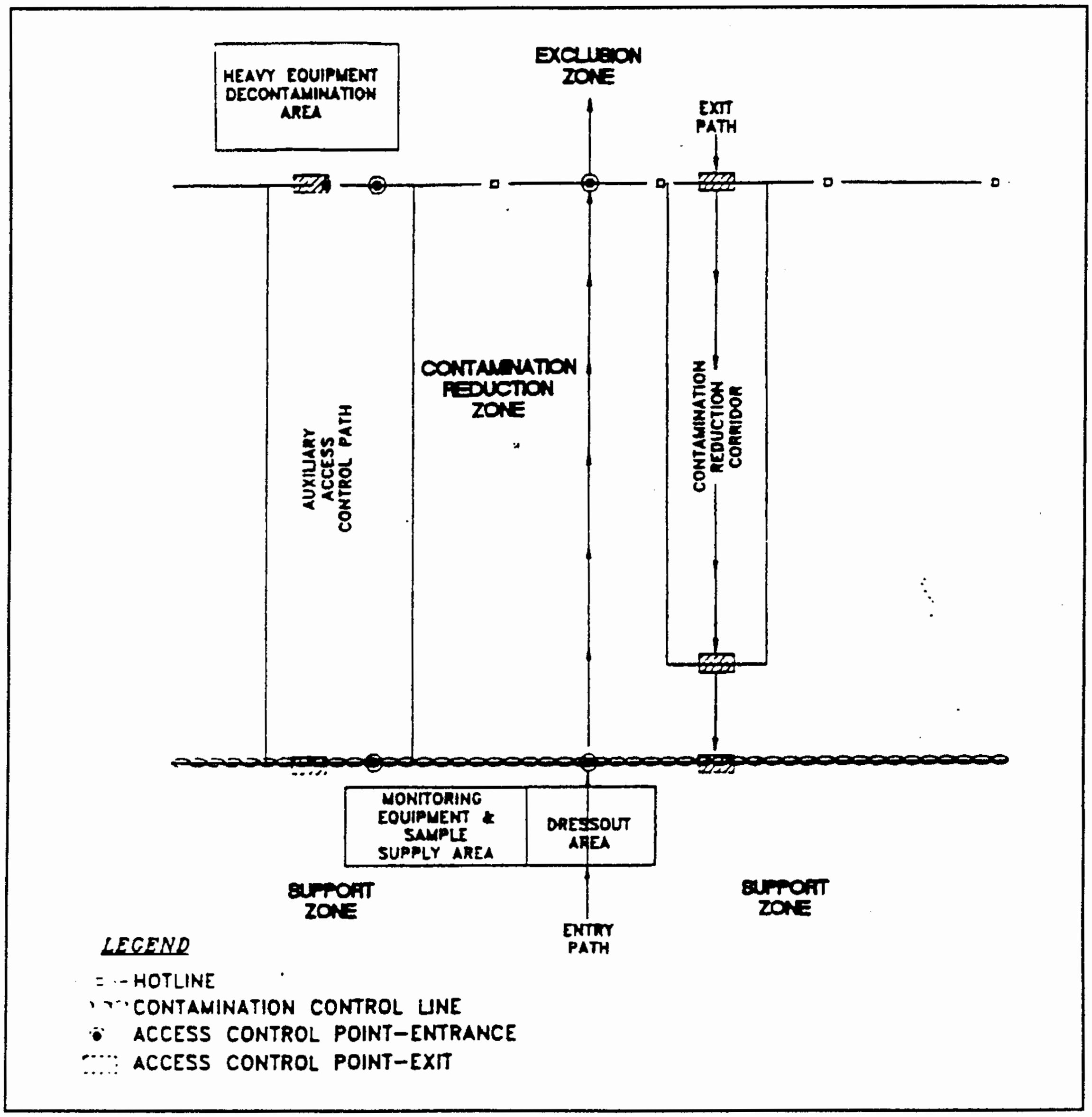
[1] - Material safety data sheets are required for all decontamination solvents or solutions as required by the Hazard Communication Standard

[2] - WARNING: Some organic solvents can permeate and/or degrade the protective clothing

APPENDIX B

Figures

Figure 1. Contamination Reduction Zone Layout



APPENDIX B (Cont'd.)

Figures

Figure 2. Decontamination Layout