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June 22, 2006

Mr. Lorenzo Thantu
Remedial Project Manager
U.S. Environmental Protection Agency
290 Broadway 20th Floor
New York, NY 10007-1866

PROJECT:	RAC II Contract No.: 68-98-210 Work Assignment No.: 164-RICO-02TK
DOC. CONTROL NO.:	3223-164-PP-QAPP-06182
SUBJECT:	Final Quality Assurance Project Plan Hopewell Precision Site Remedial Investigation/Feasibility Study Hopewell Junction, New York

Dear Mr. Thantu:

CDM Federal Programs Corporation (CDM) is pleased to submit this Final Quality Assurance Project Plan for the Remedial Investigation/Feasibility Study at the Hopewell Precision Site in Hopewell Junction, New York as partial fulfillment of Subtask No. 1.7 of the Statement of Work.

If you have any questions regarding this submittal, please contact Susan Schofield at (203) 262-6633 or me at (212) 785-9123.

Very truly yours,

CDM FEDERAL PROGRAMS CORPORATION

Jeanne Litwin, REM
RAC II Technical Operations Manager

JL/md
Enclosure

cc: F. Rosado, EPA Region II (no appendices)
D. Butler, EPA Region II (letter only)
L. Mauel, EPA Edison
R. Goltz/PSO File, CDM
S. Schofield, CDM
S. Kellogg, CDM
J. Oxford, CDM
RAC II Document Control

RESPONSE ACTION CONTRACT
FOR REMEDIAL RESPONSE, ENFORCEMENT OVERSIGHT,
CRITICAL REMOVAL ACTIVITIES AT SITES OF RELEASE OR
THREATENED RELEASE OF HAZARDOUS SUBSTANCES
IN EPA REGION II

FINAL QUALITY ASSURANCE PROJECT PLAN

HOPEWELL PRECISION SITE
REMEDIAL INVESTIGATION/FEASIBILITY STUDY
HOPEWELL JUNCTION, NEW YORK
Work Assignment No. 164-RICO-02TK

U.S. EPA CONTRACT NO. 68-W-98-210
Document Control No.: 3223-164-PP-QAPP-06182
June 22, 2006

Prepared for:
U.S. Environmental Protection Agency
290 Broadway
New York, New York 10007-1866

Prepared by:
CDM Federal Programs Corporation
125 Maiden Lane, 5th Floor
New York, New York 10038

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FINAL QUALITY ASSURANCE PROJECT PLAN (QAPP)
for
Hopewell Precision Site
Remedial Investigation/Feasibility Study
Hopewell Junction, Dutchess County, New York

US Environmental Protection Agency (EPA) Region II

Prepared by: CDM Federal Programs Corporation (CDM)
125 Maiden Lane, 5th Floor
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(212) 785-9123

Date: June 22, 2006

Investigative Organization's Site Manager: Susan Schofield, P.G., CDM

Signature: J. Litwin for

CDM Project QA Officer: Steven Martz, CDM

Signature: [signature] for

Lead Organization's Project Manager: Lorenzo Thantu, EPA

Signature: ____________________

CDM RAC II Technical Operations Manager: Jeanne Litwin, CDM

Signature: J. Litwin

EPA Region II Hazardous Waste Support Section: Linda Mauel, EPA

Signature: ____________________

Document Control Number: 3223-164-PP-QAPP-06182

QAPP Worksheet #2
QAPP Identifying Information

Site Name/Project: Hopewell Precision Site Remedial Investigation/Feasibility Study (RI/FS)

Site Location: Hopewell Junction, New York

Site Number/Code: NYD06813064

Operable Unit: Not Applicable (NA)

Contractor Name: CDM

Contract Title: Response Action Contract, Region II/No. 68-W-98-210

Work Assignment Number: 164-RICO-02TK

Guidance Used to Prepare QAPP: Requirements for QAPPs for Environmental Data Operations QA/R5, Guidance for QAPPs, QA/G5, Uniform Federal Policy for QAPPs

Regulatory Program: EPA Region II

Approval Entity: EPA Region II

Is QAPP generic or project specific: Project Specific QAPP

Dates of Scoping Sessions: April 5, 2005

Dates and Titles of QAPP Documents Written for Previous Site Work:
Final Vapor Intrusion Sub-slab and Vapor Intrusion Quality Assurance Project Plan (January 10, 2006)

Organizational Partners (Stakeholders) and Connection with Lead Organization:
New York State Department of Environmental Conservation (NYSDEC) and New York State Department of Health (NYSDOH)

Data Users: CDM, EPA Region II, NYSDEC, NYSDOH

Required QAPP elements and required information that are not applicable to the project, explanation for their exclusion: None

QAPP Worksheet #2
QAPP Identifying Information

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QAPP Worksheet #3
Distribution List

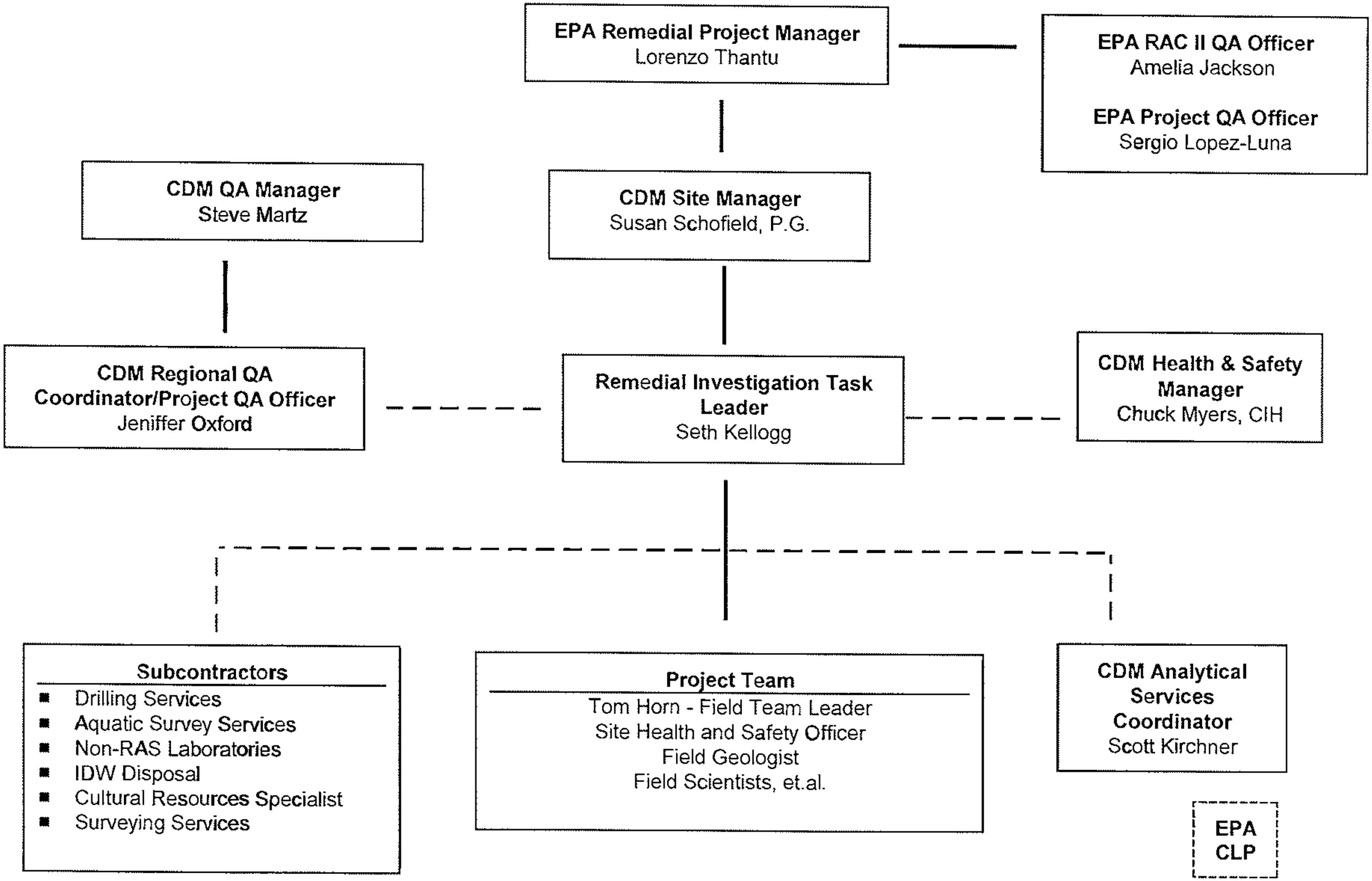
QAPP Recipients/ Document Control Number	Title	Organization	Telephone Number	Fax Number	E-mail Address
Lorenzo Thantu 3223-164-PP-QAPP-06182-001	RPM	EPA	(212) 637-4240	(212) 637-3966	thantu.lorenzo@epa.gov
Sergio Lopez-Luna 3223-164-PP-QAPP-06182-002	QA Officer	EPA	(732) 321-6778	(732) 321-4381	lopez.sergio@epa.gov
Linda Mauel 3223-164-PP-QAPP-06182-003	Hazardous Waste Support Section Chief	EPA	(732) 321-6766	(732) 321-4381	mauel.linda@epa.gov
Karen Maiurano 3223-164-PP-QAPP-06182-004	Project Manager	NYSDEC	(518) 402-9662	(518) 402-9679	ksmaiura@gw.dec.state.ny.us
Bridget Callahan 3223-164-PP-QAPP-06182-005	Project Manager	NYSDOH	(518) 402-7880	(518) 402-7859	N/A
Susan Schofield 3223-164-PP-QAPP-06182-006	Site Manager	CDM	(203) 262-6633	(203) 262-6633	schofieldse@cdm.com
Robert Goltz 3223-164-PP-QAPP-06182-007	Program Manager	CDM	(212) 785-9123	(212) 785-6114	goltzrd@cdm.com
Jeanne Litwin 3223-164-PP-QAPP-06182-008	Technical Operations Manager	CDM	(212) 785-9123	(212) 785-6114	litwinj@cdm.com
Jeniffer Oxford 3223-164-PP-QAPP-06182-009	Regional QA Coordinator/ Project QA Officer	CDM	(212) 785-9123	(212) 785-6114	oxfordjm@cdm.com
Seth Kellogg 3223-164-PP-QAPP-06182-010	RI Task Leader	CDM	(732) 225-7000	(732) 225-6147	kelloggds@cdm.com
Tom Horn 3223-164-PP-QAPP-06182-011	Field Team Leader	CDM	(732) 225-7000	(732) 225-6147	horntj@cdm.com

QAPP Worksheet #4
Project Personnel Sign-off Sheet

Organization: CDM

Project Personnel	Title	Telephone Number	Signature	Date QAPP Read
Tom Horn	Field Team Leader	(732) 261-6451		
Melissa Koberle	Field Scientist	(212) 785-9123		
TBD	Field Scientist			
Nimeesha Bulsara	Field Geologist	(212) 785-9123		
Tom Horn	Site Health and Safety Officer	(732) 225-7000		
Susan Schofield	Site Manager	(203) 262-6633		
Seth Kellogg	RI Task Leader	(732) 590-4674		

QAPP Worksheet #5
Project Organization



QAPP Worksheet #6
Communication Pathways

Communication Drivers	Responsible Entity	Name	Phone Number	Procedure
Point of Contact with EPA RPM	CDM Site Manager (SM)	Susan Schofield	(203) 262-6633	All information about the project will be sent to Lorenzo Thantu by SM. Field changes will be discussed with the EPA Remedial Project Manager (RPM) prior to implementation.
Manage Remedial Investigation Tasks	CDM RI Task Leader (RITL)	Seth Kellogg	(732) 225-7000	Act as liaison to SM concerning Remedial Investigation (RI) activities. Daily communication with project team and SM. Communicate implementation issues to Field Team Leader
Facilitate Database setup and data management planning	Field Team Leader (FTL)	Tom Horn	(732) 225-7000	Provide sample location, sample ID, and analysis information prior to sample collection. Provide information on sample and analytical reporting groups; and types of report tables required for project.
QAPP changes in the field	Field Team Leader	Tom Horn	(732) 225-7000	Notify RITL immediately and complete a Field Change Request (FCR) form and/or corrected worksheets. Distribute FCR forms to distribution list (Worksheet #3).
	CDM RI Task Leader	Seth Kellogg	(732) 225-7000	Notify EPA RPM, CDM SM and Analytical Services Coordinator (ASC) of delays or changes to field work.
Completion of daily summary reports	Field Team Leader	Tom Horn	(732) 225-7000	Complete on a daily basis and submit to SM and RITL. SM will forward to EPA RPM upon request.
Booking of analytical services	Field Team Leader	Tom Horn	(732) 225-7000	Submit request to ASC before the timeframe below.
	Analytical Services Coordinator	Scott Kirchner	(732) 225-7000	Book Division of Environmental Science and Assessment (DESA) and Contract Laboratory Program (CLP) analytical services 3 weeks ahead of sampling.
Notification of analytical issues	Analytical Services Coordinator	Scott Kirchner	(732) 225-7000	Notify FTL of any sample collection/ shipment issues. Notify Regional Sample Control Center (RSCC), DESA lab or subcontract labs to initiate corrective action.

QAPP Worksheet #6
Communication Pathways

Communication Drivers	Responsible Entity	Name	Phone Number	Procedure
Field corrective action	CDM RQAC, auditor, RITL, FTL, and field team	Tom Horn	(732) 225-7000	SM, RITL, FTL, Regional Quality Assurance Coordinator (RQAC) or auditor determines the need for corrective actions. Corrective actions may also be identified by the field team. FTL initiates corrective action on identified field issues immediately or within RQAC recommended timeframe.
Analytical services support	Analytical Services Coordinator	Scott Kirchner	(732) 225-7000	Act as liaison with RSCC for CLP laboratories, with John Birri for DESA and with subcontract laboratory(ies).
Facilitate data management	Field Team Leader	Tom Horn	(732) 225-7000	Provide electronic survey data. Transmit sample tracking information to data manager by the completion of each sampling case.
Reporting of issues relating to analytical data quality including ability to meet reporting limits, and usability of data	Laboratory QA Coordinator or Laboratory Project Manager	Scott Kirchner or designee	(732) 225-7000	Communicate to SM or ASC as appropriate.
	Data Assessor	Scott Kirchner	(732) 225-7000	Communicate to SM or ASC as appropriate. Document situation and effect in a data quality report prepared prior to evaluation of data/technical memoranda/RI report.
Release of analytical data	Analytical Services Coordinator	Scott Kirchner	(732) 225-7000	Receive and review data packages before data is used. Initiate data validation of subcontract laboratory data.
QAPP amendments	EPA RPM	Lorenzo Thantu	(212) 637-4240	Must approve QAPP and any amendments to the QAPP before they are implemented.
	Site Manager	Susan Schofield	(203) 262-6633	Initiate QAPP amendments in consultation with EPA RPM. Submit QAPPs prior to field work. Document approvals and informs FTL and RQAC of approvals.

QAPP Worksheet #6
Communication Pathways

Communication Drivers	Responsible Entity	Name	Phone Number	Procedure
Safety decisions; reporting of safety issues; tailgate safety meetings	Health and Safety Officer	To be determined (TBD)	TBD	Implement Health and Safety Plan (HSP) recommended changes due to changes in field conditions in conjunction with CDM's Health and Safety Manager, Chuck Myers. Inform RITL and SM of any changes. Hold daily safety briefings.

QAPP Worksheet #7
Personnel Responsibilities and Qualifications Table

Name	Title	Organizational Affiliation	Responsibilities	Education and Experience Qualifications
Susan Schofield, P.G.	Site Manager	CDM	Oversees project and responds to EPA RPM. Manages subcontractors. Maintains and distributes the most current version of the QAPP.	M.S., B.S., Geology; 19 years experience as a project manager in Superfund
Frank Tsang, P.E.	Feasibility Study Manager	CDM	Oversees Feasibility Study tasks and responds to SM	M.S., B.S., Chemical Engineering, PE; 28 years experience
Seth Kellogg	RI Task Leader	CDM	Oversees Remedial Investigation tasks and responds to SM	M.S., B.S., Geology; 12 years experience
John Dougherty	Project Hydrogeologist	CDM	Provide guidance on the drilling program and analyze the geologic data for the RI and FS Reports	B.S., Geology, PG, 17 years experience
Jeniffer Oxford	Regional QA Coordinator/ Project QA Officer	CDM	Oversees adherence to QA requirements	B.S., Natural Sciences; 7 years experience in analytical chemistry; 15 years experience in environmental science; American Society for Quality (ASQ) Certified QA auditor
Chuck Myers, C.I.H.	Health and Safety Manager	CDM	Oversees adherence to Health and Safety requirements	B.S. Biology; M.S. Industrial Hygiene; Certified Hazardous Materials Manager No. 619; Certified Hazard Control Manager; Certified Product Safety Manager; over 23 years experience
Scott Kirchner	Analytical Services Coordinator	CDM	Communicate with EPA RSCC, DESA laboratory and subcontract laboratories; manage data tracking, validation and data packages	B.S. Chemistry, Environmental Science Certified Hazardous Materials Manager, 19 years experience
Melinda Olsen	Data Manager	CDM	Assist in database management, data tracking and field coordination	Associates Degree; 13 years experience in data management

QAPP Worksheet #7
Personnel Responsibilities and Qualifications Table

Name	Title	Organizational Affiliation	Responsibilities	Education and Experience Qualifications
Nai-chia Luke, Ph.D.	Risk Assessor	CDM	Perform human health and ecological risk assessments	M.S., PhD, Plant Physiology, 28 years experience
Tom Horn	Field Team Leader	CDM	Oversees all field investigation activities	B.A., Geography, Environmental Analysis, 20 years experience
Melissa Koberle	Field Scientist	CDM	Performs field investigation activities	B.S., Environmental Science, Biology, 2 years field experience
Nimeesha Bulsara	Field Geologist	CDM	Performs field investigation activities	M.S., Hydrogeology; B.S. Geological Engineering, 2 years field experience

QAPP Worksheet #8
Special Personnel Training Requirements Table

Project Function	Specialized Training	Training Provider	Training Date	Personnel/Groups Receiving Training	Personnel Titles/ Organizational Affiliation	Location of Training Records/Certifications
All Field Activities	40-hour Occupational Safety and Health Administration (OSHA) Training and Annual 8 hour refresher	40 hour - EPA or vendor; 8-hour web-based or CDM training and on-site safety briefings	various	All field team members	CDM staff, subcontractors	CDM Health and Safety (H&S) database and on site
All Field Activities	Site Supervisor Training	CDM H&S Manager	various	FTL, site H&S officer	FTL, site H&S officer	CDM H&S database and on site
Sample Collection	Trained in EPA Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) QA sampling methods	On-site training	various	CDM staff (Field scientists and geologists)	FTL, Geologists, scientists	CDM
Sample Analysis	Trained in EPA analytical methods	On-site training	various	Subcontract laboratory personnel - TBD	Lab personnel	Laboratory
Data Validation	Data validation non-Routine Analytical Services (RAS) data	EPA and on-site	various	Data validators	Scott Kirchner, CDM	CDM
Data Review/ Assessment	None, performed by experienced chemists	CDM	various	CDM chemists	All personnel used for project data review	CDM

QAPP Worksheet #8
Special Personnel Training Requirements Table

Project Function	Specialized Training	Training Provider	Training Date	Personnel/Groups Receiving Training	Personnel Titles/ Organizational Affiliation	Location of Training Records/Certifications
QA Audits,	EPA G-7 auditor training	CDM	various	CDM auditors	Jeniffer Oxford, RQAC and/or designee	CDM
Self Assessments (SA)	SA training	CDM QACs	various	project personnel	All project staff	CDM

Other tasks requiring specialized skills and training will be performed by appropriately qualified subcontractors; such as, drilling, surveying, well installation and aquatic surveyors. Training, certification and permit requirements will be outlined in separate scopes of work for each task.

QAPP Worksheet #9
Project Scoping Session Participants Sheet

Projected Date(s) of Sampling: Summer - Fall 2006 **Project Manager:** Susan Schofield			**Site Name:** Hopewell Precision RI/FS Site **Site Location:** Hopewell Junction, Dutchess County, New York	
Date of Session: April 5, 2005		**Scoping Session Purpose:** Technical Scoping Meeting		
Name	**Affiliation**	**Phone Number**	**E-mail Address**	**Project Role**
Lorenzo Thantu	EPA	(212) 637-4240	thantu.lorenzo@epa.gov	Remedial Project Manager
Fernando Rosado	EPA	(212) 637-4346	rosado.fernando@epa.gov	Project Officer
Debbie Butler	EPA	(212) 637-3367	butler.deborah@epa.gov	Contracting Officer
Justin Gottesman	EPA	(212) 637-4303	gottesman.justin@epa.gov	Assistant Project Officer
Chuck Nace	EPA	(212) 637-4164	nace.charles@epa.gov	Risk Assessor
Sergio Lopez	EPA	(732) 321-6678	lopez.sergio@epa.gov	Quality Assurance Officer
John Birri	EPA	(732) 906-6886	birri.john@epa.gov	DESA Laboratory Director
Susan Schofield	CDM	(203) 262-6633	Schofieldse@cdm.com	Site Manager
Jeanne Litwin	CDM	(212) 785-9123	Litwinj@cdm.com	Technical Operations Manager (TOM)
Joe Mayo	CDM	(212) 785-9123	Mayojj@cdm.com	Senior Scientist

QAPP Worksheet #9
Project Scoping Session Participants Sheet

Comments/Decisions: EPA suggested that public meetings be held before mobilization takes place.

Action Items: NYSDEC and NYSDOH will provide to CDM a list of homes with NYSDEC-installed point of entry treatment (POET) systems, the results from the residential wells that now have POET systems, and surface water and sediment data from a recreational pond that was sampled by Dutchess County. Information was received and included in the Final Volume 1 Work Plan (April 2006).

Consensus Decisions: Two phases of field investigation: Stage 1 consists of a groundwater screening survey and limited residential sampling. Stage 2 consists of monitoring well installation, source area investigation, surface water and sediment sampling, and aquifer testing.

Additional sampling includes sub-slab/ indoor air sampling that must be conducted during specific season and therefore will be conducted during either stage. CDM will submit a technical memorandum that refines the new monitoring well locations and the screen intervals after the groundwater screening survey takes place. EPA would like to gather stratigraphic information as part of the screening investigation. CDM will add soil samples for observational descriptions to the investigation.

QAPP Worksheet #10
Problem Definition

Problem Summary
VOC concentrations above the project action limit of 5 µg/L have been detected in groundwater downgradient of the Hopewell Precision facility. Analytical data is needed to define the areal and vertical extent of VOC concentrations above 5 µg/L, to determine if the VOC concentrations in groundwater are impacting surface water and/or sediment, and to determine if the soils at the Hopewell Precision facility are a continuing source of VOC contamination to the groundwater. Concentrations of SVOCs, pesticides, PCBs, TAL metals and cyanide are needed to determine if additional compounds exceed screening criteria. Additional data (i.e., lithologic logs, gamma logs, synoptic water levels, MNA parameters, water quality readings, and topographic data) are needed to evaluate the fate and transport of the contaminants in groundwater and other impacted media.

Site Location and Background
The Hopewell Precision Site is located in Hopewell Junction, Dutchess County, New York. The Hopewell Precision facility was located at 15 Ryan Drive from 1977 to 1980. The facility moved to the adjacent property at 19 Ryan Drive in 1980 and continues to operate at that location. The combined size of the adjacent properties is 5.7 acres. The surrounding area consists mostly of residential neighborhoods, all of which are served by private wells and septic systems. Almost 27,000 people live within 4 miles of the Hopewell Precision facility. Commercial development (e.g., strip malls, businesses, gas stations) in the area is primarily along New York State Route 82, which traverses the area in a northeast/ southwest direction. An area of farmland borders the eastern side of a section of Route 82, adjacent to the mapped groundwater plume. Whortlekill Creek flows in a southerly direction across the residential area and along the western border of the groundwater plume. Several ponds are present within the area, including a large gravel pit or quarry filled with groundwater.

Hopewell Precision is an active manufacturer of sheet metal parts and assemblies. The company operated at its original location at 15 Ryan Drive from 1977 to 1980. It moved to its current location at the adjacent property at 19 Ryan Drive in 1980. The property at 19 Ryan Drive was vacant land prior to 1980 and Hopewell Precision has been the sole occupant of the building. The former facility at 15 Ryan Drive has been used by Nicholas Brothers Moving Company for equipment storage and office space since 1981.

Processes at Hopewell Precision include shearing, punching, bending, welding, and painting. The painting process included degreasing prior to the wet spray paint application. Hopewell Precision currently uses a water-based degreaser, but the company used trichloroethene (TCE) and 1,1,1-trichloroethane (1,1,1-TCA) in a vapor degreasing machine until 1998. Hopewell Precision purchased 12 drums (7,020 pounds) of 1,1,1-TCA in 1980 and 15 drums (9,000 pounds) in 1994. The company generated 1,675 gallons (32 drums) of 1,1,1-TCA waste for off-site disposal from 1986 through 1998. The company purchased 48 drums (31,680 pounds) of TCE in 1996 and 1997, but does not have any hazardous waste manifests for off-site disposal of TCE. Hopewell Precision no longer uses TCE or 1,1,1-TCA for degreasing.

EPA was made aware of Hopewell Precision in October 1979 through a letter from a former Hopewell Precision employee. At the time of the inspection, Hopewell Precision was dumping one to five gallons per day of waste solvents, paint pigments, and sodium nitrate directly onto the ground. TCE and 1,1,1-TCA have been detected in soil samples collected recently at the Hopewell Precision Site, but neither contaminant was detected in any off-site samples. The site also includes a groundwater contamination plume beneath and downgradient of the current and former Hopewell Precision facilities. The site may have an impact on ponds located downgradient of the current/former Hopewell Precision properties. The EPA Response and Prevention Branch has conducted indoor air testing from about 200 homes at the Hopewell Precision Site and installed 17 sub-slab ventilation systems.

QAPP Worksheet #10
Problem Definition

Currently the Hopewell Precision Site is comprised of the area with TCE and 1,1,1-TCA contamination in groundwater emanating from the former and present Hopewell Precision properties on Ryan Drive. Contamination migrated southwestward, intersecting residential water supply wells; it appears to be confined within the valley bordered by ridges located to the east and west. The plume extends from Ryan Drive in the north to Timothy Lane, located approximately 1.5 miles southwest of Ryan Drive. The plume is comprised of two segments: the northern two-thirds dominated by detections of TCE and the southern one-third characterized by detections of 1,1,1-TCA.

Problem Definition

Several previous investigations have been conducted at the facility and at the downgradient groundwater flow area, including initial investigations conducted onsite, the discovery of onsite contamination, and subsequent activities performed to delineate groundwater contamination. Investigations and activities were performed by New York State and federal agencies. Previous investigations at the Hopewell site are summarized below.

- A Phase II engineering investigation was conducted in 1987 and included the installation and sampling of three non-bedrock monitoring wells.
- A groundwater sampling event performed in 1993 of the onsite monitoring wells indicated a low level of TCE in one well. The absence of volatile organic compounds (VOCs) in the groundwater in the subsurface caused the site to be delisted from the NYSDEC Registry Class 2 Inactive Hazardous (1994).
- A groundwater sampling program of 450 residential wells by the EPA in 2003 detected TCE contamination in 44 wells. POET systems were installed at 37 of the TCE-contaminated residential wells with concentrations above the EPA maximum contaminant level (MCL) of 5 micrograms per liter (µg/L). 1,1,1 TCA was detected at 75 of the residential wells but concentrations were below the EPA MCL of 200 µg/L. However, NYSDOH installed POET systems on 14 residential wells with 1,1,1-TCA above the NYSDOH standard of 5 µg/L.

Project Description

The objective of this RI/FS investigation is to determine the nature and extent of contamination in groundwater, soil, sediment, surface water, deep water, and air at the Hopewell site, in order to evaluate appropriate remedial alternatives. Specifically, the RI is designed to collect information:

- To determine the area, depth, and extent of VOC concentrations exceeding 5 µg/L.
- To determine the rate and direction of groundwater and contamination movement
- To determine if groundwater discharging to Whortlekill Creek and several ponds causes VOC concentrations exceeding 5 µg/L in the surface water, deeper water in two ponds, and sediment
- To determine if TCE and 1,1,1-TCA are present in the unsaturated zone and bedrock around the former and present Hopewell Precision facilities on Ryan Drive at concentrations exceeding delineation criteria.
- To determine if dense non-aqueous phase liquid (DNAPL) is present in the unsaturated zone or in the saturated zone.
- To determine if concentrations of SVOCs, pesticides, PCB, TAL metals or cyanide exceed delineation criteria.

QAPP Worksheet #10
Problem Definition

Project Decision Conditions

If the extent of groundwater VOC concentrations exceeding 5 ug/L can be defined in the screening survey, then permanent monitoring wells will be located to monitor temporal changes in contaminant distribution.

If the groundwater/surface water interaction indicates VOC contamination at concentrations exceeding 5 ug/L are entering the surface water, then corrective action to minimize human and ecological risks will be evaluated.

If sediment contamination exceeds screening criteria, then sediment remedial alternatives will be evaluated in the feasibility study.

If subsurface soil contamination around the current and former Hopewell Precision facilities exceeds screening criteria, then soil remedial alternatives will be evaluated in the feasibility study.

QAPP Worksheet #11
Project Quality Objectives/Systematic Planning Process Statements

Who Will Use the Data?
EPA, NYSDEC, NYSDOH, and CDM will use the project data.

What Will the Data be Used For?
- To determine the area, depth, and extent of groundwater contamination.
- To determine if groundwater discharging into surface water causes the contamination of the water bodies and their sediment.
- To determine if contaminants are present in the unsaturated zone and bedrock around the former and present facilities.
- To determine if dense non-aqueous phase liquid (DNAPL) is present in the unsaturated zone or in the saturated zone. Additional details are provided on Worksheet # 17.

What Type of Data Are Needed?
The analytical sampling program will include the following elements:
- Groundwater Screening Samples - Low-Detection Level (LDL) VOCs with 24 hour turnaround for faxed results
- Surface Water and Deep Water Samples - TCL VOC (trace), Target Compound List (TCL) semi-volatile organic compounds (SVOCs), pesticides/polychlorinated biphenyls (PCBs), Target Analyte List (TAL) metals, mercury, cyanide, chloride, nitrate/nitrite, sulfate, sulfide, total organic carbon (TOC), total suspended solids (TSS), total dissolved solids (TDS), ammonia, alkalinity, hardness, and total Kjehldahl nitrogen (TKN)
- Sediment Samples - TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, mercury, cyanide, pH, TOC, and grain size
- Monitoring Well Samples - TCL VOC (trace), TCL SVOCs, pesticides/PCBs, TAL metals, mercury, cyanide, chloride, methane/ethane/ethene, nitrate/nitrite, sulfate, sulfide, TOC, ferrous iron, TSS, TDS, ammonia, hardness, and TKN
- Residential Well Samples - TCL VOC (trace)
- Source Area Soil Samples - TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, mercury, cyanide, pH, grain size, and TOC

Worksheets #18 and #23 list the analytical parameters needed.

How "good" does the data need to be in order to support the environmental decision?
The project-specific action limits and quantification limits for each sampled media are specified on Worksheet #15 for the contaminants of potential concern (COPCs). In addition, data will support a risk assessment. All laboratory analyses will be performed by EPA's Region II DESA laboratory, a CLP laboratory, or a CDM subcontract laboratory. Data must meet the data quality objectives (DQOs) that have been specified for the site.

QAPP Worksheet #11
Project Quality Objectives/Systematic Planning Process Statements

Where, When, and How Should the Data be Collected?
The samples will be collected in the vicinity of the Hopewell Precision Site, as indicated on Figures 2 through 5. Worksheet #16 (Figure 1) presents the project schedule. Worksheet #17a to I presents the sampling program design and rationale. Worksheet #18 presents the sampling locations and methods. Worksheet # 21 provides the SOPs that govern the various types of sampling.

Who will collect and generate the data?
CDM and subcontractors to CDM will collect the samples that will be shipped to DESA, CLP, and/or CDM's subcontract labs for analysis.

How will the data be reported?
Validated analytical data will be forwarded to CDM from DESA and/or CLP for evaluation and use in the RI Report, human health risk assessment (HHRA), screening level risk assessment (SLERA), and feasibility study (FS). Analytical data generated by laboratories under subcontract to CDM will be received in electronic and hard copy and validated by CDM personnel. Following completion of all laboratory analysis and receipt of all electronic and hard-copy data, an RI report will be generated by CDM and submitted to EPA, NYSDEC, and NYSDOH.

How will the data be archived?
- Preliminary data (Form 1s) will be faxed or e-mailed to CDM within the specified turnaround time.
- Data from CDM's subcontract laboratories will be received in electronic format specified in the contract and validated by CDM personnel.
- Final CLP validated data will be submitted to CDM in electronic format and hard copy consistent with CLP deliverables.
- Electronic data will be input into the project's database.
- EPA will archive CLP laboratory raw data.
- Hard copies of analytical data received by CDM will be archived in the project files.

QAPP Worksheet #12a
Measurement Performance Criteria Table
Soil/Sediment TCL VOCs

Matrix	Soil/Sediment
Analytical Group	TCL VOCs
Concentration Level	Low

Sampling Procedure	Analytical Method	Data Quality Indicators (DQIs)	Measurement Performance Criteria[1]	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
Technical Standard Operating Procedure (TSOP) 1-4 Subsurface soil sampling and TSOP 1-11 Sediment/Sludge Sampling	SOM01.1	Precision	RPD ≤ 50% [2] ABS ≤ 2xCRQL	Field Duplicates [3] (Co-located)	S&A
		Precision	RPD ≤ 40%	Analytical Duplicates[4]	A
		Accuracy	60-120% for COCs	Surrogate Spikes	A
		Accuracy	≤ CRQLs[5]	Equipment Rinsate Blank	S
		Accuracy	± 6 degrees Celsius	Temperature Blank	S
		Sensitivity	≤ CRQLs[5]	Method Blank	A
		Completeness	≥ 90%	Data assessment	S&A
		Comparability	Similar Units (µg/kg) Detection Limits meet project quantitation limits (PQLs)[5]	Data Review - Compare results from each round Review	S&A

1. Analytical criteria are outlined in the DESA SOPs and CLP statements of work (SOWs). If subcontract laboratory is utilized, analytical criteria will be outlined in laboratory SOPs.
2. The relative percent difference (RPD) will be calculated for all results reported above contract required quantification limits (CRQLs). RPDs will not be calculated where results are reported as non-detect. If one result is reported as non-detect and its duplicate is reported as a result above the CRQL then the absolute difference (ABS) between the two results will be calculated. The ABS will then be compared to two times the CRQL.
3. Only the field duplicate results will be affected since low precision may be due to non-homogenous soils.
4. Under method SOM01.1, no matrix spike/matrix spike duplicate (MS/MSD) required for VOCs. Precision will be determined from the laboratory duplicate results.
5. See Worksheet # 15 for sensitivity requirements and CRQL values for contaminants of potential concern.

QAPP Worksheet #12b
Measurement Performance Criteria Table
Soil/Sediment TCL SVOCs

Matrix	Soil/Sediment
Analytical Group	TCL SVOCs
Concentration Level	Low

Sampling Procedure	Analytical Method	Data Quality Indicators (DQIs)	Measurement Performance Criteria[1]	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
TSOP 1-4 Subsurface soil sampling and TSOP 1-11 Sediment/Sludge Sampling	SOM01.1	Precision	RPD ≤ 50%[2] ABS ≤ 2xCRQL	Field Duplicates[3] (Co-located)	S&A
		Precision	≤ 40%	Analytical Duplicates[4]	A
		Accuracy	60-120% for COCs	Surrogate Spikes	A
		Accuracy	≤ CRQLs	Equipment Rinsate Blank	S
		Accuracy	± 6 degrees Celsius	Temperature Blank	S
		Sensitivity	≤ CRQLs	Method Blank	A
		Completeness	≥ 90%	Data assessment	S&A
		Comparability	Similar Units (µg/kg) Detection Limits meet PQLs	Data Review - Compare results from each round	S&A

1. Analytical criteria are outlined in the DESA SOPs and CLP SOWs. If subcontract laboratory is utilized, analytical criteria will be outlined in laboratory SOPs.
2. The RPD will be calculated for all results reported above CRQLs. RPDs will not be calculated where results are reported as non-detect. If one result is reported as non-detect and its duplicate is reported as a result above CRQL then the ABS between the two results will be calculated. The ABS will then be compared to two times the CRQL.
3. Only the field duplicate results will be affected since low precision may be due to non-homogenous soils.
4. Under method SOM01.1 no MS/MSD required for SVOCs. Precision will be determined from the laboratory duplicate results.

QAPP Worksheet #12c
Measurement Performance Criteria Table
Soil/Sediment TCL Pesticides

Matrix	Soil/Sediment
Analytical Group	TCL Pesticides
Concentration Level	Low

Sampling Procedure	Analytical Method	Data Quality Indicators (DQIs)	Measurement Performance Criteria[1]	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
TSQP 1-4 Subsurface soil sampling and TSOP 1-11 Sediment/Sludge Sampling	SOM01.1	Precision	RPD ≤ 50%[2] ABS ≤ 2xCRQL	Field Duplicates[3] (Co-located)	S&A
		Precision	≤ 40%	Analytical Duplicates (MS/MSD)	A
		Accuracy	60-120% for COCs	MS or Surrogate Spikes	A
		Accuracy	≤ CRQLs	Equipment Rinsate Blanks	S
		Accuracy	± 6 degrees Celsius	Temperature Blank	S
		Sensitivity	≤ CRQLs	Method Blanks	A
		Completeness	≥ 90%	Data Assessment	S&A
		Comparability	Units µg/kg - Detection Limits meet PQLs	Data Review - Compare results from each round	S&A

1. Analytical criteria are outlined in the DESA SQPs and CLP SQWs. If subcontract laboratory is utilized, analytical criteria will be outlined in laboratory SOPs.
2. The RPD will be calculated for all results reported above CRQLs. RPDs will not be calculated where results are reported as non-detect. If one result is reported as non-detect and its duplicate is reported as a result above CRQL then the ABS between the two results will be calculated. The ABS will then be compared to two times the CRQL.
3. Only the field duplicate results will be affected since low precision may be due to non-homogenous soils.

QAPP Worksheet #12d
Measurement Performance Criteria Table
Soil/Sediment TCL PCBs

Matrix	Soil/Sediment
Analytical Group	TCL PCBs
Concentration Level	Low

Sampling Procedure	Analytical Method	Data Quality Indicators (DQIs)	Measurement Performance Criteria[1]	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
TSOP 1-4 Subsurface soil sampling and TSOP 1-11 Sediment/Sludge Sampling	SOM01.1	Precision	RPD ≤ 50%[2] ABS ≤ 2xCRQL	Field Duplicates[3] (Co-located)	S&A
		Precision	≤ 40%	Analytical Duplicates (MS/MSD)	A
		Accuracy	60-120% for COCs	MS or Surrogate Spikes	A
		Accuracy	≤ CRQLs	Equipment Rinsate Blanks	S
		Accuracy	± 6 degrees Celsius	Temperature Blank	S
		Sensitivity	≤ CRQLs	Method Blanks	A
		Completeness	≥ 90%	Data Assessment	S&A
		Comparability	Units µg/kg - Detection Limits meet PQLs	Data Review - Compare results from each round	S&A

1. Analytical criteria are outlined in the DESA SOPs and CLP SOWs. If subcontract laboratory is utilized, analytical criteria will be outlined in laboratory SOPs.
2. The RPD will be calculated for all results reported above CRQLs. RPDs will not be calculated where results are reported as non-detect. If one result is reported as non-detect and its duplicate is reported as a result above CRQL then the ABS between the two results will be calculated. The ABS will then be compared to two times the CRQL.
3. Only the field duplicate results will be affected since low precision may be due to non-homogenous soils.

QAPP Worksheet #12e
Measurement Performance Criteria Table
Soil/Sediment TAL Metals, Cyanide and Mercury

Matrix	Soil/Sediment
Analytical Group	Metals, Cyanide and Mercury
Concentration Level	Low

Sampling Procedure	Analytical Method	Data Quality Indicators (DQIs)	Measurement Performance Criteria[1]	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
TSOP 1-4 Subsurface soil sampling and TSOP 1-11 Sediment/Sludge Sampling	ILM05.3	Precision	RPD ≤ 50%[2] ABS ≤ 2xCRDL	Field Duplicates [3]	S&A
		Precision	RPD +/- 40%	Laboratory Duplicates	A
		Accuracy/Bias	75-125% recovery	Matrix Spikes	A
		Accuracy/Bias	80-120% recovery	Laboratory Control Sample	A
		Accuracy	≤ CRDLs	Equipment Rinsate Blanks	S
		Accuracy	± 6 degrees Celsius	Temperature Blank	S
		Sensitivity	≤ CRDLs	Method Blanks	A
		Completeness	≥ 90%	Data Assessment	S&A
		Comparability	Units mg/kg - Detection Limits meet PQLs	Data Review - Compare results from each round	S&A

1. Analytical criteria are outlined in the DESA SOPs and CLP SOWs. If subcontract laboratory is utilized, analytical criteria will be outlined in laboratory SOPs.
2. The RPD will be calculated for all results reported above the contract required detection limit (CRDL). RPDs will not be calculated where results are reported as non-detect. If one result is reported as non-detect and its duplicate is reported as a result above CRDL then the ABS between the two results will be calculated. The ABS will then be compared to two times the CRDL.
3. Only the field duplicate results will be affected since low precision may be due to non-homogenous soils.

QAPP Worksheet #12f
Measurement Performance Criteria Table
Soil/Sediment pH, TOC and Grain Size

Matrix	Soil/Sediment
Analytical Group	pH, TOC and grain size
Concentration Level	Low

Sampling Procedure	Analytical Method	Data Quality Indicators (DQIs)	Measurement Performance Criteria[1]	QC Sample and/or Activity Used to Assess Measurement Performance[4]	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
TSOP 1-4 Subsurface soil sampling and TSOP 1-11 Sediment/ Sludge Sampling	Grain size- ASTM D421-85 & D422-63 pH - SW-846, 9045C TOC - Lloyd Kahn	Precision	RPD ≤ 50%[2] ABS ≤ 2xCRDL	Field Duplicates[3]	S&A
		Precision	RPD +/- 40%	Laboratory Duplicates	A
		Accuracy/Bias	75-125% recovery	Mid Range Verification Standard (Lloyd Kahn only)	A
		Accuracy	± 6 degrees Celsius	Temperature Blank	S
		Sensitivity	≤ CRDLs	Preparation Blank (TOC by Lloyd Kahn only)	A
		Completeness	≥ 90%	Data Assessment	S&A
		Comparability	Units: varies Detection Limits meet PQLs	Data Review - Compare results from each round	S&A

1. DESA and subcontract laboratory (if needed) analytical criteria will be outlined in the appropriate laboratory SOPs.
2. The RPD will be calculated for all results reported above CRDLs. RPDs will not be calculated where results are reported as non-detect. If one result is reported as non-detect and its duplicate is reported as a result above CRDL then the ABS between the two results will be calculated. The ABS will then be compared to two times the CRDL.
3. Only the field duplicate results will be affected since low precision may be due to non-homogenous soils.
4. Field duplicates and laboratory duplicates will be collected and/or analyzed for pH, TOC, and grain size.

QAPP Worksheet #12g
Measurement Performance Criteria Table
Aqueous TCL VOC

Matrix	Aqueous
Analytical Group	TCL VOC (trace)
Concentration Level	Low

Sampling Procedure	Analytical Method	Data Quality Indicators (DQIs)	Measurement Performance Criteria[1]	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
TSOP 1-1 Surface Water Sampling; TSQP 1-9 Tap Water Sampling; & Project-specific Low flow SQP	SOM01.1 (trace procedure for groundwater sampling)	Precision	RPD ≤ 25%[2] ABS ≤ CRQL	Field Duplicates	S&A
		Precision	RPD ≤ 40%	Analytical Duplicates (LCS/LCSD)	A
		Accuracy/Bias	60-140%	System Monitoring Compounds	A
		Accuracy	≤ CRQLs[3]	Equipment Rinsate Blank	S
		Accuracy	± 6 degrees Celsius	Temperature Blank	S
		Sensitivity	≤ CRQLs[3]	Method Blank	A
		Completeness	≥ 90%	Data assessment	S&A
		Comparability	Units µg/L - Detection Limits meet PQLs[3]	Data Review - Compare results from each round	S&A

LCS Laboratory Check Sample
LCSD Laboratory Check Sample Duplicates
1. Analytical criteria are outlined in the DESA SQPs and CLP SQWs. If subcontract laboratory is utilized, analytical criteria will be outlined in laboratory SQPs.
2. The RPD will be calculated for all results reported above CRQLs. RPDs will not be calculated where results are reported as non-detect. If one result is reported as non-detect and its duplicate is reported as a result above CRQL then the ABS between the two results will be calculated. The ABS will then be compared to the CRQL.
3. See Worksheet # 15 for sensitivity requirements and CRQL values for contaminants of potential concern.

QAPP Worksheet #12h
Measurement Performance Criteria Table
AqueousTCL SVOC

Matrix	Aqueous
Analytical Group	TCL SVOCs
Concentration Level	Low

Sampling Procedure	Analytical Method	Data Quality Indicators (DQIs)	Measurement Performance Criteria[1]	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
TSOP 1-1 Surface Water Sampling; TSOP 1-9 Tap Water Sampling; & Project-specific Low flow SOP	SOM01.1	Precision	RPD ≤ 25%[2] ABS ≤ CRQL	Field Duplicates	S&A
		Precision	RPD ≤ 40%	Analytical Duplicates (MS/MSD)[3]	A
		Accuracy/Bias	60-120% for COCs	Surrogate Spikes	A
		Accuracy	≤ CRQLs	Equipment Rinsate Blank	S
		Accuracy	± 6 degrees Celsius	Temperature Blank	S
		Sensitivity	≤ CRQLs	Method Blank	A
		Completeness	≥ 90%	Data assessment	S&A
		Comparability	Units µg/L - Detection Limits meet PQLs	Data Review - Compare results from each round	S&A

1. Analytical criteria are outlined in the DESA SOPs and CLP SOWs. If subcontract laboratory is utilized, analytical criteria will be outlined in laboratory SOPs.
2. The RPD will be calculated for all results reported above CRQLs. RPDs will not be calculated where results are reported as non-detect. If one result is reported as non-detect and its duplicate is reported as a result above CRQL then the ABS between the two results will be calculated. The ABS will then be compared to the CRQL.
3. Under method SOM01.1 no MS/MSD required for SVOCs.

QAPP Worksheet #12i
Measurement Performance Criteria Table
Aqueous TCL Pesticides

Matrix	Aqueous
Analytical Group	TCL Pesticides
Concentration Level	Low

Sampling Procedure	Analytical Method	Data Quality Indicators (DQIs)	Measurement Performance Criteria[1]	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
TSOP 1-1 Surface Water Sampling; TSOP 1-9 Tap Water Sampling; & Project-specific Low flow SOP	**SOM01.1**	Precision	RPD ≤ 25[2] ABS ≤ CRQL	Field Duplicates	S&A
		Precision	RPD ≤ 40%	Analytical Duplicates (MS/MSD)	A
		Accuracy/Bias	50-150% for COCs	MS or Surrogate Spikes	A
		Accuracy	≤ CRQLs	Equipment Rinsate Blank	S
		Accuracy	± 6 degrees Celsius	Temperature Blank	S
		Sensitivity	≤ CRQLs	Method Blank	A
		Completeness	≥ 90%	Data assessment	S&A
		Comparability	Units µg/L - Detection Limits meet PQLs	Data Review - Compare results from each round	S&A

1. Analytical criteria are outlined in the DESA SOPs and CLP SOWs. If subcontract laboratory is utilized, analytical criteria will be outlined in laboratory SOPs.
2. The RPD will be calculated for all results reported above CRQLs. RPDs will not be calculated where results are reported as non-detect. If one result is reported as non-detect and its duplicate is reported as a result above CRQL then the ABS between the two results will be calculated. The ABS will then be compared to the CRQL.

QAPP Worksheet #12j
Measurement Performance Criteria Table
Aqueous TCL PCBs

Matrix	Aqueous
Analytical Group	TCL PCBs
Concentration Level	Low

Sampling Procedure	Analytical Method	Data Quality Indicators (DQIs)	Measurement Performance Criteria[1]	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
TSQP 1-1 Surface Water Sampling; TSQP 1-9 Tap Water Sampling; & Project-specific Low flow SOP	SOM01.1	Precision	RPD $\leq$ 25%[2] ABS $\leq$ CRQL	Field Duplicates	S&A
		Precision	RPD $\leq$ 40%	Analytical Duplicates (MS/MSD)	A
		Accuracy/Bias	60-120% for COCs	MS or Surrogate Spikes	A
		Accuracy	$\leq$ CRQLs	Equipment Rinsate Blank	S
		Accuracy	$\pm$ 6 degrees Celsius	Temperature Blank	S
		Sensitivity	$\leq$ CRQLs	Method Blank	A
		Completeness	$\geq$ 90%	Data assessment	S&A
		Comparability	Units µg/L - Detection Limits meet PQLs	Data Review - Compare results from each round	S&A

1.Analytical criteria are outlined in the DESA SOPs and CLP SQWs. If subcontract laboratory is utilized, analytical criteria will be outlined in laboratory SOPs.
2. The RPD will be calculated for all results reported above CRQLs. RPDs will not be calculated where results are reported as non-detect. If one result is reported as non-detect and its duplicate is reported as a result above CRQL then the ABS between the two results will be calculated. The ABS will then be compared to the CRQL.

QAPP Worksheet #12k
Measurement Performance Criteria Table
Aqueous TAL Metals, Cyanide and Mercury

Matrix	Aqueous
Analytical Group	TAL Metals, Cyanide and Mercury
Concentration Level	Low

Sampling Procedure	Analytical Method	Data Quality Indicators (DQIs)	Measurement Performance Criteria[1]	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
TSOP 1-1 Surface Water Sampling; TSOP 1-9 Tap Water Sampling; & Project-specific Low flow SOP	**ILM05.3 ICP-AES**	Precision	RPD ≤ 25%[2] ABS ≤ CRQL	Field Duplicates	S&A
		Precision	RPD ≤ 40%	Laboratory Duplicates	A
		Accuracy/Bias	75-125% recovery or not applicable	Matrix Spikes	A
		Accuracy/Bias	80-120 % recovery	Laboratory Control Samples	A
		Accuracy	≤ CRDLs	Equipment Rinsate Blank	S
		Accuracy	± 6 degrees Celsius	Temperature Blank	S
		Sensitivity	≤ CRDLs	Method Blank	A
		Completeness	≥ 90%	Data Assessment	S&A
		Comparability	Units µg/L - Detection Limits meet PQLs	Data Review - Compare results from each round	S&A

1. Analytical criteria are outlined in the DESA SOPs and CLP SOWs. If subcontract laboratory is utilized, analytical criteria will be outlined in laboratory SOPs.
2. The RPD will be calculated for all results reported above CRDLs. RPDs will not be calculated where results are reported as non-detect. If one result is reported as non-detect and its duplicate is reported as a result above CRDL then the ABS between the two results will be calculated. The ABS will then be compared to the CRDL.

QAPP Worksheet #12I
Measurement Performance Criteria Table
Aqueous Alkalinity, Ammonia and TKN

Matrix	Aqueous
Analytical Group	Alkalinity, Ammonia, and TKN
Concentration Level	Low

Sampling Procedure	Analytical Method	Data Quality Indicators (DQIs)	Measurement Performance Criteria[1]	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
TSOP 1-1 Surface Water Sampling; TSOP 1-9 Tap Water Sampling; & Project-specific Low flow SOP	Alkalinity - EPA 310.1 Ammonia - EPA 350.1/350.2 TKN - EPA 351.2/ 351.4	Precision	RPD ≤ 25%[2]	Field Duplicates	S&A
		Precision	RPD ≤ 40%	Analytical Replicates/ duplicates	A
		Accuracy/Bias	75-125% recovery or not applicable	Matrix Spike or not applicable	A
		Accuracy/Bias	80-120 % recovery	Laboratory Control Samples	A
		Sensitivity	≤(quantitation limits) QLs	Method Blanks	A
		Completeness	≥ 90%	Data assessment	S&A
		Precision	RPD ≤ 40%	Analytical	A
		Comparability	Units mg/L - Detection Limits meet PQLs	Data Review - Compare results from each round	S&A

1. DESA and subcontract laboratory (if needed) analytical criteria will be outlined in the appropriate laboratory SOPs.
2. The RPD will be calculated for all results reported above CRDLs. RPDs will not be calculated where results are reported as non-detect. If one result is reported as non-detect and its duplicate is reported as a result above CRDL then the ABS between the two results will be calculated. The ABS will then be compared to the CRDL.

QAPP Worksheet #12m
Measurement Performance Criteria Table
Aqueous Hardness, TSS and TDS

Matrix	Aqueous
Analytical Group	Hardness, Total Suspended and Dissolved Solids
Concentration Level	Low

Sampling Procedure	Analytical Method	Data Quality Indicators (DQIs)	Measurement Performance Criteria[1]	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
TSOP 1-1 Surface Water Sampling; TSOP 1-9 Tap Water Sampling; & Project-specific Low flow SOP	TDS - EPA 160.1 TSS - EPA 160.2 Hardness - EPA 130.1/130.2	Precision	RPD ≤ 50%[2]	Field Duplicates	S&A
		Precision	RPD ≤ 40%	Analytical Replicates/ duplicates	A
		Accuracy/Bias	75-125% recovery or not applicable	Matrix Spike or not applicable	A
		Accuracy/Bias	80-120 % recovery	Laboratory Control Samples	A
		Sensitivity	≤ QLs	Method Blanks	A
		Completeness	≥ 90%	Data assessment	S&A
		Comparability	Units mg/L - Detection Limits meet PQLs	Data Review - Compare results from each round	S&A

1. DESA and subcontract laboratory (if needed) analytical criteria will be outlined in the appropriate laboratory SOPs.
2. The RPD will be calculated for all results reported above CRDLs. RPDs will not be calculated where results are reported as non-detect. If one result is reported as non-detect and its duplicate is reported as a result above CRDL then the ABS between the two results will be calculated. The ABS will then be compared to the CRDL.

QAPP Worksheet #12n
Measurement Performance Criteria Table
Aqueous Chloride, Sulfate, Sulfide and Nitrate

Matrix	Aqueous
Analytical Group	Chloride, Sulfate, Sulfide, Nitrate
Concentration Level	Low

Sampling Procedure	Analytical Method	Data Quality Indicators (DQIs)	Measurement Performance Criteria[1]	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
TSOP 1-1 Surface Water Sampling; TSOP 1-9 Tap Water Sampling; & Project-specific Low flow SOP	Chloride - EPA 325.1 sulfate - EPA 375.3/375.4 sulfide - EPA 376.1 or 376.2 nitrate - EPA 352.1	Precision	RPD ≤ 25%[2]	Field Duplicates	S&A
		Sensitivity	≤ QLs	Field Blank	A
		Precision	RPD ≤ 40%	Analytical Replicates	A
		Accuracy/Bias	75-125% recovery or not applicable	Matrix spike or not applicable	A
		Accuracy/Bias	80-120 % recovery	Laboratory Control Samples	A
		Sensitivity	≤ QLs	Method Blanks	A
		Completeness	≥ 90%	Data assessment	S&A
		Precision	RPD ≤ 40%	Analytical Replicates/duplicates	A
		Comparability	Units mg/L - Detection Limits meet PQLs	Data Review - Compare results from each round	S&A

1. DESA and subcontract laboratory (if needed) analytical criteria will be outlined in the appropriate laboratory SOPs.
2. The RPD will be calculated for all results reported above CRDLs. RPDs will not be calculated where results are reported as non-detect. If one result is reported as non-detect and its duplicate is reported as a result above CRDL then the ABS between the two results will be calculated. The ABS will then be compared to the CRDL.

QAPP Worksheet #12o
Measurement Performance Criteria Table
Aqueous TOC

Matrix	Aqueous
Analytical Group	TOC
Concentration Level	Low

Sampling Procedure	Analytical Method	Data Quality Indicators (DQIs)	Measurement Performance Criteria[1]	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
TSOP 1-1 Surface Water Sampling; TSOP 1-9 Tap Water Sampling; & Project-specific Low flow SOP	EPA - 415.1/415.2	Precision	RPD ≤ 25%[2]	Field Duplicates	S&A
		Precision	RPD ≤ 40%	Analytical Replicates	A
		Accuracy/Bias	80-120 % recovery	Laboratory Control Samples	A
		Sensitivity	≤ QLs	Method Blanks	A
		Completeness	≥ 90%	Data assessment	S&A
		Precision	RPD ≤ 40%	Analytical Replicates/duplicates	A
		Comparability	Units mg/L - Detection Limits meet PQLs	Data Review - Compare results from each round	S&A

1. DESA and subcontract laboratory (if needed) analytical criteria will be outlined in the appropriate laboratory SOPs.
2. The RPD will be calculated for all results reported above CRDLs. RPDs will not be calculated where results are reported as non-detect. If one result is reported as non-detect and its duplicate is reported as a result above CRDL then the ABS between the two results will be calculated. The ABS will then be compared to the CRDL.

QAPP Worksheet #12p
Measurement Performance Criteria Table
Aqueous Methane, Ethane and Ethene

Matrix	Aqueous
Analytical Group	Methane, Ethane, Ethene
Concentration Level	Low

Sampling Procedure	Analytical Method	Data Quality Indicators (DQIs)	Measurement Performance Criteria[1]	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
TSOP 1-1 Surface Water Sampling; TSOP 1-9 Tap Water Sampling; & Project-specific Low flow SOP	RSK 175	Precision	RPD ≤ 25%[2]	Field Duplicates	S&A
		Precision	RPD ≤ 40%	Analytical Replicates	A
		Accuracy/Bias	80-120 % recovery	Laboratory Control Samples	A
		Sensitivity	≤ QLs	Method Blanks	A
		Completeness	≥ 90%	Data assessment	S&A
		Precision	RPD ≤ 40%	Analytical Replicates/duplicates	A
		Comparability	Units µg/L - Detection Limits meet PQLs	Data Review - Compare results from each round	S&A

1. Subcontract laboratory analytical criteria will be outlined in the laboratory SOPs.
2. The RPD will be calculated for all results reported above CRDLs. RPDs will not be calculated where results are reported as non-detect. If one result is reported as non-detect and its duplicate is reported as a result above CRDL then the ABS between the two results will be calculated. The ABS will then be compared to the CRDL.

QAPP Worksheet #12q
Measurement Performance Criteria Table
Ferrous Iron

Matrix	Aqueous
Analytical Group	Ferrous Iron
Concentration Level	Low

Sampling Procedure	Analytical Method	Data Quality Indicators (DQIs)	Measurement Performance Criteria[1]	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
TSOP 1-1 Surface Water Sampling; Project-specific Low flow SOP	Ferrous iron - HACH 8146	Precision	RPD ≤ 25%[2]	Field Duplicates	S&A
		Precision	RPD ≤ 40%	Analytical Replicates	S
		Accuracy/Bias	75-125% recovery	Accuracy Check Standard	A
		Sensitivity	≤ EDLs	Water Blank	A
		Completeness	≥ 90%	Data assessment	S&A
		Comparability	Units mg/L Detection Limits meet PQLs[3]	Data Review - Compare results from each round	S&A

1. The method performance precision data is outlined in the HACH manual (Appendix C)
2. The RPD will be calculated for all results reported above the estimated detection limits (EDLs). RPDs will not be calculated where results are reported as non-detect. If one result is reported as non-detect and its duplicate is reported as a result above CRDL then the ABS between the two results will be calculated. The ABS will then be compared to the EDL.

QAPP Worksheet #12r
Measurement Performance Criteria Table
Aqueous In-field Measurements

Matrix	Aqueous
Analytical Group	In-field Measurements
Concentration Level	Low

Sampling Procedure	Analytical Method	Data Quality Indicators (DQIs)	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
TSOP 1-1 Surface Water Sampling; TSOP 1-9 Tap Water Sampling; & Project-specific Low flow SOP	NA	Representative-ness[1]	± 0.1	pH (standard units)	S&A
			± 3%	Conductivity (uSiemens)	S&A
			± 10 mV	Redox Potential (Eh) (millivolts)	S&A
			± 10%	Turbidity	S&A
			± 10%	Dissolved Oxygen	S&A
			Flow rate	Monitored in the field (see Low Flow TSOP for flow rate criteria)	S&A

1. See low flow SOP for details of indicator parameter measurements. Worksheet #17g describes the tap water sampling performance. Representativeness of other analytical groups will be gauged by evaluation of holding times, and sample conditions during data review and validation.

NA Not Applicable

QAPP Worksheet #13
Secondary Data Criteria and Limitations Table

Secondary Data	Data Source	Data Generator(s)	How Data Will be Used	Limitations on Data Use
Indoor Air VOC data	Copy of EPA Database	EPA Response and Prevention Branch, January 2004	Used for project planning	None
Groundwater and Soil VOC Data - including residential well survey; geophysical logging; well sampling; and soil sampling.	Lockheed Martin, Final Report Hopewell Precision Site, Hopewell Junction, New York. January 2004. Prepared for EPA Environmental Response Team Center (ERTC)/Response Engineering and Analytical Contract (REAC).	EPA ERT/REAC. VOC Data collected August to December 2003	Determining potential source areas and range of groundwater plumes.	None. Data generated and validated by EPA.
Soil Data - on and off-site sampling.	Lockheed Martin 2004.	July 2003		
Groundwater VOC Data - 450 residential wells sampled	EPA Removal Support Team (RST).	EPA 2003		
Groundwater VOC Data - 3 onsite wells sampled	Summarized data from EPA. Report title not known.	NYSDEC April 1993	Used to delist site from NYSDEC Registry in 1994. This data set will only be used for comparison with the RI data.	Quality of data uncertain; to be used for qualitative comparison only
Groundwater VOC Data - sampling of 3 monitoring wells and geophysical survey of 33 stations.	Wehran Engineering. Report title not known. 1987. Prepared for NYSDEC.	NYSDEC 1987 Phase II Investigation	Data used for planning purposes during work plan preparation	Quality of data uncertain; to be used for qualitative comparison only

QAPP Worksheet #14
Summary of Project Tasks

Sampling Tasks: Sampling tasks are summarized below:

- Groundwater screening samples - 49 locations along 9 transects, 7 samples from each location
- Source area subsurface soil samples - 25 locations, 3 samples from each location
- Residential well samples - 2 rounds of sampling from 60 wells
- Monitoring well samples - 2 rounds of sampling from 39 wells
- Surface water samples - 39 samples collected from 5 bodies of water
- Sediment samples - 39 samples collected from 5 water bodies
- Deep water samples - 20 samples, 10 collected from Redwing Lake and 10 collected from the Gravel Pit

Analysis Tasks: See Worksheet #23 for analytical method numbers.

Groundwater screening samples:	TCL VOC (trace)
Source Area subsurface soil samples:	TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, mercury, cyanide, pH, and grain size
Sediment samples:	TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, mercury, cyanide, pH, TOC, and grain size
Residential well samples:	TCL VOC (trace)
Monitoring well samples:	TCL VOC (trace), TCL SVOCs, pesticides/PCBs, TAL metals, mercury, cyanide, chloride, methane/ethane/ethene, nitrate/nitrite, sulfate, sulfide, TOC, ferrous iron, TSS, TDS, ammonia, hardness, and TKN
Surface water and deep water samples:	TCL VOC (trace), TCL SVOCs, pesticides/PCBs, TAL metals, mercury, cyanide, chloride, nitrate/nitrite, sulfate, sulfide, TOC, TSS, TDS, ammonia, alkalinity, pH, hardness, and TKN

Quality Control Tasks: All matrices will have the following QC samples analyzed: field duplicates, matrix spike/matrix spike duplicates, VOAs trip blanks, rinsate blanks, reagent water blanks, and all other QA/QC samples defined in the method.

Secondary Data: Secondary data listed in Worksheet #13 will be reviewed and used to plan sample locations, but will not be added to the project database.

Data Management Tasks: Analytical data will be imported into the database after validation. Field measurements will also be added to the database.

Documentation and Records: All sample locations will be surveyed. Information regarding samples will be recorded in site logbooks.

QAPP Worksheet #15a
Reference Limits and Evaluation Table - Groundwater

Matrix: Groundwater

Analytical Group: VOCs-Site-specific COPCs **Concentration Level:** Low level

Analyte	CAS Number	Project Action Limit (µg/L) (1)	Project Quantitation Limit (µg/L)	Analytical Method		Achievable Laboratory Limits	
				MDLs	CRQLs	MDLs	QLs
Dichlorodifluoromethane	75-71-8	5	1	N/A	0.5	N/A	N/A
Chloromethane	74-87-3	5	1	N/A	0.5	N/A	N/A
Carbon Tetrachloride	56-23-5	5	1	N/A	0.5	N/A	N/A
Methyl ethyl ketone	78-93-3	50	10	N/A	5	N/A	N/A
1,1,1-Trichloroethane	71-55-6	5	1	N/A	0.5	N/A	N/A
1,2-Dichloroethane	107-06-02	5	1	N/A	0.5	N/A	N/A
Chloroethane	75-00-3	5	1	N/A	0.5	N/A	N/A
1,1-Dichloroethene	75-35-4	5	1	N/A	0.5	N/A	N/A
Tetrachloroethene	127-18-4	5	1	N/A	0.5	N/A	N/A
Trichloroethene	79-01-6	5	1	N/A	0.5	N/A	N/A
cis-1,2-dichloroethene	156-59-2	5	1	N/A	0.5	N/A	N/A
trans-1,2-dichloroethene	156-60-5	5	1	N/A	0.5	N/A	N/A
Methyl tert-butylether	1634-04-4	10	5	N/A	0.5	N/A	N/A
Vinyl chloride	75-01-4	2	1	N/A	0.5	N/A	N/A

(1) Project action level = NYSDEC MCLs for groundwater. While the full suite of VOCs will be analyzed, only compounds identified as COPCs are listed. Analytical QLs are those documented in method SOM01.1 for trace water. Achievable method detection limits (MDL) and OLs are limits that an individual laboratory can achieve when performing a specific analytical method. Because the laboratory performing the analyses has not yet been determined, individual laboratory limits are not known at this time.
µg/L = micrograms per liter

QAPP Worksheet #15b
Reference Limits and Evaluation Table - Soil

Matrix: Soil

Analytical Group: VOCs-Site-specific COPCs **Concentration Level:** Low level

Analyte	CAS Number	Project Action Limit (µg/kg)	Project Quantitation Limit (µg/kg)	Analytical Method		Achievable Laboratory Limits	
				MDLs	CRQLs	MDLs	QLs
Dichlorodifluoromethane	75-71-8	9400 (b)	50	N/A	5	N/A	N/A
Chloromethane	74-87-3	4700 (b)	50	N/A	5	N/A	N/A
Carbon Tetrachloride	56-23-5	220 (b)	50	N/A	5	N/A	N/A
Methyl ethyl ketone	78-93-3	300 (a)	50	N/A	10	N/A	N/A
1,1,1-Trichloroethane	71-55-6	800 (a)	50	N/A	5	N/A	N/A
1,2-Dichloroethane	107-06-02	100 (a)	20	N/A	5	N/A	N/A
Chloroethane	75-00-3	1900 (a)	50	N/A	5	N/A	N/A
1,1-Dichloroethene	75-35-4	400 (a)	50	N/A	5	N/A	N/A
Tetrachloroethene	127-18-4	480 (b)	50	N/A	5	N/A	N/A
Trichloroethene	79-01-6	53 (b)	20	N/A	5	N/A	N/A
cis-1,2-dichloroethene	156-59-2	4300 (b)	50	N/A	5	N/A	N/A
trans-1,2-dichloroethene	156-60-5	300 (a)	50	N/A	5	N/A	N/A
Methyl tert-butyl ether	1634-04-4	17,000 (b)	50	N/A	5	N/A	N/A
Vinyl chloride	75-01-4	79 (b)	20	N/A	5	N/A	N/A

(a) New York State TAGM # 4046 soil cleanup objectives to protect groundwater, using default soil carbon content (1%)
(b) EPA Region IX Soil Preliminary Remediation Goals for residential soil adjusted to a cancer risk of 1x10-6 and a non-cancer hazard index of 0.1.

QAPP Worksheet #15c
Reference Limits and Evaluation Table - Surface Water

Matrix: Surface Water

Analytical Group: VOCs-Site-specific COPCs **Concentration Level:** Low level

Analyte	CAS Number	Project Action Limit (µg/L)	Project Quantitation Limit (µg/L)	Analytical Method		Achievable Laboratory Limits	
				MDLs	CRQLs	MDLs	QLs
Dichlorodifluoromethane	75-71-8	NS	1	N/A	0.5	N/A	N/A
Chloromethane	74-87-3	NS	1	N/A	0.5	N/A	N/A
Carbon Tetrachloride	56-23-5	2 (a)	1	N/A	0.5	N/A	N/A
Methyl ethyl ketone	78-93-3	NS	1	N/A	5	N/A	N/A
1,1,1-Trichloroethane	71-55-6	NS	1	N/A	0.5	N/A	N/A
1,2-Dichloroethane	107-06-02	37 (a)	1	N/A	0.5	N/A	N/A
Chloroethane	75-00-3	NS	1	N/A	0.5	N/A	N/A
1,1-Dichloroethene	75-35-4	3 (a)	1	N/A	0.5	N/A	N/A
Tetrachloroethene	127-18-4	1 (b)	0.5	N/A	0.5	N/A	N/A
Trichloroethene	79-01-6	30 (a)	1	N/A	0.5	N/A	N/A
cis-1,2-dichloroethene	156-59-2	NS	1	N/A	0.5	N/A	N/A
trans-1,2-dichloroethene	156-60-5	140,000 (a)	1	N/A	0.5	N/A	N/A
Methyl tert-butylether	1634-04-4	NS	1	N/A	0.5	N/A	N/A
Vinyl chloride	75-01-4	530 (a)	1	N/A	0.5	N/A	N/A

NS = No Federal or State regulatory standard
(a) EPA Ambient Water Quality Criteria for Human Health Consumption (December 2003)
(b) New York State Standards and Guidance Values for Class B Surface Water for Human Consumption

QAPP Worksheet #15d
Reference Limits and Evaluation Table for Sediment

Matrix: Sediment

Analytical Group: VOCs-Site-specific (COPCs) **Concentration Level:** Low level

Analyte	CAS Number	Project Action Limit (µg/kg)	Project Quantitation Limit (µg/kg)	Analytical Method		Achievable Laboratory Limits	
				MDLs	CRQLs	MDLs	QLs
Dichlorodifluoromethane	75-71-8	30,806 (a)	50	N/A	5	N/A	N/A
Chloromethane	74-87-3	2646 (a)	50	N/A	5	N/A	N/A
Carbon Tetrachloride	56-23-5	24 (b)	10	N/A	5	N/A	N/A
Methyl ethyl ketone	78-93-3	2,710,201 (a)	50	N/A	10	N/A	N/A
1,1,1-Trichloroethane	71-55-6	694,742 (a)	50	N/A	5	N/A	N/A
1,2-Dichloroethane	107-06-02	28 (b)	10	N/A	5	N/A	N/A
Chloroethane	75-00-3	6485 (b)	50	N/A	5	N/A	N/A
1,1-Dichloroethene	75-35-4	1 (b)	10	N/A	5	N/A	N/A
Tetrachloroethene	127-18-4	32 (b)	10	N/A	5	N/A	N/A
Trichloroethene	79-01-6	80 (b)	10	N/A	5	N/A	N/A
cis-1,2-dichloroethene	156-59-2	14,630 (a)	50	N/A	5	N/A	N/A
trans-1,2-dichloroethene	156-60-5	23,482 (a)	50	N/A	5	N/A	N/A
Methyl tert-butylether	1634-04-4	157,045 (a)	50	N/A	5	N/A	N/A
Vinyl chloride	75-01-4	3 (b)	10	N/A	5	N/A	N/A

(a) EPA Region IX Industrial/Commercial soil Preliminary Remediation Goals (PRG) (EPA 2004a)
(b) NYS Sediment Screening Criteria for Human Health (January 1999)

QAPP Worksheet 16
Timeline

Figure 1 presents the project schedule.

QAPP Worksheet #17
Sampling Design and Rationale

The field investigation will evaluate the nature and extent of contamination in several media, including groundwater, surface water, deep water in two ponds, sediments and soil. The overall objectives of the RI/FS are to determine the nature and extent of contamination in the media to be sampled, in order to evaluate appropriate remedial alternatives. Specifically, the RI is designed to collect the following information:

Groundwater

- Determine the area, depth, and extent of groundwater VOC concentrations exceeding 5 ug/L
- Determine the rate and direction of groundwater and contaminant movement

Surface Water, Deep Water, Sediment

- Determine if groundwater discharging to Whortlekill Creek and several ponds causes VOC concentrations exceeding delineation criteria in of the surface water, deeper water in two ponds, and sediment

Soil

- Determine if contaminants are present in the unsaturated zone and bedrock around the former and present Hopewell Precision facilities on Ryan Drive at concentrations exceeding delineation criteria.
- Determine if DNAPL is present in the unsaturated zone or in the saturated zone (during drilling of the bedrock well)

The field investigations will be conducted in two stages. The ecological field investigation and surface water, deep water and sediment sampling events are seasonally dependent and are listed separately from the two stages. The seasonal sampling will be conducted during the summer or early fall. The field schedule is included as Figure 1.

Stage I

- Mobilization and demobilization (Worksheet 17a)
- Site reconnaissance (Worksheet 17b)
- Decontamination Procedures (Worksheet 17c)
- Groundwater screening survey and lithologic sampling and logging (Worksheet 17d and 17e)
- Source area subsurface soil sampling (Worksheet 17f)
- Residential well sampling (Round 1) (Worksheet 17g)

Stage II

- Monitoring well drilling and installation (Worksheet 17h)
- Synoptic water level measurement (Worksheet 17i)
- Natural gamma logging (Worksheet 17j)
- Slug testing (Worksheet 17k)
- Monitoring well sampling (Worksheet 17l)
- Piezometer installation (Worksheet 17m)
- Targeted residential well sampling (Round 2) (Worksheet 17g)

Seasonal Sampling

- Groundwater/Surface water interaction investigation (Worksheet 17m)
- Surface water, deep water, and sediment sampling (Worksheet 17n)
- Ecological field investigation (Worksheet 17o)

QAPP Worksheet #17a
Mobilization/Demobilization

Mobilization

Prior to the mobilization, a field planning meeting will be conducted by the CDM SM and attended by the field staff and the CDM RQAC. A field planning meeting may be held in the field instead of the office if this is more convenient for the personnel involved. In this case, the SM will notify the RQAC (who will not be required to attend) of the agenda before the meeting. The meeting will briefly discuss and clarify:

- Objectives of the fieldwork
- Equipment and training needs
- Field operating procedures, schedules of events, and individual assignments
- Required QC measures
- Documents governing field work that must be on site

A written agenda, reviewed by the RQAC, will be distributed and an attendance list signed. Copies of these documents will be maintained in the project files by the CDM SM. Additional meetings will be held when the documents governing field work require it, when the scope of the assignment changes significantly, when the field staff changes, or if the RQAC determines that maintenance of QC protocol requirements merits another meeting.

Additionally, before initiating the sample collection activities, the following preparatory activities must be completed:

- Procure subcontractor services prior to the initiation of field activities.
- Before arriving on site, the field team will review and discuss elements of this QAPP and the HSP. Personal protective equipment and health and safety guidelines are specified for each activity in the HSP.
- Ensure that all sample analyses are scheduled through the EPA CLP laboratories and the EPA DESA or CDM subcontractor laboratories.
- Obtain required sample containers and preservatives. Additional sample bottles will be taken into the field to allow for breakage.
- The identification number, maintenance and calibration dates (by the supplier or CDM equipment coordinator), and the person(s) assigned to perform field

Demobilization

After site work is complete, the FTL and/or designated field staff will be responsible for conducting an inventory of site equipment, for ensuring that equipment has been properly cleaned prior to removal offsite, for making arrangements for the discontinuance of utilities and other services that supported the operation of the field trailer and other site facilities, for securing any equipment and investigation derived waste (IDW) to be left on site, and for following up with any additional sampling requirements related to the remaining IDW. A final site walkover will be performed to confirm the condition of the site and the security of monitoring equipment such as locked well caps.

QAPP Worksheet #17b
Site Reconnaissance

Additional site reconnaissance activities will be performed to support mobilization and to prepare for drilling and sampling activities. During the site reconnaissance, sampling locations will be identified and marked; property boundaries and utility rights-of-way will be located; utility mark outs will be performed; and photographs will be taken. Site reconnaissance activities also include oversight of the cultural resources subcontractor and surveying subcontractor.

Individual reconnaissance activities are required to support implementation of specific sampling programs. Site reconnaissance activities are anticipated prior to conducting the following sampling activities:

- **Mobilization and cultural resources survey** - A subcontractor to CDM will conduct a cultural resources survey of the entire plume area. The Stage 1A Cultural Resources Survey will be prepared in order to determine the presence or absence of cultural resources which may be impacted by the implementation of any remedial actions. The Stage IA survey is the initial level of survey and requires comprehensive documentary research and an initial walk-over reconnaissance and surface inspection. CDM will oversee the on-site activities of the cultural resources subcontractor.
- **Groundwater screening and source area investigation** - Prior to conducting the groundwater screening and source area investigations CDM will visit the site to identify the exact sampling locations and any potential logistical or property access issues. Because many of the groundwater screening points are located along roadways, it is anticipated that close coordination will be required with local authorities and police on access and safety issues.
- **Surface water, deep water, and sediment sampling** - Prior to conducting surface water, deep water, and sediment sampling, the field team will visit the site to identify sampling locations, potential logistical issues, particularly those related to access to lake and pond sampling locations that will require use of a boat, and property access issues. The field team will also coordinate with local officials on property access issues.
- **Monitoring well installation** - Monitoring well installation locations will be based on the results of the groundwater screening. Prior to installing the monitoring wells, the field team will visit proposed monitoring well locations to identify exact drilling locations and assess potential logistical issues and physical access constraints for the drill rig. Potential problem locations will be documented and photographed and locations may be adjusted to facilitate access.
- **Topographic survey oversight** - The existing geographic information system (GIS) database and maps will be used for this project. A topographic map of the site will be created that shows all relevant physical features of the area. It is anticipated that survey activities will occur at the end of the Hopewell Precision Site field investigation (TSOP 3-2, Topographic Survey), including the location and elevation of all source area soil sampling locations, groundwater screening locations, monitoring wells, piezometers, and staff gauges. Three elevations will be determined at each monitoring well: the ground surface, top of the inner casing, and top of the outer casing. In addition, surface water and sediment sampling locations that are accessible from shore will be surveyed. The locations of surface water and sediment samples collected from ponds and lakes using a boat will be identified at the time of collection using on-board global positioning system (GPS) unit. The locations of residential well samples will not be surveyed. The residences will be located on tax maps.

QAPP Worksheet #17c
Decontamination Procedures

Decontamination Procedures

Field decontamination will be performed on all personnel and equipment that enters the exclusion zone. Personnel decontamination procedures will be implemented to prevent worker exposure to site contaminants. Equipment decontamination procedures will be implemented to prevent cross-contamination of environmental samples and prevent off-site migration of contaminants as a result of site investigation activities.

Personal Protective Equipment

- Non-residual detergent (Alconox) and tap water rinse
- Respirator sanitizer (for respirator or self contained breathing apparatus [SCBA] face piece)
- Thorough rinse with potable water
- Air dry

Field Monitoring and Geophysical Logging Equipment

Instruments should be cleaned per manufacturer's instructions. The electronic water level indicators, geophysical logging equipment, and water quality parameter probes cannot be rinsed with solvents or acids. The electronic water level indicators will be decontaminated with a non-phosphate detergent, tap water rinse, and a final distilled/deionized water rinse prior to use at each well. The water quality parameter probes will be rinsed prior to and after each use with deionized/distilled water only.

Well Casings

Well casings must be steam cleaned prior to installation to ensure that all oils, greases, and waxes have been removed. The casing should be stored using clean polyethylene sheeting to keep the possibility of contamination to a minimum.

Drilling Equipment and Other Large Pieces of Equipment

All drilling equipment that comes in contact with the soil must be steam cleaned before use, and after drilling each borehole. This includes drill rods, bits and augers, dredges, or any other large piece of equipment. Sampling devices such as split-spoons must be decontaminated, after each use, by the procedure listed below.

Sampling Apparatus

General Considerations:

All sampling apparatus must be properly decontaminated prior to its use in the field to prevent cross-contamination. Equipment should be decontaminated after usage (once a day or on an as needed basis). Decontamination will be performed in an area outside the contamination zone. Enough equipment will be available to be dedicated to the sampling points planned each day.

QAPP Worksheet #17c
Decontamination Procedures

Decontamination Procedure:

The required decontamination procedure for all sampling equipment is:

- a. wash and scrub with low phosphate detergent
- * b. tap water rinse
- ** c. 10 percent nitric acid rinse, ultra pure grade (one percent solution will be used when carbon steel equipments, such as split-spoons, are used)
- d. demonstrated analyte-free water rinse
- *** e. acetone or ispropynol rinse (all solvents must be pesticide-grade or better)
- **** f. demonstrated analyte-free water rinse (amount of water must be at least five times that of the solvents used)
- g. air dry
- h. wrap in aluminum foil, shiny side out, for transport

* Tap water must be from a municipal water treatment system. The use of an untreated potable water supply is not an acceptable substitute.
** Nitric acid rinse will only be used when samples are collected for inorganics
*** Solvent rinse required only when sampling for organics.
**** A sample of the demonstrated analyte-free water will be collected and submitted for chemical analysis. Analytical results will be kept on-site. Determination of analyte-free water will be according to the EPA Region II CERCLA QA Manual (EPA 1989) (see page 59).

While performing decontamination activities, phthalate-free gloves should be used to prevent phthalate contamination of the sampling equipment that could result from the interaction of the gloves with the organic solvents.

Decontamination Equipment

- Steam cleaner
- Distilled/deionized water
- Potable water
- Deep basins
- Brush
- Acetone or isopropynol (pesticide-grade)
- Personnel protective equipment
- 10 percent nitric acid (one percent when needed), ultra pure grade
- Power source (e.g., generator), if required
- Demonstrated analyte-free water
- Polyethylene sheeting
- Utility knife
- Non-phosphate detergent (i.e. Alconox)
- Aluminum foil
- Air monitoring equipment and calibration gas

QAPP Worksheet #17d
Sampling Design and Rationale
Groundwater Screening Survey

Describe and provide a rationale for choosing the sampling approach. Groundwater screening transects are generally located perpendicular to the estimated groundwater flow direction but access issues were also considered. To the extent possible, transects are located along roadways and public property to minimize the need for access to residential properties.

Sampling design and rationale: The objectives of the groundwater screening survey include to: define the vertical and lateral boundaries of groundwater contamination; fill data gaps in the residential well sampling data; provide a rational basis for selection of monitoring well locations, depths, and screen intervals; and provide preliminary information on lithology of the glacial portion of the aquifer (Worksheet 17e). Groundwater screening will be performed at an estimated 49 locations along 9 transects using the direct push technology (DPT) sampling method (Figure 2). Actual sampling locations will be based on the results of the on-site reconnaissance and will be confirmed with EPA prior to conducting the sampling. The average depth of the groundwater screening points is assumed to be 70 feet below the ground surface (bgs), however the geologic information indicates the bedrock surface ranges from 40 to 50 feet bgs in the western portion of the site to 80 to 90 feet bgs in the southern portion of the site. The groundwater table is assumed to be 10 feet bgs. Groundwater samples will be collected at the water table and every 10 feet thereafter as the DPT rods are pushed downward. Sampling will begin at the center of the transect and proceed outward, toward the ends of each transect. Sample data from the previous day's sampling will be evaluated to determine when to terminate sampling along the transect. Sampling along a given transect will be terminated when results for all parameters are below project action limits, except on transects T4, T5 and T6 where the plume has potentially bifurcated into two lobes. The CDM SM, RITL, and FTL will hold daily discussions with the EPA RPM to evaluate sample analytical data and to determine when to terminate sampling. Based on a review of the VOC data and discussions with EPA, sample locations and/or sample depths may be modified or deleted. Any modifications will be approved by the EPA RPM and documented in FCRs and/or revised worksheets.

In accordance with TSOP 3-1 Geoprobe Sampling, Section 5.3, Part 8, groundwater screening survey samples will be collected from the screened interval using sample dedicated polyethylene tubing and a peristaltic pump. The groundwater screening survey samples will be collected using a Geoprobe™ rig or equivalent direct push rig. If a bladder or submersible pump can be located that will fit inside the geoprobe rods, this procedure will be modified by a field change request. Rig-specific SOPs supplied by the drilling subcontractor will be followed for the use of drilling equipment other than a Geoprobe™.

During purging of the well, monitor and record the field indicator parameters (turbidity, temperature, specific conductance, pH, oxidation-reduction potential [Eh], and dissolved oxygen [DO]) approximately every three to five minutes. Dissolved oxygen and turbidity usually require the longest time to achieve stabilization. The pump must not be removed from the well between purging and sampling. The well is considered stabilized and ready for sample collection when the indicator parameters have stabilized for three consecutive readings as follows:

±0.1 for pH ±10 mv for redox potential ±3% for specific conductance (conductivity) ±10% for DO and turbidity

QAPP Worksheet #17d
Sampling Design and Rationale
Groundwater Screening Survey

Groundwater samples will start at the water table proceed every 10 feet vertically downward to bedrock. At each interval, groundwater samples will be collected for LDL VOC analysis and will be sent to a subcontract laboratory for 24-hour turn around time analysis. Samples will be packaged in accordance with the procedures describe in TSOP 2-1 Packaging and Shipping of Environmental Samples.

The vertical profile sampling boreholes will be abandoned using a tremied cement-bentonite mixture after all sampling has been completed. The boring locations will be restored to pre-existing conditions.

Field procedures for this activity are detailed in:

- TSOP 1-2 Sample Custody, with a RAC II clarification
- TSOP 1-6 Water Level Measurement, Section 5.2 Water Level Measurement Using Electronic Water Level Indicators
- TSOP 1-10 Field Measurement of Organic Vapors, Section 5.1 Direct Read Instruments
- TSOP 2-1 Packing and Shipping of Environmental Samples, with a RAC II clarification, Section 4 Packing and Shipping Samples Preserved with Hydrochloric acid
- TSOP 2-2 Guide to Handling Investigation Derived Waste
- TSOP 3-1 Geoprobe Sampling, Section 5.3 Groundwater Sampling
- TSOP 3-6 Underground Facility Location
- TSOP 4-1 Field Logbook Content and Control, with a RAC II clarification
- TSOP 4-2 Photographic Documentation of Field Activities, Sections 5.2.2 General Guidelines for Still Photography and 5.2.4 Photographic Documentation
- Worksheet 17c Decontamination Procedures

Analytical groups/concentrations: An estimated 7 samples will be collected at each screening location, for a total of 343 screening samples. Groundwater screening samples will be analyzed for LDL VOCs with 24 hour turnaround for faxed results (Worksheet #18). Specific conductance, pH, DO, temperature, Eh and turbidity will also be collected in accordance with Worksheet 12r.

Sampling locations: Along transects shown in Figure 2. No background samples will be collected because the screening is designed to determine the extent of the plume.

Number of samples/frequency: Groundwater samples will be collected at the water table and every 10 feet thereafter to the top of bedrock or refusal. An average of 7 samples per location is expected. Sample naming is detailed on Worksheet #26.

QAPP Worksheet #17e
Sampling Design and Rationale
Groundwater Screening Lithologic Sampling and Logging

Describe and provide a rationale for choosing the sampling approach. To provide preliminary lithological and stratigraphic information to enhance the conceptual site model (CSM) and to provide additional information to support selection of permanent monitoring well locations.

Sampling design and rationale: In conjunction with groundwater screening, subsurface lithology and stratigraphy will be collected at 10 groundwater screening locations across the site to provide preliminary information to enhance the conceptual site model (CSM) and to provide additional information to support selection of permanent monitoring well locations. The proposed groundwater screening lithologic sampling and logging locations are shown on Figure 2.

Field procedures for this activity are detailed in:
- TSOP 1-10 Field Measurement of Organic Vapors, Section 5.1 Direct Reading Measurement
- TSOP 2-2 Guide to Handling Investigation Derived Waste
- TSOP 3-1 Geoprobe Sampling, Section 5.1 Soil Sampling
- TSOP 3-5 Lithologic Logging
- TSOP 3-6 Underground Facility Location
- TSOP 4-1 Field Logbook Content and Control, with a RAC II clarification
- TSOP 4-2 Photographic Documentation of Field Activities, Sections 5.2.2 General Guidelines for Still Photography and 5.2.4 Photographic Documentation
- Worksheet 17c Decontamination Procedures

Analytical groups: No samples will be collected for chemical analysis.

Sample locations: Refer to Figure 2.

Number of samples/frequency: At each of the 10 locations, 4-foot soil "cores" in plastic sleeves will be collected at 10-foot intervals using DPT, starting at the ground surface and terminating at the bedrock surface. The lithologic borings will be completed before the groundwater screening to help identify the depth to water for each transect. Each core will be described for lithology (TSOP 3-5) and scanned with a photoionization detector (PID) (TSOP 1-10, Section 5.1). Eight soil "cores" are estimated at each location. Lithologic logging will be performed by the on-site geologist and evaluated in the technical memorandum prepared at the conclusion of the Stage I activities.

QAPP Worksheet #17f
Sampling Design and Rationale
Source Area Subsurface Soil Sampling

Describe and provide a rationale for choosing the sampling approach. The objective of the source area soil borings is to characterize the subsurface soils at the former and current Hopewell Precision Facilities. The soil data will supplement previous source area soil sampling. The boring locations were chosen based on the location of historical releases, historical boring locations and spacial limitations caused by site structures. The data will also be used to support placement of the on-site monitoring well that will be installed at the facility on Ryan Drive. Sampling locations shown on Figure 3 were selected to cover the accessible property around the two buildings, by evenly spacing locations, avoiding areas already sampled by EPA's removal group, and sampling in areas where solvents may have been disposed upon the ground.

Sampling design and rationale: Subsurface soil sampling will be conducted at 25 locations around the two buildings previously and currently occupied by Hopewell Precision (Figure 3). Four foot soil cores will be collected continuously, using a DPT rig, from the ground surface to the top of the water table (approximately 10 feet), with samples collected at 4-foot intervals. A total of 75 soil samples will be collected. Each 4-foot core will be screened for VOCs using a PID. The onsite geologist will select three intervals per boring for VOC analysis using the PID readings together with visual observations of any potential source materials. The lithology of the each sample will be characterized and logged by the field geologist. Depth to groundwater and PID readings will be recorded in the boring log. New, polyethylene sleeves will be used for each core. If there are no PID detections or visual evidence of contamination, samples will be collected from 0-2 feet, 4-6 feet and the bottom 2 feet of the boring. If necessary, VOC samples from the 0-2 foot and 4-6 foot intervals should be collected and discarded if other intervals have higher PID detections. Samples will be collected as described in TSOP 3-1, Section 5.1 and TSOP 1-3, Section 5.2.3. VOC samples will be collected as described in TSOP 1-3, Section 5.5 or TSOP 1-4, Section 5.2.5.4.

Field procedures for this activity are detailed in Appendix B:

- TSOP 1-2 Sample Custody, with a RAC II clarification
- TSOP 1-3 Surface Soil Sampling, with RAC II clarification, Section 5.5
- TSOP 1-4 Subsurface Soil Sampling, with RAC II clarification, Section 5.2.5.4 and
- TSOP 1-10 Field Measurement of Organic Vapors, Section 5.1 Direct Reading Measurement
- TSOP 2-1 Packing and Shipping of Environmental Samples, with a RAC II clarification, Section1.4 Packing Environmental Samples
- TSOP 2-2 Guide to Handling Investigation Derived Waste
- TSOP 3-1 Geoprobe Sampling, Section 5.1 Soil Sampling
- TSOP 3-6 Underground Facility Location
- TSOP 4-1 Field Logbook Content and Control, with a RAC II clarification
- TSOP 4-2 Photographic Documentation of Field Activities, Sections 5.2.2 General Guidelines for Still Photography and 5.2.4 Photographic Documentation
- Worksheet 17c Decontamination Procedures

QAPP Worksheet #17f
Sampling Design and Rationale
Source Area Subsurface Soil Sampling

Analytical groups/concentrations: Analytical details are presented in Worksheets #18 and #30. Concentrations are expected to be low.

Sampling locations: One background boring will be located north of the fence along the north side of Hopewell Precision property. The background boring samples will be collected last in order to correlate the sample depths with the depths collected in the environmental samples. All other borings will be located as shown on Figure 3.

Number of samples/frequency: Three subsurface soil samples will be analyzed from each of the 25 borings. Sample depths will be selected by the geologist, based on PID detections of VOCs and visual evidence of contamination. Sample naming is detailed on Worksheet #26.

QAPP Worksheet #17g
Sampling Design and Rationale
Residential Well Sampling

Describe and provide a rationale for choosing the sampling approach. Two rounds of samples will be collected from 60 residential wells (Table 1). The rationale for selecting each well is included on the table. The final residential well sampling locations may change base on the sampling conducted by EPA's removal group. Any changes will be documented in a FCR and/or revised Worksheets.

Sampling design and rationale: Wells selected for sampling are based on the depth of the well, location relative to other contaminated wells, and known contaminated areas. The rationale is included on Table 1. Residential well samples will be collected as near as possible to the wellhead and before any treatment systems. The tap will be run until water quality parameters stabilize or the well holding tank has been emptied to ensure that a representative sample is collected. During purging of the well, monitor and record the field indicator parameters (turbidity, temperature, specific conductance, pH, Eh, and DO) approximately every three to five minutes. Dissolved oxygen and turbidity usually require the longest time to achieve stabilization. The well is considered stabilized and ready for sample collection when the indicator parameters have stabilized for three consecutive readings as follows:

$\pm$0.1 for pH $\pm$3% for specific conductance (conductivity) $\pm$10 mv for redox potential $\pm$10% for DO and turbidity

Field procedures for this activity are detailed in Appendix B:

- TSOP 1-2 Sample Custody, with a RAC II clarification
- TSOP 1-9 Tap Water Sampling, with a RAC II clarification
- TSOP 2-1 Packing and Shipping of Environmental Samples, with a RAC II clarification, Section 4 Packing and Shipping Samples Preserved with Hydrochloric acid
- TSOP 2-2 Guide to Handling Investigation Derived Waste
- TSOP 4-1 Field Logbook Content and Control, with a RAC II clarification
- TSOP 4-2 Photographic Documentation of Field Activities, Sections 5.2.2 General Guidelines for Still Photography and 5.2.4 Photographic Documentation
- Worksheet 17c Decontamination Procedures

Analytical groups/concentration: Refer to Worksheets #18 and 30. Concentrations are expected to be low.

Sampling locations: Refer to Table 1 for the sampling locations. No background residential well samples will be collected.

Number of samples/frequency: Refer to Table 1 for the number of samples. Two rounds of residential samples will be collected from 60 wells in each Stage 1 and Stage 2. Sample naming is detailed on Worksheet #26. Sample locations are listed in Table 1.

QAPP Worksheet #17h
Sampling Design and Rationale
Monitoring Well Drilling and Installation

Describe and provide a rationale for choosing the sampling approach. Wells will be installed in pairs consisting of a deep and a shallow well to define the vertical extent of groundwater contamination in the glacial aquifer. One bedrock well will be installed. Lithologic information will be used to support development of the hydrogeologic framework and CSM for the site. Well locations and screen intervals will be recommended to EPA in a Technical Memorandum after the groundwater screening survey is completed. No analytical samples will be collected during drilling and installation of wells.

Sampling design and rationale: A total 39 monitoring wells at 20 locations are proposed (Figure 4); the number will be refined after the groundwater screening survey. Nineteen well pairs will provide a means to define the vertical extent of groundwater contamination in the glacial aquifer. Shallow wells will be drilled to 30 feet bgs and deep wells will be drilled to 80 feet bgs. One bedrock well will be installed 20 feet into the bedrock at the source area on Ryan Drive. The bedrock section of this well will be cored. A discussion of site and regional geology is located in Section 3.1 of the Work Plan Volume 1.

Overburden monitoring wells:
Overburden monitoring wells will be installed using 6.25 inch inner diameter (ID) hollow stem augers (HSA). If the HSA method is unsuccessful because boulders or other obstructions impede the augers (determined by the SM, RITM and FTL), air rotary drilling will be used. If air rotary is necessary, the change will be documented in a FCR form and/or revised worksheets. Two Eight-inch diameter boreholes will be drilled to the target depth (80 feet for deep wells and 30 feet for shallow wells) at each location. Monitoring wells will be constructed of 4-inch diameter schedule 40 polyvinyl chloride (PVC) casing and 10 foot lengths of PVC screen. It is assumed the slot size will be 0.010-inch and wells will be single-cased. The annulus around the well screen will be backfilled with No.1 sand which will extend 2-feet above the well screen. A 2-foot bentonite seal will be placed above the sand pack and the remaining annulus will be grouted to the surface. An 8-inch steel protective casing with a locking cap will be installed and a concrete collar will be installed around the well. The surface completion (stick-up or flush mount) will be determined based on the well locations (Figure 5).

Split-spoon samples will be collected at 5-foot intervals from the surface to total depth in the deep well of the each well pair. Split-spoon samples will be screened with a PID to identify contaminated zones within the borehole. Split spoons will also be described for lithology and boring logs will be created for each deep monitoring well.

Bedrock well:
The bedrock well will be installed at the source area on Ryan Drive and is estimated to be 100 feet in depth. The well will be drilled with 10.25 inch HSA to competent bedrock and 8-inch carbon steel casing will be grouted into place. An HQ size core will be collected to 20 feet below the casing. The bedrock will be reamed out to 8 inches using air rotary drilling. A monitoring well will be constructed of 4-inch diameter schedule 40 PVC casing and a 10 foot length of PVC screen. It is assumed the slot size will be 0.010-inch. The annulus around the well screen will be backfilled with No.1 sand which will extend 2-feet above the well screen. A 2-foot bentonite seal will be placed above the sand pack and the remaining annulus will be grouted to the surface. An 8-inch steel protective casing with a locking cap will be installed and a concrete collar will be installed around the well. This well will be completed as a flush mount (Figure 6).

QAPP Worksheet #17h
Sampling Design and Rationale
Monitoring Well Drilling and Installation

Development and IDW Disposal:
The screen interval in each monitoring well installation will be fully developed using a submersible pump to remove silt and well construction materials from the well screen and sand pack and to provide a good hydraulic connection between the well and the aquifer materials. Turbidity, pH, temperature, conductivity, and dissolved oxygen will be monitored during development. Development will continue until all parameters have stabilized (within 10 percent for successive measurements) and the water is clear (less than 5 NTUs).

Drill cuttings and water from drilling operations will be containerized at the drilling location and transported by the drilling subcontractor to a central waste storage area. Liquid wastes will be transferred to a 21,000 gallon Baker tank and drill cuttings will be transferred to 20 cubic yard roll-off containers for subsequent sampling, characterization, and disposal by CDM's IDW subcontractor.

Field procedures for this activity are detailed in

- TSOP 1-6 Water Level Measurement, Section 5.2 Water Level Measurement Using Electronic Water Level Indicators
- TSOP 1-10 Field Measurement of Organic Vapors, Section 5.1 Direct Reading Measurement
- TSOP 2-1 Packing and Shipping of Environmental Samples, with a RAC II clarification, Section 4
- TSOP 2-2 Guide to Handling Investigation Derived Waste
- TSOP 3-5 Lithologic Logging
- TSOP 3-6 Underground Facility Location
- TSOP 4-1 Field Logbook Content and Control, with a RAC II clarification
- TSOP 4-2 Photographic Documentation of Field Activities, Sections 5.2.2 General Guidelines for Still Photography and 5.2.4 Photographic Documentation
- TSOP 4-3 Well Development and Purging, with a RAC II clarification, Section 5.1 Well Development
- TSOP 4-4 Design and Installation of Monitoring Wells in Aquifers
- Worksheet 17c Decontamination Procedures

Analytical groups: No samples will be collected for chemical analysis.

Sample locations: Refer to Figure 4.

Number of samples/frequency: Split spoon soil samples for lithological description will be collected every 5 feet. Turbidity, pH, temperature, conductivity, and dissolved oxygen will be monitored every 3 to 5 minutes during development. Development will continue until all parameters have stabilized (within 10 percent for successive measurements) and the water is clear (turbidity below 5 Nephelometric Turbidity Units [NTUs]).

QAPP Worksheet #17i
Sampling Design and Rationale
Synoptic Water Level Measurement

Describe and provide a rationale for choosing the sampling approach. Two rounds of water level measurements will be collected with an electronic water level meter at each monitoring well prior to collection of groundwater samples. No analytical samples will be collected during these events.

Sampling Design and rationale: Two rounds of synoptic water level elevation measurements will be taken in the 39 wells to define groundwater flow at the site. An electronic water level meter will be used to collect the measurements. The synoptic groundwater level measurements will be taken in conjunction with the two rounds of groundwater sampling. Groundwater contour maps will be constructed for each of the shallow and deep groundwater monitoring zones.

Before taking water level measurements, the location and elevation of each monitoring well will be surveyed by a New York licensed surveyor. Elevation measurements will be made at marked water level measuring points on the inner casing, the top of outer protective casing, and the adjacent ground surface. The wells will be allowed to equilibrate after development for a minimum of two weeks before water level measurements are taken.

Field procedures for this activity are detailed in Appendix B:

- TSOP 1-6 Water Level Measurement, Section 5.2 Water Level Measurement Using Electronic Water Level Indicators
- TSOP 1-10 Field Measurement of Organic Vapors, Section 5.1 Direct Reading Measurement
- TSOP 4-1 Field Logbook Content and Control, with a RAC II clarification
- Worksheet 17c Decontamination Procedures

Analytical groups: No samples for chemical analysis will be collected.

Number of samples/frequency: Two rounds of measurements will be taken at each monitoring well installed at the site.

QAPP Worksheet #17j
Sampling Design and Rationale
Natural Gamma Logging

Describe and provide a rationale for choosing the sampling approach. Gamma logs will assist with identification of clay layers and will be correlated with lithologic logs.

Sampling design and rationale: Once well construction is complete, natural gamma logs will be run in the deep well of each monitoring well pair. A downhole geophysical log of natural gamma will be performed at the deep well of each monitoring well pair. Downhole geophysical logging will be conducted in accordance with CDM's TSOP 3-4 Geophysical Logging, Calibration, and Quality Control. The gamma logs will be run after the wells have been completed.

The downhole geophysical logging will be performed by CDM's project geologist in accordance with the manufacturer's specifications. The equipment supplier will be responsible for the calibration of the probes, in accordance with the manufacturer's instructions, prior to shipment. Field personnel should be familiar with TSOP 3-4 and the manufacturer's specifications for the logging instruments. The downhole logging equipment will be decontaminated between each well in accordance with the manufacturer's specifications and the procedures outlined in Worksheet 17c.

At each location, CDM will setup a portable logging system consisting of a generator, computer (with logging software), and drawworks (cable, tool power supply, winch, and tripod). The natural gamma log will be run by first connecting the tool to the cable and setting it in the borehole so that the reference is to ground surface. The tool will be run at a speed of between 15 and 18 feet per minute. Data will be collected as the tool is first lowered to the bottom of the hole and then raised back to the surface. The two sets of data (up and down) provide a check on instrument function and redundancy in case of an instrument malfunction.

Field procedures for this activity are detailed in Appendix B:

- TSOP 1-6 Water Level Measurement, Section 5.2 Water Level Measurement Using Electronic Water Level Indicators
- TSOP 1-10 Field Measurement of Organic Vapors, Section 5.1 Direct Reading Measurement
- TSOP 3-4 Geophysical logging, Calibration and Quality Control, Section 5.2.B.5 Nuclear Logging
- TSOP 4-1 Field Logbook Content and Control, with a RAC II clarification
- TSOP 4-2 Photographic Documentation of Field Activities, Sections 5.2.2 General Guidelines for Still Photography and 5.2.4 Photographic Documentation
- Worksheet 17c Decontamination Procedures

Analytical groups: No chemical samples will be collected.

Number of samples/frequency: Gamma logs will be run at the deep well of each pair of monitoring wells.

QAPP Worksheet #17k
Sampling Design and Rationale
Slug Testing

Describe and provide a rationale for choosing the sampling approach. Slug tests will be performed on 19 wells that represent a variety of depths, lithologies and locations in the glacial aquifer across the large site. CDM will recommend wells in a FCR form and/or revised Worksheets for slug tests after the monitoring well locations have been selected.

Sampling design and rationale: Slug tests will be performed at one-half of the monitoring wells (currently estimated at 19 wells). Slug tests will be conducted at monitoring wells that cover a range of depths, lithology types, and locations across the site. Slug tests are a rapid and easy means to estimate hydraulic conductivity of an aquifer. Slug tests are conducted by adding or removing/displacing a known volume to or from the monitoring well to create a rapid rise or fall in water level. Water levels are measured as the water in the well returns to static (pre-test) conditions. Water is displaced with a weighted cylinder of known volume. The slug will be a 5 foot long, 3 inch diameter solid piece of PVC. The rate of water recovery is measured with a pressure transducer and data recorder. Both rising and falling head slug tests will be conducted.

Slug test data will be evaluated using the Hvorslev Slug Test Method (Hvorslev 1951) and/or the Bouwer and Rice Slug test Method (Bouwer and Rice 1976). The most appropriate method will be determined by the project geologist.

If the EPA hydrogeologist is not satisfied with the slug test results, a limited (i.e., 24-hour) pump test will be conducted. A QAPP addendum will be submitted describing the details of the aquifer test.

Field procedures for this activity are detailed in Appendix B:
- TSOP 1-6 Water Level Measurement, Section 5.2 Water Level Measurement Using Electronic Water Level Indicators
- TSOP 1-10 Field Measurement of Organic Vapors, Section 5.1 Direct Reading Measurement
- TSOP 4-1 Field Logbook Content and Control, with a RAC II clarification
- TSOP 4-2 Photographic Documentation of Field Activities, Sections 5.2.2 General Guidelines for Still Photography and 5.2.4 Photographic Documentation
- Worksheet 17c Decontamination Procedures
- TSOP 4-6 Hydraulic Conductivity Testing, Section 5.2

Analytical Groups: No samples will be collected for analytical testing.

Number of samples/frequency: Slug tests will be conducted at an estimated 19 monitoring wells.

QAPP Worksheet #17l
Sampling Design and Rationale
Monitoring Well Sampling

Describe and provide a rationale for choosing the sampling approach. Two rounds of samples will be collected from the monitoring wells installed at the site to characterize the nature and extent of groundwater contamination.

Sampling design and rationale: Two rounds of groundwater samples will be collected from the 39 monitoring wells. Sampling will be conducted following the Site Specific Low Flow Groundwater Purging and Sampling Procedure provided in Appendix A. The samples will be analyzed on-site for ferrous iron using the HACH method detailed in Appendix C. QC requirements for the HACH method are presented on Worksheets 12r and 28e.

Field procedures for this activity are detailed in:

- Appendix A — Site-Specific Low Flow Groundwater Purging and Sampling Procedure
- TSOP 1-2 — Sample Custody, with a RAC II clarification
- TSOP 1-6 — Water Level Measurement, Section 5.2 Water Level Measurement Using Electronic Water Level Indicators
- TSOP 1-10 — Field Measurement of Organic Vapors, Section 5.1 Direct Reading Measurement
- TSOP 2-1 — Packing and Shipping of Environmental Samples, with a RAC II clarification, Section 4
- TSOP 2-2 — Guide to Handling Investigation Derived Waste
- TSOP 4-1 — Field Logbook Content and Control, with a RAC II clarification
- TSOP 4-2 — Photographic Documentation of Field Activities, Sections 5.2.2 General Guidelines for Still Photography and 5.2.4 Photographic Documentation
- Worksheet 17c — Decontamination Procedures
- Appendix C — Ferrous Iron Procedure

Analytical groups/concentrations: Refer to Worksheets #18 and #30. Concentrations are expected to be low. Water quality parameters pH, DO, specific conductance, temperature, Eh and turbidity will also be collected in accordance with Worksheet 12r.

Sampling locations: See Worksheet #17h for monitoring well location rationale. One monitoring well pair will be installed in a background location.

Number of samples/frequency: Two rounds of samples will be collected from the monitoring wells. Sample naming is detailed on Worksheet #26.

QAPP Worksheet #17m
Sampling Design and Rationale
Groundwater/Surface Water Interaction Investigation

Describe and provide a rationale for choosing the sampling approach. Groundwater/surface water interaction will be evaluated at Redwing Lake and the gravel pit to determine if potentially contaminated groundwater discharges into the lake and/or pit. The lake and gravel pit were selected for evaluation because they are in the direct pathway of the identified TCE/1,1,1-TCA groundwater plume. The lake is used as a recreational swimming facility.

Sampling design and rationale: A staff gauge will be installed in both water bodies. A piezometer will be installed at a location as close as practicable to each staff gauge (Figure 7). To account for seasonal fluctuation in the groundwater table, piezometer screens will straddle the groundwater table. The staff gauge will consist of a calibrated scale affixed to a steel rod driven into the lake bottom. Staff gauges will be installed at locations that are accessible by wading. The top of the staff gauge will be surveyed so that water level measurements can be referenced to a known datum. The top of the piezometers and adjacent ground surface will also be surveyed and referenced to the same datum. The water levels within the piezometers will be compared to the surface water levels from the staff gages to determine whether an upward or downward gradient exists between the groundwater and the surface water. Surface water and sediment samples will be collected adjacent to the piezometers to assess contaminant transport.

Staff Gagues:
Two staff gauges will be installed by hand, using a fence post driver, at the time of the surface water and sediment sampling. A seven foot length of 2-inch diameter galvanized steel pipe will be driven into the pond beds so that at least a four foot section of riser protrudes above the sediment surface. A four foot stream gauge will be secured to the riser with steel bolts through holes drilled in the riser such that the base of the gauge will be approximately six inches above the stream/pond bed. Three holes drilled at the top of the staff gauge riser will be used to secure three guide ropes. Each guide rope will be tied to steel pegs driven into the ground/sediment. The pegs should be of sufficient length to allow for solid anchoring of the gauge to prevent disturbance of the gauge during elevated stream flow events.

Piezometers:
The piezometers will be installed as close as possible to each staff gauge using a drilling rig with 3.25 inch ID HSA to 20 feet bgs. The piezometers will be constructed of 1 inch diameter schedule 40 PVC with a 10 foot screen that straddles the water table. It is assumed the slot size will be 0.010-inch. The annulus around the well screen will be backfilled with No.1 sand which will extend 2-feet above the well screen. A 2-foot bentonite seal will be placed above the sand pack and the remaining annulus will be grouted to the surface. A 4-inch steel protective casing with a locking cap will be installed and a concrete collar will be installed around the well.

The screen interval in each piezometer will be fully developed using a submersible pump or bailer to remove silt and well construction materials from the well screen and sand pack and to provide a good hydraulic connection between the well and the aquifer materials. Turbidity, pH, temperature, conductivity, and dissolved oxygen will be monitored during development. Development will continue until all parameters have stabilized (within 10 percent for successive measurements) and the water is clear (turbidity less than 5 NTUs).

QAPP Worksheet #17m
Sampling Design and Rationale
Groundwater/Surface Water Interaction Investigation

Drill cuttings and water from drilling operations will be containerized at the drilling location and transported by the drilling subcontractor to a central waste storage area. Liquid wastes will be transferred to a 21,000 gallon Baker tank and drill cuttings will be transferred to 20 cubic yard roll-off containers for subsequent sampling, characterization, and disposal by CDM's IDW subcontractor.

Field procedures for this activity are detailed in Appendix B:

- TSOP 1-6 Water Level Measurement
- TSOP 1-10 Field Measurement of Organic Vapors, Section 5.1 Direct Reading Measurement
- TSOP 4-1 Field Logbook Content and Control, with a RAC II clarification
- TSOP 4-2 Photographic Documentation of Field Activities, Sections 5.2.2 General Guidelines for Still Photography and 5.2.4 Photographic Documentation
- TSOP 4-3 Well Development and Purging, with a RAC II clarification, Section 5.1 Well Development
- TSOP 4-4 Design and Installation of Monitoring Wells in Aquifers
- Worksheet 17c Decontamination Procedures

Analytical groups: No samples will be collected for chemical analysis.

Sampling locations: Refer to Figure 7.

Number of samples/frequency: Two rounds of staff gauge readings and piezometer readings will be taken in conjunction with the two rounds of synoptic water level measurements in the monitoring wells.

QAPP Worksheet #17n
Sampling Design and Rationale
Surface Water, Deep Water and Sediment Sampling

Describe and provide a rationale for choosing the sampling approach. Surface water, deep water, and sediment samples will be collected in areas downgradient of the Hopewell Precision facility, where groundwater may be likely to discharge to surface water features (e.g., creeks or ponds). Deep water is defined as water that is deep enough to cause thermoclines in the water body.

Sampling design and rationale: *Surface water/sediment samples* - One round of surface water/sediment samples will be collected in Whortlekill Creek, a wet area south of Ryan Drive (within a wooded area), and five ponds (Figure 7). The five ponds are: 1) unnamed pond #1, south of Ryan Drive and west of Route 82, 2) unnamed pond #2, north of Creamery Road, 3) Redwing Lake, 4) the gravel pit south of Timothy Lane, and 5) a man-made pond at 100 Clove Branch Road. The surface water and sediment sample locations will be based on actual field conditions (such as amount of sediment available in the creek and ponds) and biased towards sedimentation locations (such as the slower flowing portions or the inside of the creek bend where lower stream flow velocities promote sediment fall out from suspension). Sediment samples will be collected from a depth of 0 to 6 inches. Surface water and sediment samples will be collected from the following proposed 39 sampling locations as shown on Figure 7:

- Wet area south of Ryan Drive - one surface water and one sediment sample
- Whortlekill Creek
  - Section between Creamery Road and Timothy Lane - 10 surface water and 10 sediment samples
  - Upstream - two surface water and two sediment samples, serving as background samples
- Unnamed Pond No. 1 - two surface water and two sediment samples
- Unnamed Pond No. 2 - three surface water and three sediment samples
- Redwing Lake - 10 surface water and 10 sediment samples, evenly distributed over the lake with at least 4 locations close to the swimming area
- Gravel Pit - 10 surface water and 10 sediment samples
- 100 Clove Branch Road - one surface water and one sediment sample

QAPP Worksheet #17n
Sampling Design and Rationale
Surface Water, Deep Water and Sediment Sampling

Deep water samples -. The deep water samples are needed to assess if a thermocline occurs in Redwing Lake and the Gravel Pit in the summer. A thermocline is an area of water within the water body in which the warmer upper waters (epilimnion) are prevented from mixing with the deeper level (hypolimnion). If contaminated groundwater discharges to these two large water bodies, and if a thermocline is established in these two ponds, then collection of water samples at the surface may not detect the contamination of the ponds. Therefore, collection of water samples at deeper depths in these two ponds is warranted. Sampling will occur during high summer (mid-July to early August) when the lakes are most likely to be stratified.

All deep water samples will be collected by a subcontractor with CDM oversight. The subcontractor will supply a boat/barge that has sufficient space and capacity to accommodate at least one CDM personnel, the Subcontractor work crew, and the necessary sampling equipment. The gravel pit is reportedly up to 50 feet deep and is likely to have strong thermal stratification in the summer months. Because it is a large lake and the structure of the bottom of the gravel pit may be variable, bathymetry of the lake will be determined. Thus, the physical structure of the lake, especially if the lake intercepts certain geologic layers, will be determined for a better selection of sampling locations. A Hypack (or equivalent) will be used for survey controls, ship track recording and data acquisition. The subcontractor will produce a bathymetric map of the Gravel Pit within 24 hours. Proposed sampling locations (Figure 7) will be revised based on the bathymetric mapping results. Samples should be collected in the deepest areas of the Gravel Pit.

Ten deep water samples will be collected from Red Wing Lake and ten deep water samples will be collected from the Gravel Pit (Figure 8). The deep water samples will be collected toward the center of the lakes, presumably where the water is the deepest, because stratification usually does not occur near the edges of the lakes. Each sample will be located by the subcontractor using a GPS unit capable of sub-meter accuracy. At each sample location, the depth to the lake bottom will be established using a weighted, calibrated line. A thermister will be used to determine the depth to the top of the hypolimnion and the data will be available in real-time. Deep water samples will be collected half way between the top of the hypolimnion and the bottom of the lake. If there is no hypolimnion at a location, the sample will be collected two feet above the bottom of the lake. Samples will be collected using a stainless steel Kemmerer sampler (or equivalent). CDM staff will collect water quality parameters (pH, dissolved oxygen, reduction-oxidation potential, temperature, and specific conductance) from each sample.

The bathymetry, thermal profile and depth profile measurements will be performed by a subcontractor procured by CDM. The Statement of Work will include technical requirements for the profiles. Additional procedures for collecting the samples will be provided by the Subcontractor and will be submitted as a field change request.

QAPP Worksheet #17n
Sampling Design and Rationale
Surface Water, Deep Water and Sediment Sampling

Field procedures for this activity are detailed in Appendix B:

- TSOP 1-1 Surface Water Sampling, Section 5.2 Shallow Surface Water Sample Collection
- TSOP 1-2 Sample Custody, with a RAC II clarification
- TSOP 1-10 Field Measurement of Organic Vapors, Section 5.1 Direct Reading Measurement
- TSOP 1-11 Sediment/Sludge Sampling, with a RAC II clarification, Section 5.2 Sediment and Sludge Collection from Shallow Waters
- TSOP 2-1 Packing and Shipping of Environmental Samples, with a RAC II clarification, Section 4
- TSOP 2-2 Guide to Handling Investigation Derived Waste
- TSOP 4-1 Field Logbook Content and Control, with a RAC II clarification
- TSOP 4-2 Photographic Documentation of Field Activities, Sections 5.2.2 General Guidelines for Still Photography and 5.2.4 Photographic Documentation
- Worksheet 17c Decontamination Procedures

Analytical groups/concentrations: Refer to Worksheets # 18 and #30. Concentrations are expected to be low.

Sampling locations: See Figure 4 for locations. Surface water and sediment samples in Whortlekill Creek will be collected from downstream to upstream. Background surface water and sediment samples will be collected at one location in Whortlekill Creek that is upgradient of the Hopewell Precision facility. No background deep water samples will be collected.

Number of samples/frequency: One round of surface water, deep water, and sediment samples will be collected. Sample naming is detailed on Worksheet #26.

QAPP Worksheet #17o
Sampling Design and Rationale
Ecological Field Investigation

Describe and provide a rationale for choosing the sampling approach. The ecological field investigation will be conducted to characterize the terrestrial and aquatic communities associated with groundwater discharge areas along Whortlekill Creek and in the vicinity of the natural four ponds.

Sampling design and rationale: Habitat conditions will be visually inspected by walking the stream and pond areas of the site and recording observations of species composition and relative diversity and abundance, habitat association, and surface water conditions. Field observations will be recorded in logbooks and photographs will be taken to record both representative and unusual site conditions that would influence conclusions regarding potential contamination pathways, food chain effects, receptor identification, and risks to floral and faunal communities. The following information will be gathered during the field survey:

- General aquatic habitat conditions (e.g., water velocity, bottom substrate, channel width, channel depth, and extent of bank vegetation over) along Whortlekill Creek and the ponds. The Physical Characterization/Water Quality Field Data Sheet and the Habitat Assessment Field Data Sheet included in EPA's *Rapid Bioassessment Protocols for Use in Streams and Rivers* (EPA 1989) may be used as tools to complete the characterization of the aquatic habitats.
- Vegetation community/cover types and observed vegetative species makeup of each community, including dominant species and general observation of abundance and diversity within each cover type, at and in areas related to the site.
- Wildlife use observations including wildlife habitats, species, wildlife concentrations areas, and habitat use activities.
- General surficial soil conditions
- Indications of environmental stress that could be related to site contaminants.

An ecological description will be prepared that discusses the vegetative communities, wildlife habitats, suspected surface water drainage pathways, and observed areas of environmental stress or disturbance. The following information will also be prepared and presented: observed potential surficial migration pathways; vegetation communities and composition; observed terrestrial and aquatic wildlife habitats; observed and expected wildlife utilization of the site; potential occurrence of state and federal threatened, endangered, or rare species and critical habitats; and observed ecological impairments.

Field procedures for this activity are detailed in Appendix B:

- TSOP 4-1 Field Logbook Content and Control, with a RAC II clarification
- TSOP 4-2 Photographic Documentation of Field Activities, Sections 5.2.2 General Guidelines for Still Photography and 5.2.4 Photographic Documentation

Analytical groups/concentrations: No samples will be collected for chemical analysis.

Sampling locations: Not applicable.

Number of samples/frequency: Not applicable.

QAPP Worksheet #18
Sampling Locations and Methods/SOP Requirements Table

Sampling Location/ ID Number	Matrix	Depth (feet)	Analytical Group	Concentration Level	Number Samples (Identify field duplicates)	Sampling SOP Reference	Rationale for Sampling Location
Groundwater Screening Survey, 9 transects, T1-T9, 49 locations	Groundwater	samples every 10 feet from the water table to refusal, 7 per location	TCL VOC (trace), 24 hour turnaround for faxed results	Low	343 (18 duplicates)	TSOP 3-1, Section 5.3 Groundwater sampling	See Worksheet #17d
Residential Well Sampling (2 rounds)	Groundwater	NA	TCL VOC (trace)	Low	60 wells (3 duplicates) x 2 rounds	TSOP 1-9, Tap Water Sampling	See Worksheet #17g
Source Area Subsurface Soil Sampling - 25 borings to top of the water table	Soil	TBD, 3 samples per boring	TCL VOCs, SVOCs, Pest/PCBs, TAL metals, mercury, cyanide pH, grain size, TOC	Low	75 (4 duplicates)	TSOP 3-1, Geoprobe Sampling, Section 5.1	See Worksheet #17f
Monitoring Well Sampling (2 rounds)	Groundwater	TBD	TCL VOC (trace), TCL SVOCs, pest/PCBs, TAL metals, mercury, cyanide, chloride, methane/ethane/ ethene, nitrate, sulfate, sulfide, TOC, ferrous iron, TSS, TDS, ammonia, hardness, TKN	Low	39 wells (2 duplicates) x 2 rounds	Low flow sampling method (Appendix A)	See Worksheet #17l

QAPP Worksheet #18
Sampling Locations and Methods/SOP Requirements Table

Sampling Location/ ID Number	Matrix	Depth (feet)	Analytical Group	Concentration Level	Number Samples (Identify field duplicates)	Sampling SOP Reference	Rationale for Sampling Location
Surface Water	Water	NA	TCL VOC (trace), TCL SVOCs, pest/PCBs, TAL metals, mercury, cyanide, alkalinity, ammonia, chloride, nitrate/ nitrite, sulfate, sulfide, TOC, pH, TSS, TDS, hardness, TKN	Low	39 (2 duplicates)	TSOP 1-1, Section 5.2	See Worksheet #17n
Deep Water	Deep Water	variable, TBD	Same as surface water	Low	20 (1 duplicate)	TSOP 1-1, Section 5.3	See Worksheet #17k
Sediment	Sediment	0-6 inches	TCL VOCs, SVOCs, Pest/PCBs, TAL metals, mercury, cyanide, pH, grain size, TOC	Low	39 (2 duplicates)	TSOP 1-11, Section 5.2	See Worksheet #17n

QAPP Worksheet #19
Analytical SOP Requirements

Matrix	Analytical Group	Concentration Level	Analytical and Preparation Method/SOP Reference [1]	Minimum Sample Volume	Containers [2,3] (number, size, and type)	Preservation Requirements (chemical, temperature, light protected)	Maximum Holding Time[4] (preparation/ analysis)
Aqueous	TCL VOC (trace)	Low	SOM01.1	80 ml	2-40 ml vials with Teflon septum	HCl to pH<2, cool to 4 degrees C	10 days preserved-VTSR
Aqueous	TCL VOC	Low	SOM01.1	80 ml	2-40 ml vials with Teflon septum	HCl to pH<2, cool to 4 degrees C	10 days preserved-VTSR
Aqueous	TCL SVOCs, Pest/PCBs	Low	SOM01.1	2 liters	4-1 liter amber bottles with Teflon lined caps	HCl to pH<2, cool to 4 degrees C	5 days to extraction, 40 days to analysis-VTSR
Aqueous	TAL metals, mercury, cyanide	Low	ILM05.3	1 liter	2-1 liter polyethylene bottles	metals: HNO_3 to pH <2; CN: NaOH to pH>12; Cool to 4 degrees C	metals: 178 days; Hg: 26 days; CN: 12 days-VTSR
Aqueous	chloride	Low	325.1 or 300	50 ml	1-125 ml polyehtylene bottle	Cool to 4 degrees C	28 days
Aqueous	methane/ ethane/ ethene	Low	RSK 175	40 ml	3-40 ml vials with Teflon septum	HCl to pH<2, cool to 4 degrees C	7 days
Aqueous	nitrate	Low	352.1 or 300	100 ml	1-250 ml polyethylene bottle	H_2SO_4 to pH<2, Cool to 4 degrees C	48 hours
Aqueous	sulfate	Low	375.3/375.4 or 300	100 ml	1-250 ml polyethylene bottle	Cool to 4 degrees C	28 days
Aqueous	sulfide	Low	376.2 or 376.1	25 ml	1-1 liter polyethylene bottle	NaOH to pH 9 plus zinc acetate	24 hours
Aqueous	ferrous iron	Low	HACH 8146	25 ml	1 polyethylene bottle	Cool to 4 degrees C	24 hours
Aqueous	TOC	Low	415.1/415.2	50 ml	1-250 ml amber glass (protect from light)	H_2SO_4 to pH<2; Cool to 4 degrees C	28 days
Aqueous	TSS	Low	160.2	100 ml	1-250 ml polyethylene bottle	Cool to 4 degrees C	7 days

QAPP Worksheet #19
Analytical SOP Requirements

Matrix	Analytical Group	Concentration Level	Analytical and Preparation Method/SOP Reference [1]	Minimum Sample Volume	Containers [2,3] (number, size, and type)	Preservation Requirements (chemical, temperature, light protected)	Maximum Holding Time[4] (preparation/ analysis)
Aqueous	TDS	Low	160.1	100 ml	1-250 ml polyethylene bottle	Cool to 4 degrees C	7 days
Aqueous	alkalinity	Low	310.1	100 ml	1-250 ml polyethylene bottle	Cool to 4 degrees C	14 days
Aqueous	ammonia	Low	350.1/350.2	500 ml	1-1 liter polyethylene bottle	Cool to 4 degrees C	28 days
Aqueous	hardness	Low	130.1/130.2	100 ml	1-250 polyethylene bottle	HNO_3 to pH<2, Cool to 4 degrees C	6 months
Aqueous	TKN	Low	351.2/351.4	500 ml	1-1 liter polyethylene bottle	H_2SO_4 to pH<2, Cool to 4 degrees C	48 hours to extraction; 28 days to analysis
Soil/sediment	TCL VOCs Moisture	Low	SOM01.1	5 g	3-40 ml VOA vials with polytetrafluoroethylene (PTFE) lined septa and open top screw caps each with 5 grams of soil and magnetic stir bars 1-40 ml glass jar with PTFE lined septa and open top screw caps with no headspace for moisture test	Cool to 4 degrees C	10 days to extraction; 40 days to analysis -VTSR
Soil/sediment	TCL SVOCs, Pest/PCBs	Low	SOM01.1	Fill to capacity	SVOCs: 1-8 oz jar Pest: 1-8 oz jar PCBs: 1-8 oz jar	Cool to 4 degrees C	10 days to extraction; 40 days to analyze
Soil/sediment	TAL metals, mercury, cyanide	Low	ILM05.3	10 g	1-8 oz jar	Cool to 4 degrees C	Metals: 178 days; Hg: 26 days; CN: 12 days
Soil/sediment	pH	Low	SW-846 9045C	10 g	1-8 oz jar	None	24 hours

QAPP Worksheet #19
Analytical SOP Requirements

Matrix	Analytical Group	Concentration Level	Analytical and Preparation Method/SOP Reference [1]	Minimum Sample Volume	Containers [2,3] (number, size, and type)	Preservation Requirements (chemical, temperature, light protected)	Maximum Holding Time[4] (preparation/ analysis)
Soil/sediment	grain size	Low	ASTM D421-85 ASTM D422-63	500 g minimum	1-8 oz jar	Cool to 4 degrees C	None
Soil/sediment	TOC	Low	Lloyd Kahn	10 g	1-8 oz jar	Cool to 4 degrees C	14 days

ASTM American Society for Testing Materials
C Celsius
H_2SO_4 Sulfuric Acid
HCl Hydrochloric Acid
HNO_3 Nitric Acid
mL milliliter
NaOH Sodium Hydroxide
PTFE Polytetrafluoroethylene
VOA Volatile organic analysis
VTSR Verified Days to Sample Receipt

1. SOP reference numbers are laboratory specific. This information is maintained by EPA and is not available to EPA contractors.
2. Aqueous VOC vials must be filled to capacity with no headspace or air bubbles.
3. No additional volume is required for MS/MSD analyses for VOC and SVOC analysis.
4. Holding times are from date of collection except for TCL VOC (trace), TCL and TAL analyses. These analyses holding times are from the verified time of sample receipt (VTSR).

QAPP Worksheet #20
Field Quality Control Sample Summary Table

Field Task	Matrix	Analytical Parameters	Environmental Samples	Field Duplicates	MS/MSDs[1,4]	Field Blanks[2]	Trip Blanks[3]
Groundwater Screening	GW	TCL VOCs (trace) - 24 hour TAT	343	18	18	8	24
Residential Well Sampling	GW	TCL VOCs (trace)	120	6	6	14	14
Monitoring Well Sampling	GW	TCL VOCs (trace)	78	4	4	10	10
		TCL SVOCs, P/PCBs, TAL Metals, Cyanide and Mercury	78	4	4	10	0
		Chloride, nitrate/nitrite, sulfate, sulfide, TOC, ferrous iron, TSS, TDS, ammonia, hardness, and TKN	78	4	*4*	10	0
		methane, ethane, ethene	78	4	4	10	10
Surface Water Sampling	SW	TCL VOCs (trace)	39	2	2	8	8
		TCL SVOCs, P/PCBs, TAL Metals, Cyanide and Mercury	39	2	2	8	0
		Alkalinity, ammonia, chloride, hardness, nitrate/nitrite, sulfate, sulfide, TOC, TSS, TDS, and TKN	39	2	*2*	0	0
Deep Water Sampling	SW	TCL VOCs (trace)	20	1	1	4	4
		TCL SVOCs, P/PCBs, TAL Metals, Cyanide and Mercury	20	1	1	4	0
		Alkalinity, ammonia, chloride, hardness, nitrate/nitrite, sulfate, sulfide, TOC, TSS, TDS, and TKN	20	1	*1*	0	0
Source Area Soil Sampling	Soil	TCL SVOCs, P/PCBs, TAL Metals, Cyanide and Mercury	75	4	4	5	0
		pH, grain size, TOC, 1,4-Dioxane	75	4	*4*	0	0
Sediment Sampling	SD	TCL SVOCs, P/PCBs, TAL Metals, Cyanide and Mercury	39	2	2	8	0
		pH, grain size, TOC	39	2	*2*	0	0

Notes:
1 : Matrix Spike (MS)/Matrix Spike Duplicate or MS/D for metals, mercury, and cyanide
2: Field blanks are collected at a frequency of 1 per day per sampling event
3: Trip blanks (for VOCs only) are collected at a frequency of 1 per day per cooler of VOCs
4: If using SOM01.1, MS/MSDs are not needed for VOCs and SVOCs

The numbers italicized in the MS/MSD column represent the requirement for a laboratory duplicate. These QC samples will be designated only. Matrix spike analysis is not required.

P/PCB	Pesticides/Polychlorinated biphenyls	MEE	Methane/ethane/ethene	SD	Sediment	GW	Groundwater Sample
SVOC	Semivolatile Organic Compound	TDS	Total dissolved solids	LDL	Low-Detection Limit		
TAL	Target Analyte List	TKN	Total Kjeldahl nitrogen	MW	Monitoring Well		
TCL	Total Compound List	TOC	Total Organic Carbon	SW	Surface Water		
VOC	Volatile Organic Compound	TSS	Total supended solids	TAT	Turnaround Time		

QAPP Worksheet #21
Project Sampling SOP References

Reference Number	Title, Revision, Date, and/or No.	Originating Organization	Equipment Type	Modified for Project Work (Y/N)	Comments
1-1	Surface Water Sampling, Rev. 6, 3/1/04, Section 5.2	CDM	Section 4 of TSOP	N	
1-2	Sample Custody, Rev. 4, 10/10/04	CDM	Section 4 of TSOP	N	RAC II-specific modification applies
1-3	Surface Soil Sampling, Rev. 5, 10/15/04	CDM	Section 4 of TSOP	N	RAC II-specific modification applies
1-4	Subsurface Soil Sampling, Rev. 5, 10/13/04	CDM	Section 4 of TSOP	N	RAC II-specific modification applies
1-6	Water Level Measurement, Rev. 4, 12/31/04	CDM	Section 4 of TSOP	N	
1-9	Tap Water Sampling, Rev. 2, 10/15/04	CDM	Section 4 of TSOP	N	RAC II-specific modification applies
1-10	Field Measurement of Organic Vapors, Rev. 3, 3/1/04	CDM	Section 4 of TSOP	N	
1-11	Sediment/Sludge Sampling, Rev. 6, 10/15/04	CDM	Section 4 of TSOP	N	RAC II-specific modification applies
2-1	Packaging and Shipping of Environmental Samples, Rev. 3, 10/20/04	CDM	Section 1.3 of TSOP	N	RAC II-specific modification applies
2-2	Guide to Handling Investigation- Derived Waste, Rev. 4, 3/1/04	CDM	NA	N	
3-1	Geoprobe Sampling, Rev. 4, 3/1/04	CDM	Section 4 of TSOP	N	
3-2	Topographic Survey, Rev. 5, 12/13/04	CDM	NA	N	
3-4	Geophysical Logging, Calibration, and Quality Control, Rev. 4, 3/1/2004	CDM	Gamma logs only	N	

QAPP Worksheet #21
Project Sampling SOP References

Reference Number	Title, Revision, Date, and/or No.	Originating Organization	Equipment Type	Modified for Project Work (Y/N)	Comments
3-5	Lithologic Logging, Rev. 6, 3/1/04	CDM	Section 4 of TSOP	Y	No acid will be used
3-6	Underground Facility Location, Rev. 0, 5/6/05	CDM	NA	N	
3-6	Environmental Data Management, Rev. 0, 12/31/04	CDM	NA	N	
4-1	Field Logbook Content and Control, Rev. 3, 10/14/05	CDM	NA	N	RAC II-specific modification applies
4-2	Photographic Documentation of Field Activities, Rev. 6, 3/1/04	CDM	NA	N	
4-3	Well Development and Purging, Rev. 3, 10/14/05	CDM	Section 4 of TSOP	N	RAC II-specific modification applies
4-4	Design & Installation of Monitoring Wells in Aquifers, Rev. 3, 10/14/05	CDM	see Worksheet 17h	N	RAC II-specific modification applies
Worksheet 17c	Decontamination Procedures	CDM	see Worksheet 17c	N	
4-6	Hydraulic Conductivity Testing, Rev. 2, 12/31/04	CDM	Section 4 of TSOP	N	
5-1	Control of Measurement and Test Equipment, Rev. 5, 12/31/04	CDM	NA	N	RAC II-Specific Modification applies
Appendix D CDM-029A	Data Validation of Wet Chemistry Parameters, 7/01	CDM	NA	N	
Appendix A	Low Flow Groundwater Purging and Sampling Procedure	EP 1998b	NA	Y CDM project modified	

Note: RAC II Clarifications are appended to the SOPs.

QAPP Worksheet #22
Field Equipment Calibration, Maintenance, Testing, and Inspection

Equipment Type	Calibration Activity	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference
Mini - RAE PID Toxic Gas Monitor with 11.7 eV lamp	Calibration checked at the beginning and end of day	As needed in field; semi-annually by supplier	Measure known concentration of Isobutylene 100 ppm (calibration gas)	Upon receipt, Successful operation	Calibrate am, check pm	± 10% of the calibrated value	Manually zero meter or service as necessary and recalibrate	FTL	Manufacturers specifications
YSI 600XL Water Quality Checker	Calibrate at the beginning of the day and check calibration at the end of the day	Performed before shipment and as needed	Measure solutions with known values (NIST traceable buffers and conductivity calibration solutions)	Upon receipt, Successful operation	Daily, before each use	pH: ±0.05 Specific Conductivity:± 5µS DO±0.02 ppm Temp.: ±0.3°C	Recalibrate or service as necessary	FTL	Manufacturers specifications
Natural Gamma (Downhole Geophysics)	Calibrated by manufacturer	None	Measures gamma radiation	Upon receipt, Successful operation	As needed	0-100 kcps	Recalibrate or service as necessary	PG	Manufacturers specifications
LEL/O_2 meter	Calibrate daily before each use	Performed before shipment and as needed	Measures known concentration of pentane and percent of O_2	Upon receipt, Successful operation	Calibrate am, check pm	+/- 0.5 ppm	Manually zero or service as necessary and recalibrate	FTL	Manufacturers specifications
La Mott Turbidity Meter Model 2020	Calibrate daily before each use	As needed	Measure solutions with known turbidity values (calibration solutions)	Upon receipt, Successful operation	Daily prior to use	N/A (instrument zeroed)	Manually zero or service as necessary and recalibrate	FTL	Manufacturers specifications

The following CDM's Quality Procedures (QPs) (Part 2 of QA Manual) also apply:
QP 2.1 - Procuring Measurement and Test Equipment; QP 2.3 - Control of Non-Conforming Items; QP 5.3 - Inspection of Items; and QP 5.4 - Testing

QAPP Worksheet #23
Analytical SOP References

Reference Number(1)	Title, Revision, Date, and/or No.	Definitive or Screening Data	Analytical Group	Instrument	Organization Performing Analysis	Project Work Modified (Y/N)
SOM01.1	Multi-Media, Multi- Concentration, Organic Analytical Service for Superfund (SOM01.1)	Definitive	VOCs	Gas Chromatograph (GC)/ Mass Spectrometer (MS)	DESA or CLP	N
SOM01.1	Low Concentration Organic Analytical Service for Superfund	Definitive	TCL VOC (trace)	GC/MS (24 hr TAT)	DESA, EPA CLP or CDM subcontract lab	N
SOM01.1	Multi-Media, Multi-Concentration, Organic Analytical Service for Superfund. EPA 2003.	Definitive	TCL VOCs	Purge and Trap - GC/MS	DESA or CLP	N
			TCL SVOCS	GC/MS	DESA or CLP	N
			TCL Pesticides/PCBs	GC/Electron Capture (EC)	DESA or CLP	N
RSK 175 (2)	Analysis of Dissolved Methane, Ethane, and Ethene in Groundwater	Definitive	VOCs	GC	CDM subcontract lab	N
ILM05.3 AES TAL metals, mercury, cyanide	Multi-Media, Multi-Concentration, Inorganic Analytical Service for Superfund. EPA 2004.	Definitive	Metals	ICP-Atomic Emission Spectrometer (AES)	DESA or CLP	N
ILM05.3 AES TAL metals, mercury, cyanide	Multi-Media, Multi-Concentration, Inorganic Analytical Service for Superfund. EPA 2004	Definitive	Mercury	Cold Vapor Atomic Absorption	DESA or CLP	N
			Cyanide	Distiller - Colorimeter		
EPA 310.1	Method for Chemical Analysis of Water and Wastes (MCAWW). Revised 1983	Definitive	Alkalinity	None-titration	DESA or CDM subcontract lab	N

QAPP Worksheet #23
Analytical SOP References

Reference Number(1)	Title, Revision, Date, and/or No.	Definitive or Screening Data	Analytical Group	Instrument	Organization Performing Analysis	Project Work Modified (Y/N)
350.1 or 350.2	MCAWW. Revised 1983	Definitive	Ammonia	Colorimeter-automated, Titrimetric, Potentiometric (electrode)	DESA or CDM subcontract lab	N
325.1 or 300	MCAWW. Revised 1983	Definitive	Chloride	Colorimeter, automated	DESA or CDM subcontract lab	N
130.1 or 130.2	MCAWW. Revised 1983	Definitive	Hardness	Colorimeter, automated or titrimetric	DESA or CDM subcontract lab	N
352.1 or 300	MCAWW. Revised 1983	Definitive	Nitrate	Colorimeter	DESA or CDM subcontract lab	N
375.3, 375.4 or 300	MCAWW. Revised 1983	Definitive	Sulfate	Gravimetric (balance, oven)/ Spectrophotometer	DESA or CDM subcontract lab	N
376.2, 376.1	MCAWW. Revised 1983	Definitive	Sulfide	Colorimeter	DESA or CDM subcontract lab	N
351.2, or 351.4	MCAWW. Revised 1983	Definitive	TKN	Colorimeter-automated, Titrimetric, Potentiometric (electrode)	DESA or CDM subcontract lab	N
415.1 or 415.2	MCAWW. Revised 1983	Definitive	TOC - aqueous	Balance, carbonaceous analyzer/ blender, Carbon analyzer	DESA or CDM subcontract lab	N
160.1	MCAWW. Revised 1983	Definitive	TDS	Balance, oven	DESA or CDM subcontract lab	N
160.2	MCAWW. Revised 1983	Definitive	TSS	Balance, oven	DESA or CDM subcontract lab	N

QAPP Worksheet #23
Analytical SOP References

Reference Number(1)	Title, Revision, Date, and/or No.	Definitive or Screening Data	Analytical Group	Instrument	Organization Performing Analysis	Project Work Modified (Y/N)
SW-846 9045C	Test Methods for Evaluation Solid Waste Physical/Chemical Methods, EPA, SW-846, Third Edition revised May 1997. Final Updates, I, IIA, IIB, III, IIIA, & IIIB	Definitive	pH - soil	Balance, pH meter	DESA or CDM subcontract lab	N
Lloyd Kahn	Determination of TOC in Sediment, July 1998 and Attachment B, Supplemental Technical Direction and Additional QC Procedures.	Definitive	TOC - soil	Carbon analyzer (several models apply - see method, Sec.5)	DESA or CDM subcontract lab	N
ASTM D421-85	Standard Practice for Dry Preparation of Soil Samples. 2002	Definitive	Grain size	Sieves, hydrometer	DESA or CDM subcontract lab	N
ASTM D422-63	Standard Test Method for Particle-Size Analysis of Soils. 2002					
HACH 8146	HACH Test Kit - Phenanthroline Method (adapted from SM for Water and Wastewater)	Definitive	Ferrous Iron	Spectrophotometer model DR/890, 850 or 820	CDM field personnel	N
TSOP 1-10 and Manufacturer's Manual	Field Measurement of Organic Vapors / Manufacturer's Manual	Screening	VOC, oxygen, lower explosive limit, carbon monoxide, hydrogen sulfide	Multi-RAE Dual PID-Toxic Gas Monitor (Photoionization Detector)	CDM field personnel	N
Not Applicable	Manufacturer's Manual	Definitive	Turbidity	LaMotte Turbidity Meter, Model 2020	CDM field personnel	N

QAPP Worksheet #23
Analytical SOP References

Reference Number(1)	Title, Revision, Date, and/or No.	Definitive or Screening Data	Analytical Group	Instrument	Organization Performing Analysis	Project Work Modified (Y/N)
Not Applicable	Manufacturer's Manual	Definitive	pH-aqueous	YSI Water Quality Checker, Model 600 XL	CDM field personnel	N
	Manufacturer's Manual	Definitive	Oxidation-reduction Potential			N
			Dissolved Oxygen			N
			Specific Conductance			N
			Temperature			N

Notes:

1. CLP laboratories SOPs are reviewed through EPA. DESA laboratory specific SOPs will apply and not these generic SOPs whenever the DESA laboratory is able to perform the analyses. CDM subcontract laboratory specific SOPs are not available at this stage since the Region II Field and Analytical Services Teaming Advisory Committee (FASTAC) Policy will be implemented for procuring laboratory services. If the DESA laboratory does not have capacity for these analyses, then a CDM basic ordering agreement (BOA) subcontractor laboratory will be selected.

2. Robert S. Kerr Environmental Research Laboratory Standard Operating Procedures

3. For non-RAS data, the ASC will submit the electronic "Analytical Services Tracking System (ANSETS) Data Requirement" form to the Regional Sample Control Coordinator (RSCC) by the first day of each month for the previous month's sampling.

QAPP Worksheet #24
Analytical Instrument Calibration Table[1]

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA	SOP Reference[2]
Instruments used for EPA CLP analyses follow the calibration frequencies outlined in each method SOP.						
GC, GC/MS, GC/EC	Initial Calibration; 5 point standards	After instrument set up or when daily 12-hour calibration check fails	All target compounds, initial relative standard deviation (RSD) ≤ 10% or 20% and $R^3 > 0.995$	Inspect system; correct problem; re-run failed calibration and any associated samples	Lab analyst / QA officer - (TBD)	TBD
	Continuing Calibration Verification (CCV)	Daily; every 12-hours of analysis	%D ≤15%			
	Calibration Standards Verification	Each lot of standards	As per lab established control limits	Inspect system; correct problem; re-run standard and affected samples		
GC/MS	Tuning	Daily; every 12-hours of analysis	Response factors and relative response factors as method specified	Inspect system; correct problem; re-run standard and affected samples	Lab analyst / QA officer - TBD	TBD
CV-GAS	Calibration; 3 point standards	After instrument set up	$R^3 \geq 0.995$	Inspect system; correct problem	Lab analyst / QA officer - TBD	TBD
	Initial Calibration Verification (ICV)	Before sample analysis	80-120% recovery; source of standard separate from calibration standards	Do not analyze samples until problem is corrected	Lab analyst / QA officer - TBD	TBD
	Continuing Calibration Verification	10% or every 2 hours, whichever is more frequent	80-120% recovery	Inspect system, re-calibrate and rerun associated samples	Lab analyst / QA officer - TBD	TBD
ICP-AES	Calibration; 2 point standards (blank and standard)	Daily	90-110 % recovery	Re-calibrate instrument	Lab analyst / QA officer - TBD	TBD

QAPP Worksheet #24
Analytical Instrument Calibration Table[1]

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA	SOP Reference[2]
ICP-AES	ICV	Before sample analysis	90-110% recovery; source of standard separate from calibration standards	Re-calibrate instrument; prepare fresh ICV standards; do not analyze samples until problem is corrected	Lab analyst / QA officer - TBD	TBD
ICP-AES	Reporting Limit Standard	After initial calibration verification standard	80-120% recovery or concentration ≤ 30% difference (from true value)	Re-analyze failed standard	Lab analyst / QA officer - TBD	TBD
ICP-AES	CCV	Every 10 samples and at end of analytical sequence	90-110% recovery; source of standard separate from calibration standards	Re-check; re-calibrate and rerun all samples analyzed after last valid CCV	Lab analyst / QA officer - TBD	TBD
Total Organic Carbon Analyzer (soil)	Calibration and corrective action as per Manufacturer's instruction. No samples shall be analyzed if instrument calibration exceeds the acceptance criteria.				Lab analyst / QA officer - TBD	TBD
Colorimeter	Initial Calibration; 4 - 9 point standards	Every 3 months; every 6 months for method 300. or as per lab SOP	90-110 % recovery	Re-check; re-calibrate	Lab analyst / QA officer - TBD	TBD
	Calibration check (Cal Check)	Every 10 samples and at end of analytical run	80-120 % recovery	Re-check; re-calibrate and rerun all samples analyzed after last valid Cal Check	Lab analyst / QA officer - TBD	TBD
Infra red or UltraViolet Spectro-photometer	Initial Calibration; 5 point standards	Every 3 months or when other unresolved QC failure occurs	90-110 % recovery	Re-check; re-calibrate	Lab analyst / QA officer - TBD	TBD
	Calibration check	Every 10 samples and at end of analytical run	80-120 % recovery	Re-check; re-calibrate and rerun all samples analyzed after last valid cal check		

QAPP Worksheet #24
Analytical Instrument Calibration Table[1]

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA	SOP Reference[2]
Ion Chroma-tography	Initial Calibration; 5 point standards	Every 12 hours of operation	90-110 % recovery	Find the problem and re-calibrate	Lab analyst / QA officer - TBD	TBD
Ion Chroma-tography	Calibration check	Every 10 samples and at end of analytical run	90-110 % recovery	Re-check; re-calibrate and rerun all samples analyzed after last valid cal check	Lab analyst / QA officer - TBD	TBD
pH meter	Daily buffer checks (2 point bracketing sample pH)	Before use/per batch; other checks as per rental company and manufacturer's recommendations	± 0.1 pH units or ± 0.05 pH units	Recheck; replace buffer solutions and recheck. If still fails perform instrument check or place out of service	CDM - FTL Lab analyst / QA officer - TBD	TBD
Thermometer	Calibration	Quarterly; serviced annually	See instrument manual	Replace defective thermometer	Lab analyst / QA officer - TBD	TBD
Balance	Calibration verification	Daily - before use	See instrument manual	Troubleshoot as per equipment manual/call for repair	Lab analyst / QA officer - TBD	TBD
	Mass check	Daily - before use	See instrument manual			
	Temperature check	Annually	± 2°C			
Oven	Serviced annually as per Manufacturer's instruction				Lab analyst / OA officer - TBD	TBD

1. The FASTAC decision process will be used for procuring laboratory services. CLP, DESA and CDM subcontract laboratory's calibration and/or method SQPs will be utilized to meet calibration criteria. Specific instrument information (Manufacturer and model) is not available at this time.
2. TBD - Reference SQP depends on the laboratory assignment. EPA maintains the CLP laboratory SOP information. If a subcontract laboratory is needed, CDM will submit their SOP as a field change request.
3. R=Correlation coefficient

QAPP Worksheet #25
Analytical Instrument and Equipment Maintenance, Testing, and Inspection

<table>
<tr><th>Instrument/ Equipment</th><th>Maintenance Activity</th><th>Testing Activity</th><th>Inspection Activity</th><th>Frequency</th><th>Acceptance Criteria</th><th>Corrective Action</th><th>Responsible Person</th><th>SOP Reference</th></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="9">Analytical instrument maintenance, testing and inspection information and availability of spare parts are not available since the FASTAC decision process will be utilized for analytical services.</td></tr>
<tr><td colspan="9">Information is provided in CDM BOA subcontract laboratories' QA Manuals. BOA laboratory to be utilized (if DESA is not available) not determined at this time. Maintenance, testing and inspection frequencies are documented in the BOA laboratories SOPs</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>

1. SOPs will be submitted as a field change request if a subcontract laboratory is needed.

QAPP Worksheet #26
Sample Handling Procedure

SAMPLE COLLECTION, PACKAGING, AND SHIPMENT: CDM TSOP 1-2, Sample Custody and TSOP 2-1, Packaging and Shipping of Environmental Samples apply

Sample Collection (Personnel/Organization): CDM will collect all samples under the supervision of the FTL. Sample numbers will be assigned as described below.

A coding system will be used to identify each sample collected during the field investigation phase of the project. This coding system will provide a tracking record to allow retrieval of information about a particular sample and ensure that each sample is uniquely identified.

Each sample is identified by a unique code which indicates the sample type, sample number, and, in some cases, sample depth or address. A sample numbering system is described below which provides a unique identifier for all samples that will be collected during the site field investigation.

Groundwater Screening Survey - The screening survey includes 9 transects (T1 through T9). Drilling locations along each transect are lettered (A through K); the number of letters for each transect depends on the length of the transect (Figure 2). Samples will be designated by depth at each lettered drilling location. Example: T1-A-10 designates the sample on transect T1, location A, 10 feet in depth bgs.

Residential Wells - Samples will be designated by the street address and the first four letters of the street name, followed by R1 for round one sampling or R2 for round two sampling. Example: 426mainR1 represents the round one sample from 426 Main Street.

Care will be taken to insure that street designations are unique. For example, samples may be collected on both Hamilton Road and Hamilton Drive. These streets will be designated as follows:

hamr = Hamilton Road
hamd = Hamilton Drive

Subsurface Soil Samples - Twenty-five borings will be drilled with three samples collected at depths that will be determined in the field. Borings will be designated as SB-01 through SB-25, with SB meaning "soil boring". Samples at each boring will be labeled A, B, or C, with A representing the shallowest sample collected. Sample depths will be recorded in the field logbook and on the boring logs. Example: SB-05-C designates the deepest sample from boring SB-05.

Monitoring Wells - An estimated 38 monitoring wells will be installed in pairs at the site. Wells will be labeled MW-01 through MW-19. The shallow well in the couplet will be given the letter "S" and the deeper well pairs will be given the letter "D". The bedrock well will use the letter "B", and be called MW-20B. Two rounds of samples will be collected from the monitoring wells; round one will be designated R1 and round two will be R2. Example: MW-16S designates the shallow monitoring well in couplet number 16. MW-16S-R1 represents the round one sample from monitoring well MW-16S.

QAPP Worksheet #26
Sample Handling Procedure

Surface Water/Sediment Samples - Surface water and sediment sample designations are detailed below. All surface water and sediment samples will be co-located.
Wet area south of Ryan Drive - SW-01 and SD-01
Unnamed Pond No. 1 (south of Ryan Drive and west of Route 82) - SW-02/SD-02 and SW-03/SD-03
Unnamed Pond No. 2 (north of Creamery Road) - SW-04/SD-04, SW-05/SD-05, and SW-06/SD-06
Redwing Lake - SW-07/SD-07 through SW-16/SD-16
Gravel Pit (south of Timothy Lane) - SW-17/SD-17 through SW-26/SD-26
Pond at 100 Clove Branch Road - SW-27/SD-27
Whortlekill Creek (section between Creamery Road and Timothy Lane) - SW-28/SD-28 through SW-37/SD-37
Whortlekill Creek (upstream of the Hopewell Precision facility) - SW-38/SD-38 and SW-39/SD-39

Deep Water - Deep water samples will be collected at Redwing Lake and the gravel pit. Samples will be designated DW-01 through DW-20. The first 10 samples will be collected at Redwing Lake and the second 10 samples will be from the gravel pit.

QC Sample Numbering System: Each duplicate sample will be submitted "blind" to the laboratory by using a different sample number than the associated environmental sample. The actual collection time will be recorded for both the environmental sample and its duplicate. Duplicate sample name will be recorded in the field log book.

Trip blanks will be numbered by using the prefix "TB" in front of the date as follows: TB051206 for May 12, 2006.

Field blanks, using the prefix "FB", will be numbered similarly. An additional code will be added to denote the sampling event. A field blank collected on May 12, 2006, in association with soil sampling will be labeled as FB051206-SB.

Sample Labels: Sample bottles will be pre-labeled prior to sample collection. All pertinent sample information will be noted on the label including the sample identification number, date and time the sample was collected, the type of sample, initials of person collecting the sample, preservation used and the analysis for which that sample is being submitted. Sample labels will be generated using the CLP labeling system, FORMS II Lite. Sampler, date and time will be filled out with indelible ink on the sample labels or entered into the application. Labels will be filled out with indelible ink and protected with clear tape.

Sample Packaging (Personnel/Organization): Melissa Koberle, CDM

Coordination of Shipment (Personnel/Organization): Tom Horn, FTL, CDM

Type of Shipment/Carrier: First Priority Overnight, FedEx

SAMPLE RECEIPT AND ANALYSIS

Sample Receipt (Personnel/Organization): Laboratory Sample Custodian - TBD as per FASTAC

Sample Custody and Storage (Personnel/Organization): CDM and TBD as per FASTAC

QAPP Worksheet #26
Sample Handling Procedure

Sample Preparation (Personnel/Organization):TBD as per FASTAC

Sample Determinative Analysis (Personnel/Organization): TBD as per FASTAC

SAMPLE ARCHIVING

Field Sample Storage (No. of days from sample collection): All samples will be shipped to CLP laboratory, DESA or CDM subcontractor on the day of collection via priority overnight (Fedex). Samples may be hand delivered/courier depending on laboratory location. On-site tests will be performed same day.

Sample Extract/Digestate Storage (No. of days from sample collection): Refer to Worksheet #19 for holding time requirements.

Biological Sample Storage (No. of days from sample collection): Not applicable

SAMPLE DISPOSAL

Personnel/Organization: Laboratory responsible for analysis will dispose of samples.

Number of Days from Analysis: 90 days

QAPP Worksheet #27
Sample Custody Requirements

Field Sample Custody Procedures (sample collection, packaging, shipment, and delivery to laboratory): Packaging will be performed according to the EPA *Contract Laboratory Program (CLP) Guidance for Field Samplers, Draft-Final* (EPA 2004b). To maintain a record of sample collection transfer between field personnel, shipment, and receipt by the laboratory, the applicable sample chain-of-custody paperwork (TSOP 1-2) is completed for each shipment (i.e., cooler) of packed sample bottles. The team member actually performing the sampling is personally responsible for the care and custody of the samples collected until they are transferred properly. The FTL will review all field sampling activities to confirm that proper custody procedures were followed during the field work.

All courier receipts and/or paperwork associated with the shipment of samples will serve as a custody record for the samples while they are in transit from the field to the laboratory. Custody seals should remain intact during this transfer.

When the samples are delivered to the laboratory, signatures of the laboratory personnel receiving them and courier personnel relinquishing them will be completed in the appropriate spaces on the chain-of-custody record. This will complete sample transfer.

Coolers are secured with nylon fiber tape and at least two custody seals are placed across cooler openings. Since custody forms are sealed inside the sample cooler and custody seals remain intact, commercial carriers are not required to sign the chain-of-custody form. Examples of custody seals are included in TSOP 1-2.

Laboratory Sample Custody Procedures (receipt of samples, archiving, disposal): When the samples are delivered to the laboratory, signatures of the laboratory personnel receiving them and courier personnel relinquishing them will be completed in the appropriate spaces on the chain-of-custody record. This will complete sample transfer.

It will be each laboratory's responsibility to maintain internal logbooks and records that provide a custody record throughout sample preparation and analysis. To track field samples through data handling, CDM will maintain photocopies of all chain-of-custody forms.

Sample Identification Procedure: Refer to Worksheet #26.

Chain-of-Custody Procedures: CDM will follow TSOP 1-2, Sample Custody, for chain-of-custody procedures.

QAPP Worksheet #28a
QC Samples
Aqueous VOCs

Matrix: Aqueous (groundwater and surface water)

Analytical Group/Concentration Level: TCL VOC/trace

Sampling SOP: Hopewell Low Flow Groundwater SOP, TSOP 1-1, TSOP 1-9

Analytical Method/SOP Reference: CLP SOM01.1

Sampler's Name/Field Sampling Organization: TBD/CDM

Analytical Organization: DESA, EPA CLP or CDM subcontract laboratory (FASTAC procedure will be used.)

No. of Sample Locations: 343 groundwater screening samples/120 residential well samples/78 groundwater samples/59 surface water samples

QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	Corrective Action	Persons Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Field rinsate blank	1 per decon event per matrix; or 1 per day	Not > CRQL	verify results, re-analyze	Laboratory analyst/FTL	Contamination - Accuracy/ bias	< Criteria on worksheet #15
Trip blank	1 per cooler	Not > CRQL	verify results, re-analyze	Laboratory analyst/FTL	Contamination - Accuracy/ bias	< Criteria on worksheet #15
Temperature blank	1 per cooler	4 ± 4 degrees C[1]	Inform crew to use adequate coolant	Laboratory analyst/FTL	Accuracy/ bias	See worksheet #20
Field duplicate	1 per 20 samples	None	None	Data assessor/FTL	Homogeneity - Precision	RPD = 50 ABS < QL*
Method blanks	Per SOM01.1	Per SOM01.1	Per SOM01.1	Laboratory analyst	Accuracy/ Contamination	< CRQL
Surrogates	Per SOM01.1	Per SOM01.1	Per SOM01.1	Laboratory analyst	Accuracy	As per method
LCS	1/SDG per matrix	Per SOM01.1	Per SOM01.1	Laboratory analyst	Accuracy/bias	75-125

The number of QC samples are listed on Worksheet 20

LCS - Laboratory Control Sample; PES - Performance evaluation sample not planned.

* ABS applied when sample or duplicate results are detected below five times the CRQL or CRDL

[1] The laboratory will flag samples that are outside the 4 ± 2 °C range and the data validators will qualify samples that are outside of the 4 ± 6 °C range. The project objective is for samples to be within 4 ± 4 degrees C.

QAPP Worksheet #28b
QC Samples
Aqueous SVOC

Matrix: Aqueous (groundwater and surface water)

Analytical Group/Concentration Level: TCL SVOC/low

Sampling SOP: Low Flow Groundwater SOP and TSOP 1-1

Analytical Method/SOP Reference: CLP SOM01.1

Sampler's Name/Field Sampling Organization: TBD/CDM

Analytical Organization: DESA or EPA CLP (FASTAC procedure will be used.)

No. of Sample Locations: 78 Groundwater and 59 Surface Water

QC Sample	Frequency/Number (see Worksheet 20)	Method/SOP QC Acceptance Limits	Corrective Action	Persons Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Field rinsate blank	1 per decon event per matrix; or 1 per day	< CRQL	verify results, re-analyze	Laboratory analyst	Contamination Accuracy/ bias	< CRQL
Temperature blank	1 per cooler	4 ± 4 degrees C[1]	Inform crew to use adequate coolant	Laboratory analyst/FTL	Accuracy/ bias	See worksheet #20
Field duplicate	1 per 20 samples	None	None	Data assessor	Homogeneity - Precision	RPD = 50 ABS < QL*

Note:
MS/MSDs are not required for SVOC by method SOM01.1
* ABS applied when sample or duplicate results are detected below five times the CRQL or CRDL
[1] The laboratory will flag samples that are outside the 4 ± 2 °C range and the data validators will qualify samples that are outside of the 4 ± 6 °C range. The project objective is for samples to be within 4 ± 4 degrees C.

QAPP Worksheet #28c
QC Samples
Aqueous Pesticides/PCBs

Matrix: Aqueous (groundwater and surface water)

Analytical Group/Concentration Level: TCL Pesticide-PCBs/low

Sampling SOP: Low Flow Groundwater SOP and SOP 1-1

Analytical Method/SOP Reference: CLP SOM01.1

Sampler's Name/Field Sampling Organization: TBD/CDM

Analytical Organization: DESA or EPA CLP (FASTAC procedure will be used.)

No. of Sample Locations: 78 Groundwater/59 Surface Water

QC Sample	Frequency/Number (see Worksheet 20)	Method/SOP QC Acceptance Limits	Corrective Action	Persons Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Field rinsate blank	1 per decon event per matrix; or 1 per day	Not > CRQL	verify results, re-analyze	Laboratory Analyst	Contamination Accuracy/ bias	< CRQL
Temperature blank	1 per cooler	4 ± 4 degrees C[1]	Inform crew to use adequate coolant	Laboratory analyst/FTL	Accuracy/ bias	See worksheet #20
MS/MSD	1 per 20 samples	As Per CLP Method	As Per CLP Method	Laboratory Analyst	Accuracy and Precision	AS per method
Field duplicate	1 per 20 samples	None	None	Data Assessor will inform SM if gross differences in results are found.	Homogeneity - Precision	RPD = 50 ABS < QL*

Note:
* ABS applied when sample or duplicate results are detected below five times the CRQL or CRDL
[1] The laboratory will flag samples that are outside the 4 ± 2 °C range and the data validators will qualify samples that are outside of the 4 ± 6 °C range. The project objective is for samples to be within 4 ± 4 degrees C.

QAPP Worksheet #28d
QC Samples
Aqueous TAL Metals, Mercury and Cyanide

Matrix: Aqueous (groundwater and surface water)

Analytical Group/Concentration Level: TAL metals, mercury, cyanide/low

Sampling SOP: Low Flow Groundwater SOP and TSOP 1-1

Analytical Method/SOP Reference: CLP ILM05.3

Sampler's Name/Field Sampling Organization: TBD/CDM

Analytical Organization: DESA or EPA CLP (FASTAC procedure will be used.)

No. of Sample Locations: 78 Groundwater/59 Surface Water

QC Sample	Frequency/Number (see Worksheet 20)	Method/SOP QC Acceptance Limits	Corrective Action	Persons Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Temperature blank	1 per cooler	4 ± 4 degrees C[1]	Inform crew to use adequate coolant	Laboratory analyst/FTL	Accuracy/ bias	See worksheet #20
Field rinsate blank	1 per decon event per matrix; or 1 per day	Not > CRQL	verify results, re-analyze	Laboratory Analyst	Contamination Accuracy/ bias	≤ CRQL
Method Blank	1 per SDG or batch	≤ CRQL	Re-digest and re-analyze if lowest sample results ≥10x blank value	Laboratory Analyst	Contamination and Accuracy	≤ CRQL
MS/ Duplicate	1 per 20 samples per matrix or per 7 days of sample collection	75-125% and RPD <20	Per ILM05.3	Laboratory Analyst	Accuracy and Precision	75-125% and RPD <20
Field duplicate	1 per 20 samples	NA	NA	Data Assessor	Homogeneity - Precision	RPD = 50 ABS < QL*

* ABS applied when sample or duplicate results are detected below five times the CRQL or CRDL
[1] The laboratory will flag samples that are outside the 4 ± 2 °C range and the data validators will qualify samples that are outside of the 4 ± 6 °C range. The project objective is for samples to be within 4 ± 4 degrees C.

QAPP Worksheet #28e
QC Samples
Aqueous Non-RAS

Matrix: Aqueous (groundwater and surface water)

Analytical Group/Concentration Level: Aqueous non-RAS (method EPA 300 series)[1]/low

Sampling SOP: Low Flow Groundwater SOP and TSOP 1-1

Analytical Method/SOP Reference: See Worksheet # 23

Sampler's Name/Field Sampling Organization: TBD/CDM

Analytical Organization: DESA, EPA CLP or CDM Subcontract laboratory (FASTAC procedure will be used.)

No. of Sample Locations: 78 Groundwater/59 Surface Water

QC Sample	Frequency/Number (see Worksheet 20)	Method/SOP QC Acceptance Limits	Corrective Action	Persons Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Field rinsate blank	1 per decon event per matrix; or 1 per day	Not > CRQL	Verify results, re-analyze	Laboratory Analyst	Contamination Accuracy/ bias	Not > CRQL
Temperature blank	1 per cooler	4 ± 4 degrees C[2]	Inform crew to use adequate coolant	Laboratory analyst/FTL	Accuracy/ bias	See worksheet #20
MS	5% per matrix or per 7 days of sample collection	None	Verify spiked concentration; Re-check;	Laboratory Analyst	Accuracy and Precision	75 to 125% recovery
Laboratory duplicate	5% per matrix or per 7 days of sample collection	None	Per EPA 300 and others	Laboratory Analyst	Accuracy and Precision	RPD=25
Field duplicate	5% per matrix	None	None	Data assessor	Homogeneity - Precision	RPD = 50 ABS < QL[3]

1 Chloride, nitrate/nitrite, sulfate, sulfide, ammonia, and TKN. The number of QC samples are listed on Worksheet 20. Not included above: gases, ferrous iron, TOC, TSS, TDS hardness

2 The laboratory will flag samples that are outside the 4 ± 2 °C range and the data validators will qualify samples that are outside of the 4 ± 6 °C range. The project objective is for samples to be within 4 ± 4 degrees C.

3 ABS applied when sample or duplicate results are detected below five times the CRQL or CRDL.

QAPP Worksheet #28f
QC Samples
Soil/Sediment VOCs

Matrix: Soil/Sediment

Analytical Group/Concentration Level: TCL VOC/low

Sampling SOP: TSOP 3-1 and TSOP 1-11

Analytical Method/SOP Reference: CLP SOM01.1

Sampler's Name/Field Sampling Organization: TBD/CDM

Analytical Organization: DESA or EPA CLP (FASTAC procedure will be used.)

No. of Sample Locations: 75 soil samples/39 sediment samples

QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	Corrective Action	Persons Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Field rinsate blank	1 per decon event per matrix; or 1 per day	Not > CRQL	verify results, re-analyze	Laboratory analyst/FTL	Contamination - Accuracy/ bias	< Criteria on worksheet #15
Temperature blank	1 per cooler	4 ± 4 degrees C[1]	Inform crew to use adequate coolant	Laboratory analyst/FTL	Accuracy/ bias	See worksheet #20
Field duplicate	1 per 20 samples	None	None	Data assessor/FTL	Homogeneity - Precision	RPD = 50 ABS < QL*
Method blanks	Per SOM01.1	Per SOM01.1	Per SOM01.1	Laboratory analyst	Accuracy/Contaminatio n	< CRQL
Surrogates	Per SOM01.1	Per SOM01.1	Per SOM01.1	Laboratory analyst	Accuracy	As per SOM01.1
LCS	1/SDG per matrix	Per SOM01.1	Per SOM01.1	Laboratory analyst	Accuracy/bias	75-125

The number of QC samples are listed on Worksheet 20
LCS - Laboratory Control Sample; PES - Performance evaluation sample not planned.
* ABS applied when sample or duplicate results are detected below five times the CRQL or CRDL.
[1] The laboratory will flag samples that are outside the 4 ± 2 °C range and the data validators will qualify samples that are outside of the 4 ± 6 °C range. The project objective is for samples to be within 4 ± 4 degrees C.

QAPP Worksheet #28g
QC Samples
Soil/Sediment SVOC

Matrix: Soil/Sediment

Analytical Group/Concentration Level: TCL SVOC/low

Sampling SOP: TSOP 3-1 and TSOP 1-11

Analytical Method/SOP Reference: CLP SOM01.1

Sampler's Name/Field Sampling Organization: TBD/CDM

Analytical Organization: DESA or EPA CLP (FASTAC procedure will be used.)

No. of Sample Locations: 75 soil samples/39 sediment samples

QC Sample	Frequency/Number (see Worksheet 20)	Method/SOP QC Acceptance Limits	Corrective Action	Persons Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Field rinsate blank	1 per decon event per matrix; or 1 per day	< CRQL	verify results, re-analyze	Laboratory analyst	Contamination Accuracy/ bias	< CRQL
Temperature blank	1 per cooler	4 ± 4 degrees C[1]	Inform crew to use adequate coolant	Laboratory analyst/FTL	Accuracy/ bias	See worksheet #20
Surrogate Spikes	5% of estimated analyzed samples	As per SOM01.1	As per SOM01.1	Laboratory analyst	Accuracy	See Worksheet #12
Method blank	As per method	≤Detection Limit	Re-analyze	Laboratory analyst	Sensitivity	See Worksheet #12
Field duplicate	1 per 20 samples	None	None	Data assessor	Homogeneity - Precision	RPD = 50 ABS < QL*

Note:
MS/MSDs are not required for SVOC by method SOM01.1
* ABS applied when sample or duplicate results are detected below five times the CRQL or CRDL
[1] The laboratory will flag samples that are outside the 4 ± 2 °C range and the data validators will qualify samples that are outside of the 4 ± 6 °C range. The project objective is for samples to be within 4 ± 4 degrees C.

QAPP Worksheet #28h
QC Samples
Soil/Sediment Pesticides/PCBs

Matrix: Soil/Sediment (groundwater and surface water)

Analytical Group/Concentration Level: TCL Pesticide-PCBs/low

Sampling SOP: TSOP 3-1 and TSOP 1-11

Analytical Method/SOP Reference: CLP SOM01.1

Sampler's Name/Field Sampling Organization: TBD/CDM

Analytical Organization: DESA, EPA CLP or CDM Subcontract laboratory (FASTAC procedure will be used.)

No. of Sample Locations: 75 soil samples/39 sediment samples

QC Sample	Frequency/Number (see Worksheet 20)	Method/SOP QC Acceptance Limits	Corrective Action	Persons Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Field rinsate blank	1 per decon event per matrix; or 1 per day	Not > CRQL	verify results, re-analyze	Laboratory Analyst	Contamination Accuracy/ bias	< CRQL
Temperature blank	1 per cooler	4 ± 4 degrees C[1]	Inform crew to use adequate coolant	Laboratory analyst/FTL	Accuracy/ bias	See worksheet #20
Surrogate	As per SOM01.1	As per SOM01.1	As per SOM01.1	Laboratory analyst	Accuracy	per Appendix D
MS/MSD	1 per 20 samples	As Per CLP Method	As Per CLP Method	Laboratory Analyst	Accuracy and Precision	AS per method
Field duplicate	1 per 20 samples	None	None	Data Assessor will inform SM if gross differences in results are found.	Homogeneity - Precision	RPD = 50 ABS < QL*

Note:
MS/MSDs are not required for SVOCs by method SOM01.1
* ABS applied when sample or duplicate results are detected below five times the CRQL or CRDL
[1] The laboratory will flag samples that are outside the 4 ± 2 °C range and the data validators will qualify samples that are outside of the 4 ± 6 °C range. The project objective is for samples to be within 4 ± 4 degrees C.

QAPP Worksheet #28i
QC Samples
Soil/Sediment TAL Metals, Mercury and Cyanide

Matrix: Soil/Sediment

Analytical Group/Concentration Level: TAL metals, mercury, cyanide/low

Sampling SOP: TSOP 3-1 and TSOP 1-11

Analytical Method/SOP Reference: CLP ILM05.3

Sampler's Name/Field Sampling Organization: TBD/CDM

Analytical Organization: DESA or EPA CLP (FASTAC procedure will be used.)

No. of Sample Locations: 75 soil samples/39 sediment samples

QC Sample	Frequency/Number (see Worksheet 20)	Method/SOP QC Acceptance Limits	Corrective Action	Persons Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Field rinsate blank	1 per decon event per matrix; or 1 per day	Not > CRQL	verify results, re-analyze	Laboratory Analyst	Contamination Accuracy/ bias	≤ CRQL
Temperature blank	1 per cooler	4 ± 4 degrees C[1]	Inform crew to use adequate coolant	Laboratory analyst/FTL	Accuracy/ bias	See worksheet #20
Method Blank	1 per SDG or batch	≤ CRQL	Re-digest and re-analyze if lowest sample results ≥10x blank value	Laboratory Analyst	Contamination and Accuracy	≤ CRQL
MS/ Duplicate	1 per 20 samples per matrix or per 7 days of sample collection	75-125% and RPD <20	Per ILM05.3 or DV SOP (Appendix D)	Laboratory Analyst	Accuracy and Precision	75-125% and RPD <20
Detection Limit Standard	As per method	As per method	As per method and DV SOP	Laboratory Analyst	Sensitivity	See Worksheet #12s
Field duplicate	1 per 20 samples	NA	NA	Data Assessor	Homogeneity - Precision	RPD = 50 ABS < QL*

* ABS applied when sample or duplicate results are detected below five times the CRQL or CRDL
[1] The laboratory will flag samples that are outside the 4 ± 2 °C range and the data validators will qualify samples that are outside of the 4 ± 6 °C range. The project objective is for samples to be within 4 ± 4 degrees C.

QAPP Worksheet #28j
QC Samples
Soil/Sediment Non-RAS

Matrix: Soil/Sediment

Analytical Group/Concentration Level: Soil/Sediment non-RAS (method EPA 300 series)[1]/low

Sampling SOP: TSOP 3-1 and TSOP 1-11

Analytical Method/SOP Reference: See Worksheet # 23

Sampler's Name/Field Sampling Organization: TBD/CDM

Analytical Organization: DESA/ EPA CLP/CDM Subcontract laboratory (FASTAC procedure will be used.)

No. of Sample Locations: 75 soil samples/39 sediment samples

QC Sample	Frequency/ Number (Worksheet 20)	Method/SOP QC Acceptance Limits	Corrective Action	Persons Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Laboratory duplicate	5% per matrix or per 7 days of sample collection	None	Per EPA 300 and others	Laboratory Analyst	Accuracy and Precision	RPD=25
Preparation blank (TOC)	1 per SDG or sample batch	≤ Detection Limit	Re-analyze	Laboratory Analyst	Accuracy	< CRQL per method
Detection Limit Standard	As per method	75 to 125% recovery	Re-calibrate and re-check	Laboratory Analyst	Sensitivity	75-125% recovery
Duplicate (TOC)	every sample	≤ 25% RPD	Re-test and flag data if reanalysis fails	Laboratory Analyst	Accuracy/bias	≤ 25% RPD
Temperature blank	1 per cooler	4 ± 4 degrees C[2]	Inform crew to use adequate coolant	Laboratory analyst/FTL	Accuracy/ bias	See worksheet #20
Field duplicate	5% per matrix	None	None	Data assessor	Homogeneity - Precision	RPD = 50 ABS < QL[3]

[1] The number of QC samples are listed on Worksheet 20.
[2] The laboratory will flag samples that are outside the 4 ± 2 °C range and the data validators will qualify samples that are outside of the 4 ± 6 °C range. The project objective is for samples to be within 4 ± 4 degrees C.
[3] ABS applied when sample or duplicate results are detected below five times the CRQL or CRDL.

QAPP Worksheet #29
Project Documents and Records Table

Sample Collection Documents and Records	On-Site Analysis Documents and Records	Off-site Analysis Documents and Records	Data Assessment Documents and Records	Other
Forms II Lite Traffic Reports/ COC Records	Equipment Calibration and Maintenance Log	Sample Receipt, Custody and Tracking Logs	Field Sampling Audit Plans, Reports and Checklists	M&TE (measurement and testing equipment) Forms
Airbills	Field Data Collection Logs	Standards Tracking Logs	Office Audit Plans, Reports and Checklist	Technical/QA Review Forms
Sample Tracking Log/Sheets	Boring Logs	Equipment Maintenance, Testing and Inspection Log	Corrective Action Reports	Purchase Requisition Forms
Field Logbooks	PID Logs	Sample Preparation Logs	Analytical sample results	Telephone Logs
Chain of Custody Forms	Water Quality Data Logs	Corrective Action Reports	Subcontract Laboratory certifications	Electronic Data Deliverables
Field Change Request Forms	Monitoring Well Logs	Run Logs	Subcontract Laboratory QA Plan (on file with EPA and CDM)	Subcontract Documents (Contract, Scopes of Work, Bid Sheet), Subcontract Documents and Review Forms
Custody Seals	Photographs	Corrective Action Forms	Laboratory Audit Report (optional)	NA
Daily/weekly reports	Meteorological Data from field (documented in Field Logbooks)	Data Packages (Case Narratives, Sample Results, OC Summaries and Raw Data (detailed in CLP SOPs).	Data Package Completeness Checklist Validated Data Reports	NA
ANSETS Forms	NA	Trip Reports	Self Assessment Checklist	NA
Survey Records	NA	Sample Disposal and Waste Manifests	Data Quality Assessments	NA
Draft QAPP	NA	NA	Draft Remedial Investigation Report	NA
Final QAPP	NA	NA	Final Remedial Investigation Report	NA

Identify the documents and records that will be generated for all aspects of the project including, but not limited to, sample collection and field measurement, on-site and off-site analysis, and data assessment.

QAPP Worksheet #30
Analytical Services Table

Matrix	Analytical Group	Concentration Level	Sample Locations/ID Numbers	Analytical SOP	Data Package Turnaround Time	Lab./Org. (Name and Address, Contact Person, and Telephone Number)[1]	Backup Lab./Org. (Name and Address, Contact Person, and Telephone Number)
Groundwater Screening and Residential Well Sampling: See Worksheet #26 for Sample Identification numbers							
Aqueous	TCL VOC (trace)	Low	343 samples + 18 duplicates See Figure 2	SOM01.1	24 hour	DESA EPA Primary Contact: RSCC Adly Michael/Bob Toth 732 906 6161/6171 DESA contact - John Birri 732-906-6886	EPA CLP- TBD RSCC or Subcontract Lab - TBD
Aqueous	TCL VOC (trace)	Low	120 samples + 6 duplicates See Table 1	SOM01.1	21 days		
Source Area Subsurface Soil sampling							
Soil	TCL VOC	Low	75 samples + 4 duplicates See Figure 5	SOM01.1	21 days	DESA EPA Primary Contact: RSCC Adly Michael/Bob Toth 732 906 6161/6171 DESA contact - John Birri 732-906-6886	EPA CLP- TBD RSCC or Subcontract Lab - TBD
Soil	TCL SVOCs	Low					
Soil	TCL P/PCBs	Low					
Soil	TAL metals, mercury, cyanide	Low		ILM05.3 ICP-MS			
Soil	pH	Low		SW-846 9045C		DESA contact - John Birri 732-906-6886	Subcontract Lab - TBD
Soil	grain size	Low		ASTM D421-85 & D422-63			
Soil	TOC	Low		Lloyd Kahn			

QAPP Worksheet #30
Analytical Services Table

Matrix	Analytical Group	Concentration Level	Sample Locations/ID Numbers	Analytical SOP	Data Package Turnaround Time	Lab./Org. (Name and Address, Contact Person, and Telephone Number)[1]	Backup Lab./Org. (Name and Address, Contact Person, and Telephone Number)
Monitoring Well Sampling: 2 rounds @ 38 samples per round: See Worksheet #26 for Sample Identification numbers							
Aqueous	TCL VOC (trace)	Low	78 samples + 4 duplicates See Figure 3	SOM01.1	21 days	DESA EPA Primary Contact: RSCC Adly Michael/Bob Toth 732 906 6161/6171 DESA contact - John Birri 732-906-6886	EPA CLP- TBD RSCC or Subcontract Lab - TBD
Aqueous	TCL SVOCs	Low		SOM01.1	21 days		
Aqueous	TCL P/PCBs	Low		SOM01.1	21 days		
Aqueous	TAL metals, mercury, cyanide	Low		ILM05.3	21 days		
Aqueous	Other Inorganics & Wet chemistry*	Low		Various - see Worksheet # 23	21 days	DESA/RSCC as above DESA Contact: John Birri 732-906-6886	Subcontract Lab. TBD

QAPP Worksheet #30
Analytical Services Table

Matrix	Analytical Group	Concentration Level	Sample Locations/ID Numbers	Analytical SOP	Data Package Turnaround Time	Lab./Org. (Name and Address, Contact Person, and Telephone Number)[1]	Backup Lab./Org. (Name and Address, Contact Person, and Telephone Number)
Lake and Stream Surface Water Sampling: 1 Event @ 1 sample per location. See Worksheet #26 for Sample Identification numbers							
Aqueous	TCL VOC (trace)	Low	39 samples + 2 duplicates See Figure 4	SOM01.1	21 days	DESA EPA Primary Contact: RSCC Adly Michael/Bob Toth 732 906 6161/6171 DESA contact - John Birri 732-906-6886	EPA CLP- TBD RSCC or Subcontract Lab - TBD
Aqueous	TCL SVOCs	Low		OLM04.3	21 days		
Aqueous	TCL P/PCBs	Low		OLM04.3	21 days		
Aqueous	TAL metals, mercury, cyanide	Low	39 samples + 2 duplicates See Figure 4	ILM05.3	21 days		
Aqueous	Alkalinity	Low		Various - see Worksheet # 23	21 days	DESA contact - John Birri 732-906-6886	Subcontract Lab - TBD
Aqueous	Ammonia	Low					
Aqueous	Chloride	Low					
Aqueous	Hardness	Low					
Aqueous	Nitrate/nitrite	Low					
Aqueous	Sulfide	Low					
Aqueous	Sulfate	Low					
Aqueous	pH	Low					
Aqueous	TKN	Low					
Aqueous	TOC	Low					
Aqueous	TSS	Low					
Aqueous	TDS	Low					

QAPP Worksheet #30
Analytical Services Table

Matrix	Analytical Group	Concentration Level	Sample Locations/ID Numbers	Analytical SOP	Data Package Turnaround Time	Lab./Org. (Name and Address, Contact Person, and Telephone Number)[1]	Backup Lab./Org. (Name and Address, Contact Person, and Telephone Number)
Sediment	TCL VOC	Low	39 samples + 2 duplicates See Figure 4	SOM01.1	21 days	DESA EPA Primary Contact: RSCC Adly Michael/Bob Toth 732 906 6161/6171 DESA contact - John Birri 732-906-6886	
Sediment	TCL SVOCs	Low					
Sediment	TCL P/PCBs	Low					
Sediment	TAL metals, mercury, cyanide	Low		ILM05.3 ICP-AES			
Sediment	pH	Low		SW-846 9045C		DESA contact - John Birri 732-906-6886	Subcontract Lab. TBD
Sediment	grain size	Low		ASTM D421-85 & D422-63			
Sediment	TOC	Low		Lloyd Kahn			

* These include chloride, methane, ethane, ethene, nitrate/nitrite, sulfate, sulfide, TOC, ferrous iron, TSS, TDS, ammonia, hardness and TKN

1. RSCC Address: USEPA Region 2, MS 215, 2890 Woodbridge Ave., Edison, NJ 08837
DESA Address: USEPA Region 2, MS 230, 2890 Woodbridge Ave., Edison, NJ 08837

QAPP Worksheet #31
Planned Project Assessment Table

Assessment Type	Frequency	Internal or External*	Organization Performing Assessment	Person Responsible for Performing Assessment	Person Responsible for Responding to Assessment Findings	Person Responsible for Identifying and Implementing CA	Person Responsible for Monitoring Effectiveness of CA
Sample collection and documentation	Once	Internal	CDM	Seth Kellogg, RITL	Tom Horn, Susan Schofield	Seth Kellogg (RITL), Tom Horn (FTL)	Jeniffer Oxford
Health and Safety	Once, if warranted	Internal	CDM	Chuck Myers, HSM	Seth Kellogg, Susan Schofield	Seth Kellogg, Susan Schofield (SM)	Chuck Myers
Field Sampling Technical Systems Audit	Once	Internal	CDM	Approved field auditor	Seth Kellogg ,Susan Schofield	Steve Martz (QA Manager), Seth Kellogg	Steve Martz or Jeniffer Oxford
Office Audit	Once	Internal	CDM	Jeniffer Oxford, RQAC or approved CDM QA Staff	Susan Schofield	Steve Martz, Susan Schofield	Jeniffer Oxford
QAPP	Annually	Internal	CDM	Jeniffer Oxford, RQAC	Susan Schofield	Jeniffer Oxford, Susan Schofield	Steve Martz
Data review	Once	Internal	CDM	Scott Kirchner or designee	Susan Schofield	Susan Schofield & Laboratory manager(s) (TBD)	Jeniffer Oxford
Management Systems Review	Annually	Internal	CDM	Steve Martz	Jeanne Litwin	Jeanne Litwin, Susan Schofield	Steve Martz

CA Corrective Action
* - It is not known at this time whether EPA will perform any assessments.
Assessment dates have not yet been determined. An audit plan and checklist will be prepared for each assessment to include the scope and documents to be reviewed.

QAPP Worksheet #32
Assessment Findings and Corrective Action Responses

Assessment Type	Nature of Deficiencies Documentation	Individual Notified of Findings	Timeframe of Notification	Nature of Corrective Action (CA) Response Documentation	Individual Receiving CA Response	Timeframe for Response
Sample collection and documentation	Memorandum	Tom Horn (FTL), Susan Schofield (SM)	Day of audit	Verbal briefing; Corrective Action Notice if severe or critical violations noted	Steve Martz, CDM QA Manager	Immediate CA required where possible; otherwise as specified on the CA Notice, typically 15 to 30 days from date of CA Notice
Health and Safety	Audit checklist	Seth Kellogg (RITL), Susan Schofield (SM)	Notify by phone immediately Report 1 week after audit	Memorandum	Chuck Myers, CDM Health and Safety Manager	
Field Sampling Technical Systems Audit	Field Audit Report	Seth Kellogg (RITL), Susan Schofield (SM)	Provide summary of findings to field team on day of audit; Draft Report due 15 days	Corrective Action Plan	Steve Martz	
Office Audit	Office Audit Report	Susan Schofield (SM)	Provide summary of findings to SM on day of audit; Draft Report due 15 days	Memorandum	Steve Martz	
QAPP	Memorandum	Susan Schofield (SM)	Draft Report due 15 days	Memorandum and/or FCRs	Jeniffer Oxford RQAC and Steve Martz	
Data review	Memorandum	Susan Schofield (SM)	1 week	Memorandum	Jeanne Litwin, TOM	
Management Systems Review	MSR report	Jeanne Litwin (RAC II PSO)	2 weeks	Memorandum	Steve Martz	

See worksheet # 6 for contact information.

QAPP Worksheet #33
QA Management Reports Table

Type of Report	Frequency (daily, weekly, quarterly, etc.)	Projected Delivery Dates	Person(s) Responsible for Report Preparation	Report Recipient(s)
Field Change Requests	As needed	TBD	Tom Horn, FTL	OAPP recipients
OAPP Addendums	As needed	TBD	Seth Kellogg, RITL	QAPP recipients
Field Audit Report	Once	TBD	Field Auditor	Susan Schofield, SM Bob Goltz, Program Manager, Jeanne Litwin, Deputy Program Manager Steve Martz, QA Manager, Lorenzo Thantu, EPA RPM Amelia Jackson, EPA QA
Office Audit Report	Once	TBD	Jeniffer Oxford, RQAC or designee	
Corrective Action Reports	As required on CA request	TBD	QA Auditor	
Data Usability Assessments	With each Measurement Report	TBD	Scott Kirchner, ASC	Fernando Rosado, EPA Lorenzo Thantu, EPA RPM Other EPA and stakeholders as directed by the EPA RPM Susan Schofield, SM Bob Goltz, Program Manager, Jeanne Litwin, Deputy Program Manager
Technical Memorandums	At completion of Stage I field investigations	Figure 1	SM	
RI Report (Draft and Final)	Once	Figure 1	SM	

QAPP Worksheet #34
Verification (Step 1) Process Table

Verification Input	Descriptions	Internal/ External	Responsible for Verification (Name, Organization)
Chain of custody	Form will be internally reviewed upon completion and verified against field logs, laboratory report and QAPP. Review will be conducted with completion of each measurement report.	Both	ESAT or EPA validator Seth Kellogg - CDM Scott Kirchner (ASC) - CDM
Field Report	Field reports will be verified with field log books to ensure correct reporting of information. Review will be conducted with completion of each report.	Internal	Seth Kellogg (RITL) - CDM
Field Logbooks	Field logbooks will be reviewed for accuracy and completeness and placed in project file.	Internal	Seth Kellogg (RITL) - CDM
Field and Lab data and QC Report	Data validation reports, QAPP, FCRs and outputs of the EQuis database will be used to prepare the project data quality and usability assessment report. The data will be evaluated against project DQQs and measurement performance criteria, such as completeness.	Both	Scott Kirchner (ASC) - CDM
Sampling Procedures	Evaluate whether sampling procedures were followed with respect to equipment and proper sampling support using audit and sampling reports, field change request forms and field logbooks.	Internal	Seth Kellogg (RITL) - CDM
Laboratory Data	All laboratory data will be verified by the laboratory performing the analysis for completeness and technical accuracy prior to submittal to EPA. Subsequently, EPA or its contractor will evaluate the data packages for completeness and compliance. Table 9 of the IDQTF UFP-QAPP shows items for compliance review.	External	Lab manager or QA Officer - TBD ESAT or EPA validator
Electronic Data Deliverables (EDDs)	Determine whether required fields and format were provided.	Internal	Melinda Olsen - CDM
QAPPS	All planning documents will be available to reviewers to allow reconciliation with planned activities and objectives.	Internal	All data users

QAPP Worksheet #35
Validation (Steps IIa and IIb) Process Table

Step IIa/IIb	Validation Input	Description	Responsible for Validation (Name, Organization)
IIa	Methods	Records support implementation of the SQP - sampling and analysis	EPA (Environmental Services Assistance Team [ESAT] or DESA) CDM will validate any subcontract laboratory generated data. This form will be resubmitted if a subcontract laboratory is needed.
IIa	Chain of custody	Examine traceability of data from sample collection to generation of project reported data. Provides sampling dates and time; verification of sample ID; and QC sample information.	
IIb	Data Narrative	Determine deviations from methods and contract and the impact.	
IIb	Project Quantitation Limit	PQL achieved as outlined in the QAPP and that the laboratory successfully analyzed a standard at the QL.	
IIb	Field and Lab data and QC report	A summary of all QC samples and results will be verified for measurement performance criteria, completeness and 10% verified to field and laboratory data reports from vendors. A report on the meeting the established criteria shall be prepared within 30 days of receipt.	
IIb	Data Package	Used to perform data validation on 100% of all CLP data. Any subcontractor analyzed data will be validated by CDM. A report shall be prepared within 30 days of data receipt. Ensure that all analytical procedures were followed. Corrective actions will be taken and documented when applicable per specific methods. Deviations will be documented. Data will be qualified in accordance with specific methods.	

QAPP Worksheet #36
Validation (Steps IIa and IIb) Summary Table

Step IIa/IIb	Matrix	Analytical Group	Concentration Level	Validation Criteria	Date Validator (Title, Organization)
IIa	Soil	Organics (VOC, SVOC, Pesticide &PCBs)	Low	Region II - Data Validation Guidelines SOP HW-6, rev 12	DESA/ESAT
IIa	Soil	Inorganics (metals, mercury & cyanide)	Low	Region II - Data Validation Guidelines SOP HW-2, rev 11	DESA/ESAT
IIa	Groundwater	Organics (VOCs, SVOCs, Pesticides & PCBs)	Low	Region II - Data Validation Guidelines SOP HW-6, rev 12	DESA/ESAT
IIa	Groundwater	Inorganics (metals, mercury & cyanide)	Low	Region II - Data Validation Guidelines SOP HW-2, rev 11	DESA/ESAT
IIa /IIb	Soil	Wet chemistry	Low	DESA and CDM SOP/QAPP Worksheets 12, and 15	DESA/CDM
IIa /IIb	Groundwater	Wet chemistry	Low	DESA and CDM SOP/OAPP Worksheets 12, and 15	DESA/CDM

QAPP Worksheet #37
Usability Assessment

Summarize the usability assessment process and all procedures, including interim steps and statistics, equations, and computer algorithms that will be used: The Data Usability Assessment will be performed by a team of personnel at CDM. Susan Schofield, SM, will be responsible for information in the Usability Assessment. She will also be responsible for assigning task work to the individual task members who will be supporting the Data Usability Assessment. Note that the Data Usability Assessment will be conducted on validated data. After the Data Usability Assessment has been performed, data deemed appropriate for use will then be used in the RI, HHRA, SLERA, and FS. The results of the Data Usability Assessment will be presented in the RI report. The following items will be assessed and conclusions drawn based on their results.

Precision – Results of laboratory duplicates will be assessed during data validation and data will be qualified according to the data validation procedures cited on Worksheet #36. Field duplicates will be assessed by matrix using the RPD for each pair of results reported above CRQL or CRDL for organic and inorganic analyses respectively. RPD acceptance criteria, presented in Worksheet #12, will be used to access field sampling precision. Absolute difference will be used when one or both results are at or below the CRQL or CRDL. An absolute difference of less than the CRQL or CRDL will be the acceptance criteria. A discussion summarizing the results of laboratory and field precision and any limitations on the use of the data will be described.

Accuracy/Bias Contamination – Results for all laboratory blanks will be assessed as part of the data validation. During the validation process the validator will qualify the data following the procedures described on Worksheet #36. A discussion summarizing the results of laboratory accuracy and bias based on contamination will be presented and any limitations on the use of the data will be described.

Overall Accuracy/Bias – The results of instrument calibration and matrix spike recoveries will be reviewed and data will be qualified according to the data validation procedures cited on Worksheet #36. A discussion summarizing the results of laboratory accuracy and any limitations on the use of the data will be described.

Sensitivity – Data results will be compared to criteria provided on Worksheet #15. A discussion summarizing any conclusions about sensitivity of the analyses will be presented and any limitations on the use of the data will be described.

Representativeness – A review of adherence to field procedures and of project QA audits will be performed in order to assess the representativeness of the sampling program. Data validation narratives will also be reviewed and any conclusions about the representativeness of the data set will be discussed.

Comparability – The results of this study will be used in conjunction with existing data to produce the site reports.

QAPP Worksheet #37
Usability Assessment

Reconciliation – The PQOs presented in Worksheet #12 will be examined to determine if the objectives were met. This examination will include a combined overall assessment of the results of each analysis pertinent to an objective. Each analysis will first be evaluated separately in terms of major impacts observed from data validation, data quality indicators and measurement performance criteria assessments. Based on the results of these assessments, the quality of the data will be determined. Based on the quality determined, the usability of the data for each analysis will be determined. Based on the combined usability of the data from all analyses for an objective, it will be determined if the PQOs were met and whether project goals were achieved. As part of the reconciliation of each objective, conclusions will be drawn and any limitations on the usability of any of the data will be described.

Completeness - The Environmental Quality Information Systems (EQuIS) database will be queried to summarize the number of samples in each analytical fraction that are estimated and rejected. This data will be used along with the planned samples indicated in the QAPP to calculate the completeness of the obtained data set.

Data validation reports will be reviewed to determine the quality of the data and potential impacts on data usability. Field duplicates will be evaluated against the QAPP measurement performance criteria (MPC). Non-compliant data will be discussed in the usability report.

The following equations will be used :

1. To calculate field duplicate precision: $RPD = 100 \times 2 |X1 - X2| / (X1 + X2)$ where X1 and X2 are the reported concentrations for each duplicate or replicate
2. To calculate completeness: $\% \text{ Completeness} = V/n \times 100$ where V= number of measurements judged valid; **n** = total number of measurements made

And $\% \text{ Completeness} = C/x \times 100$ where C= number of samples collected; x = total number of measurements planned

Describe the evaluation procedures used to assess overall measurement error associated with the project: Determine if quality control data is within specifications (MPC) though validation process IIb.

Identify the personnel responsible for performing the usability assessment: Scott Kirchner, ASC or designee

QAPP Worksheet #37
Usability Assessment

Describe the documentation that will be generated during usability assessment and how usability assessment results will be presented so that they identify trends, relationships (correlations), and anomalies: A usability report will describe the rationale for the data used and present any data limitations. The report will include a discussion of the accuracy, precision, representativeness, completeness and comparability of the data set and deviations from planned procedures and analysis and the impact on the project objectives. Tables will be prepared, including: a summary of planned samples, collected samples and parameters analyzed; detections in field and trip blanks; comparison of field duplicates; and a comparison of planned and actual detection limits.

The following procedures will be followed for using data in preparing the Technical Memorandum and the Remedial Investigation Report:

- Defining the nature and extent of contamination - CDM will evaluate individual sample results for the Technical Memorandum and the Remedial Investigation Report. The sample results will be compared to the site specific screening criteria.

- Identifying data gaps - Data gaps will be identified at the end of Stage I, while developing the technical meeting materials at the end of Stage II, and while writing the RI Report. As soon as data gaps are identified, CDM will discuss them with EPA. To identify data gaps, CDM will evaluate the analytical results by media and determine if results indicate levels or locations of contamination that need to be further delineated.

- Using qualified data - CDM utilizes all data not rejected during validation to determine the nature and extent of contamination.

- Deciding if high results are legitimate or outliers - CDM will assume that all data that is not rejected during validation will be considered in defining the nature and extent of contamination at the site. CDM will work with EPA if there is a concern about the statistical validity of the sample results. In particular, high "outlier" results that have no surrounding comparable results as confirmation will be discussed with EPA.

Glossary of Abbreviations

%R	Percent Recovery
1,1,1-TCA	1,1,1-trichloroethane
ABS	Absolute difference
AES	Atomic Emission Spectrometer
ANSETS	Analytical Services Tracking System Data Requirement
ASC	Analytical Services Coordinator
ASQ	American Society for Quality
ASTM	American Society of Testing and Materials
bgs	below ground surface
BOA	Basic ordering agreement
c	Celsius
CA	Corrective Action
CCV	Continuing Calibration Verification
CDM	CDM Federal Programs Corporation
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act of 1980
CHMM	Certified Hazardous Materials Manager
CLP	Contract Laboratory Program
cm/sec	Centimeters per Second
COPC	Chemical of Potential Concern
CRDL	Contact Required Detection Limit
CRQL	Contract Required Quantification Limits
CSM	Conceptual Site Model
DESA	Division of Environmental Science and Assessment
DNAPL	Dense non-aqueous phase liquid
DO	Dissolved Oxygen
DPT	Direct push technology
DQI	Data Quality Indicator
DQO	Data Quality Objective
EC	Electron Capture
EDD	Electronic Diskette Deliverable
EDL	Estimated detection limit
Eh	Oxidation-Reduction Potential
EPA	United States Environmental Protection Agency
EQuIS	Environmental Quality Information Systems
ERTC	Environmental Response Team Contractor
ESAT	Environmental Services Assistance Team
F	Fahrenheit
FASTAC	Field and Analytical Services Teaming Advisory Committee
FCR	Field Change Request Form
Fe^{+2}	Ferrous Iron
FS	Feasibility Study
FTL	Field Team Leader
GC/MS	Gas Chromatograph/Mass Spectrometer
GIS	Geographic Information System
gpm	gallons per minute
GPS	Global Positioning System
H&S	Health and Safety
HACH	HACH Company
HCl	Hydrochloric Acid
HHRA	Human Health Risk Assessment
HNO_3	Nitric Acid
H_2SO_4	Sulfuric Acid

HSA	Hollow stem auger
HSP	Health and Safety Plan
ICV	Initial Calibration Verification
ID	Inner diameter
IDW	Investigation Derived Waste
kcps	thousand counts per second
kg	Kilogram
L	Liter
LCS	Laboratory Check Sample
LCSD	Laboratory Control Sample Duplicate
LDL	low detection limit
M&TE	Measurement and Test Equipment
m^3	Cubic meter
MCAWW	Method for Chemical Analysis of Water and Wastes
MCL	Maximum Contaminant Level
MD	Matrix Duplicate
MDL	Method Detection Limit
mg/kg	Milligrams per kilogram
mg	Milligram
mL	milliliter
MPC	Measurement Performance Criteria
MS	Matrix Spike
MS/MSD	Matrix Spike/Matrix Spike Duplicate
msl	Mean Sea Level
NA	Not Applicable
NaOH	Sodium Hydroxide
NTU	Nephelometric Turbidity Units
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health
OSHA	Occupation Safety and Health Administration
PCB	Polychlorinated Biphenyl
PES	Performance evaluation sample
PG	Project Geologist
PID	Photoionization detector
POET	Point of entry treatment
ppm	Parts per million
PQL	Project Quantitation Limit
PQO	Project Quality Objective
PRGs	Preliminary Remediation Goals
PTFE	Polytetrafluoroethylene
PVC	Polyvinyl chloride
QA/QC	Quality Assurance/Quality Control
QA	Quality Assurance
QAC	Quality Assurance Coordinator
QAPP	Quality Assurance Project Plan
QC	Quality Control
QL	Quantitation limit
QP	Quality Procedure
RAC	Response Action Contract
RAS	Routine Analytical Services
REAC	Response Engineering and Analytical Contract
RI/FS	Remedial Investigation/Feasibility Study
RI	Remedial Investigation

RITL	Remedial Investigation Task Leader
RPD	Relative Percent Difference
RPM	Remedial Project Manager
RQAC	Regional Quality Assurance Coordinator
RSCC	Regional Sample Control Center
RSD	Relative Standard Deviation
RST	Removal Support Team
SA	Self Assessment
SB	Soil boring
SCBA	Self Contained Breathing Apparatus
SLERA	Screening Level Ecological Risk Assessment
SM	Site Manager
SOP	Standard Operating Procedures
SOW	Statement of Work
SVOC	Semi-volatile organic compound
TAL	Target Analyte List
TAT	Turn around time
TBD	To be determined
TCE	Trichloroethene
TCL	Target Compound List
TDS	Total dissolved solids
TKN	Total Kjehldahl nitrogen
TOC	Total organic carbon
TOM	Technical Operations Manager
TSOP	Technical Standard Operating Procedure
TSS	Total suspended solids
ug/kg	micrograms per kilograms
ug/L	Micrograms/liter
VOA	Volatile Organic Analysis
VOC	Volatile Organic Compound
VTSR	Verified time to sample reciept

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Table 1
Residential Wells To Be Sampled
Hopewell Precision Site
Hopewell Junction, New York

No.	Street No.	Street	Well Depth (feet bgs)	Rationale
1	20	Ryan Drive	45	Near source area
2	104	Oak Ridge Road	27	Across street from POET well
3	105	Oak Ridge Road	200	Next door to POET well
4	106	Oak Ridge Road	unknown	Across street from POET well
5	3	Joann Road	35	Near well with POET
6	4	Hausner Road	167	Downgradient from POET wells
7	1331	Route 82	25	Near 2 POET wells
8	1286	Route 82	176	Downgradient from POET wells
9	1282	Route 82	unknown	Downgradient from POET wells
10	1277	Route 82	unknown	Downgradient from POET wells
11	1269	Route 82	100	Downgradient from POET wells
12	1267	Route 82	210	Downgradient from POET wells
13	1257	Route 82	225	Downgradient from POET wells
14	104	Creamery Road	40	Near POET wells
15	106	Creamery Road	80 or 286	Near POET wells
16	107	Creamery Road	140 or 240	Near POET wells
17	7	Lenart Place	132	Near POET wells
18	17	Lenart Place	27	Near POET wells
19	8	Hamilton Drive	unknown	Near POET wells
20	16	Hamilton Drive	300	Near POET wells
21	16	Hamilton Drive	75	Near POET wells
22	18	Hamilton Drive	80	Near POET wells
23	22	Hamilton Drive	136	Near POET wells
24	21	Hamilton Road	130	Near POET wells
25	23	Hamilton Road	unknown	Near POET wells
26	14	Hamilton Road	125	Near POET wells
27	18	Hamilton Road	120	Near POET wells
28	22	Hamilton Road	245	Near POET wells
29	22	Hamilton Road	28	Near POET wells
30	24	Hamilton Road	125	Near POET wells
31	28	Hamilton Road	146	Near POET wells
32	30	Hamilton Road	140	Near POET wells
33	32	Hamilton Road	unknown	Near POET wells
34	29	Hamilton Road	205	Near POET wells
35	1155	Route 82	60	Just north of POET wells
36	1147	Route 82	unknown	Just north of POET wells
37	1138	Route 82	unknown	Across street from POET well
38	1123	Route 82	500	Just south of POET wells
39	1115	Route 82	100	South of POET wells
40	1	Maple Place	205	South and east of POET wells
41	2	Maple Place	245	South and east of POET wells
42	1	Mary Lane	unknown	Just east of POET wells
43	121	Clove Branch Road	unknown	South of POET wells
44	122	Clove Branch Road	200	South of POET wells

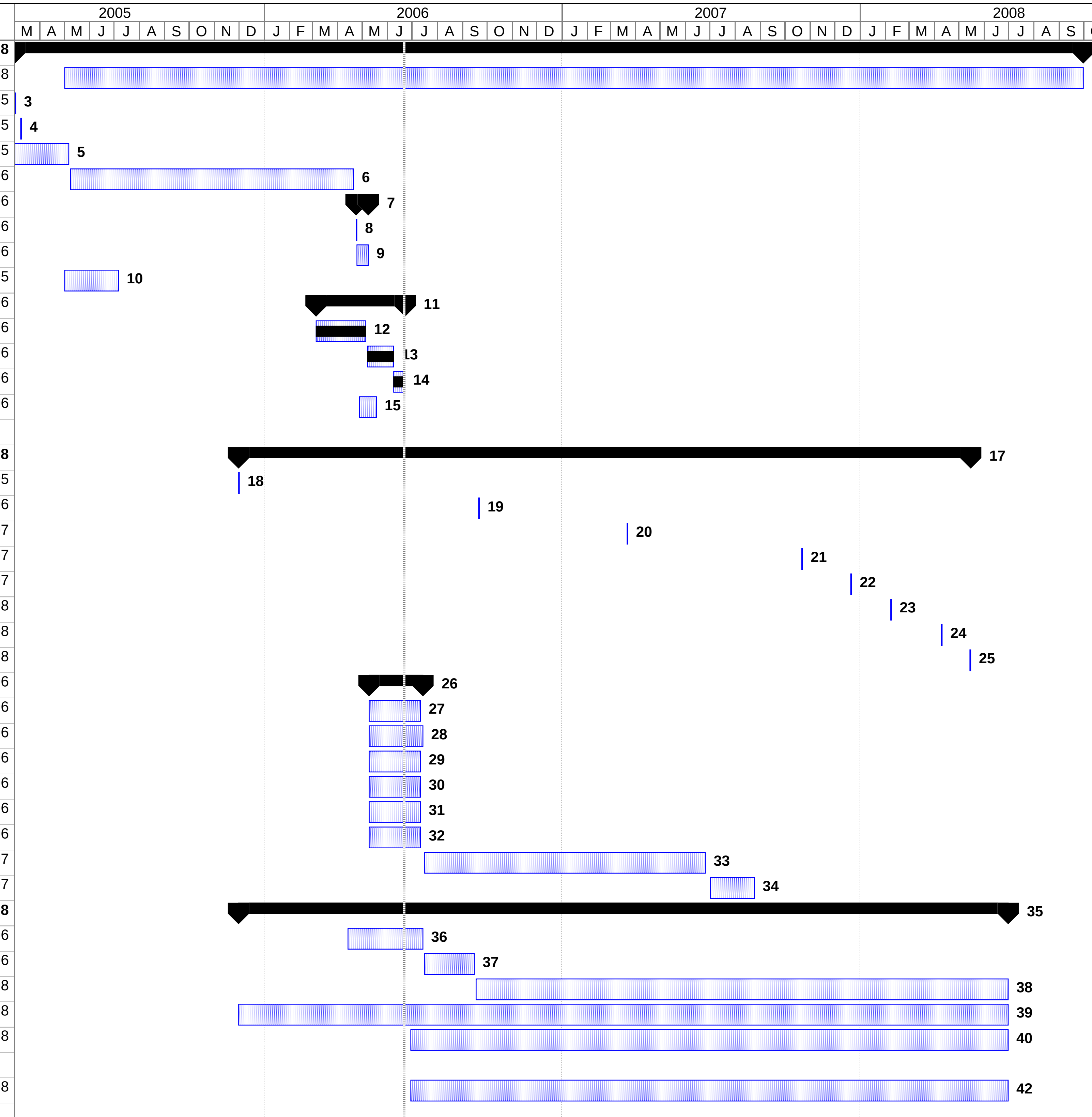
Table 1
Residential Wells To Be Sampled
Hopewell Precision Site
Hopewell Junction, New York

No.	Street No.	Street	Well Depth (feet bgs)	Rationale
45	123	Clove Branch Road	unknown	South of POET wells
46	126	Clove Branch Road	>28	South and east of POET wells
47	127	Clove Branch Road	unknown	South of POET wells
48	128	Clove Branch Road	16	South and east of POET wells
49	1103	Route 82	unknown	South of POET wells
50	1095	Route 82	63	South of POET wells
51	9	Thunder Road	45	Between EPA and NYSDEC POET wells
52	19	Thunder Road	92 or 300	Between EPA and NYSDEC POET wells
53	29	Thunder Road	150	Between EPA and NYSDEC POET wells
54	6	Baris Lane	30	Within cluster of NYSDEC POET wells
55	1	Cavelo Road	unknown	Near NYSDEC POET wells
56	2	Cavelo Road	46	Near NYSDEC POET wells
57	4	Cavelo Road	unknown	Near NYSDEC POET wells
58	3	Henry Drive	23	Near NYSDEC and EPA POET wells
59	4	Henry Drive	125	Near NYSDEC and EPA POET wells
60	6	Henry Drive	20	Near NYSDEC and EPA POET wells

Note: The list of residential wells may changed based on sampling conducted by EPA's removal group, once the final sampling schedule is known.

Hopewell Precision Site

ID	Indicators	Task Name	Duration	Start	Finish
1		**TASK 1 Project Planning & Support**	**935 days**	**3/2/05**	**9/30/08**
2		1.1 Project Administation	892 days	5/2/05	9/30/08
3		1.2 Attend Scoping Meeting	1 day	3/2/05	3/2/05
4		1.3 Conduct Site Visit	1 day	3/9/05	3/9/05
5		1.4 Develop Draft Work Plan and Associated Cost Estimate	48 days	3/2/05	5/6/05
6		EPA Review of Draft Work Plan	249 days	5/9/05	4/20/06
7		1.5 Negotiate and Revise Draft Work Plan/Budget	11 days	4/24/06	5/8/06
8		Negotiate Budget	1 day	4/24/06	4/24/06
9		Prepare/Submit Final Work Plan	10 days	4/25/06	5/8/06
10		1.6 Evaluate Existing Data and Documents	48 days	5/2/05	7/6/05
11	✓	1.7 Quality Assurance Project Plan	79 days	3/6/06	6/22/06
12	✓	Prepare/Submit Draft QAPP	45 days	3/6/06	5/5/06
13	✓	EPA Review	24 days	5/8/06	6/8/06
14	✓	Prepare/Submit Final QAPP	10 days	6/9/06	6/22/06
15		1.8 Health & Safety Plan	15 days	4/28/06	5/18/06
16		1.9 Non-RAS Analyses (Not Applicable)			
17		**1.10 Meetings**	**641 days**	**12/1/05**	**5/15/08**
18		First Meeting	1 day	12/1/05	12/1/05
19		Second Meeting	1 day	9/21/06	9/21/06
20		Third Meeting	1 day	3/22/07	3/22/07
21		Fourth Meeting	1 day	10/22/07	10/22/07
22		Fifth Meeting	1 day	12/21/07	12/21/07
23		Sixth Meeting	1 day	2/8/08	2/8/08
24		Seventh Meeting	1 day	4/10/08	4/10/08
25		Eighth Meeting	1 day	5/15/08	5/15/08
26		1.11 Subcontract Procurement	48 days	5/10/06	7/14/06
27		Topographic Survey	45 days	5/10/06	7/11/06
28		Drilling Services	48 days	5/10/06	7/14/06
29		Cultural Resources	45 days	5/10/06	7/11/06
30		Analytical Laboratory	45 days	5/10/06	7/11/06
31		Waste Hauling and Disposal	45 days	5/10/06	7/11/06
32		Aquatic Survey Services	45 days	5/10/06	7/11/06
33		1.12 Perform Subcontract Management	246 days	7/17/06	6/25/07
34		1.13 Pathway Anaysis Report (PAR)	40 days	7/2/07	8/24/07
35		**TASK 2 Community Relations**	**673 days**	**12/1/05**	**6/30/08**
36		2.1 Community Interviews	66 days	4/14/06	7/14/06
37		2.2 Community Relations Plan	45 days	7/17/06	9/15/06
38		2.3 Public Meeting Support	466 days	9/18/06	6/30/08
39		Public Meetings # 1 through #6	673 days	12/1/05	6/30/08
40		2.4 Fact Sheet Preparation	522 days	6/30/06	6/30/08
41					
42		2.6 Public Notices	522 days	6/30/06	6/30/08
43					



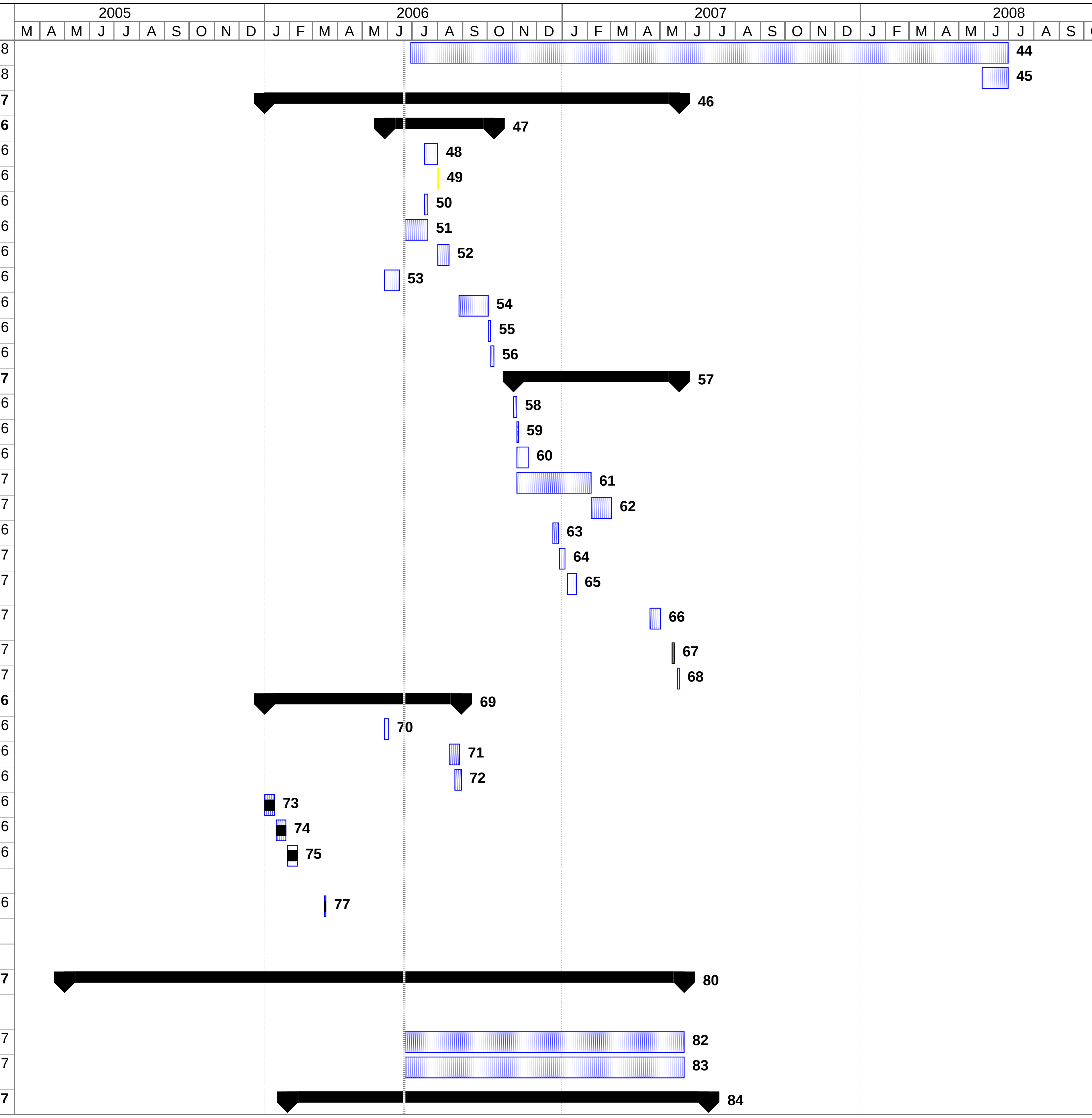
CDM
Project: Hopewell Precision Site
Date: 6/21/06

Task | Split | Progress | Milestone | Summary | Project Summary

Figure 1
Project Schedule Hopewell Precision Site
Hopewell Junction, New York

Hopewell Precision Site

ID		Task Name	Duration	Start	Finish
44		2.8 Site Mailing List	522 days	6/30/06	6/30/08
45		2.9 Responsiveness Summary Support	22 days	5/30/08	6/30/08
46		**TASK 3 Field Investigation**	**364 days**	**1/2/06**	**5/24/07**
47		**Stage I**	**96 days**	**5/29/06**	**10/9/06**
48		Mobilization	12 days	7/17/06	8/1/06
49		Cultural Resources Survey	1 day	8/2/06	8/2/06
50		Site Preparation	4 days	7/17/06	7/20/06
51		Site Access Support (for Round 1 Residential Well Sampling)	20 days	6/23/06	7/20/06
52		Residential Well Sampling (Round 1)	10 days	8/2/06	8/15/06
53		Site Access Support (Groundwater Screening)	14 days	5/29/06	6/15/06
54		Groundwater Screening	26 days	8/28/06	10/2/06
55		Source Area Subsurface Soil Sampling	3 days	10/3/06	10/5/06
56		Demobilization (Interim)	2 days	10/6/06	10/9/06
57		**Stage II**	**145 days**	**11/3/06**	**5/24/07**
58		Mobilization	2 days	11/3/06	11/6/06
59		Site access Support (MW Installation)	2 days	11/7/06	11/8/06
60		Site Preparation	10 days	11/7/06	11/20/06
61		Monitoring Well Installation	65 days	11/7/06	2/5/07
62		Well Development	19 days	2/6/07	3/2/07
63		Aquifer Testing	5 days	12/21/06	12/27/06
64		Survey of Sample and well locations	5 days	12/29/06	1/4/07
65		Groundwater Sampling (all wells - Round 1) and Water Level Measurements	9 days	1/8/07	1/18/07
66		Groundwater Sampling (all wells - Round 2) and Water Level Measurements	9 days	4/19/07	5/1/07
67		Disposal of Field Generated Waste	3 days	5/16/07	5/18/07
68		Demobilization (Final)	2 days	5/23/07	5/24/07
69		**Season-Dependent Activities**	**173 days**	**1/2/06**	**8/30/06**
70		Site Access Support (Surface Water/Sediment Sampling)	5 days	5/29/06	6/2/06
71		Surface Water/Sediment Sampling	9 days	8/16/06	8/28/06
72		Ecological Characterization	6 days	8/23/06	8/30/06
73	✓	Site Access Support (for Sub-slab Sampling)	10 days	1/2/06	1/13/06
74	✓	Installation of Sub-Slab Sampling Ports	10 days	1/16/06	1/27/06
75	✓	Sub-Slab Vapor Sampling (Initial Sampling)	10 days	1/30/06	2/10/06
76	✓				
77	✓	Sub-Slab Vapor Sampling - R2	2 days	3/16/06	3/17/06
78					
79					
80		**TASK 4 Sample Analysis**	**543 days**	**5/2/05**	**5/30/07**
81		4.1 Innovative Methods/Field Screening Sample Analysis (Not Applicable)			
82		4.2 Analytical Services Provided Via CLP, DESA or ERTC	244 days	6/23/06	5/30/07
83		4.3 Non-Routine Analytical Services (Subcontracted Analytical Services)	244 days	6/23/06	5/30/07
84		**TASK 5 Analytical Support & Data Validation**	**370 days**	**1/30/06**	**6/29/07**



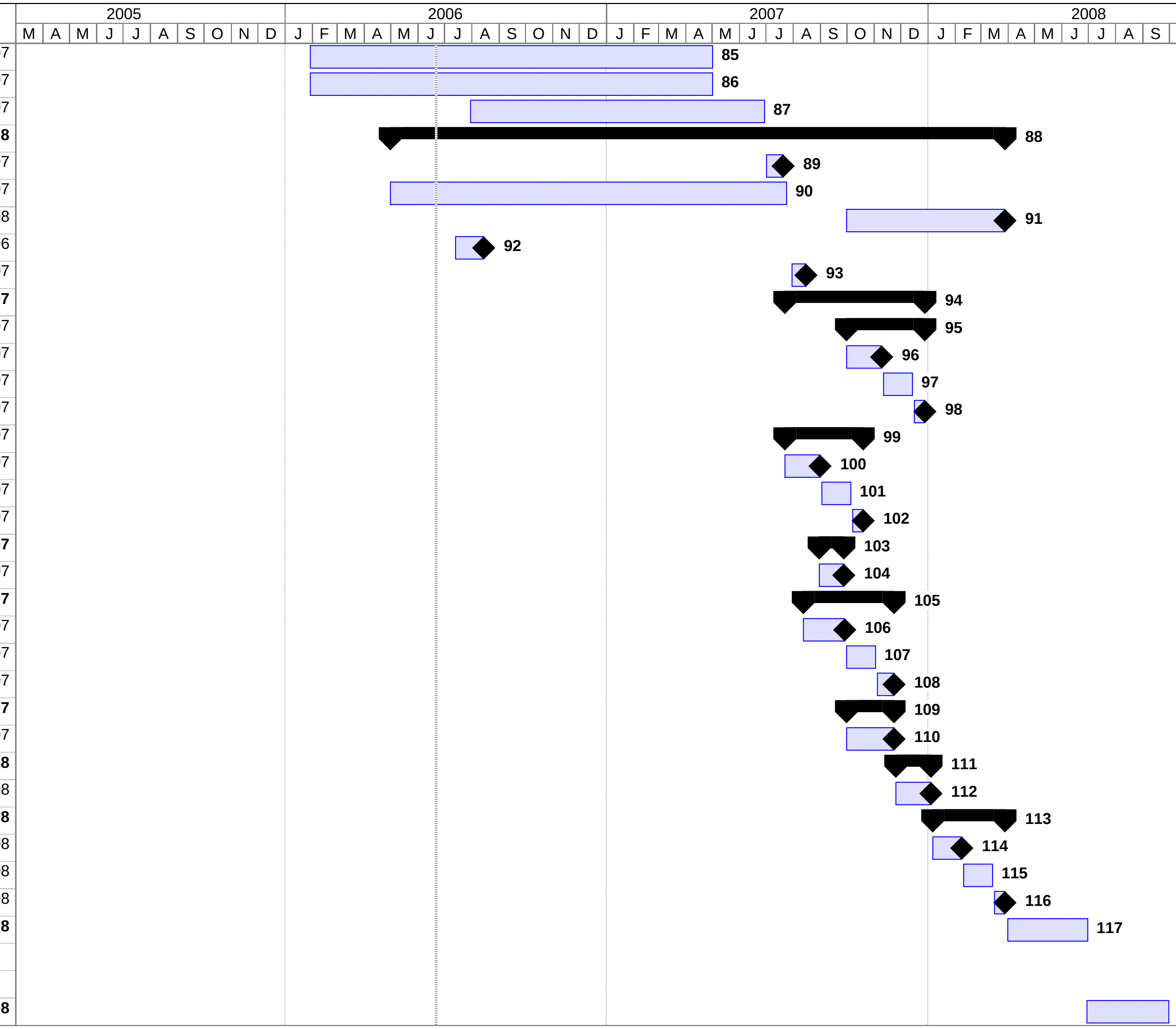
CDM
Project: Hopewell Precision Site
Date: 6/21/06

Task | Split | Progress | Milestone | Summary | Project Summary

Figure 1
Project Schedule Hopewell Precision Site
Hopewell Junction, New York

Hopewell Precision Site

ID	Indicators	Task Name	Duration	Start	Finish
85		5.1 Collect, Prepare and Ship Samples (Under Task 3.5)	327 days	1/30/06	5/1/07
86		5.2 Sample Management	327 days	1/30/06	5/1/07
87		5.3 Data Validation	240 days	7/31/06	6/29/07
88		**TASK 6 Data Evaluation**	**500 days**	**5/1/06**	**3/28/08**
89		6.1 Data Usability Evaluation	15 days	7/2/07	7/20/07
90		6.2 Data Reduction, Tabulation, and Evaluation	322 days	5/1/06	7/24/07
91		6.3 Modeling	130 days	10/1/07	3/28/08
92		6.4 Technical Memorandum	22 days	7/14/06	8/14/06
93		6.4 Technical Memorandum	12 days	7/31/07	8/15/07
94		**TASK 7 Assessment of Risk**	**115 days**	**7/23/07**	**12/28/07**
95		7.1 Baseline Risk Assessment (Human Health)	65 days	10/1/07	12/28/07
96		Prepare Draft Risk Assessment (HH)	30 days	10/1/07	11/9/07
97		EPA Review of Draft Risk Assessment (HH)	25 days	11/12/07	12/14/07
98		Prepare Final Risk Assessment (HH)	10 days	12/17/07	12/28/07
99		7.2 Ecological Risk Assessment (Screening Level)	65 days	7/23/07	10/19/07
100		Prepare Draft Ecological Risk Assessment	30 days	7/23/07	8/31/07
101		EPA Review of Draft Ecological Risk Assessment	25 days	9/3/07	10/5/07
102		Prepare Final Ecological Risk Assessment	10 days	10/8/07	10/19/07
103		**TASK 8 Treatability Study and Pilot Testing**	**20 days**	**8/31/07**	**9/27/07**
104		8.1 Literature Search	20 days	8/31/07	9/27/07
105		**TASK 9 Remedial Investigation Report**	**75 days**	**8/13/07**	**11/23/07**
106		Prepare Draft RI Report	7 wks	8/13/07	9/28/07
107		EPA Review of Draft RI Report	25 days	10/1/07	11/2/07
108		Prepare Final RI Report	15 days	11/5/07	11/23/07
109		**TASK 10 Remedial Alternative Screening**	**40 days**	**10/1/07**	**11/23/07**
110		Technical Memorandum 1	40 days	10/1/07	11/23/07
111		**TASK 11 Remedial Alternative Evaluation**	**30 days**	**11/26/07**	**1/4/08**
112		Technical Memorandum 2	30 days	11/26/07	1/4/08
113		**TASK 12 Feasibility Study Report**	**60 days**	**1/7/08**	**3/28/08**
114		Prepare Draft FS Report	5 wks	1/7/08	2/8/08
115		EPA Review of FS Report	25 days	2/11/08	3/14/08
116		Prepare Final FS Report	10 days	3/17/08	3/28/08
117		**TASK 13 Post RI/FS Support**	**65 days**	**4/1/08**	**6/30/08**
118		**TASK 14 Negotiation Support (Not Applicable)**			
119		**TASK 15 Administrative Record (Not Applicable)**			
120		**TASK 16 Work Assignment Closeout**	**67 days**	**6/30/08**	**9/30/08**



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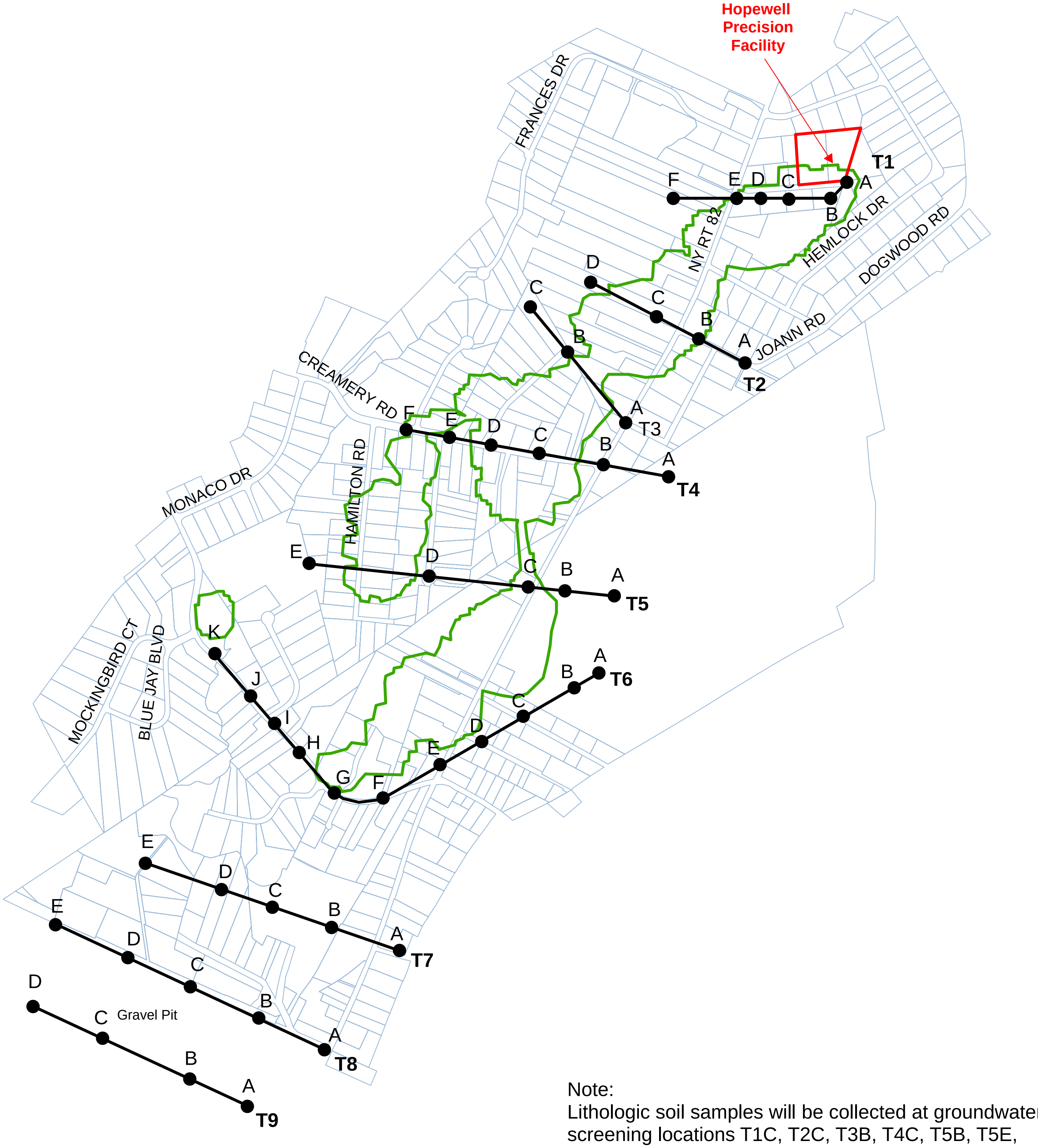
Project: Hopewell Precision Site
Date: 6/21/06

Task | Split | Progress | Milestone | Summary | Project Summary

Figure 1
Project Schedule Hopewell Precision Site
Hopewell Junction, New York



Note:
Lithologic soil samples will be collected at groundwater screening locations T1C, T2C, T3B, T4C, T5B, T5E, T6C,T6H, T7C, T8C and T9C.

The TCE plume outline was provided by the EPA Removal Branch and is based on 2003 data

Proposed Groundwater Screening Locations

TCE plume area

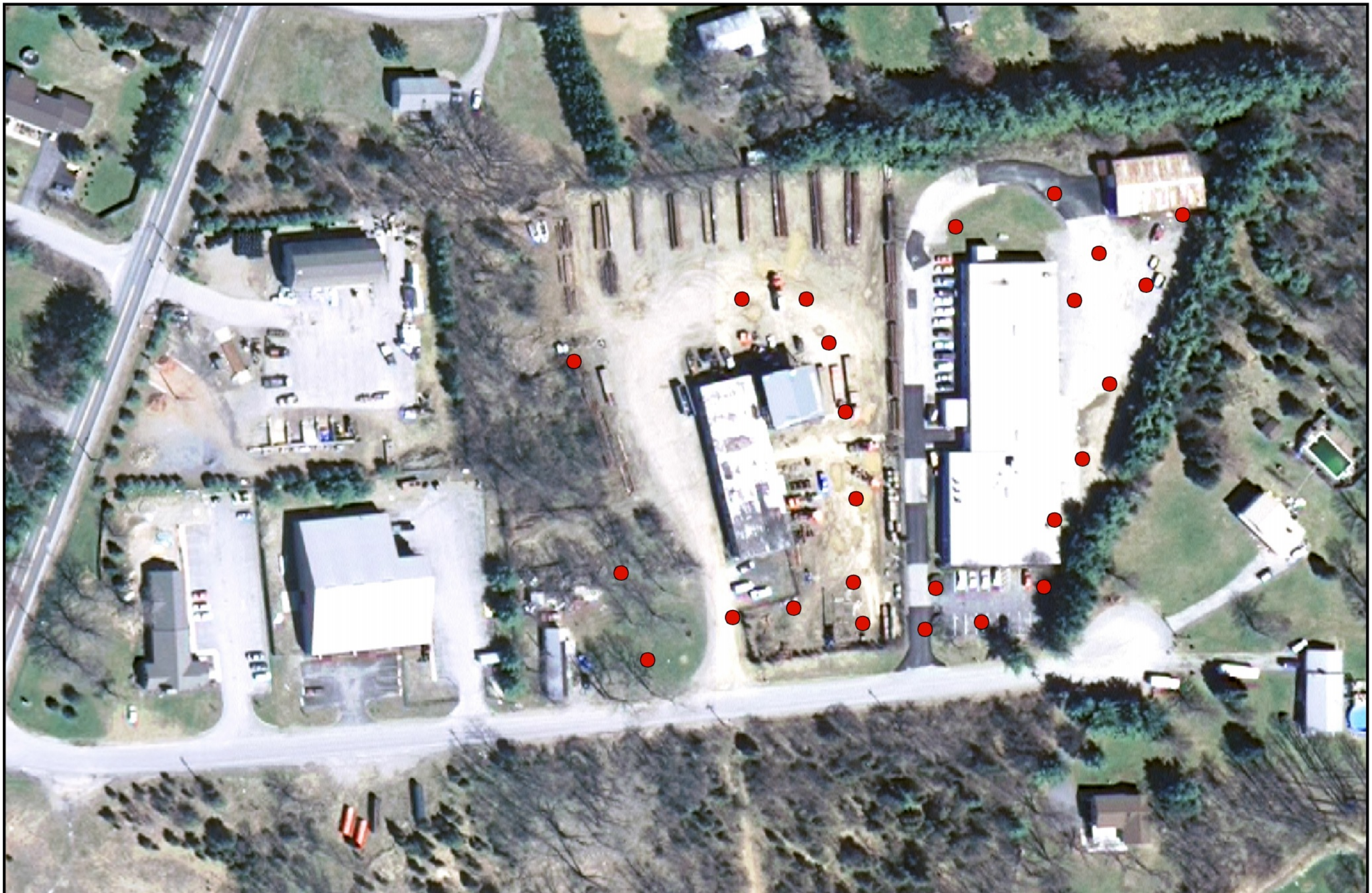
Parcels

N

0 1,000 2,000 Feet

Figure 2
Proposed Groundwater Screening Locations
Hopewell Precision Site
Hopewell Junction, New York

CDM



Proposed Source Area Soil Sampling Locations

N

0 25 50 100 150 200
Feet

Figure 3
Proposed Source Area Soil Sampling Locations
Hopewell Precision Site
Hopewell Junction, New York

A

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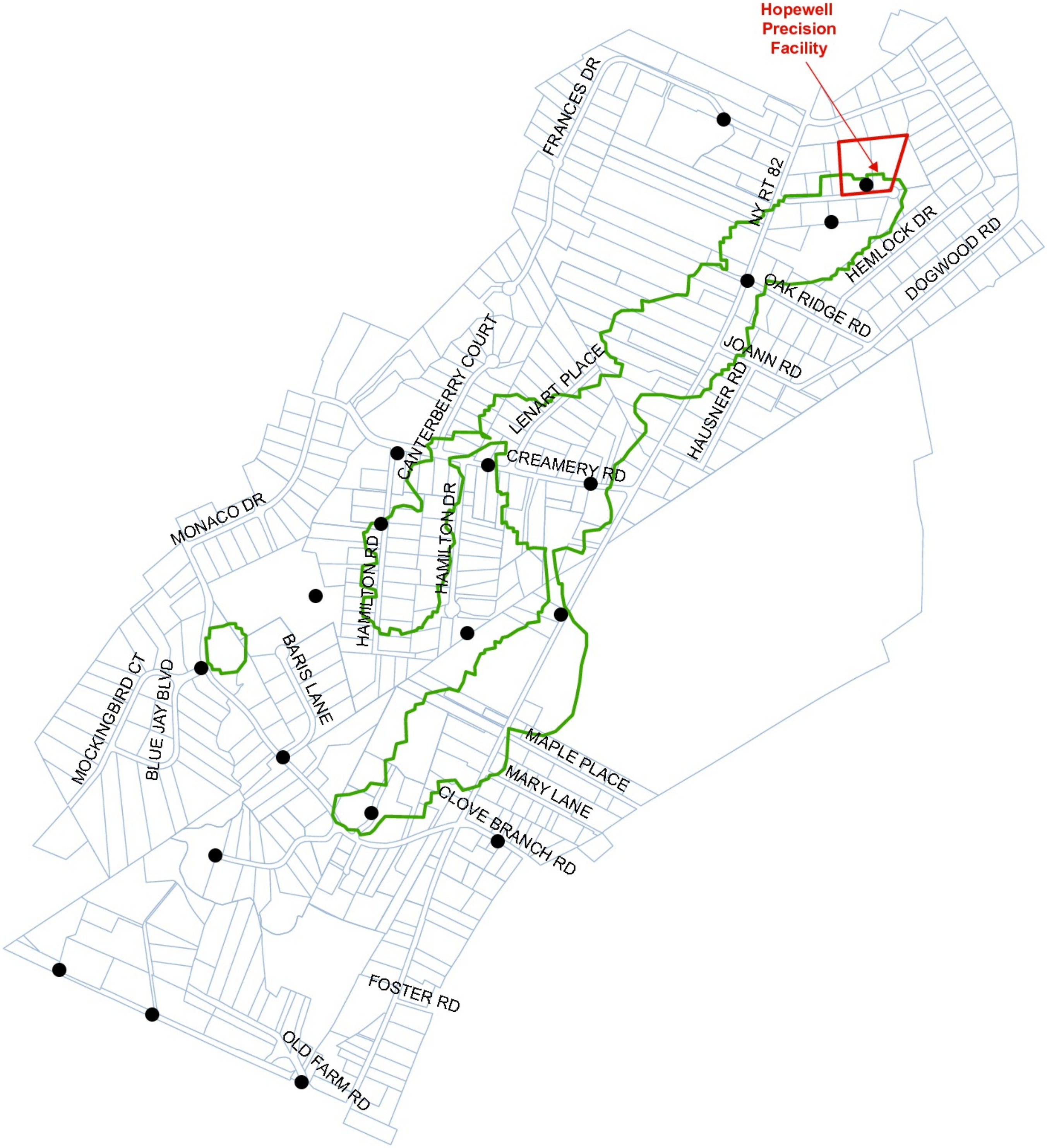

Note:
The TCE plume outline was provided by the EPA Removal Branch and is based on 2003 data

● Proposed Monitoring Well Cluster Location (final depths and locations to be determined based on ground water screening results)

TCE plume area

Parcels

N

0 1,000 2,000 Feet

Figure 4
Proposed Monitoring Well Locations
Hopewell Precision Site
Hopewell Junction, New York

CDM

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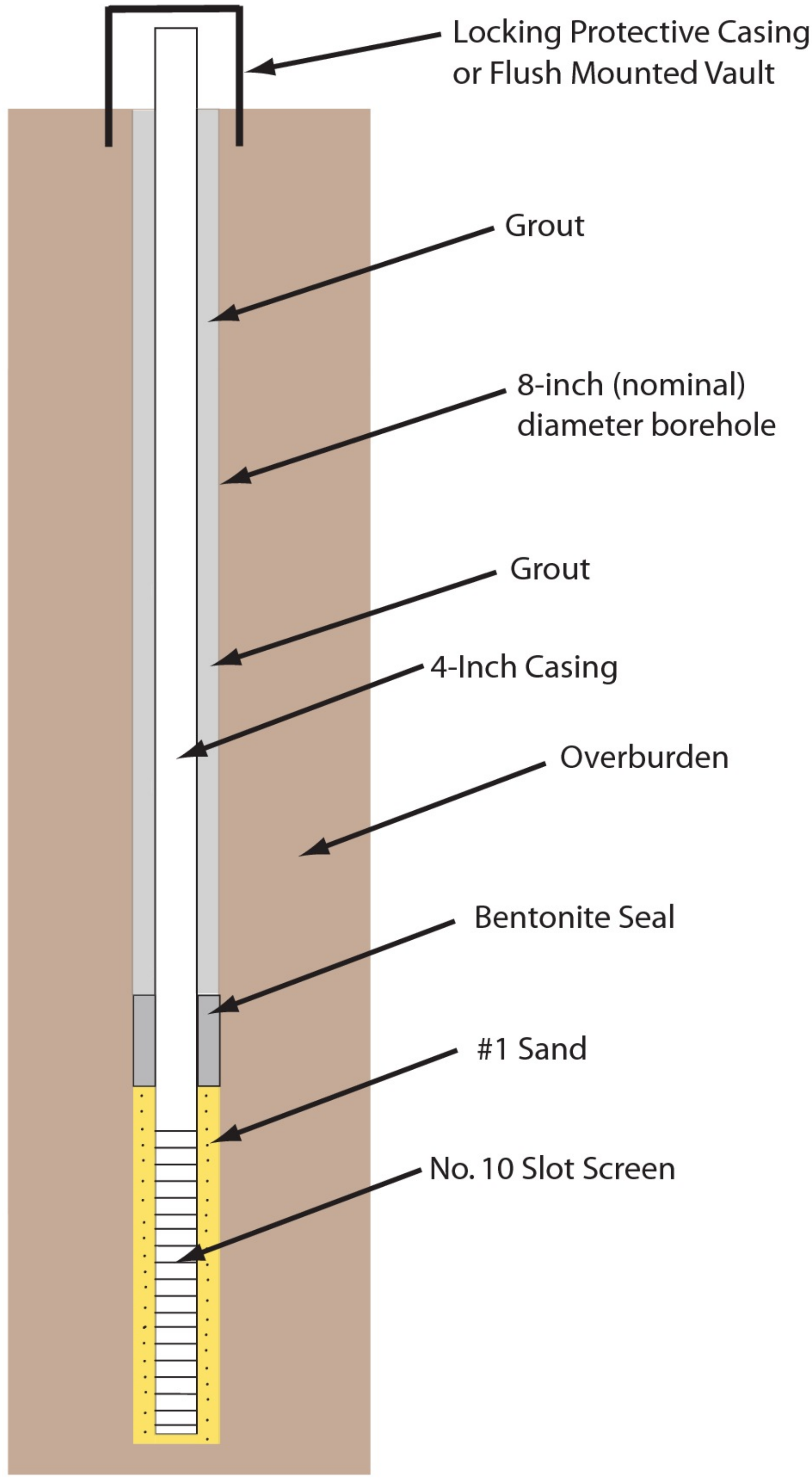
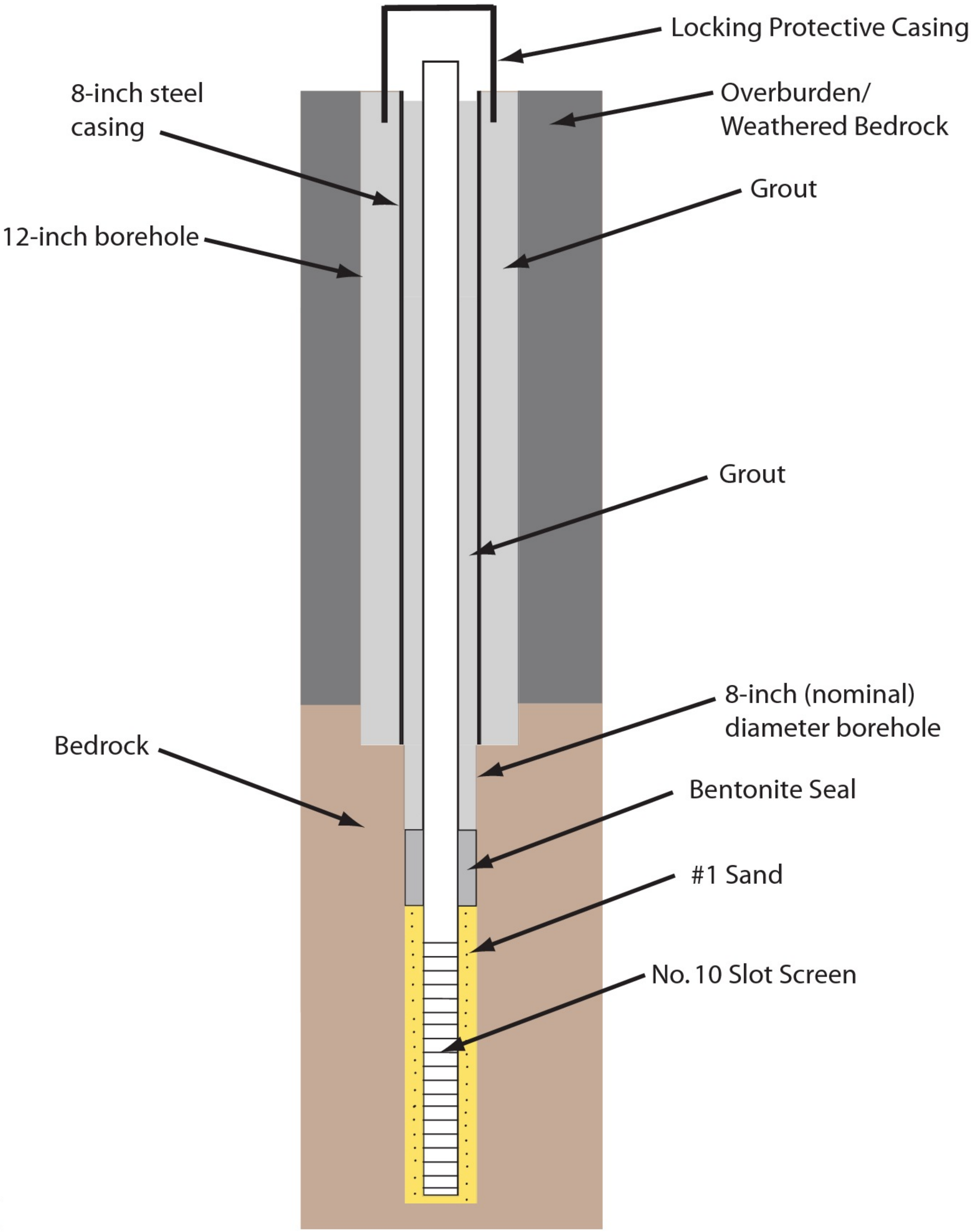


Figure 5
Four-Inch Overburden Monitoring Well
Hopewell Precision Superfund Site
Hopewell Junction, New York

CDM

Not to Scale

Well_Construction_Drawing_AI_JND.pdf



Not to Scale

Figure 6
Four-Inch Bedrock Monitoring Well
Hopewell Precision Superfund Site
Hopewell Junction, New York

CDM

Well_Construction_Drawing_AI_JND.pdf

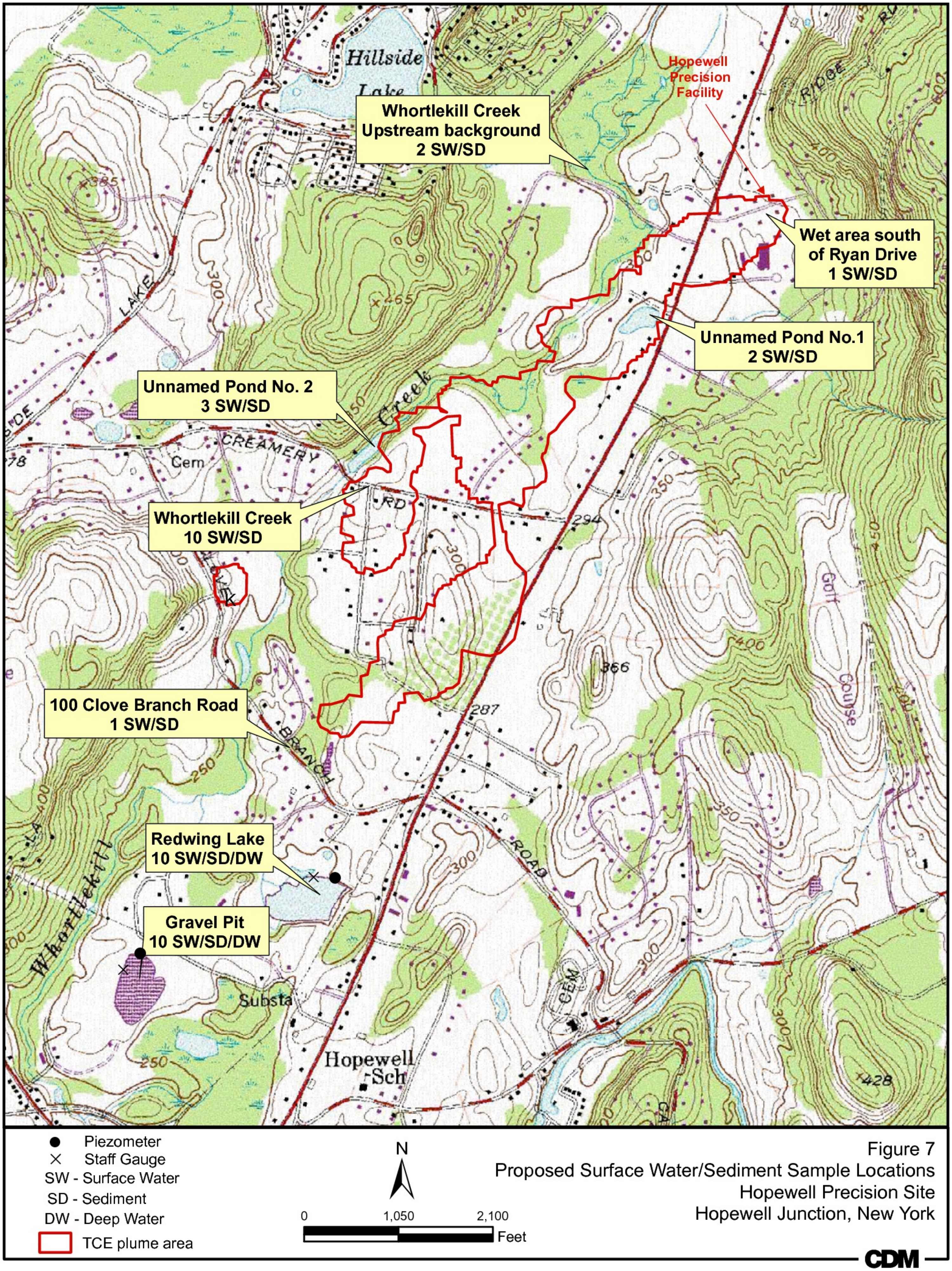


Figure 7
Proposed Surface Water/Sediment Sample Locations
Hopewell Precision Site
Hopewell Junction, New York

CDM

CDMDBSNN091:\\Hopewell\Proposed SurfaceWater.mxd

Proposed deep water sampling location

N

Scale 1 inch =1/10 mile

CDM

Figure 8
Proposed Deep Water Sampling Locations
Hopewell Precision Site
Hopewell Junction, New York

APPENDIX A

SITE-SPECIFIC LOW FLOW GROUNDWATER PURGING AND SAMPLING PROCEDURE

U.S. ENVIRONMENTAL PROTECTION AGENCY
REGION II

GROUNDWATER SAMPLING PROCEDURE
LOW STRESS (LOW-FLOW) PURGING AND SAMPLING

I. SCOPE & APPLICATION

This Low Stress (or Low-Flow) Purging and Sampling Procedure is the EPA Region II preferred method for collecting groundwater samples from monitoring wells at the Hopewell Precision Site. The procedure minimizes stress on the formation and minimizes disturbance of sediment in the well. The procedure applies to monitoring wells that have well casing with an inner diameter of 2.0 inch or greater. It is appropriate for groundwater samples that will be analyzed for volatile and semi-volatile organic compounds (VOC and SVOC), pesticides, polychlorinated biphenyls (PCB), metals, and microbiological and other contaminants in association with any EPA program.

This procedure does not address the collection of non-aqueous phase liquid (NAPL) samples and should be used for aqueous samples only. For sampling NAPLs, the reader is referred to the following EPA publications: DNAPL Site Evaluation (Cohen & Mercer, 1993) and the RCRA Ground-Water Monitoring: Draft Technical Guidance (EPA/530-R-93-001), and references therein.

II. METHOD SUMMARY

The goal of the Low Stress Purging and Sampling procedure is to collect samples that are representative of groundwater conditions in the geological formation. This is accomplished by setting the intake velocity of the sampling pump to a flow rate that allows a maximum drawdown of 0.3 foot.

Sampling at such a low flow rate has three primary benefits. First, it minimizes disturbance of sediment in the bottom of the well, thereby producing a sample with low turbidity (i.e., low concentration of suspended particles). Typically, this saves time and analytical costs by eliminating the need for collecting and analyzing a filtered sample from the same well. Second, it minimizes aeration of the groundwater during sample collection, which improves the sample quality for VOC analysis. Third, in most cases it significantly reduces the volume of

IV. EQUIPMENT

- **Approved site-specific Quality Assurance Project Plan (QAPP).** Generally, the target depth corresponds to just above the mid-point of the most permeable zone in the screened interval. Borehole geologic and geophysical logs can be used to help select the most permeable zone. However, in some cases, other criteria may be used to select the target depth for the pump intake.
- Well construction data, location map, field data from last sampling event.
- Polyethylene sheeting.
- Photo Ionization Detector (PID).
- Adjustable rate, positive displacement groundwater sampling pump constructed of stainless steel.
- Interface probe or equivalent device for determining the presence or absence of NAPL.
- Teflon-lined polyethylene tubing to collect samples for organic and inorganic analysis. Sufficient tubing of the appropriate material must be available so that each well has dedicated tubing.
- Electronic water level measuring device, 0.01 foot accuracy.
- Flow measurement supplies (e.g., graduated cylinder and stop watch).
- Power source (generator).
- Monitoring instruments for indicator parameters. Redox potential (Eh) and dissolved oxygen must be monitored in-line using an instrument with a continuous readout display. Temperature, pH and specific conductance may be monitored with an in-line monitor. A nephalometer is used to measure turbidity.
- Decontamination supplies (see Section VII, below).
- Logbook (see Section VIII, below).
- Sample bottles.
- Sample preservation supplies (as required by the analytical methods).
- Sample tags or labels, chain of custody.
- Other supplies as specified in the EPA approved field sampling plan/QAPP.

V. SAMPLING PROCEDURES

Pre-Sampling Activities

1. Start at the well known or believed to have the least contaminated groundwater and proceed systematically to the well with the most

monitored approximately every three to five minutes. Ideally, a steady flow rate should be maintained that results in a stabilized water level (drawdown of 0.3 ft or less). Pumping rates should, if needed, be reduced to the minimum capabilities of the pump to ensure stabilization of the water level. As noted above, care should be taken to maintain pump suction and to avoid entrainment of air in the tubing. Record each adjustment made to the pumping rate and the water level measured immediately after each adjustment.

12. Monitor Indicator Parameters: During purging of the well, monitor and record the field indicator parameters (turbidity, temperature, specific conductance, pH, Eh, and DO) approximately every three to five minutes. The well is considered stabilized and ready for sample collection when the indicator parameters have stabilized for three consecutive readings as follows (Puls and Barcelona, 1996):

    $\pm$0.1 for pH
    $\pm$3% for specific conductance (conductivity)
    $\pm$10 mv for redox potential
    $\pm$10% for DO and turbidity

    Dissolved oxygen and turbidity usually require the longest time to achieve stabilization. The pump must not be removed from the well between purging and sampling.

    If pH adjustment is necessary for sample preservation, the amount of acid to be added to each sample vial prior to sampling should be determined, drop by drop, on a separate and equal volume of water (e.g., 40 mls). Groundwater purged from the well prior to sampling can be used for this purpose.

13. Collect Samples: Collect samples at flow rates of between 100 and 250 ml/min or such that drawdown of the water level within the well does not exceed the maximum allowable drawdown of 0.3 ft. Samples should be collected at the same flow rate at which the indicator parameters stabilized. VOC samples must be collected first, at the lower rate, and directly into pre-preserved sample containers. All sample containers should be filled with minimal turbulence by allowing the groundwater to flow from the tubing gently down the inside of the container.

Please Note: Steps D through K should only be performed once (for each pump that is to be used) before the commencement of a particular sampling event by a person qualified to disassemble pumps.

A) Pre-rinse: Operate pump in a deep basin containing 8 to 10 gallons of potable water for 5 minutes and thoroughly flush other equipment with potable water.

B) Wash: Operate pump in a deep basin containing 8 to 10 gallons of a non-phosphate detergent solution, such as Alconox, for 5 minutes and thoroughly flush other equipment with fresh detergent solution. Use the detergent sparingly.

C) Rinse: Operate pump in a deep basin of potable water for 5 minutes and thoroughly flush other equipment with potable water for five minutes.

D) Disassemble pump.

E) Wash pump parts (inlet screen, shaft suction interconnector, motor lead assembly, stator house): Place the disassembled parts of the pump into a deep basin containing 8 to 10 gallons of non-phosphate detergent solution. Scrub all pump parts with a test tube brush.

F) Rinse pump parts with potable water for five minutes.

G) Rinse the pump parts with demonstrated analyte-free water.

H) Place impeller assembly in a large glass beaker and rinse with 1% nitric acid (HNO_3).

I) Rinse impeller assembly with potable water for five minutes.

J) Place impeller assembly in a large glass bleaker and rinse with isopropanol.

K) Thoroughly rinse impeller assembly with demonstrated analyte-free water.

18. Daily and Between-Well Decon

Cohen, R.M. and J.W. Mercer, 1993, DNAPL Site Evaluation, C.K. Smoley Press, Boca Raton, Florida.

EPA, 1993, RCRA Ground-Water Monitoring: Draft Technical Guidance, EPA/530-R-93-001.

EPA, 1998, EPA Region II, Ground Water Sampling Procedure Low Stress (Low Flow) Purging and Sampling, March 16.

Puls, R.W. and M.J. Barcelona, 1996, Low-Flow (Minimal Drawdown) Ground-water Sampling Procedures, EPA/540/S-95/504.

APPENDIX B

CDM TECHNICAL STANDARD OPERATING PROCEDURES

1-1 Surface Water Sampling
1-2 Sample Custody*
1-3 Surface Soil Sampling*
1-4 Subsurface Soil Sampling*
1-6 Water Level Measurement
1-9 Tap Water Sampling*
1-10 Field Measurement of Organic Vapors
1-11 Sediment/Sludge Sampling*
2-1 Packaging and Shipping of Environmental Samples*
2-2 Guide to Handling of Investigation Derived Waste
3-1 Geoprobe® Sampling
3-2 Topographic Survey
3-4 Geophysical Logging, Calibration, and Quality Control
3-5 Lithologic Logging
3-6 Underground Facility Location
4-1 Field Logbook Content and Control*
4-2 Photographic Documentation of Field Activities
4-3 Well Development and Purging*
4-4 Design and Installation of Monitoring Wells in Aquifers*
4-6 Hydraulic Conductivity Testing
4-8 Environmental Data Management
5-1 Control of Measurement and Test Equipment *

* Includes RAC II Contract-Specific Clarification

TSOP 1-1

SURFACE WATER SAMPLING

Surface Water Sampling

Prepared: Del Baird

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Issued: [signature] 2/18/04
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1.0 Objective

The objective of this standard operating procedure (SOP) is to define requirements for collection and containment of surface water samples.

2.0 Background

2.1 Definitions

Surface Water - Water that flows over or rests on the land and is open to the atmosphere. This includes ditches, streams, rivers, lakes, pools, ponds, and basins.

Shallow Surface Water - Water within 0.3 to 1 meter (1 to 3.3 feet) of the surface of a body of water.

Deep Surface Water - Water deeper than 1 meter (3.3 feet) of the surface of a body of water.

Grab Sample - A discrete portion or aliquot taken from a specific location at a given point in time.

Composite - Two or more sub-samples taken from a specific media and site at a specific point in time. The sub-samples are collected and mixed, then a single average sample is taken from the mixture.

2.2 Discussion

Surface water samples are collected to determine the type(s) and level(s) of contamination in a particular surface water body and/or its biological disposition.

2.3 Associated Procedures

- CDM Federal SOP 1-2, Sample Custody
- CDM Federal SOP 2-1, Packaging and Shipping Environmental Samples
- CDM Federal SOP 4-1, Field Logbook Content and Control
- CDM Federal SOP 4-2, Photographic Documentation of Field Activities
- CDM Federal SOP 4-5, Field Equipment Decontamination at Non-Radioactive Sites

3.0 Responsibilities

Site Manager - The site manager is responsible for ensuring that field personnel are trained in the use of this and related SOPs and the required equipment.

Field Team Leader - The field team leader (FTL) is responsible for ensuring that sampling efforts are conducted in accordance with this procedure and any other SOPs pertaining to specific media sampling. The FTL also must ensure that the quantity and location of surface water samples collected meet the requirements of the site-specific plans.

4.0 Required Equipment

All or part of the equipment listed under the "as needed" category may be required at any specific site, depending on the plan(s) for that site.

- Site-specific plans
- Field logbook
- Indelible black-ink pens and markers
- Labels and appropriate forms/documentation for sample shipment
- Appropriate sample containers
- Insulated cooler and waterproof sealing tape
- Ice bags or "blue ice"
- Plastic zip-top bags
- Clear waterproof tape
- Personal protective clothing and equipment
- Latex or appropriate gloves
- Rubber boots and/or rubberized waders
- 12- to 19-mm (½- to ¾-inch) braided nylon line or Teflon®-coated wire rope
- Kimwipe or paper towels
- Clean plastic sheeting
- Tap and deionized water
- Appropriate photographic equipment and supplies
- Appropriate decontamination equipment and supplies

As needed:

- Pond sampler with 1-liter (L) beaker (preferably Teflon), clamp, and heavy-duty telescoping pole
- Weighted bottle sampler, 1-L capacity (preferably Teflon); a Kemmerer or Van Dorn sampler may be used if Teflon is not required
- Teflon or stainless steel bailers
- Peristaltic pump or suitable replacement
- Temperature, pH, and conductivity meter(s), dissolved oxygen meter, redox potential meter (as required by the project plan)
- Boat with depth finder for deep water or inaccessible shorelines
- Global positioning system (GPS) unit
- Tape measure
- Any personal protective equipment specified in the site-specific health and safety plan
- Spare parts for all equipment

5.0 Procedures

5.1 Preparation

The following steps should be taken when preparing for sampling surface water:

1. Don the appropriate personal protective clothing as dictated by the site-specific health and safety plan.

2. Select stream/river sampling locations that exhibit cross-sectional homogeneity. Avoid areas where the channel is constricted or bends where scouring may have occurred. For lake samples, the investigator should consider the lake stratification caused by seasonal temperature

differences.

3. Prepare sampling site by laying out clean plastic sheeting on the ground or any flat, level surfaces near the sampling area and place equipment to be used on the plastic.

4. Make field measurements as required by the project plans in physical, chemical, and biological characteristics of the water (e.g., temperature, dissolved oxygen, conductivity, pH).

5. The samples shall be collected from areas of least to greatest contamination (when known) and, when collecting several samples in 1 day, always collect from downstream to upstream.

6. The sampler should be facing upstream when sampling.

7. Document the sampling events, recording all information in the designated field logbook and take photographs if required or if possible. Document any and all deviations from this SOP and include rationale for changes.

8. The collection points shall be located on a site map and described in the field logbook. Use GPS if required or if possible.

9. Label each sample container with the appropriate information. Secure the label by covering it with a piece of waterproof clear tape.

10. Decontaminate reusable sampling equipment after sample collection according to CDM Federal SOP 4-5.

11. Processes for verifying depth of samples must be included in site-specific project plans.

12. Check that a trip blank/temperature blank, when necessary, is included in the chilled cooler. Quality assurance/quality control sample requirements vary from project to project. Consult the project-specific work plan for quality requirements.

5.2 Shallow Surface Water Sample Collection

5.2.1 Method for Collecting Samples for Volatile Organic Compound Analysis

The following steps must be taken when collecting shallow surface water volatile organic compound (VOC) samples:

If the volatile organic analysis (VOA) vials do not require a preservative:

1. Approach the sample location from downstream; do not enter the sample area. Slowly submerge VOA vials completely into an area of gently flowing water and fill. Do not disturb bottom sediments. The sampler and open end of the vials should be pointed upstream. If wading is necessary, approach the sample location from downstream; do not enter the actual sample area. When using gasoline-powered vessels, make sure the engine is turned off.

Note: When collecting samples for VOC analysis, avoid collecting from a surface water point where water is cascading and aerating.

2. Cap the VOA vial while it is underwater. Be sure to dislodge all air bubbles from the cap before sealing the vial.
3. Turn the capped vial upside-down and check for air bubbles. Tap the bottom of the vials to dislodge any bubbles that may have formed around the cap or sides. Discard and resample if bubbles are present.

4. Proceed to Step 5 below.

If the VOA vials require a preservative:

1. Collect a sufficient sample in a clean glass jar as in Steps 1 and 2 above for unpreserved vials. Specific sampling devices to be used must be specified in site-specific plans.

2. Decant the sample immediately into pre-preserved VOA vials. It is recommended that the amount of preservative be predetermined on a separate aliquot of sample that is subsequently discarded. Tip vials slightly while filling to reduce turbulence until nearly filled. Then straighten vial to vertical for final filling. Ensure that a meniscus is raised above the lip of the vial before capping.

3. Cap each vial once the meniscus has formed.

4. Turn the capped vial upside-down and check for air bubbles. Tap the bottom of the vials to dislodge any bubbles that may have formed around the cap or sides. Discard and resample if bubbles are present.

5. Wipe the outside of sample vials with a Kimwipe or clean paper towel. Affix a completed sample label.

6. Place sample vial(s) in a zip-top plastic bag and seal the bag.

7. Immediately pack all samples into a chilled cooler.

5.2.2 Method for Collecting Shallow Surface Water Samples for Nonvolatile Organic or Inorganic Compound Analysis

The following steps must be followed when collecting shallow surface water samples for nonvolatile organic or inorganic compound analysis:

1. Directly dip the sample container, with the opening facing upstream, into the surface water and fill. If wading is necessary, approach the sample location from downstream; do not enter the actual sample area. Do not disturb underlying sediments.

2. If composite samples are desired, the samples may be pooled into a stainless steel, glass, Teflon, or appropriate container and decanted into sample containers. Filter samples if required by the site-specific plan.

3. Add appropriate preservatives to the sample containers if required and check pH.

Note: Use a separate container when field-testing pH, conductivity, temperature, etc. Do not insert pH paper or probe directly into sample container.

4. Cap the sample containers and wipe the outer surfaces of the sample containers clean with a Kimwipe or clean paper towel. Affix a completed sample label.

5. Place sample container(s) in individual zip-top plastic bags, if possible, and seal the bags.

6. Immediately pack all samples into a chilled cooler.

5.3 Deep Surface Water Sample Collection

5.3.1 Method for Collecting Samples at Specified Depth Using a Weighted Bottle Sampler

The following steps must be followed when collecting surface water samples at specific depths using a weighted bottle sampler:

1. Lower the weighted bottle sampler to the depth specified in the site-specific plan.

2. Remove the stopper by pulling on the sampler line; allow the sampler to fill with water.

3. Release the sampler line to reseat the stopper and retrieve the sampler to the surface.

4. Wipe the weighted bottle sampler dry with a Kimwipe or clean paper towel.

5. Remove the stopper slowly. Fill the specified number of sample containers by slightly tipping the sampler against each sample bottle. Samples to be used for VOC analysis should be decanted directly from the sampler first into pre-preserved VOA vials. It is recommended that the amount of preservative be predetermined on a separate aliquot of sample that is subsequently discarded. Add appropriate preservatives to the other sample containers and check pH. Samples may be pooled in stainless steel, glass, or Teflon containers to obtain the necessary volumes. Filter samples if required. Collect sample in separate container for pH, conductivity, temperature, and other measurements if necessary.

6. Close each sample container with the Teflon-lined cap once it is filled. Check for air bubbles in the VOC sample containers. If bubbles are present, discard and resample.

7. Wipe the outside of the sample containers clean with a Kimwipe or clean paper towel. Affix a completed sample label.

8. Place sample container(s), if possible, in individual zip-top plastic bags, and seal the bags.

9. Immediately pack all samples into a chilled cooler.

5.3.2 Method for Deep Surface Water Sample Collection Using a Peristaltic Pump

The following steps must be followed when collecting deep surface water samples using a peristaltic pump:

1. Install clean medical-grade silicon or Teflon tubing on the pump head. Leave sufficient tubing on the discharge side for convenient dispensing of liquid directly into sample containers.

2. Select the appropriate length of Teflon intake tubing necessary to reach the specified sampling

depth. Attach the intake sampling tube to the intake pump tube.

3. Lower the intake tube into the surface water at the specified sampling location to the specified depth; make sure the end of the intake tube does not touch underlying sediments.

4. Start the pump and allow at least three tubing volumes of liquid to flow through and rinse the system before collecting any samples. Do not immediately dispense the purged liquid back to the surface water body. Instead, collect the purged liquid and return it to the source after sample collection is complete.

5. Fill the specified number of sample containers directly from the discharge line. Filter samples if required by the site-specific plan. While filling, allow the liquid to flow gently down the inside of the sample bottle to minimize turbulence. For VOC samples, fill pre-preserved VOA vials and allow a meniscus to form above the top of the container before capping. It is recommended that the amount of preservative be predetermined on a separate aliquot of sample that is subsequently discarded. Check VOA vials to ensure that there are no air bubbles. Add appropriate preservatives to the other samples and check pH.

Note: Use a separate container when field-testing pH, conductivity, temperature, etc. Do not insert pH paper or probe directly into sample container.

6. Cap the sample container(s). Wipe the outside of sample containers clean with a Kimwipe or clean paper towel. Affix a completed sample label.

7. Place sample container(s) in individual zip-top plastic bags and seal the bags.

8. Immediately pack all samples into a chilled cooler.

9. Drain the pump system, rinse it with deionized water, and wipe it dry. Replace all tubing with new tubing before sampling at another sampling location. Place all used tubing in plastic bags to be discarded or decontaminated according to the site-specific plans.

6.0 Restrictions/Limitations

Peristaltic pumps are generally not capable of lifting water distances greater than 6 to 7.5 meters (20 to 25 feet) above the normal hydrostatic level.

Grab sampling for VOC analysis or for analysis of any other compound(s) that may be degraded by aeration is necessary to minimize sample disturbance and, hence, analyte loss. The representativeness of this sample, however, is difficult to determine because the collected sample represents a single point and has been disturbed.

7.0 References

U.S. Department of Energy, Hazardous Waste Remedial Actions Program, *Quality Control Requirements for Field Methods*, DOE/HWP-69/R1, July 1990 or current revision.

U.S. Department of Energy, Hazardous Waste Remedial Actions Program, *Standard Operating Procedures for Site Characterizations*, DOE/HWP-100/R2, September 1996 or current revision.

U.S. Environmental Protection Agency, Region II, *CERCLA Quality Assurance Manual*, March 1988 or current revision.

U.S. Environmental Protection Agency, Region IV, *Environmental Investigations, Standard Operating Procedures and Quality Assurance Manual*, May 1996 or current revision.

U.S. Geological Survey, *National Field Manual for the Collection of Water-Quality Data*, Chapter A8, October 1997.

Surface Water Sampling	SOP 1-1 Revision: 6 Date: March 1, 2004 Page 1 of 7

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- Site-specific plans
- Field logbook
- Indelible black-ink pens and markers
- Labels and appropriate forms/documentation for sample shipment
- Appropriate sample containers
- Insulated cooler and waterproof sealing tape
- Ice bags or "blue ice"
- Plastic zip-top bags
- Clear waterproof tape
- Personal protective clothing and equipment
- Latex or appropriate gloves
- Rubber boots and/or rubberized waders
- 12- to 19-mm (½- to ¾-inch) braided nylon line or Teflon®-coated wire rope
- Kimwipe or paper towels
- Clean plastic sheeting
- Tap and deionized water
- Appropriate photographic equipment and supplies
- Appropriate decontamination equipment and supplies

As needed:

- Pond sampler with 1-liter (L) beaker (preferably Teflon), clamp, and heavy-duty telescoping pole
- Weighted bottle sampler, 1-L capacity (preferably Teflon); a Kemmerer or Van Dorn sampler may be used if Teflon is not required
- Teflon or stainless steel bailers
- Peristaltic pump or suitable replacement
- Temperature, pH, and conductivity meter(s), dissolved oxygen meter, redox potential meter (as required by the project plan)
- Boat with depth finder for deep water or inaccessible shorelines
- Global positioning system (GPS) unit
- Tape measure
- Any personal protective equipment specified in the site-specific health and safety plan
- Spare parts for all equipment

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1. Don the appropriate personal protective clothing as dictated by the site-specific health and safety plan.

2. Select stream/river sampling locations that exhibit cross-sectional homogeneity. Avoid areas where the channel is constricted or bends where scouring may have occurred. For lake samples, the investigator should consider the lake stratification caused by seasonal temperature

differences.

3. Prepare sampling site by laying out clean plastic sheeting on the ground or any flat, level surfaces near the sampling area and place equipment to be used on the plastic.

4. Make field measurements as required by the project plans in physical, chemical, and biological characteristics of the water (e.g., temperature, dissolved oxygen, conductivity, pH).

5. The samples shall be collected from areas of least to greatest contamination (when known) and, when collecting several samples in 1 day, always collect from downstream to upstream.

6. The sampler should be facing upstream when sampling.

7. Document the sampling events, recording all information in the designated field logbook and take photographs if required or if possible. Document any and all deviations from this SOP and include rationale for changes.

8. The collection points shall be located on a site map and described in the field logbook. Use GPS if required or if possible.

9. Label each sample container with the appropriate information. Secure the label by covering it with a piece of waterproof clear tape.

10. Decontaminate reusable sampling equipment after sample collection according to CDM Federal SOP 4-5.

11. Processes for verifying depth of samples must be included in site-specific project plans.

12. Check that a trip blank/temperature blank, when necessary, is included in the chilled cooler. Quality assurance/quality control sample requirements vary from project to project. Consult the project-specific work plan for quality requirements.

5.2 Shallow Surface Water Sample Collection

5.2.1 Method for Collecting Samples for Volatile Organic Compound Analysis

The following steps must be taken when collecting shallow surface water volatile organic compound (VOC) samples:

If the volatile organic analysis (VOA) vials do not require a preservative:

1. Approach the sample location from downstream; do not enter the sample area. Slowly submerge VOA vials completely into an area of gently flowing water and fill. Do not disturb bottom sediments. The sampler and open end of the vials should be pointed upstream. If wading is necessary, approach the sample location from downstream; do not enter the actual sample area. When using gasoline-powered vessels, make sure the engine is turned off.

Note: When collecting samples for VOC analysis, avoid collecting from a surface water point where water is cascading and aerating.

2. Cap the VOA vial while it is underwater. Be sure to dislodge all air bubbles from the cap before sealing the vial.
3. Turn the capped vial upside-down and check for air bubbles. Tap the bottom of the vials to dislodge any bubbles that may have formed around the cap or sides. Discard and resample if bubbles are present.
4. Proceed to Step 5 below.

If the VOA vials require a preservative:

1. Collect a sufficient sample in a clean glass jar as in Steps 1 and 2 above for unpreserved vials. Specific sampling devices to be used must be specified in site-specific plans.
2. Decant the sample immediately into pre-preserved VOA vials. It is recommended that the amount of preservative be predetermined on a separate aliquot of sample that is subsequently discarded. Tip vials slightly while filling to reduce turbulence until nearly filled. Then straighten vial to vertical for final filling. Ensure that a meniscus is raised above the lip of the vial before capping.
3. Cap each vial once the meniscus has formed.
4. Turn the capped vial upside-down and check for air bubbles. Tap the bottom of the vials to dislodge any bubbles that may have formed around the cap or sides. Discard and resample if bubbles are present.
5. Wipe the outside of sample vials with a Kimwipe or clean paper towel. Affix a completed sample label.
6. Place sample vial(s) in a zip-top plastic bag and seal the bag.
7. Immediately pack all samples into a chilled cooler.

5.2.2 Method for Collecting Shallow Surface Water Samples for Nonvolatile Organic or Inorganic Compound Analysis

The following steps must be followed when collecting shallow surface water samples for nonvolatile organic or inorganic compound analysis:

1. Directly dip the sample container, with the opening facing upstream, into the surface water and fill. If wading is necessary, approach the sample location from downstream; do not enter the actual sample area. Do not disturb underlying sediments.
2. If composite samples are desired, the samples may be pooled into a stainless steel, glass, Teflon, or appropriate container and decanted into sample containers. Filter samples if required by the site-specific plan.
3. Add appropriate preservatives to the sample containers if required and check pH.

Note: Use a separate container when field-testing pH, conductivity, temperature, etc. Do not insert pH paper or probe directly into sample container.

4. Cap the sample containers and wipe the outer surfaces of the sample containers clean with a Kimwipe or clean paper towel. Affix a completed sample label.

5. Place sample container(s) in individual zip-top plastic bags, if possible, and seal the bags.

6. Immediately pack all samples into a chilled cooler.

5.3 Deep Surface Water Sample Collection

5.3.1 Method for Collecting Samples at Specified Depth Using a Weighted Bottle Sampler

The following steps must be followed when collecting surface water samples at specific depths using a weighted bottle sampler:

1. Lower the weighted bottle sampler to the depth specified in the site-specific plan.

2. Remove the stopper by pulling on the sampler line; allow the sampler to fill with water.

3. Release the sampler line to reseat the stopper and retrieve the sampler to the surface.

4. Wipe the weighted bottle sampler dry with a Kimwipe or clean paper towel.

5. Remove the stopper slowly. Fill the specified number of sample containers by slightly tipping the sampler against each sample bottle. Samples to be used for VOC analysis should be decanted directly from the sampler first into pre-preserved VOA vials. It is recommended that the amount of preservative be predetermined on a separate aliquot of sample that is subsequently discarded. Add appropriate preservatives to the other sample containers and check pH. Samples may be pooled in stainless steel, glass, or Teflon containers to obtain the necessary volumes. Filter samples if required. Collect sample in separate container for pH, conductivity, temperature, and other measurements if necessary.

6. Close each sample container with the Teflon-lined cap once it is filled. Check for air bubbles in the VOC sample containers. If bubbles are present, discard and resample.

7. Wipe the outside of the sample containers clean with a Kimwipe or clean paper towel. Affix a completed sample label.

8. Place sample container(s), if possible, in individual zip-top plastic bags, and seal the bags.

9. Immediately pack all samples into a chilled cooler.

5.3.2 Method for Deep Surface Water Sample Collection Using a Peristaltic Pump

The following steps must be followed when collecting deep surface water samples using a peristaltic pump:

1. Install clean medical-grade silicon or Teflon tubing on the pump head. Leave sufficient tubing on the discharge side for convenient dispensing of liquid directly into sample containers.

2. Select the appropriate length of Teflon intake tubing necessary to reach the specified sampling

depth. Attach the intake sampling tube to the intake pump tube.

3. Lower the intake tube into the surface water at the specified sampling location to the specified depth; make sure the end of the intake tube does not touch underlying sediments.

4. Start the pump and allow at least three tubing volumes of liquid to flow through and rinse the system before collecting any samples. Do not immediately dispense the purged liquid back to the surface water body. Instead, collect the purged liquid and return it to the source after sample collection is complete.

5. Fill the specified number of sample containers directly from the discharge line. Filter samples if required by the site-specific plan. While filling, allow the liquid to flow gently down the inside of the sample bottle to minimize turbulence. For VOC samples, fill pre-preserved VOA vials and allow a meniscus to form above the top of the container before capping. It is recommended that the amount of preservative be predetermined on a separate aliquot of sample that is subsequently discarded. Check VOA vials to ensure that there are no air bubbles. Add appropriate preservatives to the other samples and check pH.

Note: Use a separate container when field-testing pH, conductivity, temperature, etc. Do not insert pH paper or probe directly into sample container.

6. Cap the sample container(s). Wipe the outside of sample containers clean with a Kimwipe or clean paper towel. Affix a completed sample label.

7. Place sample container(s) in individual zip-top plastic bags and seal the bags.

8. Immediately pack all samples into a chilled cooler.

9. Drain the pump system, rinse it with deionized water, and wipe it dry. Replace all tubing with new tubing before sampling at another sampling location. Place all used tubing in plastic bags to be discarded or decontaminated according to the site-specific plans.

6.0 Restrictions/Limitations

Peristaltic pumps are generally not capable of lifting water distances greater than 6 to 7.5 meters (20 to 25 feet) above the normal hydrostatic level.

Grab sampling for VOC analysis or for analysis of any other compound(s) that may be degraded by aeration is necessary to minimize sample disturbance and, hence, analyte loss. The representativeness of this sample, however, is difficult to determine because the collected sample represents a single point and has been disturbed.

7.0 References

U.S. Department of Energy, Hazardous Waste Remedial Actions Program, *Quality Control Requirements for Field Methods*, DOE/HWP-69/R1, July 1990 or current revision.

U.S. Department of Energy, Hazardous Waste Remedial Actions Program, *Standard Operating Procedures for Site Characterizations*, DOE/HWP-100/R2, September 1996 or current revision.

U.S. Environmental Protection Agency, Region II, *CERCLA Quality Assurance Manual*, March 1988 or current revision.

U.S. Environmental Protection Agency, Region IV, *Environmental Investigations, Standard Operating Procedures and Quality Assurance Manual*, May 1996 or current revision.

U.S. Geological Survey, *National Field Manual for the Collection of Water-Quality Data*, Chapter A8, October 1997.

TSOP 1-2

SAMPLE CUSTODY

CONTRACT-SPECIFIC CLARIFICATION

SOP Title: **SAMPLE CUSTODY**

SOP No.: 1 - 2
Revision: 4
Date: October 10, 2004

QA Review: [signature]

Approved and Issued: [signature] 11/1/04
Program Manager Signature/Date

Contract No.: RAC II   Client: EPA Region II

Reason for Clarification: Make SOP EPA Region II – Specific
Add Forms II Lite Procedures; Sample tags requirement not applicable.

1.0 OBJECTIVE, add (to page 1 of 7):

For the RAC II contract, the sample custody paperwork will also be supplied to the U.S. Environmental Protection Agency (EPA) Region II Regional Sample Contract Laboratory Program (CLP) Coordinator and the Contract Laboratory Analytical Service Support (CLASS) contact. This will include the combination forms generated using the EPA Field Operations Records Management System II Lite (FORMS II Lite™) software and the hand written combination traffic reports & chain of custody records (TR/COCs).

All samples sent through the CLP system are required to be recorded on the FORMS II Lite™ generated combination TR/COC records. Use of hand written TR/COCs must be approved by EPA Regional Sample Control Center (RSCC) prior to use.

4.0 REQUIRED SUPPLIES, add (to page 2 of 7):

If using the FORMS II Lite™ software the following additional equipment will be required:

- FORMS II Lite™ Software
- Computer
- Printer

5.0 PROCEDURES
5.1 Chain-of-Custody

Field Custody, on page 2 of 7 under item 2, replace:

"Complete sample label or tags for each sample, using waterproof ink.", with, "Complete sample labels for each sample using indelible ink or pre-printed labels."

Add, before 5.2 Sample Labels and Tags (on page 5 of 7):

Procedure for Generating EPA's FORMS II Lite™ Combination Forms

FORMS II Lite™ is used to automate printing of sample documentation in the field and facilitate electronic capture of data prior to and during field sampling activities. FORMS II Lite™ can be populated with the general site information, laboratory information, CLP case number, sample locations, CLP sample numbers, analysis, preservatives, etc. prior to the sampling event. Sample labels can then be generated from FORMS II Lite™.

The following is a list of items required to be entered into FORMS II Lite™:

- Site spill number
- Region number, sampling entity, sampler name and signature
- Type of activity
- Date shipped, courier and air bill number
- Analytical laboratory name, address and contact
- Case number
- CLP sample number
- Sample description (media type)
- Sample concentration (low, medium, high)
- Sample type (composite, grab)
- Preservative used
- Turn-around time (for organic analysis only)
- Routine Analytical Services (RAS) fraction(s)
- Date and time of sample collection
- Sampler's initials
- Corresponding CLP inorganic CLP sample number, if applicable
- Field QC sample information (information regarding trip or field blanks but not reference to duplicate samples)
- Whether shipment for case is complete
- Sample designated for matrix spike laboratory QC purposes

The procedures for generating the FORMS II Lite™ combination forms are similar to preparing the CLP RAS combination forms detailed in the next section. The difference is the information will be entered into the FORMS II Lite™ software and the combination forms will be printed out on site instead of filling in the combination forms in by hand.

Detailed procedures for using the FORMS II Lite™ software are provided in the FORMS II Lite™ User's Guide supplied with the software.

After completing the day's sampling, the date, time and field QC sample information are entered into the FORMS II Lite™ software. Samples are assigned to the traffic reports, shipping information is entered and the traffic reports are printed. The software generates a Region and a Laboratory copy of the TR/COC record. The Laboratory copies of the TR/COC records are signed and placed in a zip-lock bag taped to the inside cooler lid and shipped with the samples to the laboratory. The Region copies of the TR/COC records are submitted to the RSCC and to CLASS along with the sampling trip report. Examples of TR/COC records that FORMS II Lite™ generates for the Laboratory copies (Figures C1 and C2) and the Region copies (Figures C3 and C4) are attached to this Contract-Specific Clarification. A copy of the sampling trip report is made and retained for the CDM RAC II files.

Procedure for Completing EPA CLP RAS Combination Forms

A combination Organic or Inorganic TR/COC record is a four-page carbonless form (Figures C5and C6). The information that must be entered in the combination forms is detailed in the *Contract Laboratory Program (CLP) Guidance for Field Samplers* (EPA/540/R-00/003). A copy of this guidance is to be on site. Field quality control blanks and matrix spike samples will be noted on the combinations forms.

Each sample will be assigned a CLP identification number that will be written or pre-printed on the sample label and affixed in the field to each container for CLP analysis. This unique number, which is recorded on the combination form, is used by EPA to identify the sample. Notations will be made if the sample is to be used as the matrix spike/ matrix spike duplicate (organics), matrix spike/duplicate (inorganics), a field (rinsate) blank or trip blank. The same information required to be entered into FORMS II Lite™ is also required on hand written combination Organic or Inorganic TR/COC.

After completing the day's sampling, the bottom two copies of each completed combination form are placed in a zip-lock bag taped to the inside cooler lid and shipped with the samples to the laboratory. The top copy is submitted to the RSCC and the second copy is submitted to CLASS along with the sampling trip report. A copy of each combination form is made and retained for the CDM RAC II files.

5.2 **Sample Labels and Tags**, (on page 5 of 7)

It should be noted that sample tags are no longer required for Region II CLP samples. Therefore, Figure 2 on page 6 of 7 is not applicable.

7.0 **REFERENCES**, add (on page 7 of 7):

Environmental Protection Agency (EPA). 1989. *Region II CERCLA Quality Assurance Manual.* Revision 1. EPA Monitoring Management Branch of the Environmental Services Division. October 1989.

_______. 2002. *FORMS II Lite™ User's Guide, Version 5.1.*

_______. 2004. *Contract Laboratory Program (CLP), Guidance for Field Samplers.* EPA-R-00-003. Final. EPA-540-R-00-003. August.

Prepared: David O. Johnson

Technical Review: Shelley Thibeault

QA Review: Laura Splichal

Approved: [signature] 2/24/04
Signature/Date

Issued: [signature] 2/18/04
Signature/Date

1.0 Objective

Due to the evidentiary nature of samples collected during environmental investigations, possession must be traceable from the time the samples are collected until their derived data are introduced as evidence in legal proceedings. To maintain and document sample possession, sample custody procedures are followed. All paperwork associated with the sample custody procedures will be retained in CDM Federal Programs Corporation (CDM) files unless the client requests that it be transferred to them for use in legal proceedings or at the completion of the contract.

Note: Sample custody documentation requirements vary with the specific EPA region or client. This SOP is intended to present basic sample custody requirements, along with common options. Specific sample custody requirements should be presented in the project-specific quality assurance (QA) project plan or project-specific modification or clarification form (see Section U-1).

2.0 Background

2.1 Definitions

Sample – A sample is material to be analyzed that is contained in single or multiple containers representing a unique sample identification number.

Sample Custody – A sample is under custody if:

1. It is in your possession
2. It is in your view, after being in your possession
3. It was in your possession and you locked it up
4. It is in a designated secure area

Chain-of-Custody Record – A chain-of-custody record is a form used to document the transfer of custody of samples from one individual to another.

Custody Seal – A custody seal is a tape-like seal that is part of the chain-of-custody process and is used to detect tampering with samples after they have been packed for shipping.

Sample Label – A sample label is an adhesive label placed on sample containers to designate a sample identification number and other sampling information.

Sample Tag – A sample tag is attached with string to a sample container to designate a sample identification number and other sampling information. Tags may be used when it is difficult to physically place adhesive labels on the container (e.g., in the case of small air sampling tubes).

3.0 Responsibilities

Sampler - The sampler is personally responsible for the care and custody of the samples collected until they are properly transferred or dispatched.

Field Team Leader - The field team leader (FTL) is responsible for ensuring that strict chain-of-custody procedures are maintained during all sampling events. The FTL is also responsible for coordinating with the subcontractor laboratory to ensure that adequate information is recorded on custody records. The FTL determines whether proper custody procedures were followed during the fieldwork and decides if additional samples are required.

Field Sample Custodian - The field sample custodian, when designated by the FTL, is responsible for accepting custody of samples from the sampler(s) and properly packing and shipping the samples to the laboratory assigned to do the analyses. A field sample custodian is typically designated only for large and complex field efforts.

4.0 Required Supplies

- Chain-of-custody records (applicable client or CDM forms)
- Sample labels or tags
- Custody seals
- Clear tape

5.0 Procedures

5.1 Chain-of-Custody Record

This procedure establishes a method for maintaining custody of samples through use of a chain-of-custody record. This procedure will be followed for all samples collected or split samples accepted.

Field Custody

1. Collect only the number of samples needed to represent the media being sampled. To the extent possible, determine the quantity and types of samples and sample locations prior to the actual fieldwork. As few people as possible should handle samples.

2. Complete sample labels or tags for each sample using waterproof ink.

3. Maintain personal custody of the samples (in your possession) at all times until custody is transferred for sample shipment or directly to the analytical laboratory.

Transfer of Custody and Shipment

1. Complete a chain-of-custody record for all samples (see Figure 1 for an example of a chain-of-custody record. Similar forms may be used when requested by the client). When transferring the possession of samples, the individuals relinquishing and receiving will sign, date, and note the time on the record. This record documents sample custody transfer from the sampler, often through another person, to the sample custodian in the appropriate laboratory.

   - The date/time will be the same for both signatures when custody is transferred directly to another person. When samples are shipped via common carrier (e.g., Federal Express), the date/time will not be the same for both signatures. Common carriers are not required to sign the chain-of-custody record.

- In all cases, it must be readily apparent that the person who received custody is the same person who relinquished custody to the next custodian.
- If samples are left unattended or a person refuses to sign, this must be documented and explained on the chain-of-custody record.

Note: If a field sample custodian has been designated, he/she may initiate the chain-of-custody record, sign, and date as the relinquisher. The individual sampler(s) must sign in the appropriate block, but does (do) not need to sign and date as a relinquisher (refer to Figure 1).

2. Package samples properly for shipment and dispatch to the appropriate laboratory for analysis. Each shipment must be accompanied by a separate chain-of-custody record. If a shipment consists of multiple coolers, samples in the coolers may be recorded on a single chain-of-custody record.

3. The original record will accompany the shipment, and the copies will be retained by the FTL and, if applicable, distributed to the appropriate sample coordinators. Freight bills will also be retained by the FTL as part of the permanent documentation. The shipping number from the freight bill shall be recorded on the applicable chain-of-custody record.

Procedure for Completing CDM Example Chain-of-Custody Record

The following procedure is to be used to fill out the CDM chain-of-custody record. The record provided herein (Figure 1) is an example chain-of-custody record. If another type of custody record (i.e., provided by the EPA contract laboratory program or a subcontract laboratory) is used to track the custody of samples, the custody record should be filled out in its entirety.

1. Record project number.
2. Record FTL for the project (if a field sample custodian has been designated, also record this name in the "Remarks" box).
3. Record the name and address of the laboratory to which samples are being shipped.
4. Enter the project name/location or code number.
5. Record overnight courier's airbill number.
6. Record sample location number.
7. Record sample number.
8. Note preservatives added to the sample.
9. Note media type (matrix) of the sample.
10. Note sample type (grab or composite).
11. Enter date of sample collection.
12. Enter time of sample collection in military time.

Figure 1
Example CDM Chain-of-Custody Record

CDM

125 Maiden Lane, 5th Floor
New York, NY 10038
(212) 785-9123
Fax: (212) 785-6114

CHAIN OF CUSTODY RECORD

PROJECT ID.	FIELD TEAM LEADER	LABORATORY AND ADDRESS	DATE SHIPPED
PROJECT NAME/LOCATION		LAB CONTRACT:	AIRBILL NO.

MEDIA TYPE	PRESERVATIVES	SAMPLE TYPE
1. Surface Water	1. HCl, pH <2	G = Grab
2. Groundwater	2. HNO3, pH <2	C = Composite
3. Leachate	3. NaOH, pH >12	
4. Field QC	4. H2SO4, pH <2	
5. Soil/Sediment	5. Zinc Acetate, pH >9	
6. Oil	6. Ice Only	
7. Waste	7. Not Preserved	
8. Other ______	8. Other ______	

ANALYSES (List no. of containers submitted)

SAMPLE LOCATION NO.	LABORATORY SAMPLE NUMBER	PRESERVATIVES ADDED	MEDIA TYPE	SAMPLE TYPE	20__ DATE	TIME SAMPLED									REMARKS (Note if MS/MSD)
1.															
2.															
3.															
4.															
5.															
6.															
7.															
8.															
9.															
10.															

SAMPLER SIGNATURES:

RELINQUISHED BY: (PRINT) (SIGN)	DATE/TIME	RECEIVED BY: (PRINT) (SIGN)	DATE/TIME	RELINQUISHED BY: (PRINT) (SIGN)	DATE/TIME	RECEIVED BY: (PRINT) (SIGN)	DATE/TIME
RELINQUISHED BY: (PRINT) (SIGN)	DATE/TIME	RECEIVED BY: (PRINT) (SIGN)	DATE/TIME	RELINQUISHED BY: (PRINT) (SIGN)	DATE/TIME	RECEIVED BY: (PRINT) (SIGN)	DATE/TIME

COMMENTS:

DISTRIBUTION: White and yellow copies accompany sample shipment to laboratory; yellow copy retained by laboratory. Pink copy retained by samplers. 1/98

Note: If requested by the client, different chain-of-custody records may be used. Copies of the template for this record may be obtained from the Chantilly Graphics Department.

13. When required by the client, enter the names or initials of the samplers next to the sample location number of the sample they collected.
14. List parameters for analysis and the number of containers submitted for each analysis.
15. Enter matrix spike/matrix spike duplicate (MS/MSD) if sample is for laboratory quality control or other remarks (e.g., sample depth).
16. Sign the chain-of-custody record(s) in the space provided. All samplers must sign each record.
17. If sample tags are used, record the sample tag number in the "Remarks" column.
18. The originator checks information entered in Items 1 through 16 and then signs the top left "Relinquished by" box, prints his/her name, and enters the current date and time (military).
19. Send the top two copies (usually white and yellow) with the samples to the laboratory; retain the third copy (usually pink) for the project files. Retain additional copies for the project file or distribute as required to the appropriate sample coordinators.
20. The laboratory sample custodian receiving the sample shipment checks the sample label information against the chain-of-custody record. Sample condition is checked and anything unusual is noted under "Remarks" on the chain-of-custody record. The laboratory custodian receiving custody signs in the adjacent "Received by" box and keeps the copy. The white copy is returned to CDM.

5.2 Sample Labels and Tags

Unless the client directs otherwise, sample labels or tags will be used for all samples collected or accepted for CDM projects.

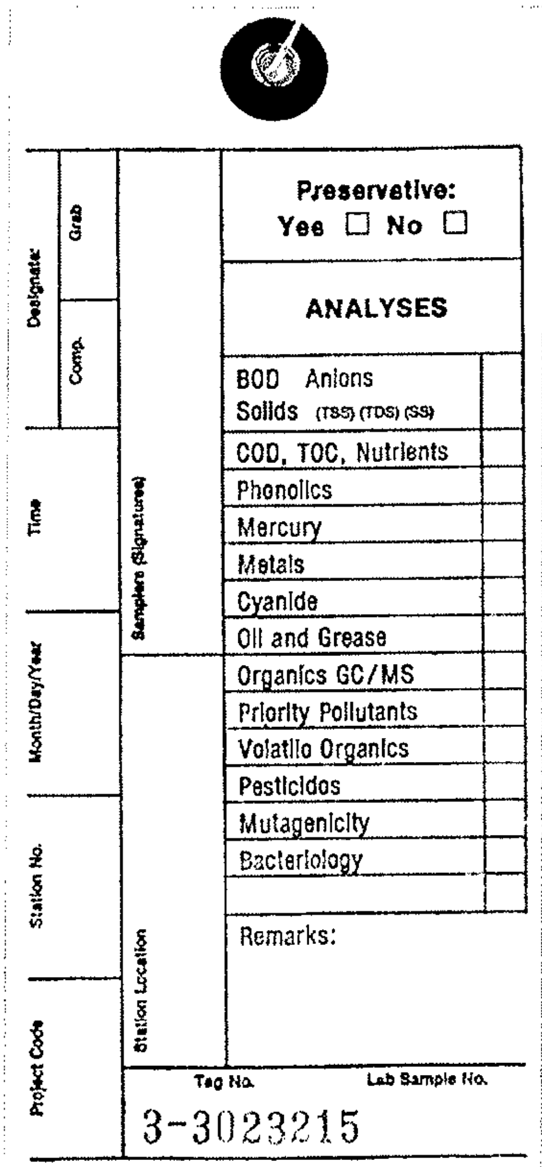
1. Complete one label or tag with the information required by the client for each sample container collected. A typical label or tag would be completed as follows (see Figure 2 for example of sample tag; labels are completed with the equivalent information):

   - Record the project code (i.e., project or task number).
   - Enter the station number (sample number) if applicable.
   - Record the date to indicate the month, day, and year of sample collection.
   - Enter the time (military) of sample collection.
   - Place a check to indicate composite or grab sample.
   - Record the station (sample) location.
   - Sign in the space provided.
   - Place a check next to "yes" or "no" to indicate if a preservative was added.
   - Place a check under "Analyses" next to the parameters for which the sample is to be analyzed. If the desired analysis is not listed, write it in the empty slot. Note: Do not write in the box for "laboratory sample number."
   - Place or write additional relevant information under "Remarks."

2. Place adhesive labels directly on the sample containers. Place clear tape over the label to protect from moisture.

3. Securely attach sample tags to the sample bottle. On 2.27 liter (80 oz.) amber bottles, the tag string may be looped through the ring style handle and tied. On all other containers, it is

Figure 2
Example Sample Tag



Designate: Grab / Comp.
Time
Month/Day/Year
Station No.
Project Code
Samplers (Signature)
Station Location

Preservative:
Yes ☐ No ☐

ANALYSES

BOD Anions Solids (TSS) (TDS) (SS)	
COD, TOC, Nutrients	
Phenolics	
Mercury	
Metals	
Cyanide	
Oil and Grease	
Organics GC/MS	
Priority Pollutants	
Volatile Organics	
Pesticides	
Mutagenicity	
Bacteriology	

Remarks:

Tag No. Lab Sample No.
3-3023215

Note: Equivalent sample labels or tags may be used.

recommended that the string be looped around the neck of the bottle, then twisted and re-looped around the neck until the slack in the string is removed.

4. Double-check that the information recorded on the sample tag is consistent with the information recorded on the chain-of-custody record.

5.3 Custody Seals

Two custody seals must be placed on opposite corners of all shipping containers (e.g., cooler) prior to shipment. The seals should be signed and dated by the shipper.

Custody seals may also be placed on individual sample bottles. Check with the client or refer to EPA regional guidelines for direction.

5.4 Sample Shipping

The CDM standard operating procedure listed below defines the requirements for packaging and shipping environmental samples.

- CDM Federal SOP 2-1, Packaging and Shipping Environmental Samples

6.0 Restrictions/Limitations

Check with the EPA region or client for specific guidelines. If no specific guidelines are identified, this procedure should be followed.

For EPA Contract Laboratory Program (CLP) sampling events, combined chain-of-custody/traffic report forms or other EPA-specific records may be used. Refer to regional guidelines for completing these forms.

The EPA FORMS II Lite™ software may be used to customize sample labels and custody records when directed by the client or the CDM project manager.

7.0 References

U.S. Environmental Protection Agency, *EPA Guidance for Quality Assurance Project Plans*, EPA QA/G-5, EPA/600/R-98/018, February 1998, Section B3.

U.S. Environmental Protection Agency, *National Enforcement Investigations Center, Multi-Media Investigation Manual*, EPA-330/9-89-003-R, Revised March 1992, p.85.

U.S. Environmental Protection Agency, *Contract Laboratory Program (CLP), Guidance for Field Samplers*, EPA-540-R-00-003, Draft Final, June 2001, Section 3.2.

U.S. Environmental Protection Agency, *FORMS II Lite™ User's Guide*, March 2001.

U.S. Environmental Protection Agency, Region IV, *Environmental Investigations Standard Operating Procedures and Quality Assurance Manual*, May 1996, Section 3.3.

U.S. Army Corps of Engineers, *Requirements for the Preparation of Sampling and Analysis Plan*, EM 200-1-3, February 2001, Appendix F.

TSOP 1-3

SURFACE SOIL SAMPLING

CONTRACT-SPECIFIC CLARIFICATION

SOP Title: **SURFACE SOIL SAMPLING**

SOP No.: 1 - 3
Revision: 5
Date: October 15, 2004

QA Review: J. Buford

Approved and Issued: J. Setwen 11/1/04
Program Manager Signature/Date

Contract No.: RAC II Client: EPA Region II

Reason for Clarification: Include 1) sample collection procedures for VOCs using 40-ml closed-system vials and 2) soil homogenization procedures for non-VOC samples.

Adds definition of homogenization to Section 2.1 and clarifies Section 5.4.2, item 6 (page 7 of 7) of TSOP 1-11:

2.1 Definitions, add (on page 1 of 7):
Homogenization - The process of mixing individual grab samples in order to minimize the bias in sample representativeness introduced by the natural stratification of constituents within the sample.

5.4.2 Homogenization of soil is accomplished by thoroughly mixing the collected soil with a stainless steel spoon or spatula in the following manner. The soil should be scraped from the stainless steel container sides, corners, and bottom, then rolled into the middle and initially mixed. The soil is then quartered and moved to the four quarters of the container. Each quarter of the sample should be mixed individually, then rolled to the center of the stainless steel container sample mixed again.

Add a Section 5.5 (page 7) to include the option for closed system vials:

5.5 Sediment/Sludge Sample Collection for Volatile Organic Compound (VOC) Analysis in Closed-System Vials
This procedure follows EPA's *CLP Sample Collection Guidelines for Volatile Organic Analytes (VOAs) in Soil by SW-846 Method 5035A*, May 2004, Option 1 (Appendix B of EPA's *Contract Laboratory Guidance for Field Samplers*).

5.5.1 Required Equipment
In addition to the required equipment listed in Section 4.0, the following equipment is also needed:

- Tared or pre-weighed, pre-labeled 40 milliliter (mL) volatile organic analysis (VOA) vials containing a magnetic spin bar (three per sample)
- 60-mL glass jar with Teflon sealed cap or one 40-mL VOA vial
- Sample labels
- Portable scale
- Stainless steel spatula

5.5.2 Method for Collecting Surface Soil Samples for Volatile Organic Compound (VOC) Analysis in Closed-System Vials

1. Use the appropriate decontaminated stainless steel or Teflon sampling device to collect the sample.
2. Retrieve the sampling device and slowly decant off any liquid phase.
3. Complete the sample label by filling in the appropriate information. ***Do not*** cover the label with tape.
4. Place the tared or pre-weighed, pre-labeled 40-mL VOA vial and cap on the scale.
5. With the aid of a clean stainless steel spatula, quickly add 5 grams of soil to the vial.
6. Immediately secure the Teflon-lined cap on the sample container.
7. Repeat the procedure for the remaining two vials.
8. Collect percent moisture sample in a 40-mL VOA vial or 60-mL jar with Teflon sealed cap. Fill the entire sample container with soil, no headspace.
9. Store samplers at 4° Celsius, and ship the sample to the analytical laboratory. The sample must be received by the laboratory within 48 hours of sample collection.

7.0 Reference

U.S. Environmental Protection Agency. 2004. *Contract Laboratory Program (CLP) Guidance for Field Samplers*, Final. EPA-540-R-00-003, August.

________. 1989. Monitoring Management Branch of the Environmental Services Division, *Region II CERCLA Quality Assurance Manual*. Final Copy. Revision 1. October.

Surface Soil Sampling

Prepared: Del R. Baird

Technical Review: Regina Clifford

QA Review: David O. Johnson

Approved: Signature/Date

Issued: Signature/Date 2/18/04

1.0 Objective

The objective of this standard operating procedure (SOP) is to define the techniques and requirements for collecting surface soil samples.

2.0 Background

Surface soils are generally defined as the soils extending from ground surface to approximately 30 centimeters (cm) (1 foot) below ground surface (bgs). Surface soil samples are frequently collected from 0 to 15 cm (0 to 6 inches) bgs. The techniques and protocols described herein may be used to collect other surface media, including sediment and sludge.

2.1 Definitions

Surface Soil - The soil that exists down from the surface approximately 30 cm (1 foot). Depending on application, the soil interval to be sampled will vary.

Grab Sample - A discrete portion or aliquot taken from a specific location at a given point in time.

Composite - Two or more sub-samples taken from a specific media and site at a specific point in time. The sub-samples are collected and mixed, then a single average sample is taken from the mixture.

Spoon/Scoop - A small stainless steel or Teflon® utensil approximately 15 cm (6 inches) in length with a stem-like handle.

Trowel - A small stainless steel or Teflon shovel approximately 15 to 20 cm (6 to 8 inches) in length with a slight (approximately 140°) curve across the length. The trowel has a stem-like handle (for hand operation). Samples are collected with a spooning action.

2.2 Discussion

Surface soil samples are collected to determine the type(s) and level(s) of contamination and are often important to risk assessment. These samples may be collected as part of an investigative plan, site-specific sampling plan, and/or as a screen for "hot spots," which may require more extensive sampling.

Sediment(s) and sludge(s) that have been exposed by evaporation, stream rerouting, or any other means are collected by the same methods as those for surface soil(s). Typically the top 1 to 2 cm of material, including vegetation, are carefully removed before collection of the sample.

Surface soil and exposed sediment or sludge are collected using stainless steel and/or Teflon-lined trowels or scoops.

2.3 Associated Procedures

- CDM Federal SOP 1-2, Sample Custody
- CDM Federal SOP 2-1, Packaging and Shipping Environmental Samples
- CDM Federal SOP 4-1, Field Logbook Content and Control
- CDM Federal SOP 4-5, Field Equipment Decontamination at Non-Radioactive Sites

3.0 Responsibilities

Site Manager - The site manager is responsible for ensuring that sampling efforts are conducted in accordance with this procedure and any other SOPs pertaining to specific media sampling. The site manager must also ensure that the quantity and location of surface soil samples collected meet the requirements of the site-specific plans.

Field Team Leader - The field team leader is responsible for ensuring that field personnel collect surface soil samples in accordance with this procedure and other relevant procedures.

4.0 Required Equipment

- Insulated cooler and clear waterproof sealing tape
- Ice bags or "blue ice"
- Latex or appropriate gloves
- Plastic zip-top bags
- Personal protective clothing and equipment
- Stainless steel and/or Teflon-lined spatulas and pans, trays, or bowls
- Stainless steel and/or Teflon-lined trowels or spoons (or equipment as specified in the site-specific plans)
- Plastic sheeting
- Project plans (work plan/health and safety plan)
- Appropriate sample containers
- Field logbook
- Indelible black ink pen and/or marker
- Sample chain-of-custody forms
- Custody seals
- Decontamination supplies

Additional equipment is discussed in Section 5.2.2, VOC Field Sampling/Preservation Methods.

5.0 Procedures

5.1 Preparation

The following steps must be followed when preparing for sample collection:

1. Don the appropriate personal protective clothing as dictated by the site-specific health and safety plan.

2. Locate sampling location(s) in accordance with project documents (e.g., work plan) and document pertinent information in the appropriate field logbook. When possible, reference locations back to existing site features such as buildings, roads, intersections, etc.

3. Processes for verifying depth of sampling must be specified in the site-specific plans.

4. Place clean plastic sheeting on a flat, level surface near the sampling area, if possible, and place equipment to be used on the plastic; place the insulated cooler(s) on separate plastic sheeting.

5. A clean, decontaminated trowel, scoop, or spoon will be used for each sample collected. Other equipment may be used (e.g., shovels) if constructed of stainless steel.

5.2 Collection

The following general steps must be followed when collecting surface soil samples:

1. Surface soil samples are normally collected from the least contaminated to the most contaminated areas, if known.

2. Document the sampling events, recording the information in the designated field logbook. Document any and all deviations from SOPs in the field logbook and include rationale for changes. See CDM Federal SOP 4-1.

3. Carefully remove stones, vegetation, snow, etc. from the ground surface in the immediate vicinity of the sampling location.

4. First collect required sample aliquot for volatile analyses as well as any other samples that would be degraded by aeration. Follow with collection of samples for other analyses.

5. Decontaminate sampling equipment between sample locations. See CDM Federal SOP 4-5.

5.2.1 Method for Collecting Samples for Volatile Organic Compound (VOC) Analysis

The requirements for collecting grab samples of surface soil for VOCs or other samples degraded by aeration are as follows:

1. VOC samples shall be collected with the least disturbance possible.

2. VOC samples shall be collected as grab samples; however, the method of collection will vary from site to site, based on data quality objectives and the degree of known or suspected contamination.

3. Complete sample label by filling in the appropriate information and securing the label to the container. Cover the sample label with a piece of clear tape.

4. Use a clean stainless steel or Teflon-lined trowel or spoon (or tube) to collect sufficient material in one grab to fill the sample containers.

5. With the aid of a clean stainless steel spatula, quickly fill the sample containers directly from the sampling device, removing stones, twigs, grass, etc., from the sample. Fill the containers as full and compact as possible to minimize headspace.

6. Immediately secure the Teflon-lined cap(s) on the sample container(s).

7. Wipe the containers with a clean Kimwipe or paper towel to remove any residual soil from the exterior of the container.

8. Place the containers in individual zip-top plastic bag(s) and seal the bag(s).

9. Pack all samples as required. Include properly completed documentation and affix signed and dated custody seals to the cooler lid.

Note: A trip blank should be included with sample coolers containing VOC samples. QC sample requirements vary from project to project. Consult the project-specific work plan for requirements.

5.2.2 VOC Field Sampling/Preservation Methods
The following four sections contain SW-846 test methods for sampling and field preservation. These methods include EN CORE™ Sampler Method for low-level analyses, EN CORE Sampler Method for high-level analyses, acid preservation for low-level analyses, and methanol preservation for high-level analyses. These methods are very detailed and contain equipment requirements at the beginning of each section.

When collecting soil samples using the EN CORE Sampler Method, collection of soil for moisture content analysis is required. Results of this analysis are used to adjust "wet" concentration results to "dry" concentrations to meet analytical method requirements.

Note: Some variations from these methods (e.g., sample volume) may be required depending on the contracted analytical laboratory.

5.2.2.1 EN CORE Sampler Collection for Low Level Analyses (≥1 μg/kg)
EN CORE Sampling Equipment Requirements
The following equipment is required for low-level analysis:

- Three 5-gram (g) samplers

Note: The sample volume requirements are general requirements. Actual sample volumes, sizes, and quantities may vary depending on client or laboratory requirements.

- One 110-milliliter (mL) (4-ounce) widemouth glass jar or applicable container for moisture analysis
- One T-handle
- Paper towels

EN CORE Sampling Steps for Low Level Analysis

1. Remove sampler and cap from package and attach T-handle to sampler body.

2. Quickly push the sampler into a freshly exposed surface of soil until the O-ring is visible within the hole on the side of the T-handle. If the O-ring is not visible within this window, then the sampler is not full.

3. Extract the sampler and wipe the sampler head with a paper towel so that the cap can be tightly attached.

4. Push cap on with a twisting motion to secure to the sampler body.

5. Rotate the sampler stem counterclockwise until stem locks in place to retain sample within the sampler body.

6. Fill out sample label and attach to sampler.

7. Repeat procedure for the remaining two samplers.

8. Collect moisture sample in 110-mL (4-ounce) widemouth jar using a clean stainless steel spoon or trowel.

9. Store samplers at 4° Celsius (C), ±2°C. Samples must be shipped and delivered to the analytical laboratory for extraction within 48 hours.

Note: Verify requirements for extraction/holding times.

5.2.2.2 Acid Preservation Sampling for Low Level Analyses (≥1 µg/kg)
Note: Determine specific field acid preservation procedure based on the requirements specified in the analytical method to be employed. Variations between analytical methods exist with respect to field acid preservation.

Acid Preservation Sampling Equipment Requirements
The following equipment and supplies are required if field acid preservation is required:

- One 40 mL VOA vial with acid preservation (for field testing of soil pH)
- Two pre-weighed 40 mL VOA vials with acid preservative and stir bar (for lab analysis)
- Two pre-weighed 40 mL VOA vials with water and stir bar (in case samples cannot be pre-preserved)
- One pre-weighed jar that contains methanol or a pre-weighed empty jar accompanied with a pre-weighed vial that contains methanol (for screening sample and/or high level analysis)
- One 110-mL (4-oz) widemouth glass jar or applicable container for moisture analysis
- One 55-mL (2-oz) jar with acid preservative (in case additional acid is needed due to high soil pH)
- One appropriately sized scoop capable of delivering 1 g of solid sodium bisulfate
- pH paper
- Weighing scale capable of reading to 0.01 g
- Set of balance weights used in daily balance calibration
- Gloves for working with pre-weighed sample vials
- Paper towels
- Sodium bisulfate acid solution ($NaHS0_4$)
- A cutoff plastic syringe or other coring device capable of collecting sufficient sample volume (5 g)

Testing Effervescing Capacity of Soils

Soils must be tested with acid to determine the amount of effervescing that will occur when preserved with acid. Effervescing will drive off VOCs as well as create a high pressure in a sealed vial that could result in the explosion of the sample container. The following steps provide information on the effervescing capacity of the soil.

1. Place approximately 5 g of soil into a vial that contains acid preservative and no stir bar.

2. Do not cap this vial as it may EXPLODE upon interaction with the soil.

3. Observe the sample for gas formation (due to carbonates in the soil).

4. If vigorous or sustained gas emissions are observed, then acid preservation is not acceptable to preserve the sample.

   - In this case the samples need to be collected in the VOA vials with only water and a stir bar. The vials with acid preservative CANNOT be used.

5. If a small amount or no gas formation occurs, then acid preservation is acceptable to preserve the sample. Keep this testing vial for use in the buffering test detailed below.

   - In this case the samples need to be collected in the VOA vials with the acid preservative and a stir bar.

Testing Buffering Capacity of Soils

The soils must be tested to determine the quantity of acid that is required to achieve a pH reading of ≤2 standard units (STUs). The following steps will assist in determining this quantity.

1. If acid preservation is acceptable for sampling soils, then the sample vial that was used to test the effervescing capacity of the soils can be used to test the buffering capacity.

2. Cap the vial that contains 5 g of soil, acid preservative, and no stir bar from Step 1 in the effervescing test.

3. Shake the vial gently to homogenize the contents.

4. Open the vial and check the pH of the acid solution with pH paper.

   - If the pH paper reads below 2, then the sampling can be done in the two pre-weighed 40 mL VOA vials with the acid preservative and stir bar. Since the pH was below 2, it is not necessary to add additional acid to the vials.

   - If the pH paper reads above 2, then additional acid needs to be added to the sample vial.

5. Use the jar with the solid sodium bisulfate acid and add another 1 g of acid to the sample.

6. Cap the vial and shake thoroughly again.

7. Repeat Step 4.

   - If the pH paper reads below 2, then the sampling can be done in the two pre-weighed 40 mL VOA vials with the acid preservative and stir bar and 1 g extra of acid.

   - Make a note of the extra gram of acid needed so the same amount of acid can be added to the vials the lab will analyze.

   - If the pH paper reads above 2, repeat Steps 5 through 7 until the sample pH ≤2 STUs.

Now that the soil chemistry has been determined, the actual sampling can occur. The procedure stated below assumes the correct vials are used based on the guidance discussed.

Sample Preservation Steps

1. Wear gloves during all handling of pre-weighed vials.

2. Add more acid if necessary (based on the buffering capacity testing discussed in the previous section).

3. Quickly collect a 5-g sample using a cutoff plastic syringe or other coring device designed to deliver 5 g of soil from a freshly exposed surface of soil.

4. Carefully wipe exterior of sample collection device with a clean paper towel.

5. Quickly transfer the sample to the appropriate VOA vial, using caution when extruding the sample to prevent splashing of the acid in the vial.

6. Remove any soil from the threads of the sample vial using a clean paper towel.

7. Cap vial and weigh the jar to the nearest 0.01 g.

8. Record exact weight on sample label.

9. Repeat sampling procedure for the duplicate VOA vial.

10. Weigh the vial containing methanol preservative to the nearest 0.01 g. If the weight of the vial with methanol varies by more than 0.01 g from the original weight recorded on the vial, discard the vial. If the weight is within tolerance, it can be used for soil preservation below.

11. Take the empty jar or the jar that contains the methanol preservative.

12. Quickly collect a 5-g or 25-g sample using a cutoff plastic syringe or other coring device designed to deliver 5 g or 25 g of soil from a freshly exposed surface of soil. The 5-g or 25-g size is dependent on who is doing the sampling and requirements specified by the client or analytical laboratory.

13. Carefully wipe the exterior of the collection device with a clean paper towel.
14. Quickly transfer the soil to an empty jar or a jar that contains methanol. If extruding into a jar that contains methanol, be careful not to splash the methanol outside of the vial.
15. If the jar used to collect the soil plug was empty before the soil was added, immediately preserve with the methanol provided, using only one vial of methanol preservative per sample jar.
16. Remove any soil from the threads of the sample vial using a clean paper towel and cap the jar.
17. Weigh the jar with sample to the nearest 0.01 g and record the weight on the sample label.
18. Collect dry weight sample using a clean stainless steel spoon or trowel.
19. Store samples at 4°C, ±2°C.
20. Ship sample containers to the analytical laboratory with plenty of ice and in accordance with Department of Transportation (DOT) regulations (CORROSIVE. FLAMMABLE LIQUID. POISON).

5.2.2.3 EN CORE Sampler Collection for High Level Analyses (≥200 µg/kg)

EN CORE Sampling Equipment Requirements

The following equipment is required for high-level analysis.

- One 5-g sampler or one 25-g sampler

Note: The volume requirements specified are general requirements. Actual sample volumes, container sizes, and quantities may vary depending on client or laboratory requirements.

- One 110-mL (4-oz) widemouth glass jar or applicable container specified for moisture analysis
- One T-handle
- Paper towels

EN CORE Sampling Steps for High Level Analysis

1. Remove sample and cap from package and attach T-handle to sampler body.
2. Quickly push the sampler into freshly exposed surface of soil until the O-ring is visible within the hole/window on the side of the T-handle. If the O-ring is not visible within the window/hole, then the sampler is not full.
3. Use a clean paper towel to quickly wipe the sampler head so that the cap can be tightly attached.
4. Push cap on with a twisting motion to secure to the sampler body.
5. Fill out sample label and attach to sampler.

6. Rotate sampler stem counterclockwise until the stem locks in place to retain the sample within the sampler body.

7. Collect moisture sample in 110-mL (4-oz) widemouth glass jar or designated container using a clean stainless steel spoon or trowel.

8. Store samplers at 4°C, ±2°C. Samples must be shipped and delivered to the analytical laboratory for extraction within 48 hours.

Note: Verify requirements for extraction/holding times.

5.2.2.4 Methanol Preservation Sampling for High Level Analyses (≥200 µg/kg)
Methanol Preservation Sampling Equipment Requirements

- One pre-weighed jar that contains methanol or a pre-weighed empty jar accompanied with a pre-weighed vial that contains methanol (laboratory grade)
- One dry weight cup
- Weighing balance that accurately weighs to 0.01 g
- Set of balance weights used in daily balance calibration
- Latex gloves
- Paper towels
- Cutoff plastic syringe or other coring device to deliver 5 g or 25 g of soil

Sampling Preservation Steps

1. Wear gloves during all handling of pre-weighed vials.

2. Weigh the vial containing methanol preservative to the nearest 0.01 g. If the weight of the vial with methanol varies by more than 0.01 g from the original weight recorded on the vial, discard the vial. If the weight is within tolerance, it can be used for soil preservation/collection below.

3. Take the empty jar or the jar that contains the methanol preservative.

4. Quickly collect a 5-g or 25-g sample using a cutoff plastic syringe or other coring device designed to deliver 5 g or 25 g of soil from a freshly exposed surface of soil.

5. Carefully wipe the exterior of the collection device with a clean paper towel.

6. Quickly transfer the soil to an empty jar or a jar that contains methanol. If extruding into a jar that contains methanol, be careful not to splash the methanol outside of the vial. Again, the type of jar used is dependent on the client or laboratory requirements.

7. If the jar used to collect the soil plug was empty before the soil was added, immediately preserve with the methanol provided, using only one vial of methanol preservative per sample jar.

8. Remove any soil from the exterior of the vial using a clean paper towel and cap the sample jar.

9. Weigh the jar with the soil in it to the nearest 0.01 g and record the weight on the sample label.

10. Collect a dry weight sample using a clean stainless steel spoon or trowel.

11. Store samples at 4°C ±2°C.

12. Ship sample containers with plenty of ice to the analytical laboratory in accordance with DOT regulations (CORROSIVE, FLAMMABLE LIQUID, POISON).

5.2.3 Method for Collecting Samples for Nonvolatile Organic or Inorganic Compound Analysis

The requirements for collecting samples of surface soil for nonvolatile organic or inorganic analyses are as follows:

1. Label each sample container with the appropriate information. Secure the label by covering it with a piece of clear tape.

2. Use a decontaminated stainless steel or Teflon-lined trowel or spoon to obtain sufficient sample from the required interval and sub-sampling points, if necessary, to fill the specified sample containers.

3. Empty the contents of each fill of the sampling device directly into a clean stainless steel or Teflon-lined tray or bowl.

4. Homogenize the sample by mixing with a spoon, spatula, or trowel.

5. Use the spoon, spatula, or trowel to distribute the uniform mixture into the labeled sample containers. Fill organic sample containers first, then inorganics.

6. Secure the appropriate cap on each container immediately after filling it.

7. Wipe the sample containers with a clean Kimwipe or paper towel to remove any residual soil.

8. Place sample containers in individual zip-top plastic bags and seal the bags.

9. Pack all samples as required. Include properly completed documentation and affix custody seals to the cooler lid.

10. Decontaminate sampling equipment according to CDM Federal SOP 4-5.

6.0 Restrictions/Limitations

When grab sampling for VOC analysis or for analysis of any other compound(s) that may be degraded by aeration, it is necessary to minimize sample disturbance and, hence, analyte loss. The representativeness of this sample is difficult to determine because the collected sample represents a single point, is not homogenized, and has been disturbed.

7.0 References

U.S. Department of Energy, Hazardous Waste Remedial Actions Program, *Quality Control Requirements for Field Methods,* DOE/HWP-69/R2, September 1996.

U.S. Department of Energy, Hazardous Waste Remedial Actions Program, *Standard Operating Procedures for Site Characterizations*, DOE/HWP-100/R1, September 1996 or current revision.

U.S. Environmental Protection Agency, *A Compendium of Superfund Field Operations Methods,* EPA/540/P-87/001, December 1987 or current revision.

U.S. Environmental Protection Agency, *Test Methods for Evaluating Solid Waste,* Physical/Chemical Methods (SW-846), Third Edition, November 1986, (as amended by Update III, June 1997). Method 5035: Closed-System Purge-and-Trap and Extraction for Volatile Organics in Soil and Waste Samples.

TSOP 1-4

SUBSURFACE SOIL SAMPLING

CONTRACT-SPECIFIC CLARIFICATION

SOP Title: **SUBSURFACE SOIL SAMPLING**

SOP No.: 1 - 4
Revision: 5
Date: October 13, 2004

QA Review: [signature]

Approved and Issued: [signature]
Program Manager Signature/Date

Contract No.: RAC II Client: EPA Region II

Reason for Clarification: Include 1) sample collection procedures for VOCs using 40-ml closed-system vials and 2) soil homogenization procedure.

2.1 Definitions, add (on page 1 of 21):

Homogenization - The process of mixing individual grab samples in order to minimize the bias in sample representativeness introduced by the natural stratification of constituents within the sample. Homogenization of soil is accomplished by thoroughly mixing the collected soil with a stainless steel spoon or spatula in the following manner. The soil should be scraped from the stainless steel container sides, corners, and bottom, then rolled into the middle and initially mixed. The soil is then quartered and moved to the four quarters of the container. Each quarter of the sample should be mixed individually, then rolled to the center of the stainless steel container sample mixed again.

For the definition of Liner add:

Only stainless steel or Teflon® liners are to be used when sampling soil.

Add a Section 5.2.5.4 (page 11) to add an option for closed system vials:

5.2.5.4 Soil Sample Collection for Volatile Organic Compound (VOC) Analysis in Closed-System Vials
This procedure follows EPA's *CLP Sample Collection Guidelines for Volatile Organic Analytes (VOAs) in Soil by SW-846 Method 5035A*, May 2004, Option 1 (Appendix B of EPA's *Contract Laboratory Guidance for Field Samplers*).

Required Equipment
In addition to required equipment listed in Section 4.0, the following equipment is also needed:

- Tared or pre-weighed, pre-labeled 40 milliliter (mL) volatile organic analysis (VOA) vials containing a magnetic spin bar (three per sample)
- 60-mL glass jar with Teflon sealed cap or one 40-mL VOA vial
- Sample labels
- Portable scale
- Stainless steel spatula

CONTRACT-SPECIFIC CLARIFICATION

SOP Title: **SUBSURFACE SOIL SAMPLING**

SOP No.: 1 - 4
Revision: 5
Date: October 13, 2004

Method for Collecting Subsurface Soil Samples for Volatile Organic Compound (VOC) Analysis in Closed-System Vials

1. Use the appropriate decontaminated stainless steel or Teflon sampling device to collect the sample.
2. Open the split-spoon, core liner, or other subsurface soil sampler.
3. Complete the sample label by filling in the appropriate information. *Do not* cover the label with tape.
4. Place the tared or pre-weighed, pre-labeled 40-mL VOA vial and cap on the scale.
5. With the aid of a clean stainless steel spatula, quickly add 5 grams of soil to the vial.
6. Immediately secure the Teflon-lined cap on the sample container.
7. Repeat the procedure for the remaining two vials.
8. Collect percent moisture sample in a 40-mL VOA vial or 60-mL jar with Teflon sealed cap. Fill the entire sample container with soil, no headspace.
9. Store samplers at 4^0 Celsius, and ship the sample to the analytical laboratory. The sample must be received by the laboratory within 48 hours of sample collection.

7.0 Reference

U.S. Environmental Protection Agency. 2004. *Contract Laboratory Program (CLP) Guidance for Field Samplers,* Final. EPA-540-R-00-003, August.

________. 1989. Monitoring Management Branch of the Environmental Services Division, *Region II CERCLA Quality Assurance Manual.* Final Copy. Revision 1. October.

Subsurface Soil Sampling

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Issued: [signature] 2/18/04
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Approved: [signature] 2/24/04
Signature/Date

1.0 Objective

The objective of this standard operating procedure (SOP) is to define the techniques and requirements for collecting soil samples from the unconsolidated zone. Techniques include use of hand augers, Shelby tubes, continuous core samplers, and split-spoon samplers.

2.0 Background

2.1 Definitions

Unconsolidated Zone - The layer of soil above bedrock that exists in a relatively loose state.

Hand Auger - A stainless steel cylinder (bucket) approximately 7 to 10 centimeters (cm) (3 to 4 inches) in diameter and 30 cm (1 foot) in length, open at both ends with the bottom edge designed to twist into the soil and cut out a soil core. The bucket collects the soil sample. The auger has a T-shaped handle (for hand operation) attached to the top of the bucket by extendable stainless steel rod(s).

Shelby Tube - A cylindrical sampling device, generally made of steel, that is driven into the subsurface soil through the hollow-stem auger. The tube, once retrieved, may be capped and the undisturbed soil sample extruded in the laboratory prior to analysis.

Split-Spoon/Split-Barrel Sampler - A cylindrical sampling device generally made of carbon steel that fits into a hollow-stem auger. The spoon is hinged lengthwise, which allows the sample to be retrieved by opening ("splitting") the spoon.

Slide Hammer – A device consisting of a drive weight (hammer) and a drive weight fall guide.

Subsurface Soil - The soil that exists deeper than approximately 30 cm (1 foot) from the surface but above bedrock or any other consolidated material.

Grab Sample - A discrete portion or aliquot taken from a specific location at a given point in time.

Liner - A cylindrical sampling device, generally made of brass, stainless steel, or Teflon® that is placed inside a split-spoon or hand auger bucket to collect undisturbed samples.

Composite Sample - Two or more sub-samples taken from a specific media and site at a specific point in time. The sub-samples are collected and mixed, and then a single average sample is taken from the mixture.

Auger Flight - A steel section length attached to an auger to extend the auger and remove unconsolidated material as coring depth increases.

2.2 Discussion

Shallow subsurface soil samples (to depths between 0.15 cm to 3 meters (m) [6 inches and 10 feet]) may be collected using hand augers. However, soil samples collected with a hand auger are commonly of poorer quality than those collected by split-spoon/split-barrel or Shelby tube samplers since the soil sample is disturbed in the augering process. Split-spoon/split-barrel and Shelby tube liners are generally used during collection of soil samples using a hollow-stem auger, but may also be used to collect undisturbed soil samples from hand auger borings using a slide-hammer device. Liners are used to minimize the loss of volatile organic compounds (VOCs). The size and construction material of sampling devices should be selected based on project and analytical objectives and defined in site-specific plans.

2.3 Associated Procedures

- CDM Federal SOP 1-2, Sample Custody
- CDM Federal SOP 2-1, Packaging and Shipping Environmental Samples
- CDM Federal SOP 3-5, Lithologic Logging
- CDM Federal SOP 4-1, Field Logbook Content and Control
- CDM Federal SOP 4-5, Field Equipment Decontamination at Nonradioactive Sites

3.0 Responsibilities

Site Manager - The site manager is responsible for ensuring that field personnel are trained in the use of this procedure and the required equipment, and for ensuring that subsurface soil samples are collected in accordance with this procedure and any other SOPs pertaining to specific media sampling. The site manager must also ensure that the quantity and location of subsurface soil samples collected meet the requirements of the site-specific plans.

Field Team Leader - The field team leader is responsible for ensuring that field personnel collect subsurface soil samples in accordance with this SOP and other relevant procedures.

4.0 Required Equipment

4.1 General

- Site-specific plans
- Field logbook
- Indelible black ink pens and markers
- Labels and appropriate forms/documentation for sample shipment
- Clear, waterproof tape
- Appropriate sample containers
- Insulated cooler(s) and waterproof sealing tape
- Ice bags or "blue ice"
- Latex or appropriate gloves
- Plastic zip-top bags
- Personal protective clothing and equipment
- Stainless steel and/or Teflon-lined spatulas and pans, trays, bowls, trowels, or spoons
- Plastic sheeting
- Decontamination supplies

Additional equipment is discussed in Section 5.2.5, Field Sampling/Preservation Methods.

4.2 Manual (Hand) Augering

- T-handle
- Hand auger: flighted-, bucket-, or tube-type auger as required by the site-specific plans
- Extension rods
- Wrench(es), pliers
- Slide-hammer with extension rods

4.3 Split-Spoon/Split-Barrel and Shelby Tube Sampling

- Drill rig equipped with a 63-kilogram (kg) (140-lb) drop hammer and sufficient hollow-stem augers to drill to the depths required by the site-specific plans.
- Sufficient numbers of split-spoon/split-barrel or Shelby tube samplers so that at least one is always decontaminated and available for sampling. Three split-spoon/split-barrel or Shelby tube samplers are generally the minimum necessary. (Shelby tubes are usually used only once.)
- Split-spoon liners (as appropriate).
- Wrench(es), hammer.

5.0 Procedures

5.1 Preparation

1. Don the appropriate personal protective clothing as dictated by the site-specific health and safety plan.

2. Locate sampling location(s) in accordance with project documents (e.g., work plan) and document pertinent information in the appropriate field logbook. When possible, reference locations back to existing site features such as buildings, roads, intersections, etc.

3. Processes for verifying depth of sampling must be specified in the site-specific plans.

4. Clear away vegetation and debris from the ground surface at the boring location.

5. Prepare an area next to the sample collection location for laying out cuttings by placing plastic sheeting on the ground to cover the immediate area surrounding the borehole.

6. Set up a decontamination line, if decontamination is required, in accordance with CDM Federal SOP 4-5.

5.2 Collection

The following general steps must be followed when collecting all subsurface soil samples:

1. VOC samples or samples that may be degraded by aeration shall be collected first and with the least disturbance possible.

2. Sampling information shall be recorded in the field logbook and on any associated forms. Describe lithology, according to CDM Federal SOP 3-5, in the field logbook or on the lithologic log form.

3. Specific sampling devices to be used shall be identified in the site-specific plans and recorded in the field logbook.

4. Care must be taken to prevent cross-contamination and misidentification of samples.

5. Sample containers containing samples for VOC analysis should be filled completely to minimize headspace.

5.2.1 Manual (Hand) Augering

The following steps must be followed when collecting hand-augered samples:

1. Auger to the depth required for sampling. Place cuttings on plastic sheeting or as specified in the site-specific plans. If possible, lay out the cuttings in stratigraphic order.

2. Throughout the augering, make detailed notes concerning the geologic features of the soil or sediments in the field logbook.

3. Cease augering when the top of the specified sampling depth has been reached. If required, remove the auger from the hole and decontaminate the auger or use a separate decontaminated auger, then obtain the sample.

4. Collect a grab sample for VOC analyses (or samples that may be degraded by aeration) immediately and place in sample container. Sample bottles should be filled completely to minimize headspace.

5. Remaining sample should be homogenized for other analyses prior to placing samples in the appropriate containers. Label containers as required.

6. Wipe containers with a clean Kimwipe or paper towel to remove residual soil from the exterior of the container(s).

7. Label the sample container with the appropriate information. Secure the label by covering it with a piece of clear tape.

8. Place the containers in zip-top plastic bags and seal the bags. Pack samples in a cooler with ice.

9. Proceed with further sampling, as required by the site-specific plans.

10. When all sampling is complete, dispose of cuttings, plastic sheeting, etc., as specified in the site-specific plans.

11. Complete the field logbook entry and other appropriate forms, being sure to record all relevant information before leaving the site.

12. Properly package all samples for shipment and complete all necessary sample shipment documentation. Remand custody of samples to the appropriate personnel. See CDM Federal

SOPs 1-2 and 2-1 or site-specific plans.

5.2.2 Manual (Hand) Augering Using a Tube Sampler with Liner or Slide-Hammer

The following steps must be followed when collecting hand-augered samples using a tube sampler with liner or slide-hammer:

1. Auger to the depth required for sampling. Place cuttings on the plastic sheeting as specified in the site-specific plans. If possible, lay out the cuttings in stratigraphic order.

2. Throughout augering, make detailed notes in the field logbook concerning the geologic features of the soil or sediments.

3. Cease augering when the top of the specified sampling depth has been reached. Remove the auger from the hole and decontaminate.

4. Prepare a decontaminated tube sampler by installing a decontaminated liner in the auger tube.

5. Obtain the sample by driving the sample tube through the sample interval with the slide-hammer. Remove the liner from the tube and immediately cover the ends with Teflon tape and cap the ends of the tube. Seal the caps with waterproof tape.

6. Wipe sealed liners with a clean Kimwipe or paper towel.

7. Label the sealed liners as required in the site-specific plans. Mark the top and bottom of the sample on the outside of the liner.

8. Place sealed liners in zip-top plastic bags and seal the bags. Pack samples in a chilled cooler.

9. Proceed with further sampling, as required by the site-specific plans.

10. When sampling is complete, dispose of cuttings, plastic sheeting, etc., as specified in the site-specific plans.

11. Decontaminate all equipment according to CDM Federal SOP 4-5 between each sample.

12. Complete the field logbook entry and other forms, being sure to record all relevant information before leaving the site.

13. Properly package all samples for shipment and complete all necessary sample shipment documentation. Remand custody of samples to the appropriate personnel. See CDM Federal SOPs 1-2 and 2-1 or site-specific plans.

5.2.3 Split-Spoon/Split Barrel Sampling

Note: Steps 1 through 12 describe activities to be performed by a licensed drilling contractor, not CDM personnel.

The following steps must be followed when collecting split-spoon samples:

1. Remove any pavement and subbase material from an area of twice the bit diameter, if necessary.
2. The drilling rig will be decontaminated at a separate location prior to drilling, per CDM Federal SOP 4-5 or the site-specific decontamination procedures.
3. Attach the hollow-stem auger with the cutting head, plug, and center rod(s) to the drill rig.
4. Begin drilling and proceed to the first designated sample depth, adding auger(s) as necessary.
5. Upon reaching the designated sample depth, slightly raise the auger(s) to disengage the cutting head, and rotate the auger without advancement to clean cuttings from the bottom of the hole.
6. Remove the plug and center rods.
7. If required by the site-specific sampling plan, install decontaminated liners in the split-spoon/split barrel sampler.
8. Install a decontaminated split-spoon on the center rod(s) and insert it into the hollow-stem auger. Connect the hammer assembly and lightly tap the rods to seat the drive shoe at the top of undisturbed soil or sediment.
9. Mark the center rod in 15-cm (6-inch) increments from the top of the auger(s).
10. Drive the split-spoon using the hammer. Use a full 76-cm (30-inch) drop as specified by the American Society for Testing and Materials (ASTM) Method D-1586. Record the number of blows required to drive the spoon or tube through each 15-cm (6-inch) increment.
11. Cease driving when the full length of the spoon has been driven or upon refusal. Refusal occurs when little or no progress is made for 50 blows of the hammer. ASTM D1586-99 § 7.2.1 and 7.2.2 defines "refusal" as >50 blows per 6-inch advance or a total of 100 blows.
12. Pull the split-spoon free by using upswings of the hammer to loosen the sampler. Pull out the center rod and split-spoon.
13. Unscrew the split-spoon assembly from the center rod and place it on the plastic sheeting.
14. Remove the drive shoe and head assembly. If necessary, tap the split-spoon assembly with a hammer to loosen threaded couplings.
15. With the drive shoe and head assembly off, open (split) the split-spoon, being careful not to disturb the sample.
16. Label sample containers with appropriate information. Secure the label, covering it with a piece of clear tape. If liners were used, immediately install Teflon tape over the ends of the liners, cap the liners, and seal the caps over the ends of the liner with waterproof tape. Label the samples

as required by the site-specific plans. Mark the top and bottom of each sample on the outside of each liner. Indicate boring/well number and depth on the outside of the liner, as required.

17. If VOC analyses are to be conducted on the soil sample and liners were not used, place that sample in its sample container immediately after opening the split-spoon, filling the sample bottle completely. Seal the container immediately, then describe it in the field logbook and/or associated forms. Record the sample identification number, depth from which the sample was taken, and the analyses to be performed on the samples in the field logbook and on the appropriate forms.

18. Remaining sample should be homogenized prior to placing samples in appropriate containers.

19. Wipe containers with a clean Kimwipe or paper towel. Label containers as required when liners are not used.

20. Place containers and/or sealed liners in zip-top plastic bags and seal the bags. Pack samples in a chilled cooler.

21. In the field logbook and on the boring log, describe sample lithology by observing cuttings and/or the bottom end of the liner.

22. Continue to advance the borehole to the next sampling point. Collect samples as outlined above.

23. When sampling is complete, remove the drilling rig to the heavy equipment decontamination area.

24. Dispose of cuttings, plastic sheeting, etc., as specified in the site-specific plans. Backfill bore hole as specified in project-specific plans.

25. Decontaminate split-spoons and other small sampling equipment according to CDM Federal SOP 4-5 before proceeding to other sampling locations.

26. Complete the field logbook entry and other forms, being sure to record all relevant information before leaving the site.

27. Properly package all samples for shipment to laboratories and complete all necessary sample shipment documentation. Remand custody of the samples to the appropriate personnel. See CDM Federal SOPs 1-2 and 2-1 or site-specific plans.

5.2.4 Shelby Tube Sampling

Note: Steps 1 through 11 describe activities to be performed by a licensed drilling contractor, not CDM personnel.

The following steps must be followed when collecting samples using the Shelby tube:

1. Remove any pavement and subbase material from an area of twice the bit diameter, if necessary.

2. The drilling rig will be decontaminated at a separate location prior to drilling.

3. Attach the hollow-stem auger with the cutting head, plug, and center rod(s).
4. Begin drilling and proceed to the first designated sample depth, adding auger(s) as necessary.
5. Upon reaching the designated sample depth, slightly raise the auger(s) to disengage the cutting head, and rotate the auger without advancement to clean cuttings from the bottom of the hole.
6. Remove the plug and center rods.
7. Attach a head assembly to a decontaminated Shelby tube. Attach the Shelby tube assembly to the center rods.
8. Lower the Shelby tube and center rods into the hollow-stem augers and seat it at the bottom. Be sure to leave 30 inches or more of center rod above the lowest point to the hydraulic piston's extension.
9. Use the rig's hydraulic drive to push the Shelby tube into undisturbed soil. The tube should be pushed with a steady force. Note the pressure used to push the Shelby tube in the field logbook.
10. When the Shelby tube has been advanced its full length or to refusal, back off the hydraulic pistons. Attach a hoisting plug to the upper end of the center rod, twist to break off the sample, and pull the apparatus out of the hole with the rig winch.
11. Retrieve the Shelby tube to the surface, detach it from the center rod, and remove the head assembly.
12. Since the typical intent of Shelby tube sampling is for engineering purposes and an undisturbed sample is required, the tube ends should be sealed immediately. Sealing is accomplished by filling any void space in the tube with beeswax, then placing caps on the ends of the tube and taping caps into place. The top and bottom ends of the tube should be marked and the tube transported to the laboratory in an upright position. Indicate boring/well number and depth on outside of liner.
13. Wipe sealed tubes with a clean Kimwipe or paper towel.
14. Place sealed tubes in zip-top plastic bags and seal bags. Pack samples in a chilled cooler.
15. Continue to advance the borehole to the next sampling point. Collect samples as outlined above.
16. When sampling is complete, remove the drilling rig to the heavy equipment decontamination area.
17. Dispose of cuttings, plastic sheeting, etc., as specified in the site-specific plans.
18. Complete the field logbook entry, being sure to record all relevant information before leaving the site. These methods may be used if directed by the EPA region, client, or governing sample plan.

5.2.5 Field Sampling/Preservation Methods

The following three sections contain SW 846 Methods for sampling and field preservation. These methods include EN CORE™ Sampler Method for low-level detection limits, EN CORE Sampler Method for high-level limits/screening, and methanol preservation. These methods may be used if required by the EPA Region, client, or governing sample plan. These methods are very detailed and contain equipment requirements at the beginning of each section.

When collecting soil samples using the EN CORE Sampler Method, collection of soil for moisture content analysis is required. Results of this analysis are used to adjust "wet" concentration results to "dry" concentrations to meet analytical method requirements.

Note: Some variations from these methods, (e.g., sample volume) may be required depending on the contracted analytical laboratory.

5.2.5.1 EN CORE Sampler Collection for Low Level Analyses (≥1 µg/kg)

EN CORE Sampling Equipment Requirements

The following equipment is required for low-level analysis:

- Three 5 grams (g) samplers

Note: The sample volume requirements specified are general requirements. Actual sample volume and/or container sizes may vary depending on client or laboratory requirements.

- One 110-milliliter (mL) (4-ounce [oz.]) widemouth glass jar or applicable container for moisture analysis
- One T-handle
- Paper towels

EN CORE Sampling Steps for Low Level Analysis

1. Remove sampler and cap from package and attach T-handle to sampler body.
2. Quickly push the sampler into a freshly exposed surface of soil until the sampler is full. The O-ring will be visible within the hole on the side of the T-handle. If the O-ring is not visible within this window, then the sampler is not full.
3. Extract sampler and wipe the sampler head with a paper towel so that the cap can be tightly attached.
4. Push cap on with a twisting motion to secure to the sampler body.
5. Rotate the sampler stem counterclockwise until stem locks in place to retain sample within the sampler body.
6. Fill out sample label and attach to sampler.
7. Repeat procedure for the remaining two samplers.

8. Collect moisture sample in 110-mL (4-oz.) widemouth jar using a clean stainless steel spoon or trowel.

9. Store samplers at 4 degrees (°) Celsius (C), ±2°C. Samples must be shipped and delivered to the analytical laboratory for extraction within 48 hours.

Note: Verify requirements for extraction/holding times.

5.2.5.2 EN CORE Sampler Collection for High Level Analyses (≥200 µg/kg)
EN CORE Sampling Equipment Requirements
The following equipment is required for high-level analysis:

- One 5-g sampler or one 25-g sampler (The sampler size used will be dependent on client and laboratory requirements.
- One 110-mL (4-oz.) widemouth glass jar or applicable container specified for moisture analysis.
- One T-handle.
- Paper towels.

EN CORE Sampling Steps for High Level Analysis

1. Remove sample and cap from package and attach T-handle to sampler body.

2. Quickly push the sampler into a freshly exposed surface of soil until the sampler is full. The O-ring will be visible within the hole on the side of the T-handle. If the O-ring is not visible within this window, then the sampler is not full.

3. Use clean paper toweling to quickly wipe the sampler head so that the cap can be tightly attached.

4. Push cap on with a twisting motion to attach cap.

5. Fill out a sample label and attach to sampler.

6. Rotate sampler stem counterclockwise until the stem locks in place to retain the sample within the sampler body.

7. Collect moisture sample in 110-mL (4-oz.) widemouth jar or designated container using a clean stainless steel spoon or trowel.

8. Store samplers at 4°C, ±2°C. Samples must be shipped and delivered to the analytical laboratory for extraction within 48 hours.

Note: Verify requirements for extraction/holding times.

5.2.5.3 Methanol Preservation Sampling for High Level Analyses (≥200 µg/kg)
Methanol Preservation Sampling Equipment Requirements

- One pre-weighed jar that contains methanol or a pre-weighed empty jar accompanied with a pre-weighed vial that contains methanol (laboratory grade)
- One dry weight cup

- Weighing balance that accurately weighs to 0.01 g (with accuracy of ±0.1 g)
- Set of balance weights used in daily balance calibration
- Latex gloves
- Paper towels
- Cutoff plastic syringe or other coring device to deliver 5 g or 25 g of soil

Sampling Preservation Steps

1. Wear gloves during all handling of pre-weighed vials.

2. Weigh the vial containing methanol preservative to the nearest 0.01 g. If the weight of the vial with methanol varies by more than 0.01 g from the original weight recorded on the vial, discard the vial. If the weight is within tolerance, it can be used for soil preservation/collection below.

3. Take the empty jar or the jar that contains the methanol preservative.

4. Quickly collect a 5-g or 25-g sample using a cutoff plastic syringe or other coring device designed to deliver 5 g or 25 g of soil from a freshly exposed surface of soil. The 5-g or 25-g size used is dependent on client and laboratory requirements.

5. Carefully wipe the exterior of the collection device with a clean paper towel.

6. Quickly transfer the soil to an empty jar or a jar that contains methanol. If extruding into a jar that contains methanol, be careful not to splash the methanol outside of the vial. Again, the type of jar used is dependent on the client or laboratory requirements.

7. If the jar used to collect the soil plug was empty before the soil was added, immediately preserve with the methanol provided, using only one vial of methanol preservative per sample jar.

8. Using the paper toweling, remove any soil off of the vial threads and cap the jar.

9. Weigh the jar with the soil in it to the nearest 0.01 g and record the weight on the sample label.

10. Collect dry weight sample using a clean stainless steel spoon or trowel.

11. Store samples at 4°, ±2°C.

12. Ship sample containers with plenty of ice in accordance with DOT regulations (CORROSIVE. FLAMMABLE LIQUID. POISON) to the laboratory.

6.0 Restrictions/Limitations

Basket or spring retainers may be needed for split-spoon sampling in loose, sandy soils.

Shelby tubes may not retain the sample in loose, sandy soils.

7.0 References

American Society for Testing and Materials, *Standard Test Method for Penetration Test and Split Barrel Sampling of Soils*, Standard Method D1586-99, 1999.

U.S. Department of Energy, Hazardous Waste Remedial Actions Program, *Quality Control Requirements for Field Methods*, DOE/HWP-69/R2, September 1996.

U.S. Department of Energy, Hazardous Waste Remedial Actions Program, *Standard Operating Procedures for Site Characterizations*, DOE/HWP-100/R1, September 1996 or current revision.

U.S. Environmental Protection Agency, *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods (SW-846)*, Third Edition, November 1986, (as amended by Updates I, II, IIA, IIB, III, and IIIA, June 1997). Method 5035 (Note: § 6.2.1.8 of this method says samples stored in En Core™ samplers should be analyzed within 48 hours or transferred to soil sample vials in the laboratory within 48 hours): December 1996, Revision O, Closed-System Purge-and-Trap and Extraction for Volatile Organics in Soil and Waste Samples.

TSOP 1-6

WATER LEVEL MEASUREMENT

Water Level Measurement

SOP 1-6
Revision: 5
Date: December 31, 2004

Prepared:	Del Baird	Technical Review:	Peggy Bloise
QA Review:	Doug Updike	Approved:	[signature] 12/21/04 Signature/Date
Issued:	[signature] 12/28/04 Signature/Date		

1.0 Objective

Water level measurements are fundamental to groundwater and solute transport studies and are conducted during groundwater sampling events to calculate purging requirements. This standard operating procedure (SOP) defines the techniques and requirements for obtaining groundwater level measurements.

2.0 Background

2.1 Definitions

Water Level Indicator - A portable device for measuring the depth from a fixed point at or above the ground surface to the groundwater inside a well, borehole, or other underground opening.

Measurement Point - An easily located and clearly defined mark at the top of a well from which all water level measurements from that particular well are made. The measurement point should be as permanent as possible to provide consistency in measurements.

Electrical Tape - A graduated plastic tape onto which a water-sensitive electrode is connected that will electronically signal the presence of water (as a result of circuit closure).

Immiscible Fluids - Two or more fluid substances that will not mix and, therefore, will exist together in a layered form. The fluid with the highest density will exist as the bottom layer, the fluid with the lowest density will exist as the top layer, and any other fluid layers will be distributed relative to their respective densities.

Discharge - The removal/release of water from the zone of saturation.

Recharge - The addition of water to the zone of saturation.

Static Water Level - The level of water in a well, borehole, or other underground opening that is not influenced by discharge or recharge.

Well Riser - A steel, stainless steel, or polyvinyl chloride pipe that extends into a borehole and is connected to the well screen or sealed at the bedrock surface in open-hole wells. The upper portion (approximately 3 to 5 feet) of the well riser is normally enclosed by an outer steel protective casing.

Protective Casing - A steel cylinder or square protective sleeve extending approximately 3 to 5 feet into the ground, surrounding the well riser, and extending above the ground surface approximately 2 to 3 feet. The protective casing protects the well riser.

2.2 Discussion

The most common uses of static water level data are to determine the direction of groundwater flow, to identify areas of recharge and discharge, to evaluate the effects of manmade and natural stresses on the groundwater system, to define the hydraulic characteristics of aquifers, and to evaluate stream-aquifer relationships. Specific uses for water level data may include:

- Determine the change in water level due to distribution or rate of regional groundwater withdrawal

- Show the relationship of groundwater to surface water
- Estimate the amount, source, and area of recharge and discharge
- Determine rate and direction of groundwater movement

Static water level measurements should be obtained from each well prior to purging, sampling, or other disturbance of the water table.

2.3 Associated Procedures

- CDM Federal (CDM) SOP 4-1, *Field Logbook Content and Control*
- CDM SOP 4-5, *Field Equipment Decontamination at Nonradioactive Sites*

3.0 Responsibilities

Project Manager - The project manager is responsible for ensuring that measurements are conducted in accordance with this procedure and any other SOP pertaining to site activities related to obtaining groundwater level measurements.

Field Team Leader - The field team leader is responsible for ensuring that field personnel obtain water level measurements in accordance with this and other relevant procedures.

4.0 Required Equipment

4.1 General

- Site-specific plans
- Field logbook
- Indelible black ink pens
- Permanent felt-tip marker (e.g., Sharpie)
- Decontamination equipment and supplies, including rinse bottles and deionized water
- Personal protective equipment
- Tap water and large beaker or bucket
- Water level meter

4.2 Measuring Devices

The equipment required to obtain water level measurements is dependent on the type of procedure chosen. Measurements may be made with a number of different devices and procedures. Measurements are taken relevant to a permanent measurement point on the well riser.

Electrical tapes are preferred over other devices such as steel tape due to the electrical tape's simplicity and ability to make measurements in a short period of time. Many types of electrical instruments have been devised for measuring water levels; most operate on the principle that a circuit is completed when two electrodes are immersed in water. Examples of electrical tapes that are frequently used include the Slope Indicator Co.® and Solinst® electronic water level indicators. These instruments are powered by batteries that should be checked prior to mobilization to the field.

Electrical tapes are coiled on a hand-cranked reel unit that contains batteries and a signaling device that indicates when the circuit is closed (i.e., when the probe reaches the water). Electrodes are generally contained in a weighted probe that keeps the tape taut in addition to providing some shielding of the electrodes against false indications as the probe is being lowered into the hole. The electrical tapes are marked with 0.01-foot increments. Caution should be exercised when using electrical tapes when the water contains elevated amounts of dissolved solids. Under these conditions, the signaling device will remain activated after the probe is removed from the water. When the water being measured contains very low amounts of dissolved solids, it is possible for the probe to extend several inches below the water level prior to activating the signaling device. Both of these conditions are related to the conductivity of the water and in some cases may be compensated for by the sensitivity control, if the device has this option.

5.0 Procedures

5.1 Preparation

The following steps must be taken when preparing to obtain a water level measurement:

- Assign a designated field logbook to record all field events and measurements according to CDM SOP 4-1. Document any and all deviations from SOPs and site-specific plans in the logbook and include rationale for the changes.
- Always exercise caution to prevent inappropriate or contaminated materials from entering an environmental well.
- Standing upwind from the well, open the groundwater well. Monitor the well with a photoionization detector, flame ionization detector, or equivalent vapor analyzer as soon as the cap is opened, as dictated by the site-specific health and safety plan.

For comparability, water level measurements should always be referenced to the same vertical (elevation) datum marker, such as a U. S. Geological Survey (USGS) vertical and horizontal control point monument. The elevations calculated from the measurement of static water levels should be referenced to mean sea level unless otherwise specified in the site-specific plans.

The measurement point must be as permanent as possible, clearly defined, marked, and easily located. Frequently, the top of the PVC riser is designated as the measurement point. However, since the top of the riser is seldom smooth and horizontal, one particular point on the riser pipe should be designated and clearly marked. This can be accomplished by marking a point on the top of the riser pipe with a permanent marker. To avoid spilling liquids into the well, paints or other liquid marking materials should not be used.

5.2 Water Level Measurement Using Electrical Water Level Indicators

The following steps must be followed when taking water level measurements using electrical tapes:

- Before lowering the probe into the well, the circuitry should be checked by dipping the probe in tap water and checking to ensure that the signaling device responds to probe submergence. The probe should then be lowered slowly into the well until contact with the water surface is indicated. The electrical tape reading is made at the measuring point. Take a second check reading to verify the measurement before completely withdrawing the tape from the well.
- Independent electrical tape measurements of static water levels using the tape should agree within 0.01 foot for depths of less than about 200 feet. At greater depths, independent measurements may not be this close. For a depth of about 500 feet, the maximum difference of independent measurement using the same tape should be within 0.1 foot.
- Decontaminate the electrical tape according to CDM SOP 4-5 before proceeding to the next well to minimize cross contamination.

It may be necessary to check the electrical tape length with a graduated steel tape after the line has been used for a long period of time (at least annually) or after it has been pulled hard in attempting to free the line. Some electrical tapes, especially the single line wire, are subject to becoming permanently stretched.

5.3 Other Water Level Measurement Methods

Although the method cited above (electrical water level indicator) for measuring water levels predominates in the environmental sector, there are a number of other methods available that may be well suited for a particular purpose.

5.3.1 Ultrasonic Method

The ultrasonic method electronically measures the amount of time it takes a sound wave to reach and reflect off the water surface and return to the ground surface. These instruments contain electronic microprocessors, capable of performing this measurement many times each second. The actual depth to water, as calculated by the microprocessor, is an average of many individual readings.

5.3.2 Pressure Gauge Method
This method, also called the air-line submergence method, uses a pressure gauge and is the preferred method for obtaining water level measurements in pumping wells. An air line constructed of semi-rigid tubing is inserted into the well below the water table. The tube end at the surface is connected to an air tank or compressor and pressure gauge. Filtered air is then forced through the tube and the resultant pressure is read in pounds per square inch (psi). This reading is converted to feet of water in the column and subtracted from the total tube length to give depth to water. Readings are then converted to groundwater elevation. Results are plotted on a field logging form. Calibration records and the exact procedures used must be maintained.

5.3.3 Acoustic Probe Method
The acoustic probe is an electronic device containing two electrodes and a battery-powered transducer. The probe is attached to a tape. The probe is lowered into the well until a sound is detected, indicating the electrodes in the probe have contacted the water surface. This method is similar to the electrical probe method discussed in Section 5.2.

5.3.4 Continuous Recording Method
The measurement of groundwater elevations within pumping or monitoring wells can be accomplished by the use of a mechanical or digital analog computerized continuous recording system and should be performed according to specifications given by the manufacturer of each unit. In general, when using the mechanical or digital system, the pressure or electrical transducer is lowered into the well until it intersects the water surface. The actual depth to water is then measured by one of the methods described above and used to calibrate the continuous recorder.

The necessary adjustments and preparations are then completed according to the specifications given for each type of continuous recorder. Proper maintenance of continuous recording devices during water level monitoring should be performed such that continuous, permanent records are developed for the specified period of time. Records shall be stored on mechanical graph paper or on a microprocessor. Frequent calibrations of equipment shall also be made during monitoring periods of long duration in accordance with the manufacturers' specifications.

6.0 Restrictions/Limitations
6.1 Groundwater and Miscible Fluids
Where water is rapidly dripping or flowing into a well, either from the top of the well or from fractures, obtaining an accurate reading may not be possible.

The effect of the water flowing into the well may interfere with an electronic water level measuring device resulting in a false water level measurement. If water levels must be recorded in wells completed in aquifers that are recharging or discharging, the electronic water level indicator is the preferred measuring device, but should be used with the awareness of possible false measurements. To minimize the effects of "splashing," a 1-inch pipe (decontaminated for environmental wells) may be lowered into the pumping well to minimize the effect of disturbance and protect the probe from potential damage due to downhole equipment (i.e., submersible pumps).

6.2 Immiscible Fluids
For wells containing immiscible contaminants, the field personnel will need to use special procedures for the measurement of fluid levels. The procedure to follow will depend on whether layers are light immiscibles that form lenses floating on the top of the water table, or dense immiscibles that sink through the aquifer and form lenses over less permeable layers.

In the case of light immiscibles, measurements of immiscible fluid and water levels cannot be accomplished by using normal techniques. A conventional electrical tape often will not respond to nonconducting immiscible fluids.

Techniques have been specially developed to measure fluid levels in wells containing immiscible fluids, particularly petroleum products. A special paste or gel applied to the end of the steel tape and submerged in the well will show the top of the oil as a wet line and the top of the water as a distinct color change, or an interface probe can be used that will detect the presence of conducting and nonconducting fluids. Thus, if a well is contaminated with low density, nonconducting immiscible fluids such as gasoline, the probe will first detect the surface of the gasoline, but it will not register electrical conduction. However, when the probe is lowered deeper to contact water, it will detect electrical conduction. Normally, a variation in an audible signal indicates the difference between phases.

Both of these methods have disadvantages. These methods are less effective with heavier and less refined petroleum products because the product tends to stick to the tape or probe, giving a greater product thickness measurement than it should. Paste or gel cannot be used when sampling groundwater for the same constituents present in the paste or gel product.

Note that water levels obtained in this situation are not suitable for determining hydraulic gradients without further interpretation. To use such data for determining hydraulic gradients, the difference in density between the light immiscible phase and water has to be considered.

Measuring fluid levels in wells screened in lenses of dense immiscible fluids resting on a low permeability formation is somewhat easier, provided the immiscible fluid is nonconducting. The top of the dense layer can be identified by simply using an electrical sounder. As an electrical sounder passes from groundwater into the immiscible phase, the detection unit will deactivate because the fluid will no longer conduct electricity. A better method would be to use an interface probe as described above. The variation in the audible signal associated with the detection of differing phase liquids will also allow the user to obtain a groundwater depth and dense immiscible thickness measurement.

7.0 References

Camp Dresser & McKee Inc., et al. 1991. *Sampling and Analysis Procedures, Geophysical Survey Procedures.* May.

U. S. Environmental Protection Agency. 1987. *A Compendium of Superfund Field Operations Methods*. EPA/540/P-87/001. December.

Westinghouse Savannah River Company. 1992. *Standard Operating Procedures Manual*, 3Q5, Chapter 13, Revision 1, Hydrogeologic Data Collection Procedures and Specifications. October.

TSOP 1-9

TAP WATER SAMPLING

CONTRACT-SPECIFIC CLARIFICATION

SOP Title: **TAP WATER SAMPLING**

SOP No.: 1-9
Revision: 2
Date: October 15, 2004

QA Review: J. Oxford

Approved and Issued: J. Litwin 11/1/04
Program Manager Signature/Date

Contract No.: RAC II Client: EPA Region II

Reason for Clarification: Make SOP EPA Region II - Specific

5.0 PROCEDURES, under Step 5 add:

When sampling, a tap must be free of any hose attachment, or water purification devices.

7.0 REFERENCES, add

U.S. Environmental Protection Agency, Monitoring Management Branch of the Environmental Services Division, *Region II CERCLA Quality Assurance Manual,* Final Copy, Revision 1. October 1989.

Tap Water Sampling

Prepared: Tom Thornburgh

Technical Review: Mike Profit

QA Review: Tony Isolda

Approved: Michael C. Malloy 2/24/04
Signature/Date

Issued: [signature] 3/18/04
Signature/Date

1.0 Objective

The objective of this standard operating procedure (SOP) is to define the requirements for collecting tap water samples for the purpose of assessing water quality. General guidelines for purging the water supply system prior to sample collection are also provided. Depending on the objective of the sampling event as defined in the site-specific sampling plan, the water source may be from a private or public potable water supply, such as a groundwater well or a surface water reservoir.

2.0 Background

2.1 Discussion

Tap water sampling may be conducted in residential, commercial, or industrial areas. Consequently, sampling personnel will interface with the general public (i.e., homeowners, business owners, or concerned citizens) and must present themselves in the utmost professional manner. Permission to access the property must be obtained prior to conducting the tap water sampling event; the client should be consulted as to the proper notification procedures. At the time of the sampling, it is recommended that a letter of introduction be presented to the property owner or representative, explaining the purpose of the tap water sampling and indicating the name of the person and phone number to contact if the property owner has questions. At no time should the sampling team enter a home or business without the approval of the property owner; the property owner or representative must be present in order to enter a building.

Generally, water supply sources and distribution systems can be categorized into two types:

- Onsite water supplies such as private, groundwater wells or surface water intakes for single residences, businesses, or industrial plants with limited distribution systems

- Large distribution systems from public or municipal groundwater or surface water supplies with extensive distribution systems for multiple users

The site-specific sampling plan should describe the source of the potable water supply, the water distribution system, and other site-specific factors that may affect the water quality (i.e., well construction details, local hydrogeology, the presence of filters or holding tanks within the distribution system, pipe age, and composition, etc.). It is preferable to collect the samples from a tap located prior to a filtering device or a holding tank so that contaminants will be less likely to have been removed or allowed to settle out. The sampling objectives and sampling requirements, including analytical parameters, preservatives, and sample handling procedures must also be specified. Depending on the water source and distribution system, the site-specific sampling plan should describe the requirements for purging the system prior to collecting the tap water sample and for disposing of the purged water.

The procedures described in this SOP provide guidelines to obtain representative tap water samples from water supplies/distribution systems ranging from small onsite water supplies to large multi-user distribution systems.

2.2 Definitions

Holding Tank - An in-house water reservoir that provides a limited reserve water supply and equalizes water pressure throughout the plumbing system. Most domestic well holding tanks have a storage capacity of approximately 30 gallons.

Onsite Water Supply - A source of potable water located on the property to be sampled. The water source could be a groundwater aquifer (i.e., a residential groundwater well) or a surface water body (i.e., a water intake from a lake).

Potable Water - Water considered safe for human consumption.

Tap Water Samples - Samples of water collected from a faucet or spigot at a residence, business, or industrial plant. Usually, samples are collected from the tap(s) nearest the water supply source or area of interest along the distribution system.

Water Filter - A device used to remove suspended particulate matter and/or various compounds from the water source. One type of common filter is a water softener that uses a calcium-salt filter to remove calcium and magnesium ions from potable water to reduce the hardness.

2.3 Associated Procedures

- CDM Federal SOP 1-2, Sample Custody
- CDM Federal SOP 2-1, Packaging and Shipping Environmental Samples
- CDM Federal SOP 4-1, Field Logbook Content and Control
- CDM Federal SOP 4-3, Well Development and Purging
- CDM Federal SOP 4-5, Field Equipment Decontamination at Non-Radioactive Sites

3.0 Responsibilities

Field Team Leader - The field team leader is responsible for ensuring that sampling efforts are conducted in accordance with this procedure and any associated SOPs.

Sampling Personnel - Field team members are responsible for conducting tap water sampling events in accordance with this procedure, all associated SOPs, and requirements as described in the site-specific plans.

4.0 Required Equipment

All or part of the equipment listed may be required at any specific site, depending on the plan(s) for that site.

- Site-specific plans including letter(s) of introduction
- Field logbook and indelible black ink pens and markers

- Forms and other documentation for sample shipment
- Sample containers, labels, and preservatives, as required
- Insulated cooler and waterproof sealing tape
- Ice bags or "blue ice"
- Plastic zip-top bags
- 5-gallon bucket and stop watch
- Temperature, conductivity, pH, dissolved oxygen, and turbidity meters (with clean beakers or other appropriate containers), as required by the site-specific plans
- Photoionization detector (PID) and/or other monitoring/screening instruments as required by the site-specific health and safety plan or sampling plan
- Decontamination supplies, as required by SOP 4-5
- Personal protective equipment (PPE), as required by the site-specific health and safety plan
- Latex or appropriate gloves

5.0 Procedures

1. Obtain the name(s) of the resident(s) or water supply owner/operator, the exact mailing address, and telephone numbers. This information is required to obtain access to the property to be sampled and to submit a letter of introduction to the owner/representative.

2. Determine the location of the tap to be sampled based on its proximity to the water source. It is preferable that the tap being sampled be prior to any holding or pressure tanks, filters, water softeners, or other treatment devices that may be present.

3. If the sample must be collected at a point in the water line beyond a pressurization or holding tank, a sufficient volume of water should be purged to provide a complete exchange of fresh water into the tank and at the location where the sample is collected. If the sample is collected from a tap or spigot located just before a storage tank, spigots located inside the building or structure should be turned on to prevent any backflow from the storage tank to the sample tap or spigot. It is generally advisable to open as many taps as possible during the purge, to ensure a rapid and complete exchange of water in the tanks.

4. Samples collected to determine if system related variables (e.g., transmission pipes, water coolers/heaters, holding/pressurization tanks, etc.) are contributing to the quality of potable water should be collected after a specific time interval (e.g., weekend, holiday, etc.). Sample collection should consist of an initial flush, a sample after several minutes, and another sample after the system has been purged.

5. Devices such as hoses, filters, or aerators attached to the tap may harbor a bacterial population and therefore should be removed prior to sampling.

6. Sample containers should not be rinsed before use when sampling for bacterial content, and precautions should be taken to avoid splashing drops of water from the ground or sink into either the bottle or cap.

7. Samples of the raw water supply and the treated water after chlorination should be collected when sampling at a water treatment plant.

8. In the logbook, record the location and describe the general condition of the tap selected for sampling. The rationale used in selecting the tap sampling location, including any discussions with the property owner, should also be recorded. Provide a sketch of the water supply/ distribution system noting the location of any filters or holding tanks and the water supply source (i.e., an onsite groundwater well or surface water intake or a water service line from a public water main). If an onsite water supply is present, observe and record the surrounding site features that may provide potential sources of contamination to the water supply.

9. Don the appropriate personal protective clothing as dictated by the site-specific health and safety plan. Latex gloves should be changed between sampling locations to avoid possible cross-contamination of the tap water samples.

10. Prior to sample collection, the supply system should be purged by turning the cold-water tap on. The following general guidelines should be followed to determine when the system is adequately purged (refer to the site-specific sampling plans for any other requirements):

    - Onsite Water Supply. A minimum of three standing volumes of water (i.e., the static volume of water in the well and holding tank, if present) should be purged. Obtain water temperature, conductivity, and pH measurements after each volume of water is purged. If the standing volume of water in the supply system is unknown, the tap should be allowed to run for a minimum of 15 minutes and temperature, conductivity, and pH measurements, or other parameters as specified by the project plan, should be collected at approximately 3- to 5-minute intervals. (In general, well construction details and holding tank volumes should be obtained prior to conducting the sampling event to estimate the standing volume of the water supply system.) The system is considered adequately purged when the temperature, conductivity, and pH stabilize within 10 percent for three consecutive readings. If these parameters do not stabilize within 15 minutes, then purging should be discontinued and tap water samples may be collected as discussed in Section 6.0.

    - Large Distribution Systems. Because it is impractical to purge the entire volume of standing water in a large distribution network, a tap should be run for a minimum of 5 minutes, which should be adequate to purge the water service line. Obtain temperature, conductivity, and pH measurements at approximately 1-minute intervals. The system is considered adequately purged when the temperature, conductivity, and pH readings, or other parameters as specified by the project plan, stabilize within 10 percent for three consecutive readings. If these parameters do not stabilize within 5 minutes, then purging should be discontinued and tap water samples may be collected as discussed in Section 6.0.

    During purging, a 5-gallon bucket and stopwatch may be used to estimate the flow rate if required by the site-specific plans. Dispose the purged water according to the site-specific plans. Record the temperature/conductivity/pH readings, or other parameters as specified by the project plan, the volume of water purged, the flow rate if measured, and the method of disposal in the field logbook.

11. After purging the supply system, collect the samples directly from the tap (i.e., if a hose was used for purging, the hose should be disconnected prior to sampling). Any fittings on the end of the faucet that might introduce air into the sample (i.e., a fine mesh screen that is commonly screwed onto the faucet) should be removed prior to sample collection also.

12. Obtain a smooth-flowing water stream at moderate pressure with no splashing. Samples for volatile organic compound (VOC) analyses should be collected using a reduced flow rate (see below). Hold the sample bottle in one hand and the cap in the other; do not touch the inside of the cap; do not allow the faucet to touch the inside of the bottle; do not allow splashing water from the ground or sink to enter the bottle or cap. VOC samples should be filled first, followed by other organic analyses, inorganic analyses, and then other water quality parameters. Refer to the site-specific plans for the required sample parameters, preservatives, and sample handling procedures. The following general guidelines should be followed when collecting samples:

    - VOC. Reduce the flow rate to a minimum to reduce aeration of the VOC sample. Use a pre-preserved "test" vial to determine the appropriate amount of hydrochloric acid (HCl) needed to reduce the pH of the sample to less than 2. Dispose of this test vial after the appropriate amount of HCl is determined. Add the required amount of HCl to the sample vials and then fill the vials with the sample water. Quickly replace the cap and check for air bubbles. If air bubbles are present, the vial will be discarded and a new vial will be filled as detailed above.

    - Semivolatile Organic Compounds (SVOCs), Pesticides, and Polychlorinated Biphenyls (PCBs). Generally, aqueous samples for SVOCs and pesticides/PCBs require no preservative. Sample containers may be filled directly from the tap.

    - Total (unfiltered) Metals. Generally, tap water samples are not collected for filtered (dissolved) metals because risk assessment data needs require total metals analyses (check the site-specific plans to determine filtering requirements). The sample container for total metals may be filled directly from the tap. Nitric acid (HNO_3) should then be added to the filled container to preserve the sample to a pH less than 2.

    - Other Sample Parameters. Other water quality parameters, such as cyanide dissolved oxygen, hardness, nitrate/nitrite, etc., should be collected and preserved as required by the site-specific sampling plans.

13. Label all sample containers as required and place them in a cooler with ice. Record all appropriate data in the field logbook and on the chain-of-custody forms.

6.0 Restrictions/Limitations

To protect the sample from contamination on the exterior of a tap, a tap should not be chosen for sampling if any of the following conditions exist:

- A leaky tap allowing water to flow out from around the stem of the valve handle and down the outside of the faucet.
- A tap located too close to the bottom of the sink or the ground surface.

- A tap that allows water to run up on the outside of the lip.
- A tap that does not deliver a steady stream of water. A temporary fluctuation in line pressure may cause sheets of microbial growth, lodged in some pipe sections or faucet connections, to break loose.

Careful sampling for VOC analysis, or for any other compound(s) that may be degraded by aeration, is necessary to minimize sample disturbance and, hence, analyte loss.

7.0 References

U.S. Environmental Protection Agency, Region IV, Environmental Investigations Standard Operating Procedures and Quality Assurance Manual, Section 8, *Sampling of Potable Water Supplies*, November 2001.

TSOP 1-10

FIELD MEASUREMENT OF ORGANIC VAPORS

Prepared: Tammy Phillips

Technical Review: Peggy Bloisa

QA Review: Rich Opem

Approved: [signature] 2/24/04
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Issued: [signature] 2/18/04
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1.0 Objective

The objective of this standard operating procedure (SOP) is to define the techniques and the requirements for the measurement of organic vapors in the field.

2.0 Background

2.1 Definitions

Flame Ionization Detector - A portable, hand-held instrument that measures the concentration of gaseous organic compounds through the flame ionization of organic vapors.

Photoionization Detector - A portable, hand-held instrument that measures the concentration of gaseous organic compounds through the photoionization of organic vapors.

2.2 Discussion

The measurement of organic vapors is a required step during numerous field activities. The primary purpose of such measurements is health and safety monitoring to determine if the breathing zone in a work area is acceptable or if personal protective equipment such as a respirator or a supplied air device is necessary for field personnel. In addition to health and safety monitoring, organic vapor measurement is also used in conjunction with sampling activities, including subsurface soil sampling and groundwater sampling, where measurements are useful for establishing approximate contaminant levels or ranges.

The two types of instruments most commonly used to measure organic vapors are photoionization detectors (PIDs) and flame ionization detectors (FIDs). Both instruments first ionize the gaseous compound and then measure the response, which is proportional to the concentration. The PID ionizes the gas using an ultraviolet lamp. The photons emitted by the ultraviolet lamp are absorbed by the gas molecules, producing a positively charged ion and an electron. The ionization potential (in electron volts) of the organic compounds to be measured must be less than the energy carried by the photons; therefore, the ionization potential of the known or suspected compounds should be checked against the energy of the ultraviolet lamp to verify that the energy provided by the lamp is greater. Additionally, manufacturer's manuals should be consulted to obtain the appropriate correction factors for known or suspected contaminants. The FID ionizes the gas by burning in a hydrogen/air flame. The FID allows measurement of a wide variety of compounds but in general its sensitivity is not as high as the PID.

2.3 Associated Procedures

- CDM Federal SOP 1-4, Subsurface Soil Sampling
- CDM Federal SOP 1-5, Groundwater Sampling Using Bailers
- CDM Federal SOP 1-6, Water Level Measurement
- CDM Federal SOP 3-1, Geoprobe Soil Sampling Survey
- CDM Federal SOP 3-5, Lithologic Logging
- CDM Federal SOP 4-3, Well Development and Purging

3.0 Responsibilities

Site Manager - The site manager is responsible for ensuring that field activities are conducted in accordance with the procedure and any other SOPs pertaining to the specific activity.

Field Team Leader - The field team leader is responsible for ensuring that field personnel conduct field activities in accordance with this and other relevant procedures.

4.0 Required Equipment

- Site-specific plans
- Field logbook
- Waterproof black ink pen
- Personal protective clothing and equipment
- Photoionization detector or flame ionization detector
- 0.5 liter (16-ounce) or "Mason" type glass jar
- Hydrogen Canister (if using FID for a period of more than 1 day)

5.0 Procedures

5.1 Direct Reading Measurement

1. Connect the measurement probe to the instrument and make necessary operational checks (e.g., battery check, etc.) as outlined in the manufacturer's manual.

2. Calibrate the instrument following the applicable manufacturer's manual

3. Make sure the instrument is reading zero and all function and range switches are set appropriately.

4. Insert the end of the probe directly into the atmosphere to be measured (e.g., breathing zone, monitoring well casing, split spoon, etc.) and read the organic vapor concentration in parts per million (ppm) from the instrument display. Apply the appropriate correction factor if necessary. Record the highest instrument response.

5. Immediately document the reading in the field logbook or on the appropriate field form.

5.2 Headspace Measurement

1. Connect the measurement probe to the instrument and make necessary operational checks (e.g., battery check, etc.) as outlined in the manufacturer's manual.

2. Calibrate the instrument following the appropriate manufacturer's manual.

3. Make sure the instrument is reading zero and all function and range switches are set appropriately.

4. Fill a clean glass jar approximately half-full of the sample to be measured. Quickly cover the top of the jar with one or two sheets of clean aluminum foil and apply cap to seal the jar.

5. Allow headspace to develop for approximately 10 minutes. It is generally preferable to shake the sealed jar for 10 to 15 seconds at the beginning and end of headspace development. **Note:** When the ambient temperature is below 0°C (32°F), the headspace development and subsequent measurement should occur within a heated vehicle or building.

6. Remove the jar cap and quickly puncture the foil and insert the instrument probe to a point approximately one-half of the headspace depth.

7. Read the organic vapor concentration in ppm from the instrument display. Apply the appropriate correction factor if necessary. Record the highest instrument response.

8. Immediately record the reading in the field logbook or on the appropriate field form.

6.0 Restrictions/Limitations

The two methods outlined above are the most commonly used for field measurement of organic vapors but do not apply to all circumstances. Consult project- or program-specific procedures and guidelines for deviations. Both the PID and FID provide quantitative measurement of organic vapors, but generally neither instrument is compound-specific. The typical reading range of the PID is 0 to 2,000 ppm, and the typical reading range of the FID is 0 to 1,000 ppm. The FID will measure methane while the PID will not. **Note:** The presence of methane will cause erratic PID measurements. In methane rich environments, toxic organic vapors should be monitored with an FID. If desired, a charcoal filter can be placed temporarily on the FID inlet probe, which will trap all organic vapors except methane. The filtered (methane only) reading can be subtracted from unfiltered (total organic vapors) to provide an estimate of non-methane organic vapors. The reading accuracy of both instruments can be affected by ambient temperature, barometric pressure, humidity, lithology, etc.

7.0 References

Martin Marietta Energy Systems, Inc., *Environmental Surveillance Procedures Quality Control Program,* ESH/Sub/87-21706/1, 1988.

TSOP 1-11

SEDIMENT/SLUDGE SAMPLING

CONTRACT-SPECIFIC CLARIFICATION

SOP Title: **SEDIMENT/SLUDGE SAMPLING**

SOP No.: 1 - 11
Revision: 6
Date: October 15, 2004

QA Review: [signature]

Approved and Issued: [signature] 11/1/04
Program Manager Signature/Date

Contract No.: RAC II   Client: EPA Region II

Reason for Clarification: Include 1) sample collection procedures for VOCs using 40-ml closed-system vials and 2) sediment/sludge homogenization procedures for non-VOC samples.

Adds definition of homogenization to Section 2.1 and clarifies Section 5.4.2, item 6 (page 7 of 7) of TSOP 1-11:

2.1 Definitions, add (on page 1 of 7):
Homogenization - The process of mixing individual grab samples in order to minimize the bias in sample representativeness introduced by the natural stratification of constituents within the sample.

5.4.2 Homogenization of soil is accomplished by thoroughly mixing the collected soil with a stainless steel spoon or spatula in the following manner. The soil should be scraped from the stainless steel container sides, corners, and bottom, then rolled into the middle and initially mixed. The soil is then quartered and moved to the four quarters of the container. Each quarter of the sample should be mixed individually, then rolled to the center of the stainless steel container sample mixed again.

Add a Section 5.5 (page 7) to include the option for closed system vials:

5.5 Sediment/Sludge Sample Collection for Volatile Organic Compound (VOC) Analysis in Closed-System Vials
This procedure follows EPA's *CLP Sample Collection Guidelines for Volatile Organic Analytes (VOAs) in Soil by SW-846 Method 5035A*, May 2004, Option 1 (Appendix B of EPA's *Contract Laboratory Guidance for Field Samplers*).

5.5.1 Required Equipment
In addition to the required equipment listed in Section 4.0, the following equipment is also needed:

- Tared or pre-weighed, pre-labeled 40 milliliter (mL) volatile organic analysis (VOA) vials containing a magnetic spin bar (three per sample)
- 60-mL glass jar with Teflon sealed cap or one 40-mL VOA vial
- Sample labels
- Portable scale
- Stainless steel spatula

5.5.2 Method for Collecting Surface Sediment/Sludge Samples for Volatile Organic Compound (VOC) Analysis in Closed-System Vials

1. Use the appropriate decontaminated stainless steel or Teflon sampling device to collect the sample.
2. Retrieve the sampling device and slowly decant off any liquid phase.
3. Complete the sample label by filling in the appropriate information. ***Do not*** cover the label with tape.
4. Place the tared or pre-weighed, pre-labeled 40-mL VOA vial and cap on the scale.
5. With the aid of a clean stainless steel spatula, quickly add 5 grams of sediment or sludge to the vial.
6. Immediately secure the Teflon-lined cap on the sample container.
7. Repeat the procedure for the remaining two vials.
8. Collect percent moisture sample in a 40-mL VOA vial or 60-mL jar with Teflon sealed cap. Fill the entire sample container with sediment or sludge, no headspace.
9. Store samplers at 4° Celsius, and ship the sample to the analytical laboratory. The sample must be received by the laboratory within 48 hours of sample collection.

7.0 Reference

U.S. Environmental Protection Agency. 2004. *Contract Laboratory Program Guidance for Field Samplers*. EPA-540-R-00-003. August.

________. 1989. Monitoring Management Branch of the Environmental Services Division, *Region II CERCLA Quality Assurance Manual*. Final Copy. Revision 1. October.

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Issued: [signature] 2/18/04
Signature/Date

1.0 Objective

The objective of this standard operating procedure (SOP) is to define requirements for collection and containment of sediment/sludge samples.

2.0 Background

2.1 Definitions

Sediment - Geologic and/or organic material underlying a body of water. The material has been transported by a fluid and deposited within the boundaries of the body of water.

Sludge - Materials ranging in type from dewatered solids to high viscosity liquids. The material may exist suspended throughout the water or settled from the water as all or part of the sediment.

Grab Sample - A discrete portion or aliquot taken from a specific location at a given point in time.

Composite - Two or more sub-samples taken from a specific media and site at a specific point in time. The sub-samples are collected and mixed, then a single average sample is taken from the mixture.

2.2 Discussion

Sediment/sludge samples are collected to determine the type(s) and level(s) of contamination in a particular surface water body and/or its biological disposition. Sediment/sludge samples will provide a more historical account of contamination than will water samples due to the nature of the matrix.

2.3 Associated Procedures

- CDM Federal SOP 1-2, Sample Custody
- CDM Federal SOP 2-1, Packaging and Shipping Environmental Samples
- CDM Federal SOP 4-1, Field Logbook Content and Control
- CDM Federal SOP 4-2, Photographic Documentation of Field Activities
- CDM Federal SOP 4-5, Field Equipment Decontamination at Non-Radioactive Sites

3.0 Responsibilities

Site Manager - The site manager is responsible for ensuring that field personnel are trained in the use of this and related SOPs and the required equipment.

Field Team Leader - The field team leader (FTL) is responsible for ensuring that sampling efforts are conducted in accordance with this procedure and any other SOPs pertaining to specific media sampling. The FTL must also ensure that the quantity and location of sediment/sludge samples collected meet the requirements of the site-specific plans.

4.0 Required Equipment

All or part of the equipment listed under the "as needed" category may be required at any specific site, depending on the plan(s) for that site.

- Site-specific plans
- Field logbook
- Indelible black-ink pens and markers
- Labels and appropriate forms/documentation for sample shipment
- Appropriate sample containers
- Insulated cooler and waterproof sealing tape
- Ice bags or "blue ice"
- Plastic zip-top bags
- Clear waterproof tape
- Personal protective clothing and equipment
- Latex or appropriate gloves
- Rubber boots and/or rubberized waders
- Stainless steel or Teflon® spoons, spatulas, or scoops
- Teflon or stainless steel mixing bowls or trays
- Aluminum foil
- 12- to 19-mm (½- to ¾-inch) braided nylon line or Teflon-coated wire rope
- Kimwipe or paper towels
- Clean plastic sheeting
- Tap and deionized water
- Water spray bottle
- Appropriate photographic equipment and supplies
- Appropriate decontamination equipment and supplies
- Eckman grab for depositional area (primarily stream) sediment sampling
- Ponar sampler for lake sampling

As needed:

- Global Positioning System (GPS) unit
- Hand or gravity corer with extensions or stainless steel hand auger
- Core liners of Teflon, stainless steel, brass, aluminum, or polybutyrate, as specified in the site-specific plan(s)
- Stainless steel push tubes
- Dredge with 4.5- to 6.0-meter (15- to 20-foot) sampling pole (hollow) and insert (e.g., Peterson, Eckman, Ponar)
- Boat with depth finder for deep water or inaccessible shorelines
- Tape measure
- Any personal protective equipment specified in the site-specific health and safety plan
- Spare parts for all equipment

5.0 Procedures

5.1 Preparation

The following steps should be taken when preparing for sampling sediment/sludge:

1. Don the appropriate personal protective clothing as dictated by the site-specific health and safety plan.

2. Select stream/river sampling locations that exhibit cross-sectional homogeneity. Avoid areas where the channel is constricted or bends where scouring may have occurred. For lakes, collect sediment samples away from the shoreline.

3. Prepare sampling site by laying out clean plastic sheeting on the ground or any flat, level surfaces near the sampling area and place equipment to be used on the plastic.

4. If surface water is present at the sample location, make field measurements in physical, chemical, and biological characteristics of the water (e.g., temperature, dissolved oxygen, conductivity, pH), as dictated by the project-specific plans.

5. The samples shall be collected from areas of least to greatest contamination (when known) and, when collecting several samples in 1 day, always collect from downstream to upstream.

6. When sampling sediment and surface water from the same surface water body, collect surface water samples prior to sediment samples.

7. Document the sampling events, recording all information in the designated field logbook and take photographs if required or if possible. Document any and all deviations from this SOP and include rationale for changes.

8. The collection points shall be located on a site map and described in the field logbook. Use GPS if required or if possible.

9. Label each sample container with the appropriate information. Secure the label by covering it with a piece of waterproof clear tape.

10. Decontaminate reusable sampling equipment after sample collection according to CDM Federal SOP 4-5.

11. Processes for verifying depth of samples must be included in site-specific project plans.

12. Check that a trip blank/temperature blank, when necessary, is included in the chilled cooler. Quality assurance/quality control requirements vary from project to project. Consult the project-specific work plan for quality requirements.

5.2 Sediment/Sludge Sample Collection from Shallow Waters

5.2.1 Method for Collecting Samples for Volatile Organic Compound (VOC) Analysis

The following steps must be followed when collecting shallow water sediment/sludge VOC samples:

1. Use a decontaminated stainless steel or Teflon, long-handled scoop, corer, push tube, or dredge to collect the entire sample in one grab. If wading is necessary, approach the sample location from downstream. Do not enter the actual sample area.

2. Retrieve the sampling device and slowly decant off any liquid phase.

3. Immediately fill the specified sample container(s) with the solid. Use a clean stainless steel or Teflon spoon or spatula to completely fill the container(s), ensuring no headspace.

Note: Samples to be analyzed for VOC or other compounds degraded by aeration should be taken as grab samples. Do not homogenize or composite these samples.

4. Once each container is filled, close the container with the Teflon-lined cap. Wipe the outside of the container clean with a Kimwipe or clean paper towel. Affix a completed sample label.

5. Place the sample container(s) in individual zip-top plastic bags and seal the bags.

6. Immediately pack all samples into a chilled cooler.

5.2.2 Method for Collecting Samples for Nonvolatile Organic and Inorganic Compound Analysis

The following steps must be taken when collecting shallow water sediment/sludge samples for analytes not degraded by aeration:

1. Collect sufficient volume to fill specified sample containers using decontaminated stainless steel or Teflon-lined equipment (scoops, corer, dredge sampler, etc.). If wading is necessary, approach the sample location from downstream. Do not enter the actual sample area.

2. Retrieve the sampling device with the sample and slowly decant off any liquid phase.

3. Pool and homogenize samples in a stainless steel, Teflon, or appropriate pan or mixing bowl, using stainless steel spatula or spoon.

4. Fill each sample container with the homogenized sample to approximately 75 to 90 percent capacity, filling sample containers for organics analyses first.

5. Once each container is filled, close the container with a Teflon-lined cap. Wipe the outside of sample containers clean with a Kimwipe or clean paper towel. Affix a completed sample label.

6. Place the sample container(s) in individual zip-top plastic bags and seal the bags.

7. Immediately pack all samples into a chilled cooler.

5.3 Subsurface Sediment/Sludge Sample Collection Using a Corer or Auger from Shallow Waters

5.3.1 Method for Collecting Samples for Volatile Organic Compound Analysis Using an Unlined Corer (also applies to augers)

The following steps must be taken when collecting subsurface sediment/sludge VOC samples that underlie shallow water:

1. At the specified sampling location, force or drive the corer to the specified depth.

2. Twist and withdraw the corer in a smooth motion.

3. Retrieve the sampling device, remove the corer nosepiece (if possible), and extrude the sample into the specified sampling container(s). Use a clean stainless steel or Teflon spoon or spatula to completely fill the container(s), ensuring no headspace.

4. Once each container is filled, close the container with the Teflon-lined cap. Wipe the outside of the sample container clean with a Kimwipe or clean paper towel. Affix a completed sample label.

5. Place the sample container(s) in individual zip-top plastic bags and seal the bags.

6. Immediately pack all samples into a chilled cooler.

5.3.2 Method for Collecting Samples for Volatile Organic Compound Analysis Using a Lined Corer
The following steps must be followed when collecting shallow water subsurface sediment/sludge VOC samples that underlie shallow water:

1. Install decontaminated liner(s) in the corer barrel.

2. At the specified sampling location, force or drive the corer to the specified depth.

3. Twist and withdraw the corer in a smooth motion.

4. Retrieve the sampling device, remove the corer nosepiece (if possible) and remove the liner(s), cap the liner(s), and seal the caps with Teflon tape.

5. Wipe the outside of the liner clean with a Kimwipe or clean paper towel. Label the top and bottom ends of the liner(s). Affix a completed sample label.

6. Place capped and sealed liners in individual zip-top plastic bags and seal the bags.

7. Immediately pack all samples into a chilled cooler.

5.3.3 Method for Collecting Samples for Nonvolatile Organic and Inorganic Compound Analysis Using a Corer (also applies to augers)
The following steps must be followed when collecting subsurface sediment/sludge samples that underlie shallow water for analytes not degraded by aeration:

1. At the specified sampling location, force or drive the corer to the specified depth.

2. Twist and withdraw the corer in a smooth motion.

3. Retrieve the sampling device. Remove the corer nosepiece (if possible) and extrude the sample into a stainless steel or Teflon-lined pan or bowl. Collect sufficient sample volume to fill all containers.

4. Use a stainless steel or Teflon spoon or spatula to homogenize and then divide the sample material into the appropriate number of sample containers.

5. Fill each container to approximately 75 to 90 percent capacity, filling containers for organics analyses first. Close the container with a Teflon-lined cap. Wipe the outside of sample

containers clean with a Kimwipe or clean paper towel. Affix a completed sample label.

6. Place the sample container(s) in individual zip-top plastic bags and seal the bags.
7. Immediately pack all samples into a chilled cooler.

5.4 Sediment/Sludge Sample Collection Using a Dredge from Deep Waters

5.4.1 Method for Collecting Samples for Volatile Organic Compound Analysis

The following steps must be followed when collecting deep-water sediment/sludge VOC samples:

1. Attach a clean piece of 12- to 19-mm (½- to ¾-inch) braided nylon line or Teflon-coated wire rope to the top of the sampler. The line must be of sufficient length to reach the sediment or sludge and have enough slack to release the mechanism. Mark the distance to the bottom on the line.

2. Attach the free end of the sampling line to a fixed support to prevent loss of the sampler.

3. At the specified sampling location, open the sampler jaws and slowly lower the sampler until contact with the bottom (sediment/sludge) is felt.

4. Release tension on the line; allow sufficient slack for the mechanism (latch) to release. Slowly raise the sampler.

5. Once the sampler is above the water surface, place the sampler in a stainless steel or Teflon-lined tray or pan. Open the sampler. Immediately collect the sample for VOC analysis, using a stainless steel or Teflon spoon or spatula. Fill each container completely to minimize headspace.

6. Once each container is filled, close the container with the Teflon-lined cap. Wipe the outside of sample containers clean with a Kimwipe or clean paper towel. Affix a completed sample label.

7. Place the sample container(s) in individual zip-top plastic bags and seal the bags.

8. Immediately pack all samples into a chilled cooler.

5.4.2 Method for Collecting Samples for Nonvolatile Organic and Inorganic Compounds

The following steps must be followed when collecting deep-water sediment/sludge samples for analytes not degraded by aeration:

1. Attach a clean piece of 12- to 19-mm (½- to ¾-inch) braided nylon line or Teflon-coated wire rope to the top of the sampler. The line must be of sufficient length to reach sediment or sludge and have enough slack to release the mechanism. Mark the distance to the bottom on the line.

2. Attach the free end of the sampling line to a fixed support to prevent loss of the sampler.

3. At the specified sampling location, open the sampler jaws and slowly lower the sampler until contact with the bottom (sediments/sludge) is felt.

4. Release tension on the line; allow sufficient slack for the mechanism (latch) to release. Slowly raise the sampler.

5. Once the sampler is above the water surface, place the sampler in a stainless steel or Teflon-lined tray or pan. Open the sampler.

6. Collect sufficient volume of sample to fill the specified sampler containers. Pool the grab samples in a tray, pan, or bowl. Homogenize the pooled samples by mixing them together with a stainless steel or Teflon spoon or spatula.

7. Fill the specified sample containers to approximately 75 to 90 percent capacity with the homogenized sample using the stainless steel or Teflon spoon or spatula. Fill sample containers for organics analyses first.

8. Once each container is filled, close the container with the Teflon-lined cap. Wipe the outside of sample containers clean with a Kimwipe or clean paper towel. Affix a completed sample label.

9. Place sample container(s) in individual zip-top plastic bags and seal the bags.

10. Immediately pack all samples into a chilled cooler.

6.0 Restrictions/Limitations

Core sampling devices may not be usable if cobbles exist in the sediment/sludge. Bumping of core sampling devices and Ponar dredge samplers may result in the loss of some of the sample.

Grab sampling for VOC analysis or for analysis of any other compound(s) that may be degraded by aeration is necessary to minimize sample disturbance and, hence, analyte loss. The representativeness of this sample, however, is difficult to determine because the collected sample represents a single point, is not homogenized, and has been disturbed.

7.0 References

U.S. Department of Energy, Hazardous Waste Remedial Actions Program, *Quality Control Requirements for Field Methods*, DOE/HWP-69/R1, July 1990 or current revision.

U.S. Department of Energy, Hazardous Waste Remedial Actions Program, *Standard Operating Procedures for Site Characterizations*, DOE/HWP-100/R2, September 1996 or current revision.

U.S. Environmental Protection Agency, Region II, *CERCLA Quality Assurance Manual*, March 1988 or current revision.

U.S. Environmental Protection Agency, Region IV, *Environmental Investigations, Standard Operating Procedures and Quality Assurance Manual*, May 1996 or current revision.

U.S. Geological Survey, *National Field Manual for the Collection of Water-Quality Data*, Chapter A8, October 1997.

TSOP 2-1

PACKAGING AND SHIPPING OF ENVIRONMENTAL SAMPLES

CONTRACT-SPECIFIC CLARIFICATION

SOP Title: **PACKAGING AND SHIPPING OF ENVIRONMENTAL SAMPLES**

SOP No.: 2 - 1
Revision: 3
Date: October 20, 2004

QA Review: [signature]

Approved and Issued: [signature] 11/4/04
Program Manager Signature/Date

Contract No.: RAC II   Client: EPA Region II

Reason for Clarification: Make SOP EPA Region II - Specific

1.3 REQUIRED EQUIPMENT

Add to the list of equipment:

- Paint can-type metal cans with lids, clean (optional)

1.4 PROCEDURES

Under Step 2, add:

Clean to the description of the cooler used to transport samples.

Under Step 4, add:

- If bubble wrap or other wrapping material will be placed around the labeled containers, write the sample number and analysis on the outside of the wrap, and then place wrapped container in a plastic zip-top bag and close the bag.

- If samples are determined to be of medium or high hazard by visual observation or instrument reading, or if the sample is known to contain dioxin, all such sample bottles will be placed in waterproof plastic bags and then placed in a metal can (paint can). Vermiculite will be used to secure the bottles within the metal can, and clips or tape will be used to permanently hold the can lid tightly in place. One bottle is packed per can. The metal cans will be labeled as the sample bottle is labeled. High level samples will not be cooled to 4^0 centigrade.

- Note: A labeled cooler temperature blank must be added to each cooler.

Under Step 4, remove the sentence:
"Optionally, place three to six VOA vials in a quart metal can and then fill the can with vermiculite or equivalent".

CONTRACT-SPECIFIC CLARIFICATION

SOP Title: **PACKAGING AND SHIPPING OF ENVIRONMENTAL SAMPLES**

SOP No.: 2 - 1
Revision: 3
Date: October 20, 2004

Under Step 9, add:

At least two custody seals must be attached to each cooler at diagonally opposing corners.

Under Step 10, add:

The outside of the cooler must be marked "Environmental Samples" if the samples are designated "Low-Level."

Bills of Lading (DOT shipping papers) are required only for shipment of medium- or high-level samples. Shipment of medium- or high-level samples are as per the *Contract Laboratory Program (CLP) Guidance for Field Samplers* (June 2001).

8.0 REFERENCES

Remove:
U.S. Environmental Protection Agency, *Sampler's Guide to the Contract Laboratory Program,* EPA/540/P-90/006, December 1990.

Add:
U.S. Environmental Protection Agency. 2004. *Contract Laboratory Program (CLP) Guidance for Field Samplers,* Final. EPA-540-R-00-003. August.

Prepared: Krista Lippoldt

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Approved: [signature] 2/24/04
Signature/Date

Issued: [signature] 2/18/04
Signature/Date

1.0 Packaging and Shipping of All Samples

This standard operating procedure (SOP) applies to the packaging and shipping of all environmental samples. If the sample is preserved or radioactive, the following sections may also be applicable.

Section 2.0 – Packaging and Shipping Samples Preserved with Methanol
Section 3.0 – Packaging and Shipping Samples Preserved with Sodium Hydroxide
Section 4.0 – Packaging and Shipping Samples Preserved with Hydrochloric Acid
Section 5.0 – Packaging and Shipping Samples Preserved with Nitric Acid
Section 6.0 – Packaging and Shipping Samples Preserved with Sulfuric Acid
Section 7.0 – Packaging and Shipping Limited-Quantity Radioactive Samples

1.1 Objective

The objective of this SOP is to outline the requirements for the packaging and shipment of environmental samples. Additionally, Sections 2.0 through 7.0 outline requirements for the packaging and shipping of regulated environmental samples under the Department of Transportation (DOT) Hazardous Materials Regulations, the International Air Transportation Association (IATA), and International Civil Aviation Organization (ICAO) Dangerous Goods Regulations for shipment by air and applies only to domestic shipments. This SOP does not cover the requirements for packaging and shipment of equipment (including data loggers and self-contained breathing apparatus [SCBAs] or bulk chemicals that are regulated under the DOT, IATA, and ICAO.

1.2 Background

1.2.1 Definitions

Environmental Sample - An aliquot of air, water, plant material, sediment, or soil that represents the contaminant levels on a site. Samples of potential contaminant sources, like tanks, lagoons, or non-aqueous phase liquids are normally not "environmental" for this purpose. This procedure applies only to environmental samples that contain less than reportable quantities for any foreseeable hazardous constituents according to DOT regulations promulgated in 49 CFR - Part 172.101 Appendix A.

Custody Seal – A custody seal is a narrow adhesive-backed seal that is applied to individual sample containers and/or the container (i.e., cooler) before offsite shipment. Custody seals are used to demonstrate that sample integrity has not been compromised during transportation from the field to the analytical laboratory.

Inside Container – The container, normally made of glass or plastic, that actually contacts the shipped material. Its purpose is to keep the sample from mixing with the ambient environment.

Outside Container – The container, normally made of metal or plastic, that the transporter contacts. Its purpose is to protect the inside container.

Secondary Containment – The outside container provides secondary containment if the inside container breaks (i.e., plastic overpackaging if liquid sample is collected in glass).

Excepted Quantity – Excepted quantities are limits to the mass or volume of a hazardous material in the inside and outside containers below which DOT, IATA, ICAO regulations do not apply. The excepted quantity limits are very low. Most regulated shipments will be made under limited quantity.

Limited Quantity – Limited quantity is the maximum amount of a hazardous material below which there are specific labeling or packaging exceptions.

Performance Testing – Performance testing is the required testing of outer packaging. These tests include drop and stacking tests.

Qualified Shipper – A qualified shipper is a person who has been adequately trained to perform the functions of shipping hazardous materials.

1.2.2 Discussion

Proper packaging and shipping is necessary to ensure the protection of the integrity of environmental samples shipped for analysis. These shipments are potentially subject to regulations published by DOT, IATA, or ICAO. Failure to abide by these rules places both CDM and the individual employee at risk of serious fines. The analytical holding times for the samples must not be exceeded. The samples should be packed in time to be shipped for overnight delivery. Make arrangements with the laboratory before sending samples for weekend delivery.

1.2.3 Associated Procedure

- CDM Federal SOP 1-2, Sample Custody

1.3 Required Equipment

- Coolers with return address of the appropriate CDM office
- Heavy-duty plastic garbage bags
- Plastic zip-type bags, small and large
- Clear tape
- Nylon reinforced strapping tape
- Duct tape
- Vermiculite (or an equivalent nonflammable material that is inert and absorbent)*
- Bubble wrap (optional)
- Ice
- Custody seals
- Completed chain-of-custody record or contract laboratory program (CLP) custody records, if applicable
- Completed bill of lading
- "This End Up" and directional arrow labels

* Check for any client-specific or laboratory reqnirements related to the use of absorbent packaging materials.

1.4 Packaging Environmental Samples

The following steps must be followed when packing sample bottles and jars for shipment:

1. Verify the samples undergoing shipment meet the definition of "environmental sample" and are not a hazardous material as defined by DOT. Professional judgment and/or consultation with qualified persons such as the appropriate health and safety coordinator or the health and safety manager should be observed.

2. Select a sturdy cooler in good repair. Tape any interior opening in the cooler (drain plug) from the inside to ensure control of interior contents. Also, tape the drain plug from the outside of the cooler. Line the cooler with a large heavy-duty plastic garbage bag.

3. Be sure the caps on all bottles are tight (will not leak); check to see that labels and chain-of-custody records are completed properly (SOP 1-2, Sample Custody).

4. Place all bottles in separate and appropriately sized plastic zip-top bags and close the bags. Up to three VOA vials may be packed in one bag. Binding the vials together with a rubber band on the outside of the bag, or separating them so that they do not contact each other, will reduce the risk of breakage. Bottles may be wrapped in bubble wrap. Optionally, place three to six VOA vials in a quart metal can and then fill the can with vermiculite or equivalent. **Note**: Trip blanks must be included in coolers containing VOA samples.

5. Place 2 to 4 inches of vermiculite (or equivalent) into a cooler that has been lined with a garbage bag, and then place the bottles and cans in the bag with sufficient space to allow for the addition of packing material between the bottles and cans. It is preferable to place glass sample bottles and jars into the cooler vertically. Glass containers are less likely to break when packed vertically rather than horizontally.

6. While placing sample containers into the cooler, conduct an inventory of the contents of the shipping cooler against the chain-of-custody record. The chain-of-custody with the cooler should reflect only those samples within the cooler.

7. Put ice in large plastic zip-top bags (double bagging the zip-tops is preferred) and properly seal. Place the ice bags on top of and/or between the samples. Several bags of ice are required (dependant on outdoor temperature, staging time, etc.) to maintain the cooler temperature at approximately 4° Celsius (C) if the analytical method requires cooling. Fill all remaining space between the bottles or cans with packing material. Securely fasten the top of the large garbage bag with fiber or duct tape.

8. Place the completed chain-of-custody record or the CLP traffic report form (if applicable) for the laboratory into a plastic zip-top bag, seal the bag, tape the bag to the inner side of the cooler lid and close the cooler.

9. The cooler lid shall be secured with nylon reinforced strapping tape by wrapping each end of the cooler a minimum of two times. Attach a completed chain-of-custody seal across the opening of the cooler on opposite sides. The custody seals should be affixed to the cooler with half of the seal on the strapping tape so that the cooler cannot be opened without breaking the seal. Complete two more wraps around with fiber tape and place clear tape over the custody seals.

10. The shipping container lid must be marked "**THIS END UP**" and arrow labels that indicate the proper upward position of the container should be affixed to the cooler. A label containing the name and address of the shipper (CDM) shall be placed on the outside of the container. Labels used in the shipment of hazardous materials (such as Cargo Only Air Craft, Flammable Solids, etc.) are not permitted on the outside of containers used to transport environmental samples and shall not be used. The name and address of the laboratory shall be placed on the container, or when shipping by common courier, the bill of lading shall be completed and attached to the lid of the shipping container.

2.0 Packaging and Shipping Samples Preserved with Methanol

2.1 Containers

- The maximum volume of methanol in a sample container is limited to 30 ml.
- The sample container must not be full of methanol.

2.2 Responsibility

It is the responsibility of the qualified shipper to:

- Ensure that the samples undergoing shipment contain no other contaminant that meets the definition of "hazardous material" as defined by DOT
- Determine the amount of preservative in each sample so that accurate determination of quantities can be made

2.3 Additional Required Equipment

The following equipment is needed in addition to the required equipment listed in Section 1.3:

- Inner packing may consist of glass or plastic jars
- Outer packaging (for limited quantities) insulated cooler that has passed the ICAO drop test
- Survey documentation (if shipping from Department of Energy [DOE] or radiological sites)
- Class 3 flammable liquid labels
- Orientation labels
- Consignor/consignee labels

2.4 Packaging Samples Preserved with Methanol

The following steps are to be followed when packaging limited-quantity sample shipments.

- Tape any interior opening in the cooler (drain plug) from the inside to ensure control of interior contents. Also, tape the drain plug from the outside of the cooler.
- All sample containers will be properly labeled and the label protected with waterproof tape prior to sampling.

- At a minimum the label must contain:
  - Project name
  - Project number
  - Date and time of sample collection
  - Sample location
  - Sample identification number
  - Collector's initials
  - Preservative (note amount of preservative used in miscellaneous section of the chain-of-custody form)
- Wrap each container (40-ml VOA vials) in bubble wrap (secure with waterproof tape) to prevent breakage.
- Place the bubble-wrapped container into a 2.7-mil zip-type bag, removing trapped air.
- Place wrapped containers inside a polyethylene bottle filled with vermiculite; seal the bottle. (Maximum of 4 VOA vials will fit inside a 500-ml wide-mouth polyethylene bottle.)
- Total volume of methanol per shipping container must not exceed 500 ml.
- Place sufficient amount of vermiculite in the bottom of the cooler to absorb any leakage that may occur.
- Place a garbage bag in the cooler.
- Pack the samples appropriately inside the garbage bag (bottles placed upright) to prevent movement during shipment.
- Place a sufficient amount of double-bagged ice around the samples to maintain the required temperature during shipment.
- Seal the garbage bag by tieing or taping.
- The maximum weight of the cooler shall not exceed 30 kg (66 lbs) for any limited-quantity shipment of dangerous goods.
- Secure the chain-of-custody form (placed inside a zip-type bag) to the interior of the cooler lid.
- If the shipment is from a DOE or other facility, place the results of the radiation screen and cooler/sample survey with the chain-of-custody.
- Wrap strapping tape or duct tape around both ends of the cooler and around the cooler lid.
- Affix custody seals to opposite sides of the cooler lid. Cover the custody seals with clear waterproof tape.
- Mark the outside of the cooler with the proper shipping name of the contents, corresponding UN number, and LTD. QTY. (as shown below).

Methanol Mixture
UN1230
LTD. QTY.

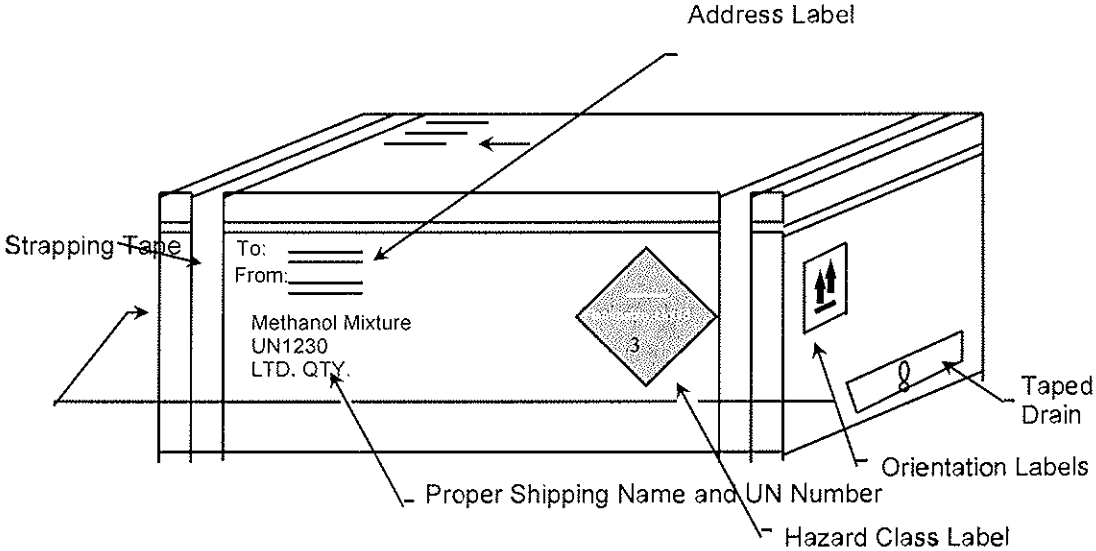
- Place a label on the front of the cooler with the company name, contact name, phone number, full street address, and state with zip code for both shipper and recipient.
- Affix a Flammable Liquid label to the outside of the cooler.
- Affix package orientation labels on two opposite sides of the cooler.
- Secure the marking and labels to the surface of the cooler with clear waterproof tape to prevent accidental removal during shipment.
- An example of cooler labeling/marking locations is shown in Figure 1.

Note: No marking or labeling can be obscured by strapping or duct tape.

Note: The inner packaging of dangerous goods must be placed into the designated cooler for shipment. Other non-regulated environmental samples may be added to the cooler for shipment.

- When shipping from a DOE facility, the cooler will be surveyed by a qualified radiation control technician to ensure that radiation flux on exterior surfaces does not exceed 0.5 mrem/h on all sides. This survey will be documented and the results reviewed by the qualified shipper.
- Complete the Dangerous Goods and Hazardous Materials Inspection Checklist for Shipping Limited-Quantity (Appendix A).
- Complete a Dangerous Goods Airbill.

Figure 1 - Example of Cooler Label/Marking Locations



3.0 Packaging and Shipping Samples Preserved with Sodium Hydroxide

3.1 Containers

The inner packaging container (and amount of preservative) that may be used for these shipments includes:

Excepted Quantities of Sodium Hydroxide Preservatives

Preservative		Desired in Final Sample		Quantity of Preservative (ml) for Specified Container				
		pH	Conc.	40 ml	125 ml	250 ml	500 ml	1 L
NaOH	30%	>12	0.08%		.25	0.5	1	2

5 drops = 1 ml

3.2 Responsibility

It is the responsibility of the qualified shipper to determine the amount of preservative in each sample so that accurate determination of quantities can be made.

3.3 Additional Required Equipment

The following equipment is needed in addition to the required equipment listed in Section 1.3:

- Outer packaging (for limited quantities) insulated cooler that has passed the ICAO drop test
- Inner packings may consist of glass or plastic jars no larger than 1 pint
- Survey documentation (if shipping from DOE or radiological sites)
- Class 8 corrosive labels
- Orientation labels
- Consignor/consignee labels

3.4 Packaging Samples Preserved with Sodium Hydroxide

Samples containing NaOH as a preservative that exceed the excepted concentration of 0.08 percent (2 ml of a 30 percent NaOH solution per liter) may be shipped as a limited quantity per packing instruction Y819 of the IATA/ICAO Dangerous Goods Regulations.

The following steps are to be followed when packaging limited-quantity samples shipments.

- Tape any interior opening in the cooler (drain plug) from the inside to ensure control of interior contents. Also, tape the drain plug from the outside of the cooler.
- All sample containers will be properly labeled and the label protected with waterproof tape prior to sampling.
- At a minimum the label must contain:
  - Project name
  - Project number
  - Date and time of sample collection
  - Sample location
  - Sample identification number
  - Collector's initials
  - Preservative (note amount of preservative used in miscellaneous section of the chain-of-custody form)
- This step is optional; wrap each container in bubble wrap (secure with waterproof tape) to prevent breakage.
- Place the bubble-wrapped container into a 2.7-mil zip-type bag, removing trapped air.
- Place glass containers inside a polyethylene bottle filled with vermiculite; seal the bottle.
- The total volume of sample in each cooler must not exceed 1 liter.
- Place sufficient amount of vermiculite in the bottom of the cooler to absorb any leakage that may occur.
- Place a garbage bag in the cooler.
- Pack the samples appropriately inside the garbage bag (bottles placed upright) to prevent movement during shipment.
- Place a sufficient amount of double-bagged ice around the samples to maintain the required temperature during shipment.
- Seal the garbage bag by tieing or taping.
- The maximum weight of the cooler shall not exceed 30 kg (66 lbs) for any limited-quantity shipment of dangerous goods.

- Secure the chain-of-custody form (placed inside a zip-type bag) to the interior of the cooler lid.
- If the shipment is from a DOE or other facility, place the results of the radiation screen and cooler/sample survey with the chain-of-custody.
- Wrap strapping tape or duct tape around both ends of the cooler and around the cooler lid.
- Affix custody seals to opposite sides of the cooler lid. Cover the custody seals with clear waterproof tape.
- Mark the outside of the cooler with the proper shipping name of the contents, corresponding UN number, and LTD. QTY. (as shown below).

Sodium Hydroxide Solution
UN1824
LTD. QTY.

- Place a label on the front of the cooler with the company name, contact name, phone number, full street address, and state with zip code for both shipper and recipient.
- Affix a Corrosive label to the outside of the cooler.
- Affix package orientation labels on two opposite sides of the cooler.
- Secure the marking and labels to the surface of the cooler with clear waterproof tape to prevent accidental removal during shipment.
- An example of cooler labeling/marking locations is shown in Figure 1.

Note: Samples meeting the exception concentration of 0.08 percent NaOH by weight may be shipped as non-regulated or non-hazardous following the procedure in Section 1.4.

Note: No marking or labeling can be obscured by strapping or duct tape.

Note: The inner packaging of dangerous goods must be placed into the designated cooler for shipment. Other non-regulated environmental samples may be added to the cooler for shipment.

- When shipping from a DOE facility, the cooler will be surveyed by a qualified radiation control technician to ensure that radiation flux on exterior surfaces does not exceed 0.5 mrem/h on all sides. This survey will be documented and the results reviewed by the qualified shipper.
- Complete the Dangerous Goods and Hazardous Materials Inspection Checklist for Shipping Limited-Quantity (Appendix A).
- Complete a Dangerous Goods Airbill.

4.0 Packaging and Shipping Samples Preserved with Hydrochloric Acid

4.1 Containers

The inner packaging container (and amount of preservative) that may be used for these shipments includes:

Excepted Quantities of Hydrochloric Acid Preservatives

Preservative		*Desired in Final Sample*		*Quantity of Preservative (ml) for Specified Container*		
		pH	Conc.	40 ml	125 ml	250 ml
HCl	2N	<1.96	0.04%	.2	.5	1

5 drops = 1 ml

4.2 Responsibility

It is the responsibility of the qualified shipper to:

- Determine the samples undergoing shipment contain no other contaminant that meets the definition of hazardous material as defined by DOT
- Determine the amount of preservative in each sample so that accurate determination of quantities can be made

4.3 Additional Required Equipment

The following equipment is needed in addition to the required equipment listed in Section 1.3.

- Inner packing may consist of glass or plastic jars no larger than 1 pint.
- Outer packaging (for limited quantities) insulated cooler that has passed the ICAO drop test.
- Survey documentation (if shipping from DOE or radiological sites)
- Class 8 corrosive labels
- Orientation labels
- Consignor/consignee labels

4.4 Packaging Samples Preserved with Hydrochloric Acid

The following steps are to be followed when packaging limited-quantity sample shipments.

- Tape any interior opening in the cooler (drain plug) from the inside to ensure control of interior contents. Also, tape the drain plug from the outside of the cooler.
- All sample containers will be properly labeled and the label protected with waterproof tape prior to sampling.
- At a minimum the label must contain:
  - Project name
  - Project number
  - Date and time of sample collection
  - Sample location
  - Sample identification number
  - Collector's initials
  - Preservative (note amount of preservative used in miscellaneous section of the chain-of-custody form)
- Wrap each container (40-ml VOA vials) in bubble wrap (secure with waterproof tape) to prevent breakage.
- Place the bubble-wrapped container into a 2.7-mil zip-type bag, removing trapped air.
- Place wrapped containers inside a polyethylene bottle filled with vermiculite; seal the bottle. (No more than 4 VOA vials will fit inside a 500-ml wide-mouth polyethylene bottle.)

- Total volume of sample inside each cooler must not exceed 1 liter.
- Place sufficient amount of vermiculite in the bottom of the cooler to absorb any leakage that may occur.
- Place a garbage bag in the cooler.
- Pack the samples appropriately inside the garbage bag (bottles placed upright) to prevent movement during shipment.
- Place a sufficient amount of double-bagged ice around the samples to maintain the required temperature during shipment.
- Seal the garbage bag by tieing or taping.
- The maximum weight of the cooler shall not exceed 30 kg (66 lbs) for any limited-quantity shipment of dangerous goods.
- Secure the chain-of-custody form (placed inside a zip-type bag) to the interior of the cooler lid.
- If the shipment is from a DOE or other facility, place the results of the radiation screen and cooler/sample survey with the chain-of-custody.
- Wrap strapping tape or duct tape around both ends of the cooler and around the cooler lid.
- Affix custody seals to opposite sides of the cooler lid. Cover the custody seals with clear waterproof tape.
- Mark the outside of the cooler with the proper shipping name of the contents, corresponding UN number, and LTD. QTY. (as shown below).

  Hydrochloric Acid Solution
  UN1789
  LTD. QTY.

- Place a label on the front of the cooler with the company name, contact name, phone number, full street address, and state with zip code for both shipper and recipient.
- Affix a Corrosive label to the outside of the cooler.
- Affix package orientation labels on two opposite sides of the cooler.
- Secure the marking and labels to the surface of the cooler with clear waterproof tape to prevent accidental removal during shipment.
- An example of cooler labeling/marking locations is shown in Figure 1.

  Note: Samples containing less than the exception concentration of 0.04 percent HCl by weight will be shipped as non-regulated or non-hazardous following the procedure in Section 1.4.

  Note: No marking or labeling can be obscured by strapping or duct tape.

  Note: The inner packaging of dangerous goods must be placed into the designated cooler for shipment. Other non-regulated environmental samples may be added to the cooler for shipment.

- When shipping from a DOE facility, the cooler will be surveyed by a qualified radiation control technician to ensure that radiation flux on exterior surfaces does not exceed 0.5 mrem/h on all sides. This survey will be documented and the results reviewed by the qualified shipper.

- Complete the Dangerous Goods and Hazardous Materials Inspection Checklist for Shipping Limited-Quantity (Appendix A).
- Complete a Dangerous Goods Airbill.

5.0 Packaging and Shipping Samples Preserved with Nitric Acid

5.1 Containers

The inner packaging container (and amount of preservative) that may be used for these shipments includes:

Excepted Quantities of Nitric Acid Preservatives

Preservative		Desired in Final Sample		Quantity of Preservative (ml) for Specified Container				
		pH	Conc.	40 ml	125 ml	250 ml	500 ml	1 L
HNO_3	6N	<1.62	0.15%		2	4	5	8

5 drops = 1 ml

5.2 Responsibility

It is the responsibility of the qualified shipper to:

- Determine the samples undergoing shipment contain no other contaminant that meets the definition of hazardous material as defined by DOT
- Determine the amount of preservative in each sample so that accurate determination of quantities can be made

5.3 Additional Required Equipment

The following equipment is needed in addition to the required equipment listed in Section 1.3.

- Inner packings may consist of glass or plastic jars no larger than 100 ml.
- Outer packaging (for limited quantities) insulated cooler that has passed the ICAO drop test.
- Survey documentation (if shipping from DOE or radiological sites)
- Class 8 corrosive labels
- Orientation labels
- Consignor/consignee labels

5.4 Packaging Samples Preserved with Nitric Acid

Samples containing HNO_3 as a preservative that exceed the excepted concentration of 0.15 percent HNO_3 will be shipped as a limited quantity per packing instruction Y807 of the IATA/ICAO Dangerous Goods Regulations.

The following steps are to be followed when packaging limited-quantity sample shipments.

- Tape any interior opening in the cooler (drain plug) from the inside to ensure control of interior contents. Also, tape the drain plug from the outside of the cooler.
- All sample containers will be properly labeled and the label protected with waterproof tape prior to sampling.
- At a minimum the label must contain:
  - Project name

- Project number
- Date and time of sample collection
- Sample location
- Sample identification number
- Collector's initials
- Preservative (note amount of preservative used in miscellaneous section of the chain-of-custody)

- This step is optional; wrap each container in bubble wrap (secure with waterproof tape) to prevent breakage.
- Place the bubble-wrapped container into a 2.7-mil zip-type bag, removing trapped air.
- Place glass containers inside a polyethylene bottle filled with vermiculite; seal the bottle.
- Place sufficient amount of vermiculite in the bottom of the cooler to absorb any leakage that may occur.
- Place a garbage bag in the cooler.
- Pack the samples appropriately inside the garbage bag (bottles placed upright) to prevent movement during shipment.
- Place a sufficient amount of double-bagged ice around the samples to maintain the required temperature during shipment.
- Seal the garbage bag by tieing or taping.
- The maximum volume of preserved solution in the cooler must not exceed 500 ml.
- The maximum weight of the cooler shall not exceed 30 kg (66 lbs) for any limited-quantity shipment of dangerous goods.
- Secure the chain-of-custody form (placed inside a zip-type bag) to the interior of the cooler lid.
- If the shipment is from a DOE or other facility, place the results of the radiation screen and cooler/sample survey with the chain-of-custody.
- Wrap strapping tape or duct tape around both ends of the cooler and around the cooler lid.
- Affix custody seals to opposite sides of the cooler lid. Cover the custody seals with clear waterproof tape.
- Mark the outside of the cooler with the proper shipping name of the contents, corresponding UN number, and LTD. QTY. (as shown below).

Nitric Acid Solution (with less than 20 percent)
UN2031
Ltd. Qty.

- Place a label on the front of the cooler with the company name, contact name, phone number, full street address, and state with zip code for both shipper and recipient.
- Affix a Corrosive label to the outside of the cooler.
- Affix package orientation labels on two opposite sides of the cooler.
- Secure the marking and labels to the surface of the cooler with clear waterproof tape to prevent accidental removal during shipment.
- An example of cooler labeling/marking locations is shown in Figure 1.

Note: Samples meeting the exception concentration of 0.15 percent HNO_3 by weight will be shipped as non-regulated or non-hazardous following the procedure in Section 1.4.

Note: No marking or labeling can be obscured by strapping or duct tape.

Note: The inner packaging of dangerous goods must be placed into the designated cooler for shipment. Other non-regulated environmental samples may be added to the cooler for shipment.

- When shipping from a DOE facility, the cooler will be surveyed by a qualified radiation control technician to ensure that radiation flux on exterior surfaces does not exceed 0.5 mrem/h on all sides. This survey will be documented and the results reviewed by the qualified shipper.
- Complete the Dangerous Goods and Hazardous Materials Inspection Checklist for Shipping Limited-Quantity (Appendix A).
- Complete a Dangerous Goods Airbill.

6.0 Packaging and Shipping Samples Preserved with Sulfuric Acid

6.1 Containers

The inner packaging container (and amount of preservative) that may be used for these shipments includes:

Excepted Quantities of Sulfuric Acid Preservatives

Preservative		*Desired in Final Sample*		*Quantity of Preservative (ml) for Specified Container*				
		pH	**Conc.**	**40 ml**	**125 ml**	**250 ml**	**500 ml**	**1 L**
H_2SO_4	37N	<1.15	0.35%	.1	.25	0.5	1	2

5 drops = 1 ml

6.2 Responsibility

It is the responsibility of the qualified shipper to:

- Determine the samples undergoing shipment contain no other contaminant that meets the definition of hazardous material as defined by DOT
- Determine the amount of preservative in each sample so that accurate determination of quantities can be made

6.3 Additional Required Equipment

The following equipment is needed in addition to the required equipment listed in Section 1.3.

- Inner packings may consist of glass or plastic jars no larger than 100 ml.
- Outer packaging (for limited quantities) insulated cooler that has passed the ICAO drop test.
- Survey documentation (if shipping from DOE or radiological sites)
- Class 8 corrosive labels
- Orientation labels
- Consignor/consignee labels

6.4 Packaging of Samples Preserved with Sulfuric Acid

Samples containing H_2SO_4 as a preservative that exceed the excepted concentration of 0.35 percent will be shipped as a limited quantity per packing instruction Y809 of the IATA/ICAO Dangerous Goods Regulations.

The following steps are to be followed when packaging limited-quantity samples shipments.

- Tape any interior opening in the cooler (drain plug) from the inside to ensure control of interior contents. Also, tape the drain plug from the outside of the cooler.
- All sample containers will be properly labeled and the label protected with waterproof tape prior to sampling.
- At a minimum the label must contain:
  - Project name
  - Project number
  - Date and time of sample collection
  - Sample location
  - Sample identification number
  - Collector's initials
  - Preservative (note amount of preservative used in miscellaneous section of the chain-of-custody form)
- Wrap each glass container in bubble wrap (secure with waterproof tape) to prevent breakage.
- Place the bubble-wrapped container into a 2.7-mil zip-type bag, removing trapped air.
- Place glass containers inside a polyethylene bottle filled with vermiculite; seal the bottle.
- Place sufficient amount of vermiculite in the bottom of the cooler to absorb any leakage that may occur.
- Place a garbage bag in the cooler.
- Pack the samples appropriately inside the garbage bag (bottles placed upright) to prevent movement during shipment.
- Place a sufficient amount of double-bagged ice around the samples to maintain the required temperature during shipment.
- Seal the garbage bag by tieing or taping.
- The maximum volume of preserved solution in the cooler must not exceed 500 ml.
- The maximum weight of the cooler shall not exceed 30 kg (66 lbs) for any limited-quantity shipment of dangerous goods.
- Secure the chain-of-custody form (placed inside a zip-type bag) to the interior of the cooler lid.
- If the shipment is from a DOE or other facility, place the results of the radiation screen and cooler/sample survey with the chain-of-custody.
- Wrap strapping tape or duct tape around both ends of the cooler and around the cooler lid.
- Affix custody seals to opposite sides of the cooler lid. Cover the custody seals with clear waterproof tape.
- Mark the outside of the cooler with the proper shipping name of the contents, corresponding UN number, and LTD. QTY. (as shown below).

Sulfuric Acid Solution
UN2796
LTD. QTY.

- Place a label on the front of the cooler with the company name, contact name, phone number, full street address, and state with zip code for both shipper and recipient.
- Affix a Corrosive label to the outside of the cooler.
- Affix package orientation labels on two opposite sides of the cooler.
- Secure the marking and labels to the surface of the cooler with clear waterproof tape to prevent accidental removal during shipment.
- An example of cooler labeling/marking locations is shown in Figure 1.

Note: Samples containing less than the exception concentration of 0.35 percent H_2SO_4 by weight will be shipped as non-regulated or non-hazardous in accordance with the procedure described in Section 1.4.

Note: No marking or labeling can be obscured by strapping or duct tape.

Note: The inner packaging of dangerous goods must be placed into the designated cooler for shipment. Other non-regulated environmental samples may be added to the cooler for shipment.

- When shipping from a DOE facility, the cooler will be surveyed by a qualified radiation control technician to ensure that radiation flux on exterior surfaces does not exceed 0.5 mrem/h on all sides. This survey will be documented and the results reviewed by the qualified shipper.
- Complete the Dangerous Goods and Hazardous Materials Inspection Checklist for Shipping Limited-Quantity (Appendix A).
- Complete a Dangerous Goods Airbill.

7.0 Packaging and Shipping Limited-Quantity Radioactive Samples

7.1 Containers

The inner packaging containers that may be used for these shipments include:

- Any size sample container

7.2 Description/Responsibilities

- The qualified shipper will determine that the samples undergoing shipment contain no other contaminant that meets the definition of hazardous material as defined by DOT.
- The qualified shipper will ship all samples that meet the Class 7 definition of radioactive materials and meet the activity requirements specified in Table 7 of 49 CFR 173.425, as Radioactive Materials in Limited Quantity. The qualified shipper will verify that all packages and their contents meet the requirements of 49 CFR 173.421, *Limited Quantities of Radioactive Materials.*
- The packaging used for shipping will meet the general requirements for packaging and packages specified in 49 CFR 173.24 and the general design requirements provided in 173.410. These standards state that a package must be capable of withstanding the effects of any acceleration, vibration, or vibration resonance that may arise under normal condition of transport without any deterioration in the effectiveness of the closing devices on the various

receptacles or in the integrity of the package as a whole and without loosening or unintentionally releasing the nuts, bolts, or other securing devices even after repeated use.

- If the shipment is from a DOE facility, radiological screenings will be completed on all samples taken. The qualified shipper will review the results of each screening (alpha, beta, and gamma speciation). Samples will not be shipped offsite until the radiological screening has been performed.
- The total activity for each package will not exceed the relevant limits listed in Table 7 of 49 CFR 173.425. The A_2 value of the material will be calculated based on all radionuclides found during previous investigations (if any) in the area from which the samples are derived. The A_2 values to be used will be the most restrictive of all potential radionuclides as listed in 49 CFR 173.435.
- The radiation level at any point on the external surface of the package bearing the sample(s) will not exceed 0.005 mSv/hour (0.5 mrem/hour). These will be verified by dose and activity monitoring prior to shipment of the package.
- The removable radioactive surface contamination on the external surface of the package will not exceed the limits specified in 49 CFR 173.443(a). CDM will apply the DOE-established free release criteria for removable surface contamination of less than 20 dpm/100 cm^2 (alpha) and 1,000 dpm/100 cm^2 (beta/gamma). It should be noted that these values are more conservative than the DOT requirements for removable surface contamination.
- The qualified shipper will verify that the outside of the inner packaging is marked "Radioactive."
- The qualified shipper will verify that the excepted packages prepared for shipment under the provisions of 49 CFR 173.421 have a notice enclosed, or shown on the outside of the package, that reads, **"This package conforms to the conditions and limitations specified in 49 CFR 173.421 for radioactive material, excepted package-limited quantity of material, UN2910."**

7.3 Additional Required Equipment

The following equipment is needed in addition to the required equipment listed in Section 1.3.

- Survey documentation/radiation screening results (if shipping from DOE or radiological sites)
- Orientation labels
- Excepted quantities label
- Consignor/consignee labels

7.4 Packaging of Limited-Quantity Radioactive Samples

The following steps are to be followed when packaging limited-quantity sample shipments.

- The cooler is to be surveyed by a qualified radiation control technician to ensure that radiation flux on exterior surfaces does not exceed 0.5 mrem/h on all sides. This survey will be documented and the results reviewed by the qualified shipper.
- Tape any interior opening in the cooler (drain plug) from the inside to ensure control of interior contents. Also, tape the drain plug from the outside of the cooler.
- All sample containers will be properly labeled and the label protected with waterproof tape prior to sampling.
- At a minimum the label must contain:
  - Project name
  - Project number

- Date and time of sample collection
- Sample location
- Sample identification number
- Collector's initials

- This step is optional; wrap each container in bubble wrap (secure with waterproof tape) to prevent breakage.
- Place sufficient amount of vermiculite, or approved packaging material, in the bottom of the cooler to absorb any leakage that may occur.
- Place a garbage bag in the cooler.
- Pack the samples appropriately inside the garbage bag (bottles placed upright) to prevent movement during shipment.
- If required, place a sufficient amount of double-bagged ice around the samples to maintain the required temperature during shipment.
- Seal the garbage bag by tieing or taping.
- Place a label marked Radioactive on the outside of the sealed bag.
- Enclose a notice that includes the name of the consignor or consignee and the following statement: "This package conforms to the conditions and limitations specified in 49 CFR 173.421 for radioactive material, excepted package-limited quantity of material, UN2910."
- Note that both DOT and IATA apply different limits to the quantity in the inside packing and in the outside packing.
- The maximum weight of the package shall not exceed 30 kg (66 lbs) for any limited-quantity shipment of dangerous goods.
- Secure the chain-of-custody form (placed inside a zip-type bag) to the interior of the cooler lid.
- If the shipment is from a DOE or other facility, place the results of the radiation screen and cooler/sample survey with the chain-of-custody.
- If a cooler is used, wrap strapping tape or duct tape around both ends of the cooler and around the cooler lid.
- Affix custody seals to opposite sides of the cooler lid. Cover the custody seals with clear waterproof tape.
- Place a label on the front of the cooler with the company name, contact name, phone number, full street address, and state with zip code for both shipper and recipient.
- Affix package orientation labels on two opposite sides of the cooler/package.
- Affix a completed Excepted Quantities label to the side of the cooler/package.
- Secure any marking and labels to the surface of the cooler with clear waterproof tape to prevent accidental removal during shipment.
- An example of the cooler labeling/marking is shown in Figure 2.

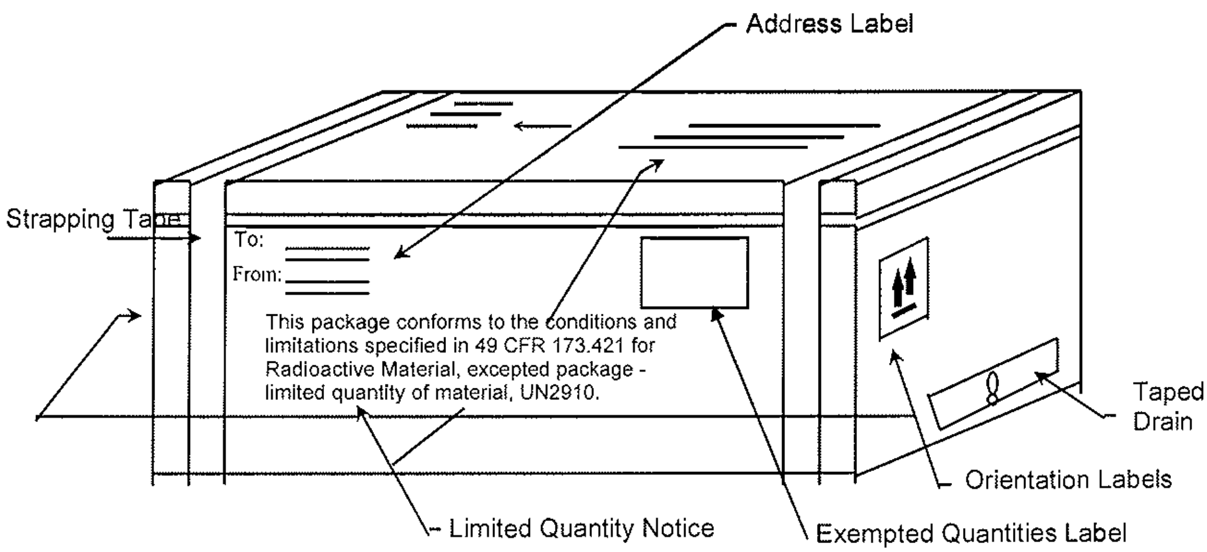
Note: No marking or labeling can be obscured by strapping or duct tape.

- Complete the Shipment Quality Assurance Checklist (Appendix B).

Note: Except as provided in 49 CFR 173.426, the package will not contain more than 15 grams of ^{235}U.

Note: A declaration of dangerous goods is not required.

Figure 2 - Radioactive Material – Limited-Quantity Cooler Marking Example



8.0 References

U.S. Environmental Protection Agency, *Sampler's Guide to the Contract Laboratory Program,* EPA/540/P-90/006, December 1990.

U.S. Environmental Protection Agency, Region IV, *Standard Operating Procedures and Quality Assurance Manual,* February 1991.

U.S. Environmental Protection Agency Rule, 40 CFR 136.

Appendix A

Dangerous Goods and Hazardous Materials Inspection Checklist for Shipping Limited-Quantity

Sample Packaging

Yes	No	N/A	
❑	❑	❑	The VOA vials are wrapped in bubble wrap and placed inside a zip-type bag.
❑	❑	❑	The VOA vials are placed into a polyethylene bottle, filled with vermiculite, and tightly sealed.
❑	❑	❑	The drain plug is taped inside and outside to ensure control of interior contents.
❑	❑	❑	The samples have been placed inside garbage bags with sufficient bags of ice to preserve samples at 4°C.
❑	❑	❑	The cooler weighs less than the 66-pound limit for limited-quantity shipment.
❑	❑	❑	The garbage bag has been sealed with tape (or tied) to prevent movement during shipment.
❑	❑	❑	The chain-of-custody has been secured to the interior of the cooler lid.
❑	❑	❑	The cooler lid and sides have been taped to ensure a seal.
❑	❑	❑	The custody seals have been placed on both the front and back hinges of the cooler, using waterproof tape.

Air Waybill Completion

Yes	No	N/A	
❑	❑	❑	Section 1 has the shipper's name, company, and address; the account number, date, internal billing reference number; and the telephone number where the shipper can be reached.
❑	❑	❑	Section 2 has the recipient's name and company along with a telephone number where they can be reached.
❑	❑	❑	Section 3 has the **Bill Sender** box checked.
❑	❑	❑	Section 4 has the **Standard Overnight** box checked.
❑	❑	❑	Section 5 has the **Deliver Weekday** box checked.
❑	❑	❑	Section 6 has the number of packages and their weights filled out. Was the total of all packages and their weights figured up and added at the bottom of Section 6?
❑	❑	❑	Under the **Transport Details** box, the **Cargo Aircraft Only** box is obliterated, leaving only the **Passenger and Cargo Aircraft** box.
❑	❑	❑	Under the **Shipment Type**, the **Radioactive** box is obliterated, leaving only the **Non-Radioactive** box.
❑	❑	❑	Under the **Nature and Quantity of Dangerous Goods** box, the **Proper Shipping Name, Class or Division, UN or ID No., Packing Group, Subsidiary Risk, Quantity and Type of Packing, Packing Instructions, and Authorization** have been filled out for the type of chemical being sent.
❑	❑	❑	The Name, **Place and Date, Signature, and** Emergency **Telephone** Number appears at the bottom of the FedEx Airbill.
❑	❑	❑	The statement "In accordance with IATA/ICAO" appears in the **Additional Handling Information** box.
❑	❑	❑	The Emergency **Contact Information** at the bottom of the FedEx Airbill is truly someone who can respond any time of the day or night.

Proper Shipping Name	Class or Division	UN or ID No.	Packing Group	Sub. Risk	Quantity	Packing Instruction	Authorization
Hydrochloric Acid Solution	8	UN1789	II		1 plastic box × 0.5 L	Y809	Ltd. Qty.
Nitric Acid Solution (with less than 20%)	8	UN2031	II		1 plastic box × 0.5 L	Y807	Ltd. Qty.
Sodium Hydroxide Solution	8	UN1824	II		1 plastic box × 0.5 L	Y809	Ltd. Qty.
Sulfuric Acid Solution	8	UN2796	II		1 plastic box × 0.5 L	Y809	Ltd. Qty.
Methanol	3	UN1230	II		1 plastic box × 1 L	Y305	Ltd. Qty.

Sample Cooler Labeling

Yes	No	N/A	
❑	❑	❑	The proper shipping name, UN number, and Ltd. Qty. appears on the shipping container.
❑	❑	❑	The corresponding hazard labels are affixed on the shipping container; the labels are not obscured by tape.
❑	❑	❑	The name and address of the shipper and receiver appear on the top and side of the shipping container.
❑	❑	❑	The air waybill is attached to the top of the shipping container.
❑	❑	❑	**Up Arrows** have been attached to opposite sides of the shipping container.
❑	❑	❑	Packaging tape does not obscure markings or labeling.

Appendix B
Shipment Quality Assurance Checklist

Date: ____________ Shipper: ____________________________ Destination: ________________________

Item(s) Description: ____

Radionuclide(s): ____

Radiological Survey Results: surface __________________mrem/hr 1 meter _____________________

Instrument Used: Mfgr: _________________________________ Model: __________________________

S/N: ____ Cal Date: ____________________________________

Limited-Quantity or Instrument and Article

Yes	No	
___	___	1. Strong tight package (package that will not leak material during conditions normally incidental to transportation).
___	___	2. Radiation levels at any point on the external surface of package less than or equal to 0.5 mrem/hr.
___	___	3. Removable surface contamination less than 20 dpm/100 cm^2 (alpha) and 1,000 dpm/100 cm^2 (beta/gamma).
___	___	4. Outside inner package bears the marking "Radioactive."
___	___	5. Package contains less than 15 grams of ^{235}U (check yes if ^{235}U not present).
___	___	6. Notice enclosed in or on the package that includes the consignor or consignee and the statement, "**This package conforms to the conditions and limitations specified in 49 CFR 173.421 for radioactive material, excepted package-limited quantity of material, UN2910.**"
___	___	7. Activity less than that specified in 49 CFR 173.425. Permissible package limit: Package Quantity:
___	___	8. On all air shipments, the statement **Radioactive Material, excepted package-limited quantity of material** shall be noted on the air waybill.

Qualified Shipper: _____________________________ Signature: ____________________________________

TSOP 2-2

GUIDE TO HANDLING OF INVESTIGATION DERIVED WASTE

Guide To Handling Investigation-Derived Waste

Prepared: Tim Eggert

Technical Review: Sharon Budney

QA Review: Jeniffer Oxford

Approved: [signature] 2/24/04
Signature/Date

Issued: [signature] 2/18/04
Signature/Date

1.0 Objective

This standard operating procedure (SOP) presents guidance for the management of investigation-derived waste (IDW). The primary objectives for managing IDW during field activities include:

- Leaving the site in no worse condition than existed prior to field activities
- Remove wastes that pose an immediate threat to human health or the environment
- Proper handling of onsite wastes that do not require offsite disposal or extended above-ground containerization
- Complying with federal, state, and facility applicable or relevant and appropriate requirements (ARARs)
- Careful planning and coordination of IDW management options
- Minimizing the quantity of IDW

2.0 Background

2.1 Definitions

Hazardous Waste – Discarded material that is regulated listed waste, or waste that exhibits ignitability, corrosivity, reactivity, or toxicity as defined in 40 CFR 261.3 or state regulations.

Investigation-Derived Wastes (IDWs) - Discarded materials resulting from field activities such as sampling, surveying, drilling, excavations, and decontamination processes that, in present form, possess no inherent value or additional usefulness without treatment. Wastes may be solid, liquid, or gaseous, or multiphase materials that may be classified as hazardous or non-hazardous.

Mixed-Waste - Any material that has been classified as hazardous and radioactive.

Radioactive Wastes – Discarded materials that are contaminated with radioactive constituents with specific activities in concentrations greater than the latest regulatory criteria (i.e., 10 CFR 20).

Treatment, Storage, and Disposal Facility (TSDF) - Permitted facilities that accept hazardous waste shipments for further treatment, storage, and/or disposal. These facilities must be permitted by the U.S. Environmental Protection Agency (EPA) and appropriate state agencies.

2.2 Discussion

Field investigation activities result in the generation of waste materials that may be characterized as hazardous or radioactive waste. IDWs may include drilling muds, cuttings, and purge water from test pit and well installation; purge water, soil, and other materials from collection of samples; residues from testing of treatment technologies and pump and treat systems; personal protective equipment (PPE); solutions (aqueous or otherwise) used to decontaminate non-disposable protective clothing and equipment; and other wastes or supplies used in sampling and testing potentially hazardous or radiologically contaminated material.

Note: The client's representatives may not be aware of all potential contaminants. The management of IDW must comply with applicable regulatory requirements.

3.0 Responsibilities

Site Manager - The site manager is responsible for ensuring that all IDW procedures are conducted in accordance with this SOP. The site manager is also responsible for ensuring that handling of IDW is in accordance with site-specific requirements.

Project Manager - The project manager is responsible for identifying site-specific requirements for the disposal of IDW in accordance with federal, state, and/or facility requirements.

Field Crew Members - Field crew members are responsible for implementing this SOP and communicating any unusual or unplanned condition to the project manager's attention.

4.0 Required Equipment

Equipment required for IDW containment will vary according to site-specific/client requirements. Management decisions concerning the necessary equipment required should consider: containment method, sampling, labeling, maneuvering, and storage (if applicable). Equipment must be onsite and inspected before commencing work.

4.1 IDW Containment Devices

The appropriate containment device (drums, tanks, etc.) will depend on site- or client-specific requirements and the ultimate disposition of the IDW. Typical IDW containment devices can include:

- Plastic sheeting (polyethylene) with a minimum thickness of 20 millimeters
- Department of Transportation (DOT) approved steel containers
- Bulk storage tanks comprised of polyethylene or steel

Containment of IDW should be segregated by waste type (i.e., solid or liquid, corrosive or flammable, etc.) and source location. Volume of the appropriate containment device should be site-specific.

4.2 IDW Container Labeling

A "Waste Container" or "IDW Container" label or indelible marking should be applied to each container. Labeling or marking requirements for onsite IDW not expected to be transported offsite are:

- Labels and markings that contain the following information: project name, generation date, location of waste origin, container identification number, sample number (if applicable), and contents (drill cuttings, purge water, PPE, etc.).
- Each label or marking will be applied to the upper one-third of the container at least twice, on opposite sides.
- Containers that are 5 gallons or less may only require one label or set of markings.
- Labels or markings will be positioned on a smooth part of the container. The label must not be affixed across container bungs, seams, ridges, or dents.

- Labels must be constructed of a weather-resistive material with markings made with a permanent marker or paint pen and capable of enduring the expected weather conditions. If markings are used, the color must be easily distinguishable from the drum color.
- Labels will be secured in a manner to ensure the label remains affixed to the container.

Labeling or marking requirements for IDW expected to be transported offsite must be in accordance with the requirements of 49 CFR 172.

4.3 IDW Container Movement

Staging areas for IDW containers should be predetermined and in accordance with site-specific and/or client requirements. Arrangements should be made prior to field mobilization as to the methods and personnel required to safely transport IDW containers to the staging area. Transportation offsite onto a public roadway is prohibited unless 49 CFR 172 requirements are met.

4.4 IDW Container Storage

Containerized IDW should be staged pending chemical analysis or further onsite treatment. Staging areas and bulk storage procedures are to be determined according to site-specific requirements. Containers are to be stored in such a fashion that the labels can be easily read. A secondary/spill container must be provided as appropriate.

5.0 Procedures

The three general options for managing IDW are (1) collection and onsite disposal, (2) collection for offsite disposal, and (3) collection and interim management. Attachment 1 summarizes media-specific information on generation processes and management options. The option selected should take into account the following factors:

- Type (soil, sludge, liquid, debris), quantity, and source of IDW
- Risk posed by managing the IDW onsite
- Compliance with regulatory requirements
- IDW minimization and consistency with the IDW remedy and the site remedy

In all cases the client should approve the plans for IDW. Formal plans for the management of IDW must be prepared as part of a work plan or separate document.

5.1 Onsite Disposal

5.1.1 Soil/Sludge/Sediment

The options for handling soil/sludge/sediment IDW are as follows:

1. Return to boring, pit, or source immediately after generation as long as returning the media to these areas will not increase site risks (e.g., the contaminated soil will not be replaced at a greater depth than where it was originally so that it will not contaminate "clean" areas).

2. Spread around boring, pit, or source within the area of contamination (AOC) as long as returning the media to these areas will not increase site risks (e.g., direct contact with surficial contamination).

3. Consolidate in a pit within the AOC as long as returning the media to these areas will not increase site risks (e.g., the contaminated soil will not be replaced at a greater depth than where it was originally so that it will not contaminate "clean" areas).

4. Send to onsite TSDF - may require analytical analysis prior to treatment/disposal.

Note: These options may require client and/or regulatory approval.

5.1.2 Aqueous Liquids

The options for handling aqueous liquid IDW are as follows:

1. Discharge to surface water, only when IDW is not contaminated.

2. Discharge to ground surface close to the well, only if soil contaminants will not be mobilized in the process and the action will not contaminate clean areas. If IDW from the sampling of background upgradient wells is not a community concern or associated with soil contamination, this presumably uncontaminated IDW may be released on the ground around the well.

3. Discharge to sanitary sewer.

4. Send to onsite TSDF - may require analysis prior to treatment/disposal.

Note: These options may require analytical results to obtain client and/or regulatory approval.

5.1.3 Disposable PPE

The options for handling disposable PPE are as follows:

1. Double-bag contents in non-transparent trash bags and place in onsite industrial dumpster, only if PPE is not contaminated.

2. Containerize, label, and send to onsite TSDF - may require analysis prior to treatment/disposal.

5.2 Offsite Disposal

Before sending to an offsite TSDF, analysis may be required. Also, manifests are required. Arrangements must be made with the client responsible for the site; it is CDM's policy not to sign manifests. The TSDF and transporter must be permitted for the respective wastes.

5.2.1 Soil/Sludge/Sediment

When the final site remedy requires offsite treatment and disposal, the IDW may be stored (e.g., drummed, covered in a waste pile) or returned to its source until final disposal. The management option selected should take into account the potential for increased risks, applicable regulations, and other relevant site-specific factors (e.g., weather, storage space, and public concern/perceptions).

5.2.2 Aqueous Liquids

When the final site remedy requires offsite treatment and disposal, the IDW may be stored (e.g., mobile tanks or drums) until final disposal. The management option selected should take into account the potential for increased risks, applicable regulations, and other relevant site-specific factors (e.g., weather, storage space, and public concern/perceptions).

5.2.3 Disposable PPE

When the final site remedy requires offsite treatment disposal, the IDW may be containerized and stored. The management option selected should take into account potential for increased risks, applicable regulations, and other relevant site-specific factors (e.g., weather, storage space, and public concern/perceptions).

5.3 Interim Measures

All interim measures must be approved by the client and regulatory agencies.

1. Storing IDW onsite until the final action may be practical in the following situations:

   A. Returning wastes (especially sludges and soils) to their onsite source area would require re-excavation for disposal in the final remediation alternative.

   B. Interim storage in containers may be necessary to provide adequate protection to human health and the environment.

   C. Offsite disposal options may trigger land disposal regulations under the Resource Conservation and Recovery Act (RCRA). Storing IDW until the final disposal of all wastes from the site will eliminate the need to address this issue more than once.

   D. Interim storage may be necessary to provide time for sampling and analysis.

2. Segregate and containerize all waste for future treatment and/or disposal.

   A. Containment options for soil/sludge/sediment may include drums or covered waste piles in AOC.

   B. Containment options for aqueous liquids may include mobile tanks or drums.

   C. Containment options for PPE may include drums or roll-off boxes.

6.0 Restrictions/Limitations

Site Managers Should Determine the Most Appropriate Disposal Option for Aqueous Liquids on a Site-Specific Basis. Parameters to consider, especially when determining the level of protection, include the volume of IDW, the contaminants present in the groundwater, the presence of contaminants in the soil at the site, whether the groundwater or surface water is a drinking water supply, and whether the groundwater plume is contained or moving. Special disposal/handling may be needed for drilling fluids because they may contain significant solid components.

Disposable sampling materials, disposable PPE, decontamination fluids, etc. will always be managed on a site-specific basis. **Under No Circumstances Should These Types of Materials Be Brought Back to the Office or Warehouse.**

7.0 References

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U. S. Environmental Protection Agency, Region IV. May 1996 and 1997. *Environmental Investigations Standard Operating Procedures and Quality Assurance Manual,* revisions.

Attachment 1
IDW Management Options

Type of IDW	Generation Processes	Management Options
Soil	▪ Well/Test pit installations ▪ Borehole drilling ▪ Soil sampling	**Onsite Disposal** ▪ Return to boring, pit, or source immediately after generation ▪ Spread around boring, pit, or source within the AOC ▪ Consolidate in a pit (within the AOC) ▪ Send to onsite TSDF **Offsite Disposal** ▪ Client to send to offsite TSDF **Interim Management** ▪ Store for future treatment and/or disposal
Sludge/Sediment	▪ Sludge pit/sediment sampling	**Onsite Disposal** ▪ Return to boring, pit, or source immediately after generation ▪ Send to onsite TSDF **Offsite Disposal** ▪ Client to send to offsite TSDF **Interim Management** ▪ Store for future treatment and/or disposal
Aqueous Liquids (groundwater, surface water, drilling fluids, wastewaters)	▪ Well installation/development ▪ Well purging during sampling ▪ Groundwater discharge during pump tests ▪ Surface water sampling ▪ Wastewater sampling	**Onsite Disposal** ▪ Pour onto ground close to well (nonhazardous waste) ▪ Discharge to sewer ▪ Send to onsite TSDF **Offsite Disposal** ▪ Client to send to offsite commercial treatment unit ▪ Client to send to publicly owned treatment works (POTW) **Interim Management** ▪ Store for future treatment and/or disposal
Decontamination Fluids	▪ Decontamination of PPE and equipment	**Onsite Disposal** ▪ Send to onsite TSDF ▪ Evaporate (for small amounts of low contamination organic fluids) ▪ Discharge to ground surface **Offsite Disposal** ▪ Client to send to offsite TSDF ▪ Discharge to sewer **Interim Management** ▪ Store for future treatment and/or disposal
Disposable PPE and Sampling Equipment	▪ Sampling procedures or other onsite activities	**Onsite Disposal** ▪ Place in onsite industrial dumpster ▪ Send to onsite TSDF **Offsite Disposal** ▪ Client to send to offsite TSDF **Interim Management** ▪ Store for future treatment and/or disposal

Adapted from U.S. Environmental Protection Agency, Guide to Management of Investigation-Derived Wastes, 9345-03FS, January 1992.

TSOP 3-1

GEOPROBE® SAMPLING

Prepared: Kent Hankinson

Technical Review: Sharon Budney

QA Review: Doug Updike

Approved: Signature/Date 2/24/04

Issued: Signature/Date 2/18/04

1.0 Objective

The objective of this standard operating procedure (SOP) is to define the requirements for collecting soil, soil gas, and groundwater samples using the Geoprobe® sampling system. Geoprobe is a trade name proprietary to Geoprobe Systems of Salina, Kansas.

2.0 Background

2.1 Discussion

The Geoprobe unit consists of a hydraulically operated hammer device mounted in the back of a van or pickup truck (Figure 1). The Geoprobe system hydraulically advances small-diameter, hollow rods to the desired sampling depth. The specific type of Geoprobe sampling equipment for soil, soil gas, and groundwater collection is then employed.

The use of Geoprobe technology may be a cost-effective alternative to using conventional drilling techniques for collecting subsurface soil, soil gas, and groundwater samples depending on the site-specific geologic and hydrogeologic conditions and sample requirements. The Geoprobe system is generally used to gather screening-level data. The site-specific sampling plans must consider such factors as soil types, presence of cobbles, depth to groundwater, quantity and depth of samples, site access and topography, data quality objectives (DQOs), analytical requirements, and waste handling and disposal requirements prior to selecting the use of the Geoprobe.

Advantages of using the Geoprobe include:

- Areas usually considered inaccessible by drill rigs because of overhead wires, steep slopes, size constraints, etc., may be accessed with the pickup truck or van-mounted Geoprobe.

- Investigation-derived wastes such as soil cuttings and purge water are minimized with the Geoprobe due to its small diameter rods and because it displaces soil horizontally, not vertically.

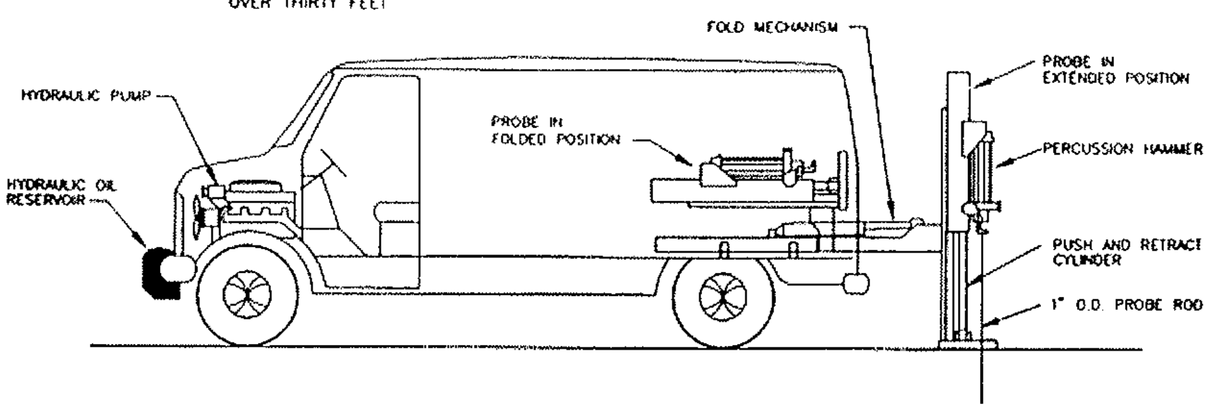
Cost savings over conventional drilling techniques may be realized. The Geoprobe is rented/leased on a weekly or monthly basis or purchased for a fixed price as opposed to drilling subcontractors who are generally compensated based on the footage drilled; the Geoprobe may be operated by field personnel rather than subcontractors. A cost evaluation based on project-specific requirements and site conditions should be conducted to determine the most cost-effective method for a particular project.

Two people are required to operate the Geoprobe and conduct sampling and recordkeeping activities. Safety considerations should be addressed when operating the Geoprobe. A safety hazard is present whenever the Geoprobe is operated. The hydraulic system operates with a fluid pressure of over 907 kilograms (kg) (2,000 pounds per square inch [psi]). A leaking hose may produce a stream of hydraulic

Figure 1
Geoprobe Unit

BASICS

- HYDRAULICALLY POWERED PROBE OPERATES FROM HYDRAULIC SYSTEM DRIVEN FROM THE VEHICLE OR AN AUXILIARY ENGINE
- REMOTE VEHICLE IGNITION ALLOWS OPERATORS TO START VEHICLE ENGINE FROM REAR COMPARTMENT.
- BELT DRIVEN HYDRAULIC PUMP SUPPLIES 10 GPM AT 2000 RPM, 2250 PSI OPERATING PRESSURE.
- PROBE UNIT FOLDS FOR TRANSPORT AND SETS UP AGAIN IN SECONDS.
- UTILIZES STATIC FORCE (WEIGHT OF VEHICLE) AND PERCUSSION TO ADVANCE PROBING TOOLS.
- POWERFUL 8 HP HYDRAULIC HAMMER DELIVERS OVER 1800 BLOWS PER MINUTE.
- HAMMER FEATURES 0-300 RPM LH DIRECTIONAL ROTARY FUNCTION FOR DRILLING SURFACE PAVEMENTS.
- PROBE HAS GREATER THAN 12,000 LBS. OF PULLING CAPACITY.
- DRIVES SMALL DIAMETER (1" O.D. - 1.6" O.D.) PROBING TOOLS TO DEPTHS LIMITED ONLY BY SOIL TYPE AND DEPTH TO BEDROCK, TYPICALLY TO OVER THIRTY FEET



fluid with sufficient pressure to penetrate skin. Therefore, periodic checks of the hydraulic lines and hoses should be conducted to ensure they are in good condition and connections are tight. Do not attempt to repair or tighten hoses with the engine running and the system under pressure. Use paper or cardboard to check for leaks.

2.2 Definitions

Geoprobe - A hydraulically operated hammer device installed in the back of a van or pickup truck, used to advance a hollow-stem rod into the soil for the purpose of collecting soil, soil gas, or groundwater samples.

Probe-Drive Sampler - A sampling device, similar to a split-spoon sampler, used to collect soil samples with a Geoprobe rig. Three types of soil samplers are available: standard 25- and 60-cm (in 10- and 24-inch lengths), large bore (with an acetate liner), and Kansas stainless sampler.

Extension Rod - Stainless steel rod used to remove stop-pin and drive-point assembly.

Extension Rod Coupler - Stainless steel connector used to join sections of extension rods.

Drive Point - Solid steel retractable point used to advance sample collection device to the required sample depth.

Probe Rod - Hollow, flush-threaded, steel rod similar to a drill rod.

Stop-Pin - Steel plug that threads into the top of the drive cap to hold the drive point in place during advancement of the probe rods.

Drive Cap - Threaded, hardened-steel top cap that attaches to the top of the probe rod; used when advancing the probe rods with the hydraulic hammer.

Pull Cap - Threaded, hardened-steel top cap that attaches to the top of the probe rod; used when retracting the probe rods.

Extruder Rack and Piston - A device used in conjunction with the Geoprobe to force soil sample volume out of the sample tube.

Screen Point Groundwater Sampler - A groundwater sampling device designed for use with the Geoprobe consisting of a well screen encased in a perforated stainless steel sleeve.

Mill-slotted Well Rod and Point - A groundwater sampling device designed for use with the Geoprobe consisting of a Geoprobe probe rod with 15-mil slots, each 5 cm long by 0.05 cm wide (2 inches long x 0.020 inches wide).

Post-Run Tubing System (PRT) - The Geoprobe soil vapor sampling system uses disposable poly-ethylene or Teflon tubing (inserted into the probe rods at the desired sampling depth) and a vacuum.

Expendable Drive Point - Solid steel point attached to the end of the screen point groundwater sampler and PRT expendable point holder.

2.3 Associated Procedures

- CDM Federal SOP 1-2, Sample Custody
- CDM Federal SOP 1-5, Groundwater Sampling Using a Bailer
- CDM Federal SOP 1-6, Water Level Measurements
- CDM Federal SOP 2-1, Packaging and Shipping Environmental Samples
- CDM Federal SOP 4-1, Field Logbook Content and Control
- CDM Federal SOP 4-3, Well Development and Purging
- CDM Federal SOP 4-5, Field Equipment Decontamination

3.0 Responsibilities

Field Team Leader (FTL) - The field team leader (FTL) is responsible for ensuring that sampling efforts are conducted in accordance with this procedure, associated SOPs, and the site-specific plans.

Sampling Personnel - Field team members are responsible for conducting Geoprobe sampling events in accordance with this procedure, all associated SOPs, and requirements as described in the site-specific plans.

4.0 Required Equipment

General

- Site-specific plans
- Field logbook, chain-of-custody forms, other forms for documenting sample shipment
- Indelible black or blue ink pens and markers
- Sample containers with labels and preservatives
- Insulated coolers
- Bagged ice or "blue ice"
- Plastic zip-top bags
- Waterproof sealing tape
- Temperature, conductivity, pH, dissolved oxygen, and turbidity meters (with clean beakers or other appropriate containers), as required by the site-specific plans
- Monitoring/Screening instruments as required by the site-specific health and safety plan or sampling plan
- Decontamination supplies, as required by SOP 4-5
- Personal protective equipment (PPE), as required by the site-specific health and safety plan (at a minimum, hard hat, steel-toed shoes, safety glasses, and hearing protection are required)
- Latex or appropriate gloves
- Geoprobe rig (van, truck, or skid-mounted) with the following:
  - Probe rods 30-, 60-, and 90-cm lengths (1-, 2-, and 3-foot lengths)
  - Extension rods 30-, 60-, and 90-cm lengths (1-, 2-, and 3-foot lengths), couplers, and handle
  - Piston stop-pins (two each per rig, minimum)
  - Drive caps and pull caps (two each per rig, minimum)
  - Carbide-tipped drill bit for working in concrete- or asphalt-covered areas
  - O-rings

Geoprobe Soil Sampling Equipment

- Extruder rack and piston (if soil is to be extruded into a sample container - otherwise, the steel sample tube with the standard and Kansas stainless samplers or acetate liner with the large bore Sampler may be shipped to the laboratory, as indicated in the site-specific plans)

- Assembled soil samplers (i.e., standard 25-cm or 60-cm [10-inch or 24-inch] sampler, Kansas stainless sampler, or large bore sampler - refer to the Geoprobe Systems Equipment and Tools Catalog for specific parts for each sampler)

Geoprobe Soil Gas Sampling Equipment

- Expendable drive points (one each per sample location, plus spares)
- Extension rod ram
- 10 millimeter (mm) (3/8-inch) polyethylene (Teflon -lined) tubing and PRT adapter
- Vacuum or sampling system
- Syringe
- PRT adapter
- PRT expendable point holder

Geoprobe Groundwater Sampling Equipment

- Expendable drive points (one each per sample location, plus spares)
- Mill-slotted well point or screen point groundwater sampler assemblies
- Extension rod ram
- 10-mm (3/8-inch) polyethylene (Teflon -lined) tubing
- Check valves (if using Waterra system)
- Peristaltic pump
- Mini-bailer (and thin nylon line)

5.0 Procedures

Procedures common to all three sampling methods are discussed below.

Prior to sampling:

- Arrange utility clearance.
- Decontaminate all Geoprobe equipment according to SOP 4-5, Field Equipment Decontamination.
- Don the appropriate PPE as dictated by the site-specific health and safety plan.
- If the sampling site is in a concrete- or asphalt-covered area, drill a hole using the rotary function and a specially designed 3.75-cm or 5-cm (1.5-inch or 2.0-inch) diameter carbide-tipped drill bit. Otherwise, the area needs to be cleared of heavy underbrush and immediate overhead obstructions.

After sampling is completed:

- Thread the pull cap onto the top probe rod and retract the probe rods.
- Seal the borehole with sand, neat cement, or bentonite grout, if necessary.
- Record all appropriate data in the field logbook and on the chain-of-custody forms as outlined in CDM Federal SOP 4-1, Field Logbook Content and Control and CDM Federal SOP 2-1, Packaging and Shipping Environmental Samples.
- Decontaminate the sampling equipment according to CDM Federal SOP 4-5 "Field Equipment Decontamination."

5.1 Soil Sampling

Assembly

1. Assemble the sampling device as follows:

   - Screw the cutting shoe to the bottom end of the sample tube (unless using standard probe drive sampler, which has built-in cutting edge).
   - Screw the piston tip onto the piston rod.
   - Screw the drive head onto the top end of the sample tube.
   - If using Teflon liner, insert liner into sample tube.
   - Slide the piston rod into the sample tube, leaving the piston tip sticking out of bottom end of the sample tube.
   - Screw the piston stop-pin onto the top end of the piston rod in a counter-clockwise direction.

2. Attach the assembled sampler onto the leading probe rod. A 30-cm (12-inch) probe rod is recommended to start the 60-cm (24-inch) standard and large bore samplers.

Probing

3. Thread the drive cap onto the top of the probe rod and advance the sampler. Replace the 30-cm (12-inch) rod with a 90-cm (36-inch) rod as soon as the top of the sampler is driven to within 15 cm (6 inches) of the ground surface.

4. Advance the sampler to the interval to be sampled using the hydraulic hammer. Add additional probe rods as necessary to reach the specified sampling depth.

Stop-pin Removal

5. Move the probe unit back from the top of the probe rods and remove the drive cap.

6. Lower the extension rods into the inside diameter of the probe rods using extension rod couplers to join the extension rods.

7. Attach the extension rod handle to the top extension rod and rotate the handle clockwise until the leading extension rod is screwed into the piston stop-pin. Continue to rotate the handle clockwise until the stop-pin disengages from the drive head.

8. Remove the extension rods and attached piston stop-pin from the probe rods.

Sampling

9. Replace the drive cap, mark the top probe rod with a marker or tape at a distance above the ground equal to the length of the sample tube (either 30 or 60 cm [12 or 24 inches]).

10. Advance the probe rods using the hydraulic hammer the length of the sample tube (either 30 or 60 cm [12 or 24 inches]).

11. Replace the drive cap with the pull cap and retract the probe rod(s). Secure the rod(s) with a clamp or by hand during removal so they do not fall back down the resulting borehole.

12. Detach the sampler from the lead probe rod, verifying that sufficient sample volume was recovered (the length of sample contained within the tube is approximately equal to the length of exposed piston rod).

13. Disassemble the sampler. If the sample is to be analyzed for VOCs, then the sample tube or liner should be sealed immediately by placing a Teflon septa over the ends and covering them with plastic caps.

14. If samples do not require VOC analysis, they may be extruded from the sampler and transferred to the sample jars specified in the site-specific plans or SOP 2-1, Packaging and Shipping Environmental Samples. Samples can be extruded by one of two methods:

    - Using the Geoprobe rig and the extruder rack (Figure 2), position the extruder rack on the foot of the Geoprobe derrick; insert the sample tube into the extruder rack with cutting end up; and position the extruder piston, pushing the sample out of the sample tube using the "probe" function. Catch the sample as it exits beneath the extruder in a sample jar or stainless steel mixing bowl. Samples to be collected for VOCs will be collected directly from the sample tube into the sample jars.

    - Lightly tap the side of the sample tube with a hammer while also lightly pushing the Piston Rod.

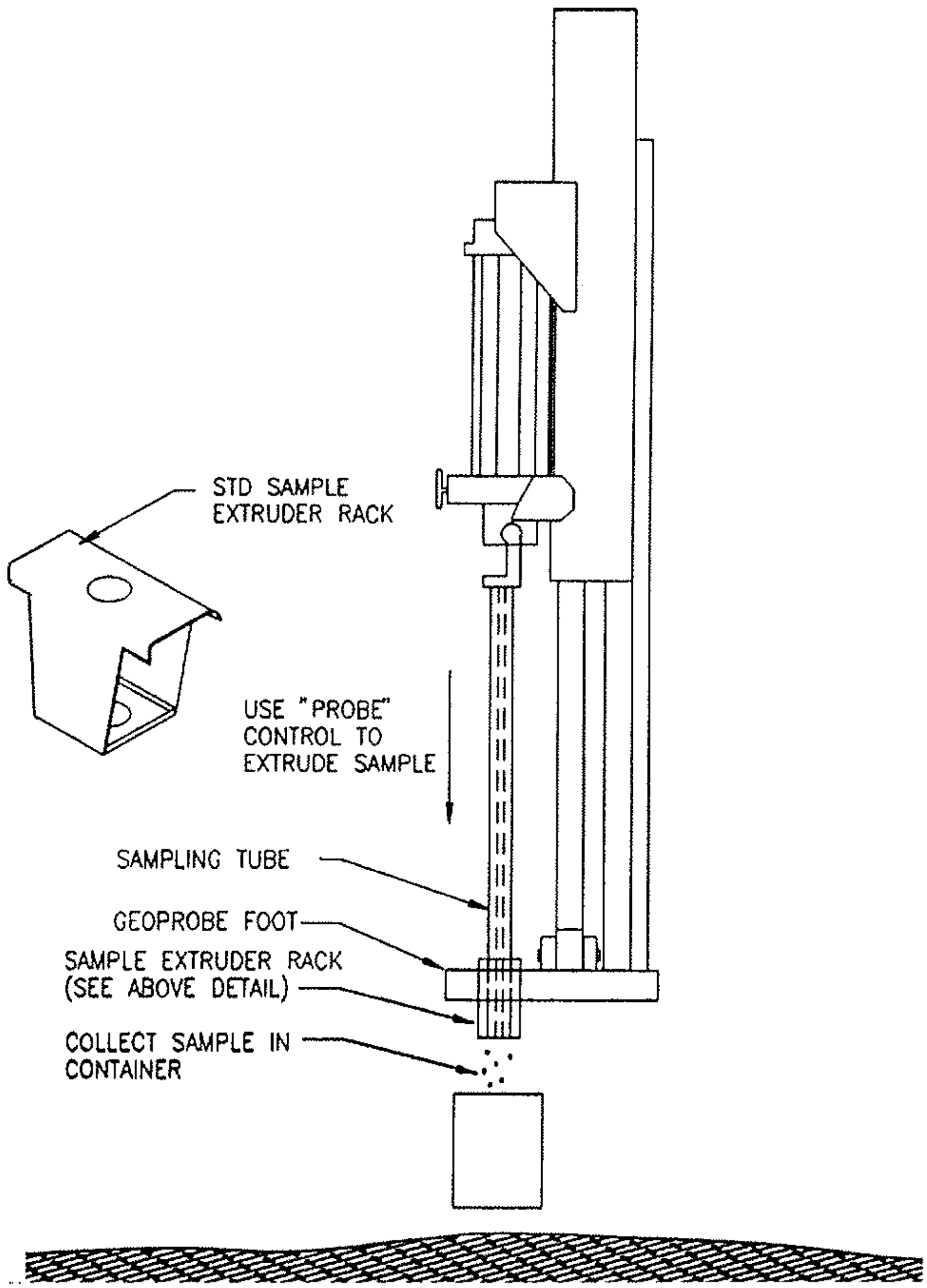
15. Label the sample liner or sample jars as required, securing the label by covering it with a piece of clear, waterproof tape.

16. Homogenize the sample in a stainless steel bowl with a stainless steel spoon or spatula. Transfer the sample from the bowl to the sample container.

17. Clean the outside of the sample jars and place individual samples into sealable bags and seal closure.

18. Place samples in a cooler containing ice according to SOP 2-1, Packaging and Shipping Environmental Samples.

Figure 2
Sample Extruder Rack



5.2 Soil Gas Sampling

Assembly

1. Assemble the sampling device as follows (Figure 3):

   - Test fit the adapter with the PRT expendable point holder or retractable point holder to ensure that threads are compatible and fit together smoothly.
   - Attach the PRT adapter to flexible tubing equal in length to the depth of sampling (with some additional for sampling activities).
   - Secure PRT adapter with a length of electrician's tape and check the condition of the O-ring attached to the end of the PRT adapter.
   - Screw the PRT expendable point holder into the bottom of the lead probe rod.
   - Attach an expendable drive point to the bottom of the PRT expendable point holder.

2. Attach the assembled sampler onto the leading probe rod. A 30-cm (12-inch) probe rod is recommended to start the 60-cm (24-inch) standard and large bore samplers.

Probing

3. Thread the drive cap onto the top of the probe rod and advance the sampler. Replace the 30-cm (12-inch) rod with a 90-cm (36-inch) rod as soon as the top of the sampler is driven to within 15 cm (6 inches) of the ground surface.

4. Advance the sampler to 1 foot past the interval to be sampled using the hydraulic hammer. Add additional probe rods as necessary to reach the specified sampling depth.

Sampling

5. Replace the drive cap with a pull cap and retract the probe rods approximately 30 cm (1 foot).

6. Move the probe unit back from the top of the probe rods and remove the drive cap.

7. Push the drive point out of the PRT expendable drive point holder with extension rods fitted with a ram.

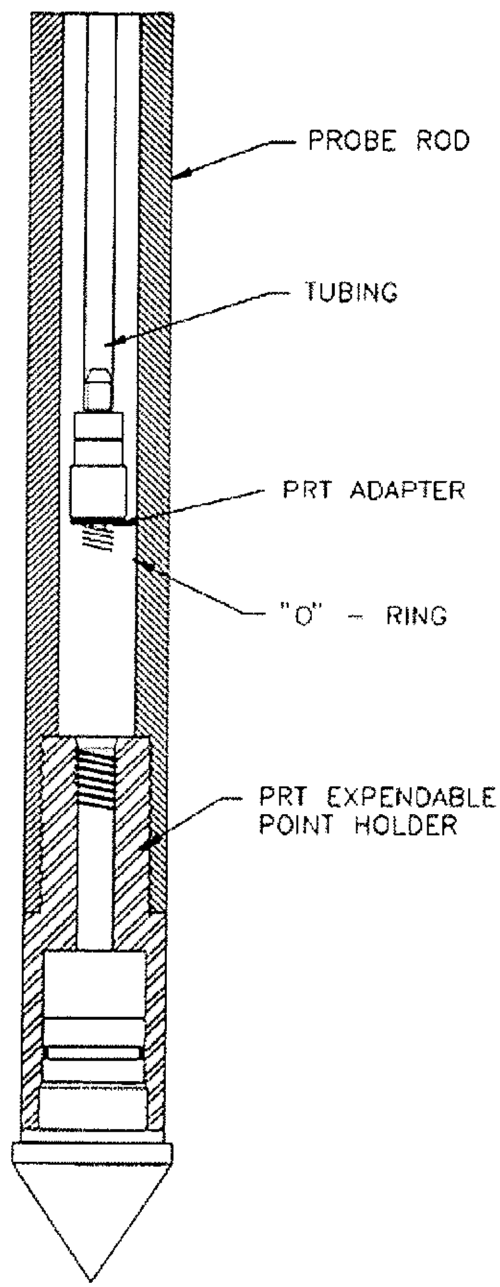
8. Remove the extension rods from the probe rods.

9. Insert the adapter end of the tubing down the inside diameter of the probe rods, feeding the tubing down until the adapter contacts the top of the PRT expendable point holder.

10. Holding the out-of-hole end of the tubing, apply downward pressure while turning in a counter-clockwise direction to screw the adapter into the PRT expendable point holder.

11. Pull lightly on the tubing to ensure that the threads have engaged.

Figure 3
PRT Soil Gas Sampling System



12. Connect the out-of-hole tubing to a vacuum or sampling system. A short section of inert silicon tubing may be connected to the end of the out-of-hole tubing so that a sample can be collected with a glass gas chromatograph (GC) syringe.

13. Start the vacuum or sampling system and allow the system to operate for 2 to 3 minutes to ensure that a sufficient volume of air has been run through the tubing. Document the depth, vacuum pressure, and purge duration in logbook. Note: Make sure the vacuum evacuation pump is able to pull vapors from the formation. Excessive vacuum may occur in clay/clayey units resulting in insufficient sample volume.

14. Collect sample using the method specified in the site-specific plan.

15. Label all sample containers as required, securing the label by covering it with a piece of clear, waterproof tape.

16. Remove the tubing from the probe rods. Dispose of the tubing or set it aside for decontamination.

17. Remove probe rod(s) from hole. Leave tubing in place for longer term monitoring.

5.3 Groundwater Sampling

Assembly

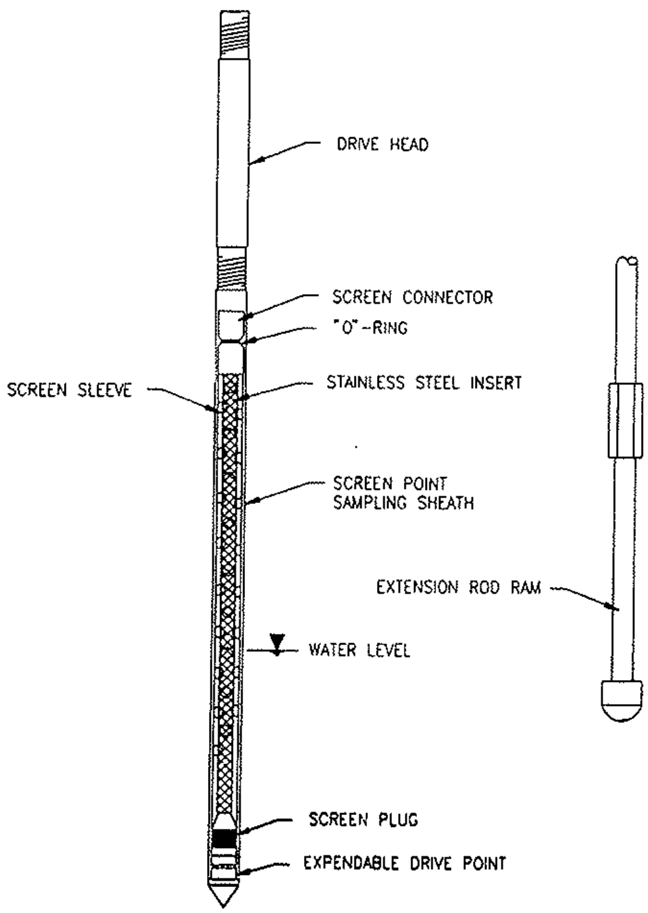
1. Assemble the screen point groundwater sampler (see Geoprobe Systems Equipment and Tools Catalog, Groundwater Sampling Tools, pp. 5.1-5.12) as follows (Figure 4):

   - Push the screen insert and plug into the screen sleeve from the bottom. The bottom end has one drain hole.
   - Push the screen connector over the top end of the screen sleeve and push the screen connector pin into place. The pin must be held in place as it has a loose fit.
   - Insert the screen sleeve, screen connector first, into one end of the sampler sheath.
   - Slide the drive point seat over the end of the screen assembly that protrudes from the sampler sheath. Thread it in until tight using a 22-mm (7/8-inch) wrench.
   - Push the screen assembly just far enough into the sampler sheath that an expendable drive point can be pushed into place in the drive seat.
   - Screw the groundwater drive head with the O-ring end first into the open end of the sampler sheath.
   - O-rings are installed at various critical places in the sampler assembly. Ensure that all O-rings have not been worn and that the connections made at O-ring locations are tight.

   The Mill-slotted well point does not need any assembly.

2. Attach the Mill-slotted well point, or screen point groundwater sampler, onto the leading probe rod. A 30-cm (12-inch) probe rod is recommended to start either groundwater sampler.

Figure 4
Groundwater Sampling



Probing

3. Thread the drive cap onto the top of the probe rod and advance the sampler using either the hydraulic hammer or hydraulic probe mechanism on the Geoprobe rig. Replace the 30-cm (12-inch) rod with a 90-cm (36-inch) rod as soon as the top of the sampler is driven to within 15 cm (6 inches) of the ground surface.

4. Advance the sampler to the interval to be sampled using the hydraulic hammer. Add additional probe rods as necessary to reach the specified sampling depth.

Sampling

5. Move the probe unit back from the top of the probe rods and remove the drive cap.

6. The next step varies depending on the type of sampler being used:

   - Mill-slotted well point - measure and record the water level, allowing time for the water level to reach equilibrium.

   - Screen Point groundwater sampler - attach the pull cap to the top probe rod, retract the probe rods approximately 60 cm (2 feet), push the screen into the formation using extension rods fitted with a ram, remove extension rods from the probe rods, and measure and record the water level, allowing time for the water level to reach equilibrium.

7. Label all sample containers as required, securing the label by covering it with a piece of clear, waterproof tape.

8. Collect groundwater samples using one of three methods (as outlined in site-specific plans) described below:

   - Collect sample from the inside diameter of the probe rods using a decontaminated mini-bailer. Follow CDM Federal SOP 1-5, Groundwater Sampling Using a Bailer.

   - Collect sample using a peristaltic pump and flexible tubing system.

   - Collect sample using a check valve (Waterra-type valve) attached to the bottom of 10-mm (3/8-inch) diameter tubing. The tubing is lowered into the probe rods below the top of the water table, check valve-end first. Water sample is collected through the tubing by rapidly oscillating the tubing up and down creating an inertial pump.

9. Clean the outside of the sample containers and place individual samples into sealable bags and seal closure.

10. Place samples in a cooler containing ice according to SOP 2-1, Packaging and Shipping Environmental Samples.

6.0 Restrictions/Limitations

The Geoprobe sampling system is not designed for collecting large sample volumes, thereby limiting the number of analytical parameters. Sample recovery rates may be reduced in soils with substantial amounts of gravel and/or cobbles. Depending on sampling depths and intervals, a typical sample production rate of between 10 and 15 samples per day can be expected.

The most efficient sampling depth is limited by the geologic and hydrogeologic conditions. Practical, efficient sampling depths should be limited to approximately 6 meters (20 feet) under most conditions. However, sampling depths in excess of 20 meters (65 feet) have been achieved in unconsolidated, homogeneous sandy soils; attainable depths will be greatly reduced in tighter formations and in soils with gravel and cobbles.

The presence of gravel and cobbles in soils will likely damage soil sampling tubes and possibly probe rods, couplers, stop-pins, and other probing equipment. A sufficient supply of replaceable equipment should be kept onsite in the event of damage or breakdowns. This often requires replacement at the project's - not the subcontractor's - expense. A copy of the Geoprobe Systems Equipment and Tools Catalog should also be kept onsite; Geoprobe Systems provides overnight deliveries.

Prior to conducting the Geoprobe sampling event, underground utilities and structures must be demarcated on the ground surface. The local utility companies must be notified at least 72 hours prior to the scheduled sampling event to allow sufficient time to locate and mark the utility lines. The selected sampling location should be a safe distance from the demarcated utility. In some cases, records regarding utility locations may not exist. In any event, a good practice is to push the probe rods the first few feet, rather than hammering, to ensure that no utilities, underground storage tanks, or other subsurface structures are present.

7.0 References

Geoprobe Systems, *The Probe-Drive Soil Sampling System*, September 1991.

Geoprobe Systems, *Equipment and Tools Catalog*, 1992.

TSOP 3-2

TOPOGRAPHIC SURVEY

Topographic Survey

SOP 3-2
Revision: 5
Date: December 31, 2004

Prepared:	Demetrios Klerides	Technical Review:	Frank Morris
QA Review:	Doug Updike	Approved:	[signature] 12/21/04 Signature/Date
Issued:	[signature] 12/28/04 Signature/Date		

1.0 Objective

The objective of this standard operating procedure (SOP) is to provide guidance for a site topographic survey. The survey will produce a base map of the area under study, showing topographic and site-specific features. Also, the base map will incorporate site-specific grid system coordinates, if appropriate, to show sample and exploration location, monitoring wells, test pits, and any other features required by the scope of work.

2.0 Background

A site-specific grid system may be established at the area under study to coordinate the collection of samples. The topographic survey will establish the coordinates for the grid and facilitate the transposition of the grid and sample locations from the field to the topographic base map. At areas where a grid system is not used, sample and exploration locations will be marked by the field team using appropriate markers such as stakes, nails, flagging, or paint. The base map will also locate site-specific planimetric details such as significant manmade and geographic features via the survey.

The scale for the base maps will vary based on the size of the area under study, but a suitable scale will be selected that clearly shows map features and sample locations. The base maps will be at a scale appropriate for the intended use. Areas with significant detail requirements will be shown in scale that ranges from 1 inch equals 10 feet to 1 inch equals 40 feet. Areas with less detail requirements will be shown in smaller scale such as 1 inch equals 100 or 200 feet. Topography will be shown with 1- or 2-foot contour intervals. However, the contour interval should clearly identify the variation in topography to the degree necessary for the work to be performed. For example, gently sloping areas may require a smaller contour interval (i.e., 1 foot between contour lines) to reveal more subtle topographic variations. Similarly, steeply sloping areas may require larger contour intervals to legibly depict the topography. Index contours should be indicated at elevations that are multiples of five times the contour interval.

If appropriate, aerial photographs may be used to assist in the development of the topographic base maps. Existing or new photographs can be used for this purpose. In areas with deciduous trees, new photographs should be taken during late fall or winter when the leaves are off the trees and better ground surface image can be achieved. The scale of the aerial photographs should provide sufficient detail for developing the topographic base map.

3.0 Responsibilities

Project Manager - The project manager is responsible for ensuring that the topographic survey is completed in accordance with the project requirements.

Field Team Leader - The field team leader is responsible for developing the survey scope of work and ensuring that the topographic survey is coordinated properly with the grid system (if used) and the sampling points, so that the base map produced is a true representation of the field locations.

4.0 Required Equipment

The required equipment for a topographic survey shall be provided by the selected surveyor. All equipment proposed by the surveyor shall be submitted to CDM for approval prior to initiating the topographic survey work.

The selected surveyor must be licensed in the state in which the survey is conducted.

For topographic surveys conducted at hazardous waste sites, all surveyor personnel who work onsite will be 40-hour health and safety trained as per OSHA requirements for hazardous waste sites (29 CFR 1910.120), unless approved differently by the corporate health and safety manager.

All final drawings and maps must be signed and sealed by the licensed land surveyor.

5.0 Procedures

5.1 A site visit may be conducted prior to submitting the bid proposal. A kickoff meeting should be held between the selected surveyor and CDM's project manager to discuss the specific requirements of the scope of work.

5.2 The surveyor shall be responsible for executing the work, including deed search, if required.

5.3 The surveyor shall develop and implement a site-specific health and safety plan according to the requirements specified in the subcontract between CDM and the surveyor.

5.4 To the extent practical, the work shall be performed in the presence of an authorized representative(s) of CDM. CDM will interpret and clarify the specifications and will answer all questions in connection therewith.

5.5 The CDM field team leader will be responsible for ensuring that appropriate calibration procedures are performed and documented by the surveyor. Calibration procedures shall be consistent with the data quality objectives for the survey and with the equipment manufacturers' requirements.

5.6 The surveyor shall establish at least one primary horizontal control monument and one vertical benchmark, as established by the United States Coastal and Geodetic Survey (USC&GS) or equivalent authority. Additional monuments may be established by the surveyor.

5.7 Local benchmarks will be established at least every 500 feet or closer, if warranted by site conditions, to tie the basic control points together. Where required, established horizontal and vertical data, such as state planar coordinate systems and the national geodetic vertical datum of NAVD 88, or subsequent corrections and/or revisions, shall be used to tie the survey data to the national network.

5.8 Temporary monuments will be set as necessary to perform the surveying. They may be wood, metal, or otherwise marked on facilities such as sidewalks, paved streets, curbs, etc. All monuments should be described in the field notes and marked on site maps for future reference.

5.9 If appropriate, the surveyor should be encouraged to use technologies such as Global Positioning System (GPS) that will meet the accuracy requirements but that may be more flexible and efficient than traditional techniques. All geodetic control work shall conform to either the Standards and Specifications for Geodetic Control networks, Federal Geodetic Control Subcommittee or NAVSTAR Global Positioning System Surveying, U. S. Army Corps of Engineers, for third order Class II control surveys. Short traverses, less than 1 mile, may use generally accepted fourth order techniques (including vertical angles for elevations) that will provide the spatial accuracy required. Angles shall be doubled and redoubled if the mean of the doubled angle differs from the first angle by more than 10 seconds. Length measurements shall be made with a calibrated tape corrected for temperature and tension or with Electronic Distance Measuring (EDM) equipment corrected for variation of the index of refraction.

5.10 The CDM field team leader will review the draft map to ensure that all sampling and exploration locations, grid coordinates, and other appropriate features are located by the surveyor. The surveyor will record all field survey information in a field logbook; a copy of the logbook shall be provided to CDM with the submittal of the topographic map.

5.11 A working drawing of the base map will be field checked and corrected by the surveyor as necessary. The completed topographic base map shall be plotted on Mylar® or other suitable drafting film, as directed by the CDM project manager. All survey and topographical data will be in digital format, compatible with the latest version of AutoCAD, DXF, or geographic information system (GIS) export format may also be acceptable. The specific format of the data to be provided to CDM will be specified in the SOW. It is recommended that a review of CDM client requirements be completed to determine the appropriate data format. Sufficient documentation of the digital information shall be provided to explain the data. For clarity, the surveyor will prepare the base map with groups of features on separate layers in the AutoCAD files. The CDM project manager should designate which features will be placed on the separate layers. Tick marks indicating the latitude and longitude in the state that the work is performed should be provided on the base map. The project manager will be responsible for ensuring that the topographic base map and digital information is completed according to CDM's drafting standards for the project.

5.12 In the event that aerial photographs are used, the surveyor shall field edit and statistically test the aerial topographic mapping of the site base map for conformance with the horizontal and vertical components of the National Map Accuracy Standards. The surveyor shall run random baselines throughout the site (minimum of four) to verify that less than 10 percent of horizontal and/or vertical locations exceed the values determined in the National Map Accuracy Standards. If more than 10 percent of the locations exceed the values in the National Map Accuracy Standards, then the surveyor will notify CDM.

5.13 Stereo map compilation by stereo photogrammetric methods will be accomplished through the use of approved stereophotogrammetric instruments using professionally recognized plotting ratios for each type of instrument. Fully trained and experienced photogrammetrists will be employed to complete stereomap compilation.

5.14 For broad area high precision topographic mapping, digital elevation/terrain model compilation using light detection and ranging (LiDAR) technologies is becoming more common. This method can be an efficient and effective tool for increasing engineering production at all levels. However, the error budget for a given LiDAR mapping system is dependent on the accuracy of its core subsystems (i.e., the laser rangefinder, the GPS position solution, and the inertial measurement unit [IMU]). System engineers need to balance each subsystem contribution against desired system performance (Shrestha et al. 2000).

5.15 The surveyor shall establish and maintain a quality control program to ensure that the survey is performed within acceptable limits. At a minimum, the surveyor will:

- Check all equipment, including compasses, transits, and levels, for accuracy and maintain records of such checks. The surveyor will make records of these checks available to CDM on request.
- Maintain and submit copies of all survey field notes.
- Field notes for each surveying activity will be kept in bound books dedicated exclusively to this project. Each book will have a table of contents. Each page of field notes shall be numbered, dated, and show the initials of all crewmembers. Black waterproof ballpoint pens will be used. Erasing is not acceptable. All errors will be crossed out with a single line and the correct data entered adjacent to the error. The crossed out and corrected data will be initialed by the party marking field notes.

5.16 Permits:

- The surveyor shall be responsible for obtaining any federal, state, and local permits that may be required to perform and complete the ground surveys at the site.
- The surveyor shall not perform any work until permits (if required) are obtained.
- The surveyor shall provide separate copies of all permits to CDM prior to performing any onsite activities.

6.0 Restrictions/Limitations

The horizontal positions are to be surveyed within one tenth of a foot, relative to the datum coordinate system. The vertical elevations of monitoring wells, piezometers, and staff gauges are to be surveyed within one hundredth of a foot (0.01 foot), relative to the local benchmarks. The vertical elevations of all other sampling points are to be surveyed within one tenth of a foot, relative to the local benchmarks.

7.0 References

http://www.ngs.noaa.gov

Moffitt, F.H. and H. Bouchard. 1982. *SURVEYING* (7th ed.), Harper and Row, Publishers, New York.

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TSOP 3-4

GEOPHYSICAL LOGGING, CALIBRATION, AND QUALITY CONTROL

Geophysical Logging, Calibration, and Quality Control
(Includes Potential Radioactive Sites)

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1.0 Objective

The objective of this standard operating procedure (SOP) is to provide guidelines and define requirements for the generation of quantifiable geophysical logs of selected boreholes. The procedure defines use of a logging systems check, calibration and maintenance check, and well maintenance data documentation.

2.0 Background

Geophysical logging can be used to interpret the physical characteristics surrounding a borehole. These characteristics include the lithology, geometry, resistivity, formation resistivity factor, bulk density, porosity, permeability, structural integrity, and moisture content. Logging can also be used to evaluate well integrity and characterize vertical groundwater flow and groundwater quality within the water column. Interpretations from tool response can be used in a more quantitative fashion when the instruments used during a specific logging process are accurately and properly calibrated and operated by trained personnel. To provide consistently reliable data, a logging operator needs to ensure the following: proper tool calibration or standardization maintenance checks, a logging systems check, complete and well-maintained data documentation, and identification and protection against potential hazards.

2.1 Associated Procedures

- CDM Federal SOP 4-1, Field Logbook Content and Control

3.0 Responsibilities

Site Manager – The site manager translates client requirements into technical direction of the project. The site manager plans and directs the overall project; sets technical criteria; reviews and approves technical progress; defines or approves what logs and tools are to be used after consultation with the field team leader; and considers the objectives of the project, the lithology surrounding the borehole, and the borehole conditions.

Field Team Leader – The field team leader (FTL) provides onsite supervision of the borehole logging program, administers the logging subcontractor operation, and ensures that this SOP is properly followed at all times. The FTL confers with the site manager and the logging subcontractor on what logs and tools are to be used and maintains the field logbook in accordance with CDM Federal SOP 4-1, Field Logbook Content and Control. The field team leader provides the logging subcontractor with a unique, site-specific document control or ID number for use in identifying each individual borehole or well, provides copies of checklists pertinent to the operation, and provides copies of borehole or well construction details.

Logging Subcontractor – The logging subcontractor provides equipment appropriate to the task as described in the project statement of work, provides appropriately trained and qualified personnel, and responds to administration of the FTL. The logging subcontractor ensures proper tool calibration or standardization maintenance checks, a logging systems check, complete and well-maintained data documentation, and identification and protection against potential hazards. The logging subcontractor ensures that logging subcontractor personnel read and observe requirements defined in this SOP and provides copies of their company standard and emergency operating procedures for approval by FTL prior to implementing any logging activities.

4.0 Required Documentation

- Field logbook
- Appropriate log sheets (boring logs, well completion data sheets, or equivalent)
- File containing:
  a) One copy of the logging contract stating the technical requirements
  b) One approved copy of subcontractor standard operating procedures and emergency operating procedures
  c) One copy of the current Nuclear Regulatory Commission (NRC) license listing certifications and approval of the type and activity level of the radioactive sources to be used onsite, if appropriate
  d) One copy of the current leak test (swipe) results of all radioactive sources containers on board the logging vehicle
  e) Physical survey forms indicating activity level at monitoring points adjacent to the radioactive source storage area of the logging vehicle
  f) Documentation of current radiation monitoring instrument calibration
  g) Documentation that all geophysical tools have been inspected and are properly operating
- Site-Specific Checklists (see attached samples)
  a) Health and Safety Checklist (Attachment 1)
  b) QA Geophysical Checklist for Borehole Logging (Attachment 2)
  c) Geophysical Logging Tool Checklist (Attachment 3)
  d) Sample Log Heading (Attachment 4)

5.0 Procedures

5.1 Preparation

The logging subcontractor and the FTL or designee will confer prior to field activities regarding the suite of geophysical tools to be used in the operation. The FTL should define what logs are to be used.

Considering the objectives of the logging program, the choice of tools may be further determined by the lithology surrounding the borehole and the borehole conditions. Prior logs will be used, if available, as aids to determine the appropriateness of the logging suite. These logs will be studied and serve as a baseline for the current logging activity.

Generally, fluid logs are run first within a logging suite with nuclear logs last. In uncased holes, a caliper log should be run shortly after the fluid log, as it can yield measurements of the borehole rugosity and diameter variations useful in the onsite evaluation of uncompensated logs that may follow. Both are necessary in determining the borehole integrity and appropriateness and suitability of future logs.

The logging subcontractor shall have an approved emergency operating procedure covering all emergencies relating to tool operation, including the retrieval of a logging tool that has been lost down a hole. The logging subcontractor and FTL or designee will cooperate in determining the most suitable approach for retrieval of any tool.

The following documents, certificates, and inspections will be completed by the logging subcontractor prior to well logging and shall be in an open, active file during logging activities.

- One copy of the current NRC license listing certifications and approval of the type and activity level of the radioactive sources to be used in the logging program.
- One copy of the current leak test (swipe) results of all radioactive sources containers on board the logging vehicle.
- Physical survey forms indicating activity level at monitoring points adjacent to the radioactive source storage area of the logging vehicle.
- Documentation of current calibration of radiation monitoring instrument.
- Copy of the logging SOP and emergency operating procedures to be followed during logging activities. Emergency procedures should include provisions for retrieval of lost probes, with physical descriptions and drawings of the probes and head connections available at the well site.
- Documentation that all geophysical tools have been inspected and are properly operating.

Prior to proceeding to the field site, each geophysical logging tool will be "shop calibrated." The shop calibration (or standardization) is a method of subjecting the energized probe to a known signal level to ascertain the integrity of the logging equipment. These offsite standardization trials will be available for comparison to onsite calibration or standardization, which will be performed before and after each logging tool run. American Petroleum Institute (API) calibration scales are not usually applicable to geophysical logs made in cased holes, and log headings, in such cases, should not exhibit environmental units or any other non-applicable scales. Radiation logs, made through steel casing, should display non-environmental "shop calibration" scale units, such as counts per second, counts per minute, or API units.

5.2 Operation

After all required equipment and material have been mobilized onsite and necessary consultations and preparations are completed, the field operations may begin.

Once at the site, each piece of logging equipment will go through routine standardization before and after the logging of every borehole using portable standards. All tool responses to each standard will be recorded on each borehole log trace. Personnel responsible for running the geophysical log should perform the standardization procedures.

Calibrations and standardization will be recorded as untransformed (analog) log data (non-environmental units). A conversion factor or graph will accompany these data and be used to convert the raw data to environmental units. Analog to digital (A/D) conversion will be done onsite to more easily assess any problems that may arise and to implement immediate correction.

Mechanical and electrical zero response and full scale settings will be recorded and labeled as such at the beginning of each logging trace.

Prior to logging any borehole, the FTL or designee will review the most up-to-date information on borehole conditions such as: depth, variations in diameter, lost circulation zones, casing, debris in hole, fluid type, and known contaminants (if any) in the borehole. Each logging procedure will be determined based on assessment of borehole conditions using the most recent and previously run logs (if available).

A thorough inspection needs to be made of all probe O-ring seals to prevent potential water leaks from developing within the instrument. Seals should be clean and dirt free.

All logging cables need to be kink free. Logging subcontractor personnel should be prepared to wipe or clean cables prior to retraction onto the storage drum.

The cable measuring sheave between the winch and well must be pre-calibrated to the currently used cable size. The sheave should be free of any debris (e.g., dirt, ice, or dry drilling mud).

Cable heads should be checked for electrical leaks or shorts using a volt- or ohm-meter.

Prior to the completion of each logging suite, a geophysical checklist will be studied and completed, where appropriate, by the FTL or designee. All checklists will be completed in black indelible ink. The Geophysical Logging Tool Checklist (Attachment 3), to be completed by the logging subcontractor equipment operator, will indicate the specific logging tools used, order of use, and the combination of tools used concurrently. A preview of the checklist by the logging subcontractor equipment operator will serve, in part, as a reminder of potential problems that may arise during the logging run.

Log headings, as shown in the attached samples, will be used. The analog trace for each log will have all pertinent information (listed below) written on the trace by the logging subcontractor equipment operator as it occurs. This may include:

- Depths per interval or division of log tracing paper
- Horizontal scale values (written at the start of each log)
- Scale changes (if done during a logging run)
- Pen positions
- Borehole/well identification
- Probe type
- Logging speed
- Tool calibration tails
- Module adjustments
- Digitized record information number

This information will be copied to a formal well log heading at the end of the logging run. Each log heading will give information relating to well and geophysical tool parameters. In order to interpret the well log as quantitatively as possible, it is imperative that all criteria and data entries within a log heading be filled out by the logging subcontractor equipment operator before the logging tool is removed from the cable. The completed heading will be attached to the well analog record at the well site. If required for the project, the FTL or designee may supply a unique site-specific document control or ID number written on both analog record and the log heading. Attachment 4 gives a sample log heading that contains necessary data.

Analog and digital data records will be run as follows:

- A minimum of two independent log channels will be available to record analog data, thus permitting two traces to be recorded using different gain and baseline values. Recorder channels should have wraparound capabilities if the trace exceeds chart span.

- The raw analog data will be converted to or recorded as a digital record onsite. Raw conversion (if required) of the analog record to digital form will allow easy data interpretation such that quick module adjustments can be made if a problem arises. The sample time and interval of the digitized record will coincide with that of the raw analog data. The digitized record will be stored on CD ROM or floppy disk. This will provide an onsite backup record if the original analog record is damaged or lost. The digital sample time must be predetermined prior to conversion and must be consistent with the onsite sample interval and time. The digitized version of the borehole record will have a document control number that will be referenced on the analog record. The analog record, in turn, will refer to the digital record label, file number, sample interval and time, and recorded depth interval. The original of records will be given to the FTL or designee. Copies should be maintained by the logging subcontractor.

It is imperative that the logging operator continually monitor the data output of the strip chart recorder, monitor, or logging film to determine any spurious and anomalous conditions that may arise. A review of the geophysical checklist prior to logging will be done to prompt the logging subcontractor equipment operator of potential problems that might arise. The following briefly summarizes some of the potential problems associated with each logging technique. It should not be a substitute for thorough training in the nuances and idiosyncrasies of specific instruments, as each tool used will have a unique circumstance that may result in a spurious log. For these reasons, it is imperative that each logging operator be thoroughly trained in the use of each logging tool and be aware of idiosyncrasies that may arise between brands.

A. Scaling of Recording Equipment

Several problems may arise in log interpretation if horizontal and vertical scales on the strip chart recorder have not been properly set on the recorder at the beginning of the log run. While logging, repeated checks must be made to ensure readings from the depth indicator agree with chart paper divisions.

Horizontal and vertical scales need to be preset prior to the log run and tested within the range of expected borehole responses.

During setup time, the horizontal log scale will be written on the log paper and the depth of major chart divisions will be clearly marked as logging progresses. Knowledge of well conditions is helpful in determining the proper horizontal and vertical scale.

If during a log run the horizontal or vertical scale is determined to be insufficient and an adjustment needs to be made, it will be necessary to stop and restart the logging from the starting depth.

B. Extraneous Conditions Resulting in Anomalous Logs
The following briefly describes conditions that may give rise to anomalous log traces and should be watched for by the logging subcontractor equipment operator.

1. Fluid Logging
   In newly drilled holes, it is unusual to have chemical or thermal equilibrium between the borehole fluid and surrounding borehole matrix. Consequently, fluid logs generally measure the conditions of the borehole fluid rather than borehole matrix that sometimes requires months to reach equilibrium (this would be especially true if the hole was drilled using drilling mud and development was not properly performed).

   Temperature Logs
   The introduction of fluid or air to remove drill cuttings during the drilling operation causes false temperature anomalies often requiring months to reach equilibrium. Foreign material introduced into the annulus, especially curing cement, causes anomalies not related to formation properties. For these reasons, temperature logs in recently drilled holes should not be interpreted as formation temperature logs. Temperature logs are not easily repeated due to disturbance of the fluid during initial entry. Therefore, formation or fluid temperature logs should be done first and recorded as the probe descends down the borehole, generally long after the well has been developed.

   Typical thermal gradients should range between 0.47°C and 0.6°C per 30 meters (m) (100 feet) of well depth. If a log results in temperatures outside this range, extraneous effects affecting the log should be considered. In rare instances, a log may be erroneous due to problems that arise within the probe such as thermal lag, electronic drift, and self-heating of the probe thermistor. Since these conditions are the exception and not the rule, other conditions should be examined first as a result of questionable temperature logs.

   Log traces that result in small temperature fluctuations near the fluid surface may arise from large diameter probes descending too fast within the borehole and may not be representative of borehole conditions. Small temperature fluctuations with respect to depth may be a result of borehole conditions rather than improper tool operation. Inter-bore flow due to large head differential between aquifers can cause very small or even reversal of the thermal gradient. Fluid tracers or flow measurements may help to determine these effects.

   Convection cells within the borehole can result in temperature readings that are unrelated to the flow of water within the borehole. This is especially true for boreholes that have large diameters, fracture zones, and washouts. Consequently, the more accurate temperature logs are taken in small boreholes with small diameter probes.

Conductivity Logs
Conductivity logs measure the fluid conductivity within the borehole and are not always a measurement of interstitial water conductivity. Temperature drifts and movement of the probe in and out of steel casing material may give rise to sharp log deflections.

Flow Logs
Impeller flow-meters (commonly called spinners) are generally less sensitive than heat pulse or tracer release methods. In many aquifers, water movement is predominantly in the horizontal direction, with substantial seepage velocity variations as a function of vertical position. In these cases, knowledge of hydraulic conductivity with vertical position is essential. These conditions can be investigated best by installing the impeller flow-meter below an operating pump or in flowing artesian wells. Inter-borehole flow can often be determined by the heat pulse or tracer release methods.

2. Caliper Logs
Caliper log errors should be questioned when one of the arm traces shows no deflections. Several conditions are suspect. Heavy drilling muds, most prevalent at the bottom of the borehole, can cause failure of caliper arms to open up. Non-extended arms may be jarred open by bouncing the probe up and down or simply moving the probe to a zone with thinner muds.

Boreholes with a large degree of rugosity may give rise to peculiar log traces, especially in arm-averaging traces. For these types of holes, it is recommended that non-averaging or a single arm caliper be used. When a single arm caliper is used, repeat logs may not be exact duplicates of one another due to potential probe rotation.

Electrical leakage and grounding problems may cause spurious trace spikes.

3. Electrical Logging
Spontaneous Potential (SP) Logs
Stray electrical currents caused by underground cables, lightening strikes, corroding underground pipes, and nearby electrical motors can affect SP logs, inducing spikes or a uniform cyclical response. A repeat log will need to be done should such interferences occur.

If the logging cable has become magnetized, the log trace will consist of a cyclical sinusoidal wave that corresponds to each revolution of the cable winch. The cable should be demagnetized and the log rerun.

Single Point Resistance Logs
Single point resistance logs are affected by electrical fields generated from underground cables. Alternating current from the underground cable becomes superimposed over the alternating current applied to the probe. This can be detected when the trace pen fluctuates when the probe is stationary. The problem can be alleviated by changing the current frequency applied to the probe electrode and double-checking while the pen is stationary.

Normal Resistivity Logs
Nearby underground cables with currents of 60 cycles per second will produce an oscillating periodic logging trace. This problem can be alleviated by changing the current frequency applied to the probe from the generator or other power source.

A logging trace that appears to be cupped, or reversed, may be the result of an electrode spacing that is greater than the formation thickness.

Induction Logs
Problems will arise if the resistivity of the formation water is fives times greater than the resistivity of the borehole fluid. As a double check, the inverse of induction measurements should be in close agreement with formation resistivity measurements taken with other instruments.

4. **Acoustical Logging**
Acoustical televiewer (ATV) logging relies on a rotating trigger switch that is activated when a sensor passes magnetic north. Lithologic formations that are composed of magnetized material, lost drilling equipment in the borehole, and metal casing will cause the switch to malfunction. Therefore, the logging operator will need to change the trigger switch to a mechanical mechanism if they suspect the presence of magnetically susceptible materials.

Boreholes that deviate from the vertical will require careful corrections on the ATV log; these corrections should be noted on the logging trace. If the probe is not properly centralized, dark splotches will appear on the log. This may be exacerbated when coupled with low gains.

Acoustical logs are questionable when the log trace is composed of rapid fluctuations labeled as cycle skipping. This may be a result of several conditions, such as gains that are too small or too large. For example, an amplitude that is too small will result in the first compression wave being masked by pre-arrival "noise." Skipping may also be a result of borehole fractures, solution openings, attenuating rocks, or gas in the borehole fluid.

5. **Nuclear Logging**
All nuclear logs will be run near the end of the logging suite. Borehole conditions will be carefully scrutinized for integrity and their suitability for nuclear logging during previously run logs within the logging suite. Confirmation that the borehole is suitable for nuclear logging will be between the FTL or designee and the logging operator. This will be noted on the nuclear logging checklist.

Any suspicions of potential problems arising during a nuclear log operation will be addressed immediately and resolved before further nuclear logging is carried out.

The following paragraphs briefly describe conditions that may give rise to anomalous nuclear log traces and should be watched for by the logging operator.

Natural Gamma (Gamma Ray) Logs
The natural gamma log trace should have maximum deflection with minimal statistical variation. Pulses of natural gamma radiation are collected and averaged over a predetermined time constant. If the time constant is too short, relative to the amplifier gain, the trace will be masked by spikes of statistical variation. If the time constant is too long, relative to the probe travel and amplifier gain, the log trace is rounded off and lacks resolution. Logging speed and time constant setting should produce a trace with sharp anomalous peaks, with a minimum of clutter and maximum horizontal span.

Natural gamma logs are sensitive to borehole configurations and packing materials. Sudden trace deflections or changes in amplitude may be due to borehole diameter irregularities and drilling or well construction fluids; consequently, all gamma traces will be checked with a caliper trace.

Migration of water containing radioactive colloidal particles (i.e., clays or sylvite) through the borehole cracks and fissures will give traces that are not representative of the borehole matrix.

Gamma-Gamma (Gamma Density) Logs
Gamma-gamma logs are affected by borehole configuration, casing, cement, mud, probe "stand off," and background radiation. Therefore, a high resolution caliper log and background radiation check should always be compared with the gamma-gamma log trace to differentiate whether the trace response is due to matrix porosity and density parameters or extraneous effects.

A 4-pi gamma-gamma density log, because of its capability to propagate energy in four directions, is very effective in evaluating the integrity of material placed between the well casing and borehole walls. A thorough background check is especially critical to the success of this logging technique.

Attention should be given to sharp trace deflections. These should be compared to other logs as they may be due to the presence of cement boundary zones, the threaded interface between casing lengths, casing nested strings, and gravel packs. In the case of the 4-pi density log, these anomalous features are the target.

Neutron Logs
Neutron logs are affected by the same borehole parameters as gamma-gamma logs (except borehole casing materials) but less dramatically. As with gamma-gamma logs, cross checks between high-resolution caliper logs, background radiation, and the neutron log should be performed to adequately interpret the trace.

Large trace deflections will occur at the interface between fluids of different densities, such as a saline/fresh water or air/water interface.

The presence of clays and shales surrounding the borehole will give anomalously low trace responses, indicating high total porosity.

5.3 Post Operation

All checklists shown in this SOP's attachments will be filled out prior to leaving the site. These checklists are designed for health and safety, quality assurance, and tool operation.

At the end of each logging run (within a suite), the logging operator will complete the appropriate portions of the tool checklist. The checklist will then be verified by the FTL or designee. Any correction in data entry will be crossed out with a single line, dated, and initialed. At the end of the logging suite, each category in the checklist will have a handwritten entry. If a specific parameter does not apply, the logging operator will enter "N/A" by that category.

The original of all records will be given to the FTL or designee along with copies as may be specified. Copies of all completed checklists will also be provided.

To check for leaks, a radiation survey will be done on all nuclear probes. Shields will be checked for proper installation and defective components prior to probe storage. If shields of neutron sources have been found to be defective, storage prior to repair will be away from sodium-iodide crystals (a common component in some probe detectors) as they become radioactive when impinged upon by a neutron source.

All radioactive sources and radioactive tracers will be kept in a designated and carefully monitored storage area that has been specifically designed for storing or transporting nuclear sources. Sources stored within the facility will be sealed and placed in source holders specifically designed for their use. Each storage container will be clearly labeled with the following information: source material, concentration in Curies, and dose rate at 1 meter from the holder. Labels, warning signs, and alarms for source containers and the storage facility will follow that prescribed by the NRC. The storage facility and source containers will not be altered in any way, and both will be locked when unattended.

Each probe will be securely fixed to a stand or other similar structure where it will be cooled, cleaned, and inspected for damage. Repairs will be made when possible. If the probe cannot be repaired onsite, a note will be made of this on the tool checklist and the tool will be labeled "out of service" until repairs can be made.

The site will be checked for any debris, spills, or litter resulting from logging activities. All such matter will be removed and disposed of in accordance with regulations applicable to the site.

6.0 Restrictions/Limitations

Several hazards are associated with activities surrounding geophysical logging and these are outlined below:

6.1 Mechanical Hazards

The use of machinery to lift and lower the probe in and out of the borehole may require the use of hoists, cables, winches, rigs, etc., that are under tension or compression. Breakage or malfunction of any one of these components could cause the release of uncontrollable forces that may in turn impart tremendous physical damage to personnel and other equipment.

Site personnel should be aware of swinging probes (weighing up to 136 kilograms [kg] [300 pounds]), or other associated equipment, suspended in midair prior to entry or after exiting the borehole. Site personnel should also guard against falling components from probes that have had joints loosened.

6.2 Electrical Hazards

Hazards may arise from the use of several electrical power sources. Potential shocks may arise from improper handling of nongrounded power supplies or from probes using induced current electrodes or high voltage generators (120 to 600 V) used to power the tools. Lines from these power sources will be connected to ground fault circuit breakers.

All generators will be grounded. All extension cords from any power source will be composed of three conductor insulated wires and will be inspected for any frays, cuts, or other damage.

6.3 Nuclear Hazards

Many geophysical logging programs rely on a suite of techniques that are collectively classified as nuclear logging. Some nuclear logging tools contain radioactive materials that serve as sources of radiation that are uniquely attenuated by the surrounding borehole matrix. Other nuclear logging tools measure ambient gamma radiation and do not use radioactive sources but require frequent calibration with radioactive materials. All permits will be kept in an open file in the logging vehicle. The use of nuclear tools needs to be preplanned and carefully thought out, monitored, and well supervised by highly trained individuals familiar with the particular logging technique and equipment. Active nuclear logging tools will be stored in shields specifically designed for each tool (passive tools do not need shielding). Monitoring equipment must be used at specified times in nuclear tool storage facilities and will be calibrated at specified intervals. Tags indicating the dates of monitor equipment calibration will be attached. Wipe test results and calibration records will be stored onsite in open files.

For the health and safety of the staff engaged in geophysical logging, all personnel working with the geophysical team will wear a Thermoluminescent Dosimeter (TLD) badge or a Radiation Exposure Film Badge as required by project, client, and/or site requirements. This badge must be worn on the top front outer garment. Exception to this rule is given to visitors and temporary assistants, who must at all times maintain a safe distance (determined by the site safety officer) between themselves and the radioactive source(s).

A radiation survey meter will be available, checked, and calibrated for operation prior to site transport. An up-to-date copy of the radiation survey and meter calibration will be kept on file in the logging vehicle.

The following briefly summarizes the radioactive materials used for each logging technique:

- Natural gamma logging measures the ambient gamma radiation of in situ, naturally occurring elements within the geological strata such as potassium, thorium, and uranium. Tools used to detect natural gamma radiation do not emit radiation but are calibrated with radioactive material. Calibration standards requiring a license for purchase, handling, and transport will be used only by licensed and trained individuals.

- Neutron logging requires the use of radioactive sources that emit high-energy neutrons within the logging probe, some of which also emit gamma radiation. Neutron concentrations for these probes range between a low of 10 millicuries (mCi) to a high of 5 Curies (Ci). Radioactive sources commonly used in a neutron probe are americium/beryllium mixtures. Older probes may have mixtures of beryllium and radium or beryllium and plutonium. Radium/beryllium probes have an added danger over those made of americium/beryllium in that they emit high doses of gamma radiation. Because neutron radiation is most effectively attenuated by hydrogen atoms, shields for neutron sources are composed of hydrogenous materials. Storage facilities will be monitored to assure all shields are effectively blocking neutron radiation.

- Gamma-gamma and density logs contain radioactive sources that emit gamma radiation. The radioactive source most commonly used is cesium-137, with older probes using cobalt-60 as a gamma radiation source.

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8.0 Attachments

Attachment 1 - Health and Safety Checklist
Attachment 2 - QA Geophysical Checklist for Borehole Logging
Attachment 3 - Geophysical Logging Tool Checklist
Attachment 4 - Sample Log Heading

Attachment 1
Health And Safety Checklist

Well Name and Number ______________________ Location ______________________

Logging Company ____

Suite of Logs Run ____

Name of Recorder ______________________ Initials ______________________

Yes	No	General Health and Safety Checklist
____	____	All personnel working in the restricted area wearing TLD Badges or Radiation Exposure Film Badges as required?
____	____	Restricted area properly controlled, thus preventing any unauthorized entry?
____	____	All radioactive sources are stored in a secured, labeled, and properly shielded location?
____	____	A copy of the operating and emergency procedures has been reviewed by logging supervisor and is on file in the field office?
____	____	Were there any incidents that required implementation of emergency procedures? If yes, were the emergency procedures followed?
____	____	Were storage facilities of radioactive sources posted with the proper labels?

Attachment 2
QA Geophysical Checklist For Borehole Logging

Well Name and Number ____________ Location ____________

Logging Subcontractor ____________ Date ____________

Total Borehole Depth ______ (feet) Well Depth ______ (feet) Logger ______ (feet)

Ground Elevation ______ (feet) Permanent Datum ____________

Permanent Datum Elevation ____________ (feet)

Suite of logs to be run: Sp ____ Temp ____ "16-64" Ris ____ SPRis ____ Ind ____

Gam Ray ____ Gam Gam ____ Caliper ____ Other ____

Name of Operator: ____________ Date: ____________ Initials: ____________

Name of Recorder: ____________ Date: ____________ Initials: ____________

Monitor Well Construction Materials: Casing ____________ Screen ____________

Drilling/Construction Fluids: ____________

General Quality Assurance Checks

Yes	No	
____	____	Base map is located onsite.
____	____	Prior to running the nuclear logging suite, borehole conditions were evaluated and considered suitable for such logs using information from caliper and previously run logs.
____	____	Appropriate scales have been chosen using nearby, onsite well logs. These are available for a comparison to present log readings.
____	____	Onsite tool calibrations have been performed using calibration checks implemented before and after each log run.
____	____	Logging scales chosen for all logging tools are appropriate for borehole conditions and required sensitivity. Off-scale logs have been rerun using scale adjustments when the offending off-scale run cannot generate an on-scale plot.
____	____	Were there scale changes while running a log? If yes, which logs? ____________
____	____	Scale changes, exceptional conditions, and other anomalies have been appropriately annotated on the affected logs.
____	____	Depth control during log mergings have been checked.
____	____	After Survey Depth Errors (ASDE) have been checked.
____	____	Hard copies have been examined for several log runs and there is good correlation of well depth between them.

General Quality Assurance Checks (Cont.)

Yes	No	
____	____	All well log herd copies have been examined upon completion of the logging suite and good correlation exists between them.
____	____	Borehole mud samples have been taken just prior to logging and mud resistivity measured.
____	____	Optimal data acquisition has been achieved by choosing the most appropriate logging speed and time constant from test runs (when necessary) of varying speeds.
____	____	Logging speeds for boreholes less than 2,000 feet have not exceeded 25 feet per minute. Some tools may require slower logging speeds.
____	____	Field log headings are filled out as completely as possible. Final print log headings are completely filled out.
____	____	The repeat length for a uniform section has not been less than 50 feet, a variable section not less than 200 feet. When possible, boreholes less than 1,000 feet have had the entire hole length repeated.
____	____	If log quality appears questionable, attempts have been made to ascertain cause and make adjustments. If a satisfactory log cannot be obtained, note reason.
____	____	The specific hardware brand and model number used for data acquisition has been recorded in the field logbook. All software used for data acquisition and retrieval has been recorded in the field logbook.
____	____	Tool manufacturer, model, and serial numbers have been noted. Tool configuration, diagrams, and manuals are available and located in the field (or logging) operation office.
____	____	Logging subcontractor has been questioned to determine whether any tools have been modified or deviate from factory specifications. Modifications have been noted on field log checklist.
____	____	Two floppy disks or CD ROMs have been made of the unedited, raw digital logging data and are stored in the field operation office.
____	____	Processed, raw digital data that is in final form accompanies the final processing report.
____	____	The final processing report has the necessary audit and audit process documentation.

Attachment 3
Geophysical Logging Tool Checklist

Temperature Log (This log should be run first.)		
Make	Model	Serial No.
Modification (Yes/No)?	(Describa fully on separate sheet and attach.)	
Tool schematic and operating manual on file (Yes/No)		Location of schematic
Order in which tool was run.	Run in combination with (other tools)	
Logging Speed (m/min) (ft/min)	Repeat Section Interval Location	
___ Tool logged in fluid-filled hole? (Yes/No) ___ Calibrated onsite (optional)? (Yes/No) If no, where calibrated and date of calibration? ___ Readings appear to be of good quality, no noise. (Yes/No) If noise exists, what is this attributed to?		

Spontaneous Potential (SP) Log		
Make	Model	Serial No.
Modification (Yes/No)?	(Describe fully on separate sheet and attach.)	
Tool schematic and operating manual on file (Yes/No)		Location of schematic
Order in which tool was run.	Run in combination with (other tools)	
Logging Speed (m/min) (ft/min)	Repeat Section Interval Location	
___ Tool logged in fluid-filled hole? (Yes/No) ___ Calibration performed before logging? (Yes/No) ___ Calibration performed after logging? (Yes/No) ___ Calibration data printed and attached to log trace. ___ Sensitivity for conditions appropriate? Line has "character." (Sensitivity sediment and fluid conditions may cause lack of character.) ___ No excessive SP baseline drift. ___ Baseline shifts (if necessary) annotated on log. ___ Resistivity of borehole fluid taken and recorded on log. ___ Resistivity of interstitial water taken and recorded on log.		

Date __________

Logging Subcontractor _______ Geophysical Logging Engineer _______ Well _______ Location _______

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Attachment 3
Geophysical Logging Tool Checklist (Cont.)

Caliper (i.e., 1 arm, 3 arm?) **Log**		
Make	Model	Serial No.
Modification (Yes/No)?	(Describe fully on separate sheet and attach.)	
Tool schematic and operating manual on file (Yes/No)		Location of schematic
Order in which tool was run.	Run in combination with (other tools)	
Logging Speed (m/min) (ft/min)	Repeat Section Interval Location	
___ Calibration check performed ___ Caliper reading checked in casing, if casing is present ___ Repeat section logged or second run performed		

Gamma-Gamma (Density) Log		
Make	Model	Serial No.
Modification (Yes/No)?	(Describe fully on separate sheet and attach.)	
Tool schematic and operating manual on file (Yes/No)		Location of schematic
Order in which tool was run.	Run in combination with (other tools)	
Logging Speed (m/min) (ft/min)	Repeat Section Interval Location	
___ Hole condition good, checked by previous log runs (do not run nuclear tools under questionable hole conditions) ___ Tool logged in fluid-filled or air-filled (circle one), uncased or cased (circle one) hole ___ Radiation survey conducted in immediate vicinity of drill site before unshielding source ___ Radiation survey conducted in immediate vicinity of drill site after last nuclear source is shielded and logging job is finished ___ Calibration performed before logging ___ Calibration performed after logging ___ Calibration data printed and attached to log trace ___ Log checked for anomalous spikes, drift, and cyclic readings ___ Compare density log to caliper log; density should show a variant reading in area of washouts ___ With probe sitting still, statistical variation should be on the order of the square root of the count rate		

Date ________

Logging Subcontractor ______ Geophysical Logging Engineer ______ Well ______ Location ______

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Attachment 3
Geophysical Logging Tool Checklist (Cont.)

Normal Resistivity	Spacing between electrodes (inches)	
Make	Model	Serial No.
Modification (Yes/No)?	(Describe fully on separate sheet and attach.)	
Tool schematic and operating manual on file (Yes/No)		Location of schematic
Order in which tool was run.	Run in combination with (other tools)	
Logging Speed (m/min) (ft/min)	Repeat Section Interval Location	
___ Tool logged in fluid-filled hole, uncased hole ___ Calibration performed before logging ___ Calibration performed after logging ___ Calibration data printed and attached to log trace ___ Curve is stable, with no abnormal looking excursions		

Single Point Resistance		
Make	Model	Serial No.
Modification (Yes/No)?	(Describe fully on separate sheet and attach.)	
Tool schematic and operating manual on file (Yes/No)		Location of schematic
Order in which tool was run.	Run in combination with (other tools)	
Logging Speed (m/min) (ft/min)	Repeat Section Interval Location	
___ Tool logged in fluid-filled, uncased hole ___ Calibration performed before logging ___ Calibration performed after logging ___ Calibration data printed and attached to log trace ___ Resistance greater than cable line resistance ___ Scale reads in ohms ___ Check for sharp deflections of consistent amplitude and frequency caused by mechanical problems ___ Compare to caliper log. Is log greatly affected by change in borehole diameter?		

Date ________

Logging Subcontractor ______ Geophysical Logging Engineer ______ Well ______ Location ______

(Initial to certify this page)

Attachment 3
Geophysical Logging Tool Checklist (Cont.)

Induction	Spacing between electrodes (inches)	
Make	Model	Serial No.
Modification (Yes/No)?	(Describe fully on separate sheet and attach.)	
Tool schematic and operating manual on file (Yes/No)		Location of schematic
Order in which tool was run.	Run in combination with (other tools)	
Logging Speed (m/min) (ft/min)	Repeat Section Interval Location	

___ Tool logged in fluid-filled or air-filled (circle one), uncased hole
___ Calibration performed before logging
___ Calibration performed after logging
___ Calibration data printed and attached to log trace
___ Check for negative resistivity readings for indication of improper calibration
___ Check for similarity to 16" normal resistivity curve, for single curve, shallow investigation induction log
___ Repeat section logged

Natural Gamma (Gamma Ray) Log		
Make	Model	Serial No.
Modification (Yes/No)?	(Describe fully on separate sheet and attach.)	
Tool schematic and operating manual on file (Yes/No)		Location of schematic
Order in which tool was run.	Run in combination with (other tools)	
Logging Speed (m/min) (ft/min)	Repeat Section Interval Location	

___ Tool logged in fluid-filled or air-filled (circle one), uncased or cased (circle one)
___ Radiation survey conducted in immediate vicinity of drill site before unshielding source
___ Radiation survey conducted in immediate vicinity of drill site after last nuclear source is shielded after job is finished
___ Hole condition is shielded after job is finished
___ Hole condition good, checked by previous log runs; do not run nuclear tools under questionable hole conditions
___ Tool run in fluid-filled or air-filled (circle one), uncased or cased (circle one)
___ Calibration performed before logging
___ Calibration performed after logging
___ Calibration data printed and attached to log trace
___ Check for cyclic noise
___ Repeat section logging

Date __________

Logging Subcontractor _______ Geophysical Logging Engineer _______ Well _______ Location _______

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Attachment 3
Geophysical Logging Tool Checklist (Cont.)

Neutron	Spacing between electrodes (inches)	
Make	Model	Serial No.
Modification (Yes/No)?	(Describe fully on separate sheet and attach.)	
Tool schematic and operating manual on file (Yes/No)		Location of schematic
Order in which tool was run.	Run in combination with (other tools)	
Logging Speed (m/min) (ft/min)	Repeat Section Interval Location	

___ Hole condition good, checked by previous log runs (do not run nuclear tools under questionable hole conditions)
___ Tool logged in fluid-filled or air-filled (circle one), uncased or cased (circle one) hole
___ Radiation survey conducted in immediate vicinity of drill site before unshielding source
___ Radiation survey conducted in immediate vicinity of drill site after last nuclear source is shielded after logging job is finished
___ Calibration performed before logging
___ Calibration performed after logging
___ Calibration data printed and attached to log trace
___ Check log for adequate sensitivity
___ Check log for anomalous spikes, drifts, and cyclic readings
___ Repeat section logged

Acoustic Logs		
Make	Model	Serial No.
Modification (Yes/No)?	(Describe fully on separate sheet and attach.)	
Tool schematic and operating manual on file (Yes/No)		Location of schematic
Order in which tool was run.	Run in combination with (other tools)	
Logging Speed (m/min) (ft/min)	Repeat Section Interval Location	

___ Tool logged in fluid-filled, uncased hole (yes/no). If no, explain.
___ Calibration not required; check tool for function by listening for transmitter clicking; may calibrate tool in fluid-filled surface casing if present
___ Tool centralized
___ Log checked for noise spikes, cycle skipping, or other anomalies
___ Repeat section logged

Date ___________

Logging Subcontractor _______ Geophysical Logging Engineer _______ Well _______ Location _______

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Attachment 4
Sample Log Heading

Logging Subcontractor:			Log Technique:		
Address:			Date:		
Logging Operator:					
Drilling Subcontractor:					
Client:					
Well:					
Location:					
State:			Ground Elevation (m) (ft): Log Depth Ref:		
Borehole Data					
Logging Depth:					
Customer Measurement (m) (ft):			Logging Subcontractor Measurement (m) (ft):		
Bit Record			Casing Record		
Size	From	To	Size/Wgt/TLK	From	To

Hole Medium:		Drilling Method:
Borehole Mud:		Circulation Time:
Weight:	Viscosity:	Restrictions: ____ ____ mud formation at Temperature: ____ ____

Date __________

Logging Subcontractor _______ Geophysical Logging Engineer _______ Well _______ Location _______

(Initial to certify this page)

Attachment 4
Sample Log Heading (Cont.)

Logging Data						
Log Function	Run No.	Equipment			Logging	
		Model	Probe No.	Uphole S.N.	Dig Int (m/ft)	Speed (m/min)(ft/min)

Logging Data							
Detect OR	Spacing		Source		Logged Interval		
Type	Tx-Rx (m/ft)	Rx-Rx	Type	Curie Amount	From	To	Int. (m/ft)

Date __________

Logging Subcontractor _______ Geophysical Logging Engineer _______ Well _______ Location _______

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TSOP 3-5

LITHOLOGIC LOGGING

Prepared: Del R. Baird

Technical Review: Sharon Budney

QA Review: James Romig

Approved: Signature/Date

Issued: Signature/Date

1.0 Objective

This standard operating procedure (SOP) governs lithologic logging of core, cuttings, split-spoon samples, and subsurface samples collected during field operations at sites where environmental investigations are performed by CDM Federal Programs Corporation (CDM). The purpose of this SOP is to present a set of descriptive protocols and standardized reporting formats to be used by all investigators in making lithologic observations. It prescribes protocols for recording basic lithologic data including, but not limited to, lithologic names, texture, composition, color, sedimentary structures, bedding, lateral and vertical contacts, and secondary features such as fractures and bioturbation.

The goal of this SOP is to provide a set of instructions to produce uniform lithologic descriptions and to present a list of references to help in this task.

2.0 Background

2.1 Definitions

The following list of definitions corresponds to the description sequences outlined in Section 5.2.1. They are provided to aid the lithologic logger in what to look for when following the sequences. An example lithologic log is given in Attachment A.

Name of Sediment or Rock - In naming unconsolidated sediments, the logger should use field equipment and reference charts to help identify the grain-size distribution and should name the material according to the procedure in Section 5.2.1. In naming sedimentary, igneous, and metamorphic rocks, the logger should examine the specimen for mineralogy and use the appropriate classification chart in the attachments.

Texture - In examining unconsolidated sediments, the texture shall refer to the grain-size distribution, particle angularity, sorting, and packing. The logger should provide estimates of the grain sizes present using Attachment B and C. When larger particles such as cobbles are present, determine the size of the particles and give a percentage estimate. The sediment particles should be examined for angularity by comparing with Attachment B and the sorting should be determined by percentage estimation. The logger should note that the Unified Soil Classification System (USCS) uses the term grading to describe how the materials are sorted. (A poorly sorted unconsolidated material is well graded.) In examining igneous rocks, texture refers to whether the specimen is aphanitic, phaneritic, glassy, fragmental, porphyritic, or pegmatitic. Attachment D has more specific definitions of these terms. For metamorphic rocks, texture refers to whether the specimen has a foliate structure (slaty, phyllitic, schistose, or gneissic) or nonfoliate structure (granular).

Color - Color may be determined using the appropriate Munsell color chart (soil or rock) and listing the Munsell number that corresponds to the color. If an unconsolidated material is mottled in color, the ranges in color should be described. When describing core samples with several individual colors such as in phaneritic textures, individual color names should be listed, and an overall best color name should be given.

Sedimentary Structures - This term refers primarily to unconsolidated sediments and sedimentary rocks. There are several different sedimentary structures, and the logger is referred to Compton's *Manual of Field Geology* (1962) book for more details. Among the more common structures are bedding, cross-bedding, laminations, and burrows. These structures should only be included in the description if found in the samples.

Degree of Consolidation - The degree of consolidation is applicable to sedimentary rocks and unconsolidated sediments and refers to how well the material has been indurated. Unconsolidated sediments may be compacted somewhat and should be described as loose, moderately compacted, or strongly compacted. In some cases they may be slightly cemented by caliche and should be described as slightly cemented, moderately cemented, or strongly cemented. Sedimentary rocks are typically indurated but may vary in the degree of cementation. These materials should be described as friable, moderately friable, or well indurated. When describing the cementing material, a test for reaction to hydrochloric acid (HCl) should be done and results recorded under the description. If the logger believes he/she can identify the cementing material, then it should be included in the description.

Moisture Content - Moisture content refers to the amount of water within the sediment or the matrix. Typically sedimentary rocks and unconsolidated sediments may have water within and should be described as dry, moist, or wet. Igneous and metamorphic rocks may have water within fractures and cavities. The presence of water and pertinent observations that may help in site evaluation in these rocks should be noted.

Presence of Fractures, Cavities, and Secondary Mineralization - The rock types that may be encountered during drilling may have fractures or joints present within them. Should fractures be observed, they should be noted and a description as to the density of fractures should be given. Cavities or vugs may be present, and the density of voids as well as a size estimation should be given. If fractures or cavities contain evidence of secondary minerals such as zeolites, clays, or iron oxides, then a description of the mineral fill should be added.

Evidence of Contamination - The logger should examine the core and note any obvious signs of contamination such as streaking, free product, odor, or discoloration. These observations should be noted in the field book as should any readings from the photoionization or flame ionization detector (PID/FID). PID/FID hits should be recorded on the Lithologic Log Form also.

Description of Contacts - The logger should note any significant change in lithology. These changes may be gradational contacts within sediments or may be sharp contacts such as sediments over rocks. The contacts should be noted as to whether they are erosional, gradational, or sharp, and the depth below the surface should be noted.

Composition - The composition of the rock refers to the mineralogy of the material encountered. For sedimentary rocks, it is important to note the matrix composition and use Attachment E in naming. In igneous and metamorphic rocks, the minerals that make up the rock should be stated and an estimation of their percentage should be noted. The classification charts listed in Attachments D and F provide a description of common compositions.

Degree of Vitrification - This term is applicable to volcanic rocks and refers to the degree of welding in pyroclastic materials. Describe these rocks as poorly welded, moderately welded, or strongly welded.

2.2 Discussion

The installation of monitoring wells, piezometers, and boreholes is a standard practice at many sites requiring environmental investigations. The installation of these devices requires that a trained geologist, or other earth scientist, provide lithologic descriptions as they encounter subsurface material during auguring or drilling. In evaluating these lithologic descriptions from different boreholes, monitoring wells, or piezometers, it is sometimes possible to correlate similar units. To help in this task, it is important to provide uniform and consistent descriptions.

In describing lithologies, it is helpful to have a set of references covering items such as the classification of igneous, metamorphic, and sedimentary rocks; grain-size percentage estimation; particle shape; grain-size charts; and lithologic symbols. In order to make lithologic descriptions produced by CDM staff as uniform and consistent as possible, this SOP provides a list of references to be used in the field. This SOP also provides a sequence for recording information on a standardized log form to make descriptions as uniform and consistent as possible.

2.3 Associated Procedures

- CDM Federal SOP 4-1, Field Logbook Content and Control

3.0 Responsibilities

Geologist - The field person performing lithologic logging is responsible for making a consistent and uniform log and for turning in field forms and logbooks to the field team leader (FTL).

Field Team Leader - The FTL is responsible for maintaining logbooks and forms and for approving techniques of lithologic logging not specifically described in this SOP.

4.0 Required Equipment

The description of subsurface lithologies requires a minor amount of field equipment for the geologist. This section provides a list of equipment to be used by the lithologic logger but does not include equipment such as drill rigs, PID/FID, sampling equipment, and personal protection equipment. The following is a general list of equipment that may be used:

- Field logbook and Lithologic Log Form
- Clipboard
- Dilute (10 percent) HCl
- Plastic sheeting

- PVC sampling trays
- Waterproof pens
- No. 2 sieve
- 10x magnifying hand lens
- Reference field charts

5.0 Procedures

5.1 Office

- Obtain field logbook and Lithologic Log Forms
- Coordinate schedules/actions with FTL
- Obtain necessary field equipment (i.e., hand lens, 10 percent HCl)
- Obtain CDM reference field charts
- Review field support documents (i.e., sampling plan, health and safety plan)
- Review applicable geologic references such as U.S. Department of Agriculture (USDA) Soil Conservation Survey Soil Surveys and/or geologic maps

5.1.1 Documentation

Individuals performing lithologic logging will record their observations in a commercially available, bound field logbook (e.g., Lietz books) and/or on individual Lithologic Log Forms. Lithologic loggers will follow the general procedures for keeping a field logbook (SOP 4-1). When using a bound field logbook, record the same data required on the Lithologic Log Form. Data from the field logbook must be transcribed to the Lithologic Log Form if filling in the form in the field is not feasible. However, the data must be the same as that recorded in the field logbook. Editing of field logbook data is not allowed. In addition, if data are transcribed to the Lithologic Log Form, it should be done within 1 day of the original data recording. All blanks in the Lithologic Log Form must be filled out. If an item is not applicable, an "NA" should be entered.

The Lithologic Log Form should be filled out according to the following instructions:

The top part of the form contains general information. The project name and number must be filled in to identify the site. The date that drilling was started and completed, and the well number within the site should be stated. The name of the person logging the well is recorded as is the total depth drilled. Weather condition descriptions should correlate with what is written in the logbook. The last item to be completed is the name and company of the driller and the type of drill rig and bits used.

The bottom part of the form shall be completed according to the instructions provided within this section and according to the sequence provided in Section 5.2.1. The depth column refers to the depth below ground surface and should be provided in feet. The tick marks can be arbitrarily set to any depth interval depending on the scale needed except where client requirements dictate the spacing. The lithology column should contain a schematic representation of the subsurface according to the symbols found in Attachment G. Use a single X to mark the area where no core was recovered, and notes should be recorded as to why the section was not recovered. The X should be marked from the top to the bottom of the section so that the entire interval is marked. If the geologist can interpret the probable lithology of the missing section with reasonable confidence, they may fill in the symbols behind the X. Sharp or abrupt contacts between lithologies will be indicated by a solid horizontal line.

Gradational changes in lithologic composition will be shown by a gradual change of lithologic symbol in the appropriate zone. PID/FID hits should be recorded within the PID/FID column at the appropriate depth, if applicable. Blow counts specifically refer to the number of hammer blows it takes to drive a split-spoon into the ground. Usually this is recorded as the number of blows per 6 inches but may vary. The recording of blow counts provides a relative feel for the cohesiveness of the formation. The individual recording lithologic logs should ask the FTL whether it is required information. The description column is the most important part of the Lithologic Log Form and is where the lithology is described. In completing this section, use the applicable reference charts and complete according to the sequence in Section 5.2.1. The sample interval column is reserved for noting any samples taken and processed for the laboratory. The sample number shall be filled in at the appropriate depth. The last column refers to the percent core recovery. The individual performing lithologic logging should determine the amount recovered and write the percentage at the appropriate depth.

In addition to the information on the lithologic form, the logger should fill in appropriate information into the logbook when there is a rig shutdown, rig problems, failures to recover cores, or other issues.

5.2 General Guidelines for Using and Supplementing Lithologic Descriptive Protocols

This SOP is intended to serve as a guide for recording basic lithologic information with emphasis on those sediment or rock properties that affect groundwater flow and contaminant transport. The fields of specialization of geologists using this SOP will vary. If the user has expertise in a particular field of petrology or soil science that allows for descriptions of certain geologic sections beyond the basic level required by this SOP, they may expand their descriptions. This should be done only with approval of the FTL. The descriptive protocol presented here must be followed in making basic observations. Any further descriptions must follow a protocol that is published and generally recognized by the geologic community as a standard reference. General lithologic description will not include collecting detailed information such as can be obtained from sieve analysis or petrographic analysis. This SOP is a guide for recording visual observations of samples in the field aided by a 10x hand lens and the other simple tools. Field descriptions should be supplemented by petrographic analysis and sieve analysis when the FTL needs data on numerical grain-size distributions, secondary porosity development, or other data that can be collected by these methods.

This SOP includes protocols for describing igneous, metamorphic, sedimentary rocks, and unconsolidated materials. Common abbreviations are given in Attachment H. This SOP includes charts to be used for classification and naming of rocks, sediments, and soils and descriptions of texture, sedimentary structures, and percentage composition of grains. There is also a chart of lithologic symbols to be used and a list of abbreviations. For charts covering other observations or field procedures not specified by this SOP, the user is referred to the following for more information:

- *Compton's Manual of Field Geology* and *American Geological Society (AGI) Data Sheets for Geology in the Field, Laboratory, and Office* contain other reference charts applicable to descriptions. The source of the chart used must be recorded on the Lithologic Log Form or in the field logbook.
- The Munsell soil color chart may be used for descriptions of color.
- The *Dictionary of Geological Terms* (AGI) is to be used for definitions of geological terms.

Some observations will be common to all rock and soil descriptions. All descriptions should include as appropriate: name of sediment or rock, color, sedimentary structures, texture, moisture content, composition, fabric, significant inclusions, and degree of consolidation or induration. The description of each category should be separated by a semicolon. Each section that discusses descriptions of a particular lithology provides a sequence for recording observations. Follow these sequences for all descriptions. All lithologic descriptions shall be segregated from interpretive comments by recording them in the field book.

Secondary features affecting porosity and permeability such as fractures (joints or faults), cavities, and/or bioturbation should be described if observed. Exact measurement of apparent bed thicknesses should be made when logging core and should supplement terminology such as "thin" or "thick." Particular attention is to be given to recording exact locations of water tables, perched saturated zones, and description of contaminants that may be visible.

In some cases individuals logging may wish to describe materials such as unconsolidated sediments and soils according to different systems such as the USCS or USDA Soil Taxonomy System. These descriptions can provide additional information from what is required by this SOP. If an individual is competent in using other description methods, then they should do so with permission from the FTL.

It is often more practical to use abbreviations for often repeated terminology when recording lithologic descriptions. For the terms given in this SOP, its attachments, or the associated charts to be used for description in the field, use only the designated abbreviations. Other abbreviations are allowed; however, the abbreviation and its meaning should be recorded on the lithologic log the first time it is used and should be recorded at least once for every well or boring log. Loggers are cautioned to limit the use of abbreviations to avoid producing a lithologic log that is excessively cryptic.

5.2.1 Protocols for Lithologic Description

This section describes the protocols for completing a lithologic description. The logger should use the appropriate portion of this section when describing cores. In recording descriptions of sedimentary sections from a whole core, it is possible to reduce the amount of description being written by at least two strategies. One is to look at as long of a section of core as possible, looking for the "big" picture. For instance, in a 20-foot-thick zone, the dominant lithology may be siltstone that is interrupted by several thin beds of another lithology such as gravel. This section description can be simplified by writing: 35-55 below ground surface (bgs) = siltstone (with other descriptors) except as noted; 37.5-38.5 gravel zone (with descriptors); 40-42 pebble zone (with descriptors); etc. This also aids in "seeing" the thickest unit designations possible for use in modeling. Another acceptable way to describe the same interval would be: 35-37.5 siltstone; 37.5-38.5 gravel zone (with descriptors); 38-40 same as 35-37.5; 40-42 pebble zone (with descriptors); etc.

Description of Unconsolidated Material

Unconsolidated material comprises a significant portion of the sections of interest at CDM sites. The shallow subsurface is very important to the hydrologic investigation, as this is the portion of the geologic section where infiltration first occurs. Much of the contamination at sites being investigated is surface contamination and therefore lies on, or within, the upper portion of the surficial material.

For the purpose of this SOP, soil refers to the upper biochemically weathered portion of the regolith and not the entire regolith itself. Soils are to be described as unconsolidated material and should use the same description format. The scientist may use the USCS classification if consistent with project objectives (Attachment K). More detailed soil descriptions should only be made in addition to descriptions outlined below.

Descriptions of unconsolidated sediments should follow the following sequence:

- Name of sediment (sand, silt, clay, etc.)
- Texture
- Composition of larger-grained sediments
- Color
- Structure
- Degree of consolidation and cementation
- Moisture content
- Evidence of bioturbation
- Description of contacts

In naming unconsolidated material (refer to Attachment I - Naming of Unconsolidated Materials), the particle size with the highest percentage is the root name. When additional grains are present in excess of 15 percent, the root name is modified by adding a term in front of the root name. For instance, if a material is 80 percent sand and 20 percent gravel, then it is gravelly sand. If the subordinate grains comprise less than 15 percent but greater than 5 percent, the name is written: ____________________(dominant grain) with ________________(subordinate grain). For example, a sediment with 90 percent sand and 10 percent silt would be named a sand with silt. If a sediment contains greater than 15 percent of four particle sizes, then the name is comprised of the dominant grain size as the root name and modifiers as added before. For example, if a material is 60 percent sand, 20 percent silt and 20 percent clay the name would be a silty clayey sand. If a material is 70 percent sand, 20 percent silt and 10 percent clay, it would be a silty sand with clay. When large cobbles or boulders are present, their percentage should be estimated and their mineralogy recorded. Use AGI Data Sheet 29.1 (Attachment B) for grain terms. Refer to Attachment J for an example sorting chart.

Description of Sedimentary Rocks

Sedimentary rocks consist of lithified detrital sediments such as sand and clay, chemically precipitated sediments such as limestone and gypsum, and biogenic material such as coal and coquina. The classification scheme for naming these rocks is found in Attachment E - Classification of Sedimentary Rocks.

Descriptions for sedimentary rocks should be given in the lithologic log in the following sequence:

- Name of rock
- Texture
- Color
- Sedimentary structures
- Degree of composition
- Presence of fractures or vugs
- Moisture content
- Bioturbation
- Description of contacts

Description of Igneous and Metamorphic Rocks
Igneous rocks, volcanic and plutonic, and metamorphic rocks are not as commonly observed at work sites, but they may be found interspersed in the sedimentary section as ash layers and as bedrock. Where they form bedrock, the development of fractures and vugs is important to their hydrologic properties. If the logger is unsure of the name of the rock because of difficulty in determining mineralogy, the name shall be accompanied by a question mark. Attachments D and F provide a classification system for these materials.

Igneous and metamorphic rock descriptions should follow the general format:

- Name of rock
- Texture
- Color
- Degree of induration for volcaniclastics
- Composition
- Presence of fractures or vugs
- Presence of secondary mineralization
- Moisture content
- Weathering

6.0 Restrictions/Limitations

Only geologists, or similarly qualified persons trained in lithologic description, are qualified to perform the duties described in this SOP. The FTL for a project will have the authority to decide whether or not an individual is qualified.

7.0 References

American Geological Society, *American Geological Society Data Sheets for Geology in the Field*, Laboratory, and Office, 3rd Ed, 1989.

American Geological Society, *Dictionary of Geologic Terms*, Anchor Press, Garden City, New York, 1960.

Compton, R.R., *Manual of Field Geology*, John Wiley & Sons Inc., New York, New York, 1962.

Munsell Color Chart, Soil Test Inc., Evanston, Illinois, 1975.

U.S. Department of Agriculture Soil Conservation Service, *Soil Taxonomy*, U.S. Government Printing Office, Washington, D.C., 1972.

Woodward, L.A., *Laboratory Manual Physical Geology*, University of New Mexico Printing, Albuquerque, New Mexico, 1988.

8.0 Attachments

Note: These Attachments are for informational purposes. Other equivalent charts such as USCS or logs may be used.

Attachment A - CDM Federal Programs Corporation Lithologic Log

Attachment B - Grain-Size Scale; Graph determining size of sedimentary particles, particle degree of roundness charts

Attachment C - Comparison Chart for Estimating Percentage Composition

Attachment D - Classification of Igneous Rocks

Attachment E - Classification of Sedimentary Rocks

Attachment F - Classification of Metamorphic Rocks

Attachment G - Lithologic Symbol Chart

Attachment H - Common Abbreviations

Attachment I - Naming of Unconsolidated Materials

Attachment J - Sorting Chart

Attachment K - Example of Unified Soil Classification System (USCS)

Attachment A

CDM Federal Programs Corporation
Lithologic Log

Boring No. ____________		Sheet ____ of ____
Project:	Project No.:	Date Started:
Well No.:	Rig:	Date Ended:
Logged By:	Total Depth:	Driller:
Weather:		Bits:

Depth	Lithology	Sample Interval	% Recovery	PID/ FID	Blow Counts	Description

Proportions		Cohesionless		Cohesive Consistency	
		Blows		Blows	
trace	0 to 10%	loose	0 to 10	0-4	soft
little	10 to 20%	med dens	10 to 30	4-8	med stiff
some	20 to 35%	dense	30 to 50	8-15	stiff
and	35 to 50%	very dense	50+	15-30	very stiff
				30+	hard

Attachment B

AGI DATA SHEET 29.1

Grain-size Scales

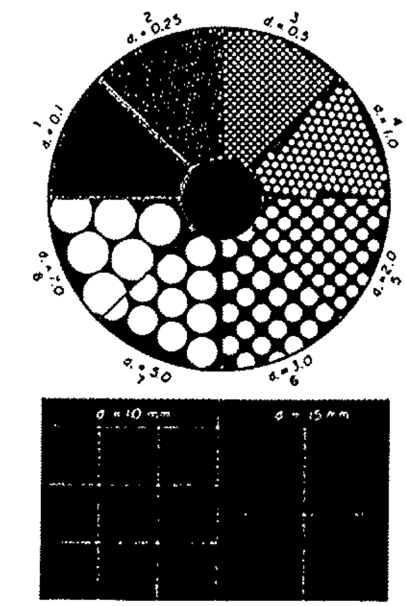
By Roy L. Ingram, University of North Carolina

GRAIN-SIZE SCALE USED BY AMERICAN GEOLOGISTS
Modified Wentworth Scale — after Lane, et al., 1947, Trans. American Geophysical Union, v. 28, p. 936-938

phi	mm	mm	inches	U.S. Standard Sieve Series	GRADE NAME		
−12	4096		161.3				
					very large		
−11	2048		80.6				
					large		
−10	1024		40.3			Boulders	
					medium		
−9	512		20.2				
					small		
−8	256		10.1				
					large		
−7	128		5.0			Cobbles	
					small		GRAVEL
−6	64		2.52	63 mm			
					very coarse		
−5	32		1.26	31.5 mm			
					coarse		
−4	16		0.63	16 mm			
					medium	Pebbles	
−3	8		0.32	8 mm			
					fine		
−2	4		0.16	No. 5			
					very fine		
−1	2		0.08	No. 10			
					very coarse		
0	1		0.04	No. 18			
					coarse		
+1	1/2	0.500		No. 35			
					medium	Sand	SAND
+2	1/4	0.250		No. 60			
					fine		
+3	1/8	0.125		No. 120			
					very fine		
+4	1/16	0.062		No. 230			
					coarse		
+5	1/32	0.031					
					medium		
+6	1/64	0.016				Silt	
					fine		
+7	1/128	0.008					
					very fine		
+8	1/256	0.004					MUD
					coarse		
+9	1/512	0.002					
					medium		
+10	1/1024	0.001				Clay size	
					fine		
+11	1/2048	0.0005					
					very fine		
+12	1/4096	0.00024					

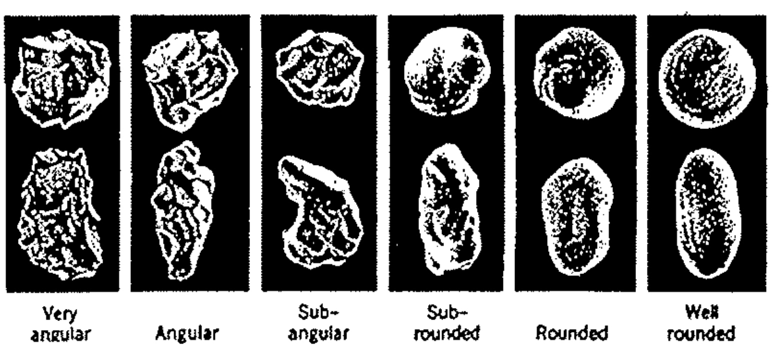
AGI DATA SHEET 28.2

LIGHT PARTICLES



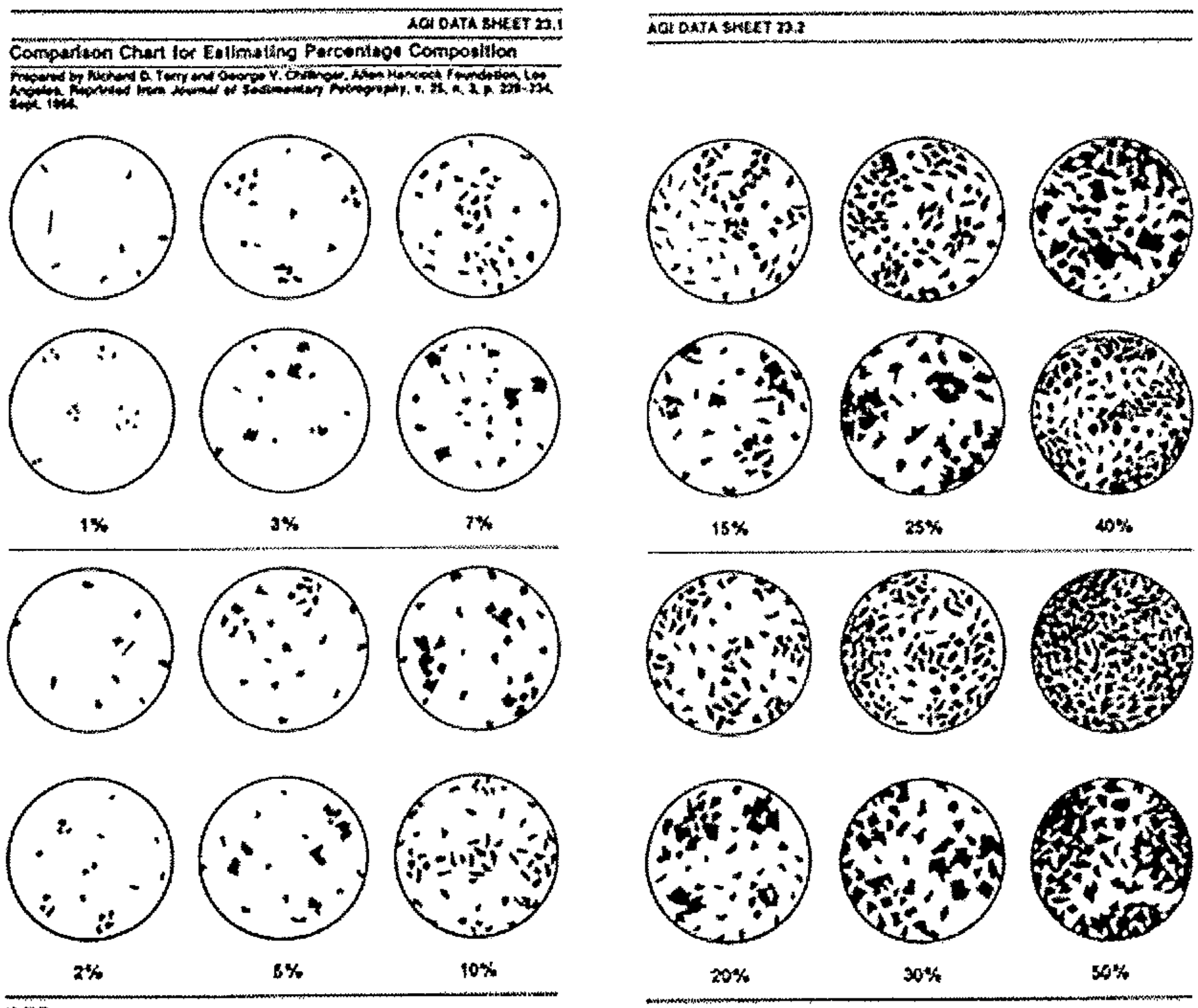
References. (1) George V. Chilingar, 1956, Soviet classification of sedimentary particles and Vasil'evskiy graph: AAPG Bull., v. 40, no. 7, p. 1714. (2) M.S. Shvetsov, 1948, Petrography of sedimentary rocks, 2nd ed., 387 p. Gosgeolizdat, Moscow-Leningrad.

American Geological Institute, Data Sheets, Third Edition, 1989.



Compton, R.R., Manual of Field Geology, 1962.

Attachment C



American Geological Institute, Data Sheets, Third Edition, 1989.

Attachment D

<table>
<tr><th colspan="6">Classification of Igneous Rocks</th></tr>
<tr><th colspan="6">Mineral Composition</th></tr>
<tr><td colspan="2"></td><td>Quartz >10%
Abundant feldspar
Mafic minerals minor</td><td>Quartz <10%
Abundant feldspar
Mafic minerals moderate</td><td>Feldspar abundant
Mafic Minerals 40-70%;
Quartz minor or absent</td><td>Mafic minerals >70%</td></tr>
<tr><td colspan="2">Color Index</td><td>Light Color</td><td>Intermediate color</td><td>Dark</td><td>Dark</td></tr>
<tr><td colspan="2">Chemistry</td><td>SiO_2 70%</td><td>SiO_2 60%</td><td>SiO_2 50%</td><td>SiO_2 40%</td></tr>
<tr><td></td><td>Phaneritic (visible with naked eye)</td><td>Granite (Gr)</td><td>Diorite (Dr)</td><td>Gabbro (Gb)</td><td>Peridotite (Pr)
(mostly olivine)</td></tr>
<tr><td rowspan="4">TEXTURE</td><td rowspan="2">Aphanitic (microscopic)</td><td>Rhyolite (Ry)
(quartz phenocrysts)</td><td>Andesite (An)
(feldspar or mafic phenocrysts; no quartz)</td><td rowspan="2">Basalt (Ba)</td><td rowspan="4">Komatiite (Km)
(very rare)</td></tr>
<tr><td colspan="2">Felsite (Fl)
(no phenocrysts)</td></tr>
<tr><td>Glassy</td><td colspan="2">Obsidian (ob) Pumice (Pu)</td><td>Rare</td></tr>
<tr><td>Glassy-Fragmental (Pyroclastic)</td><td colspan="2">Tuff <4mm (Tf)
Breccia >4mm (Br)</td><td>Rare</td></tr>
</table>

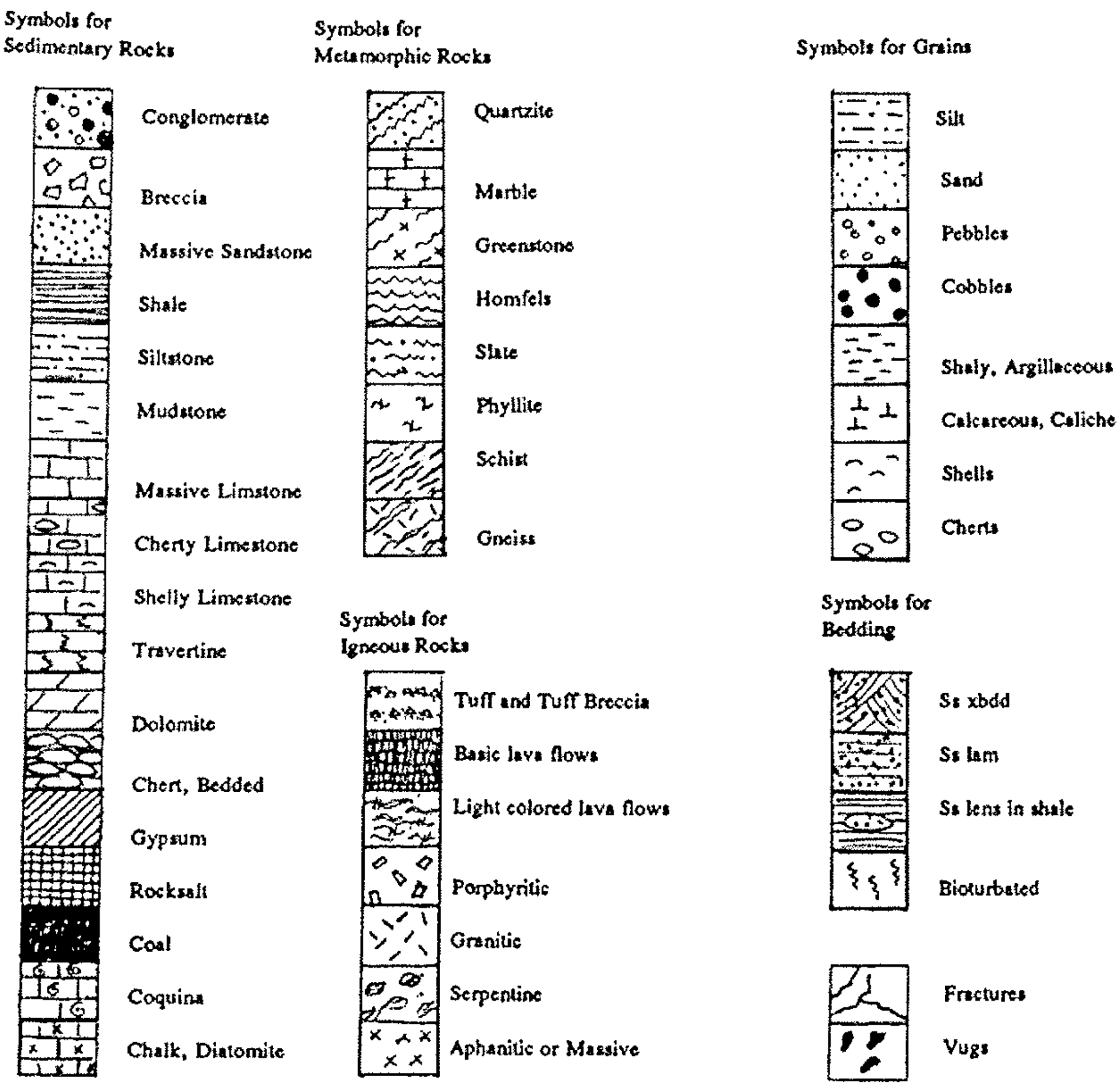
Attachment E

Classification of Sedimentary Rocks				
Detrital	***Detrital Classification***	***Principal Composition***	***Additional Identifying Characteristics***	***Name of Rock***
	Rudaceous (clast diameter > 2 mm)	Gravel	Rounded Clasts	Conglomerate (Cg)
			Angular Clasts	Breccia (Br)
	Arenaceous (clast diameter between 0.0625 mm [1/16 mm] and 2 mm)	Sand	Mineral composition and detrital matrix content varies. Additional detrital matrix qualifiers (arenite or wacke) and mineral composition qualifiers (quartz, arkose, feldspathic, etc.) may be necessary.	Sandstone (Sa)
	Argillaceous (clast diameter <0.0625 mm)	Mud	Non-fissile along bedding planes, silt predominant over clay	Siltstone (Sls)
			Non-fissile along bedding planes, clay predominant over silt	Claystone
			Non-fissile along bedding planes, silt and clay fraction approximately equal or unknown	Mudstone (Ms)
			Fissile along bedding planes	Shale (Shl)
Chemical	***Chemical Classification***	***Principal Composition***	***Additional Identifying Characteristics***	***Name of Rock***
	Calcareous	Calcite (Calcium Carbonate)	Effervesces on contact with dilute HCl	Limestone (La)
		Dolomite (Calcium Magnesium Carbonate)	Pulverized sample effervesces on contact with dilute HCL	Dolomite (Dl), Dolostone
	Siliceous	Quartz (Silicon Dioxide)	Hard, dense, fractures conchoidally	Chert (Ch)
	Evaporites	Hydrated Calcium Sulfate	Earthy and crumbly	Gypsum (Gy)
		Calcium Sulfate	Usually exhibits indistinct stratification	Anhydrite
		Halite (Sodium Chloride)	Cubic cleavage	Rock Salt (Na)
Organic (Organogenetic or Biochemical)	***Chemical Classification***	***Principal Composition***	***Additional Identifying Characteristics***	***Name of Rock***
	Calcareous	Fossil shells and fragments	Loosely cemented fragmental limestone	Coquina (Cq)
		Foraminiferal shells	Soft, micritic limestone	Chalk (Chk)
		Calcite or aragonite	Derived from evaporation of spring water	Travertine (Tvr)
	Siliceous	Diatom shells (saltwater or freshwater organisms)	Light-colored, soft, friable, and porous siliceous deposit	Diatomite (Dm)
	Carbonaceous	Plant Remains	Degree of lithification varies-additional qualifiers such as peat, lignite, bituminous and anthracite may be necessary.	Coal (Cl)

Attachment F

Classification of Metamorphic Rocks			
Structure	**Texture**	**Chief Minerals**	**Name**
Non foliate	granular; breaks across grains	quartz	Quartzite (Qzt)
	granular; grains clearly visible	calcite	Marble (Mbl)
	granular; grains altered and indistinct	plagioclase, chlorite, epidote hornblende	Greenstone (Grs)
	very fine-grained	indistinguishable; mostly submicroscopic micas and clays	Hornfels (Hnf)
Foliate	slaty	submicroscopic mica, quartz	Slate (Slt)
	phyllitic	microscopic mica, quartz	Phyllite (Pyl)
	schistose	microscopic mica, quartz, amphibole	Blueschist
		chlorite, mica plagioclase	chlorite schist (CL-Sch)
		muscovite, quartz	Muscovite (Ms) Schist (Sch)
		garnet, muscovite	Garnet (G) Muscovite (Ms) Schist (Sch)
		hornblende, plagioclase	Amphibolite (Amp)
		staurolite, garnet, muscovite	Garnet (G) Staurolite (S) Muscovite (Ms) Schist (Sch)
	gneissose	plagioclase, hornblende	Amphibolite (Amp) Gneiss (Gns)
		feldspar, quartz	Granitie (Gr) Gneiss (Gns)
		eye-shaped feldspar, mica	Augen (Au) Gneiss (Gns)

Attachment G



Compton, R.R., Manual of Field Geology, 1962.

Attachment H

Common Abbreviations		
Abundant - abnt	Diameter – dia	Laminated – lam
Amount – amt	Different – diff	Maximum – max
Approximate – approx	Disseminated – dissem	Pebble – pbl
Arenaceous – aren	Elevation – elev	Phenocryst – phen
Argillaceous – arg	Equivalent – equiv	Porphyritic – proph
Average – ave	foliated – fol	Probable – prob
Bedded – bdd	Formation frm	Quartz – qrz
Bedding – bdg	Fracture – frac	Regular – reg
Calcareous – calc	Fragmental – frag	Rocks – rx
Cemented – cmt	Granular – Gran	Rounded – rnd
Cobble – cbl	Gypsiferous – Gyp	Saturated – sat
Contact – ctc	Horizontal – hriz	Secondary – sec
Cross-bedded - xbdd	Igneous – ign	Siliceous – sil
Cross-bedding – xbdg	Inclusion – incl	Structure – struc
Cross-laminated – xlam	Interbedded – intbdd	Unconformity – uncnf
Crystal – xl	Irregular – ireg	Variegated – vrgt
Crystalline – xln	Joint – jnt	Vein – vn
Grain Size	**Contacts**	**Sorting**
grain – gn	gradational – grad	poor – pr
fine – f	erosional – er	moderate – mod
very fine – vf	abrupt – ab	well – well
medium – med		
coarse – crs	**Fabric**	
large – lg	grain supported – gs	
very large – vlg	matrix supported – ms	
small – sm	imbricate – im	

Adapted from, Compton, R.R., *Manual of Field Geology*, 1962.

Attachment I

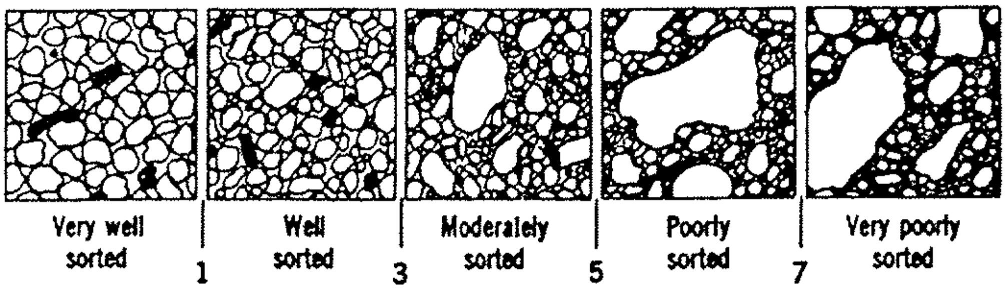
Naming of Unconsolidated Materials

Main Particle	Gravel	Sand	Silt	Clay
> 15 % gravel	Gravel	Gravelly Sand	Gravelly Silt	Gravelly Clay
> 15 % sand	Sandy Gravel	Sand	Sandy Silt	Sandy clay
> 15 % silt	Silty Gravel	Silty Sand	Silt	Silty Clay
> 15 % clay	Clayey Gravel	Clayey Sand	Clayey Silt	Clay
5-15 % gravel	Not Applicable	Sand with Gravel	Silt with Gravel	Clay with Gravel
5-15 % sand	Gravel with sand	Not applicable	Silt with Sand	Clay with sand
5-15 % silt	Gravel with silt	Sand with silt	Not applicable	Clay with silt
5-15 % clay	Gravel with clay	Sand with clay	Silt with clay	Not applicable
> 15% gravel plus 15% sand	Sandy Gravel	Gravelly Sand	Gravelly Sandy Silt	Gravelly Sandy Clay
> 15% gravel plus 15% silt	Silty Gravel	Gravelly Silty Sand	Gravelly Silt	Gravelly Silty Clay
> 15% gravel plus 15% clay	Clayey Gravel	Gravelly Clayey Sand	Gravelly Sandy Silt	Gravelly Clay
> 15% sand plus 15% silt	Silty Sand Gravel	Silty Sand	Sandy Silt	Sandy Silty Clay
> 15% sand plus 15% clay	Sandy Clayey Gravel	Clayey Sand	Sandy Clayey Silt	Sandy Clay
> 15% silt plus 15% clay	Silty Clayey Gravel	Silty Clayey Sand	Clayey Silt	Silty Clay
Note: Other combinations are possible when all particle sizes are present in greater than 15%. For example, a Silty Clayey Gravelly Sand. Other possible combinations exist such as a Gravelly Sand with silt.				

Compton, R.R., *Manual of Field Geology*, 1962.

Attachment J

Sorting Chart



Compton, R.R., Manual of Field Geology, 1962.

Attachment K

Example of Unified Soil Classification System (USCS)

Unified Soil Classification System (USCS)

	MILLIMETERS	INCHES	SIEVE SIZES
BOULDERS	> 300	> 11.8	-
COBBLES	75 - 300	2.9 - 11.8	-
GRAVEL: COARSE	75 - 19	2.9 - .75	-
FINE	19 - 4.8	.75 - .19	3/4" - No. 4
SAND: COARSE	4.8 - 2.0	.19 - .08	No. 4 - No. 10 
MEDIUM	2.0 - .43	.08 - .02	No. 10 - No. 40 
FINE	.43 - .08	.02 - .003	No. 40 - No. 200 
FINES: SILTS	< .08	< .003	< No. 200 
CLAYS	< .08	< .003	< No. 200

Attachment K

Example of Unified Soil Classification System (USCS) (Continued)

CLAY

CLAY CONSISTENCY	THUMB PENETRATION	SPT, N BLOWS/ FT.	Undrained Shear Strength c (PSF) TORVANE	Unconfined Compressive Strength q_u Pocket Penetrometer
VERY SOFT	Easily penetrated several inches by thumb. Exudes between thumb and finger's when squeezed in hand.	< 2	250	500
SOFT	Easily penetrated one inch by thumb. Molded by light finger pressure.	2 - 4	250 - 500	500 - 1000
MEDIUM STIFF	Can be penetrated over 1/4" by thumb with moderate effort. Molded by strong finger pressure.	4 - 8	500 - 1000	1000 - 2000
STIFF	Indented about 1/4" by thumb but penetrated only with great effort.	8 - 15	1000 - 2000	2000 - 4000
VERY STIFF	Readily indented by thumbnail.	15 - 30	2000 - 4000	4000 - 8000
HARD	Indented with difficulty by thumbnail.	> 30	> 4000	> 8000

SAND

SOILTYPE	SPT, N Blows/ft.	Relative Density,%	FIELD TEST
VERY LOOSE SAND	4	0 - 15	Easily penetrated with 1/2" reinforcing rod pushed by hand.
LOOSE SAND	4 - 10	15 - 35	Easily penetrated with 1/2" reinforcing rod pushed by hand.
MEDIUM DENSE SAND	10 - 30	35 - 65	Penetrated a foot with 1/2" reinforcing rod driven with 5-lb hammer.
DENSE SAND	30 - 50	65 - 85	Penetrated a foot with 1/2" reinforcing rod driven with 5-lb hammer.
VERY DENSE SAND	50	85 - 100	Penetrated only a few inches with 1/2" reinforcing rod driven with 5-lb hammer.

Summary of USCS Field Identification Tests

Coarse-Grained Soils **More than half the material (by weight) is individual grains visible to the naked eye**	**Gravelly Soils** More than half of coarse fraction is larger than 4.75 mm	**Clean Gravels** Will not leave a stain on a wet palm	Substantial amounts of all grain particle sizes	GW
			Predominantly one size or range of sizes with some intermediate sizes missing	GP
		Dirty Gravels Will leave a stain on a wet palm	Non-plastic fines (to identify, see ML below)	GM
			Plastic fines (to identify, see CL below)	GC
	Sandy Soils More than half of coarse fraction is smaller than 4.75 mm	**Clean Sands** Will not leave a stain on a wet palm	Wide range in grain size and substantial amounts of all grain particle sizes.	SW
			Predominantly one size or a range of sizes with some intermediate sizes missing	SP
		Dirty Sands Will leave a stain on a wet palm	Non-plastic fines (to identify, see ML below)	SM
			Plastic fines (to identify, see CL below)	SC

Fine-Grained Soils	**Ribbon**	**Liquid Limit**	**Dry Crushing Strength**	**Dilatancy Reaction**	**Toughness**	**Stickiness**	
More than half the material (by weight) is individual grains not visible to the naked eye (<0.074 mm)	None	<50	None to Slight	Rapid	Low	None	ML
	Weak	<50	Medium to High	None to Very Slow	Medium to High	Medium	CL
	Strong	>50	Slight to Medium	Slow to None	Medium	Low	MH
	Very Strong	>50	High to Very High	None	High	Very High	CH

Highly Organic Soils	Readily identified by color, odor, spongy feel, and frequently by fibrous texture	OL OH Pt

TSOP 4-4

DESIGN AND INSTALLATION OF MONITORING WELLS IN AQUIFERS

CONTRACT-SPECIFIC CLARIFICATION

SOP Title: **DESIGN & INSTALLATION OF MONITORING WELLS IN AQUIFERS**

SOP No.: 4-4
Revision: 3
Date: October 14, 2004

QA Review: [signature]

Approved and Issued: [signature] 11/1/04
Program Manager Signature/Date

Contract No.: RAC II Client: EPA Region II

Reason for Clarification: Make SOP EPA Region II - Specific

2.2 Discussion
When constructing wells in New Jersey follow the New Jersey Department of Environmental Protection (NJDEP) guide lines for monitoring well construction.

When designing a monitoring well and planning the drilling program, take into account that cement grout will generate heat while it is setting. Make sure that the casing material used in well construction can withstand the heat and that, if necessary, the grout is installed in lifts to avoid overheating the casing which may cause it to fail.

5.2.5 Installation of the Bentonite Seal
Under this item on page 8 of 10, add:
No. 00 sand (or equivalent) may be used in place of bentonite pellets as an annular seal above the filter pack. Calculate the volume of bentonite or #00 sand required to fill the annular space before beginning installation. This will help you determine if sufficient material has been emplaced. If the amount used is significantly less or more than the amount calculated than consult with the driller to determine the cause of the discrepancy and the best way to address the issue.

4.0 REQUIRED EQUIPMENT AND MATERIALS
4.1 Equipment

- Mud balance (for checking density of grout)

4.2 Required Construction Materials
Under Slot Size (page 3 of 10), add:
If necessary to select a slot size compatible with the formation and sand pack, follow the procedures for screen slot size selection discussed in *Groundwater and Wells* (Driscoll 1986).

Under Grout (page of 3 of 10), add:
When constructing wells in New Jersey follow the NJDEP guide lines for monitoring well construction regarding preparation of grout (NJDEP 2004). If a bentonite slurry is used to grout the annular space, use a product designed to produce a pumpable mixture with the required percent solids.

Under Well Screen (page 2 of 10), add:
Monitoring well screens should be 5 to 10 feet in length to avoid dilution of the contaminated groundwater with water from less contaminated zones in this aquifer. In New Jersey, consult current NJDEP requirements for well construction regarding the maximum screen length allowed.

Under Transition Sand (page 4 of 10) add:
Number 00 sand (or equivalent) may be used in place of a bentonite annular seal above the filter pack.

5.2.4 Installation of the Primary Filter Pack
Under this item on page 8 of 10, add:
Calculate the volume of sand required to fill the annular space before beginning installation. This will help you determine if sufficient sand has been emplaced. If the amount used is significantly less or more than the amount calculated than consult with the driller to determine the cause of the discrepancy and the best way to address the issue.

5.2.5 Installation of the Bentonite Seal
Under this item on page 8 of 10, add:
No. 00 sand (or equivalent) may be used in place of bentonite pellets as an annular seal above the filter pack. Calculate the volume of bentonite of #00 sand required to fill the annular space before beginning installation. This will help you determine if sufficient material has been emplaced. If the amount used is significantly less or more than the amount calculated than consult with the driller to determine the cause of the discrepancy and the best way to address the issue.

5.3 Well Protection
Under this item on page 9 of 10, add:
Whenever possible do not install a flush mounted monitoring well in a parking lot or road. In this situation, the protective casing is very vulnerable to damage and failure thereby creating a potential pathway for surface water runoff to enter the well. Instead, locate the well in a traffic island or off the edge of a parking area.

When installing a stickup protective casing, install filter pack inside the protective casing to within about 6 inches of the top of the well casing to prevent insects from nesting inside the well.

7.0 REFERENCES, add (on page 10 of 10)
NJDEP Monitoring Well Construction Requirements. http://www.state.nj.us/dep/watersupply/well.htm
U.S. Environmental Protection Agency, Monitoring Management Branch of the Environmental Services Division, *Region II CERCLA Quality Assurance Manual*, Final Copy, Revision 1, October 1989.

Prepared: Del R. Baird

Technical Review: Mark Caldwell

QA Review: James Romig

Approved: [signature] 2/24/04
Signature/Date

Issued: [signature] 2/18/04
Signature/Date

1.0 Objective

The purpose of this standard operating procedure (SOP) is to provide guidelines for the installation of groundwater monitoring wells. These guidelines will help to produce consistency of approach in the design and installation of monitoring wells. Individual installations will probably vary in some respects as they may encounter differing hydrogeologic conditions.

2.0 Background

2.1 Definitions

Monitoring Well Installation - The act of installing well casing, screen, filter pack, bentonite seal, grout, and other specified materials in a borehole to construct a complete monitoring well.

2.2 Discussion

This SOP is intended to cover the installation of monitoring wells for use in conducting a variety of environmental investigations. It is intended to be a general guideline listing the types of materials and methods to be considered when a well is installed. Materials are not specified in detail since it is likely there will be wide variability required to meet the needs of individual site conditions or specific clients. Ideally, the well should not alter the medium that is being sampled.

2.3 Associated Procedures

- CDM Federal SOP 3-5, Lithologic Logging
- CDM Federal SOP 4-1, Field Logbook Content and Control
- CDM Federal SOP 4-2, Photographic Documentation of Field Activities
- CDM Federal SOP 4-3, Well Development and Purging
- CDM Federal SOP 4-5, Field Equipment Decontamination at Nonradioactive Sites

3.0 Responsibilities

Site Manager - Translates client's requirements into technical direction of project. Sets technical criteria, reviews and approves technical progress, and ensures that all participating personnel have proper training. Note: Other titles such as project manager may be used.

Field Team Leader (FTL) - Supervises field operations. Assures that all necessary equipment including safety equipment is available and functioning properly before project operations begin. Assures that all necessary personnel are mobilized on time. Maintains daily log of activities each work day.

Field Geologist - Collects and maintains data and completes Monitoring Well Construction Forms. Coordinates and consults with site manager on decisions relative to unexpected encounters during well installation and deviation from this SOP. Directs overall activities of drill and support subcontractors.

Drilling Subcontractor - Provides necessary personnel, equipment, and services to meet terms of the contract.

4.0 Required Equipment and Materials

4.1 Required Equipment

- Field logbook
- Monitoring Well Construction Forms
- Measuring tape

4.2 Required Construction Materials

General - The materials that are used in the construction of a monitoring well and that come in contact with the groundwater should not measurably alter the chemical quality of a groundwater sample. The well casing and well screen should be steam cleaned (if appropriate for the selected material) prior to well installation or certified clean from the manufacturer and delivered to the site in protective wrapping. Samples of the cleaning water, drilling fluids, filter pack, annular seal, and mixed grout should be retained to be analyzed if groundwater contamination as the result of well installation is suspected. These samples will serve as quality control checks until the completion of at least one round of groundwater quality sampling and analysis.

Water – Water, which may be used in the well completion process, should be obtained from a source that does not contain constituents that could compromise the integrity of the well installation. A certificate of analysis should be provided with the water, or a sample of the water should be analyzed and documented as contaminant-free.

Primary Filter Pack - The primary filter pack (sand or gravel pack) consists of a clean, well-sorted, rounded granular material of selected grain size and gradation that is installed in the annulus between the screened interval and the borehole wall. The filter pack may be installed along the screened interval using a tremie pipe from the total depth of the well to the designated distance above the top of the screened interval. A filter pack material mostly consisting of siliceous, rather than calcareous, particles are preferred. Select the grading of the filter pack on the basis of the layer of finest material to be screened. A minimum filter pack thickness should be between 2 to 3 inches and generally never greater than 8 inches. The filter pack should extend at least 2 to 3 feet above the screened interval or more depending on the screen length to provide for filter pack settlement.

Well Screen - The well screen should be new and composed of materials most suited for the environment being monitored. The screened interval should be plugged at the bottom. The plug should be of the same material as the bottom section of screen and should be securely attached, making a positive seal. This assembly must have the capability to withstand well installation and development stresses without becoming dislodged or damaged. The length of the well screen slotted area should be appropriate for the interval to be monitored including some allowance for changes in elevation of the water table. Prior to installation, the casing string and associated equipment should be cleaned with steam or high-pressure water, if not certified cleaned. Well screens to be used should be composed of stainless steel or polyvinyl chloride (PVC), as appropriate. Fluoropolymer materials may be substituted if necessary due to the potential for incompatible chemical reactions between contaminants and the stainless steel screen, or if stainless steel constituents are possible site contaminants. The minimum internal diameter of the well screen should be chosen based on the particular application. Well screens should be flush threaded per American Society for Testing and Materials (ASTM) standards. Glued or solvent-welded joints may not be used since glues and solvents may alter the chemistry of the water samples.

Slot Size - The slot size of the well screen should be determined relative to the grain-size analysis of the stratum to be monitored and the gradation of the filter pack material. In granular non-cohesive strata that falls in easily around the screen, filter packs may not be necessary. In these cases of natural development, the slot size of the well screen is to be determined using the grain size of the materials in the surrounding strata. The slot size and arrangement should retain at least 90 percent of the filter pack.

Casing - The well casing will be composed of PVC, stainless steel, or some other appropriate material and will extend from the screen to the surface. The type of casing and wall thickness should be adequate to withstand the forces of installation. Several different casing sizes may be required depending on the subsurface geologic conditions. The diameter of the casing for filter packed wells should be selected so that a minimum annular space of 2 inches is maintained between the casing and the borehole wall. The diameter of the casings in multi-cased wells should be selected so that a minimum annular space of 2 inches is maintained between casing strings and between the outer casing and the borehole (e.g., a 2-inch-diameter well screen will require first setting a 6-inch-diameter casing in a 10-inch-diameter boring). Under difficult drilling conditions (collapsing soils, rock, or cobbles), it may be necessary to advance temporary casing. Under these conditions, a smaller space may be maintained. The ends of each casing section should be flush-threaded.

Protective Casing - Protective casings may be made of galvanized steel (or rarely stainless steel). The protective casing should have a lid capable of being secured by a locking device. The inside dimensions of the protective casing should be at a minimum 4 inches larger than the diameter of the casing to facilitate the installation and operation of sampling equipment. Protective casing should extend approximately 2 to 3 feet into the ground to anchor it securely.

Annular Sealants - The materials used to seal the annulus may be prepared as a slurry or used un-mixed in a dry pellet form. Sealants should be selected for compatibility with local geologic, hydrogeologic, climatic, and human-induced conditions anticipated to occur during the life of the well.

Bentonite - Bentonite should be powdered or pelletized sodium montmorillonite furnished in sacks or buckets from a commercial source and free of impurities that adversely impact water quality in the well. The diameter of pellets selected for monitoring well construction should be less than one-fifth the width of the annular space into which they are placed to reduce the potential for bridging. Pellets are typically used for placing annular seals, and powdered bentonite is used for mixing in grout slurry.

Cement - Each type of cement has slightly different characteristics that may be appropriate under various physical and chemical conditions. Cement should generally be Portland Type I, Type II, or Type I/II as specified in ASTM C 150. Quick-setting cements containing additives are not allowable for use in monitoring well installation. Additives may leach from the cement and influence the chemistry of the groundwater.

Grout - The grout backfill that is placed above the bentonite annular seal should be a liquid slurry consisting of water, bentonite grout of Volclay or equivalent quality, and Portland cement. Bentonite-based grouts are typically used when a more flexible grout is desired (i.e., freeze-thaw). Cement-based grout provides a more rigid installation. A typical bentonite grout mixture is 1 to 1.25 pounds bentonite to 2 pounds of Type I Portland Cement per gallon of water. Cement-based grout is typically 6 to 7 gallons of water per 94 pound bag of Type I Portland Cement and 2.7 percent bentonite powder.

Transition Sand - A layer of fine to very fine sand may be placed on top of the primary filter pack before emplacement of the bentonite seal. It should be of sufficient thickness to prevent bentonite from penetrating to the vicinity of the well screen during placement of the bentonite seal.

Annular Seal Equipment (Tremie Pipe) - A tremie pipe is used to inject the annular seals and filter pack. Tremie pipes are typically constructed of PVC or galvanized steel. Associated equipment may include a trough or mixing box and "mud pump" to place the material.

Primary Filter Pack - Screened and washed sand that is placed between the well screen and the borehole wall the full length of the screen.

5.0 Procedures

5.1 Drilling Methods

The actual methods of drilling at a site will vary depending on site conditions. The method to be used at a site shall be stated in the site-specific plans. Deviations from the methods prescribed in these plans shall be approved by the FTL. Typical drilling methods include air rotary, mud/fluid rotary, and hollow-stem auger. Drilling with mud, foam, or water is not desirable, but the driller shall have the capability to use this method if hole conditions warrant it. Installation of wells drilled by mud, foam, water, or air rotary shall be reamed to the appropriate borehole diameter. Installation of wells with protective casing shall be done by either penetrating the outer casing into the ground by hammer blows or by drilling a borehole. The outer casing should be set and secured by grouting or other means specified in the site-specific plans. The inner well borehole can then be drilled through the center of the outside casing. The monitoring wells shall be drilled vertical or at an angle if specified in the site-specific plans. The wells shall be drilled to a depth specified in the site-specific plans and may vary based on actual lithologic conditions. The depth to completion should be approved by the FTL prior to monitoring well construction. Drillers must prevent grease, oil, and other fluids from the drill rig from coming in contact with the ground around the area of well installation.

5.2 Monitoring Well Installation

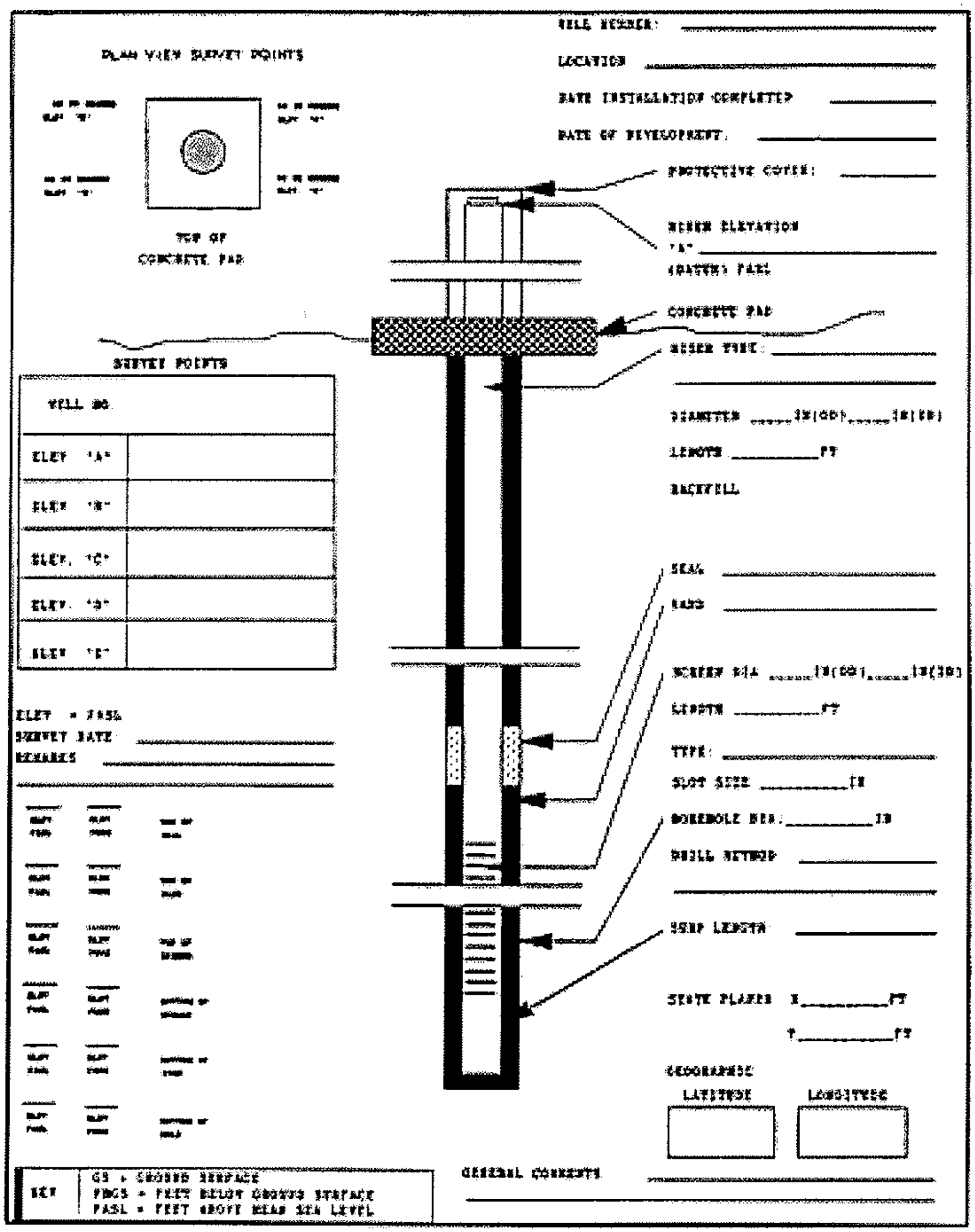
5.2.1 Stable Borehole

A stable borehole must be constructed prior to attempting to install the monitoring well casing and assembly. Steps must be taken to stabilize the borehole before attempting installation if the borehole tends to cave or blow-in, or both. Boreholes that are not straight or are partially obstructed should be corrected prior to attempting the installations described herein.

Although all monitoring wells will not be completed exactly alike, there are common elements among them. The Monitoring Well Construction Form (Figure 1 or equivalent) must be completed by the end of the activity with data obtained through the installation process. The well construction field form should be reviewed prior to initiation of drilling activities to assure that the required data are collected at appropriate times during drilling and installation.

Some monitoring wells may require collection of continuous core, which will be maintained from surface to total depth. Samples may be collected by the wire line coring method (or split-spoon sampler). A description of soil/lithologic materials and drilling observations needs to be recorded in a boring logbook (CDM Federal SOP 3-5).

Figure 1 - Monitoring Well Construction Form



The retrieved samples will be visually screened for indications of water saturation to identify any perched zone and associated impervious layer. If there is sufficient groundwater in a perched zone, a monitoring well may be completed in that zone. Operations will resume if the suspected saturated interval is determined not to be perched water or to be of insufficient thickness to warrant well construction.

For wells not completed in perched zones, the drilling method should ensure isolation of the perched water from the advancing hole, which can be accomplished by an outer protective casing. This method, however, may require short core sections to maintain a close interval between the drive casing and the core depth (that is, until the perched water zone has been completely penetrated). During completion of the well through the perched water zones, the cement grout should stay well above the retracting drive casing shoe.

5.2.2 Well Casing Assembly

The well screen, casing, and bottom plug should be either certified clean from the manufacturer or decontaminated according to CDM Federal SOP 4-5.

Personnel should take precautions to assure that grease, oil, or other contaminants that may alter water samples do not contact any portion of the well casing assembly. As a precaution, personnel should wear a pair of clean gloves while handling the assembly.

Normally, couplings are tightened by hand; however, steam- or high-pressure-cleaned strap wrenches may also be used. Use pipe wrenches with care as they may scar and weaken the pipe. Precautions should be taken to prevent damage to the threaded joints during installation.

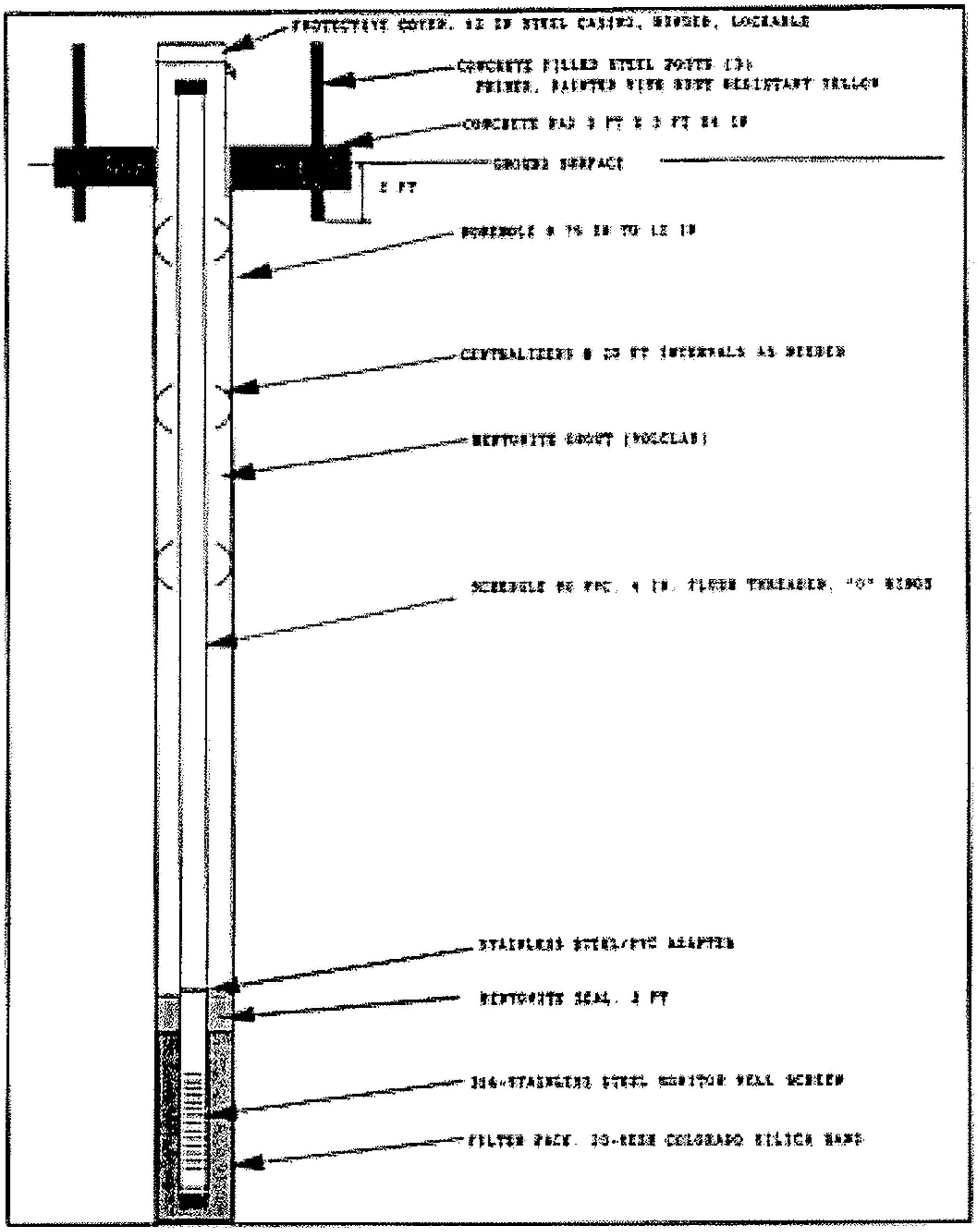
5.2.3 Setting the Well Screen and Casing Assembly in Fluid Filled Holes

When the well screen and casing assembly is lowered to the predetermined level and held in position, the assembly may require a ballast to counteract the tendency to float in the borehole. Ballasting may be accomplished by continuously filling the casing assembly with contaminant-free water. If fluid ballasts are used, the quantity introduced must be recorded in the field logbook. Alternatively, the casing assembly may be slowly pushed into the fluid in the borehole with the aid of hydraulic rams on the drill rig and held in place as additional sections of casing are added to the column. Care must be taken to secure the casing assembly so that personnel safety is assured during the installation. For wells greater than 100 feet, the assembly should be installed straight using centralizers at selected intervals.

Difficulty in maintaining a straight installation may be encountered when the weight of the well screen and casing assembly is significantly less than the buoyant force of the fluid in the borehole. The casing should extend to grade or approximately 2 feet above grade, depending on the intended surface completion, and be capped or covered temporarily to deter entrance of foreign materials during completion operations.

A typical monitoring well is illustrated in Figure 2 - Typical Construction Detail of Monitor Well. Modification of the construction and dimensions on this diagram may be needed depending on site-specific conditions. The monitoring wells will be completed with material as approved by the FTL. The casing should be flush-threaded, using Schedule 40 PVC or other suitable monitoring well casing. No adhesives, cements, or lubricants shall be used during casing make-up or during other drilling and well completion operations.

Figure 2 - Typical Construction Detail of Monitor Well
(Not to Scale - Shown as an Example Only)



5.2.4 Installation of the Primary Filter Pack

Placement of the casing assembly is followed by placing the primary filter pack sand/filter pack (consisting of silica sand sized according to the average grain size of the screened formation) into the bottom of the borehole by using a tremie pipe. The remaining primary filter pack is then placed in increments as the tremie is gradually raised. The sand pack will be emplaced by the "washdown" gravity method and the depth to the top of the sand pack shall be determined and recorded frequently during the operation to ensure proper placement. The tremie pipe or a weighted line inserted through the tremie pipe can be used to measure the top of the primary filter pack as work progresses. As primary filter pack material is poured into the tremie pipe, water from a source of known chemistry may be added to help move the filter pack. The quantity of water introduced must be recorded. If bridging of the primary filter pack occurs, the bridged material should be broken mechanically prior to proceeding with the addition of more filter pack material. The depth, volume, and gradation of the primary filter pack will be recorded on the well construction diagram.

If used, temporary casing or auger sections will be withdrawn in increments. Care should be taken to minimize lifting the casing with the withdrawal of the temporary casing/augers. To limit borehole collapse, the temporary casing or hollow-stem auger is usually withdrawn until the lowermost point on the temporary casing or hollow-stem auger is at least 2 feet, but no more than 5 feet, above the filter pack for unconsolidated materials; or at least 5 feet, but no more than 10 feet, for consolidated materials. Ascertain the depth of the sand with an acceptable measuring device or with tremie pipe and verify the thickness of the sand pack. The primary filter pack is typically placed a minimum of 2 feet above the top of the well screen to account for settlement of the filter pack.

5.2.5 Installation of the Bentonite Seal

A minimum 2-foot-thick bentonite seal should be emplaced on top of the filter pack or transition sand (if used) by using a tremie pipe, if required. If the tremie pipe becomes plugged, requiring an increase in pressure to clear it, not less than 20 feet of tremie pipe shall be pulled up to avoid jetting into the sand pack. If the seal is installed above the water level, water shall be added to allow proper hydration of the annular seal (approximately 1 gallon for each linear foot of annular seal). The volume and depth of the bentonite seal material should be measured and recorded on the well construction diagram.

5.2.6 Grouting the Annular Space

The following procedures apply to both single- and multi-cased monitoring wells. However, it should be noted that grouting procedures will vary with the type of well design.

A sufficient volume of grout should be premixed onsite, according to procedure stipulated by the manufacturer, to compensate for unexpected losses and checked against the known volume of annular space to ensure that bridging does not occur during emplacement. The use of alternate grout materials, including grout containing Portland cement, may be necessary to control zones of high grout loss. The mixing (and placing) of grout should be performed with recorded weights and volumes of materials, according to procedures stipulated by the manufacturer. Lumpy grout should not be used in an effort to prevent bridging within the tremie and the well; however, lost circulation materials may be added to the grout if excessive grout loss occurs. Bentonite-based grout of Volclay or equivalent type should be mixed to the manufacturer's specifications then pumped into place using minimum pump pressure. All additives to grouts should be evaluated for their effects on subsequent water samples.

Depending upon the well design, grouting may be accomplished using a pressure grouting technique or by gravity feed through a tremie pipe. With either method, grout is introduced in one continuous operation until grout flows out at the ground surface without evidence of drill cuttings or fluid. The grout backfill should be injected under pressure using a tremie pipe to reduce the possibility of leaving voids in the annular seal and to displace any liquids and drill cuttings that may remain in the annulus.

Grouting should begin directly above the bentonite seal, after the bentonite has been adequately hydrated. Grout should be injected using a tremie pipe. The tremie pipe should be kept full of grout from start to finish with the discharge end of the pipe completely submerged as it is slowly and continuously lifted. Pump pressure shall be kept to a minimum. Approximately 5 to 10 feet of tremie pipe should remain submerged during group emplacement. If possible, steel tape soundings should be made to ensure the level of the tremie material is in agreement with the calculated volume and that the desired placement of annular materials is achieved. A staged grouting procedure may be considered if the couplings of the selected casing cannot withstand the shear or if there is collapse stress exerted by the full column of grout as it sets. If used, the temporary casing or hollow-stem auger should be removed in increments (immediately following each lift of grout installation) well in advance of the time when the grout begins to set. The initial grout mixture must be allowed to cure for approximately 12 hours, then refilled to the surface.

The well casing should not be developed until the grout sets and cures for the amount of time necessary to prevent a break in the seal between the grout and casing. The amount of time required (generally 24 to 48 hours) will vary with grout content and climate conditions and should be documented on the well completion diagram along with the volume and depth of grout used to backfill the annular space.

5.3 Well Protection

Well protection refers specifically to installations made at or above the ground surface to deter unauthorized entry to the monitoring well and to prevent surface water from entering the annulus.

The protective casing should extend from below the frost line (at least 2 feet below grade) to slightly above the well casing top. The protective casing should be sealed and immobilized in concrete that has been placed around the outside of the protective casing above the set grout backfill. The casing should be positioned and stabilized in a position concentric with the casing. Clearance (usually 6 inches) should be maintained between the lid of the protective casing and the top of the casing to accommodate sampling equipment. A ¼-inch-diameter weep hole should be drilled in the protective casing at the ground surface to permit water to drain out of the annular space. This hole will also prevent water freezing between the well protector and the well casing.

All materials used should be documented on the well construction diagram. The monitoring well identification number should be clearly visible on the inside and outside of the lid of the protective casing and the outside of the protective casing.

A 3-feet x 3-feet x 6-inch-thick concrete pad, sloped to provide water drainage away from the well, may be placed around the installation. Pad size may vary according to site conditions or client specifications. Three 2½-inch-diameter concrete-filled steel posts set at least 24 inches below the surface in concrete should be equally spaced around the well to protect against damage by vehicular traffic for aboveground well completions. The protective casing and steel posts may be primed and painted with rust-resistant yellow paint.

A flush-mounted, traffic-rated casing or vault is typically used for the surface completion of monitoring wells installed in high-use paved areas. The well box cover should be finished slightly above pavement surface to prevent water entry. A layer of sand or gravel material should be placed under the casing/vault to allow infiltrating surface water to drain out.

5.4 Post Operation

5.4.1 Field

At the conclusion of the monitoring well installation activities, all equipment must be decontaminated (according to CDM Federal SOP 4-5) prior to moving the equipment to a different work location. All water used in the decontamination of drilling equipment will be contained in an appropriate container, if required in the site-specific plans.

5.4.2 Documentation

The Groundwater Monitoring Well Construction Form (Figure 1 or equivalent) should be completed by the CDM FTL or designee at the conclusion of the field activity.

Copies of all field notes, the daily logs, and any completed Groundwater Monitoring Well Construction Forms shall be given to the site manager. These records shall be maintained in the project and document control files. At a minimum, all materials used for construction should be documented by entering identifying numbers (lot numbers, manufacturer's identification, etc.) in the field logbook. Samples of well materials (including grout, sand, etc.) may be archived if specified in the project plans.

6.0 Restrictions and Limitations

None.

7.0 References

American Society for Testing and Materials, Designation: D 5092-90, *Standard Practice for Design and Installation of Ground Water Monitoring Wells in Aquifers*, ASTM Committee D-18-.21.05. October 1990.

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TSOP 4-6

HYDRAULIC CONDUCTIVITY TESTING

Hydraulic Conductivity Testing

SOP 4-6
Revision: 2
Date: December 31, 2004

Prepared: Del Baird
QA Review: Doug Updike
Issued: [signature] 12/28/04
Signature/Date

Technical Review: Aaron Frantz
Approved: [signature] 12/21/04
Signature/Date

1.0 Objective

The objective of this standard operating procedure (SOP) is to define requirements for conducting and analyzing in situ hydraulic conductivity (slug) tests in small, developed wells.

2.0 Background

Selected monitoring wells are used to approximate local hydraulic conductivity using either rising-head or falling-head slug test methods.

Slug testing is a rapid and easy means of estimating the hydraulic conductivity of an aquifer. If the thickness of the aquifer is known, then the transmissivity can also be determined. Advantages of slug testing over pump testing include the fact that little or no contaminated water is produced requiring containment and disposal as well as that several areas can be tested in a relatively short period of time. A disadvantage is that the resulting estimate of hydraulic conductivity is limited to a small volume of the aquifer around the tested well and care must be taken in extrapolating the results from one well to other areas or intervals of the aquifer.

Slug testing is accomplished by adding (or removing/displacing) a known volume to (or from) the monitoring well to create a rapid rise (or fall) in water level. Water levels are then measured as the water level in the well returns to static (pre-test) conditions. The most common practice for displacing water in the well is to use a weighted cylinder (also known as a slug bar) of known volume. A bailer may be used in place of a slug bar under low-recharge aquifer conditions.

In addition, a pneumatic system can also be used to lower the water level. This system uses an air pump, compressor or compressed air cylinder to increase the air pressure in the well, which is sealed with an air-tight cap that has ports through which the compressed air is introduced and a water level indicator or pressure transducer can be inserted. This displacement method is commonly employed in high transmissivity aquifers, where sufficient displacement is difficult to achieve using a slug bar or bailer.

In all cases, the rate of water level recovery is then measured using a pressure transducer and data recorder or a water level meter and stopwatch (the former method is preferable in most environments). Data, as displacement-time pairs, are then graphed and used in equations to determine hydraulic conductivity.

If possible, when designing the field program or considering in which interval to place a well screen, try to screen only one formation type. If a well is screened across more than one formation (such as fine sand and coarse sand or overburden and bedrock), it will not be possible to attribute the slug test response to either formation with any accuracy.

2.1 Associated SOPs

- CDM Federal (CDM) SOP 1-5, *Groundwater Sampling with Bailers*
- CDM SOP 1-6, *Water Level Measurement*
- CDM SOP 2-6, *Handling Investigative-Derived Waste*
- CDM SOP 4-1, *Field Logbook Content and Control*
- CDM SOP 4-3, *Well Development and Purging*
- CDM SOP 4-4, *Design and Installation of Monitoring Wells in Aquifers*
- CDM SOP 4-5, *Field Equipment Decontamination at Nonradioactive Sites*

3.0 Responsibilities

Site Manager - The site manager is responsible for ensuring that field personnel have been trained in conducting slug tests and for ensuring that slug tests are conducted in accordance with this procedure.

Field Team Leader - The field team leader is responsible for performing slug tests in accordance with this procedure and for verifying that the data collected are adequate and of high quality. The project field geologist should perform a field calculation to check data quality.

4.0 Required Equipment

The following equipment should be used when performing a rising or falling-head slug test in a monitoring well. Site-specific conditions may warrant the use of additional equipment.

- Pressure transducer and data recorder, if data are to be automatically recorded (recommended), and manufacturers' instructions
- Laptop or hand-held computer for downloading and viewing data (field printer optional)
- Water level measuring device
- Stopwatch, if measurements collected manually (not recommended)
- Slug device of known volume
- Rope or wire
- Duct tape
- Field logbook
- Decontamination equipment and supplies
- Data on the construction of the well: depth to screen, screen length, well drilled diameter, riser diameter, height of sandpack above screen and length of riser above ground surface

Note that the well construction data shall be used so that the slug test data being collected are appropriate and of acceptable quality. Additional information (e.g., distance from screen to confining layer) may be necessary to analyze the data and determine the hydraulic conductivity. Data analysis is not covered under this procedure.

The slug bar shall be constructed of plastic, such as polyvinyl chloride (PVC), or metal such as aluminum or steel (depending upon the chemical environment in the well) and have no buoyancy. For example, a standard slug is constructed with a PVC pipe filled with sand and capped at both ends. The slug bar should be of sufficient size to cause a recommended minimum of 2 feet of displacement in a well. A slightly lesser or greater head change is acceptable so long as a sufficient response curve is recorded that can be applied in a subsequent analysis. For a 2-inch diameter monitoring well, the slug bar should be no more than 1.5 inches in diameter and a minimum of 5 feet long. For a 4-inch diameter well, the slug bar should be no more than 3 inches in diameter and a minimum of 5 feet long. The slug bar should be securely fastened to a nylon rope or braided metal wire.

A standard sampling or well development bailer may be used in place of the slug bar, as long as the volume of water displaced by the bailer is sufficient to change the water level in the well a minimum of 2 feet. If the bailer is to be used for a falling-head test, it should be filled with analyte-free water so that the bailer will not have any buoyancy.

5.0 Procedures

5.1 Preparation

The following steps must be followed when preparing for slug testing:

- Lay plastic sheeting around the wellhead. Arrange needed equipment and decontamination materials on the sheet.

- Put on personnel protective clothing, as specified in the site-specific health and safety plan.

- Open the protective casing locking lid and vented riser caps following the procedures outlined in SOP 1-6. Note the physical condition of the well, including damage, deterioration and signs of tampering. Note any unusual odors, sounds, or difficulties in opening the well. Record organic vapor readings with a suitable organic vapor screening device.

- Measure and record the static water level, the depth to the bottom of the well and inside diameter of the well casing. Record these data in the appropriate logbook.

- If using a pressure transducer and data logger (transducers with built-in data loggers are commonly used for slug tests), lower the pressure transducer into the well to a sufficient depth so that the transducer will be below the maximum depth reached by the bottom of the slug bar or other displacement device. If necessary, calibrate the transducer as specified by the manufacturer. Allow the transducer to temperature equilibrate in the well for approximately 15 minutes (or as recommended by the manufacturer) after insertion and prior to any calibration or test procedure to ensure that it will accurately record water level changes. Make sure that the transducer is not placed below its maximum operating depth, or it will not be able to detect any change in pressure. For example, pressure increases 1 pound per square inch (psi) per 2.3 feet of head; therefore, a 10 psi transducer will function to a depth of 23 feet below the water level in the well.

- Secure the pressure transducer cable to the well riser or casing using duct tape. The transducer cable should lay flat along side the well riser, so that disturbance by the slug bar will be minimized. Do not kink the transducer cable, otherwise the pressure equalization vent tube in the cable will be damaged and the transducer will not function properly.

- Allow the water level in the well to recover to static after emplacement of the pressure transducer, prior to starting the test. Measure and record this water level.

- Program the data logger to record logarithmically, with a maximum time interval of no more than 1 minute between readings. If the formation is expected to have low hydraulic conductivity, the maximum interval between readings can be set to a longer time interval, such as 10 minutes.

- Confirm and/or set the transducer and logger parameters as recommended by the manufacturer. This task may also be performed prior to placing the instrument in the well.

- Determine the distance from the top of the well riser to the water surface in the well and add 1 foot to this length. The resulting length is the amount of wire or rope needed so that the slug bar or bailer will be submerged a minimum of 1 foot when it is placed in the well. A loop should be placed in the rope or wire at this length and a strong metal rod or wooden stick placed and secured through the loop. If the bottom of the well is less than this length added to the length of the slug bar or bailer, the length of the rope or wire should be adjusted so that the slug bar will be no less than 1 foot above the top of the pressure transducer when the bar is inserted into the well.

- If depth readings are to be recorded manually (this procedure is not recommended but may be used in formations suspected of having low hydraulic conductivity, less than 1 foot per day), readings should be taken every 10 seconds for the first minute of the test, every 30 seconds for the next 4 minutes and every minute until 10 minutes. Thereafter, readings should be taken every 5 minutes for the duration of the test. If the well has not recovered within 1 hour, readings should be taken every 0.5 hours until 6 hours and 1 hour every hour thereafter. This process will require two personnel during the first 10 minutes of the test: one to act as time keeper/data recorder and one to measure depth to water in the well.

5.2 Standard Displacement Slug Tests

5.2.1 Falling-Head Slug Test Procedure

This test can only be conducted in wells whose screens are fully submerged, otherwise, displaced water will be introduced into the unsaturated zone and recovery rates will be due to flow in both the unsaturated and saturated zones. All slug test analytical procedures assume flow in the saturated zone only. The following steps must be followed when performing falling-head slug tests:

- Place the slug or bailer in the well until the bottom of the displacement device is no more than 6 inches to 1 foot above the water level in the well. The person holding the device should be holding the rope or wire by the rod or stick described in Section 5.1, ninth bullet.

- Switch on the data recorder, or set the water level meter probe near the level at which water is expected to rise.

- To start the test, the person holding the slug bar will signal the person operating the data logger or water level indicator, then rapidly lower the displacement device into the well until the stick or rod is resting horizontally on top of the well riser. The slug bar should not be dropped, in order to minimize sloshing in the well. The data logger is turned on immediately prior to the slug bottom entering the water.

- Continue recording depth-time data until the well has recovered to at least 90 percent of the static water level. When using data recorders, it is advisable to check and record the reading every few minutes to ensure that data are being properly recorded. If 90 percent recovery has not occurred within 12 hours, the test may be stopped. Field conditions and time constraints may warrant stopping the test in less than 12 hours. The final decisions under these circumstances will be the responsibility of the field team leader.

- Record the time of test completion in the logbook. If a data recorder with random access memory (RAM) or erasable programmable read only memory (EPROM) was used, record the file name used.

- Review the response curve. If a sufficient response curve was not recorded (e.g., logging was not started soon enough to identify maximum water level displacement), then the test shall be repeated. If an acceptable response curve is not being recorded due to field conditions (e.g., no water level response due to high hydraulic conductivity) the project manager shall be notified and a determination on the well test shall be made.

- Decontaminate all equipment according to SOP 4-5. Clean up the site, and close and lock the well before leaving. Contaminated plastic sheeting and disposable protective clothing should be taken to designated disposal containers.

- Download the data logger to a computer or to hardcopy to ensure that the data is not inadvertently lost. If the data were recorded manually, calculate the relative change in head by subtracting the recorded depths to water during recovery from the initial static depth to water reading and record the absolute value of that change, for each depth-time data pair.

Note: Both rising- and falling-head slug tests may be carried out in the same operation by first measuring the rate of water level fall immediately after slug insertion, then measuring the rate of water level rise after slug withdrawal. Be sure that the well has recovered to the static water level before conducting the rising-head test. If using a data logger, the recovery tests needs to be set up and run as a separate test.

5.2.2 Rising-Head Slug Test Procedure

The steps for a rising-head test are essentially the same as those for a falling-head test. In a well screened across the water table, a rising-head test is the only test that is valid. The following steps must be followed when performing rising-head slug tests:

- Lower the slug bar or bailer of known volume into the well until it is fully submerged. Allow the well to re-equilibrate to static water level. In formations of suspected low hydraulic conductivity, re-equilibration may take several hours or overnight. In such cases, it is suggested that the displacement device be placed in the well at the end of a field day and the test conducted the following day.

- Turn on the data recorder, if used, or verify that static water level has been re-established with a water level meter.

- To start the test, the person holding the slug bar will signal the person operating the data logger or water level indicator, then rapidly and smoothly raise the displacement device from the well until the bottom of the slug bar is above the water level in the well. The data logger is turned on or manual measurements commence at the moment the slug bar is raised and before it (or any portion of it) is removed from the water. If a data logger is being used, the slug bar wire or rope should be secured to the well casing or riser for the duration of the test and only removed from the well after the test has been completed, in order to avoid disturbing or dislocating the pressure transducer.

- Continue recording depth-time data until the well has recovered to at least 90 percent of the static water level. When using data recorders, it is advisable to check and record the reading every few minutes to ensure that data are being properly recorded. If 90 percent recovery has not occurred within 12 hours, the test may be stopped. Field conditions and time constraints may warrant stopping the test in less than 12 hours. The final decisions under these circumstances will be the responsibility of the field team leader.

- Record the time of test completion in the logbook. If a data recorder with random access memory (RAM) or erasable programmable read only memory (EPROM) was used, record the file name used.

- Review the response curve. If a sufficient response curve was not recorded (e.g., logging was not started soon enough to identify maximum water level displacement), then the test shall be repeated. If an acceptable response curve is not being recorded due to field conditions (e.g., no water level response due to high hydraulic conductivity), the project manager shall be notified and a determination on the well test shall be made.

- Decontaminate all equipment according to SOP 4-5. Clean up the site, and close and lock the well before leaving. Contaminated plastic sheeting and disposable protective clothing should be taken to designated disposal containers.

- Download the data logger to a computer or to hardcopy to ensure that the data is not inadvertently lost. If the data were recorded manually, calculate the relative change in head by subtracting the recorded depths to water during recovery from the initial static depth to water reading and record the absolute value of that change, for each depth-time data pair.

5.3 Pneumatic Rising-Head Tests

This test can be performed in aquifers of high hydraulic conductivity that are expected to respond very rapidly to slug displacement. It can only be performed in wells where the screen is substantially below the water table, otherwise, increased air pressure in the well casing will be able to bleed off to the unsaturated zone through the well screen and the test will not be successful.

5.3.1 Required Equipment

In addition to the required equipment outlined in Section 4.0, the following equipment should be used when conducting a pneumatic rising-head slug test.

- Minimum 30-psi rated transducer and data logger
- Electric water level indicator with on/off switch
- Pressure-tight "tree" assembly, as described below
- Short length (6 inches) of flexible rubber hose whose inside diameter is the same as the outside diameter of the well riser
- Two 2- or 4-inch diameter hose clamps
- Compressor, air pump, or compressed air tank with hose and appropriate adapters

The pressure-tight tree assembly is a device placed on the top of the well that will accomplish the following:

- Form a pressure-tight seal between the well and the atmosphere
- Allow the injection of compressed air into the well via an air hose connected to the pump, compressor, or air supply
- Provide a pressure-tight passage for a pressure transducer cable and a water level meter
- Allow for rapid well depressurization

The tree is illustrated in Figure 1. If the top of the riser is threaded, the device may be screwed onto the riser if the threads are compatible (Teflon™ tape should be used to ensure a good seal). If the threaded end of the riser has been cut off, a slip coupling will need to be placed over the base of the tree and the top of the riser. A small length of flexible rubber hose the same inside diameter as the outside diameter of the coupling will need to be slipped over the coupling and secured in place with tightly closed hose clamps to form a pressure-tight seal between the riser and the well.

The simplest method for providing access through the tree for the pressure transducer cable indicator is to use a modified standard large diameter black rubber cork. A hole the same diameter should be drilled through the cork's axis and a vertical slit should be cut radially from the hole to an edge of the cork. The pressure transducer cable should be threaded through the hole and the water level indicator tape should be placed flat in the slit. The cork should be firmly placed in the top of the tree to form a pressure-tight seal. To ensure that the cork does not pop out while the well is under pressure, it can be secured in place with duct tape or a friction fit plastic cap placed over the cork and onto the tree.

The tree will have a standard ball valve with an inside valve orifice diameter no less than the diameter of the well riser as shown in Figure 1. In addition, a pressure-tight coupling (swage-loc, quick-connect, or Schrader valve) will be attached to the side of the tree to act as a compressed air inlet.

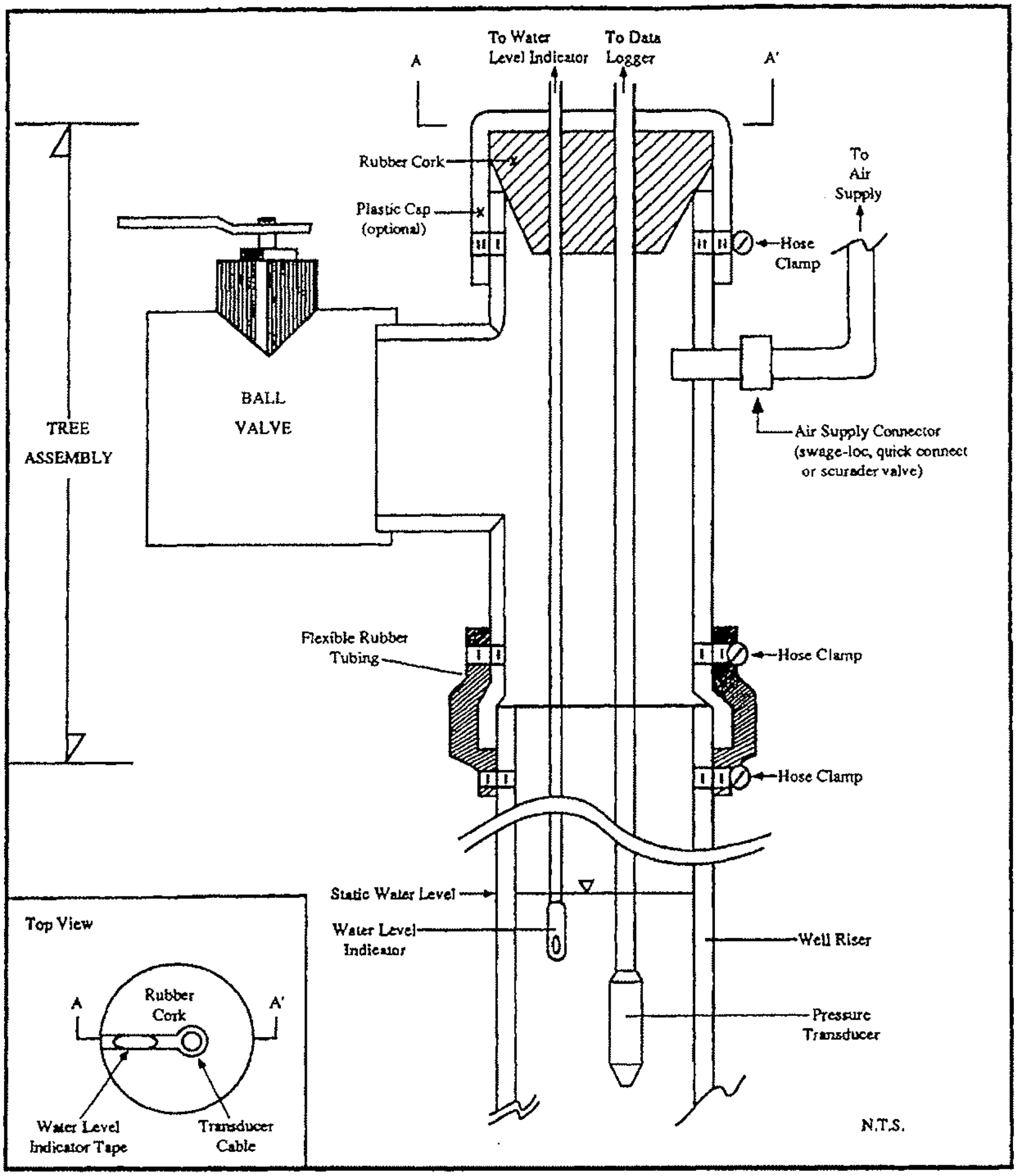
5.3.2 Preparation

Preparation procedures for the pneumatic test are similar to those for the standard slug bar displacement test, with the exception that an electronic data logger is a necessity for this procedure.

5.3.3 Pneumatic Slug Test Procedure

- Install the test tree to the top of the well, using a method appropriate to the type of riser present (threaded or unthreaded). Make sure that the seal to the riser top is pressure-tight.
- Lower the pressure transducer into the well through the top of the tree to a minimum of 10 feet below the water table. The pressure transducer should be rated no less than 30 psi. Allow the transducer to equilibrate at least 15 minutes prior to initiating any calibration or test procedure.
- Turn on and insert a water level indicator into the well to approximately 5 feet depth below the water table. Turn off the indicator.
- Secure the water level indicator and pressure transducer to the test tree using the rubber cork described in Section 5.3.1. Insert the transducer cable into the hole in the rubber cork via the slit and place the water level indicator tape flat in the slit. Place the cork firmly in the top of the tree so that no gaps are left in the cork. Place small strips of duct tape over the assembly to ensure that the seal is airtight and that the cork cannot loosen when the well is pressurized. During this procedure, do not kink the transducer cable or the pressure equalization vent tube in the cable will be damaged and the transducer will not function.
- Connect the pressure transducer to the data logger and calibrate the system according to manufacturer's instructions. Set the data logger to record logarithmically with a maximum recording interval of no more than 1 minute. Set the logger to record relative change in head only.
- Connect the air hose to the compressed air supply, pump, or compressor and to the tree. Make sure the ball valve is securely closed.
- Turn on the water level indicator and start feeding compressed air to the well. When the water level in the well has been depressed sufficiently, the water level indicator submergence tone will stop sounding. The pressure required should be no more than 2 or 3 pounds over atmospheric pressure.
- Simultaneously open the ball valve and activate the data logger. Open the ball valve quickly so that the pressure is released at once.
- In highly permeable aquifers, the water level should recover to pre-test water levels within a few seconds. Full recovery should be accomplished in no more than 1 minute. In any event, do not stop the test until a minimum of 90 percent recovery can be confirmed by interrogating the data logger.

Figure 1 - Pneumatic Slug Test "Tree" Schematic



- Review the response curve. If a sufficient response curve was not recorded (e.g., logging was not started soon enough to identify maximum water level displacement), then the test shall be repeated. If an acceptable response curve is not being recorded due to field conditions (e.g., no water level response due to high hydraulic conductivity) the project manager shall be notified and a determination on the well test shall be made.

- Record the time of test completion in the logbook. If a data recorder with RAM or EPROM was used, record the file name used.

- Decontaminate all equipment according to SOP 4-5. Clean up the site, and close and lock the well before leaving. Contaminated plastic sheeting and disposable protective clothing should be taken to designated disposal containers.

- Download the data logger to a computer or to hardcopy to ensure that the data is not inadvertently lost.

6.0 Data Reduction and Analysis Procedures

6.1 General

The following slug test data reduction procedure and report is recommended.

- All raw data should be printed out and listed as an appendix to the analysis report.

- All data should be plotted using the graphing method of the accepted analytical solution. These plots should be included as an appendix to the analysis report.

- All well geometry data should be tabulated and included in the analysis report. Most of these data must be known prior to the start of testing, except for items related to the water level in the well at the time of testing. The purpose of this tabulation is to ensure consistent calculation of all variables required in the data analysis, make input into a data analysis computer program an easier task, and to make technical review of the analyses and input values easier. This table should include the following items for each tested well or piezometer (the list of items may vary depending on the analytical method employed):

    - Well ground surface elevation
    - Well reference elevation (i.e., top of riser)
    - Depth to static water level at start of test
    - Elevation of static water level at start of test
    - Depth to top of screen or open interval from ground surface or top of casing
    - Depth to bottom of screen or open interval from ground surface or top of casing
    - Elevation of top of screen or open interval
    - Elevation of bottom of screen or open interval
    - Depth to base of aquifer (if available)
    - Elevation of base of aquifer (if available)
    - Aquifer saturated thickness
    - Depth to top of screen or open interval relative to the top of the aquifer
    - Depth to bottom of screen or open interval relative to the top of the aquifer
    - Length of saturated well screen
    - Length of saturated riser
    - Diameter of well riser and screen (or open interval)
    - Diameter of borehole
    - Grain-size of filter pack

- The report should include a detailed description of the data collection procedures and test methods.

- The report should include a detailed listing of all analysis results.

- When reviewing the data for analysis, note that if the water level recovered to the static level (or close to it) before the test was stopped, only the data prior to 100 percent recovery should be included in the data plot. Plotting 100 minutes of data when the recovery occurred over 30 seconds or 2 minutes will make analysis of the actual response very difficult and often lead to a substantial underestimate of the formation hydraulic conductivity. Raw data plots should also be examined for evidence of sloshing of the water level in the well caused by insertion or removal of the slug bar. In most cases, these early data points can also be removed from the data set and time values reset to the new starting point represented by the remaining data. This evaluation is shown on Figure 2. The data may also be removed using common software packages developed for analyzing slug tests.

6.2 Review and Analysis of Data

Slug test response generally falls into three categories illustrated on Figure 3. Overdamped or normal response occurs where the well recovers to static level without exceeding that level. Critically damped response occurs where the well recovers to static level and the water level flows above (rising-head test) or below (falling-head test) then recovers to static in a sinusoidal manner within one cycle, as shown in Figure 3. The third category is underdamped harmonic oscillatory response, where the water level in the well oscillates around the static water level as a sine wave of decreasing amplitude.

Slug test data are recommended to be analyzed with computer software; however, data may also be analyzed manually. The CDM groundwater modeling tool kit contains Aquifer^{WIN32}, which is a program that may be used for analyzing slug test data. Other programs are also available. Software packages are useful since they can be used to manage a significant amount of data in short time periods and contain many different confined and unconfined slug test solutions. The trained user can use these benefits to generate detailed response curve graphs, precise hydraulic conductivity values, and insights into the hydrogeologic framework near the well. Regardless of the analytical method employed or whether the data is analyzed manually or by computer, the analyst should review the original technical paper or textbook summary of the method in order to understand the mechanics and assumptions underlying the method prior to attempting any analysis.

Slug test data analyses and hydraulic conductivity calculations shall be performed by an experienced professional. Data analysis and parameter calculations are beyond the scope of this SOP and, therefore, are not discussed here.

7.0 Restrictions and Limitations

In wells in which the static water level and water levels induced during testing are above the top of the screened or open hole interval, both rising-head and falling-head tests should be conducted to provide a redundancy check of results. However, in most cases, rising-head tests provide more consistent data, less subject to sloshing of the water level due to displacement by the slug bar than is often observed in falling-head tests.

Falling-head slug tests are invalid in wells where the static water level is at or below the top of the screened or open-hole interval.

Regardless of which testing method is used, it is recommended that the hydraulic conductivity testing be performed three times in each well, if time constraints such as recovery time or the project schedule will allow multiple tests. The purpose of multiple testing is to demonstrate the precision of the test results. Ideally, the test results will be similar, which results in an increased level of confidence in the data. In addition, if one of the data sets is bad, there is additional data available for analysis.

8.0 References

American Society for Testing and Materials. 2002. *Standard Test Method (Field Procedure) for Instantaneous Change in Head (Slug) Tests for Determining Hydraulic Properties of Aquifers.*

Environmental Simulations, Inc. 2000. *Guide to Using Aquifer^{WIN32}.*

U. S. Environmental Protection Agency. 1987. *A Compendium of Superfund Field Operations Methods*, EPA/540/P-87/001.

__________. 1996. Region 4. *Environmental Investigations Standard Operating Procedures and Quality Assurance Manual.*

Figure 2 - Deletion of Nonessential Data

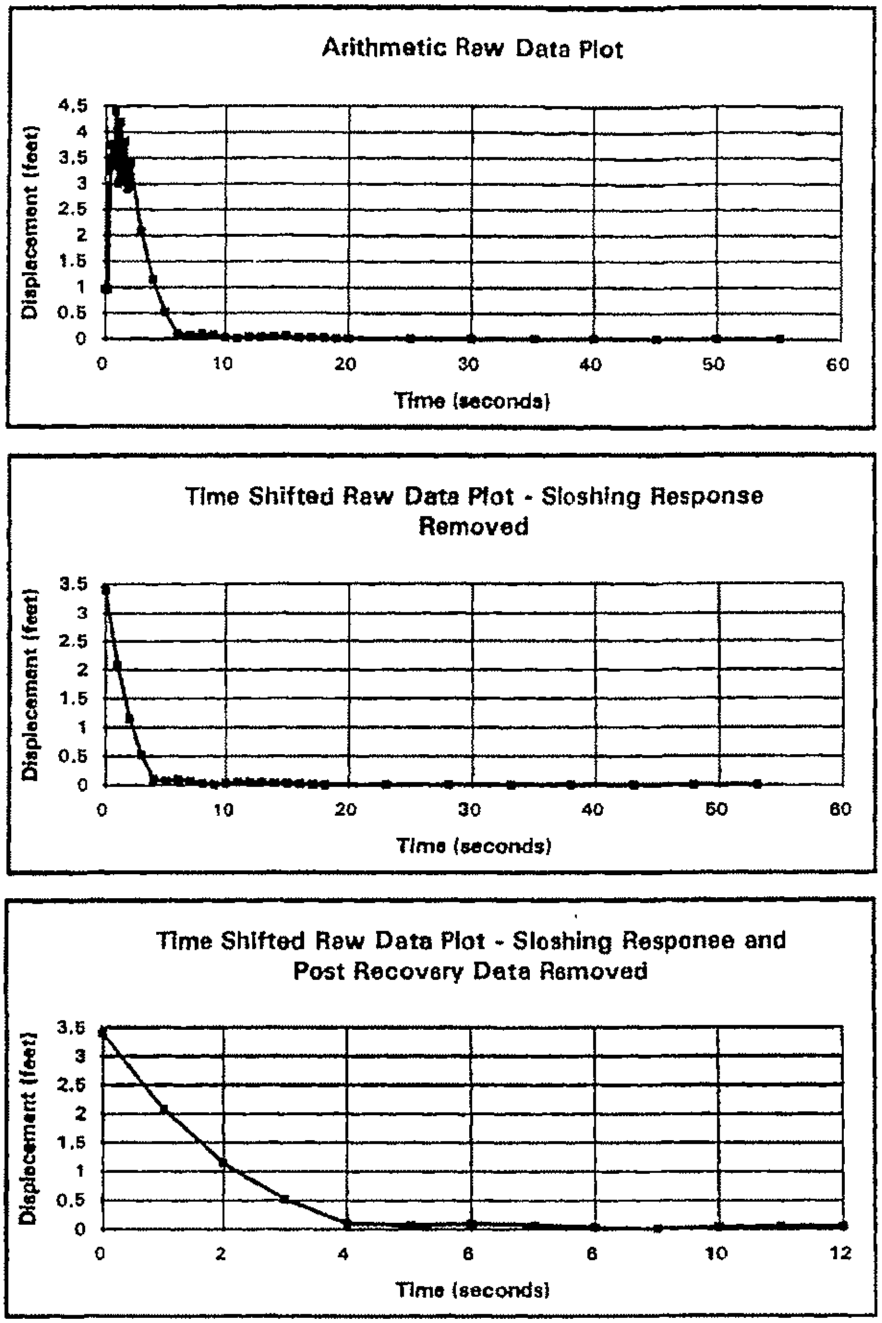
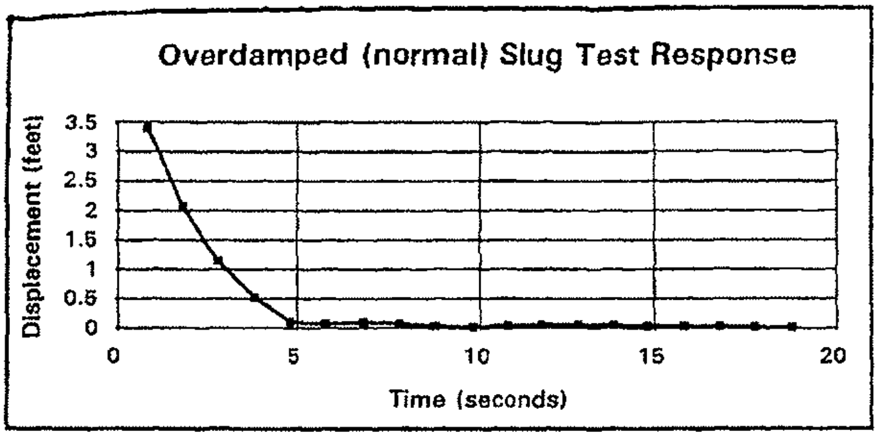
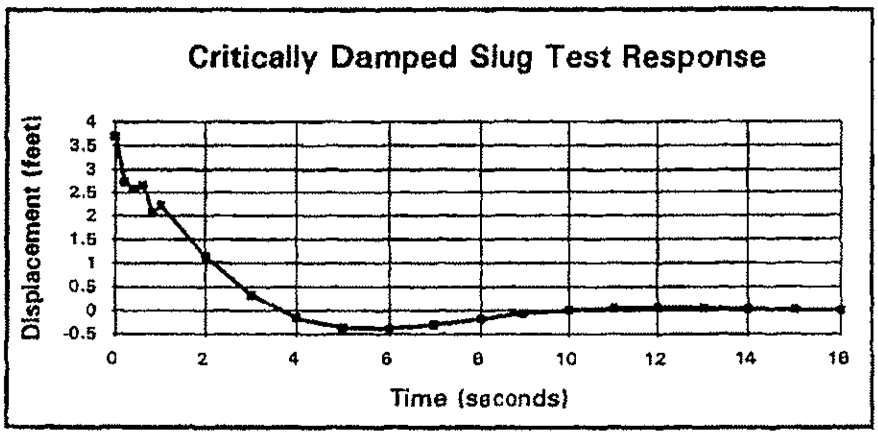
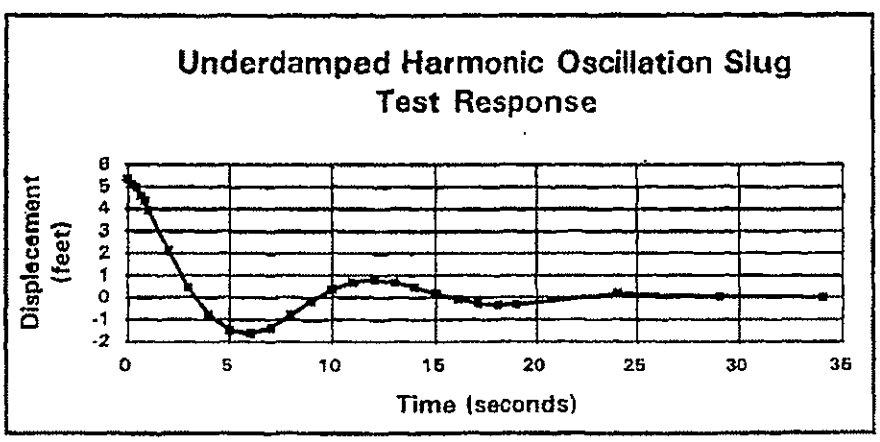


Figure 3 - Typical Slug Test Responses







TSOP 4-8

ENVIRONMENTAL DATA MANAGEMENT

Environmental Data Management

SOP 4-8
Revision: 0
Date: December 31, 2004

Prepared: Doug Updike
QA Review: Jeniffer ~~Oxford~~
Issued: Signature/Date

Technical Review: Michael T. Robinson
Approved: 12/21/04
Signature/Date

1.0 Objective

The objective of this standard operating procedure (SOP) is to provide instruction to data managers, technical staff, and project managers in preparing an environmental project data management plan. The data management plan identifies and documents a project's requirements and responsibilities for managing and using environmental information. Details determined and provided in the data management plan must clearly define:

- Data types the project will generate and use
- Responsibilities for activities associated with information management
- How the project data will be managed
- When data transfers will occur and who will provide and receive data

Additionally, this SOP defines the technical approach for data management activities associated with the collection and analysis of environmental data.

2.0 Background

The data management plan must be completed at the beginning of the project lifecycle. This ensures that the necessary environmental data management systems and personnel are identified and in place prior to the initiation of data collection. Reviews and updates of the data management plan must also be completed as necessary.

The data management plan only addresses the management of a project's environmental information. Environmental information includes electronic and hardcopy records that document environmental processes and conditions and are used to support the project objectives related to environmental and remedial decisions. Information generated by the project activities (e.g., chemical, physical) and information obtained from outside sources (e.g., historical data) are managed within the scope of the data management plan. Information such as human resources and financial records are not within the scope of the data management plan.

Project managers, technical staff, and data coordinators have the responsibility for developing the data management plan. Additional staff (e.g., field team leaders, data users) should also be involved in the data management plan generation as necessary. The minimum project data requirements will depend on the statement of work for individual projects. The project team should work together to identify project data management requirements, define the environmental data collection and handling process, and define the project data management responsibilities. The process to generate a data management plan is provided in Section 4.0.

2.1 Associated Procedures

All SOPs used to collect environmental data are subject to the procedures and processes presented in this SOP. These include:

- CDM Federal (CDM) SOP 1-1, *Surface Water Sampling*
- CDM SOP 1-2, *Sample Custody*
- CDM SOP 1-3, *Surface Soil Sampling*
- CDM SOP 1-4, *Subsurface Soil Sampling*
- CDM SOP 1-5, *Groundwater Sampling Using Bailers*
- CDM SOP 1-6, *Water Level Measurement*
- CDM SOP 1-7, *Wipe Sampling*

- CDM SOP 1-8, *Volatile Organic Compound Air Sampling Using USEPA Method TO-15 with SUMMA Canister*
- CDM SOP 1-9, *Tap Water Sampling*
- CDM SOP 1-11, *Sediment/Sludge Sampling*
- CDM SOP 2-1, *Packaging and Shipping Environmental Samples*
- CDM SOP 3-1, *Gaoprobe Sampling*
- CDM SOP 3-2, *Topographic Survey*
- CDM SOP 3-4, *Geophysical Logging, Calibration, and Quality Control*
- CDM SOP 3-5, *Lithologic Logging*
- CDM SOP 4-1, *Field Logbook Content and Control*
- CDM SOP 4-3, *Well Development and Purging*
- CDM SOP 4-4, *Design and Installation of Monitoring Wells in Aquifers*
- CDM SOP 4-6, *Hydraulic Conductivity Testing*

3.0 Roles and Responsibilities

A general description of roles and responsibilities associated with environmental data management is provided below. It should be understood that not all roles listed below will be required on all projects and that one person may perform multiple roles.

Project Manager - The project manager has the overall responsibility for completing the project. With respect to data management, this involves directing the project team in identifying existing sources of data, identifying the specific project study parameters (e.g., scope of the project), and selecting an effective data collection approach. Additionally, the project manager ensures that data management requirements are effectively communicated in any subcontractor statements of work.

Technical Leader - The technical leader serves as the single point of contact for technical issues. This person provides support during the planning, implementation, and reporting of the project.

Project Team - The project team consists of technical and support staff (e.g., data management and administrative staff) who completes various tasks on the project. The project team is responsible for the development of requirement documents (e.g., sampling plans) and ensuring that client contractual requirements are met.

Field Team Leader - The field team leader supervises field teams during planning and implementation of field data collection. The field team leader ensures that field activities are documented according to project-specific requirements, reviewed as required, and that deviations are tracked and justified.

Field Team - The field team consists of individuals who perform activities detailed in the project-specific requirement documents. Field team responsibilities include recording field activities and information as required by the project-specific planning documents. Quality assurance reviews of procedure implementation are completed by a field team member. Quality assurance reviews include ensuring samples are collected as required, calibrations are completed correctly, and that all information is recorded as required.

Data Management Team - The data management team consists of a data manager and data support staff. The data manager is responsible for developing and implementing the project data management plan and ensuring that requirements specified in the data management plan are met. The data manager ensures that existing data and new data generated during the course of the project are incorporated into the project files and applicable databases. The data manager also identifies and obtains appropriate data management training for the project team. The data manager is responsible for overseeing the data support staff.

Data support staff are responsible for entering environmental project data into the project files or database and ensuring that all information is entered accurately. Data support staff also work with the field teams and data users to ensure that data collection is complete and access to the data is appropriate.

Laboratory Coordinator - The laboratory coordinator develops the project-specific analytical statement of work. Analytical methods, detection limits, laboratory quality control requirements, and deliverable requirements must be detailed in the statement of work. The laboratory coordinator also communicates with the data manager to ensure that hardcopy and electronic deliverable formats are specified and will meet project requirements.

Data Validation Coordinator - The data validation coordinator is responsible for developing the data validation process specific to the project requirements and is responsible for supervising data validation staff. Included in this process is the approach to verifying that analytical data and field data are complete and accurate, have fulfilled the requested analyses, and are in concurrence with the contract requirements. If discrepancies arise, the data validation coordinator interfaces with the laboratory for resolution. If data validation occurs via a subcontractor, the data validation coordinator is responsible for the development of the subcontractor statement of work and supervision and review of the subcontractor's work.

Data validation staff are responsible for ensuring that analytical data and field data are accurate and correct according to a project-specific set of criteria, including the evaluation of quality control samples to ensure analyses were performed within specified control limits. All validation issues must be identified and corrected. Qualifiers may be assigned to the data to indicate concerns about usability.

Data User - Data users are members of the project team who require access to project information for project decisions and to prepare deliverables. The data user is responsible for documenting information used (e.g., GIS coverage, database queries, statistical analysis completed) to generate any data deliverables (e.g., data tables, maps). This requirement ensures that deliverables may be reproduced in the future using an identical process. Additionally, the data user is responsible for determining whether or not the data used meet their specific usability requirements.

4.0 Data Management Plan

This section describes the process to complete preparation of a project data management plan. The data management plan must be completed early in the life cycle of a project to ensure that the necessary and appropriate data management systems and personnel are identified and in place before a project begins to generate data. The data management plan identifies and documents the project requirements and responsibilities for managing and using environmental information. The data management plan must provide enough detail to clearly define:

- The types of data the project will generate and use
- Responsibilities for information management activities and procedures to follow
- How the project will manage its data
- When data transfers will occur and who will provide and receive data

4.1 Data Management Plan Outline

The project manager, data manager, and technical leader will evaluate project and client requirements to prepare the data management plan. The following outline should be customized to meet the project-specific requirements. Additionally, as the project evolves over time, the data management plan must be reviewed and updated periodically to ensure that it suitably meets modifications to the project requirements.

Section 1 - Introduction

- Briefly describe project objectives
- Briefly describe data management objectives
- Briefly describe data management plan objectives and organization
- Summarize the types of data required by the project
- Summarize the data management activities

Section 2 - Data Sources and Needs

- Identify the project data needs (e.g., internal sources, external sources)
- Identify data collection formats (e.g., field forms to be used, geographic information system coverages)

Section 3 - Data Management Team Organization
- Present roles and responsibilities
- Identify lines of communication

Section 4 - Data Management Activities
- Project planning and setup and data flow process (e.g., sample locations and identification nomenclature, laboratory subcontracting)
- Field data collection (e.g., sample tracking, field data entry, historical data)
- Data validation, evaluation, and qualification
- Database entry and post qualification
- Data analysis and output (e.g., mapping format and specifications, data sharing, figure generation)
- Data quality assurance and quality control

Section 5 - Data Management and Geographic Information System and Process Administration
- Identify project data management and geographic information systems to be used
- Identify any project-specific systems to be used for analysis, modeling, or mapping
- Describe how the project will ensure that data, geographic, and analysis systems and processes are controlled (e.g., configuration change control, security)
- Project documentation and storage (records management)
- Quality control implementation (e.g., quality control of electronic documents, geographical information system software guidelines, other analytical software guidelines)

4.2 Data Management Plan Preparation

Data management plan development includes a seven-step process. Each of the steps involved in the process are annotated below. Critical issues of the data management plan are the definition of project activities, roles, and responsibilities related to data management.

- **Determine the Data Manager** - Every project must have a project data manager. The data manager is responsible for assisting in identification of data management and data record needs according to project and client requirements. The data manager will work with the project technical leader in the development of the data management plan.

- **Identify the Project Data Needs and Sources** - The data needs and sources will be determined during project scoping meetings and by discussions with the project team. The data types, sources, and uses must be considered when requirements are being defined. Identification of data types includes topics such as:

  - Maps
  - Field measurements
  - Inspection information
  - Sample media
  - Analyses
  - Locations
  - Quantity of samples
  - Quality for intended use
  - Observations

  Data source considerations will include historical, project-generated, and other similar projects. Examples of data uses include modeling (contaminant contouring/transport, geospatial), regulatory compliance, and risk assessment.

- **Identify Existing Database Requirements** - A requirement may exist that all project information shall be transferred into a pre-existing client database. Close coordination with the client data managers and review of guidance will provide information associated with specific requirements. These requirements will include specific data loading tools, submission file groupings, and data entry guidance.

- **Identify Records Management Requirements** - The project manager, data manager, and technical leader will identify the records management requirements. Additionally, they will identify the types and quantities of records that will be generated and determine what requirements are necessary for their transmittal to the client or central storage location. Records will consist of the guidance and planning documents (sampling plan, quality assurance plan) that detail how samples and data are collected, processed, and used by the project.

- **Define Data Management Activities and Responsibilities** - This step details the data flow process for the project. Within this process, responsibilities for data collection, data transfer, updates, and maintenance are defined. A clear understanding of these responsibilities is critical to ensure that the technical activities of the project are completed efficiently and effectively. Section 5.0 of this procedure provides generic activity descriptions and responsibilities common to many environmental projects.

  The data flow process must be reviewed by the project team to ensure completeness and project specificity. Small projects may allow one individual to complete several roles and responsibilities whereas large projects may require multiple personnel to complete one role. Project team understanding and comprehension of the activities and responsibilities are important to the efficient implementation of the overall data management program.

- **Determine Database Needs** - The project manager, data manager, and technical leader will determine the database needs and requirements. Project components to consider during this process are the complexity, types, and volume of data the project will generate; types, frequency, and detail of reports required; and required accessibility of the data. Based on these components and any other project requirements, a database need will be determined. Automation of the database should also be considered during this step. Database automation consideration should include factors such as:

  - Volume of data
  - Frequency that data will be received
  - Format of the received data (electronic or hardcopy)
  - Time constraints on data reports
  - Complexity of the data

  After database needs have been determined, the project manager and data manager will identify appropriate personnel to support the data management process. Personnel identification support can include geographical information system specialists, laboratory coordinators, and data support staff. Additionally, the project manager and data manager must identify any training requirement appropriate to the project data management process.

- **Prepare the Data Management Plan** - Based on the decisions made in the preceding steps and the customized outline, the data manager and technical leader will prepare the data management plan.

5.0 Project Data Management Activities

This section identifies typical environmental data management activities in the context of a generic project lifecycle. It is unlikely that all activities presented will be implemented on a single project. Only activities applicable to project-specific data management requirements need to be implemented. The activities presented below have been grouped into three sections. Section 5.1 presents planning activities that will identify the project data needs, identify existing information, plan for project data collection, and identify data management requirements. Section 5.2 presents data collection activities, which include data management support that will provide for efficient field data and field sample collection, data processing, and reporting. Section 5.3 provides review and data use activities that include the evaluation of data quality and project reporting.

5.1 Planning Activities

Environmental projects are most commonly conducted to determine contaminant characterization, remedial design parameters, remedial action requirements, or to complete environmental monitoring of some type. Data generated from these activities are used as the basis for decisionmaking.

5.1.1 Project Scoping

Prior to making decisions on data management requirements, a complete understanding of the project is required. Completing a scoping exercise based on client requirements and available information is the first step in planning for development of data management requirements. The following activities are included in the project scoping exercise:

- **Project Definition** - The effort to define projects is highly variable and completely dependent on the complexity of the project. For example, the project may be defined specifically in the client statement of work (e.g., sample wells 1, 2, and 3 and analyze water for volatile organics) or may be iterative where a specific condition may require investigation with further refinement of the project scope based on the results and findings (e.g., delineate nature and extent of contamination). Some projects may also be defined by first determining what questions need to be answered to meet the project objective. Therefore, project scoping can be conducted in multiple phases. First, the project scope is initially determined based on limited information and data (such as the information provided in the client statement of work). Next, after the review of more detailed and specific information, the project may be defined more accurately. Some projects may go through a data quality objective step where contractor, client, and regulators are involved. Project definition serves as the method of focusing and developing a conceptual model of the project so that appropriate management tools can be identified. For example, for a project where characterizing the nature and extent of contamination is the objective, the conceptual model would include determining the environmental setting, the area of contamination, the contaminants of concern, fate and transport of contaminants, and potential risk associated with contaminants.

- **Project Boundaries** - Identifying the project boundary is the next step in project scoping. Once the project has been defined, the boundary of the project can be determined. Project boundaries can be either defined fixed areas or defined release locations (such as in the case of a source releasing contaminants into a plume). Each project must be defined with specific geographic limits. This information will be maintained and used throughout the lifecycle of the project.

- **Identify Historical Information** - Information may exist from previous and similar projects within the project boundaries. This information can prove to be valuable in providing insight into operational processes, contaminants of potential concern, and environmental compliance issues as well as geographical information.

- **Project Scoping Meeting** - A project scoping meeting must be held to finalize the project objectives, project decisions, and project tasks necessary to meet the project objectives. The scoping meeting may include the project team members only or may also include team members, clients, and regulators. Data quality objectives are to be discussed and resolved during the scoping meeting.

- **Project Data Requirements** - During the scoping meeting, project data collection needs should be clearly identified in terms of data use, quantity, and quality. Additionally, decision criteria, acceptable levels of uncertainty, and acceptable levels of false positive and false negative decisions need to be established in accordance with applicable data quality objective guidance.

5.1.2 Acquiring Existing Data

Environmental data collected during previous investigations and studies can prove to be valuable with respect to descriptive information and contaminants. Historical information may contain details in areas such as environmental compliance, geographical data, and characterization investigations. Existing data should undergo the same review and evaluation as any recently collected information. This review assists in ensuring the quality of data collected during the initial stages of the project. While a quality review of this data is advisable, obtaining the necessary quality control data is not always possible. Included in the process of acquiring existing data are the following activities:

- **Locate the Existing Data** - The project manager will define the criteria by which existing data will be considered relevant (e.g., time period). Based on these criteria and additional information potentially provided by the client, a file search will be completed. These data can include physical, chemical, and geographic information.

- **Document Existing Data** - Once existing data have been located and acquired, documentation of these data must be completed. These data will be transferred into the project data management files.

- **Evaluate Existing Data** - Data users will evaluate the existing data for relevance to the current project objectives and data requirements. An essential part of this step is to determine the quality and suitability of the existing data to the current project objectives and requirements. Existing data may have been collected for very different intended uses. After evaluation, the project team will determine which existing data are useful and applicable to the current project. Documenting and inventorying the evaluation and data selected for inclusion to the project files must then be completed.

- **Process Existing Data** - The data manager will incorporate the appropriate existing data into the project database. Processing the data includes converting information into common systems to be used for the project (e.g., common coordinate systems). All data processing steps completed during conversion and incorporation must be documented.

5.1.3 Project Data Collection Planning

Prior to starting this step, the project goals and data requirements must be defined to allow for the development of more detailed project plans. Included in the process of planning project data collection are the following activities:

- **Data Requirements** - Project data requirements need to have been developed during the previous project scoping activities. Types of data that will be required include site operations with respect to:
  - Hazardous substances
  - Disposal practices
  - Quantities of hazardous substances
  - Potential migration of contaminants
  - Site conditions
  - Historical and aerial photographs and base map data
  - Geographical information system coverage of soils, geology, hydrogeology, and delineated contaminant plumes

- **Develop Project Work Plans** - All projects require that guidance documents be developed to describe in detail how the project objectives will be met. These guidance documents will range in complexity dependent on the project type, project complexity, and the project regulatory requirements. The guidance document must be developed using the level of detail required to enable any entity to implement it. Examples of projects requiring guidance documents include:
  - Remedial investigation/feasibility studies
  - Remedial design/remedial action
  - Engineering evaluation/cost analysis

  Additionally, supporting plans and procedures may need to be developed to supplement the work plan. Examples of supplemental plans are:
  - Sampling and analysis plans
  - Quality assurance plans
  - Health and safety plans
  - Waste management plans

- **Develop the Laboratory Statement of Work** - The laboratory coordinator will prepare the laboratory statement of work specific to the project requirements determined in the project work plans. The laboratory statement of work must detail:
  - The number of samples to be sent for analysis
  - The analytical methods
  - Detection limits
  - Laboratory quality assurance/quality control requirements
  - Data deliverable requirements

The statement of work must define the electronic data deliverable format and requirements and request an example from the laboratory to confirm requirements will be met. Additionally, the laboratory statement of work must define the data deliverable requirements necessary to ensure that validation and evaluation may be completed.

- **Develop Data Validation and Evaluation Criteria** - The data validation coordinator is responsible for developing the data validation and evaluation process. The data validation and evaluation process will document the approach to verify that project data quality objectives are achieved. The range of effort required to meet the project validation and evaluation needs may range from none to very exhaustive, dependent on the client and project objectives. Validation and evaluation criteria may be modeled after national guidelines (e.g., National Functional Guidelines), client requirements (e.g., specific client work instructions or procedures), or a combination of both. Variables that are usually considered include:

  - Sample preservation and holding times
  - Calibration of instruments
  - Blanks
  - Laboratory quality control samples
  - Field quality control analysis

  The data validation and evaluation process will be included as a section in the project work plan or equivalent. If data validation and evaluation will be completed by a subcontractor, the statement of work (detailing the project required process) will be developed.

5.2 Data Collection

The following data collection activities identify the data management team support and project team interactions that will ensure efficient field data and field sample collection, event documentation, data processing, and reporting.

5.2.1 Field Activity Preparation

After completing the work plan and detailed project plans, several interactions between the project team members are required. Preparing for field activities ensures that data and sampling processes for the project are complete and appropriate. Field preparation activities may include obtaining permits, surveying and marking sample locations, installing wells, and testing any required equipment. Data management team preparation activities include ensuring all data users have been trained and have access to the data management system, laboratory data deliverables can be transferred into the project database (laboratory test electronic data deliverables have been received and checked), project field forms have been created, and the records management requirements identified in the data management plan are established. Additional field preparation activities are detailed below.

- **Data Management Plan and Data File Management** - The data manager will ensure that the data management plan is implemented. Implementation of the plan must begin prior to collecting field data to ensure that the system developed is appropriate and functional. The data manager will also ensure that the data file management system is established prior to collecting field samples or measurements.

- **Site Survey** - The field team leader inspects the project site area for placement of sampling locations and equipment. These locations should be documented on site maps and stored in the project files (hardcopy, geographical information system, etc.). These identified locations should be physically marked at the site with flagging, paints, stakes, etc.

- **Identify Locations** - The sampling stations identified are differentiated by assigning a unique identifier to each location. Historical location identifiers must be confirmed and consistently used throughout the project. Geographic coordinates must then be obtained for each sampling location. The method of determining the geographic location should be selected based on project accuracy requirements. Information used to select and document accuracy must be maintained. Examples of this information include the type of equipment, processing software, and accuracy reports.

- **Install Sampling Locations** - Sampling location installation will include the placement of:
  - Monitoring wells
  - Boreholes
  - Direct push locations
  - Cone penetrometer locations

  Record and maintain the following information:
  - Drilling and monitoring well construction information (e.g., borelogs, construction logs)
  - Development logs
  - Purging logs
  - Associated measurements (e.g., air monitoring, water quality monitoring)

- **Instrumentation and Equipment** - After placement of the sampling locations, any required instrumentation and equipment must be installed. An inventory of the instrumentation and equipment must be maintained. Included in the inventory would be:
  - The type and manufacturer of the instrument and equipment
  - Calibration requirements
  - Identification numbers
  - Type of data the instrument will collect

- **Update Project Database** - All information and data collected during the preparation activities should be captured in the project database. After these preparatory steps have been completed, the collection of environmental data will begin. The project data manager should be kept current on sampling and data collection schedules and activities.

5.2.2 Field Data Collection

Depending on the type of project, field data may consist of several different types. Field data may consist of observations, checklists, photographs, or preliminary field screening analytical data. Any time field data collection activities are conducted, they must be planned and scheduled. Data entry items such as checklists, field logbooks, and field data forms must be generated during the planning stage to ensure that the required data are captured. Information and data collected during the field data collection activities must enable the project team members to recreate or reconstruct the events that occurred during the activity. Due to project data needs ranging from simple to complex, not all steps provided below will apply to all projects.

- **Schedule** - The project manager is responsible for scheduling the field activity. Each field activity event will be defined by the site requirements and the data requiring collection. The appropriate work plans will be referenced to specify the data that will be collected. After completing the schedule, the field team and data manager are informed of the requirements by holding a field planning meeting.

- **Mobilize** - Mobilizing for a field activity includes generating any specific field forms or checklists, ordering, receiving and inspecting required field equipment, and conducting required project-specific training.

- **Field Data Forms** - Any field data forms that will contain predefined information about the field event (e.g., location identifiers, site name, and quality control samples) should be preprinted to ensure consistency and increase efficiency in the field. Some projects may have automated field data collection systems that would replace the need for field forms (e.g., data loggers). These data loggers would be prepared and tested at this time.

- **Field Instruments** - Many instruments used for collecting field measurements require calibration. Calibration of these instruments provides for more accurate field measurements. Information that must be collected during the calibration of field equipment includes the type of instrument, instrument serial number or property number, time and date of calibration, instrument reading prior to and after calibration, and the calibration media used. Calibrations of field equipment should always be completed in accordance with the manufacturer's recommendations. For field equipment that only requires a calibration check, the vendor's date of calibration should be recorded.

- **Field Data** - Field data are always collected at the same time as analytical samples. Examples of field data are:
  - Photographs
  - Water quality parameters
  - Checklists
  - Surveys
  - Time and date of sample collection
  - Weather conditions

- **Quality Assurance Review** - The project manager is responsible for ensuring that quality assurance reviews are completed. A quality assurance review of the field data collected will be completed. The field data (e.g., logbooks, field forms) review ensures that the data are recorded correctly and the activities were completed in compliance with the planning documents. The quality assurance review will determine if discrepancies between the planned events and actual events occurred.

- **Compile Field Data** - The field team leader is responsible for ensuring that the field data are compiled and submitted to the data manager. Compiling the field data will include copying the field forms, downloading data loggers, and verifying that the field data were recorded as required.

5.2.3 Field Data Processing

Processing field data provides the mechanism for making the data available to the data users. The project manager is responsible for completing this process. Field data will include logbook copies, field forms, checklists, and data logger data. Since project data collection will vary significantly from one project to the next, not every project will require the completion of the following steps. An important part of preparing the data management plan is defining this process specific to the project requirements.

- **Update Project Files** - The field data collected during the field activity and any changes or deviations implemented must be documented and placed into the project files.

- **Field Data** - The following steps only apply to a project where an electronic database is required. Hardcopy field data will be entered into the electronic database. The data entry will be reviewed for accuracy by an independent person to verify correctness. Electronic field data (e.g., from data loggers) will be processed by programs that are designed for use with the specific piece of equipment that logged the data.

- **Error Resolution** - Any errors identified during field data processing or on review of field documentation must be resolved. Resolution is accomplished through discussions with project personnel.

- **Updates** - Upon completion of field data processing, the project database and project files must be updated. The data manager then makes the data available to project personnel for use.

5.2.4 Field Sample Collection

Field sample collection includes all activities implemented to gather samples from a perticular site. Field sampling activities are planned and scheduled. Prior to implementation, the required field data forms, field logbooks, etc. are prepared. Recorded information is intended to provide data and observations to enable the reconstruction of the field sampling activities. The following process steps can be implemented as required:

- **Schedule** - The project manager will prepare a schedule of sampling events. The schedule should include the types and number of samples to be collected at each location.

- **Generate Sampling Labels and Forms** - Each sample collected during the scheduled sampling event will receive a sample label and sample collection form. Information to be captured on the sample container labels includes the sample location, container type, preservative, and analysis. Field forms for each can also be generated. Field forms may be preprinted and include lines for documenting conditions under which the sample was collected (e.g., moisture content, depth, water quality parameters).

- **Notify Analytical Laboratories** - The analytical laboratories need to be notified of the sampling activity schedule. The laboratory needs to be informed of the anticipated arrival of sample shipments including the numbers of samples and the types of analyses that will be requested.

- **Acquire Equipment and Supplies** - All equipment required to complete the field sampling activity must be ordered, received, and documented. Notation of all equipment identification numbers and serial numbers must be made. An equipment checklist may be used to document this step. All supplies needed to accomplish the scheduled sampling activities, including sample containers and shipping materials need to be assembled.

- **Collect Samples** - Samples will be collected in accordance with required sampling procedures. Information regarding sampling activities, site conditions, and deviations from the planning documents will be recorded in the field logbook or field data forms.

- **Process Samples** - Samples collected in the field may need additional preparation prior to shipping to the laboratory. Two examples of additional processing that may be required are compositing of samples and filtering of an aliquot of the sample.

- **Updates** - The project database and project files need to be updated with the information collected during the field activities. A part of this process includes the verification that field data entered into the database are correct. Verification consists of comparing field forms and field logbooks to the information entered.

5.2.5 Submit Samples for Analysis
Submitting samples to a laboratory for analysis includes preparation, packing, documenting, shipping, and verification of sample receipt. The process for submitting samples to a laboratory for analysis is detailed below.

- **Preparation for Shipment** - Preparing to ship samples includes the final sample processing such as splitting, compositing, or filtering. All sample containers shipped to a laboratory must have labels identifying, at a minimum, the sample number or identifier, analyses to be completed, and sample collection date and time. Sampling shipments shall be completed in accordance with CDM SOP 2-1, *Packaging and Shipping of Environmental Samples*, current version.

- **Chain-of-Custody Documentation** - All samples collected need to be documented and accompanied by a chain-of-custody form. The chain-of-custody must identify, at a minimum the:
  - Sample identification number
  - Matrix
  - Collection date and time
  - Sample type
  - Preservative
  - Analyses
  - Signature blocks for documenting sample transfers

  Sample chain-of-custody must be completed in accordance with CDM SOP 1-2, *Sample Custody*, current version.

- **Ship Samples** - Samples will be shipped in accordance with CDM SOP 2-1, *Packaging and Shipping of Environmental Samples*, current version. Each sample shipped should be checked against the chain-of-custody as it is packed for shipment.

- **Laboratory Receipt of Samples** - The laboratory will confirm that custody seals are still intact, the number of samples received matches the chain-of-custody, and the analyses match the sample labels and chain-of-custody. Additionally, the laboratory will note the condition of the samples when they are received against any noted requirements (e.g., 4° Celsius) on the chain-of-custody. The chain-of-custody will be signed and dated as received by the laboratory. A copy of the chain-of-custody should be faxed back to the shipper for confirmation of sample receipt.

- **Confirmation of Sample Receipt** - The laboratory coordinator is responsible for confirming that the information provided by the laboratory is accurate. Confirmation is required for the following items:
  - What samples were received
  - Condition of samples upon receipt
  - Presence of signature on laboratory chain-of-custody form
  - Sample identification numbers
  - Types of analyses performed

  The laboratory coordinator is responsible for resolution and reconciliation of any conflicting information.

- **Sample Shipping Documentation** - Sample shipment files will include information with respect to the completion of the shipping process. This documentation will include:
  - Signed copy of the chain-of-custody
  - Shipping company airbill if applicable
  - Laboratory sample receipt or login form
  - Field forms associated with samples included in the shipment

- **Laboratory Analysis** - The laboratory will analyze samples according to the laboratory statement of work and the requested analyses identified on the chain-of-custody.

5.2.6 Sample Data Processing

Sample data processing includes receiving and processing the laboratory data package and making the data available for review. Activities associated with this process are data package receipt, evaluation of the data package, and updating the project database with the data package information. The process for these activities is detailed below.

- **Receiving the Data Package** - The laboratory should send the data package to the project laboratory coordinator. At a minimum, the data package will consist of a hardcopy of the analytical results. The laboratory coordinator will note which samples the data package represents and review the data package for completeness and legibility. Any problems identified during this review must be communicated to the laboratory and corrected. If an electronic data deliverable is a part of the data package, it may be either sent directly to the data management team or retained by the laboratory coordinator and distributed after review. If an electronic data deliverable was not provided as a component of the data package and the data needs to be entered into the database, the laboratory coordinator will provide a copy of the data package to the data management team as required for data entry.

- **Evaluation of the Data Package** - Upon receipt of electronic data deliverables, the diskette or other media will be scanned for possible viruses before loading the information onto a computer. If a virus is detected, the laboratory will be notified immediately and another electronic deliverable requested. Electronic data deliverables should be compared to the hardcopy version of the data package to ensure consistency and accuracy. In cases where no electronic copy exists, and the entry of the hardcopy data package into an electronic database is a project requirement, verification of the accuracy of the entered data is required subsequent to completion of data entry. All errors and problems identified during the evaluation must be documented and resolved during the evaluation. Any changes made to the hardcopy data package and the electronic data package must be documented.

- **Update the Project Database** - The project database will be updated with the sample results and associated laboratory data qualifiers. Some projects may also require additional quality control information in the database. Examples of the type of information that may be required include:
  - Results from the matrix spike/matrix spike duplicates
  - Percent recoveries
  - Laboratory control samples
  - Blanks

  Documentation of problem resolution and changes made to the data package must be maintained.

5.3 Review and Data Use

The data review process determines whether a set of environmental data meets the requirements established during the project scoping. The process involves the data management team, the laboratory coordinator, and the data users. Prior to completing the data review, the data validation and evaluation process must be completed to ensure data meet analytic guidelines since qualifiers affecting the usability of the data may be added.

5.3.1 Data Validation and Evaluation

Validation and evaluation of environmental data is performed to evaluate the usability of the data for the intended application. The process is equally applicable to field data as well as analytical laboratory data. Data of questionable quality or representativeness are qualified to inform the data user of the limitations associated with the data use. The process to complete a data validation and evaluation is presented below.

- **Data Deliverables** - Data are received in either hardcopy or electronic format by the data validation coordinator. These data deliverables are evaluated against the requirements specified in the analytical laboratory statement of work or the client requirements. Upon completion of the evaluation of the data deliverables with respect to the contract requirements (laboratory subcontract or client contract), the data deliverables are forwarded to the validation and evaluation personnel. If the data validation and evaluation is not required for the data deliverable, it is forwarded to the data manager for uploading into the project database.

- **Validate and Evaluate Data** - Data deliverables are validated and evaluated according to the procedures and requirements established during the project planning and data management plan development. Following validation and evaluation, the data are forwarded to the data management team for subsequent update of the project database.

- **Data Validation and Evaluation Report** - The data validator and evaluator will prepare a report documenting the process used to validate and evaluate the data, the usability of the data, and the qualification of the data, if applicable.

5.3.2 Data Review

Review of the data encompasses all data and supporting documentation, historical and recent, collected by the project activities as defined during the project scoping. Evaluation of the data will include the following process.

- **Evaluate Data for Outliers** - The data evaluation will first review the data to detect possible outliers. If extreme values are observed, a review of the potential for sampling and analysis problems must be completed to determine the accuracy of the data point. This review may include the evaluation of historical data ranges for the particular analyte at a particular location, or comparing similar analytical method results for samples processed differently (e.g., filtered vs. unfiltered). Based on the results of this evaluation, a determination about the use of the outlier result can be made.

- **Evaluate Precision, Accuracy, Representativeness, Completeness, and Comparability** - Precision, accuracy, representativeness, completeness, and comparability make up the PARCC parameters.

Precision is the degree of agreement between independent measurements and is determined by the evaluation of laboratory control sample and laboratory control sample duplicate pairs, the matrix spike/matrix spike duplicate pair or an environmental sample and environmental duplicate pair analyses.

Accuracy is the closeness of agreement between an observed value and an accepted value. Accuracy is determined by comparing percent recovery of spiked samples such as laboratory control samples and matrix spike samples.

Representativeness expresses the degree to which the data accurately reflect the analyte or parameter for the environmental media examined at the site. Representativeness is a qualitative term and is evaluated based on use of proper sample design, sample collection methods, use of standard analysis methods, etc.

Completeness is the measure of the amount of valid data received from the laboratory or field measurements. Completeness is determined by dividing the number of valid results by the number of possible results.

Comparability is the confidence with which one data set may be compared to another data set produced by different laboratories or field instruments. Comparability is a qualitative term and can be evaluated by reviewing sampling methods, sampling devices, and standard control limits. Understanding the PARCC parameters provides a level of confidence in the data reported for decisionmaking purposes.

- **Evaluate Data Quality** - An integral component of the data review process is the comparison of results against the project-specific data quality requirements established during project planning. Results of the data quality evaluation will determine if the data meet or exceed the data quality requirements necessary for decisionmaking. A final usability determination is made by the data reviewers. If required, data qualifiers are placed on the data to indicate usability.

- **Update Database** - After the data review is complete, the project database must be updated with the qualifiers assigned. Updating of the database also includes noting the qualifiers on the hardcopy of the data package.

5.3.3 Data Analysis and Use

Data analysis and use consists of the activities necessary to process the data and transform the entire data set into customized data sets for the generation of deliverables for decisionmaking and reporting. Data users may use only portions of data (e.g., geological or chemical) or summarize the data to generate tables, graphs, text, maps, or other deliverables necessary to describe the results obtained and the conclusions drawn. The analysis process is very often iterative. Results and conclusions from one analysis will often lead to other analyses. The process for data analysis and use is presented below.

- **Data Selection** - Data analysis will usually focus on a particular subset of the data collected. Data selection involves defining these subsets, querying the data, consolidating these data from the project database, and transferring the data to the appropriate tool for analysis (drafting, GIS, statistical program, etc.). Standardization may also need to occur at this point in the process (e.g., units, analytes, spatial).

- **Report and Analyze Data** - Data analysis involves summarizing the data to ensure that the technical requirements of the project are met. Examples of data analysis include statistical, risk assessment, and modeling. Results of the analysis are then used to report information in the form of tables, graphs, maps, text, and three-dimensional visualizations.

- **Documentation** - The information necessary to recreate a data analysis must be documented and kept. This includes the query criteria used to acquire the data subset, the database that provided the data for analysis, the procedure completed to perform the analysis, and the date the analysis was performed.

6.0 Software and Computer System

This section defines the documentation, quality assurance, and configuration control requirements for software and databases used on environmental projects. Section 6.1 applies to all projects using an electronic database and provides requirements for project-specific databases and software. Section 6.2 applies to all projects using an electronic database and defines requirements for the day-to-day operation of the data management system. The project data manager is responsible for implementation and providing guidance to meet the project objectives.

6.1 Project-Specific Database and Software Requirements

The need for a project-specific database and software will vary depending on the requirements of the project. A project may use an existing data management system and therefore not have project-specific software or databases, while other projects may develop project-specific databases and spreadsheets or software programs to analyze the project data. This section presents the minimum documentation, quality assurance, and configuration control requirements for project-specific databases and software developed during the course of a project.

- **Database Documentation** - Project databases will include spreadsheets and databases defined by the project data management team. The database documentation will identify the commercial database product, the database name, structure, and location using an entity relationship diagram (ERD) and data dictionary. The backup and recovery plans and processes for the database will also be documented. The minimum database documentation will consist of the name of the software used, names of the project databases created, database structure definitions (including names and field descriptions), any table relationships, and the storage location.

- **Software Documentation** - Software documentation will include the software program name, description, special requirements, revision, completion date, and evidence of technical and quality review. Documentation of deliverables created must also include the necessary information required to describe exactly how the data deliverable was produced. Software documentation may be maintained in hardcopy or included as a comment block embedded within the project software program. The minimum software documentation will consist of the name of the commercial software, name and version of any software written by the project personnel, author, date, revision, system requirements, and storage location.

- **Software Quality Assurance** - The project will define the quality assurance requirements for project-specific software. At a minimum, the functionality and analytical results of software programs will be reviewed to ensure that they meet requirements and objectives. The reviewer of the software will be someone other than the person who wrote the program. The project-specific software quality assurance requirements will be defined in the project data management plan.

- **Software Configuration Control** - Project-specific software will be protected from unauthorized modification or deletion. This can be accomplished by administrative controls or file security options. Changes to project software will be documented and maintained in the project files. The minimum project software configuration control documentation will include the commercial software used, the program names, revisions including the date, and the storage location.

6.2 System Administration

This section addresses the day-to-day operations of the data management system, including backups, access, security, data entry, and database control. All projects using an electronic database will adhere to the requirements in this section. The data manager is responsible for implementation of system security.

- **System Backup** - Project data will be protected from loss through a preventive backup and recovery process. Database backups will be performed on a periodic basis at a frequency to be defined for each project in the data management plan. The frequency will be selected to minimize the extent of consequences of data loss and time required to recover the data. Recovery procedures will be developed and documented. The detailed description of the backup and recovery procedures will be presented in the data management plan.

- **System Access** - Access to the computer system will be made available only to authorized personnel with an assigned role that specifies their access rights. Before gaining access, personnel may login by providing a login name and password.

- **Database Access** - Projects will protect data from unauthorized access by implementing administrative controls. Access will be managed based on the specific data user role. The mechanism for implementing control will be documented in the project data management plan.

- **Data Security** - Security considerations must establish a balance between making the data inaccessible to unauthorized individuals while still making it accessible to those who have access and maintaining the integrity of the data. Security processes apply to field data, electronic data, the database, and distribution of data outside of CDM. Original copies of all field records (e.g., chain-of-custody forms, sample collection sheets, and shipping airbills) will be placed in the permanent project file. All electronic files will be maintained in an electronic file management system and administered accordingly. Security of data distributed outside of CDM will be maintained by providing read only access to the data and/or including time, date, and version on the data files within the file naming convention.

- **Data Entry** - Data entry and transcription activities will be reviewed and checked to ensure that data integrity is maintained. Review and checking must occur for all data when moving or copying data from one media to another. For example, if a field technician collects data from a water quality instrument and records it in a logbook, enters the data from the logbook into an electronic format, and then transfers the data into a deliverable, verification of accuracy would be completed during or immediately after the transcription. The mechanism for data entry and transcription must be documented in the project data management plan.

- **Database Control** - Each project must establish database control requirements for the contents of the project database. The requirements must ensure traceability of field and laboratory data from its original reported values through changes to current values stored in the database. The control requirements will define the approval process required for making changes to the database and the documentation required for each database change. The minimum information maintained for each database change will include:
  - Description of the change
  - Reason the change was made
  - Name of the individual making the change
  - Date the change was made

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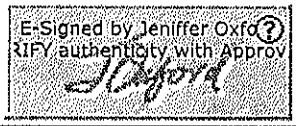
Woodard & Curran, Inc., GIS-Based Data Management for Environmental Investigations.

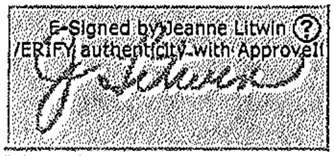
TSOP 5-1

CONTROL OF MEASUREMENT AND TEST EQUIPMENT

CONTRACT-SPECIFIC CLARIFICATION

SOP No.: 5 - 1
Revision: 5
SOP Title: CONTROL OF MEASUREMENT AND TEST EQUIPMENT Date: March 26, 2003

QA Review: 

Approved and Issued: 

Program Manager Signature/Date

Contract No.: RAC II Client: USEPA, Region II

Reason for and Clarification: Make SOP USEPA Region II – Specific

Clarification (attach additional sheets if necessary; state section and page numbers when applicable):

2.0 BACKGROUND

2.2 Discussion, add (to page 1 of 7):

As the RAC II contract does not use any company-owned or government furnished equipment, only procedures discussed for leased and rented measurement and test equipment apply.

Control of Measurement and Test Equipment

Prepared: Dave Johnson
Technical Review: Mike Clark
QA Review: Doug Updike
Approved: [signature] 12/21/04
Signature/Date
Issued: [signature] 12/28/04
Signature/Date

1.0 Objective

The objective of this standard operating procedure (SOP) is to establish the baseline requirements, procedures, and responsibilities inherent to the control and use of all measurement and test equipment (M&TE). Contractual obligations may require more specific or stringent requirements that must also be implemented.

2.0 Background

2.1 Definitions

Traceability - The ability to trace the history, application, or location of an item and like items or activities by means of recorded identification.

2.2 Discussion

M&TE may be government furnished (GF), rented or leased from an outside vendor, or purchased. It is essential that measurements and tests resulting from the use of this equipment be of the highest accountability and integrity. To facilitate that, the equipment shall be used in full understanding and compliance with the instructions and specifications included in the manufacturer's operations and maintenance and calibration procedures and in accordance with any other related project-specific requirements.

2.3 Associated Procedures

- CDM Federal (CDM) Technical SOP 4-1
- CDM Quality Procedures (QPs) 2.1 and 2.3
- Manufacturer's operating and maintenance and calibration procedures

3.0 Responsibilities

All staff with responsibility for the direct control and/or use of M&TE are responsible for being knowledgeable of and understanding and implementing the requirements contained herein as well as any other related project-specific requirements.

The project manager (PM) or designee (equipment coordinator, quality assurance coordinator, field team leader, etc.) is responsible for initiating and tracking the requirements contained herein.

4.0 Required Equipment

- Determine and implement M&TE related project-specific requirements
- The maintenance and calibration procedures must be followed when using M&TE
- Obtain the maintenance and calibration procedures if they are missing or incomplete
- Attach or include the maintenance and calibration procedures with the M&TE
- Prepare and record maintenance and calibration in an Equipment Log or a Field Log as appropriate (Figure 1)
- Maintain M&TE records
- Label M&TE requiring routine or scheduled calibration (when required)
- Perform maintenance and calibration using the appropriate procedure and calibration standards
- Identify and take action on nonconforming M&TE

5.0 Procedures

5.1 Determine if Other Related Project-Specific Requirements Apply

For All M&TE:
The PM or designee shall determine if M&TE related project-specific requirements apply. If M&TE related project-specific requirements apply, obtain a copy of them and review and implement as appropriate.

5.2 Obtain the Operating and Maintenance and Calibration Documents

For GF M&TE that is to be procured:
Requisitioner - Specify that the maintenance and calibration procedures be included.

For GF M&TE that is acquired as a result of a property transfer:
Receiver - Inspect the M&TE to determine whether maintenance and calibration procedures are included with the item. If missing or incomplete, order the appropriate documentation from the manufacturer.

For M&TE that is to be rented or leased from an outside vendor:
Requisitioner - Specify that the maintenance and calibration procedures, the latest calibration record, and the calibration standards certification be included. If this information is not delivered with the M&TE, ask Procurement to request it from the vendor.

5.3 Prepare and Record Maintenance and Calibration Records

For all M&TE:
PM or Designee - Record all maintenance and calibration events in a Field Log unless other project-specific requirements apply.

For GF M&TE only (does not apply to rented or leased M&TE):
If an Equipment Log is a project specific requirement, perform the following:

Receiver - Notify the PM or designee for the overall property control of the equipment of the receipt of an item of M&TE.

PM or Designee - Prepare a sequentially page numbered Equipment Log for the item using the maintenance and calibration form (or equivalent) from the CDM *Property Control Manual* (Figure 1).

PM or Designee and User - Record all maintenance and calibration events in an Equipment Log.

5.4 Label M&TE Requiring Calibration

For GF M&TE only (does not apply to rented or leased M&TE):
If calibration labeling is a project specific requirement, perform the following:

PM or Designee - Read the maintenance and calibration procedures to determine the frequency of calibration required.

PM or Designee - If an M&TE item requires calibration before use, affix a label to the item stating "Calibrate Before Use."

PM or Designee - If an M&TE item requires calibration at other scheduled intervals, e.g., monthly, annually, etc., affix a label listing the date of the last calibration, the date the item is next due for a calibration, the initials of the person who performed the calibration, and a space for the initials of the person who will perform the next calibration.

5.5 Operating, Maintaining or Calibrating an M&TE Item

For all **M&TE:**
PM or Designee and User - Operate, maintain, and calibrate M&TE in accordance with the maintenance and calibration procedures. Record maintenance and calibration actions in the Equipment Log or Field Log.

Figure 1

CDM
A subsidiary of Camp Dresser & McKee Inc.

Maintenance and Calibration

Date: ____ Time: ____ (AM/PM)

Employee Name: ____ Equipment Description: ____

Contract/Project: ____ Equipment ID No.: ____

Activity: ____ Equipment Serial No.: ____

Maintenance

Maintenance Performed:

Comments:

Signature: ____ Date: ____

Calibration/Field Check

Calibration Standard: ____ Concentration of Standard: ____

Lot No. of Calibration Standard: ____ Expiration Date of Calibration Standard: ____

Pre-Calibration Reading: ____ Post-Calibration Reading: ____

Additional Readings: ____ Additional Readings: ____

Additional Readings: ____ Additional Readings: ____

Pre-Field Check Reading: ____ Post-Field Check Reading: ____

Adjustment(s):

Calibration: ☐ Passed ☐ Failed

Comments:

Signature: ____ Date: ____

5.6 Shipment

For GF M&TE:

Shipper - Inspect the item to ensure that the maintenance and calibration procedures are attached to the shipping case, or included, and that a copy of the most recent Equipment Log entry page (if required) is included with the shipment. If the maintenance and calibration procedures and/or the current Equipment Log page (if required) is missing or incomplete, do not ship the item. Immediately contact the PM or designee and request a replacement.

For M&TE that is rented or leased from an outside vendor:

Shipper - Inspect the item to ensure that the maintenance and calibration procedures and latest calibration and standards certification records are included prior to shipment. If any documentation is missing or incomplete, do not ship the item. Immediately contact Procurement and request that they obtain the documentation from the vendor.

5.7 Records Maintenance

For GF M&TE:

PM or Designee - Create a file upon the initial receipt of an item of M&TE or calibration standard. Organize the files by contract origin and by M&TE item and calibration standard. Store all files in a cabinet, file drawer, or other appropriate storage media at the pertinent warehouse or office location.

PM or Designee - Maintain all original documents in the equipment file except for the packing slip and Field Log.

Receiver - Forward the original packing slip to Procurement and a photocopy to the PM or designee.

PM or Designee - File the photocopy of the packing slip in the M&TE file.

PM or Designee and User - Record all maintenance and calibration in an Equipment Log or Field Log (as appropriate.) File the completed Equipment Logs in the M&TE records. Forward completed Field Logs to the PM for inclusion in the project files.

For M&TE rented or leased from an outside vendor:

Receiver - Forward the packing slip to Procurement.

User - Forward the completed Field Log to the PM for inclusion in the project files.

User - Retain the most current maintenance and calibration record and calibration standards certifications with the M&TE item and forward previous versions to the PM for inclusion in the project files.

5.8 Traceability of Calibration Standards

For all items of M&TE:

PM or Designee and User - When ordering calibration standards, request nationally recognized standards as specified or required. Request commercially available standards when not otherwise specified or required. Or, request standards in accordance with other related project-specific requirements.

PM or Designee and User - Require certifications for standards that clearly state the traceability.

PM or Designee and User - Note standards that are perishable and consume or dispose of them on or before the expiration date.

PM or Designee - Require Material Safety Data Sheet to be provided with standards.

5.9 M&TE That Fails Calibration

For any M&TE item that cannot be calibrated or adjusted to perform accurately:
PM or Designee - Immediately discontinue use and segregate the item from other equipment. Notify the appropriate PM and take appropriate action in accordance with the CDM QP 2.3 for nonconforming items.

PM or Designee - Review the current and previous maintenance and calibration records to determine if the validity of current or previous measurement and test results could have been affected and notify the appropriate PM(s) of the results of the review.

6.0 Restrictions/Limitations

On an item-by-item basis, exemptions from the requirements of this SOP may be granted by the HDQ health and safety manager and/or HDQ quality assurance director. All exemptions shall be documented by the grantor and included in the equipment records as appropriate.

7.0 References

CDM Federal Programs Corporation *Property Control Manual*. 2002. March.

APPENDIX C

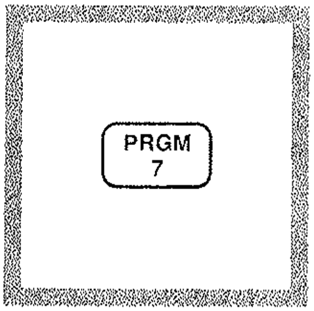
FERROUS IRON HACH METHOD

IRON, FERROUS (0 to 3.00 mg/L)

For water, wastewater, and seawater

1,10 Phenanthroline Method* (Powder Pillows or AccuVac Ampuls)

Using Powder Pillows



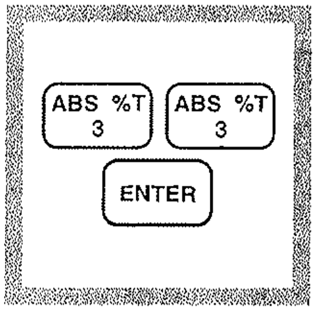
1. Enter the stored program number for Ferrous iron (Fe^{2+})- powder pillows.

Press: **PRGM**

The display will show:

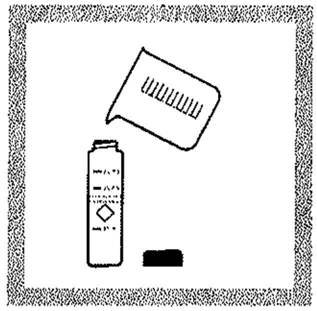
PRGM ?

Note: Analyze samples as soon as possible to prevent oxidation of ferrous iron to ferric iron, which is not determined.

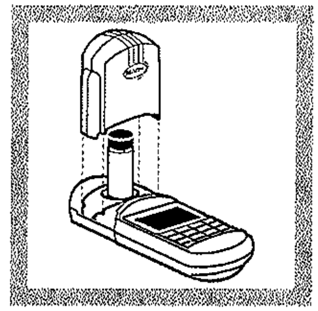


2. Press: **33 ENTER**

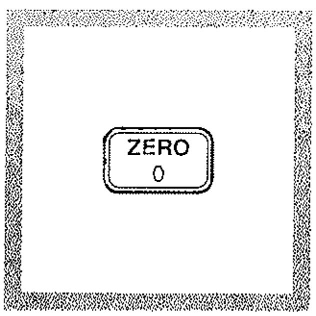
The display will show **mg/L, Fe** and the **ZERO** icon.



3. Fill a sample cell with 25 mL of sample (the blank).



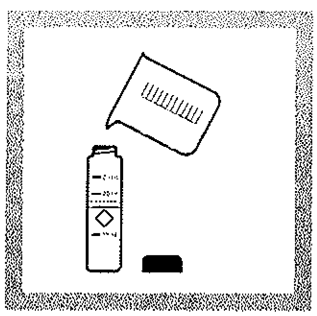
4. Place the blank into the cell holder. Tightly cover the sample cell with the instrument cap.



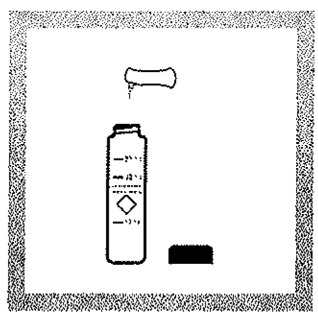
5. Press: **ZERO**

The cursor will move to the right, then the display will show:

0.00 mg/L Fe

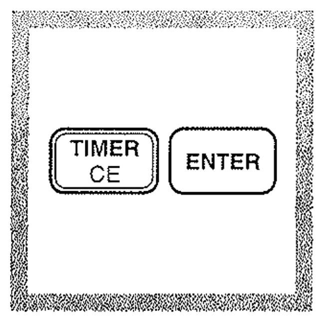


6. Fill another sample cell with 25 mL of sample.



7. Add the contents of one Ferrous Iron Reagent Powder Pillow to the sample cell (the prepared sample). Cap and invert to mix.

Note: Undissolved powder does not affect accuracy.



8. Press:

TIMER ENTER

A three-minute reaction period will begin.

Note: An orange color will form if ferrous iron is present.

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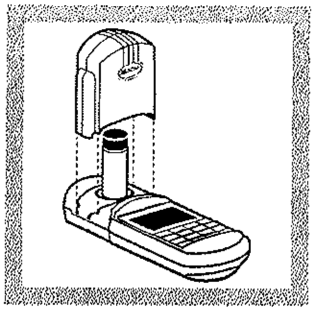
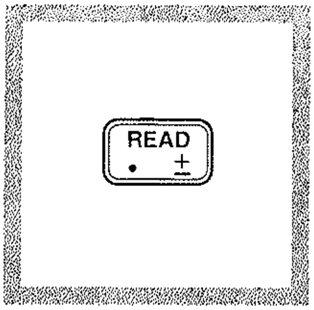
* Adapted from *Standard Methods for the Examination of Water and Wastewater.*



9. Place the prepared sample into the cell holder. Tightly cover the sample cell with the instrument cap.

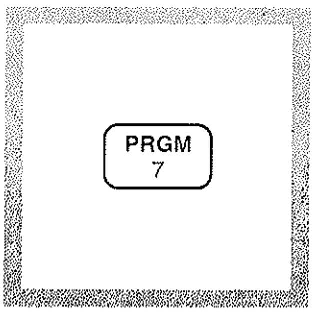


10. Press: **READ**

The cursor will move to the right, then the result in mg/L ferrous iron will be displayed.

Note: Standard Adjust may be performed using a prepared standard (see Section 1).

Using AccuVac Ampuls



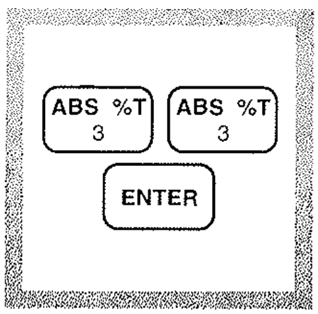
1. Enter the stored program number for ferrous iron (Fe^{2+}) AccuVac ampuls.

Press: **PRGM**

The display will show:

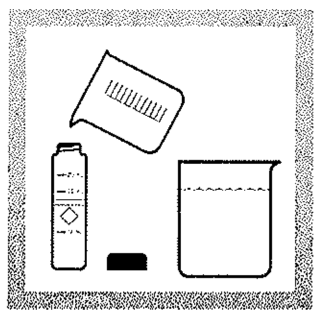
PRGM ?

Note: Analyze samples as soon as possible to prevent air oxidation of ferrous iron to ferric, which is not determined.

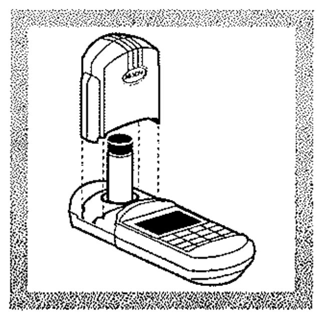


2. Press: **33 ENTER**

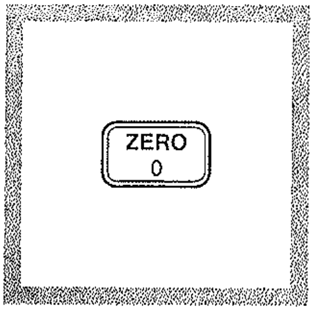
The display will show **mg/L, Fe** and the **ZERO** icon.



3. Fill a sample cell with at least 10 mL of sample (the blank). Collect at least 40 mL of sample in a 50-mL beaker.



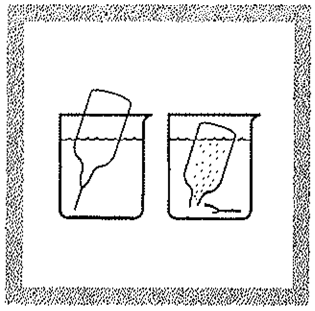
4. Place the blank into the cell holder. Tightly cover the sample cell with the instrument cap.



5. Press: **ZERO**

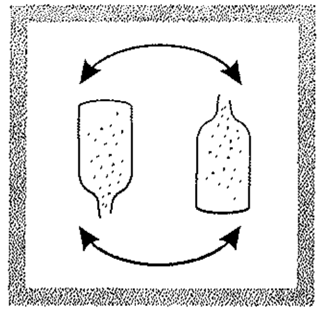
The cursor will move to the right, then the display will show:

0.00 mg/L Fe



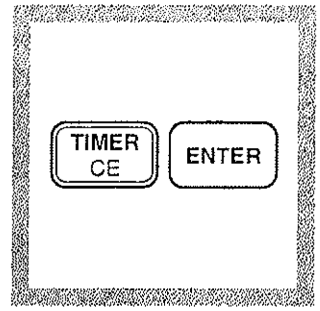
6. Fill a Ferrous Iron AccuVac Ampul with sample.

Note: Keep the tip immersed while the ampul fills completely.



7. Quickly invert the ampul several times to mix. Wipe off any liquid or fingerprints.

Note: Undissolved powder does not affect accuracy.

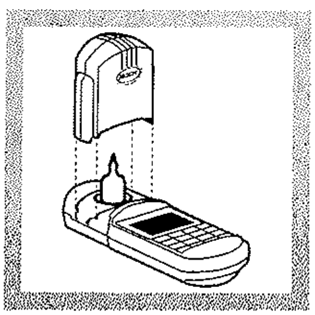


8. Press:

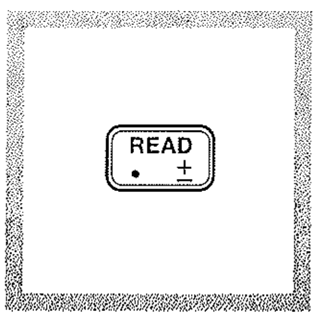
TIMER ENTER

A three-minute reaction period will begin.

Note: An orange color will form if ferrous iron is present.



9. Place the AccuVac ampul into the cell holder. Tightly cover the sample cell with the instrument cap.



10. Press: **READ**

The cursor will move to the right, then the result in mg/L ferrous iron will be displayed.

Note: Standard Adjust may be performed using a prepared standard (see Standard Adjust in Section 1).

Sampling and Storage

Ferrous iron must be analyzed immediately and cannot be stored. Analyze samples as soon as possible to prevent oxidation of ferrous iron to ferric iron, which is not measured.

Accuracy Check

Standard Solution Method
Prepare a ferrous iron stock solution (100 mg/L Fe^{2+}) by dissolving 0.7022 grams of ferrous ammonium sulfate, hexahydrate, in deionized water. Dilute to 1 liter. Prepare immediately before use. Dilute 1.00 mL of this solution to 100 mL with deionized water to make a 1.00 mg/L standard solution. Prepare immediately before use.

Run the test using the 1.00 mg/L Fe^{2+} Standard Solution by following either the powder pillow or AccuVac procedure. Results should be between 0.90 mg/L and 1.10 mg/L Fe^{2+}.

Method Performance

Precision
In a single laboratory using an iron standard solution of 2.00 mg/L Fe^{2+} and two representative lots of powder pillow reagents with the instrument, a single operator obtained a standard deviation of ±0.017 mg/L Fe^{2+}.

In a single laboratory using a standard solution of 2.00 mg/L Fe^{2+} and two representative lots of AccuVac ampuls with the instrument, a single operator obtained a standard deviation of ±0.009 mg/L Fe^{2+}.

Estimated Detection Limit
The estimated detection limit for program 33 (powder pillows and AccuVac Ampuls) is 0.03 mg/L Fe. For more information on the estimated detection limit, see *Section 1*.

Summary of Method

The 1,10-phenanthroline indicator in Ferrous Iron Reagent reacts with ferrous iron in the sample to form an orange color in proportion to the iron concentration. Ferric iron does not react. The ferric iron (Fe^{3+}) concentration can be determined by subtracting the ferrous iron concentration from the results of a total iron test.

REQUIRED REAGENTS & APPARATUS (USING POWDER PILLOWS)

Description	Quantity Required Per Test	Units	Cat. No.
Ferrous Iron Reagent Powder Pillows	1 pillow	100/pkg	1037-69
Sample Cell, 10-20-25 mL, w/ cap	2	6/pkg	24019-06

REQUIRED REAGENTS & APPARATUS (USING ACCUVAC AMPULS)

Ferrous Iron Reagent AccuVac Ampuls	1 ampul	25/pkg	25140-25
Beaker, 50 mL	1	each	500-41H

OPTIONAL REAGENTS

Ferrous Ammonium Sulfate, hexahydrate, ACS	113 g	11256-14
Water, deionized	4 L	272-56

OPTIONAL APPARATUS

AccuVac Snapper Kit	each	24052-00
Balance, analytical, 115 V, 0.1 mg	each	28014-01
Balance, analytical, 230 V, 0.1 mg	each	28014-02
Clippers, for opening powder pillows	each	968-00
Flask, volumetric, 100 mL, Class A	each	14574-42
Flask, volumetric, 1000 mL, Class A	each	14574-53
Pipet, volumetric, Class A, 1.00 mL	each	14515-35
Pipet Filler, safety bulb	each	14651-00
Weighing Boat, 67/46 mm, 8.9 cm square	500/pkg	21790-00

For Technical Assistance, Price and Ordering

In the U.S.A.—Call 800-227-4224

Outside the U.S.A.—Contact the Hach office or distributor serving you.

APPENDIX D

CDM DV SOP 029A, REVISION 0

PACKAGE COMPLETENESS AND DELIVERABLES

CASE NUMBER:______________________ LAB: ______________________

SITE: ____

			Yes	No	N/A
1.0	Data Completeness and Deliverables				
	1.1	Has all data been submitted in a CLP or CLP-like deliverable format?	[]	___	___
	1.2	Have any missing deliverables been received and added to the data package?	[]	___	___

ACTION: Call lab for explanation/resubmittal of any missing deliverables. If lab cannot provide them, note the effect on review of the data in the reviewer narrative.

2.0	Cover Letter, SDG Narrative				
	2.1	Is a laboratory narrative or cover letter present?	[]	___	___
	2.0	Are the case number and/or SDG number contained in the narrative or cover letter?	[]	___	___
3.0	Data Validation Checklist				
	3.1	Does this data package contain:			
		Water data?	[]	___	___
		Waste data?	[]	___	___
		Soil/Solid data?	[]	___	___

GENERAL CHEMISTRY ANALYSES

			Yes	No	N/A
I.	Traffic Reports and Laboratory Narrative				
	1.1	Are traffic report and/or chain-of-custody forms present for all samples?	[]	___	___

ACTION: If no, contact lab for replacement of missing or illegible copies. Qualify samples that are not traceable through signature records on COC's "R."

1.2 Do the traffic reports and/or chain-of-custody forms or SDG narrative indicate any problems with sample receipt, condition of the samples, analytical problems or special circumstances affecting the quality of the data? [] ___ ___

ACTION: If samples were not iced or if the ice was melted upon arrival at the laboratory and the temperature of the cooler was elevated (> 10 degrees Celcius), flag all positive results "J" and all nondetects "UJ."

2.0 Holding Times and Preservation

2.1 Have any general chemistry parameters holding times, determined from the date of collection to date of extraction, been exceeded? [] ___ ___

2.2 Were all general chemistry parameters preserved properly? [] ___ ___

ACTION: The following table indicates holding time and preservation requirements for some common wet chemistry parameters for water samples. If technical holding times are exceeded, flag all positive results as estimated "J," and sample quantitation limts (nondetects) as "UJ." Document in the narrative that holding times were exceeded. If analyses were performed beyond **twice** the holding time, either on the first analysis or upon reanalysis, the reviewer must use professional judgement to determine the reliability of the data and the effects of additional storage on the sample results. At a minimum, all the data should at least be qualified "J," but the reviewer may determine that non-detects are unusable "R."

Table 1.1 Wet Chemistry Paramcters Holding Times, Containers, and Preservatives

Parameters	Containers	Preservatives	Holding Times
Specific Conductance	Plastic (P) or glass (G)	4 ± 2°C	28 days
Hardness	P, G	HNO_3 to pH<2	6 months
Residue			
Filterable	P, G	4 ± 2°C	7 days
Nonfilterable	P, G	4 ± 2°C	7 days
Total	P, G	4 ± 2°C	7 days
Volatile	P, G	4 ± 2°C	7 days
Settleable Matter	P, G	4 ± 2°C	48 hours
Turbidity	P, G	4 ± 2°C	48 hours
Hexavalent chromium	P, G	4 ± 2°C	24 hours
Acidity and/or Alkalinity	P, G	4 ± 2°C	14 days

Table 1.1 Wet Chemistry Parameters Holding Times, Containers, and Preservatives

Parameters	Containers	Preservatives	Holding Times
Ammonia	P, G	4 ± 2°C, H_2SO_4 to pH<2	28 days
Bromide	P, G	None required	28 days
Chromium, hexavalent	P, G	4 ± 2°C	30 days to soil extraction 24 hours-aqueous
Chloride	P, G	4 ± 2°C	28 days
Chlorine	P, G	None required	Analyze immediately
Cyanides	P, G	4 ± 2°C NaOH to pH>12 0.6 g ascorbic acid*	14 days
Ferrous Ion (Iron II)	P, G	4 ± 2°C	Analyze immediately
Fluoride	P, G	None required	28 days
Iodide	P, G	4 ± 2°C	24 hours
Nitrogen			
Ammonia	P, G	4 ± 2°C, H_2SO_4 to pH<2	28 days
Kjeldahl, total	P, G	4 ± 2°C, H_2SO_4 to pH<2	28 days
Nitrate plus Nitrite	P, G	4 ± 2°C, H_2SO_4 to pH<2	28 days
Nitrate	P, G	4 ± 2°C	48 hours
Nitrite	P, G	4 ± 2°C	48 hours
Phosphorus			
Orthophosphate, dissolved	P, G	Filter on site; 4 ± 2°C	48 hours
Hydrolyzable	P, G	4 ± 2°C, H_2SO_4 to pH<2	28 days
Total	P, G	4 ± 2°C, H_2SO_4 to pH<2	28 days
Total, dissolved	P, G	4 ± 2°C, H_2SO_4 to pH<2; Filter on site	24 hours
Silica	P, G	4 ± 2°C	28 days
Sulfate	P, G	4 ± 2°C	28 days
Sulfide	P, G	4 ± 2°C, add 2 mL zinc acetate plus NaOH to pH>9	7 days
Sulfite	P, G	None required	Analyze immediately
Biochemical Oxygen Demand	P, G	4 ± 2°C	48 hours
Chemical Oxygen Demand	P, G	4 ± 2°C, H_2SO_4 to pH<2	28 days
Oil & Grease	G only	4 ± 2°C, H_2SO_4 to pH<2	28 days

Table 1.1 Wet Chemistry Parameters Holding Times, Containers, and Preservatives

Parameters	Containers	Preservatives	Holding Times
Organic Carbon	P, G	4 ± 2°C, H_2SO_4 or HCl to pH<2	28 days
Phenolics	G only	4 ± 2°C, H_2SO_4 to pH<2	28 days

* Only used in the presence of residual chlorine.
See the Lloyd Kahn method for requirements for soil total organic carbon (TOC)

3.0 Calibration and Performance

NOTE: Specific deliverables will depend on the method and instrumentation used for analysis. Some of these deliverables may not be applicable to all general chemistry methods: initial and continuing calibration results, sample preparation log, and analytical run log.

3.1 Was the instrument calibrated at the appropriate frequency? ☐ ___ ___

NOTE: Initial calibration must be performed before any samples are analyzed. Continuing calibration samples should be analyzed at a 10% frequency. If not document this occurrence in the validation narrative. If no calibration was performed, "R" all sample results.

3.2 Were the minimum number of standards used in calibrating the instrument? ☐ ___ ___

NOTE: At a minimum, a three- to five-point curve bracketing sample concentration, plus a blank, must be generated daily for most wet chemical methods. The correlation coefficient for a linear standard curve must be ≥0.995. For gravimetric methods, evidence of balance calibration must be provided. For titrimetric methods, documentation of titrant standardization must be provided. If a pH meter is used for the analysis, the meter must be calibrated with at least two pH buffer solutions.

3.3 Were the correlation coefficients ≥0.995? ☐ ___ ___

ACTION: If the calibration correlation coefficient for the standard curve is <0.995, qualify results greater than te reporting limit as estimated "J," and results less than the reporting limit as estimated "UJ."

3.4 Were appropriate standard concentrations used? ☐ ___ ___

3.5 Were continuing calibration recoveries within control limits? ☐ ___ ___

NOTE: For continuing calibration, the percent recovery for the calibration verification analysis should be within limits established by the laboratory or a specified in the analytical method. In the absence of such limits, it is recommended that limit of 90-110%R is used.

ACTION: If the %R for the continuing calibration is outside laboratory-generated or method-specific limits, the following action is to be taken:

- If the %R is greater than the upper control limit, qualify all associated detected results as estimated "J." Nondetected results do not require qualification.
- If the %R is less than the lower control limit, qualify all associated results as estimated, "J " or "UJ."

In the absence of laboratory-generated or method-specified criteria, control limits of 90-110%R shall be used, and the following action taken in addition to the what is stated above:

- If the %R is >125%, qualify positive results as unusable "R"; nondetected results are acceptable.
- if the %R is <75%, qualify all results (detects and nondetects) as unusable, "R."

4.0 Blanks (Laboratory and Field)

4.1 Were method blanks and instrument blanks prepared and/or analyzed at the appropriate frequency?(every 20 samples of similar matrix or each extraction batch) [ ] ___ ___

NOTE: If blank data are missing or not available, reject "R" all associated positive data. However, using professional judgement, the data reviewer may substitute field blank data for missing method blank data.

4.2 Were sample results verified as uncorrected for blank concentrations? [ ] ___ ___

4.3 Were all blanks evaluated for contamination? [ ] ___ ___

4.4 Were negative concentrations in the blanks evaluated? [ ] ___ ___

4.5 Do any method/instrument blanks have positive results? [ ] ___ ___

ACTION: If the blank result has an absolute value less than or equal to the reporting limit, no qualification of data is necessary.

- If the reported blank result is greater than or equal to the reporting limit, qualify all sample results greater than the reporting limit but < 5x the amount in any blank as undetected, "U." Sample results >5x the blank concentration require no qualification.
- If the blank result is negative, and the absolute value is greater than the reporting limit, all associated samples must be carefully examined. Sample results reported as positive, but <5x the absolute value of the blank shall be qualified as estimated "J," and sample results reported

as undetected will be qualified as estimated "UJ."

- if gross contamination is present, the affected analyte in associated samples may be qualified as unusable, "R."

4.6 Do any field/rinse/equipment blanks have positive results? [] ___ ___

NOTE: All field blank results associated with a particular group of samples may be used to qualify data. Blanks may not be qualified because of contamination in another blank. Field blanks may be qualified because of calibration and LCS quality control problems.

ACTION: If the sample result is greater than the RDL but <5x the blank result, qualify the sample result as nondetect, "U."

- If the sample result is less than the RDL but <5x the blank result, qualify the sample result as nondetect, "U."

- If the sample result is greater than the RDL and >5x the blank result, no qualification is necessary.

- If gross contamination exists, all data in the associated samples should be qualified as unusable "R."

5.0 <u>QC Check Sample (LCS)</u>

5.1 Have LCS results been included in the data package? [] ___ ___

5.2 Was the LCS prepared and analyzed at the appropriate frequency? [] ___ ___

5.3 Were percent recoveries within acceptance limits? [] ___ ___

NOTE: If laboratory-generated control limits or vendor-supplied limits are not provided, control limits of 80-120%R shall be used.

ACTION: If the LCS recovery falls within the range of 50-79% or >120%, qualify detected results as estimated, "J."

- If the LCS recovery is >120%, nondetected results are acceptable and no qualification is required.

- If the LCS recovery falls within the range of 50-79%, nondetected results are qualified as estimated, "UJ."

- If the LCS recovery results are <50%, qualify positive results as estimated, "J," and nondetected results as unusable, "R."

6.0 <u>Matrix Spike/Matrix Spike Duplicates (MS/MSD)</u>

NOTE: Qualification must not be applied to sample data based on MS/MSD data alone, but should be used in conjunction with other QC parameters in judging data usability and the need for data qualification.

Spike recoveries should be within control limits generated by the laboratory. If laboratory-generated control limts are not provided, limits of 75-125%R shall be used.

Relative percent difference (RPD) between MS and MSD results must be within control limits generated by the laboratory. If laboratory-generated RPDs are not provided, control limts of +/- 20% RPD for aqueous samples and +/-35% RPD for soil samples shall be used.

6.1 Have MS/MSD results been included in the data package? [] ___ ___

6.2 Were the MS/MSD analyzed at the appropriate frequency for each of the following matrices?

Water? [] ___ ___

Waste? [] ___ ___

Soil/Solid? [] ___ ___

6.3 Are MS/MSD percent recoveries within acceptance criteria? [] ___ ___

ACTION: If the validator determines that data qualification is justified based on MS recoveries, the following guidance shall be used:

- If MS recoveries are above the upper control limit, qualify detected analytes as estimated,"J." (Nondetects do not require qualification)
- If MS recoveries are below the lower control limit, qualify detected analytes as estimated, "J," and nondetects as estimated, "UJ" or "R."

6.4 Are all MS/MSD RPDs within control criteria? [] ___ ___

ACTION: If RPDs are outside control limits, qualify detected results as estimated, "J."

7.0 <u>Field and Laboratory Duplicates</u>

7.1 Were field duplicates collected and analyzed with these samples? [] ___ ___

7.2 Were the field duplicate RPDs within acceptable control criteria? [] ___ ___

NOTE: Field duplicate criteria for aqueous samples shall be less than 40% RPD. The field duplicate criteria for soil/solid samples shall be less than 70%.

ACTION: If the field duplicate is greater than 40% for aqueous samples or greater than 70% for soil/solid samples, qualify all detected results as estimated "J." (Nondetect results do not require qualification).

7.3 Were laboratory duplicates performed with each sample batch? [] ___ ___

7.4 Were laboratory duplicate RPDs within acceptable control limits? [] ___ ___

NOTE: If laboratory duplicate RPD is not established, use +/-20% for aqueous sample results, and +/-35% for soil/solid sample results.

ACTION: If laboratory duplicate RPD results are greater than 20% for aqueous samples, or greater than 35% for soil/solid samples, qualify all detected results as estimated "J." (Nondetect results do not require qualification).

8.0 <u>Sample Result Verification</u>

8.1 Are there any transcription/calculation errors in the Form I or equivalent results? Check at least two positive values. Were any errors found? [] ___ ___

NOTE: If the laboratory has a high rate of manual transcription in generation of sample results, the project team may choose to manually recalculate sample results at a determined frequency. If the sample results cannot be reproduced through manual calculation, contacting the laboratory may be necessary to resolve the problem. Data may be qualified as rejected "R" as a last resort if no actions can reproduce reported values.

8.2 Were reported results within the calibration range of the instrument? [] ___ ___

8.3 Were results from diluted samples corrected for the dilution factor? [] ___ ___

8.4 Are the RDLs or EDLs (estimated detection limits) adjusted to reflect sample dilutions and , for soils, %moisture? [] ___ ___

ACTION: When a sample is analyzed at more than one dilution, the lowest EDL/RDL are used. Replace concentrations that exceed the calibration range in the original analysis by crossing out the value on the original Form I or equivalent and substituting it with data from the analysis of the diluted sample. Specify which Form I or equivalent is to be used, then draw a red "X" across the entire page of all Form I's or equivalent that should not be used, including any in the summary package.