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SAMPLING AND ANALYSIS PLAN FOR SITE INVESTIGATION AT UST SITE 9, FUEL FARMS 217 AND 244, NAS CORPUS CHRISTI TX

9/1/2013

RESOLUTION CONSULTANTS

SAMPLING AND ANALYSIS PLAN

SITE INVESTIGATION
UNDERGROUND STORAGE TANK SITE 9, FUEL FARMS 244 AND 217
NAVAL AIR STATION CORPUS CHRISTI
CORPUS CHRISTI, TEXAS

Version Number: 0

Prepared For:

Department of the Navy
Naval Facilities Engineering Command Southeast
Building 135 North, P.O. Box 30
Jacksonville, Florida 32212-0030

Prepared By:

Resolution Consultants
A Joint Venture of AECOM & EnSafe
1500 Wells Fargo Building
440 Monticello Avenue
Norfolk, Virginia 23510

Contract Number: N62470-11-D-8013
CTO JM46

September 2013

SAP WORKSHEET #1: TITLE AND APPROVAL PAGE

(UFP-QAPP Manual Section 2.1)

SAMPLING AND ANALYSIS PLAN

Site Investigation
Underground Storage Tank Site 9, Fuel Farms 244 and 217
Naval Air Station Corpus Christi
Corpus Christi, Texas

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Project Chemist/ Quality Assurance Officer/Date

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Arne Olsen, NAVFAV SE
Remedial Project Manager/Date

EXECUTIVE SUMMARY

Resolution Consultants has prepared this Uniform Federal Policy Sampling and Analysis Plan under the Comprehensive Long-Term Environmental Action Navy Contract No. N62470-11-D-8013 Contract Task Order JM46. This Uniform Federal Policy Sampling and Analysis Plan has been prepared for a Site Investigation (SI) to address the potential release of petroleum contamination from Underground Storage Tank Site 9, which includes underground storage tanks in the former Fuel Farms 217 and 244 at Naval Air Station Corpus Christi, Texas.

This SI is intended to establish whether a release to environmental media has occurred, and whether either fuel farm site merits additional investigation or a no further action determination in accordance with state and federal requirements. The SI sampling plan will closely follow the recommendations in Texas Commission on Environmental Quality publication RG-411, *Investigating and Reporting Releases from Petroleum Storage Tanks (PST) (*August 2012). The SI sampling plan also takes into consideration the evaluation of lead scavengers in groundwater based on recommendations in the May 2010 U.S. Environmental Protection Agency (U.S. EPA) Memorandum: *Recommendations for States, Tribes, and EPA Regions to Investigate and Clean Up Lead Scavengers When Present at Leaking Underground Storage Tank (LUST) Sites.*

This SAP outlines the organization, objectives, planned activities, and data review/reporting procedures associated with the SI. Protocols for sample collection, handling, and storage, chain-of-custody, laboratory and field analyses, data validation, and reporting are also addressed herein. This SAP was generated for, and complies with, applicable United States Department of the Navy, U.S. EPA Region 6, and Texas Commission on Environmental Quality requirements, regulations, guidance, and technical standards, as appropriate. This includes the Department of Defense, Department of Energy, and U.S. EPA Interagency Data Quality Task Force environmental requirements regarding federal facilities, as specified in the Uniform Federal Policy Quality Assurance Project Plan guidance (U.S. EPA 2005) and the Navy's SAP guidance. Field activities conducted under this SAP will be conducted in accordance with Resolution Consultants' Standard Operating Procedures and a Site-Specific Health and Safety Plan.

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Appendices

Appendix A Field Standard Operating Procedures

List of Acronyms

bgs	Below ground surface
BTEX	Benzene, toluene, ethylbenzene, xylenes
CAS	Chemical Abstracts Service
CCC	Calibration check compounds
CLEAN	Comprehensive Long-Term Environmental Action Navy
COPC	Contaminant of potential concern
CSM	Conceptual site model
CTO	Contract task order
1,2-DCA	1,2 dichloroethane
DL	Detection limit
DO	Dissolved oxygen
DoD	Department of Defense
DPT	Direct push technology
DQO	Data quality objective
DVA	Data Validation Assistant
EB	Equipment blank
EDB	Ethylene dibromide
EDD	Electronic data deliverable
EICP	Extracted ion current profile
ELAP	Environmental Laboratory Accreditation Program
eQAPP	Electronic Quality Assurance Project Plan
FD	Field duplicate
FF	Fuel Farm
FID	Flame ionization detector
FRC	Federal Records Center
FTL	Field team leader
GCAL	Gulf Coast Analytical Laboratories
GC	Gas chromatograph
GC/ECD	Gas chromatograph/electron capture detector
GC/MS	Gas chromatograph/mass spectrometer
HSM	Health and safety manager
ICAL	Initial calibration
IDW	Investigation derived waste
LCS	Laboratory control sample
LOD	Limit of detection
LOQ	Limit of quantitation
LPST	Leaking petroleum underground storage tank

List of Acronyms (continued)

mg/kg	Milligrams per kilogram
mg/L	Milligrams per Liter
µg/L	Micrograms per Liter
MPC	Measurement performance criteria
MS/MSD	Matrix spike/matrix spike duplicate
MTBE	Methyl tert-butyl ethylene
mV	MilliVolt
MQL	Method quantitation limit
NAPL	Non-aqueous phase liquid
NAS	Naval Air Station
NAVFAC	Naval Facilities Engineering Command
NAVFAC SE	Naval Facilities Engineering Command Southeast
NELAP	National Environmental Laboratory Accreditation Program
NIRIS	Naval Installation Restoration Information Solution
NTU	Ne turbidity unit
ORP	Oxidation reduction potential
PAH	Polynuclear aromatic hydrocarbon
PAL	Project action level
PID	Photoionization detector
PM	Project manager
POC	Point of contact
PSQ	Principal study question
PST	Petroleum storage tank
QA	Quality assurance
QAO	Quality assurance officer
QAPP	Quality assurance project plan
QC	Quality control
QSM	Quality Systems Manual
r	Linear least squares regression
r^2	Non-linear regression-coefficient of determination
%R	Percent recovery
RCRA	Resource Conservation and Recovery Act
RF	Response factor
RPD	Relative percent difference
RPM	Remedial project manager
RRT	Relative retention time
RT	Retention time
RSD	Relative standard deviation

List of Acronyms (continued)

SAP	Sampling and analysis plan
SI	Site Investigation
SIM	Selective ion monitoring
SOP	Standard operating procedure
SPCC	System performance check compound
SRA	Screening risk assessment
SSO	Site safety officer
SWMU	Solid waste management unit
TAC	Texas Administrative Code
TBD	To be determined
TCEQ	Texas Commission on Environmental Quality
TDEM	Time domain electromagnetics (geophysics technique)
TOM	Task order manager
TPH	Total petroleum hydrocarbon
TRRP	Texas Risk Reduction Program
$TX\ ^{GW}GW_{Class\ 3}$	Texas Class 3 Groundwater Protective Concentration Level
UFP	Uniform Federal Policy
U.S. EPA	U.S. Environmental Protection Agency
UST	Underground storage tank
VOC	Volatile organic compounds

SAP WORKSHEET #2: SAMPLING AND ANALYSIS PLAN IDENTIFYING INFORMATION

(UFP-QAPP Manual Section 2.2.4)

Site Name/Number: Underground Storage Tank Site 9, Former Fuel Farms 217 and 244, Naval Air Station (NAS) Corpus Christi, Texas

Contractor Name: Resolution Consultants

Contract Title: Comprehensive Long-term Environmental Action (CLEAN)

Contract Number: N62470-11-D-8013

Work Assignment No: JM46

1. This sampling and analysis plan (SAP) was prepared in accordance with the requirements of the *Uniform Federal Policy for Quality Assurance Plans (UFP-QAPP)* (U.S. EPA 2005) and United States Environmental Protection Agency (U.S. EPA) *Guidance for Quality Assurance Project Plans, EPA QA/G-5* (U.S. EPA 2002).

2. Identify regulatory program: National Oil and Hazardous Substances Pollution Contingency Plan and Comprehensive Environmental Response, Compensation, and Liability Act of 1980 ; Texas Petroleum Storage Tank Program requirements established at Chapter 334 of Title 30 Texas Administrative Code and as outlined by Texas Commission on Environmental Quality (TCEQ) guidance RG-411, *Investigating and Reporting Releases from Petroleum Storage Tanks (PST) (*August 2012).

3. This SAP is a project-specific SAP.

4. List organizational partners (stakeholders) and identify the connection with lead organization:

Organization Partners/Stakeholders	Connection
U.S. EPA Region 6	Lead Regulatory Oversight
Texas Commission on Environmental Quality	Lead Regulatory Oversight
Naval Facilities Engineering Command Southeast	Lead Agency
NAS Corpus Christi	Property Owner
Resolution Consultants	Tier I Team Partner
The Management Edge	Tier I Team Partner

5. Lead organization: Naval Facilities Engineering Command Southeast

6. If any required SAP elements and required information are not applicable to the project or are provided elsewhere, then note the omitted SAP elements and provide an explanation for their exclusion below: Not Applicable, as there are no exclusions.

SAP WORKSHEET #3: DISTRIBUTION LIST

(UFP-QAPP Manual Section 2.3.1)

SAP Recipients	Title	Organization	Telephone Number	E-mail Address or Mailing Address
Arne Olsen	Navy Remedial Project Manager	Naval Facilities Engineering Command, Southeast 135 Ajax Street North, PO Box 30 Jacksonville, Florida 32212-0030	904-542-6159 904-654-3059 (cell)	arne.olsen@navy.mil
Ross Ybarra	Lead Environmental Protection Specialist/Point of Contact	Naval Air Station Corpus Christi, Public Works Department 11001 D Street, Building 19 Corpus Christi, Texas 78419	361-961-2170 361-658-9572 (cell)	ross.ybarra@navy.mil
Tara Hubner	Project Manager	U.S. Environmental Protection Agency Region 6, Multimedia Planning and Permitting Division (6PD) RCRA Federal Facilities Section 1445 Ross Avenue, Suite 200 Dallas, Texas 75202	214-665-7246 972-571-2439 (cell)	hubner.tara@epa.gov
Allan Posnick	Project Manager	Texas Commission on Environmental Quality PO Box 13087 Austin, Texas 78711	512-239-2332 512-739-0668 (cell)	allan.posnick@tceq.texas.gov
Claire Barnett	Task Order Manager	Resolution Consultants 5724 Summer Trees Drive Memphis, Tennessee 38134	901-937-4425 901-634-4554 (cell)	cbarnett@ensafe.com
Ben Elliott	Project Engineer/ Technical Lead	Resolution Consultants 10918 Whisper Valley San Antonio, Texas 78230	210-545-9527 512-635-4229 (cell)	belliott@ensafe.com
Tina Cantwell	Project Chemist/Data Manger/Quality Assurance Officer	Resolution Consultants 2724 Summer Trees Drive Memphis, Tennessee 38134	901-937-4315	tcantwell@ensafe.com
Brett Hamby	Field Team Leader	Resolution Consultants 4545 Fuller Drive, Suite 342 Irving, Texas 75038	972-791-3222 940-577-5755 (cell)	bhamby@ensafe.com
Brenda Martinez	Laboratory Project Manager	Gulf Coast Analytical Laboratories 7979 GSRI Rd. Baton Rouge, Louisiana 70820	225-769-4900	brenda.martinez@gcal.com

SAP WORKSHEET #4: PROJECT PERSONNEL SIGN-OFF SHEET

(UFP-QAPP Manual Section 2.3.2)

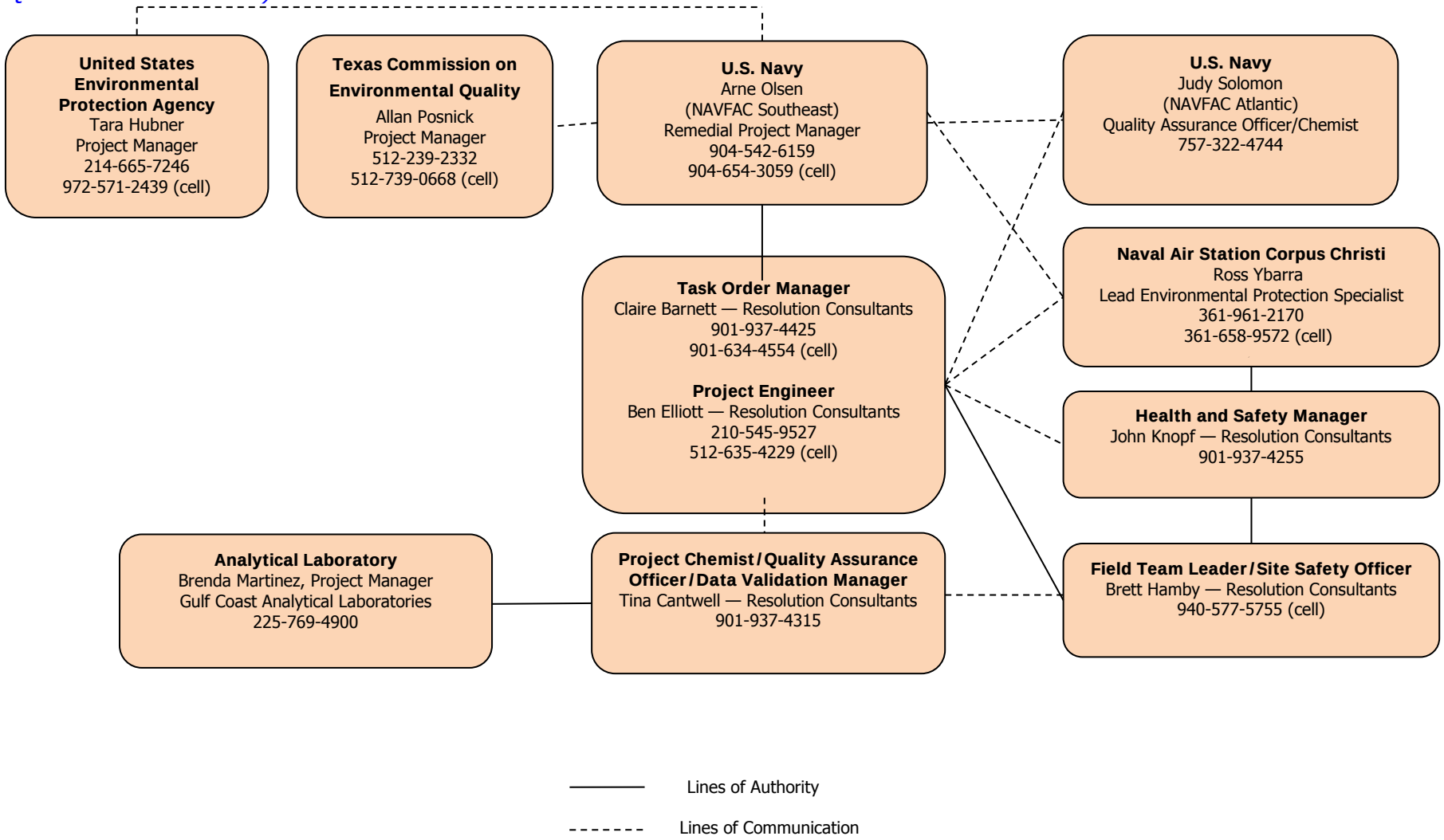
Project Personnel Sign-Off Sheet					
Name	**Organization/Title/Role**	**Telephone Number**	**Signature/e-mail receipt**	**SAP Section Reviewed**	**Date SAP Read**
Navy and Regulator Project Team Personnel					
Arne Olsen	Navy Remedial Project Manager	904-542-6159		All	
Ross Ybarra	NAS Corpus Christi Point of Contact	361-961-2170		All	
Tara Hubner	U.S. EPA Region 6 Project Manager	214-665-7246		All	
Allan Posnick	TCEQ Project Manager	512-239-2332		All	
Resolution Consultants Project Team Personnel					
Claire Barnett	Resolution Consultants/TOM	901-937-4425		All	
Ben Elliott	Resolution Consultants/Project Engineer	512-635-4229 (cell)		All	
Tina Cantwell	Resolution Consultants/Chemist/QAO/ Data Manager	901-937-4315		All	
Brett Hamby	Resolution Consultants/Field Team Leader	940-577-5755		All	
Subcontractor Personnel					
Brenda Martinez	Laboratory Project Manager	225-769-4900		Worksheets #6, #12, #14, #15, #19, #20, #23-28, #30, and #34-36	

Notes:
Persons listed on this worksheet will be responsible for distributing the Sampling and Analysis Plan to the appropriate people within their organizations.

SAP = Sampling and Analysis Plan
U.S. EPA = United States Environmental Protection Agency
TCEQ = Texas Commission on Environmental Quality
NAS = Naval Air Station
TOM = Task Order Manager
QAO = Quality Assurance Officer

SAP WORKSHEET #5: PROJECT ORGANIZATIONAL CHART

(UFP-QAPP Manual Section 2.4.1)



SAP WORKSHEET #6: COMMUNICATION PATHWAYS

(UFP-QAPP Manual Section 2.4.2)

The communication pathways for the SAP are shown below.

Communication Drivers	Responsible Entity	Name	Phone Number	Procedure (Timing, Pathway To/From, etc.)
Regulatory Agency Interface	Navy RPM TCEQ RPM U.S. EPA RPM	Arne Olsen Allan Posnick Tara Hubner	904-542-6159 512-239-2332 214-665-7246	The Navy RPM informs the regulatory agencies of work progress on a periodic basis.
Field Progress Reports	Resolution Consultants FTL Resolution Consultants TOM	Brett Hamby Claire Barnett	940-577-5755 901-937-4425	The Resolution Consultants FTL will contact the Resolution Consultants TOM on a daily basis via phone, and every 1-2 days summarizing progress via e-mail.
Gaining Site Access	Resolution Consultants FTL NAS Corpus Christi POC	Brett Hamby Ross Ybarra	940-577-5755 361-961-2170	The Resolutions Consultants FTL will contact the NAS Corpus Christi POC verbally or via e-mail at least 3 days before commencement of field work to arrange for access to the site for all personnel.
SAP Changes prior to Field/ Laboratory work	Resolution Consultants TOM Navy RPM TCEQ RPM U.S. EPA RPM	Claire Barnett Arne Olsen Allan Posnick Tara Hubner	901-937-4425 904-542-6159 512-239-2332 214-665-7246	Any change of the approved SAP will be made only upon authorization by the Navy RPM and regulatory agencies. The Resolution Consultants TOM is responsible for initiating any SAP change requests via the communication channels described for the Navy and regulatory agencies.
Obtaining Utility Clearances for Intrusive Activities	Resolution Consultants FTL NAS Corpus Christi POC	Brett Hamby Ross Ybarra	940-577-5755 361-961-2170	The Resolution Consultants FTL will coordinate verbally or via e-mail with NAS Corpus Christi POC at least 7 days in advance of the site access to initiate the utility clearance process for all intrusive sampling locations. The Resolution Consultants FTL will contact both the Texas 811 utility locator service and NAS Corpus Christi POC verbally or via e-mail at least 3 days prior to commencement of field work to complete a utility clearance ticket for the areas under investigation.
Field Corrective Actions	Resolution Consultants FTL/SSO Resolution Consultants TOM Navy RPM	Brett Hamby Claire Barnett Arne Olsen	340-577-5755 901-937-4425 904-542-6159	FTL informs TOM verbally within same day; TOM informs Navy RPM via e-mail within 24 hours that corrective actions have been implemented. Corrective actions will be documented in weekly progress reports. Navy RPM will notify TCEQ and U.S. EPA of any significant corrective actions taken.

Communication Drivers	Responsible Entity	Name	Phone Number	Procedure (Timing, Pathway To/From, etc.)
Stop Work due to Safety Issues	Resolution Consultants TOM Resolution Consultants FTL/SSO Resolution Consultants HSM Navy RPM NAS Corpus Christi POC	Claire Barnett Brett Hamby John Knopf Arne Olsen Ross Ybarra	901-937-4425 940-577-5755 901-937-4255 904-542-6159 361-961-2170	Any field team member who observes an unsafe situation has the authority to stop work. The responsible party verbally informs the TOM and subcontractor within 1 hour of recommendation to stop work and within 24 hours of recommendation to restart work. Responsible party follows verbal notification with an e-mail to the Project Team within 24 hours. If a subcontractor is the responsible party, the subcontractor PM must verbally inform Resolution Consultants SSO within 15 minutes and the Resolution Consultants SSO will then follow the procedure listed above.
SAP Changes in the Field	Resolution Consultants FTL/SSO Resolution Consultants TOM Navy RPM TCEQ RPM U.S. EPA RPM	Brett Hamby Claire Barnett Arne Olsen Allan Posnick Tara Hubner	940-577-5755 901-937-4425 904-542-6159 512-239-2332 214-665-7246	FTL informs TOM verbally within the same day; TOM informs Navy RPM via e-mail within 24 hours; TOM sends a concurrence letter, if warranted, within 7 calendar days and the RPM signs the letter within 5 business days of receipt. The scope change is to be implemented before work is executed. Document the change on a field task modification request form (within 2 business days) or SAP amendment (within timeframe agreed to by Project Team). Any change of the approved SAP, affecting the scope or implementation of the sampling program, will be made only upon authorization of the Navy RPM and regulatory agencies.
Recommendations to stop work and initiate work upon corrective action	Resolution Consultants FTL/SSO Resolution Consultants TOM Navy RPM TCEQ RPM U.S. EPA RPM	Brett Hamby Claire Barnett Arne Olsen Allan Posnick Tara Hubner	940-577-5755 901-937-4425 904-542-6159 512-239-2332 214-665-7246	Responsible party verbally informs the TOM, FTL, and subcontractors within 1 hour of recommendation to stop work and within 24 hours of recommendation to restart work. Responsible party follows verbal notification with an e-mail to the Project Team within 24 hours. Significant corrective actions will be communicated to the regulatory agencies.
Sample Receipt Variances	Laboratory PM Resolution Consultants TOM Resolution Consultants FTL	Brenda Martinez Claire Barnett Brett Hamby	225-769-4900 901-937-4425 940-577-5755	The Laboratory PM will notify (verbally or via e-mail) the Resolution Consultants FTL immediately upon receipt of any chain of custody/sample variances for clarification or direction from the Resolution Consultants FTL. The Resolution Consultants FTL will notify (verbally or via e-mail) the Resolution Consultants TOM within 1 business day, if corrective action is required. The Resolution Consultants TOM will notify (verbally or via e-mail) the Laboratory PM and the Resolution Consultants FTL within 1 business day of any required corrective action.

Communication Drivers	Responsible Entity	Name	Phone Number	Procedure (Timing, Pathway To/From, etc.)
Analytical Data Quality Issues	Laboratory PM Resolution Consultants TOM Resolution Consultants Project Chemist Navy RPM	Brenda Martinez Claire Barnett Tina Cantwell Arne Olsen	225-769-4900 901-937-4425 901-397-4315 904-542-6159	The laboratory PM notifies (verbally or via e-mail) the Resolution Consultants chemist within 1 business day of when an issue related to laboratory data is discovered. Resolution Consultants chemist notifies Resolution Consultants TOM within 1 business day. Resolution Consultants chemist notifies the Resolution Consultants TOM verbally or via e-mail within 48 hours of validation completion that a non-routine and significant laboratory quality deficiency has been detected that could affect this project and/or other projects. Resolution Consultants TOM verbally advises the Navy RPM within 24 hours of notification from the project chemist. The Navy RPM takes corrective action that is appropriate for the identified deficiency. The Navy RPM, may at his discretion, contact the Navy QAO/Chemist for assistance in problem resolution. If there are significant data quality or non-useable data issues the Navy QAO/Chemist will be contacted to ensure the issues do not have the potential to impact other Navy projects.
Analytical Corrective Actions	Laboratory PM Resolution Consultants Chemist	Brenda Martinez Tina Cantwell	225-769-4900 901-397-4315	The laboratory shall notify the Resolution Consultants chemist of any analytical data anomaly within 1 business day of discovery. After the laboratory receives guidance from the Resolution Consultants chemist, the laboratory shall initiate any corrective action to prevent further anomalies.
Reporting Data Validation Issues/ Data Validation Corrective Actions	Resolution Consultants Project Chemist Resolution Consultants TOM	Tina Cantwell Claire Barnett	901-397-4315 901-937-4425	The Resolution Consultants project chemist/data validator, performing validation as specified in Worksheets #34, #35, and #36, will contact the laboratory as soon as possible if issues are found that require corrective action. If, the Resolution Consultants project chemist/data validator identifies non-usable data that require corrective action, the Resolution Consultants TOM will coordinate with the project chemist to take corrective action appropriate for the identified deficiency to ensure the project objectives are met. Corrective action may include resampling and/or reanalyzing the affected samples, as determined by the TOM.

Communication Drivers	Responsible Entity	Name	Phone Number	Procedure (Timing, Pathway To/From, etc.)
Notification of Non-Usable Data	Laboratory PM Resolution Consultants TOM Resolution Consultants Chemist Navy RPM TCEQ RPM U.S. EPA RPM	Brenda Martinez Claire Barnett Tina Cantwell Arne Olsen Allan Posnick Tara Hubner	225-769-4900 901-937-4425 901-397-4315 904-542-6159 512-239-2332 214-665-7246	If the laboratory determines that any data they have generated is non-usable, the Laboratory PM will notify (verbally or via e-mail) the Resolution Consultants project chemist within 1 business day of when the issue is discovered. The Resolution Consultants project chemist will notify (verbally or via e-mail) the Resolution Consultants TOM within 1 business day of the need for corrective action, if the non-usable data is a significant issue (i.e., critical sample data). Corrective action may include resampling and/or reanalyzing the affected samples. If the Resolution Consultants project chemist or data validator identifies non-usable data during the data validation process, the TOM will be notified verbally or via e-mail within 48 hours of validation completion that a non-routine and significant laboratory quality deficiency has resulted in non-usable data. The Resolution Consultants TOM will take corrective action appropriate for the identified deficiency to ensure the project objectives are met. The Resolution Consultants TOM will notify (verbally or via e-mail) the Navy RPM of any problems with the laboratory or analysis that could significantly affect the usability of the data or project failures that impact the ability to complete the scope of work. The Navy RPM, may at his discretion, contact the Navy QAO/Chemist for assistance in problem resolution. Such notification will be made within 1 business day of when the issue is discovered. The Navy RPM will notify the TCEQ RPM when any significant corrective action is taken.

Notes:

RPM	=	Remedial project manager	FTL	=	Field team leader
TOM	=	Task order manager	NAS	=	Naval Air Station
POC	=	Point of contact	SSO	=	Site safety officer
HSM	=	Health and safety manager	SAP	=	Sampling and Analysis Plan
TCEQ	=	Texas Commission on Environmental Quality	PM	=	Project manager
U.S. EPA	=	Environmental Protection Agency	QAO	=	Quality Assurance officer

SAP WORKSHEET #7: PERSONNEL RESPONSIBILITIES TABLE

(UFP-QAPP Manual Section 2.4.3)

Name	Title/Role	Organizational Affiliation	Responsibilities
Arne Olsen	Remedial Project Manager/ Manages project activities for the Navy	Naval Facilities Engineering Command, Southeast	Primary Point of Contact for the Navy. Oversees project implementation, including scoping, data review, and evaluation, on behalf of the Navy.
Ross Ybarra	Activity Point of Contact/ Oversees onsite project activities	Naval Air Station Corpus Christi	Point of Contact for base-specific activity. Oversees onsite activities.
Tara Hubner	Project Manager/ Regulatory Support	U.S. EPA Region 6	Functions as primary U.S. EPA interface. Participates in scoping and data review/evaluation, and provides review and approval of project deliverables.
Allan Posnick	Project Manager/ Regulatory Support	TCEQ	Functions as primary TCEQ interface. Participates in scoping and data review/evaluation, and provides review and approval of project deliverables.
Claire Barnett	Contractor Task Order Manager/ Manages project on a daily basis	Resolution Consultants	Primary point of contact for Resolution Consultants. Oversees project implementation, including financials, schedule, and technical aspects.
Ben Elliott	Contractor Project Engineer/ Manages project on a daily basis	Resolution Consultants	Secondary point of contact for Resolution Consultants. Assists in overseeing project implementation, including financials, schedule, and technical aspects.
Brett Hamby	Field Team Leader/Site Safety Officer/ Manages field operations and oversees site activities to ensure safety requirements are met	Resolution Consultants	Supervises, coordinates, and performs field activities. Responsible for onsite project-specific health and safety training and monitoring site conditions.
Tina Cantwell	Project Chemist/Quality Assurance Officer/Data Validation Manager/ Oversees quality and chemistry aspects of project	Resolution Consultants	As project chemist, prepares laboratory scopes of work, and coordinates laboratory related functions with laboratory. Performs or oversees data reviews and quality assurance of data validation deliverables. As quality assurance officer, ensures quality aspects of the project are implemented, documented, and maintained. As data validation manager, performs or oversees data validation and data input in both the project database and the Navy's Naval Installation Restoration Information Solution database.
John Knopf	Health and Safety Manager/ Oversees health and safety activities	Resolution Consultants	Oversees the Resolution Consultants Health and Safety Program.
Brenda Martinez	Laboratory Project Manager/ Analytical Subcontractor	Gulf Coast Analytical Laboratories	Oversees quality and technical aspects related to subcontracted analytical services.

Notes:
U.S. EPA = United States Environmental Protection Agency
TCEQ = Texas Commission on Environmental Quality

SAP WORKSHEET #8: SPECIAL PERSONNEL TRAINING REQUIREMENTS TABLE

(UFP-QAPP Manual Section 2.4.4)

All field personnel will have appropriate training to conduct the field activities to which they are assigned. Each site worker will be required to have completed appropriate Hazardous Waste Operations and Emergency Response training specified in Occupational Safety and Health Administration 29 Code of Federal Regulations 1910.120(e). Additionally, the field team leader will have the 30-hour Occupational Safety and Health Administration Standards for Construction training.

SAP WORKSHEET #9: PROJECT SCOPING SESSION PARTICIPANTS SHEET

(UFP-QAPP Manual Section 2.5.1)

Project Name:	Site Investigation		**Site Name:** UST Site 9, Former Fuel Farms 217 & 244	
Projected Sampling Date(s):	Fall 2013		**Site Location:** NAS Corpus Christi, Texas	
Project Manager:	Claire Barnett, PE/Ben Elliott, PE — Project Engineer			
Date of Session:	27 June 2013			
Scoping Session Purpose:	Conceptual Site Model, Data Quality Objectives, and Sampling Design			
Name	**Title/role**	**Affiliation**	**Phone #**	**E-mail Address**
Arne Olsen	Remedial Project Manager	NAVFAC SE	904-542-6159	arne.olsen@navy.mil
Ross Ybarra	Lead Environmental Protection Specialist/ Point of Contact	NAS Corpus Christi NAVFAC SE, Public Works Department	361-658-2170	ross.ybarra@navy.mil
Allan Posnick	Remedial Project Manager	TCEQ — Corrective Action	512-239-2332	allan.posnick@tceq.texas.gov
Tara Hubner	Remedial Project Manager	U.S. EPA Region 6	214-665-7246	hubner.tara@epa.gov
Ben Elliott	Project Engineer/Technical Lead	Resolution Consultants	512-635-4229	belliott@ensafe.com

Notes:

UST	=	Underground storage tank
NAS	=	Naval Air Station
NAVFAC SE	=	Department of the Navy, Naval Facilities Engineering Command Southeast
TCEQ	=	Texas Commission on Environmental Quality
U.S. EPA	=	U.S. Environmental Protection Agency

Comments/Decisions:

A site walk though was conducted during the 28 November 2012 partnering meeting at NAS Corpus Christi. At the request of the Navy Remedial Project Manager, on 14 June 2013, Resolution Consultants issued Sampling and Analysis Plan (SAP) worksheets #10, #11, and #17 to the project team for review prior to the data quality objectives (DQO) scoping session. The DQO scoping session was held on 27 June 2013 at the NAS Corpus Christi partnering team meeting in Austin, Texas. At the DQO scoping meeting, the project team reviewed and discussed the conceptual site models, project quality objectives/systematic planning process statements, and sampling design and rationale. The TCEQ and U.S. EPA requested clarification on the approach to vertical delineation of potential contamination, particularly with respect to groundwater.

Action Items:

Resolution Consultants was tasked with completing the full SAP and submitting it to the project team for review. The SAP will address temporary well completion, development, and abandonment requirements and will incorporate sampling requirements of the Texas PST Program as identified in TCEQ Guidance RG-411. The SAP also will address analysis for lead scavengers in groundwater in accordance with U.S. EPA's May 2010 technical memorandum.

Consensus Decisions:

None.

SAP WORKSHEET #10: CONCEPTUAL SITE MODEL

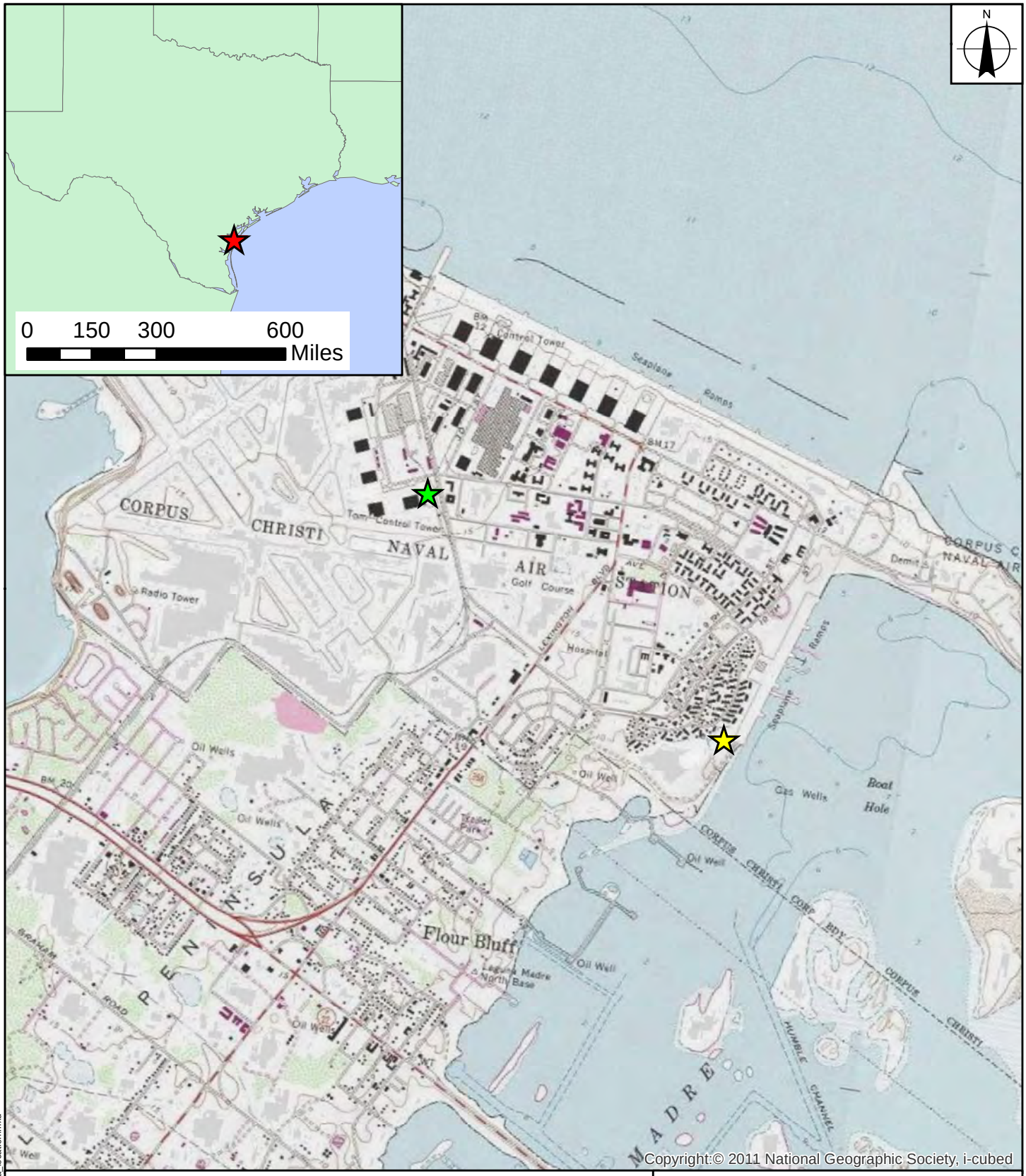
(UFP-QAPP Manual Section 2.5.2)

This worksheet presents a brief site description, history, and a preliminary conceptual site model (CSM) for Underground Storage Tank (UST) Site 9, which includes tanks in former Fuel Farms 217 and 244 at NAS Corpus Christi, Texas. Historical reports and records, including an *Initial Assessment Study of Naval Air Station Corpus Christi* (Navy 1984), a *RCRA Facility Assessment Evaluation Preliminary Review Visual Site Inspection and Sampling Visit* (U.S. EPA Region 6, 1989), and miscellaneous project files for Fuel Farm 244, were used to develop this preliminary CSM, which will be used in establishing the basis for the Site Investigation (SI) sampling and analysis program.

The following contaminants of potential concern (COPCs) have been determined based on historical documentation of operations at the site: benzene, toluene, ethylbenzene, and xylenes (BTEX), methyl tert-butyl ether (MTBE), total petroleum hydrocarbons (TPH), and polynuclear aromatic hydrocarbons (PAHs). This preliminary CSM will be refined following implementation of the SI to better define the COPCs, potential contamination routes and possible exposure pathways to humans and ecological receptors, and will serve as the basis for future phases and tasks that may be conducted at UST Site 9. At this time, the SI (and site DQOs) will be focused on meeting the requirements outlined by TCEQ guidance RG-411, *Investigating and Reporting Releases from Petroleum Storage Tanks (PST)* (August 2012). The requirements for the Texas PST Program are described in this guidance and are based on Title 30 of the Texas Administrative Code, Chapter 334 (30 TAC 334). The objective of the RG-411 site investigation approach is determining whether or not a PST site must be entered into the Texas PST program and issued a Leaking PST (LPST) number, and if the site warrants further investigation prior to closure under the requirements of 30 TAC 334 as administered by the TCEQ.

10.1 Site Description

NAS Corpus Christi is situated on the northern end of the Encinal Peninsula and is bounded on three sides by water: Oso Bay lies to the west, Corpus Christi Bay to the north, and Laguna Madre to the east. A barrier island (Mustang Island) lies east of Laguna Madre and separates Corpus Christi from the Gulf of Mexico (Figure 10-1).



Legend

- 217 Fuel Farm
- 244 Fuel Farm
- NAS Corpus Christi

0 1,000 2,000 3,000 4,000 Feet

FIGURE 10-1
AREA LOCATION MAP
UST SITE 9
NAS CORPUS CHRISTI
CORPUS CHRISTI, TEXAS

NAVFAC Naval Facilities Engineering Command
RESOLUTION CONSULTANTS

REQUESTED BY: B. ELLIOTT	DATE: 3/26/2013
DRAWN BY: B. LIPSCOMB	TASK ORDER NUMBER: JM46

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Former Fuel Farm 217 (FF217) consists of eight 25,000-gallon USTs that were installed in 1940 in the eastern area of NAS Corpus Christi, less than 100 feet from the shore of Laguna Madre (Figure 10-2). The current surface conditions at FF217 include regularly mowed grass. The tanks were used to store aviation gasoline and JP-5 fuel (U.S. EPA 1989). The tanks were abandoned-in-place by filling with sand and cement sometime in 1987.

Former Fuel Farm 244 (FF244) consists of eight 25,000-gallon USTs that were installed in 1940 near Building 252 in the central part of NAS Corpus Christi (Figure 10-3). The tanks were used to store aviation fuels (U.S. EPA 1989). The tanks were abandoned-in-place by filling with sand sometime in 1973.

10.2 Site History

Former Fuel Farm 217. The eight former FF217 tanks (Solid Waste Management Unit [SWMU] Nos. 54 through 61) were active between 1945 and 1986 and were filled with sand and cement in 1987. Between 1977 and 1980, 7,000 gallons of aviation fuel are known to have been released to the environment from the FF217 USTs during three separate events; however, the specific tanks sourcing these spills are not identified in the record.

Former Fuel Farm 244. The eight former FF244 tanks (SWMU Nos. 62 through 69) were active from the early 1940s until 1973 when they were filled with sand. There are no documented releases on file from FF244.

10.3 Preliminary Conceptual Site Model

A summary of the CSMs based on current site conditions at UST Site 9 Fuel Farms 217 and 244 are shown on Figure 10-4 (FF217) and Figure 10-5 (FF244), respectively. The following text describes the current CSM for each site. Development of the CSM is an iterative process, and will be refined during the SI and subsequent stages of investigation associated with UST Site 9.

10.3.1 Nature and Extent of Contamination

The following COPCs have been determined based on historical documentation of operations at the site: BTEX, MTBE, TPH and PAHs. The nature and extent of COPCs is unknown, and must be determined during the SI and any subsequent investigations in accordance with RG-411.

Legend

- Transfer Pit
- Underground Storage Tank
- Fuel Farm 217 Site Boundary SWMU Nos. 54 through 61

0 100 200 Feet

FIGURE 10-2
SITE MAP
UST SITE 9 FUEL FARM 217
NAS CORPUS CHRISTI
CORPUS CHRISTI, TEXAS

NAVFAC Naval Facilities Engineering Command
RESOLUTION CONSULTANTS

REQUESTED BY: B. ELLIOTT	DATE: 4/8/2013
DRAWN BY: B. LIPSCOMB	TASK ORDER NUMBER: JM46

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Legend

- Transfer Pit
- Underground Storage Tank
- Fuel Farm 244 Site Boundary SWMU Nos. 62 through 69

0 100 200 Feet

FIGURE 10-3
SITE MAP
UST SITE 9 FUEL FARM 244
NAS CORPUS CHRISTI
CORPUS CHRISTI, TEXAS

NAVFAC Naval Facilities Engineering Command
RESOLUTION CONSULTANTS

REQUESTED BY: B. ELLIOTT	DATE: 4/8/2013
DRAWN BY: B. LIPSCOMB	TASK ORDER NUMBER: JM46

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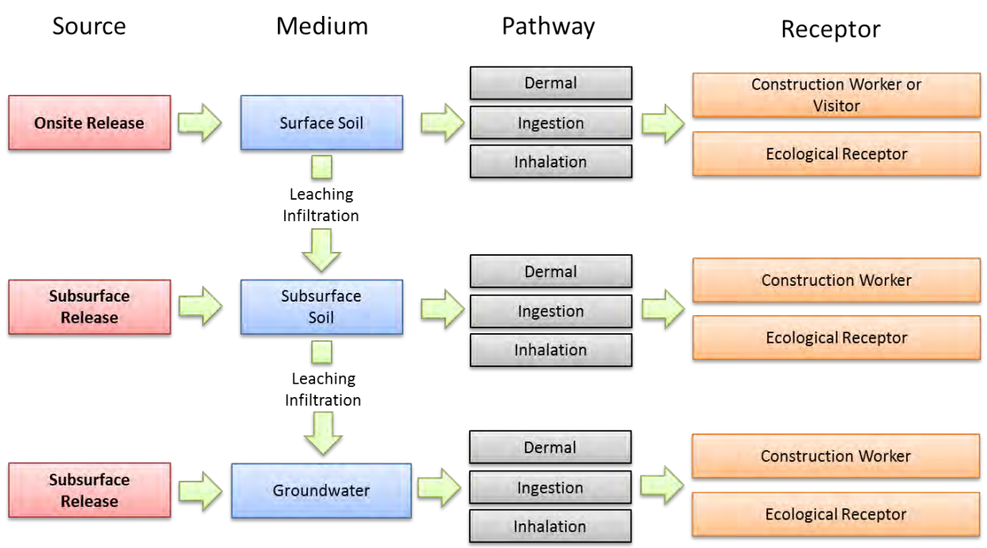
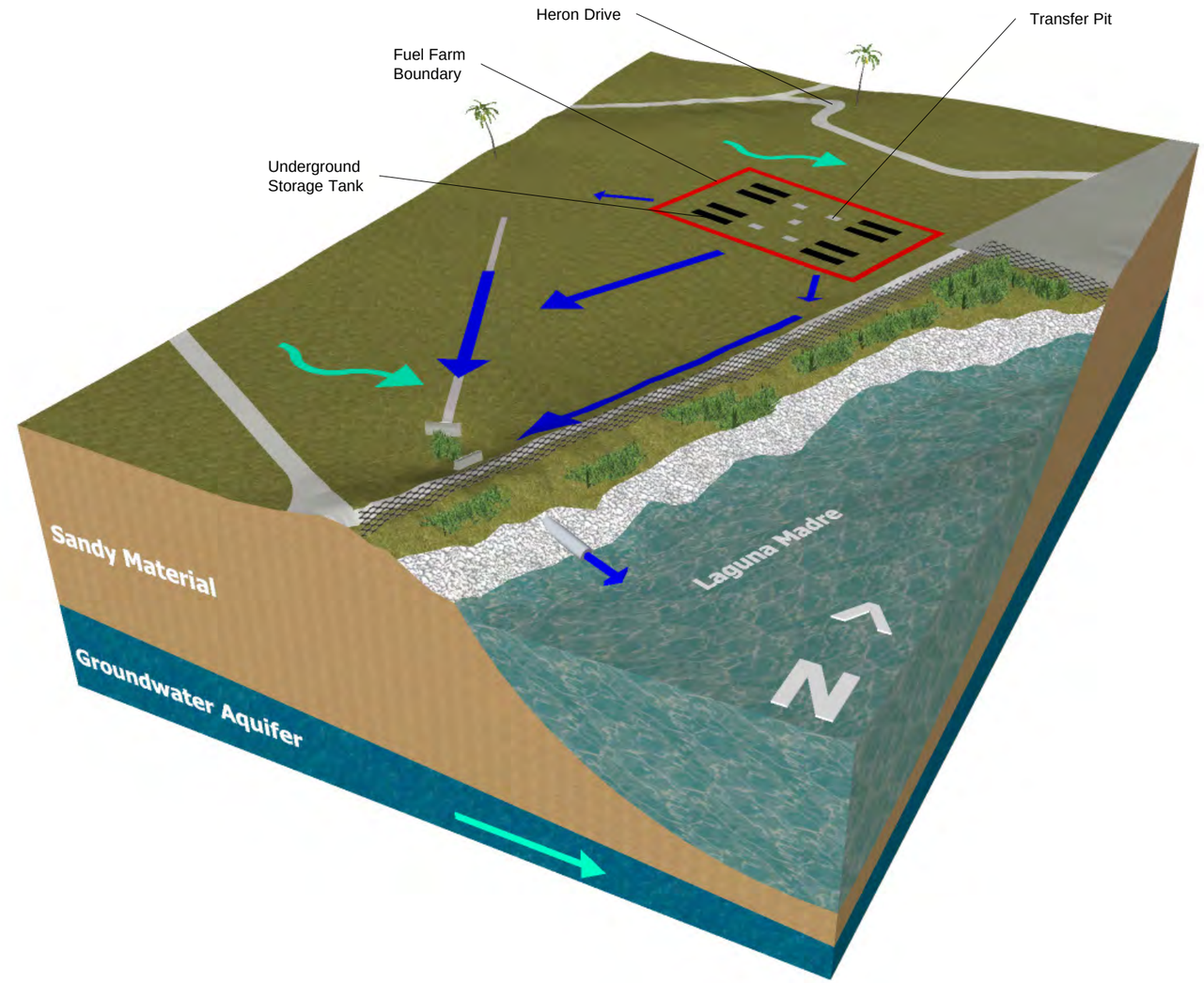




Component Credits: bush, Stefevr; bush#1, Stefevr; Tropical fan palm tree, SketchUp; Terrain created from National Elevation Dataset (NED) from USGS

Legend

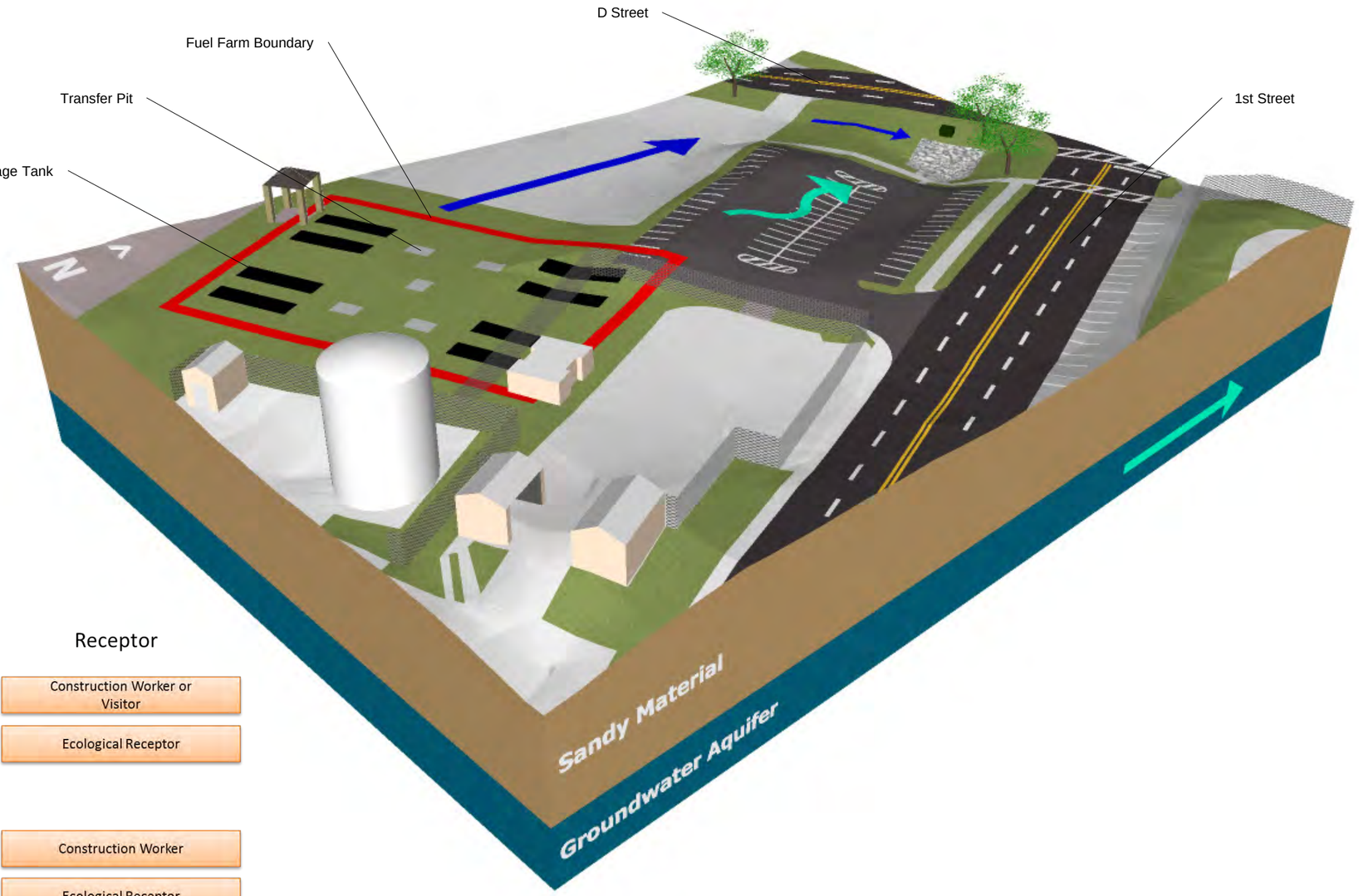
- Groundwater Flow
- Surface Water Flow
- Fuel Farm 217 Site Boundary SWMU Nos. 54 through 61
- Transfer Pits
- Underground Storage Tank

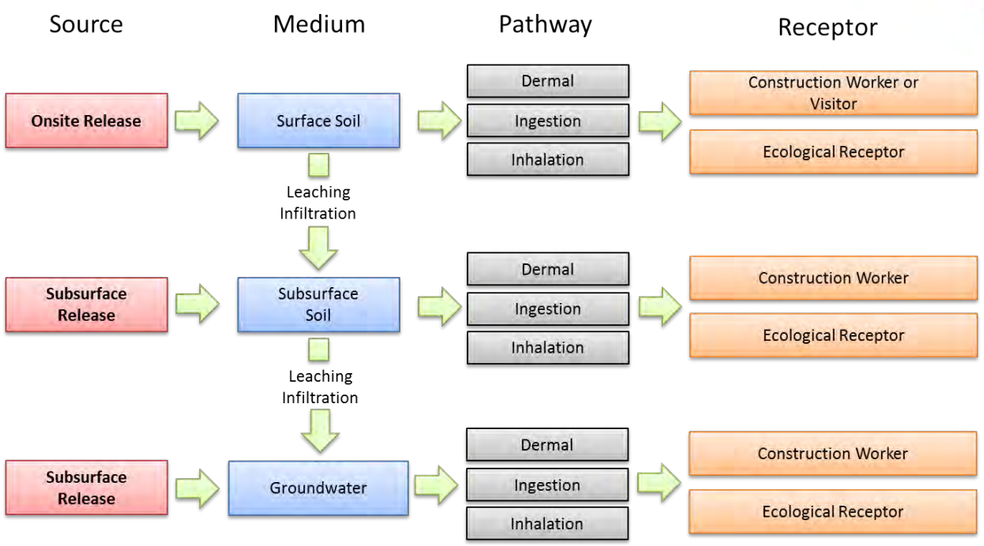
FIGURE 10-4
CONCEPTUAL SITE MODEL
UST SITE 9 FUEL FARM 217
NAS CORPUS CHRISTI
CORPUS CHRISTI, TEXAS

NAVFAC Naval Facilities Engineering Command

RESOLUTION CONSULTANTS

REQUESTED BY: B. ELLIOTT	DATE: 03/26/2013
DRAWN BY: B. LIPSCOMB	TASK ORDER NUMBER: JM46





Component Credits: tree, amilagroso; Terrain created from National Elevation Dataset (NED) from USGS

Legend

- Groundwater Flow
- Surface Water Flow
- Fuel Farm 244 Site Boundary SWMU Nos. 62 through 69
- Transfer Pits
- Underground Storage Tank

FIGURE 10-5
CONCEPTUAL SITE MODEL
UST SITE 9 FUEL FARM 244
NAS CORPUS CHRISTI
CORPUS CHRISTI, TEXAS

NAVFAC Naval Facilities Engineering Command

RESOLUTION CONSULTANTS

REQUESTED BY: B. ELLIOTT	DATE: 03/26/2013
DRAWN BY: B. LIPSCOMB	TASK ORDER NUMBER: JM46

10.3.2 Geology, Hydrogeology, and Hydrology

No site-specific investigations have been performed to date, to provide lithologic or hydrogeologic information. However, general hydrology and soil series information is provided below to begin the CSM process.

Former Fuel Farm 217 is situated on top of made land. Made land consists of sand, mud and shells that have been excavated from the floor of lagoons and bays. Within NAS Corpus Christi these soils are typically deep, undulating, and of variable permeability. They are generally clayey, saline, and covered with 6 to 8 inches of topsoil to support vegetation. Laguna Madre is less than 100 feet away from the abandoned tank farm and likely influences and is influenced by shallow groundwater in this area. Surface water runoff in the vicinity of FF217 generally sheet flows to the south southeast where it is intercepted and directed by a roadside ditch. The roadside ditch drains toward a culvert under the road to a designated outfall to Laguna Madre approximately 450 feet to the southwest of the tank farm. More specific site hydrogeology and hydrology will be obtained as part of the SI.

Former Fuel Farm 244 is situated on top of a sandy fill placed over Galveston-Mustang series soils near the center of the Encinal Peninsula between Oso Bay and Laguna Madre, over 7,000 feet away from surface water to the east and west, and closest to Corpus Christi Bay approximately 3,600 feet to the north. The sandy fill consists of fine sand and loam with variable permeability that has been used to raise the original land surface to a uniform height for runway sites. The Galveston-Mustang series soils consists of deep nearly level to sloping, slightly acidic, loose fine sands with moist to wet sandy subsoils with permeability ranging between 3 and 8 inches per hour (Galveston) and slightly less permeable clayey sands (Mustang) with permeability ranging from less than 0.05 inches per hour to 3 inches per hour. Surface water runoff in the vicinity of FF244 generally sheet flows to the north northeast where it is intercepted by paved surfaces and directed by curb and gutter to the storm water system. More specific site hydrogeology and hydrology will be obtained as part of the SI.

10.3.3 Contamination Migration Pathways

Residual product (aviation fuels) is suspected to be present within the abandoned-in-place tanks associated with former fuel farms FF217 and FF244. Historical fuel spills at FF217 have been documented, but little detail on the associated tanks or cleanup performed is presently known. No fuel spills or releases are documented associated with FF244.

The nature and extent of potential releases to surface or subsurface soils from tanks and spills at FF217 and FF244 are largely unknown at this stage and will be developed during the SI and any future investigations associated with UST Site 9. Based on current and historical aerials, potential anthropogenic migration pathways may include the following:

- The fuel pipelines and corridors associated with the fuel conveyances for FF217 and FF244.
- The surface water conveyances near FF217 do not appear to have been lined; they are a consideration for contaminant migration of any surface spills in the area.
- The storm sewer in the vicinity of FF244 may be a consideration in the evaluation of migration pathways.

Natural migration pathways may exist along geologic/stratigraphic contacts (e.g., between overburden and subsoil).

Fuel releases to surface or subsurface soils in these areas have the potential to impact shallow groundwater and possibly surface water and sediments due to proximity, soil permeability, and potential influence of tidal interactions between shallow groundwater and surface waters.

As indicated by available permeability data for surficial and shallow soils and geologic units at NAS Corpus Christi, shallow groundwater migration is possible with potential flows in the shallow water table toward Corpus Christi Bay, Laguna Madre, and Oso Bay. Artesian aquifers in the vicinity of NAS Corpus Christi become increasingly saline with depth and the base of fresh to slightly saline water (less than 3,000 milligrams per Liter [mg/L] total dissolved solids) is at or above sea level, indicating very limited potential for fresh artesian water at these sites. The presence of saline groundwater is a consideration in the evaluation of potential impacts to shallow groundwater in these areas, and in assessing geochemical conditions relative to natural attenuation or other potential site remedies.

10.3.4 Receptors and Exposure Pathways

The information presented in the preceding sections was used to develop the CSMs shown on Figures 10-4 (FF217) and 10-5 (FF244). Both human and ecological receptors are assumed to have the potential to contact contaminated site media. The facility's current land uses are expected to remain unchanged in the near future and residential land use is unlikely. As shown on the CSM, current human receptors include visitors and construction workers. Human receptors may be exposed to contaminated media through dermal contact, ingestion, or inhalation.

Potential ecological receptors include terrestrial plants and invertebrates, birds, and mammals. Ecological receptors may be exposed through direct contact with or ingestion of contaminated media, as well as through the food chain (i.e., by ingesting plants and animals that have been impacted through uptake of soil contaminants). TCEQ Guidance presented in RG-411 for investigating releases at PST sites does not specifically address ecological receptors. However, in the event a release is confirmed for either FF217 or FF244 with the potential to impact surface soil, water, and/or sediments, exclusion and *de minimus* criteria will be evaluated with respect to Tier 1 Ecological Checklist requirements described under the Texas Risk Reduction Program (TRRP).

SAP WORKSHEET #11: PROJECT QUALITY OBJECTIVES/SYSTEMATIC PLANNING PROCESS STATEMENTS

(UFP-QAPP Manual Section 2.6.1)

11.1 Problem Statement

Historical information regarding fuel farm operations and fuel releases and information from previous studies indicate that soil and groundwater at the FF217 and FF244 have potential to be impacted by release of petroleum products remaining in the abandoned tanks or spilled on the surface during operations. These UST sites were abandoned–in-place prior to the implementation of the Texas PST Program requirements and, consequently, were never entered into the PST Program for site closure. Additional sampling is required to determine whether or not a release associated with the abandoned tanks has occurred and to take measures to close the fuel farms under the Texas PST requirements and guidelines.

11.2 Goals of the Study

The goal of the SI is to obtain an understanding of the FF217 and FF244 potential source areas to determine if either site must be entered into the Texas PST Program and issued an LPST number, and if either site warrants further investigation prior to closure. To fill the data gaps, the following tasks will be performed:

1. Geophysical survey to locate the abandoned tanks and pipeline features.

2. Soil sampling via direct push technology (DPT) core barrels spaced at 25-foot intervals around each of the fuel farm perimeters and at key pipeline locations identified during the geophysical survey to assess the potential for petroleum related releases at each site.

3. Groundwater sampling via DPT installation, development, and sampling of temporary groundwater monitoring wells at six locations per fuel farm site where groundwater is encountered to screen for potential groundwater contaminants identified by TCEQ guidance RG-411 that may warrant further investigation under the Texas PST Program; additional analysis for lead scavengers will be performed in accordance with guidance in the May 2010 U.S. EPA technical memorandum on lead scavengers in groundwater.

4. Visual inspection of soil samples to screen for potential non-aqueous phase liquid (NAPL) presence.

Principal study questions (PSQs) for the initial phase are as follows:

- PSQ1: What are the physical boundaries of the abandoned USTs at FF217 and FF244?
- PSQ2: Do concentrations in soil or groundwater at either FF217 or F244 exceed Project Action Limits (PALs), thus requiring follow-up action?
- PSQ3: Do sufficient ecological receptors exist at either FF217 or F244 or in the immediate vicinity, resulting in the need for further evaluation?
- PSQ4: Based on visual inspections, do any of the soil or groundwater samples observed at FF217 or F244 exhibit signs of NAPL presence, thus requiring follow-up action?
- PSQ5: Can either or both of the fuel farm sites be closed under Texas PST Program requirements established in 30 TAC 334 based on current conditions or will the sites require a removal/response action or additional investigation? The answer to this question may be determined after this SI or subsequent sampling, depending on the results of the SI.

Based on these PSQs, the following project decision statements have been developed:

- Ascertain the physical boundaries of the abandoned USTs.
- Assess whether COPCs in soil and groundwater exceed PALs.
- Identify the presence of ecological receptors; if identified, supplemental sampling may be necessary (not currently included in Worksheet #17).
- Assess the presence/absence of residual NAPL, as required to obtain site closure under 30 TAC 334.
- If chemicals of concern are detected above PALs or if NAPL is present in either soil or groundwater make recommendations for further assessment and/or remedial action as necessary to obtain site closure under 30 TAC 334. (Note, the current SAP scope does not include evaluation of remedial actions or further site assessment — field activities include SI efforts only.)

11.3 Information Inputs to Problem Resolution

The inputs needed to resolve the project problem statement identified in Section 11.1 include field observations and measurements, analytical data, site feature locations, and PALs as described below. Specific informational inputs, to serve as the basis for decisions during the execution of this project, include the following:

- Tank System, Piping Layout and Sample Locations: The understanding of tank system and piping layouts will be updated with observations made during time domain electromagnetic (TDEM) geophysical surveys of each site.

- Geologic/Hydrogeologic Information: Site geology and hydrogeology will be updated with observations made during installation of soil borings using a DPT rig. Up to six temporary monitoring wells per fuel farm site are included in this SAP based on input from TCEQ and U.S. EPA regarding RG-411 guidance for meeting the requirements under 30 TAC 334. In the event that either of these sites meets the requirements for listing within the PST Program, then additional investigation phases may be required to include groundwater sampling from permanently installed wells.

- Sample Location Data: Sample location horizontal coordinates and vertical depths will be measured for use in mapping each location so that data can be analyzed and presented in a spatial context. Horizontal coordinates of each sample location will be determined by Global Positioning System, which will allow for future reacquisition of the locations if further investigation or remedial action is necessary.

- Ecological Checklist and Screening Risk Assessment: Site habitats will be characterized using TCEQ's Tier 1 Ecological Exclusion Criteria Checklist to determine if ecological communities at the site and in the nearby surrounding area could be affected by site activities and if the impact could have an adverse effect at a community or population level. Such information will be considered in determining the need for a Screening Risk Assessment (SRA).

- Chemical Data: Soil and groundwater chemical data will be collected for BTEX, MTBE, TPH, and PAHs to determine if target analytes are present. In addition to these target analytes identified by RG-411, the presence of lead scavengers ethylene dibromide (EDB) and 1,2-dichloroethane (1,2-DCA) in groundwater will be assessed. The concentrations of any

detected target analytes will be compared to their respective PALs and the results will support the decision making process for future actions such as permanent monitoring well installation.

- Project Screening Limits: PALs for this investigation are the Texas PST Program Action Levels (TCEQ, 12 August 2011). These soil and groundwater action levels are the lowest applicable health based or groundwater protective target concentration for BTEX, MTBE, TPH and PAHs, and include limitations toward their use that precludes the presence of NAPLs in environmental media onsite and also potential for direct impacts to surface water or impacts associated with vapor intrusion. The PALs for the Texas PST program do not identify a class of receptors as either residential or industrial. The PALs for lead scavengers EDB and 1,2-DCA are identified in the 2010 U.S. EPA technical memorandum on lead scavengers. The PALs for all COPCs are in Worksheet #15. UST Site 9 former FF217 and FF244 sites are not currently in a TCEQ program; as such, TCEQ standards from more than one program could eventually become applicable. The project requires laboratory data that can be compared to PALs so that appropriate decisions can be made. Laboratory quantitation limits must be low enough to measure COPC concentrations equal to or below the PALs.

- Field Screening: Results of field screening, including the use of a photoionization detector (PID) to measure organic vapors and visual inspection of soils and groundwater samples for the presence of NAPL, will assist with characterization and in selecting soil samples to be submitted for laboratory analysis. If NAPL is visible in a given sample, the sample will not need to be analyzed in a lab setting because the presence of NAPL is already a determining factor in listing a site in the Texas PST program. The PID results are not considered definitive; thus, decision making will be made using analytical data.

11.4 Define the Study Boundaries

FF217 consists of eight 25,000-gallon USTs laid out in an approximately half acre site, less than 100 feet from the shore of Laguna Madre (Figure 10-2). FF244 consists of eight 25,000-gallon USTs laid out in an approximately half acre site near Building 252 in the central part NAS Corpus Christi (Figure 10-3).

The populations of interest are the soil and groundwater that have been contaminated either directly (by site operations) or indirectly (by subsequent migration of contaminants). The Texas PST program guidance in RG-411 suggests sampling from two depths at each location unless groundwater is encountered prior to the bottom of the tank hold. The tank hold is defined in the guidance as the footprint of the tank or tanks plus 3 feet out laterally and vertical limits are defined as 1 foot below the bottom of the tank. Tank depths are currently assumed to be 15 feet; shallow groundwater is expected to be encountered between 10 and 20 feet below ground surface (bgs) at FF244 and less than 10 feet bgs at FF217. Therefore, the vertical boundary of the SI extends from the ground surface to approximately 10 to 16 feet bgs. There are no existing monitoring wells at either FF217 or FF244 but groundwater is currently assumed to be present at both fuel farm sites near or above the bottom of the tank holds.

Temporal boundaries of the SI include the estimated duration of the field activities.

11.5 Analytical Approach

The SI will investigate potential contamination and assess potential threats to human health and the environment at the site. Biased sampling locations will be collected within the area of suspected contaminated area based TCEQ RG-411 guidance. Sampling locations may be adjusted based on field observations and professional judgment.

Initial determinations on the need for follow-up action will be based on whether analytical data exceed PALs. Prior to implementing decision rules, risk managers will review the analytical data and effective pathways to determine if the site poses any unacceptable risk, whether additional information is needed, or whether tank closure can be sought. The resulting decision rules are summarized as follows.

The decision rules for the investigations are:

- Decision Rule 1: If TPH is detected in soil or groundwater, the sample with the highest TPH >C12 concentration must be analyzed for PAHs.

- Decision Rule 2: If soil or groundwater exceed PALs, then the site meets the requirements for listing in the Texas PST Program and additional investigation and/or response actions may be required to meet the site closure needs of 30 TAC 334. However, if the former tank farms comply with closure requirements outlined in RG-411, then a Release Determination Report (TCEQ–0621) requesting closure/no further action will be submitted.

- Decision Rule 3: If NAPL is present in either soil or groundwater, then the site meets the requirements for listing in the Texas PST Program and additional investigation and/or response action may be required to meet the site closure needs of 30 TAC 334.[1]

- Decision Rule 4: If the ecological checklist and resulting scientific management decision indicate the presence of sufficient ecological habitat, then an SRA will be recommended to determine if unacceptable risk is present.[2] If the ecological checklist and resulting scientific management decision do not indicate the presence of sufficient ecological habitat, then no further action is required to evaluate ecological risks.

- Decision Rule 5: If groundwater PAL exceedances have been identified (or free product is present), permanent monitoring wells will be recommended.

As stated previously, investigations will be focused on meeting the requirements outlined by TCEQ guidance RG-411, *Investigating and Reporting Releases from Petroleum Storage Tanks (PST)* (August 2012). The decision rules described above are based on this guidance; the flow chart in Figure 11-1 summarizes regulatory guidance.

11.6 Performance Criteria

The objective of this section is to complete the following:

- Identify potential sources of study error (i.e., field error, analytical error)
- Establish and identify the methods used to reduce potential sources of error
- Determine how decision errors will be managed during the project

Sampling Strategy — Biased sampling will be used to collect soil and groundwater to fill data gaps for decision making purposes. This sampling approach was developed, based on TCEQ RG-411 guidance, to determine if any further remedial work is required in the source zone, to characterize COPCs in soil and groundwater, and to help in determining future actions.

[1] No groundwater samples will be collected from locations with identifiable free product.
[2] Supplemental sampling may be necessary to further characterize receptors. If required, sampling will be scoped upon completion of the ecological checklist.

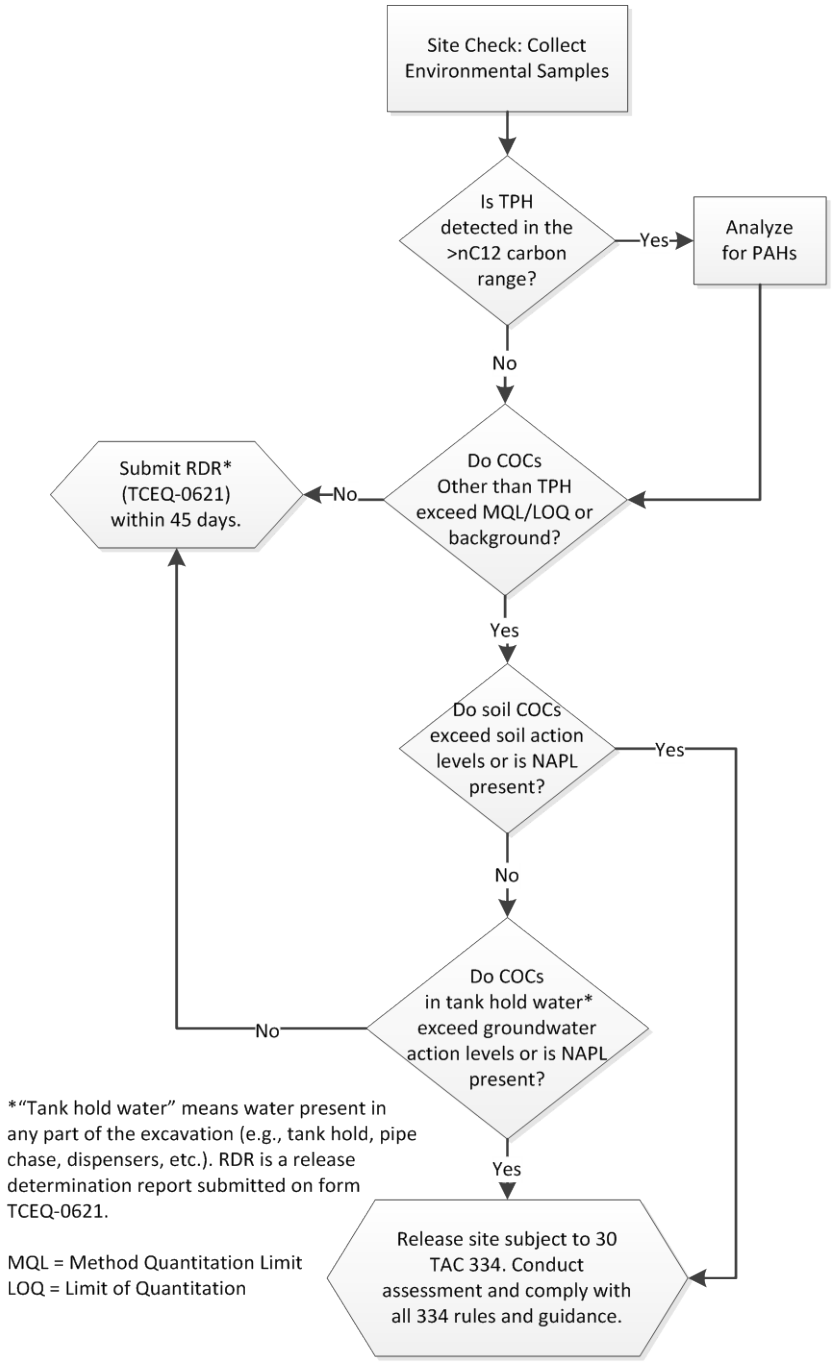


Figure 11-1 Investigation Flow Chart

PST Release Investigation — Release Determination Reporting (Source: RG-411 Figure 2)

Sources of Error — Sources may be divided into two main categories: sampling errors and measurement errors. A sampling error occurs when the sampling design, planning, and implementation do not provide for a representative range of heterogeneity at the site. A measurement error occurs because of performance variance from laboratory instrumentation, analytical methods, and operator error. The U.S. EPA identifies the combination of all these errors as a "total study error" (U.S. EPA 2006). One objective of the investigation is to reduce the total study error so that decision-makers can be confident that the data collected accurately represent the chemical characteristics of the site.

Managing Decision Error — The investigation will utilize decision-error minimization techniques in sampling design, sampling methodologies, and laboratory measurement of COPCs. Possible decision errors will be minimized during the field investigation by using the following methods:

- Use standard field sampling methodologies (as discussed in Worksheets #18 and #21)
- Use applicable analytical methods and standard operating procedures (SOPs) for sample analysis by a competent analytical laboratory having Texas National Environmental Laboratory Accreditation Program accreditation, and be accredited through the Department of Defense Environmental Laboratory Accreditation Program
- Confirm analytical data to identify and control potential laboratory error and sampling error by using spikes, blanks, and replicated samples

Decision errors associated with judgmental sampling are based on sample design and measurement errors. Assuming that the best possible professional judgment was used to develop the sampling plan (i.e., position sampling locations), the most important decision errors will be associated with field and laboratory techniques involved in the collection and analysis of the data.

Sampling Methodologies and Procedures — Possible decision errors generated by sampling errors will be minimized during the field investigation by applying standardized field sampling methodologies (discussed in Worksheets #18, #20, #21, and #22). Sampling activities will be performed in accordance with the SOPs specified in Appendix A of this SAP.

Field Data Logs — All sample information will be transcribed into a field logbook and/or onto field data sheets.

Analytical Laboratory Sample Management — The sample matrix, number of samples, and number and type of laboratory quality assurance/quality control samples are summarized in worksheets #18, #19, #20, and #30. Also included on this combined worksheet are details on the analytical group, sample volumes, sample container specifications, preservation requirements, and maximum and holding times.

The laboratory will provide electronic data deliverable files, portable document format files of the data deliverables for all project data, and a hard copy of data deliverables for all results. Designated samples will be used to obtain necessary subsamples for laboratory quality control measurements (i.e., analytical sample duplicate and sample matrix spike/matrix spike duplicate). Tasks will be completed using the laboratory SOPs.

Resolution Consultants will provide data validation services and verify and evaluate the usability of the data as described in Worksheets #34 through #36.

Portable document format copies of all analytical data packages will be stored on CD-ROM, archived in the NAVFAC Atlantic Administrative Record, and uploaded onto the Naval Installation Restoration Information Solution system at the close of the project. All other data generated in the field and reports generated for the project will be stored as computer readable data files by Resolution Consultants.

11.7 Sampling Design

Non-statistical methods (professional judgment), based on TCEQ RG-411 guidance, will be used as the primary basis for the sampling design. This approach was chosen to identify the extent of specific COPCs and assess whether or not an impact to human or ecological receptors (if any) has occurred. The sample design, rationale, and locations are presented in Worksheets #17 and #18. These worksheets identify where soil and groundwater samples will be collected and the analyses to be conducted for each sample.

SAP WORKSHEET #12: FIELD QUALITY CONTROL SAMPLES

(UFP-QAPP Manual Section 2.6.2)

Measurement Performance Criteria Table — Field QC Samples				
QC Sample	**Analytical Group**	**Frequency**	**Data Quality Indicators**	**Measurement Performance Criteria**
Trip Blanks	EDB, 1,2-DCA, BTEX and MTBE	One per cooler containing EDB, 1,2-DCA, BTEX and MTBE samples	Accuracy/Bias/ Contamination	No analytes > ½ LOQ, except common lab contaminants, which must be < LOQ
Equipment Rinsate Blanks	EDB, 1,2-DCA, BTEX, MTBE, PAHs, and TPH	One per matrix per sampling event [1]	Accuracy/Bias/ Contamination	No analytes > ½ LOQ, except common lab contaminants, which must be < LOQ
Field Duplicates	EDB, 1,2-DCA, BTEX, MTBE, PAHs, and TPH	One per 10 field samples	Precision	Values > 5X LOQ: RPD must be ≤30 (aqueous); ≤50 (solids)[2].
Matrix Spike/Matrix Spike Duplicate	EDB, 1,2-DCA, BTEX, MTBE, PAHs, and TPH	One pair per 20 field samples	Accuracy/Bias/ Precision	Percent recoveries — DoD QSM Limits RPD must be ≤ 30
Cooler Temperature Indicator	All	One per cooler	Representative ness	Temperature less than 6 degrees Celsius

Notes:
[1] Equipment rinsate blanks will be collected when decontamination is required.
[2] If duplicate values are less than five times the LOQ, the absolute difference should be less than or equal to two times the LOQ.

EDB = Ethylene dibromide
1,2-DCA = 1,2-Dichloroethane
BTEX = Benzene, toluene, ethylbenzene, xylenes
MTBE = Methyl tert-butyl ether
PAHs = Polynuclear aromatic hydrocarbons
TPH = Total petroleum hydrocarbons
LOQ = Limit of Quantitation
RPD = Relative Percent Difference
DoD QSM = *Department of Defense Quality Systems Manual for Environmental Laboratories*, Version 4.2, October 2010 or the most recent version at the time of sampling.

SAP WORKSHEET #13: SECONDARY DATA CRITERIA AND LIMITATIONS TABLE

(UFP-QAPP Manual Section 2.7)

Secondary Data Criteria and Limitations Table				
Secondary Data	**Data Source (originating organization, report title and date)**	**Data Generator(s) (originating organization, data types, data generation/collection dates)**	**How Data Will Be Used**	**Limitations on Data Use**
Historical Background Information	RCRA Facility Assessment Evaluation, Preliminary Review, Visual Site Inspection, Corpus Christi Naval Air Station, May 1989	*Originating Organization*: U.S. EPA Region 6 *Data Types*: Background information *Data Collection Dates*: 1989	Background information was used in planning of the sampling effort	None
Historical Background Information	Internal files including historical utility maps and aerial photos, site chronology notes, unpublished draft reports and proposals, communication logs	*Originating Organization*: NAS Corpus Christi *Data Types*: Background information *Data Collection Dates*: 1951 — 2009	Background information was used in planning of the sampling effort	Not Available for Publication

Notes:

RCRA = Resource Conservation and Recovery Act
U.S. EPA = United States Environmental Protection Agency
NAS = Naval Air Station

SAP WORKSHEET #14: SUMMARY OF PROJECT TASKS

(UFP-QAPP Manual Section 2.8.1)

The following project tasks are summarized below:

- Field Tasks
- Analytical Tasks
- Data Management and Review
- Project Report

Field Tasks

Mobilization/Demobilization — Mobilization includes procurement of field equipment and supplies; a Site walkover; mobilization of field staff, equipment, and supplies to the Site; and Site set-up. The Navy Remedial Project Manager (RPM) and NAS Corpus Christi point of contact (POC) will be notified of Resolution Consultants' mobilizations a minimum of 1 week before the start of field activities.

A field team orientation meeting will be conducted prior to starting the fieldwork to familiarize the team personnel with the Site-specific health and safety requirements, the objectives and scope of the field activities, and chain-of-command. This meeting will be attended by the field staff and conducted by the Field Team Leader (FTL).

Demobilization includes removing field equipment and supplies from the site, returning rented equipment, managing investigation derived waste (IDW), performing general site cleanup, organizing and finalizing field paperwork, and entering field records/data into the database.

Utility Clearance — The Resolution Consultants FTL will coordinate verbally or via e-mail with NAS Corpus Christi POC at least 7 days in advance of the site access to initiate the utility clearance process for all intrusive sampling locations in accordance with SOP-3-01. The Resolution Consultants FTL will contact both the Texas 811 utility locator service and NAS Corpus Christi POC verbally or via electronic-mail at least 3 days prior to commencement of field work to complete a utility clearance ticket for the areas under investigation.

Utilities that are identified in the field, but not shown or incorrectly located on the work approval documentation, will be marked directly on the document and returned to the NAS Corpus Christi POC for inclusion in the Geographic Information System database.

TDEM Geophysical Survey — A TDEM geophysical survey will be conducted at both fuel farms, to confirm tank and piping layout in accordance with SOP-3-09. TDEM will locate only metallic features to a depth of approximately 6 feet. The basis of the TDEM surveys is to cover an area of approximately 74,000 square feet at each fuel farm, with data collected at a high density over a subset of this area (about 150 feet by 250 feet based on the FF244 layout sketch) to precisely locate the tanks: lines will be located approximately 5 feet apart and data collected every 0.5 foot along the lines. Outside of the tank areas, data collection will be less dense, e.g., lines every 20 to 50 feet, with the objective of tracing the layout of pipes that radiate out from the tank array and manifolds. After data processing, the TDEM survey results will be projected on a site map and sample location coordinates will be selected. Field personnel for the soil sampling task will use these coordinates to locate and stake boring locations in the field.

Soil Sampling — The soil sampling and analysis program is outlined in Worksheets #17 and #18. Subsurface soil samples will be collected from soil borings advanced via direct push technology (DPT) tooling, in accordance with SOP-3-17(CC) and SOP-3-21. Sample collection and handling will be in accordance with SOP-3-03A, SOP-3-04A, and SOP-3-21 and as described in Worksheet #21. At the discretion of the FTL, head space samples per SOP-3-21 and SOP-3-19 may be used to select soil samples based on qualitative TPH concentration data from a PID; however head space readings are not required for soil sample collection. If a photoionization detector (PID) is used for soil screening, SOP-3-20 will be followed for calibration. All soil samples will be collected as discrete grab samples. A soil boring log will be prepared for each boring with soil descriptions and relevant information, observations, depth to water, sample depths, and field screening results in accordance with SOP-3-17(CC). After sampling, each borehole will be backfilled to within 6 to 24 inches of grade using bentonite grout or other acceptable method described in SOP-3-17(CC). After 24 hours, the grouted borehole will be inspected for grout shrinkage and re-grouted if necessary. The remaining portion of the hole will be filled with soil cuttings removed from borehole, local topsoil, and/or appropriate paving materials to match areas where pavements are impacted by the boring location.

Groundwater Sampling — Six temporary groundwater monitoring wells per fuel farm will be installed by DPT, completed, and developed in accordance with SOP-3-17(CC). Well locations will be upgradient (1), downgradient (1), cross gradient (2), and located within the tank holds or pipeline chases based on locations (2) exhibiting the highest PID readings. At the discretion of the FTL, head space samples per SOP-3-21 and SOP-3-19 may be used to select temporary well locations based on qualitative soil TPH concentration data from a PID; however

head space readings are not required for temporary well location selection. If a PID is used for selection of temporary well locations, SOP-3-20 will be followed for calibration. Groundwater will be sampled in accordance with SOP-3-17(CC) and SOP-3-14. Well development for these temporary wells will consist of obtaining stabilized water quality parameters in accordance with SOP-3-24. In the event that a temporary well does not produce sufficient groundwater for a groundwater sample, that well may be surged at the discretion of the FTL with input from the driller or replaced by a temporary well at a different location. Groundwater is expected to be encountered above or near the base of the tank holds. Groundwater samples will be collected from properly developed temporary wells using dedicated tubing and peristaltic pumps in accordance with SOP-3-17(CC) and SOP-3-24. Sample collection and handling will be in accordance with SOP-3-03A, SOP-3-04A, and SOP-3-24 and as described in Worksheet #21. All temporary wells will be removed within 48 hours of well completion, the boreholes will be backfilled to within 6 to 24 inches of grade using bentonite grout or other acceptable method described in SOP-3-17(CC). After 24 hours, the grouted borehole will be inspected for grout shrinkage and re-grouted if necessary. The remaining portion of the hole will be filled with soil cuttings removed from borehole, local topsoil, and/or appropriate paving materials to match areas where pavements are impacted by the boring location. Well abandonment reports will be prepared in accordance with State of Texas water well abandonment requirements.

Ecological Receptor Survey/Checklist — A field survey of potential ecological receptors will be conducted within a 0.5-mile radius of each range to properly evaluate ecological risk. The Texas Commission on Environmental Quality (TCEQ) Tier I ecological exclusion criteria checklist will be used to assess whether or not further ecological evaluation is necessary. This checklist will aid in determining whether there are incomplete or insignificant ecological exposure pathways due to the nature of the affected property setting and/or the condition of the affected property media. The TCEQ Tier I ecological exclusion checklist is in Appendix A.

Field Documentation Procedures — Field documentation will be performed in accordance with Resolution Consultants SOP-3-02. Sample collection information will be recorded in bound field notebooks or specific field forms. Samples will be packaged and shipped according to Resolution Consultants SOP-3-04A.

A summary of field activities will be properly recorded in indelible ink in a bound logbook with consecutively numbered pages that cannot be removed. Logbooks will be assigned to field personnel and stored in a secured area when not in use.

All entries will be written in indelible ink, and no erasures will be made. If an incorrect entry is made, striking a single line through the incorrect information will make the correction; and the person making the correction will initial and date the change. Boring logs, sampling forms, and other field forms will also be used to document field activities.

Surveying — Soil sampling locations will be marked in the field using a wooden stake or brightly colored pin flag. Coordinates of each sample location will be determined by Global Positioning System, in accordance with SOP-3-07.

Field Quality Control Tasks — Field quality control (QC) samples will be collected as part of each sample round, including field duplicates, matrix spikes, and matrix spike duplicates, and equipment rinsate blanks (if sampling tools are decontaminated in the field). Worksheet #20 presents the field QC sample summary.

Decontamination — Non-disposable equipment that comes into contact with the sample medium will be decontaminated to prevent cross-contamination between sampling points. Decontamination of sampling equipment will not be necessary for dedicated and disposable samplers. Decontamination of reusable sampling equipment (e.g., non-disposable spoons and hand augers) will be conducted prior to sampling and between samples at each location. The decontamination procedures in SOP-3-06 will be followed.

Investigation-Derived Waste — Solid or liquid decontamination fluids will be generated during field activities. To the extent possible, soil removed during sampling activities but not included in the sample volume shipped to the laboratory for analysis will be replaced into the boring from which it was removed.

If non-disposable equipment is used to collect soil samples, liquid IDW decontamination fluids, will be handled in accordance with Resolution Consultants SOP-3-05-TX. All aqueous IDW will be containerized in drums provided by the NAS Corpus Christi Public Works Department. The Public Works Department will pick up the filled drums and stage them at the designated waste accumulation area to await waste characterization analyses. Based on waste characterization results, the drummed IDW will be transported and appropriately disposed at a Navy-approved offsite disposal facility coordinated through the NAS Corpus Christi Public Works Department. Used personal protective equipment will be bagged and disposed of as regular trash in an appropriate facility waste container.

Analytical Tasks

To support the environmental decisions, the analytical laboratory will hold and maintain current National Environmental Laboratory Accreditation Program (NELAP) accreditation in Texas. In addition, the laboratory will be accredited through the Department of Defense Environmental Laboratory Accreditation Program (DoD ELAP). The laboratory analytical data packages will contain summary forms, raw data, laboratory review checklists and exception reports and will comply with TCEQ's *Regulatory Guidance for Review and Reporting of Chemical of Concern Concentration Data under TRRP* (RG-366/TRRP-13 May 2010).

Chemical analyses will be performed by Gulf Coast Analytical Laboratories (GCAL) who holds accreditation from both the Texas NELAP and DoD ELAP. Analyses will be performed in accordance with the analytical methods identified in Worksheet #19 and the laboratory will strive to meet the project quantitation limit goals specified in Worksheet #15. GCAL will perform the chemical analyses following laboratory-specific SOPs identified in Worksheet #23. Full laboratory SOPs are available upon request.

The laboratory will report soil results on a dry-weight basis. Results of percent moisture will be reported in each analytical data package and associated electronic data deliverable (EDD) files. This information will also be captured in the project database, which will eventually be uploaded to the Naval Installation Restoration Information Solution (NIRIS) database.

Data Management and Review

The principal data generated for this project will be from field data and laboratory analytical data. The field forms, chain of custody, air bills, and logbooks will be placed in the project files after the completion of the field program. The field logbooks for this project will be used only for this site, and will also be categorized and maintained in the project files after the completion of the field program. All project records will be maintained in a secure location.

Data Tracking — The Resolution Consultants Task Order Manager (TOM), or designee, is responsible for the overall tracking and control of data generated for the project. Data are tracked from generation to archiving in the project specific files. The project chemist, or designee, is responsible for tracking the samples collected and shipped to the contracted laboratory. Upon receipt of the data packages from the analytical laboratory, the project chemist will oversee the data validation effort, which includes verifying that the data packages are complete and that results for all samples have been delivered by the analytical laboratory.

Resolution Consultants shall submit all Administrative Record Files, Site Files, and Post Decision Files in accordance with the specifications defined in the NAVFAC *Environmental Restoration Recordkeeping Manual* (NAVFAC, 2009). Additionally, Resolution Consultants will update and manage the project related documents, data, and maps in NIRIS. Project related spatial data including maps, models, and associated collected or created data will also be uploaded into NIRIS. All documentation submittals for NIRIS will be coordinated with the Navy RPM.

Data Storage, Archiving, and Retrieval — After the data are validated, the data packages are entered into the Resolution Consultants' file system and archived in secure files. The field records including field logbooks, sample logs, chain-of-custody records, and field calibration logs will be submitted by the Resolution Consultants FTL to be entered into the file system before archiving in secure project files. Project files are audited for accuracy and completeness. Project files will be kept in a secured, limited access area. At the completion of the Navy contract, files will be shipped to the Federal Records Center for storage where the files will remain until 50 years after the last decision document for NAS Corpus Christi.

Data Security — Access to Resolution Consultants project files is restricted to designated personnel only. The Resolution Consultants data manager maintains the electronic data files, and access to the data files is restricted to qualified personnel only. File and data backup procedures are routinely performed.

Electronic Data — Laboratory data, provided in electronic format, will be verified for accuracy prior to use and during the data validation process. After data are validated, the electronic data results will be uploaded into the Resolution Consultants database for use in data evaluation and subsequent report preparation. The project database will be on a password protected secure network and access to changing data files will be restricted to qualified personnel. The Resolution Consultants TOM (or designee) is responsible for the overall tracking and control of data generated for the project. All final electronic data and administrative records will be compiled and uploaded into NIRIS for final repository.

Data Review and Validation — After receipt of analytical laboratory results, Resolution Consultants will verify data completeness as specified on Worksheet #34. To ensure that the analytical results meet the project quality objectives, the laboratory data will undergo verification and validation as cited in Worksheets #34 through #36 and described below. The usability assessment processes are described in Worksheet #37.

Prior to data validation, electronic laboratory data will be verified for accuracy against the hardcopy laboratory report and the electronic quality assurance project plan (eQAPP) will be established using the project-specific criteria defined in Worksheets #12, #19, and #28. The laboratory will be requested to resubmit electronic data found to be inaccurate.

During the data validation process, the Resolutions Consultant's Data Validation Assistant (DVA) tool will be used to review method accuracy and precision data from field and laboratory QC samples contained in the laboratory EDD and qualify that data according to the project-specific eQAPP. The DVA tool uses the power of EarthSoft's EQuIS relational database to assemble a series of Excel worksheets into a DVA workbook for the validator that present:

- Data validation QC elements that need review, compared to control limits stored in the project-specific eQAPP
- Associated sample results for duplicated samples and blanks
- A place to make the necessary qualifications and result updates directly into an electronic format documentation of qualifications using coded reasons
- A list of all samples affected by the qualification

Laboratory calibration will be assessed against the criteria presented in Worksheet #24 using the hardcopy laboratory report, and the results of these findings will be added to the Excel DVA workbook. The DVA workbook ultimately serves as an EDD to update the project database with the validator's changes. Using standard EQuIS tools that check and load data, qualifiers and edits are directly uploaded to the database, thereby eliminating the manual data entry process and allowing for 100 percent of data to be reviewed prior to uploading to the project database.

Project Reports

Resolution Consultants will compile, review, and evaluate available data, and produce an SI Report. If during data evaluation, additional information is required to complete the SI process, Resolution Consultants will prepare recommendations for the Navy to fill data gaps as a modification to this SAP. Report elements will include a summary of field efforts, deviations from the work planning documents (if any), data tables and figures, comprehensive discussion of the

nature and extent of contamination, and all other standard Navy requirements for SI Reports, and will conclude whether additional action(s) are warranted or if a no further action determination can be made.

SAP WORKSHEET #15: REFERENCE LIMITS AND EVALUATION TABLES

(UFP-QAPP Manual Section 2.8.1)

TPH does not have action levels as it is used to determine whether PAHs need to be analyzed.

Matrix: Soil
Analytical Group: BTEX and MTBE
Analytical Method: SW-846 Method 8260B

Analyte	CAS No.	Project Action Level (mg/kg)	Project Action Level Source	Project Quantitation Limit Goal (mg/kg)	Laboratory Limit of Quantitation[1] (mg/kg)	Laboratory Limit of Detection[1] (mg/kg)	Laboratory Method Detection Limit[1] (mg/kg)
Benzene	71-43-2	0.12	RG-411	0.04	0.005	0.0005	0.000051
Ethylbenzene	100-41-4	36.8	RG-411	13	0.005	0.0005	0.000183
Toluene	108-88-3	39.1	RG-411	13	0.005	0.0005	0.000107
Xylene (Total)	1330-20-7	117	RG-411	39	0.015	0.0015	0.000247
Methyl Tert-Butyl Ether	1634-04-4	2.56	RG-411	0.83	0.005	0.0005	0.000061
Total Petroleum Hydrocarbons (>C12)	NA	NA	RG-411	NA	10	5	1

Notes:

[1] LOQ, LOD, and DLs are provided by Gulf Coast Analytical Laboratories and are targets that are achievable under optimal conditions; they may vary during the course of the project. Soil results will be reported on a dry weight basis. Physical characteristics, such as moisture content, will affect the actual limits achieved.

BTEX = Benzene, toluene, ethylbenzene, xylenes (total)
MTBE = Methyl tert-butyl ether
CAS = Chemical Abstracts Service
mg/kg = Milligram per kilogram
NA = not applicable
RG-411 = *Investigating and Reporting Releases from Petroleum Storage Tanks,* Texas Commission on Environmental Quality Regulatory Guidance RG-411, Revised August 2011

SAP WORKSHEET #15: REFERENCE LIMITS AND EVALUATION TABLES (continued)

Matrix: Soil
Analytical Group: Polynuclear Aromatic Hydrocarbons
Analytical Method: SW-846 Method 8270D (dibenzofuran) and 8270D — SIM (remaining PAHs)

Analyte	CAS No.	Project Action Level (mg/kg)	Project Action Level Source	Project Quantitation Limit Goal (mg/kg)	Laboratory Limit of Quantitation[1] (mg/kg)	Laboratory Limit of Detection[1] (mg/kg)	Laboratory Method Detection Limit[1] (mg/kg)
Acenaphthene	83-32-9	34.1	RG-411	11	0.00333	0.00165	0.000828
Acenaphthylene	208-96-8	54.7	RG-411	18	0.00333	0.00165	0.000530
Anthracene	120-12-7	2.04	RG-411	0.68	0.00333	0.00165	0.000227
Benzo(a)anthracene	56-55-3	0.877	RG-411	0.29	0.00333	0.00165	0.000669
Benzo(a)pyrene	50-32-8	0.0877	RG-411	0.029	0.00333	0.00165	0.000400
Benzo(b)fluoranthene	205-99-2	0.877	RG-411	0.29	0.00333	0.00165	0.000892
Benzo(g,h,i)perylene	191-24-2	0.824	RG-411	0.27	0.00333	0.00333	0.000716
Benzo(k)fluoranthene	207-08-9	1.35	RG-411	0.45	0.00333	0.00165	0.000312
Chrysene	218-01-9	1.24	RG-411	0.41	0.00333	0.00333	0.000347
Dibenz(a,h)anthracene	53-70-3	0.0877	RG-411	0.029	0.00333	0.00333	0.000410
Dibenzofuran	132-64-9	48.8	RG-411	16	0.33	0.033	0.005135
Fluoranthene	206-44-0	25.5	RG-411	8.5	0.00333	0.00165	0.000613
Fluorene	86-73-7	30.2	RG-411	10	0.00333	0.00165	0.000314
Indeno(1,2,3-cd)pyrene	193-39-5	0.877	RG-411	0.29	0.00333	0.00333	0.000591
Naphthalene	91-20-3	99.7	RG-411	33	0.00333	0.00333	0.000543
Phenanthrene	85-01-8	28.2	RG-411	9.4	0.00333	0.00165	0.000574
Pyrene	129-00-0	10.3	RG-411	3.4	0.00333	0.00165	0.000521

Notes:
[1] LOQ, LOD, and DLs are provided by Gulf Coast Analytical Laboratories and are targets that are achievable under optimal conditions; they may vary during the course of the project. Soil results will be reported on a dry weight basis. Physical characteristics, such as moisture content, will affect the actual limits achieved.

SIM = Selective ion monitoring
PAHs = Polynuclear aromatic hydrocarbons
CAS = Chemical Abstracts Service
mg/kg = Milligram per kilogram
RG-411 = *Investigating and Reporting Releases from Petroleum Storage Tanks,* Texas Commission on Environmental Quality Regulatory Guidance RG-411, Revised August 2011

SAP WORKSHEET #15: REFERENCE LIMITS AND EVALUATION TABLES (continued)

TPH does not have action levels as it is used to determine whether PAHs need to be analyzed.

Matrix:	Groundwater
Analytical Group:	Selected VOCs: Ethylene Dibromide, 1,2-Dichloroethane, BTEX and MTBE
Analytical Method:	SW-846 Method 8011 (Ethylene Dibromide) and 8260B (remaining VOCs)

Analyte	CAS No.	Project Action Level (µg/L)	Project Action Level Source	Project Quantitation Limit Goal (µg/L)	Laboratory Limit of Quantitation[1] (µg/L)	Laboratory Limit of Detection[1] (µg/L)	Laboratory Method Detection Limit[1] (µg/L)
Benzene	71-43-2	5	RG-411	1.7	1	0.2	0.111
Ethylene Dibromide	106-93-4	5	TX CI $^{GW}GW_{Class3}$	0.05	0.01	0.01	0.0039
Ethylbenzene	100-41-4	700	RG-411	230	1	0.2	0.109
1,2-Dichloroethane	107-06-2	500	TX CI $^{GW}GW_{Class3}$	5	1	0.2	0.116
Toluene	108-88-3	1000	RG-411	330	1	0.2	0.122
Xylene (Total)	1330-20-7	10000	RG-411	3300	3	0.6	0.179
Methyl Tert-Butyl Ether	1634-04-4	240	RG-411	80	1	0.2	0.078
Total Petroleum Hydrocarbons (>C12)	NA	NA	RG-411	NA	5000	1000	1000

Notes:

[1] LOQ, LOD, and DLs are provided by Gulf Coast Analytical Laboratories and are targets that are achievable under optimal conditions; they may vary during the course of the project.

VOCs = Volatile organic compounds
BTEX = Benzene, toluene, ethylbenzene, xylenes (total)
MTBE = Methyl tert-butyl ether
CAS = Chemical Abstracts Service
µg/L = Micrograms per Liter
NA = not applicable
RG-411 = *Investigating and Reporting Releases from Petroleum Storage Tanks,* Texas Commission on Environmental Quality Regulatory Guidance RG-411, Revised August 2011
TX CI $^{GW}GW_{Class3}$ = Tier 1 Commercial/Industrial Groundwater Protective Concentration Level for 0.5 acre source area and Class 3 Groundwater, June 2012

SAP WORKSHEET #15: REFERENCE LIMITS AND EVALUATION TABLES (continued)

Matrix: Groundwater
Analytical Group: Polynuclear Aromatic Hydrocarbons
Analytical Method: SW-846 Method 8270D (dibenzofuran) and 8270D- SIM (remaining PAHs)

Analyte	CAS No.	Project Action Level (µg/L)	Project Action Level Source	Project Quantitation Limit Goal (µg/L)	Laboratory Limit of Quantitation[1] (µg/L)	Laboratory Limit of Detection[1] (µg/L)	Laboratory Method Detection Limit[1] (µg/L)
Acenaphthene	83-32-9	2190	RG-411	730	0.1	0.05	0.037
Acenaphthylene	208-96-8	2190	RG-411	730	0.1	0.10	0.070
Anthracene	120-12-7	11000	RG-411	3700	0.1	0.05	0.024
Benzo(a)anthracene	56-55-3	0.117	RG-411	0.039	0.1	0.10	0.059
Benzo(a)pyrene	50-32-8	0.2	RG-411	0.067	0.1	0.05	0.022
Benzo(b)fluoranthene	205-99-2	0.117	RG-411	0.039	0.1	0.05	0.018
Benzo(g,h,i)perylene	191-24-2	1100	RG-411	370	0.1	0.05	0.036
Benzo(k)fluoranthene	207-08-9	1.17	RG-411	0.39	0.1	0.05	0.039
Chrysene	218-01-9	11.7	RG-411	3.9	0.1	0.05	0.018
Dibenz(a,h)anthracene	53-70-3	0.2	RG-411	0.067	0.1	0.05	0.034
Dibenzofuran	132-64-9	146	RG-411	49	10	0.5	0.198
Fluoranthene	206-44-0	1460	RG-411	487	0.1	0.05	0.039
Fluorene	86-73-7	1460	RG-411	487	0.1	0.10	0.097
Indeno(1,2,3-cd)pyrene	193-39-5	0.117	RG-411	0.039	0.1	0.05	0.040
Naphthalene	91-20-3	730	RG-411	240	0.1	0.05	0.037
Phenanthrene	85-01-8	1100	RG-411	370	0.1	0.05	0.028
Pyrene	129-00-0	1100	RG-411	370	0.1	0.05	0.036

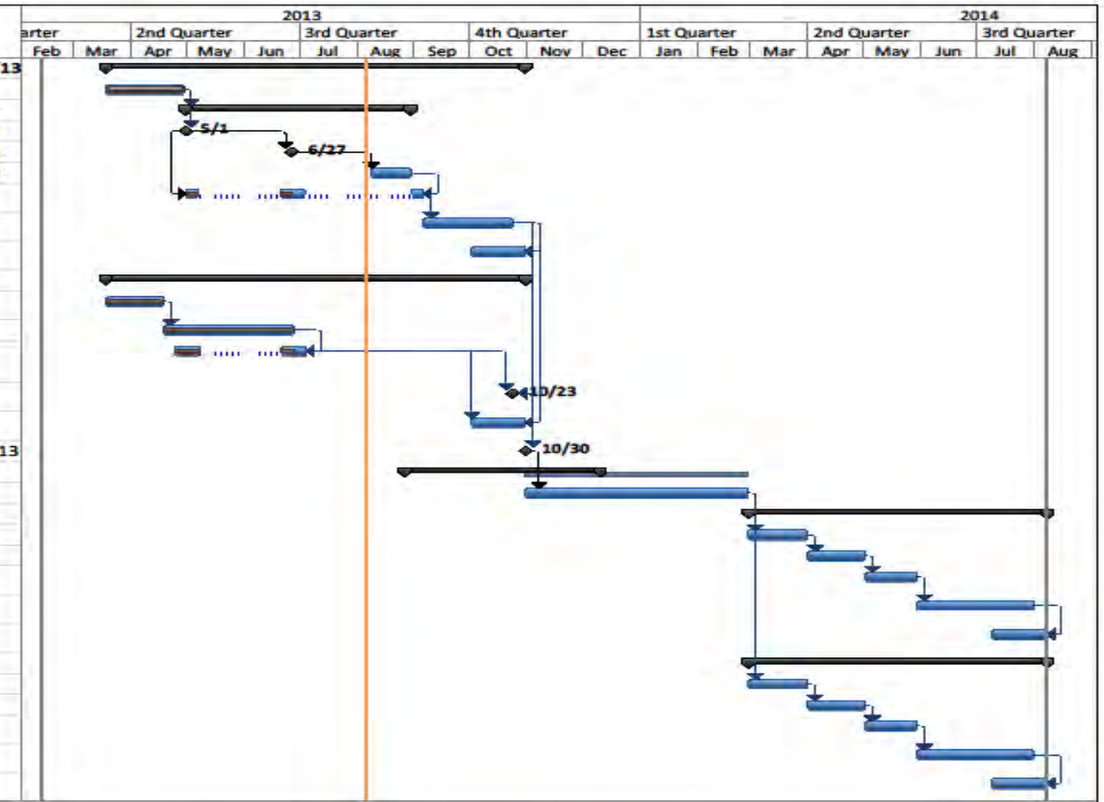
Notes:
[1] LOQ, LOD, and DLs are provided by Gulf Coast Analytical Laboratories and are targets that are achievable under optimal conditions; they may vary during the course of the project.

SIM = Selective ion monitoring
PAHs = Polynuclear aromatic hydrocarbons
CAS = Chemical Abstracts Service
µg/L = Micrograms per Liter
RG-411 = *Investigating and Reporting Releases from Petroleum Storage Tanks,* Texas Commission on Environmental Quality Regulatory Guidance RG-411, Revised August 2011

SAP WORKSHEET #16: PROJECT SCHEDULE/TIMELINE TABLE

(UFP-QAPP Manual Section 2.8.2)

ID	WBS	Task Name	Duration	Start	Finish
1	**1**	**UFP-SAP/QAPP**	**162 days**	**Tue 3/19/13**	**Wed 10/30/13**
2	1.1	Draft UFP-SAP/QAPP	30 days	Tue 3/19/13	Mon 4/29/13
3	**1.2**	**Navy Review & Comments**	**87 days**	**Wed 5/1/13**	**Thu 8/29/13**
4	1.2.1	RPM Review of Worksheets 10, 11, 17	0 days	Wed 5/1/13	Wed 5/1/13
5	1.2.2	DQO Team Meeting (Worksheets 10, 11, 17)	0 days	Thu 6/27/13	Thu 6/27/13
6	1.2.3	Navy Chemist Review of Worksheets 10, 11, 17	15 days	Fri 8/9/13	Thu 8/29/13
7	1.3	Comment Response & Draft Final UFP-SAP/QAPP	19 days	Wed 5/1/13	Thu 9/5/13
8	1.4	Regulatory Review (TCEQ & USEPA)	34 days	Fri 9/6/13	Wed 10/23/13
9	1.5	Response to Comments & Final UFP-SAP/QAPP	21 days	Wed 10/2/13	Wed 10/30/13
10	**2**	**SI Work Plan & HASP**	**162 days**	**Tue 3/19/13**	**Wed 10/30/13**
11	2.1	Draft SI Work Plan & Draft HASP	23 days	Tue 3/19/13	Thu 4/18/13
12	2.2	Navy Review & Comments (HASP)	50 days	Fri 4/19/13	Thu 6/27/13
13	2.3	Response to Comments & Draft Final SI Work Plan & Final HASP	19 days	Thu 4/25/13	Thu 7/4/13
14	2.4	Regulatory Review SI Work Plan (TCEQ & USEPA)	0 days	Wed 10/23/13	Wed 10/23/13
15	2.5	Response to Comments & Final SI Work Plan	21 days	Wed 10/2/13	Wed 10/30/13
16	3	Final RI Work Plan (UFP-SAP & HASP)	0 days	Wed 10/30/13	Wed 10/30/13
17	**3**	**SI Field Work**	**75 days**	Tue 8/27/13	Mon 12/9/13
18	4.1	SI Field Work	86 days	Thu 10/31/13	Thu 2/27/14
19	**4**	**SI Report**	**115 days**	Fri 2/28/14	Thu 8/7/14
20	4.1	Draft SI Report	22 days	Fri 2/28/14	Mon 3/31/14
21	4.2	Navy Review & Comments	23 days	Tue 4/1/14	Thu 5/1/14
22	4.3	Response to Comments & Draft Final SI Report	20 days	Fri 5/2/14	Thu 5/29/14
23	4.4	Regulatory Review (TCEQ & USEPA)	45 days	Fri 5/30/14	Thu 7/31/14
24	5.5	Response to Comments & Final SI Report	22 days	Wed 7/9/14	Thu 8/7/14
25	**5**	**Feasibility Study**	**115 days**	Fri 2/28/14	Thu 8/7/14
26	5.1	Draft FS Report	22 days	Fri 2/28/14	Mon 3/31/14
27	5.2	Navy Review & Comments	23 days	Tue 4/1/14	Thu 5/1/14
28	5.3	Response to Comments & Draft Final FSReport	20 days	Fri 5/2/14	Thu 5/29/14
29	5.4	Regulatory Review (TCEQ & USEPA)	45 days	Fri 5/30/14	Thu 7/31/14
30	6.5	Response to Comments & Final FS Report	22 days	Wed 7/9/14	Thu 8/7/14



Project: JM46_SI_FuelFarms_217-244_NASCC__trackingschedule_6AUG2013
Date: Tue 8/6/13
JM46 NAS Corpus Christi Texas
UST Site 9 SI: Fuel Farms 217 & 244

Task		External Tasks		Manual Task		Finish-only	
Split		External Milestone		Duration-only		Deadline	
Milestone		Inactive Task		Manual Summary Rollup		Progress	
Summary		Inactive Milestone		Manual Summary			
Project Summary		Inactive Summary		Start-only			

Page 1

SAP WORKSHEET #17: SAMPLING DESIGN AND RATIONALE

(UFP-QAPP Manual Section 3.1.1)

17.1 General Sampling Design and Rationale

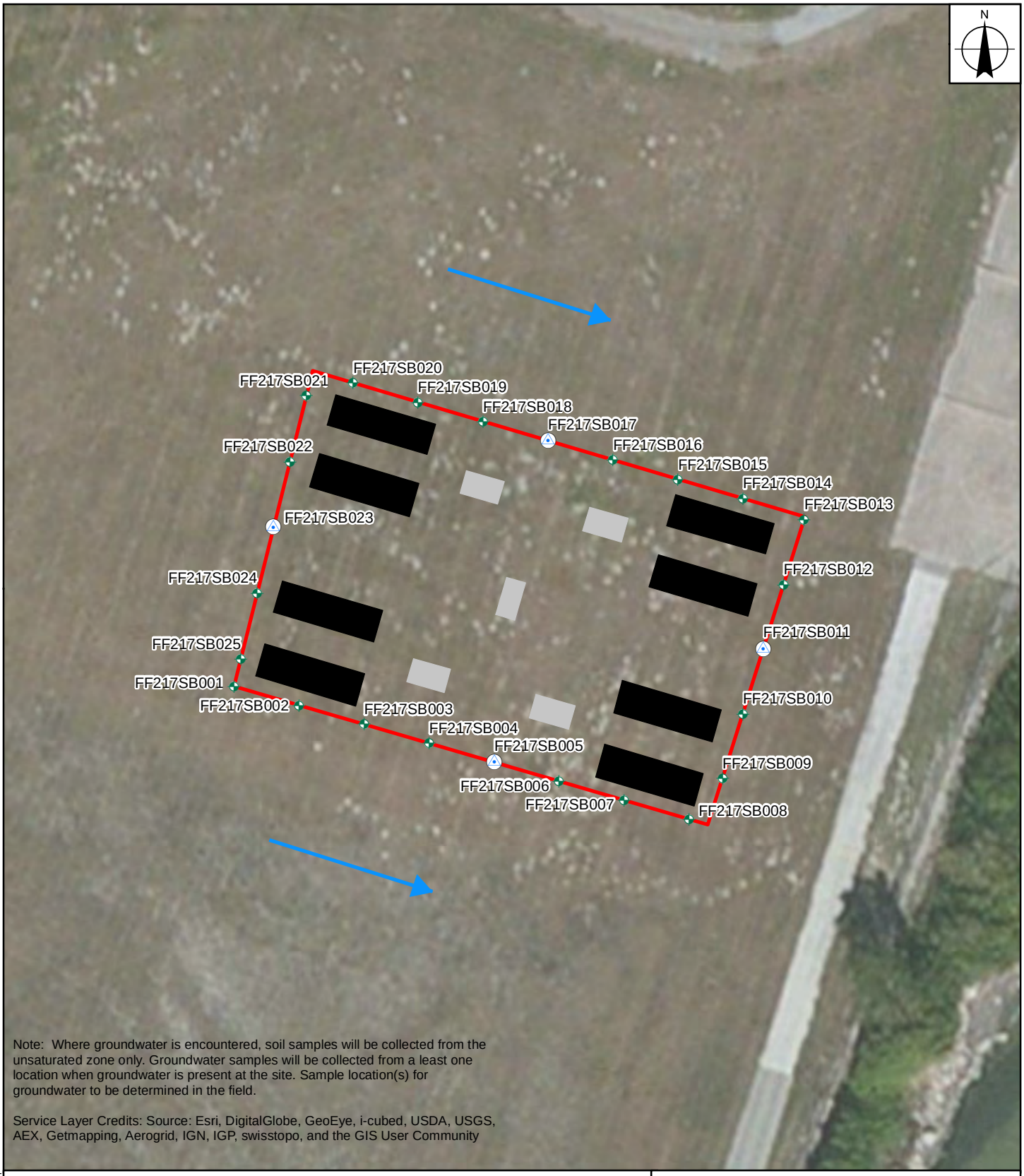
The sampling design and rationale was developed using information on historical operations, the CSM (including subsurface conditions and anticipated groundwater flow directions) as presented in Worksheet #10, assumptions regarding potential contaminant distribution, general site information collected during previous studies, and guidance provided on Texas PST Program requirements in RG-411. The steps outlined in this worksheet represent the initial steps in the SI.

17.1.1 Geophysical Survey

For each fuel farm site, TDEM geophysical surveys will cover an area of approximately 74,000 square feet, with data collected at a high density over a subset of this area (about 150 feet by 250 feet based on the FF244 layout sketch) to precisely locate the USTs. Survey lines will be spaced every 5 feet or better and data collected along that line at 0.5 feet. Outside of the tank areas, data collection will be less dense, every 20 to 50 feet, with the objective of tracing the layout of pipes that radiate out from the tank array and manifolds. Other utilities in the area may also be observable within the survey; however the geophysical survey will not be used in place of obtaining actual utility clearances from each utility stakeholder with utilities in these areas. The objective of the survey is solely to locate underground features associated with the tanks and pipelines to assist in refining the soil sample locations. The currently proposed approach does not anticipate the use of geophysical techniques to detect the presence or absence of light non-aqueous phase liquid or the sand tank fill.

17.1.2 Soil Sampling Program

For the fuel farms, soil and groundwater sampling shall be performed generally as outlined in the Texas PST Program requirements in RG-411. The tank hold perimeter for each fuel farm will be defined during the TDEM surveys and will be sampled at 25-foot intervals. As per RG-411, piping is to be sampled at a rate of every 20 linear feet of trench and at turns and fittings; however,because it is anticipated that much of the piping will be internal to the tank hold, sampling along piping will be limited to that outside the tank hold. The exact number of sample stations along pipe will not be known until completion of the TDEM surveys; for planning purposes, six sample locations along the pipelines are proposed at each fuel farm (not shown in Figures 17-1 or 17-2). Based on available information regarding the tank hold configuration, approximately 24 tank hold perimeter sampling locations are planned for each fuel farm. At each fuel farm site, 30 samples are planned (total of 60 locations for the UST Site 9 SI effort), as shown on Figures 17-1 and 17-2 for FF217 and FF244, respectively.



Note: Where groundwater is encountered, soil samples will be collected from the unsaturated zone only. Groundwater samples will be collected from a least one location when groundwater is present at the site. Sample location(s) for groundwater to be determined in the field.

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Legend

- Proposed Sample Location
- Proposed Temporary Well Location
- Groundwater Flow Direction
- Transfer Pit
- Underground Storage Tank
- Fuel Farm 217 Site Boundary SWMU Nos. 54 through 61

0 50 100 Feet

FIGURE 17-1
PROPOSED SAMPLE LOCATIONS
UST SITE 9 FUEL FARM 217
NAS CORPUS CHRISTI
CORPUS CHRISTI, TEXAS

NAVFAC Naval Facilities Engineering Command
RESOLUTION CONSULTANTS

REQUESTED BY: B. ELLIOTT	DATE: 3/19/2014
DRAWN BY: BL, SS	TASK ORDER NUMBER: JM46

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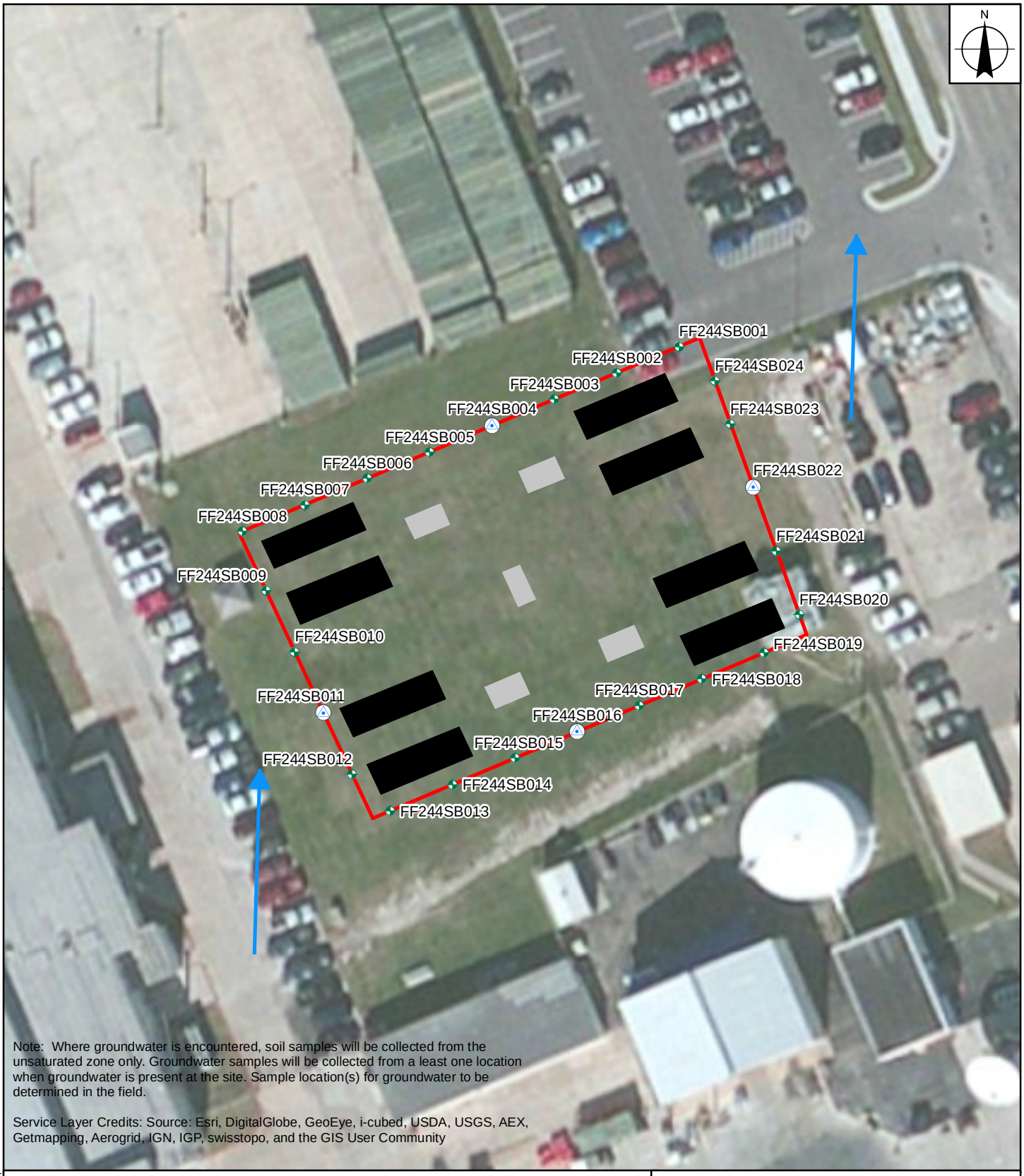

Note: Where groundwater is encountered, soil samples will be collected from the unsaturated zone only. Groundwater samples will be collected from a least one location when groundwater is present at the site. Sample location(s) for groundwater to be determined in the field.

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Legend

- Proposed Sample Location
- Proposed Temporary Well Location
- Groundwater Flow Direction
- Transfer Pit
- Underground Storage Tank
- Fuel Farm 244 Site Boundary SWMU Nos. 62 through 69

0 50 100 Feet

FIGURE 17-2
PROPOSED SAMPLE LOCATIONS
UST SITE 9 FUEL FARM 244
NAS CORPUS CHRISTI
CORPUS CHRISTI, TEXAS

NAVFAC Naval Facilities Engineering Command
RESOLUTION CONSULTANTS

REQUESTED BY: B. ELLIOTT	DATE: 3/19/2014
DRAWN BY: BL, SS	TASK ORDER NUMBER: JM46

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Due to the fuel farms' proximity to Oso Bay, Corpus Christi Bay, and Laguna Madre, it is anticipated that groundwater will be encountered before the bottom of the tank holds are reached during the DPT soil boring. Therefore, at each soil boring location, collection of a single soil sample at the top of groundwater at a depth of less than 15 feet below ground surface is expected based on guidance in RG-411. At each piping trench station, one soil sample is to be obtained from the top of groundwater (when present) encountered in each boring, or 1 foot below anticipated bottom of pipeline. Professional judgment may be used to adjust sampling locations and/or depths in the field based on visual observations/staining, free product, odors, and elevated headspace PID readings.

Soil samples will be analyzed for BTEX, MTBE, and TPH. Soil samples for PAH analysis will be collected at the same time as the TPH samples but will be put on hold after extraction. TPH sample analysis results will be used to determine if PAH analysis is required, as outlined in Section 11.5. Worksheet #18 provides sample identifications that will be used.

17.1.3 Groundwater Sampling Program

Groundwater analytical data should be collected to determine the current concentrations of COPCs at a minimum of one location per fuel farm site in accordance with TCEQ guidance in RG-411. However, six temporary wells will be installed and developed for groundwater sampling based on input from TCEQ and U.S. EPA due to the size and distribution of the tank holds and associated piping. Well locations will be upgradient (1), downgradient (1), cross gradient (2), and located within the tank holds or pipeline chases based on locations (2) exhibiting the highest PID readings. Groundwater will be sampled in accordance with SOP-3-17(CC) and SOP-3-14. Groundwater is expected to be encountered above or near the base of the tank holds.

Groundwater samples will be collected from properly developed temporary wells using dedicated tubing and peristaltic pumps in accordance with SOP-3-17(CC) and SOP-3-24. Sample collection and handling will be in accordance with SOP-3-03A, SOP-3-04A, and SOP-3-24 and as described in Worksheet #21. All temporary wells will be removed within 48 hours of well completion, the boreholes will be backfilled to within 6 to 24 inches of grade using bentonite grout or other acceptable method described in SOP-3-17(CC). After 24 hours, the grouted borehole will be inspected for grout shrinkage and re-grouted if necessary. The remaining portion of the hole will be filled with soil cuttings removed from borehole, local topsoil, and/or appropriate paving materials to match areas where pavements are impacted by the boring location. Well abandonment reports will be prepared in accordance with State of Texas water well abandonment requirements.

The groundwater sampling depth will be from a minimum of 2 feet and a maximum of 5 feet below the initial top of groundwater column elevation with the intent of collecting a sample from the top of the water column. This depth may be adjusted in the field to collect sufficient sample for analysis.

Groundwater samples will be analyzed for ethylene dibromide, 1,2-dichloroethane, BTEX, MTBE, and TPH. Groundwater samples for PAHs will be collected at the same time as the TPH samples but will be put on hold after extraction. TPH sample analysis results will be used to determine if PAH analysis is required, as outlined in Section 11.5. Worksheet #18 provides sample identifications that will be used.

SAP WORKSHEET #18: LOCATION-SPECIFIC SAMPLING METHODS/SOP REQUIREMENTS TABLE

(UFP-QAPP Manual Section 3.1.1)

Sample Matrix: Soil
Location: Fuel Farm 217

Sample Location	Sample ID	Longitude	Latitude	Depth, feet bgs	Sampling Standard Operating Procedures	BTEX	MTBE	TPH	PAHs
FF217SB001	FF217SB001xx FF217CB001xx (FD)	-97.2607956	27.6833305	capillary fringe	SOP-3-03A, SOP-3-04A, SOP-3-17(CC), SOP-3-21	X	X	X	
FF217SB002	FF217SB002xx FF217CB002xx (FD) FF217SB002xx (+MS/MSD)	-97.2607193	27.6833096	capillary fringe	SOP-3-03A, SOP-3-04A, SOP-3-17(CC), SOP-3-21	X	X	X	
FF217SB003	FF217SB003xx	-97.260643	27.6832905	capillary fringe	SOP-3-03A, SOP-3-04A, SOP-3-17(CC), SOP-3-21	X	X	X	
FF217SB004	FF217SB004xx	-97.2605667	27.6832695	capillary fringe	SOP-3-03A, SOP-3-04A, SOP-3-17(CC), SOP-3-21	X	X	X	
FF217SB005	FF217SB005xx	-97.260498	27.6832504	capillary fringe	SOP-3-03A, SOP-3-04A, SOP-3-17(CC), SOP-3-21	X	X	X	
FF217SB006	FF217SB006xx	-97.2604218	27.6832294	capillary fringe	SOP-3-03A, SOP-3-04A, SOP-3-17(CC), SOP-3-21	X	X	X	
FF217SB007	FF217SB007xx	-97.2603455	27.6832104	capillary fringe	SOP-3-03A, SOP-3-04A, SOP-3-17(CC), SOP-3-21	X	X	X	
FF217SB008	FF217SB008xx	-97.2602768	27.6831913	capillary fringe	SOP-3-03A, SOP-3-04A, SOP-3-17(CC), SOP-3-21	X	X	X	
FF217SB009	FF217SB009xx	-97.2602386	27.6832314	capillary fringe	SOP-3-03A, SOP-3-04A, SOP-3-17(CC), SOP-3-21	X	X	X	
FF217SB010	FF217SB010xx	-97.2602158	27.6832962	capillary fringe	SOP-3-03A, SOP-3-04A, SOP-3-17(CC), SOP-3-21	X	X	X	
FF217SB011	FF217SB011xx	-97.2601852	27.683363	capillary fringe	SOP-3-03A, SOP-3-04A, SOP-3-17(CC), SOP-3-21	X	X	X	
FF217SB012	FF217SB012xx	-97.2601624	27.6834278	capillary fringe	SOP-3-03A, SOP-3-04A, SOP-3-17(CC), SOP-3-21	X	X	X	
FF217SB013	FF217SB013xx	-97.2601395	27.6834927	capillary fringe	SOP-3-03A, SOP-3-04A, SOP-3-17(CC), SOP-3-21	X	X	X	
FF217SB014	FF217SB014xx	-97.2602081	27.6835155	capillary fringe	SOP-3-03A, SOP-3-04A, SOP-3-17(CC), SOP-3-21	X	X	X	
FF217SB015	FF217SB015	-97.2602844	27.6835346	capillary fringe	SOP-3-03A, SOP-3-04A, SOP-3-17(CC), SOP-3-21	X	X	X	
FF217SB016	FF217SB016xx	-97.2603607	27.6835556	capillary fringe	SOP-3-03A, SOP-3-04A, SOP-3-17(CC), SOP-3-21	X	X	X	
FF217SB017	FF217SB017xx	-97.2604294	27.6835766	capillary fringe	SOP-3-03A, SOP-3-04A, SOP-3-17(CC), SOP-3-21	X	X	X	
FF217SB018	FF217SB018xx	-97.2605057	27.6835957	capillary fringe	SOP-3-03A, SOP-3-04A, SOP-3-17(CC), SOP-3-21	X	X	X	
FF217SB019	FF217SB019xx	-97.260582	27.6836166	capillary fringe	SOP-3-03A, SOP-3-04A, SOP-3-17(CC), SOP-3-21	X	X	X	

Sample Matrix: **Soil**
Location: **Fuel Farm 217**

Sample Location	Sample ID	Longitude	Latitude	Depth, feet bgs	Sampling Standard Operating Procedures	BTEX	MTBE	TPH	PAHs
FF217SB020	FF217SB020xx	-97.2606506	27.6836357	capillary fringe	SOP-3-03A, SOP-3-04A, SOP-3-17(CC), SOP-3-21	X	X	X	
FF217SB021	FF217SB021xx	-97.260704	27.6836243	capillary fringe	SOP-3-03A, SOP-3-04A, SOP-3-17(CC), SOP-3-21	X	X	X	
FF217SB022	FF217SB022xx	-97.2607269	27.6835575	capillary fringe	SOP-3-03A, SOP-3-04A, SOP-3-17(CC), SOP-3-21	X	X	X	
FF217SB023	FF217SB023xx	-97.2607422	27.6834908	capillary fringe	SOP-3-03A, SOP-3-04A, SOP-3-17(CC), SOP-3-21	X	X	X	
FF217SB024	FF217SB024xx	-97.2607651	27.683424	capillary fringe	SOP-3-03A, SOP-3-04A, SOP-3-17(CC), SOP-3-21	X	X	X	
FF217SB025	FF217SB025xx	-97.2607803	27.6833572	capillary fringe	SOP-3-03A, SOP-3-04A, SOP-3-17(CC), SOP-3-21	X	X	X	
FF217SB026	FF217SB026xx	TBD	TBD	capillary fringe	SOP-3-03A, SOP-3-04A, SOP-3-17(CC), SOP-3-21	X	X	X	
FF217SB027	FF217SB027xx	TBD	TBD	capillary fringe	SOP-3-03A, SOP-3-04A, SOP-3-17(CC), SOP-3-21	X	X	X	
FF217SB028	FF217SB028xx	TBD	TBD	capillary fringe	SOP-3-03A, SOP-3-04A, SOP-3-17(CC), SOP-3-21	X	X	X	
FF217SB029	FF217SB029xx	TBD	TBD	capillary fringe	SOP-3-03A, SOP-3-04A, SOP-3-17(CC), SOP-3-21	X	X	X	
FF217SB030	FF217SB030xx	TBD	TBD	capillary fringe	SOP-3-03A, SOP-3-04A, SOP-3-17(CC), SOP-3-21	X	X	X	

Notes:

bgs = Below ground surface
BTEX = Benzene, toluene, ethylbenzene, xylenes (total)
MTBE = Methyl tert-butyl ether
TPH = Total petroleum hydrocarbons
PAHs = Polynuclear aromatic hydrocarbons
+MS/MSD = Sample will be used for matrix spike/matrix spike duplicate analysis
FD = Field duplicate will be sampled from this location
TBD = Sample location to be determined based on geophysical survey

Example sample identification: FF217SB007xx = Fuel Farm 217, soil boring, location 007, x-foot sampling end depth

If TPH is detected in soil or groundwater, the sample with the highest concentration of carbon chains 12 or greater (TPH >C12) must be analyzed for PAHs. Samples for PAHs will be collected at the same time as the TPH samples for soil and groundwater, but will be put on hold after extraction until it is determined whether PAH analysis is required.

SAP WORKSHEET #18: LOCATION-SPECIFIC SAMPLING METHODS/SOP REQUIREMENTS TABLE (continued)

Sample Matrix: Soil
Location: Fuel Farm 244

Sample Location	Sample ID	Longitude	Latitude	Depth, feet bgs	Sampling Standard Operating Procedures	BTEX	MTBE	TPH	PAHs
FF244SB001	FF244SB001xx FF244CB001xx (FD)	-97.279007	27.6935024	capillary fringe	SOP-3-03A, SOP-3-04A, SOP-3-17(CC), SOP-3-21	X	X	X	
FF244SB002	FF244SB002xx FF244CB002xx (FD) FF244SB002xx (+MS/MSD)	-97.2790833	27.6934757	capillary fringe	SOP-3-03A, SOP-3-04A, SOP-3-17(CC), SOP-3-21	X	X	X	
FF244SB003	FF244SB003xx	-97.2791519	27.693449	capillary fringe	SOP-3-03A, SOP-3-04A, SOP-3-17(CC), SOP-3-21	X	X	X	
FF244SB004	FF244SB004xx	-97.2792282	27.6934242	capillary fringe	SOP-3-03A, SOP-3-04A, SOP-3-17(CC), SOP-3-21	X	X	X	
FF244SB005	FF244SB005xx	-97.2792969	27.6933975	capillary fringe	SOP-3-03A, SOP-3-04A, SOP-3-17(CC), SOP-3-21	X	X	X	
FF244SB006	FF244SB006xx	-97.2793655	27.6933708	capillary fringe	SOP-3-03A, SOP-3-04A, SOP-3-17(CC), SOP-3-21	X	X	X	
FF244SB007	FF244SB007xx	-97.2794418	27.693346	capillary fringe	SOP-3-03A, SOP-3-04A, SOP-3-17(CC), SOP-3-21	X	X	X	
FF244SB008	FF244SB008xx	-97.2795105	27.6933193	capillary fringe	SOP-3-03A, SOP-3-04A, SOP-3-17(CC), SOP-3-21	X	X	X	
FF244SB009	FF244SB009xx	-97.27948	27.6932583	capillary fringe	SOP-3-03A, SOP-3-04A, SOP-3-17(CC), SOP-3-21	X	X	X	
FF244SB010	FF244SB010xx	-97.2794495	27.6931973	capillary fringe	SOP-3-03A, SOP-3-04A, SOP-3-17(CC), SOP-3-21	X	X	X	
FF244SB011	FF244SB011xx	-97.2794189	27.6931343	capillary fringe	SOP-3-03A, SOP-3-04A, SOP-3-17(CC), SOP-3-21	X	X	X	
FF244SB012	FF244SB012xx	-97.2793884	27.6930714	capillary fringe	SOP-3-03A, SOP-3-04A, SOP-3-17(CC), SOP-3-21	X	X	X	
FF244SB013	FF244SB013xx	-97.279274	27.6930599	capillary fringe	SOP-3-03A, SOP-3-04A, SOP-3-17(CC), SOP-3-21	X	X	X	
FF244SB014	FF244SB014xx	-97.2792053	27.6930866	capillary fringe	SOP-3-03A, SOP-3-04A, SOP-3-17(CC), SOP-3-21	X	X	X	
FF244SB015	FF244SB015	-97.279129	27.6931114	capillary fringe	SOP-3-03A, SOP-3-04A, SOP-3-17(CC), SOP-3-21	X	X	X	
FF244SB016	FF244SB016xx	-97.2790604	27.6931381	capillary fringe	SOP-3-03A, SOP-3-04A, SOP-3-17(CC), SOP-3-21	X	X	X	
FF244SB017	FF244SB017xx	-97.2789917	27.6931648	capillary fringe	SOP-3-03A, SOP-3-04A, SOP-3-17(CC), SOP-3-21	X	X	X	
FF244SB018	FF244SB018xx	-97.2789154	27.6931915	capillary fringe	SOP-3-03A, SOP-3-04A, SOP-3-17(CC), SOP-3-21	X	X	X	
FF244SB019	FF244SB019xx	-97.2788773	27.6932297	capillary fringe	SOP-3-03A, SOP-3-04A, SOP-3-17(CC), SOP-3-21	X	X	X	
FF244SB020	FF244SB020xx	-97.2789001	27.6932945	capillary fringe	SOP-3-03A, SOP-3-04A, SOP-3-17(CC), SOP-3-21	X	X	X	
FF244SB021	FF244SB021xx	-97.2789307	27.6933594	capillary fringe	SOP-3-03A, SOP-3-04A, SOP-3-17(CC), SOP-3-21	X	X	X	
FF244SB022	FF244SB022xx	-97.2789536	27.6934242	capillary fringe	SOP-3-03A, SOP-3-04A, SOP-3-17(CC), SOP-3-21	X	X	X	
FF244SB023	FF244SB023xx	-97.2789688	27.6934662	capillary fringe	SOP-3-03A, SOP-3-04A, SOP-3-17(CC), SOP-3-21	X	X	X	

Sample Matrix: **Soil**
Location: **Fuel Farm 244**

Sample Location	Sample ID	Longitude	Latitude	Depth, feet bgs	Sampling Standard Operating Procedures	BTEX	MTBE	TPH	PAHs
FF244SB024	FF244SB024xx	-97.2793427	27.6930332	capillary fringe	SOP-3-03A, SOP-3-04A, SOP-3-17(CC), SOP-3-21	X	X	X	
FF244SB025	FF244SB025xx	-97.279007	27.6935024	capillary fringe	SOP-3-03A, SOP-3-04A, SOP-3-17(CC), SOP-3-21	X	X	X	
FF244SB026	FF244SB026xx	TBD	TBD	capillary fringe	SOP-3-03A, SOP-3-04A, SOP-3-17(CC), SOP-3-21	X	X	X	
FF244SB027	FF244SB027xx	TBD	TBD	capillary fringe	SOP-3-03A, SOP-3-04A, SOP-3-17(CC), SOP-3-21	X	X	X	
FF244SB028	FF244SB028xx	TBD	TBD	capillary fringe	SOP-3-03A, SOP-3-04A, SOP-3-17(CC), SOP-3-21	X	X	X	
FF244SB029	FF244SB029xx	TBD	TBD	capillary fringe	SOP-3-03A, SOP-3-04A, SOP-3-17(CC), SOP-3-21	X	X	X	
FF244SB030	FF244SB030xx	TBD	TBD	capillary fringe	SOP-3-03A, SOP-3-04A, SOP-3-17(CC), SOP-3-21	X	X	X	

Notes:

bgs = Below ground surface
BTEX = Benzene, toluene, ethylbenzene, xylenes (total)
MTBE = Methyl tert-butyl ether
TPH = Total petroleum hydrocarbons
PAHs = Polynuclear aromatic hydrocarbons
+MS/MSD = Sample will be used for matrix spike/matrix spike duplicate analysis
FD = Field duplicate will be sampled from this location
TBD = Sample location to be determined based on geophysical survey

Example sample identification: FF217SB007xx = Fuel Farm 217, soil boring, location 007, x-foot sampling end depth

If TPH is detected in soil or groundwater, the sample with the highest concentration of carbon chains 12 or greater (TPH >C12) must be tested for PAHs. Samples for PAHs will be collected at the same time as the TPH samples for soil and groundwater, but will be put on hold after extraction until it is determined whether PAH analysis is required.

SAP WORKSHEET #18: LOCATION-SPECIFIC SAMPLING METHODS/SOP REQUIREMENTS TABLE (continued)

Sample Matrix: **Groundwater**
Location: **Fuel Farm 217**

Sample Location	Sample ID	Longitude	Latitude	Depth, feet bgs	Sampling Standard Operating Procedures	BTEX	MTBE	TPH	PAHs	EDB	1,2-DCA
FF217TW001	FF217TW001mmddyy FF217TW001mmddyy (FD)	TBD	TBD	TBD	SOP-3-03A, SOP-3-04A, SOP-3-17(CC), SOP-3-14, SOP-3-24	X	X	X		X	X
FF217TW002	FF217TW002mmddyy FF217TW002mmddyy (+MS/MSD)	TBD	TBD	TBD	SOP-3-03A, SOP-3-04A, SOP-3-17(CC), SOP-3-14, SOP-3-24	X	X	X		X	X
FF217TW003	FF217TW003mmddyy	TBD	TBD	TBD	SOP-3-03A, SOP-3-04A, SOP-3-17(CC), SOP-3-14, SOP-3-24	X	X	X		X	X
FF217TW004	FF217TW004mmddyy	TBD	TBD	TBD	SOP-3-03A, SOP-3-04A, SOP-3-17(CC), SOP-3-14, SOP-3-24	X	X	X		X	X
FF217TW005	FF217TW005mmddyy	TBD	TBD	TBD	SOP-3-03A, SOP-3-04A, SOP-3-17(CC), SOP-3-14, SOP-3-24	X	X	X		X	X
FF217TW006	FF217TW006mmddyy	TBD	TBD	TBD	SOP-3-03A, SOP-3-04A, SOP-3-17(CC), SOP-3-14, SOP-3-24	X	X	X		X	X

Notes:

bgs = Below ground surface
BTEX = Benzene, toluene, ethylbenzene, xylenes (total)
MTBE = Methyl tert-butyl ether
TPH = Total petroleum hydrocarbons
PAHs = Polynuclear aromatic hydrocarbons
EDB = Ethylene dibromide
1,2-DCA = 1,2-Dichloroethane
+MS/MSD = Sample will be used for matrix spike/matrix spike duplicate analysis
FD = Field duplicate will be sampled from this location
TBD = Sample location and depth to be determined based on geophysical survey and actual field conditions

Example sample identification: FF217TW007mmddyy = Fuel Farm 217, temporary well location 007, sample date

If TPH is detected in soil or groundwater, the sample with the highest concentration of carbon chains 12 or greater (TPH >C12) must be tested for PAHs.

SAP WORKSHEET #18: LOCATION-SPECIFIC SAMPLING METHODS/SOP REQUIREMENTS TABLE (continued)

Sample Matrix: **Groundwater**
Location: **Fuel Farm 244**

Sample Location	Sample ID	Longitude	Latitude	Depth, feet bgs	Sampling Standard Operating Procedures	BTEX	MTBE	TPH	PAHs	EDB	1,2-DCA
FF244TW001	FF244TW001mmddyy FF244TW001mmddyy (FD)	TBD	TBD	BGWT	SOP-3-03A, SOP-3-04A, SOP-3-17(CC), SOP-3-14, SOP-3-24	X	X	X		X	X
FF244TW002	FF244TW002mmddyy FF244TW002mmddyy(MS/MSD)	TBD	TBD	BGWT	SOP-3-03A, SOP-3-04A, SOP-3-17(CC), SOP-3-14, SOP-3-24	X	X	X		X	X
FF244TW003	FF244TW003mmddyy	TBD	TBD	BGWT	SOP-3-03A, SOP-3-04A, SOP-3-17(CC), SOP-3-14, SOP-3-24	X	X	X		X	X
FF244TW004	FF244TW004mmddyy	TBD	TBD	BGWT	SOP-3-03A, SOP-3-04A, SOP-3-17(CC), SOP-3-14, SOP-3-24	X	X	X		X	X
FF244TW005	FF244TW005mmddyy	TBD	TBD	BGWT	SOP-3-03A, SOP-3-04A, SOP-3-17(CC), SOP-3-14, SOP-3-24	X	X	X		X	X
FF244TW006	FF244TW006mmddyy	TBD	TBD	BGWT	SOP-3-03A, SOP-3-04A, SOP-3-17(CC), SOP-3-14, SOP-3-24	X	X	X		X	X

Notes:

bgs = Below ground surface
BTEX = Benzene, toluene, ethylbenzene, xylenes (total)
MTBE = Methyl tert-butyl ether
TPH = Total petroleum hydrocarbons
PAHs = Polynuclear aromatic hydrocarbons
EDB = Ethylene dibromide
1,2-DCA = 1,2-Dichloroethane
+MS/MSD = Sample will be used for matrix spike/matrix spike duplicate analysis
FD = Field duplicate will be sampled from this location
TBD = Sample location and depth to be determined based on geophysical survey and actual field conditions

Example sample identification: FF244TW007mmddyy = Fuel Farm 244, temporary well location 007, sample date

If TPH is detected in soil or groundwater, the sample with the highest concentration of carbon chains 12 or greater (TPH >C12) must be tested for PAHs.

SAP WORKSHEET #19: FIELD SAMPLING REQUIREMENTS TABLE

(UFP-QAPP Manual Section 3.1.1)

Matrix	Analytical Group	Analytical and Preparation Method / SOP Reference	Containers (number, size, and type)	Sample Volume	Preservation Requirements (chemical, temperature, light protected)	Maximum Holding Time[1] (preparation / analysis)
Groundwater	1,2-DCA, BTEX, and MTBE	SW-846 5030/8260B *GCMSV-003*	(3) 40 milliliter glass volatile vials	40 milliliters	Hydrochloric acid to a pH less than 2; Cool to 0-6° Celsius; no headspace	14 days
Groundwater	EDB	SW-846 8011 *GC-034*	(2) 40 milliliter glass volatile vials	35 milliliters	Cool to 0-6° Celsius; no headspace	7 days
Soil	BTEX and MTBE	SW-846 5035/8260B *GCMSV-003*	(3) 40 milliliter glass plus 2 ounce jar	5 grams	Methanol (1 vial) and water (2 vials); Cool to 0-6° Celsius	14 days
Groundwater	PAHs	SW-846 3510C/8270D and 8270D SIM *EXT-003/GCMSSV-004*	(2) 1 liter amber glass bottles	1000 milliliters	Cool to 0-6° Celsius	7 days to preparation 40 days to analysis
Soil	PAHs	SW-846 3550C/8270D and 8270D SIM *EXT-001/GCMSSV-004*	(1) 4 ounce glass jar	30 grams	Cool to 0-6° Celsius	14 days to preparation 40 days to analysis
Groundwater	TPH	*TCEQ Method 1005 EXT-010/GC-007*	(3) 40 milliliter glass volatile vials	40 milliliters	Hydrochloric acid to a pH less than 2; Cool to 0-6° Celsius; no headspace	14 days to preparation 14 days to analysis
Soil	TPH	*TCEQ Method 1005 EXT-002/GC-007*	(3) 40 milliliter glass (C6-C12) range) plus 4 ounce jar (>C12 range)	10 grams	Sodium bisulfate; Cool to 0-6° Celsius	14 days to preparation 14 days to analysis

Notes:

[1] Maximum holding time is calculated from the time the sample is collected to the time the sample is prepared/extracted.

1,2-DCA = 1,2-Dichloroethane
BTEX = Benzene, toluene, ethylbenzene, xylenes (total)
MTBE = Methyl tert-butyl ether
EDB = Ethylene dibromide
PAH = Polynuclear aromatic hydrocarbons
SIM = Selective ion monitoring
TPH = Total petroleum hydrocarbons
C6-C12 = 6 to 12 carbon range
>C12 = Greater than 12 carbon range

SAP WORKSHEET #20: FIELD QUALITY CONTROL SAMPLE SUMMARY TABLE

(UFP-QAPP Manual Section 3.1.1)

Matrix	Analytical Group	Number of Sampling Locations	Number of Field Duplicates	Number of Equipment Blanks[1]	Number of Trip Blanks	Number of MS/MSDs	Total Number of Samples to Lab[2]
Soil	BTEX and MTBE	60	4	3	10	4/4	77
Soil	TPH	60	4	3	10	4/4	77
Soil	PAHs	2	2	3	0	1/1	7
Groundwater	1,2-DCA, BTEX, and MTBE	12	2	0	2	2/2	16
Groundwater	EDB	12	2	0	2	2/2	16
Groundwater	TPH	12	2	0	2	2/2	16
Groundwater	PAHs	2	1	0	0	1/1	3

Notes:
[1] Equipment rinsate blanks will be collected if decontamination is required.
[2] Total number of samples does not include MS/MSD analysis.

MS = Matrix spike
MSD = Matrix spike duplicate
BTEX = Benzene, toluene, ethylbenzene, xylenes (total)
MTBE = Methyl tert-butyl ether
TPH = Total petroleum hydrocarbons
PAHs = Polynuclear aromatic hydrocarbons
1,2-DCA = 1,2-Dichloroethane
EDB = Ethylene dibromide

Frequency of QA/QC sample collection:

Field Duplicate = One per 20 field samples for each site
MS/MSD = One pair per 20 field samples (including field quality control samples)
Equipment Blank = One per field-cleaned sampling equipment per week
Trip Blank = One per cooler containing volatile organic compounds

SAP WORKSHEET #21: PROJECT SAMPLING SOP REFERENCES TABLE

(UFP-QAPP Manual Section 3.1.2)

Field SOPs presented below are in Appendix A.

SOP Reference Number	Title, Revision Date and/or Number	Originating Organization of Sampling SOP	Equipment Type	Modified for Project Work? (Yes/No)	Comments
SOP-3-01	*Utility Clearance*, Revision 0, June 2012	Resolution Consultants	None	No	None
SOP-3-02	*Field Log Books*, Revision 0, May 2012	Resolution Consultants	None	No	None
SOP-3-03A	*Sample Labeling and Chain of Custody*, Revision 0, August 2012	Resolution Consultants	None	No	None
SOP-3-04A	*Packaging and Shipping Procedures for Low Concentration Samples*, Revision 0, May 2012	Resolution Consultants	None	No	None
SOP-3-05-TX	*Investigative Derived Waste Management for Texas* Revision 0, May 2012	Resolution Consultants	None	No	None
SOP-3-06	*Equipment Decontamination*, Revision 0, May 2012	Resolution Consultants	Buckets, brushes	No	None
SOP-3-07	*Land Surveying*, Revision 0, August 2012	Resolution Consultants	Global Positioning System	No	None
SOP-3-09	*Geophysical Testing Procedures*, Revision 0, April 2013	Resolution Consultants	TDEM	No	None
SOP-3-14	*Monitoring Well Sampling*, Revision 0, May 2012	Resolution Consultants	Peristaltic pump	No	None
SOP-3-16	*Soil Classification*, Revision 0, August 2012	Resolution Consultants	None	No	None
SOP-3-17 (CC)	*Direct Push Sampling Techniques (Corpus Christi)*, Revision 0, July 2013	Resolution Consultants	Drill Rig, Peristaltic pump	Yes	Includes groundwater well installation and sampling
SOP-3-19	*Headspace Screening for VOCs*, Revision 0, May 2012	Resolution Consultants	PID	No	None
SOP-3-20	*Operation and Calibration of a Photoionization Detector, Revision 0,* May 2012	Resolution Consultants	PID	No	None
SOP-3-21	*Surface and Subsurface Soil Sampling*, Revision 0, May 2012	Resolution Consultants	Direct Push Sampling, Spoons, Bowl	No	None
SOP-3-24	*Water Quality Parameter Testing, Revision 0,* August 2012	Resolution Consultants	Flow Thru Cell with Meters		
TCEQ Ecological Checklist	*Figure: 30 TAC §350.77(b) Tier I: Exclusion Criteria Checklist*	TCEQ	None	No	None

Notes:

PID = Photoionization Detector
SOP = Standard operating procedure
TCEQ = Texas Commission on Environmental Quality
TDEM = Time Domain Electromagnetic Method

SAP WORKSHEET #22: FIELD EQUIPMENT CALIBRATION, MAINTENANCE, TESTING, AND INSPECTION TABLE

(UFP-QAPP Manual Section 3.1.2.4)

Field Equipment	Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference	Comments
Global Positioning System Trimble Geo XT (or similar)	Positioning	Beginning and end of each day used	Accuracy: sub-meter horizontal dilution of precision < 3, number of satellites must be at least six	Wait for better signal, replace unit, or choose alternate location technique	Resolution Consultants FTL or designee	SOP-3-07	None
Geophysical Survey Equipment EM61 Mk2	Locate metal tanks & pipes	Null; base station ties periodically & beginning and end of the day	System precision ±100 mV	Identify noise source, QC equipment, or replace equipment	Resolution Consultants FTL or designee	SOP-3-09	None
pH Meter	Groundwater Parameters	Daily	±0.2 Standard pH Units	Recalibrate or replace meter	Resolution Consultants FTL or designee	SOP-3-24	None
Specific Conductance	Groundwater Parameters	Daily	±5% of the standard	Recalibrate or replace meter	Resolution Consultants FTL or designee	SOP-3-24	None
ORP Meter	Groundwater Parameters	Daily	±10 mV from the theoretical standard value at that temperature	Recalibrate or replace meter	Resolution Consultants FTL or designee	SOP-3-24	None
Turbidity Meter	Groundwater Parameters	Daily	0.1 to 10 NTU: ±10% of the standard 11 to 40 NTU: ±8% of the standard 41 to 100 NTU: ±6.5% of the standard	Recalibrate or replace meter	Resolution Consultants FTL or designee	SOP-3-24	None
DO	Groundwater Parameters	Daily	±0.3 mg/L of the theoretical oxygen solubility	Recalibrate or replace meter	Resolution Consultants FTL or designee	SOP-3-24	None
Thermometer	Groundwater Parameters	Daily	Not applicable	Not applicable	Resolution Consultants FTL or designee	SOP-3-24	None
Flow Rate	Groundwater Parameters	Daily	Not applicable	Not applicable	Resolution Consultants FTL or designee	SOP-3-24	None
PID	Soil Screening	Daily	Per Manufacturer Instructions	Recalibrate or replace meter	Resolution Consultants FTL or designee	SOP-3-20	None

Notes:

FTL = Field team leader
mg/L = Milligrams per liter
DO = Dissolved oxygen
SOP = Standard operating procedure
SU = Standard units
ORP = Oxidation reduction potential
mV = Millivolts
PID = Photoionization Detector
NTU = Nephelometric turbidity units
QC = Quality control

SAP WORKSHEET #23: ANALYTICAL SOP REFERENCES TABLE

(UFP-QAPP Manual Section 3.2.1)

Laboratory Name and Address: Gulf Coast Analytical Laboratories, 7979 GSRI Road, Baton Rouge, LA 70820
Laboratory Point of Contact/Project Manager: Brenda Martinez, brenda.martinez@gcal.com, 225-769-4900

SOP Number	Title, Revision Date, and/or Number	Definitive or Screening Data	Matrix and Analytical Group	Instrument	Variance to Quality Systems Manual	Modified for Project Work? (Yes/No)
EXT-001	*Preparation of Base/Neutral/Acid Low Level Soil/Sediment Samples,* Revision 19, 04/11/13	Definitive	Soil Extraction PAHs	Not applicable	No	No
EXT-003	*Base/Neutral/Acid Sample Extraction Using Separatory Funnel*, Revision 23, 04/01/13	Definitive	Groundwater Extraction PAHs	Not applicable	No	No
GC-007	*TPH by TCEQ 1005 and Characterization of C6 to C35 Petroleum Hydrocarbons by TCEQ 1006 in Environmental Samples,* Revision 11, 01/01/12	Screening	Soil and Groundwater Extraction and Analysis TPH	GC Agilent 6890N	No	No
GCMSV-003	*SOP for the Analysis of Volatile Samples by 8260B*, Revision 23, 12/12/11	Definitive	Soil and Groundwater, 1,2-DCA, BTEX, and MTBE	GC Agilent 6890 and 7890 with MS Agilent 5973 and 5975 Or HP5890 with 5972 MS	No	No
GC-034	*SOP for Determination of 1,2-Dibromoethane and 1,2-Dibromo-3-Chloropropane by Microextraction and Gas Chromatography SW-846 8011*, Revision 9, 07/25/2013	Definitive	Groundwater, EDB	GC Agilent 6890N	No	No
GCMSSV-004	*Standard Operating Procedure for the Analysis Semi-volatile Mass Spec Samples for 8270D*, Revision 8, 01/25/13	Definitive	Soil and Groundwater Analysis PAHs	GC/MS Agilent 5973-6890N or 5975-6890N	No	No

Notes:
Laboratory standard operating procedures will be available upon request.

SOP = Standard operating procedure
PAH = Polynuclear aromatic hydrocarbons
GC = Gas chromatograph
MS = Mass spectrometer
GC/MS = Gas chromatograph/mass spectrometer
TPH = Total petroleum hydrocarbons
BTEX = Benzene, toluene, ethylbenzene, xylenes (total)
MTBE = Methyl tert-butyl ether
1,2-DCA = 1,2-Dichloroethane
EDB = Ethylene dibromide

SAP WORKSHEET #24: ANALYTICAL INSTRUMENT CALIBRATION TABLE

(UFP-QAPP Manual Section 3.2.2)

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action	Person Responsible for Corrective Action	GCAL SOP Reference
GC/MS 1,2-DCA, BTEX and MTBE	Tuning	Prior to ICAL and at the beginning of each 12-hour period.	Refer to method for specific ion criteria.	Retune instrument and verify. Rerun affected samples. Flagging criteria are not appropriate.	Analyst, Supervisor	GCAL SOP GCMSV-003
GC/MS 1,2-DCA, BTEX and MTBE	ICAL Minimum five-point initial calibration for all analytes	Initial calibration prior to sample analysis and after any routine maintenance (source cleaning, new column, etc.) or if ICAL fails.	Average RF for SPCCs: ≥ 0.30 for chlorobenzene and 1,1,2,2-tetrachlorolethane; ≥ 0.1 for chloromethane, bromoform, and 1,1-dichloroethane, %RSD for RFs for CCCs: ≤ 30% and must meet one of the following: Option 1: %RSD for each analyte ≤ 15%; Option 2: linear least squares regression for each analyte: r ≥ 0.995; Option 3: non-linear regression-coefficient of determination for each analyte: r^2 ≥ 0.99.	Repeat calibration if criterion is not met	Analyst, Supervisor	GCAL SOP GCMSV-003
GC/MS 1,2-DCA, BTEX and MTBE	Second source CV	Once after each ICAL	All analytes within ± 20% of expected value	Remake standard, recalibrate if necessary	Analyst, Supervisor	GCAL SOP GCMSV-003
GC/MS 1,2-DCA, BTEX and MTBE	CCV	CV daily, before sample analysis, and every 12 hours of analysis time	RF for SPCCs: ≥ 0.30 for chlorobenzene and 1,1,2,2-tetrachlorolethane; ≥ 0.1 for chloromethane, bromoform, and 1,1-dichloroethane; and %D ≤20 for all target compounds	Repeat initial calibration and reanalyze all samples analyzed since the last successful ICV	Analyst, Supervisor	GCAL SOP GCMSV-003
GC/MS 1,2-DCA, BTEX and MTBE	RRT Evaluation	Prior to sample analysis	Set at mid-point of ICAL; +/- 30 seconds each CCV	CCV fails, perform column maintenance, inspect pumps, and leak checks. After instrument correction, repeat ICAL.	Analyst, Supervisor	GCAL SOP GCMSV-003
GC/ECD EDB	RT window width calculated for each analyte and surrogate	After installing a new column, performing major maintenance or at initial set-up	Width is 3 times standard deviation of a minimum of three injections over a minimum of 72 hours, or default of 0.03 minutes whichever is greater.	Not applicable	Analyst, Supervisor	GCAL SOP GC-034
GC/ECD EDB	RT Window position establishment and verification for each analyte and surrogate	Set using mid-point of ICAL or at first CCV of the day if ICAL is not performed.	Not applicable	Not applicable	Analyst, Supervisor	GCAL SOP GC-034

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action	Person Responsible for Corrective Action	GCAL SOP Reference
GC/ECD EDB	ICAL Minimum five-point initial calibration for all analytes	Initial calibration prior to sample analysis	%RSD <20% for all compounds or linear or quadratic calibration $r^2 > 0.990$	Repeat calibration if criterion is not met	Analyst, Supervisor	GCAL SOP GC-034
GC/ECD EDB	Second source ICV	Once after each ICAL	All analytes within ± 15% of expected value	Repeat initial calibration and reanalyze all samples analyzed since the last successful ICV.	Analyst, Supervisor	GCAL SOP GC-034
GC/ECD EDB	CCV	CCV after every 10 samples and at the end of the analytical sequence	%D or Drift < 20% for all analytes	Repeat initial calibration and reanalyze all samples analyzed since the last successful Calibration verification.	Analyst, Supervisor	GCAL SOP GC-034
GC/ECD EDB	Confirmation of positive results (second column or second detector)	All samples and quality control samples	Detections agree within 40%	Report the result from the primary column and include a narrative unless matrix interference is creating a high bias.	Analyst, Supervisor	GCAL SOP GC-034
GC/MS PAHs	Tuning	Prior to ICAL and at the beginning of each 12-hour period.	Refer to method for specific ion criteria.	Retune instrument and verify. Rerun affected samples. Flagging criteria are not appropriate.	Analyst, Supervisor	GCAL SOP GCMSV-004
GC/MS PAHs	Breakdown check (DDT)	At the beginning of each 12-hour period, prior to analysis of samples.	Degradation ≤ 20% for DDT. Benzidine and pentachlorophenol should be present at their normal responses, and should not exceed a tailing factor of 2	Correct problem then repeat the breakdown check. No samples shall be run until degradation ≤ 20%	Analyst, Supervisor	GCAL SOP GCMSSV-004
GC/MS PAHs	ICAL Minimum five-point initial calibration for all analytes	Initial calibration prior to sample analysis and after any routine maintenance (source cleaning, new column, etc.) or if ICAL fails.	Average RF ≥ 0.050 RSD for RFs for CCCs: ≤ 30% and must meet one of the following: Option 1: %RSD for each analyte ≤ 15%; Option 2: linear least squares regression for each analyte: r ≥ 0.995; Option 3: non-linear regression-coefficient of determination for each analyte: $r^2 \geq 0.99$.	Repeat calibration if criterion is not met	Analyst, Supervisor	GCAL SOP GCMSSV-004
GC/MS PAHs	Second source ICV	Once after each ICAL	All analytes within ± 20% of expected value	Remake standard, recalibrate if necessary	Analyst, Supervisor	GCAL SOP GCMSSV-004
GC/MS PAHs	CCV	CV daily, before sample analysis, and every 12 hours of analysis time	All targets ≤ 20%D	Repeat initial calibration and reanalyze all samples analyzed since the last successful ICV	Analyst, Supervisor	GCAL SOP GCMSSV-004
GC/MS PAHs	RRT Evaluation	Prior to sample analysis	Set at mid-point of ICAL; +/- 30 seconds each CCV	CCV fails, perform column maintenance, inspect pumps, and leak checks. After instrument correction, repeat ICAL.	Analyst, Supervisor	GCAL SOP GCMSSV-004

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action	Person Responsible for Corrective Action	GCAL SOP Reference
GC/FID TPH	ICAL Minimum five-point initial calibration for all analytes	Initial calibration prior to sample analysis and after any routine maintenance (new column, etc.) or if ICAL fails.	Each analyte must meet one of the following: Option 1: %RSD for each analyte ≤ 25%; or Option 2: linear regression for each analyte: $r^2 \geq 0.995$	Repeat calibration if criterion is not met	Analyst, Supervisor	GCAL SOP GC-007
GC/FID TPH	Second source ICV	Once after each ICAL	All analytes within ± 15% of expected value	Repeat initial calibration and reanalyze all samples analyzed since the last successful calibration verification	Analyst, Supervisor	GCAL SOP GC-007
GC/FID TPH	CCV	CCV after every 10 samples and at the end of the analytical sequence	%D or Drift < 25% for all analytes	Repeat initial calibration and reanalyze all samples analyzed since the last successful Calibration verification	Analyst, Supervisor	GCAL SOP GC-007

Notes:

GCAL = Gulf Coast Analytical Laboratories
SOP = Standard operating procedure
GC/MS = Gas chromatograph/mass spectrometer
1,2-DCA = 1,2-Dichloroethane
BTEX = Benzene, toluene, ethylbenzene, xylenes
MTBE = Methyl tert-butyl ether
ICAL = Initial calibration
RF = Response factor
SPCC = System performance check compound
%RSD = Percent relative standard deviation
CCCs = Calibration check compounds
r = linear least squares regression
r^2 = Non-linear regression-coefficient of determination
ICV = Initial calibration verification
CCV = Continuing calibration verification
%D = Percent difference or percent drift
RRT = Relative retention time
GC/ECD = Gas chromatography/Electron capture detector
RT = Retention time
PAH = Polynuclear aromatic hydrocarbons
DDT = 4,4'-Dichlorodiphenyltrichloroethane
GC/FID = Gas chromatography/Flame ionization detector
TPH = Total petroleum hydrocarbon

SAP WORKSHEET #25: ANALYTICAL INSTRUMENT AND EQUIPMENT MAINTENANCE, TESTING, AND INSPECTION TABLE

(UFP-QAPP Manual Section 3.2.3)

Instrument/ Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	GCAL SOP Reference
GC/MS	Check for leaks, replace gas line filters, recondition or replace trap, replace column, clean injection port/liner	1,2-DCA, BTEX, and MTBE	Inspect vacuum pressure daily. Instrument will be inspected prior to each ICAL and/or as needed. Clean source and replace vacuum pump oil annually or as needed. Routine maintenance as necessary.	As needed	No maintenance is required as long as instrument meets tuning criteria and QC meets DoD QSM criteria.	Replace connections, clean source, replace gas line filters, replace GC column, clip column, replace injection port liner, clean injection port, replace Electron Multiplier. Inspect system and correct problem; re-tune instrument and perform new initial calibration after major maintenance.	Analyst, Supervisor	GCAL SOP GCMSV-003
GC/ECD	Clean injection port and replace liner Clip column Maintain pumps	EDB	Instrument will be inspected prior to each ICAL and/or as needed. Routine maintenance as necessary.	Daily	No maintenance is required as long as calibration meets SOP criteria.	Replace connections, replace gas line filters, replace GC column, clip column, replace injection port liner, clean injection port. Inspect system and correct problem; perform new initial calibration after major maintenance.	Analyst, Supervisor	GCAL SOP GC-034
GC/MS	Check for leaks, replace gas line filters, replace column, clean injection port/liner	PAHs	Inspect vacuum pressure daily. Instrument will be inspected prior to each ICAL and/or as needed. Clean source and replace vacuum pump oil annually or as needed. Routine maintenance as necessary.	As needed	No maintenance is required as long as instrument meets tuning criteria and QC meets DoD QSM criteria.	Replace connections, clean source, replace gas line filters, replace GC column, clip column, replace injection port liner, clean injection port, replace Electron Multiplier. Inspect system and correct problem; re-tune instrument and perform new initial calibration after major maintenance.	Analyst, Supervisor	GCAL SOP GCMSSV-004
GC/FID	Clean injection port and replace liner Clip column Maintain pumps	TPH	Instrument will be inspected prior to each ICAL and/or as needed. Routine maintenance as necessary.	Daily	No maintenance is required as long as calibration meets SOP criteria.	Replace connections, replace gas line filters, replace GC column, clip column, replace injection port liner, clean injection port. Inspect system and correct problem; perform new initial calibration after major maintenance.	Analyst, Supervisor	GCAL SOP GC-007

Notes:

GCAL	=	Gulf Coast Analytical Laboratories	MTBE	=	Methyl tert-butyl ether	GC/ECD	=	Gas chromatograph/electron capture detector
SOP	=	Standard operating procedure	ICAL	=	Initial calibration	EDB	=	Ethylene dibromide
GC/MS	=	Gas chromatograph/mass spectrometer	QC	=	Quality control	PAHs	=	Polynuclear aromatic hydrocarbons
1,2-DCA	=	1,2-Dichloroethane	DoD QSM	=	Department of Defense Quality Systems Manual	GC/FID	=	Gas chromatograph/flame ionization detector
BTEX	=	Benzene, toluene, ethylbenzene, xylenes	GC	=	Gas chromatograph	TPH	=	Total Petroleum hydrocarbons

SAP WORKSHEET #26: SAMPLE HANDLING SYSTEM

(UFP-QAPP Manual Appendix A)

SAMPLE COLLECTION, PACKAGING, AND SHIPMENT	
Sample Collection (Personnel/Organization):	FTL/Resolution Consultants
Sample Packaging (Personnel/Organization):	FTL/Resolution Consultants
Coordination of Shipment (Personnel/Organization):	FTL/Resolution Consultants
Type of Shipment/Carrier:	Overnight via FedEx
SAMPLE RECEIPT AND ANALYSIS	
Sample Receipt (Personnel/Organization):	Sample Receiving Supervisor, Charlotte Saucier/GCAL
Sample Custody and Storage (Personnel/Organization):	Sample Receiving Supervisor, Charlotte Saucier/GCAL
Sample Preparation (Personnel/Organization):	Extractions, Prep Supervisor, Rob Martin/GCAL
Sample Determinative Analysis (Personnel/Organization):	Laboratory Manager, Scott Bailey/GCAL
SAMPLE ARCHIVING	
Field Sample Storage (No. of days from sample collection):	180 Days from Receipt of Samples
Sample Extract/Digestate Storage (No. of days from extraction/digestion):	180 Days from Receipt of Samples
SAMPLE DISPOSAL	
Personnel/Organization:	Waste Compliance Manager John Bailey/GCAL
Number of Days from Analysis:	180 Days from Receipt of Samples

Notes:

FTL = Field team leader
GCAL = Gulf Coast Analytical Laboratories

SAP WORKSHEET #27: SAMPLE CUSTODY REQUIREMENTS

(UFP-QAPP Manual Section 3.3.3)

27.1 Sample Nomenclature, Sample Collection Documentation, Handling, and Tracking Procedures

The following sections outline the procedures that will be used to document project activities and sample collection, handling, tracking, and custody procedures during the investigation. All forms must be filled in as completely as possible.

27.1.1 Sample Nomenclature

Sample labeling will be conducted in general accordance with the procedures outlined in Worksheet #18. Nomenclature for soil samples includes the site being investigated, matrix code, soil boring identification number, and depth interval.

Sample type codes planned for this event will include N for normal samples, FD for field duplicates, and EB for equipment blanks. Field duplicates will be labeled so they will be "blind" to the laboratory; they will use the same sample identification as the parent sample but the differentiator will be the fifth character, which will be changed to a C. For example, a soil duplicate of FF244SB00110 would be indicated using FF244CB00110. Equipment blanks will be labeled sequentially followed by the date (i.e., EB07222013). Samples to be used for matrix spike (MS) and matrix spike duplicate (MSD) will be labeled MS/MSD on the container label and noted on the chain-of-custody; however, "MS/MSD" will not be part of the unique sample identifier in order to maintain consistency with the project database. Worksheet #18 provides anticipated sample identifiers for this scope of work.

27.1.2 Sample Collection Documentation

Documentation of field observations will be recorded in a field logbook(s) and/or field log sheets including sample collection logs, boring logs, and monitoring well construction logs. The field logbook utilized on this project will consist of a bound, water-resistant logbook. All pages of the logbook will be numbered sequentially and observations will be recorded with indelible ink.

Field sample log sheets will be used to document sample collection details and other observations and activities will be recorded in the field logbook. Instrument calibration logs will be used to record the daily instrument calibration.

For sampling and field activities, the following types of information will be recorded in the field logbook as appropriate:

- Site name and location
- Date and time of logbook entries
- Personnel and their affiliations
- Weather conditions
- Activities involved with the sampling
- Subcontractor activity summary
- Site observations including site entry and exit times
- Site sketches made onsite
- Visitor names, affiliations, arrival and departure times
- Health and safety issues, including personal protective equipment

27.1.3 Sample Handling and Tracking System

Following collection, all samples will be immediately placed on ice in a cooler. The glass sample containers will be enclosed in bubble-wrap in order to protect the bottleware during shipment. The cooler will be secured using strapping tape along with a signed custody seal. Sample coolers will be delivered to a local courier location for priority overnight delivery to the selected laboratory for analysis. Samples will be preserved as appropriate based on the analytical method. The laboratories will provide pre-preserved sample containers for sample collection. Samples will be maintained at 0 to 6 degrees Celsius until delivery to the laboratory. Proper custody procedures will be followed throughout all phases of sample collection and handling.

After collection, each sample will be maintained in the sampler's custody until formally transferred to another party (e.g., FedEx). For all samples collected, chain-of-custody forms will document the date and time of sample collection, the sampler's name, and the names of all others who subsequently held custody of the sample. Specifications for chemical analyses will also be documented on the chain-of-custody form. Further details on chain-of-custody procedures are provided in SOP-3-03A.

The following subsections outline the procedures that will be used by field and laboratory personnel to document project activities and sample-collection procedures. All forms must be filled in as completely as possible.

Resolution Consultants personnel will collect the samples. The samplers will take care not to contaminate samples through improper handling. Samples will be sealed in appropriate containers, packaged by Resolution Consultants' personnel and placed into sealed coolers under chain-of-custody in accordance with the applicable SOP. All coolers will contain a temperature blank. Samples will be transferred under chain-of-custody to a courier as described below. Once received by the laboratory, receipt will be documented on the chain-of-custody form and the samples will be checked in. The samples will remain under chain-of-custody throughout the analysis period to ensure their integrity is preserved. Details are provided below.

Samples to be delivered to the laboratory(s) will be made by a public courier (i.e., FedEx). After samples have been collected, they will be sent to the laboratory(s) within 24 hours.

27.2 Field Sample Custody Procedures

Chain-of-custody protocols will be used throughout sample handling to establish the evidentiary integrity of sample containers. These protocols will be used to demonstrate that the samples were handled and transferred in a manner that would eliminate possible tampering. Samples for the laboratory will be packaged and shipped in accordance with Resolution Consultants SOP-3-04A.

A sample is under custody if:

- The sample is in the physical possession of an authorized person
- The sample is in view of an authorized person after being in his/her possession
- The sample is placed in a secure area by an authorized person after being in his/her possession
- The sample is in a secure area, restricted to authorized personnel only

Custody documentation is designed to provide documentation of preparation, handling, storage, and shipping of all samples collected. A multi-part form is used with each page of the form signed and dated by the recipient of a sample or portion of sample. The person releasing the sample and the person receiving the sample each will retain a copy of the form each time a sample transfer occurs.

Integrity of the samples collected will be the responsibility of identified persons from the time the samples are collected until the samples, or their derived data, are incorporated into the final report.

The Resolution Consultants FTL is responsible for the care and custody of the samples collected until they are delivered to the laboratory or are entrusted to a carrier. When transferring samples, the individuals relinquishing and receiving them will sign, date, and note the time on the chain-of-custody form. This record documents the sample custody transfer from the sampler to the laboratory, often through another person or agency (common carrier). Upon arrival at the laboratory, internal sample custody procedures will be followed as defined in the laboratory SOPs.

27.3 Laboratory Chain-of-Custody

Laboratory sample custody procedures (receipt of samples, archiving, and disposal) will be used in accordance with laboratory SOPs. Coolers are received and checked for proper temperature. A sample cooler receipt form will be filled out to note conditions and any discrepancies. The chain-of-custody form will be checked against the sample containers for accuracy. Samples will be logged into the laboratory information management system and given a unique log number, which can be tracked through processing. The laboratory project manager will notify the Resolution Consultants Field Team Leader verbally or via e-mail immediately if any problems are identified. Discrepancies and resolutions will be documented on the sample receiving checklist.

SAP WORKSHEET #28: LABORATORY QC SAMPLES TABLE

(UFP-QAPP Manual Section 3.4)

Matrix:	Soil and Groundwater
Analytical Group:	1,2-Dichloroethane, BTEX and MTBE
Analytical Method/SOP Reference:	SW-846 8260B/GCAL SOP GCMSV-003

QC Sample	Frequency & Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicators	Measurement Performance Criteria
Method Blank	One per batch of 20 or fewer samples per matrix	No analytes detected > ½ LOQ and > 1/10 the amount measured in any sample or 1/10 the regulatory limit (whichever is greater). Blank result must not otherwise affect sample results. For common laboratory contaminants, no analytes detected > LOQ. (See Box D-1 in QSM V4.2.)	Correct problem; re-prepare and/or reanalyze any sample associated with a blank that fails criteria.	Analyst, Supervisor, QA Manager	Bias Contamination	See Method/SOP QC Acceptance Limit Column
Surrogates	All field and QC samples	**DoD QSM Surrogate Limits** / **Soil %R** / **Water %R** 1,2-Dichloroethane-d4: 62-125* / 70-120 4-Bromofluorobenzene: 85-120 / 75-120 Dibromofluoromethane: 65-130* / 85-115 Toluene-d8: 85-115 / 85-120 * Laboratory limit is used; %R not listed in DoD QSM.	Re-prepare and/or reanalyze if sufficient sample is available. If reanalysis confirms failing recoveries, report and narrate.	Analyst, Supervisor, QA Manager	Accuracy Bias	QC acceptance criteria specified in DoD QSM Version 4.2 See Method/SOP QC Acceptance Limit Column
LCS	One per batch of 20 or fewer samples per matrix	QC acceptance criteria specified in Table G-6 of DoD QSM Version 4.2	Correct problem. If the LCS recoveries are high but the sample results are <LOQ narrate. Otherwise, re-prepare and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available.	Analyst, Supervisor, QA Manager	Accuracy Bias	QC acceptance criteria specified in Table G-6 of DoD QSM Version 4.2
Internal Standards	In all field samples and standards	Retention time ± 30 seconds from retention time of the midpoint standard in the ICAL; EICP area within -50% to +100% of ICAL midpoint standard	Inspect MS or GC for malfunctions. Reanalyze all samples with internal standard failures. If reanalysis confirms matrix interference, report sample and narrate	Analyst, Supervisor, QA Manager	Accuracy Bias	See Method/SOP QC Acceptance Limit Column

Matrix:	Soil and Groundwater
Analytical Group:	1,2-Dichloroethane, BTEX and MTBE
Analytical Method/SOP Reference:	SW-846 8260B/GCAL SOP GCMSV-003

QC Sample	Frequency & Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicators	Measurement Performance Criteria
MS/MSD	One per batch of 20 or fewer samples per matrix	For matrix accuracy evaluation, use LCS recovery criteria; RPD $\leq$30%.	Contact the client to determine if additional measures are required.	Analyst, Supervisor, QA Manager	Accuracy Bias Precision	See Method/SOP QC Acceptance Limit Column

Notes:

BTEX	=	Benzene, toluene, ethylbenzene, xylenes
MTBE	=	Methyl tert-butyl ether
SOP	=	Standard operating procedure
GCAL	=	Gulf Coast Analytical Laboratories
QC	=	Quality control
LOQ	=	Limit of quantitation
DoD QSM	=	Department of Defense Quality Systems Manual
QA	=	Quality assurance
%R	=	Percent recovery
LCS	=	Laboratory control sample
ICAL	=	Initial calibration
EICP	=	Extracted ion current profile
MS	=	Mass Spectrometer
GC	=	Gas chromatograph
MS/MSD	=	Matrix spike/matrix spike duplicate
RPD	=	Relative percent difference

SAP WORKSHEET #28: LABORATORY QC SAMPLES TABLE (continued)

Matrix:	Groundwater
Analytical Group:	Ethylene Dibromide
Analytical Method/SOP Reference:	SW-846 8011/GCAL SOP GC-034

QC Sample	Frequency & Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicators	Measurement Performance Criteria
Method Blank	One per batch of 20 or fewer samples per matrix	No analytes detected > ½ LOQ and > 1/10 the amount measured in any sample or 1/10 the regulatory limit (whichever is greater)	Correct problem; Re-prepare and/or reanalyze any sample associated with a blank that fails criteria	Analyst, Supervisor, QA Manager	Bias Contamination	See Method/SOP QC Acceptance Limit Column
Surrogates	All field and QC samples	%R — 70-130%	Re-prepare and/or reanalyze if sufficient sample is available. If reanalysis confirms failing recoveries, report and narrate	Analyst, Supervisor, QA Manager	Accuracy Bias	%R — 70-130%
LCS	One per batch of 20 or fewer samples per matrix	%R — 55-141% RPD <40%	Re-prepare and/or reanalyze all associated samples	Analyst, Supervisor, QA Manager	Accuracy Bias	%R — 55-141% RPD <40%
MS/MSD	One per batch of 20 or fewer samples per matrix	%R — 55-141% RPD <40%	Contact the client to determine if additional measures are required	Analyst, Supervisor, QA Manager	Accuracy Bias Precision	%R — 55-141% RPD <40%

Notes:

GCAL = Gulf Coast Analytical Laboratories
SOP = Standard operating procedure
QC = Quality control
LOQ = Limit of quantitation
QA = Quality assurance
%R = Percent recovery
LCS = Laboratory control sample
RPD = Relative percent difference
MS/MSD = Matrix spike/matrix spike duplicate

SAP WORKSHEET #28: LABORATORY QC SAMPLES TABLE (continued)

Matrix:	Soil and Groundwater
Analytical Group:	PAHs
Analytical Method/SOP Reference:	SW-846 Method 8270D (dibenzofuran) and 8270D-SIM (remaining PAHs) /GCAL SOP GCMSSV-004

QC Sample	Frequency & Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicators	Measurement Performance Criteria
Method Blank	One per batch of 20 or fewer samples per matrix	No analytes detected > ½ LOQ and > 1/10 the amount measured in any sample or 1/10 the regulatory limit (whichever is greater). Blank result must not otherwise affect sample results. For common laboratory contaminants, no analytes detected > LOQ. (See Box D-1 in QSM V4.2.)	Correct problem; re-prepare and/or reanalyze any sample associated with a blank that fails criteria.	Analyst, Supervisor, QA Manager	Bias Contamination	See Method/SOP QC Acceptance Limit Column
Surrogates	All field and QC samples	**DoD QSM Surrogate Limits** / **Soil %R** / **Water (Soil Leach) %R** 2-Fluorobiphenyl: 45-105 / 50-110 Terphenyl-d14: 30-125 / 50-135 Nitrobenzene-d5: 35-100 / 40-110	Re-prepare and/or reanalyze if sufficient sample is available. If reanalysis confirms failing recoveries, report and narrate.	Analyst, Supervisor, QA Manager	Accuracy Bias	QC acceptance criteria specified in DoD QSM Version 4.2 See Method/SOP QC Acceptance Limit Column
LCS	One per batch of 20 or fewer samples per matrix	QC acceptance criteria specified in Table G-6 of DoD QSM Version 4.2	Correct problem. If the LCS recoveries are high but the sample results are <LOQ narrate. Otherwise, re-prepare and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available.	Analyst, Supervisor, QA Manager	Accuracy Bias	QC acceptance criteria specified in Table G-6 of DoD QSM Version 4.2
Internal Standards	In all field samples and standards	Retention time ± 30 seconds from retention time of the midpoint standard in the ICAL; EICP area within -50% to +100% of ICAL midpoint standard	Inspect MS or GC for malfunctions. Reanalyze all samples with internal standard failures. If reanalysis confirms matrix interference, report sample and narrate.	Analyst, Supervisor, QA Manager	Accuracy Bias	See Method/SOP QC Acceptance Limit Column

Matrix:	Soil and Groundwater
Analytical Group:	PAHs
Analytical Method/SOP Reference:	SW-846 Method 8270D (dibenzofuran) and 8270D-SIM (remaining PAHs) /GCAL SOP GCMSSV-004

QC Sample	Frequency & Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicators	Measurement Performance Criteria
MS/MSD	One per batch of 20 or fewer samples per matrix	For matrix accuracy evaluation, use LCS recovery criteria; RPD $\leq$30%.	Contact the client to determine if additional measures are required.	Analyst, Supervisor, QA Manager	Accuracy Bias Precision	See Method/SOP QC Acceptance Limit Column

Notes:

PAHs = Polynuclear aromatic hydrocarbons
SIM = Selective ion monitoring
GCAL = Gulf Coast Analytical Laboratories
SOP = Standard operating procedure
QC = Quality control
LOQ = Limit of quantitation
DoD QSM = Department of Defense Quality Systems Manual
QA = Quality assurance
%R = Percent recovery
LCS = Laboratory control sample
ICAL = Initial calibration
EICP = Extracted ion current profile
MS = Mass Spectrometer
GC = Gas chromatograph
MS/MSD = Matrix spike/matrix spike duplicate
RPD = Relative percent difference

SAP WORKSHEET #28: LABORATORY QC SAMPLES TABLE (continued)

Matrix:	Soil and Groundwater
Analytical Group:	TPH
Analytical Method/SOP Reference:	Texas 1005 /GCAL SOP GC-007

QC Sample	Frequency & Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicators	Measurement Performance Criteria
Method Blank	One per batch of 20 or fewer samples per matrix	No analytes detected > ½ LOQ and > 1/10 the amount measured in any sample or 1/10 the regulatory limit (whichever is greater)	Correct problem; Re-prepare and/or reanalyze any sample associated with a blank that fails criteria	Analyst, Supervisor, QA Manager	Bias Contamination	See Method/SOP QC Acceptance Limit Column
Surrogates	All field and QC samples	o-Terphenyl %R — 58-148% (soil and water)	Re-prepare and/or reanalyze if sufficient sample is available. If reanalysis confirms failing recoveries, report and narrate	Analyst, Supervisor, QA Manager	Accuracy Bias	%R — 58-148%
LCS	One per batch of 20 or fewer samples per matrix	%R — 75-125% RPD <20%	Re-prepare and/or reanalyze all associated samples	Analyst, Supervisor, QA Manager	Accuracy Bias	%R — 75-125% RPD <20%
MS/MSD	One per batch of 20 or fewer samples per matrix	%R — 75-125% RPD <20%	Contact the client to determine if additional measures are required	Analyst, Supervisor, QA Manager	Accuracy Bias Precision	%R — 75-125% RPD <20%

Notes:

TPH = Total petroleum hydrocarbons
GCAL = Gulf Coast Analytical Laboratories
SOP = Standard operating procedure
QC = Quality control
LOQ = Limit of quantitation
QA = Quality assurance
%R = Percent recovery
LCS = Laboratory control sample
RPD = Relative percent difference
MS/MSD = Matrix spike/matrix spike duplicate

SAP WORKSHEET #29: PROJECT DOCUMENTS AND RECORDS TABLE

(UFP-QAPP Manual Section 3.5.1)

Document	Where Maintained
Sample Collection Documents and Records Project personnel sign-off record Field logbook (and sampling notes) Field sample forms (e.g., sample log sheets, drilling logs, etc.) Chain-of-custody records Sample shipment air bills Equipment calibration logs Photographs Sampling and Analysis Plans including field sampling standard operating procedures Safe work permit forms	Sample collection documents and records (may include printed copy as well as electronic information) will be maintained at the Resolution Consultants office at 5724 Summer Trees Drive, Memphis, Tennessee 38134. These records will be transferred to the Federal Records Center (FRC) accordance with in the NAVFAC *Environmental Restoration Recordkeeping Manual* where they will be retained for 50 years after the last decision document is signed.
Analytical Results Documents and Records Sample receipt/log-in forms Sample preparation logs Equipment calibration logs Sample analysis run logs Reported field sample results Reported results for standards, quality control checks Reported results for standards, quality control samples Data completeness checklists Data validation memoranda	Analytical results, documents and records will be provided by the laboratory in printed and electronic formats. Printed copies of laboratory data will be stored at Resolution Consultants office at 5724 Summer Trees Drive, Memphis, Tennessee 38134 until transfer to the FRC. The records will be retained by the FRC for 50 years after the last decision document is signed. Electronic analytical results will also be verified, entered, and maintained in a database on a password protected Structured Query Language server. Data qualifiers will be added to the database during data validation. After validation, the validated data files will be transferred to the Navy's NIRIS data management system.

Document	Where Maintained
Other Documents Personnel training records Health and Safety certifications Health and Safety Plan Letter reports, Investigation Reports, etc. Analytical Audit Checklist	Personnel training records and health and safety certificates will be stored in personnel records and electronically in the Resolution Consultants training database located at project file at 5724 Summer Trees Drive, Memphis, Tennessee 38134. Plans and reports will be stored in printed version and electronically in the Administrative Record file. Printed copies will be stored at Resolution Consultants office at 5724 Summer Trees Drive, Memphis, Tennessee 38134 transfer to the FRC. The records will be retained by the FRC for 50 years after the last decision document is signed. Analytical Audit Checklists will be retained by the respective accreditation authorities.
Final Document/Records Repository Administrative Record files Site files Post decision Files Analytical data Spatial data Maps	All final documents/Records repositories will be stored in accordance with in the NAVFAC *Environmental Restoration Recordkeeping Manual*. Printed copies will be stored at Resolution Consultants office at 5724 Summer Trees Drive, Memphis, Tennessee 38134 until transfer to the FRC, and electronic copies will be maintained, verified, and stored on the Navy's NIRIS data management system. These files will be retained by the FRC for 50 years after the last decision document is signed.

Notes:
FRC = Federal Records Center
NIRIS = Naval Installation Restoration Information Solution
NAVFAC = Naval Facilities Engineering Command

SAP WORKSHEET #30: ANALYTICAL SERVICES TABLE

(UFP-QAPP Manual Section 3.5.2.3)

Matrix	Analytical Group	Sample Locations/ID Numbers	Analytical SOP	Data Package Turnaround Time	Laboratory/Organization[1] (name and address, contact person and telephone number)	Backup Laboratory/ Organization
Soil and Groundwater	1,2-DCA, BTEX, and MTBE	See Worksheet #18	GCAL GCMSV-003	21 Days	Gulf Coast Analytical Laboratories, 7979 GSRI Road, Baton Rouge, Louisiana 70820 Brenda Martinez, brenda.martinez@gcal.com, 225-769-4900	None
Groundwater	EDB	See Worksheet #18	GCAL GC-034	21 Days	Gulf Coast Analytical Laboratories, 7979 GSRI Road, Baton Rouge, Louisiana 70820 Brenda Martinez, brenda.martinez@gcal.com, 225-769-4900	None
Soil and Groundwater	PAHs	See Worksheet #18	GCAL GCMSSV-004	21 Days	Gulf Coast Analytical Laboratories, 7979 GSRI Road, Baton Rouge, Louisiana 70820 Brenda Martinez, brenda.martinez@gcal.com, 225-769-4900	None
Soil and Groundwater	TPH	See Worksheet #18	GCAL GC-007	21 Days	Gulf Coast Analytical Laboratories, 7979 GSRI Road, Baton Rouge, Louisiana 70820 Brenda Martinez, brenda.martinez@gcal.com, 225-769-4900	None

Notes:
[1] Laboratory meets accreditation requirements to support project needs.
1,2-DCA = 1,2-Dichloroethane
EDB = Ethylene dibromide
BTEX = Benzene, toluene, ethylbenzene, xylenes
MTBE = Methyl tert-butyl ether
PAHs = Polynuclear aromatic hydrocarbons
TPH = Total petroleum hydrocarbon
GCAL = Gulf Coast Analytical Laboratories

SAP WORKSHEET #31: PLANNED PROJECT ASSESSMENTS TABLE

(UFP-QAPP Manual Section 4.1.1)

Worksheet is not applicable; no project-specific assessments are planned.

SAP WORKSHEET #32: ASSESSMENT FINDINGS AND CORRECTIVE ACTION RESPONSES TABLE

(UFP-QAPP Manual Section 4.1.2)

Worksheet is not applicable; no project-specific assessments are planned.

SAP WORKSHEET #33: QUALITY ASSURANCE MANAGEMENT REPORTS TABLE

(UFP QAPP Manual Section 4.2)

Type of Report	Frequency	Projected Delivery Date(s)	Person(s) Responsible for Report Preparation	Report Recipient(s)
Data Validation	Report per data package	Within 4 weeks of receipt of laboratory data	Resolution Consultants project chemist or designee	TOM, project file, Resolution Consultants
Major Analysis Problem Identification (Internal Resolution Consultants Memorandum)	When persistent analysis problems are detected by Resolution Consultants that may impact data usability	Immediately upon detection of problem (same day)	Resolution Consultants quality assurance officer or project chemist	TOM, program manager, contracts department, project file, Resolution Consultants
Progress Report	Monthly for duration of the project	Monthly	TOM, Resolution Consultants	Navy RPM, program manager, project file, Resolution Consultants
Laboratory Quality Assurance Report	When significant plan deviations result from unanticipated circumstances	Immediately upon detection of problem (same day)	Laboratory quality assurance manager or project manager	TOM, project chemist, project file, Resolution Consultants

Notes:
TOM = Task order manager
RPM = Remedial project manager

SAP WORKSHEETS #34-36: DATA VERIFICATION AND VALIDATION (STEPS I AND IIA/IIB) PROCESS TABLE

(UFP-QAPP Manual Section 5.2.1), (UFP-QAPP Manual Section 5.2.2), (Figure 37 UFP-QAPP Manual), (Table 9 UFP-QAPP Manual)

Data Review Input	Description	Responsible for Verification (name, organization)	Step I/ IIa/IIb [1]	Internal/ External
Verification Chain-of-custody forms Sample Login/Receipt	Review the sample shipment for completeness, integrity, and sign accepting the shipment. All sample labels will be checked against the chain-of-custody form, and any discrepancies will be identified, investigated, and corrected. The samples will be logged in at every storage area and work station required by the designated analyses. Individual analysts will verify the completeness and accuracy of the data recorded on the forms. Verification of sample login/receipt and chain-of-custody forms will be documented on the laboratory sample receipt form.	Laboratory sample custodians and analysts, Gulf Coast Analytical Laboratories	I	Internal
Verification Chain-of-custody forms	Check that the chain-of-custody form was signed/dated by the sampler relinquishing the samples and by the laboratory sample custodian receiving the samples for analyses. Verification of chain-of-custody forms will be documented in the DVA workbook.	Project chemist or data validators, Resolution Consultants	I	External
Verification SAP sample tables	Verify that all proposed samples listed in the SAP tables have been collected. Sample completeness will be documented in the DVA workbook and Data Usability Summary Report in accordance with TCEQ TRRP-13.	FTL or designee, Resolution Consultants	I	External
Verification Sample log sheets and field notes	Verify that information recorded in the log sheets and field notes are accurate and complete. Sample log sheet verification will be documented by dated signature on the last page or page immediately following the review material.	FTL or designee, Resolution Consultants	I	External
Verification Field QC samples	Check that field QC samples, described in Worksheet #12 and listed in Worksheet #20, were collected as required. QC sample completeness will be documented in the DVA workbook and Data Usability Summary Report in accordance with TCEQ TRRP-13.	FTL or designee, Resolution Consultants	I	External
Verification Analytical data package	Verify all analytical data packages will be verified internally for completeness by the laboratory performing the work. The laboratory project manager (or designee) will sign the case narrative for each data package. All laboratory data package reviews will be documented on the laboratory review checklists and exception reports that accompany the data in accordance with TCEQ TRRP-13.	Laboratory project manager, Gulf Coast Analytical Laboratories	I	Internal
Verification Analytical data package	Verify the data package for completeness. Missing information will be requested from the laboratory and validation (if performed) will be suspended until missing data are received. Data package completeness will be documented in the DVA workbook.	FTL, Project chemist or data validators, Resolution Consultants	I	External
Verification Electronic data deliverables	Verify the electronic data against the chain-of-custody and hard copy data package for accuracy and completeness. Electronic data deliverable verification will be documented in the DVA workbook.	Data manager and/or validator, Resolution Consultants	I	External

Data Review Input	Description	Responsible for Verification (name, organization)	Step I/ IIa/IIb [1]	Internal/ External
Validation Chain-of-custody	Examine the traceability of the data from time of sample collection until reporting of data. Ensure that the custody and integrity of the samples were maintained from collection to analysis and the custody records are complete and any deviations are recorded. Chain-of-custody verification will be documented in the DVA workbook.	Project chemist or data validators, Resolution Consultants	IIa	External
Validation Holding Times	Review that the samples were shipped and stored at the required temperature and sample pH for chemically-preserved samples meet the requirements listed in Worksheet #19. Ensure that the analyses were performed within the holding times. If holding times were not met, confirm that deviations were documented. Holding time examination will be documented in the DVA workbook and in the Data Usability Summary Report in accordance with TCEQ TRRP-13.	Project chemist or data validators, Resolution Consultants	IIa	External
Validation Sample results for representativeness	Check that the laboratory recorded the temperature at sample receipt and the pH of the chemically preserved samples to ensure sample integrity from sample collection to analysis. Sample receipt and preservation will be documented in the DVA workbook and in the Data Usability Summary Report in accordance with TCEQ TRRP-13.	Project chemist or data validators, Resolution Consultants	IIa/IIb	External
Validation Laboratory data results for accuracy	Ensure that the laboratory QC samples were analyzed and that the measurement performance criteria, listed in Worksheet #28, were met for all field samples and QC analyses. Check that specified field QC samples were collected and analyzed, as listed in Worksheet #12, and that the analytical QC criteria were met. Accuracy will be documented in the DVA workbook and in the Data Usability Summary Report in accordance with TCEQ TRRP-13.	Project chemist or data validators, Resolution Consultants	IIa/IIb	External
Validation Field and laboratory duplicate analyses for precision	Check the field sampling precision by calculating the RPD for field duplicate samples. Check the laboratory precision by reviewing the RPD or percent difference values from laboratory duplicate analyses; MS/MSDs; and LCS/LCSDs. Ensure compliance with the precision goals listed in Worksheet #12 and 28. Precision will be documented in the DVA workbook and in the Data Usability Summary Report in accordance with TCEQ TRRP-13.	Project chemist or data validators, Resolution Consultants	IIa/IIb	External
Validation Project action limits	Assess and document the impact on matrix interferences or sample dilutions performed because of the high concentration of one or more contaminant, on the other target compounds reported as undetected. Project action limit achievement will be documented in the DVA workbook and in the Data Usability Summary Report in accordance with TCEQ TRRP-13	Project chemist or data validators, Resolution Consultants	IIa/IIb	External
Validation Data quality assessment report	Summarize deviations from methods, procedures, or contracts. Qualify data results based on method or QC deviation and explain all the data qualifications. Present tabular qualified data and data qualifier codes and summarize data qualification outliers. Determine if the data met the measurement performance criteria and determine the impact of any deviations on the technical usability of the data. Result qualification will be documented in the in the DVA workbook and in the Data Usability Summary Report in accordance with TCEQ TRRP-13.	Project chemist or data validators, Resolution Consultants	IIa/IIb	External

Data Review Input	Description	Responsible for Verification (name, organization)	Step I/ IIa/IIb [1]	Internal/ External
Validation SAP QC sample documentation	Ensure that all QC samples specified in the SAP were collected and analyzed and that the associated results were within acceptance limits. QC sample completeness and assessment will be documented in the DVA workbook and Data Usability Summary Report in accordance with TCEQ TRRP-13.	Project chemist or data validators, Resolution Consultants	IIa/IIb	External
Validation Analytical data deviations	Determine the impact of any deviation from sampling or analytical methods and laboratory SOP requirements and matrix interferences effect on the analytical results. Data deviations will be documented in the DVA workbook and Data Usability Summary Report in accordance with TCEQ TRRP-13.	Project chemist or data validators, Resolution Consultants	IIb	External
Validation Project quantitation limits for sensitivity	Ensure that the project detection limits were achieved. Project quantitation limit achievement will be documented in the DVA workbook and in the Data Usability Summary Report in accordance with TCEQ TRRP-13	Project chemist or data validators, Resolution Consultants	IIb	External
Validation Soil and Groundwater 1,2-Dichloroethane, BTEX and MTBE	Validate 1,2-dichloroethane, BTEX and MTBE data using TCEQ TRRP-13 and MPC identified in Worksheets #12, 19, 24, and 28. All data will be validated and raw instrument outputs assessed and recalculated for 10% of the reported results. *U.S. EPA Contract Laboratory Program National Functional Guidelines for Superfund Organic Methods Data Review*, (June 2008) will be used as a guidance on applying qualifiers when MPC identified in Worksheets #12, 19, 24, and 28 are not met, including identifying when samples will be qualified estimated or rejected and when individual or all samples in a batch will be qualified. All data validation finding will be documented in a Data Usability Summary Report in accordance with TCEQ TRRP-13.	Project chemist or data validators, Resolution Consultants	IIa/IIb	External
Validation Soil and Groundwater PAHs	Validate PAH data using TCEQ TRRP-13 and MPC identified in Worksheets #12, 19, 24, and 28. All data will be validated and raw instrument outputs assessed and recalculated for 10% of the reported results. *U.S. EPA Contract Laboratory Program National Functional Guidelines for Superfund Organic Methods Data Review*, (June 2008) will be used as a guidance on applying qualifiers when MPC identified in Worksheets #12, 19, 24, and 28 are not met, including identifying when samples will be qualified estimated or rejected and when individual or all samples in a batch will be qualified. All data validation finding will be documented in a Data Usability Summary Report in accordance with TCEQ TRRP-13.	Project chemist or data validators, Resolution Consultants	IIa/IIb	External

<table>
<tr><th>Data Review Input</th><th>Description</th><th>Responsible for Verification (name, organization)</th><th>Step I/ IIa/IIb [1]</th><th>Internal/ External</th></tr>
<tr><td>Validation
Soil and Groundwater
TPH</td><td>Validate TPH data using TCEQ TRRP-13 and MPC identified in Worksheets #12, #19, #24, and #28. U.S. EPA Contract Laboratory Program National Functional Guidelines for Superfund Organic Methods Data Review, (June 2008) will be used as a guidance on applying qualifiers when MPC identified in Worksheets #12, #19, #24, and #28 are not met.

The end use of the TPH results data will be to screen samples and determine if PAH analysis is required. Therefore, validation for will be limited to the following elements: holding times, blank analyses, laboratory control samples, and laboratory duplicates.

All data validation finding will be documented in a Data Usability Summary Report in accordance with TCEQ TRRP-13.</td><td>Project chemist or data validators, Resolution Consultants</td><td>IIa/IIb</td><td>External</td></tr>
<tr><td>Validation
Data qualifiers</td><td>Qualifiers that will be applied during the data validation process are summarized below and, as indicated, results will be considered usable for interpretation unless the results are rejected when extreme data quality indicator failures are noted.
<table>
<tr><th>Data Qualifier</th><th>Qualifier Definition</th><th>Interpret Result As a Detection?</th><th>Result Usable?</th><th>Potential Result Bias</th></tr>
<tr><td>no qualifier</td><td>Acceptable</td><td>Yes</td><td>Yes</td><td>None expected</td></tr>
<tr><td>J</td><td>Estimated</td><td>Yes</td><td>Yes</td><td>High or Low</td></tr>
<tr><td>JH</td><td>Estimated and Biased High</td><td>Yes</td><td>Yes</td><td>High</td></tr>
<tr><td>JL</td><td>Estimated and Biased Low</td><td>Yes</td><td>Yes</td><td>Low</td></tr>
<tr><td>U</td><td>Undetected</td><td>No</td><td>Yes</td><td>None expected</td></tr>
<tr><td>UJ</td><td>Undetected and Estimated</td><td>No</td><td>Yes</td><td>High or Low</td></tr>
<tr><td>UJL</td><td>Undetected and Estimated Biased Low</td><td>No</td><td>Yes</td><td>Low</td></tr>
<tr><td>UR</td><td>Undetected and Rejected</td><td>No</td><td>No</td><td>Unspecified</td></tr>
<tr><td>R</td><td>Rejected</td><td>No</td><td>No</td><td>Unspecified</td></tr>
</table></td><td>Project chemist or data validators, Resolution Consultants</td><td>IIa/IIb</td><td>External</td></tr>
</table>

Notes:

[1] IIa = compliance with methods, procedures, and contracts [see Table 10, page 117, UFP-QAPP manual, V.1, March 2005.]
IIb = comparison with measurement performance criteria in the SAP [see Table 11, page 118, UFP-QAPP manual, V.1, March 2005]
SAP = Sampling and analysis plan
DVA = Data validation assistant
FTL = Field team leader
QC = Quality control
RPD = Relative percent difference
MS/MSD = Matrix spike/Matrix Spike duplicate
LCS/LCSD = Laboratory control sample/laboratory control sample duplicate

SOP	=	Standard operating procedure
BTEX	=	Benzene, toluene, ethylbenzene, xylenes
MTBE	=	Methyl tert-butyl ether
TCEQ	=	Texas Commission on Environmental Quality
TRRP-13	=	Texas Risk Reduction Program *Review and Reporting of Chemical of Concern (COC) Concentration Data under TRRP*, RG-366/TRRP-13, Revised May 2010.
U.S. EPA	=	U.S Environmental Protection Agency
PAH	=	Polynuclear aromatic hydrocarbons
TPH	=	Total petroleum hydrocarbon
MPC	=	Measurement performance criteria

SAP WORKSHEET #37: USABILITY ASSESSMENT

(UFP-QAPP Manual Section 5.2.3)

Data Review

The usability of the data directly affects whether project objectives can be achieved and the following characteristics will be evaluated at a minimum. The results of these evaluations will be included in the project report. The characteristics will be evaluated for multiple concentration levels if the evaluator determines that this is necessary. To the extent required by the type of data being reviewed, the assessors will consult with other technically competent individuals to render sound technical assessments of these data characteristics:

- *Completeness* — Completeness is a measure of the amount of valid data obtained from a measurement system compared to the amount expected to be obtained under correct normal conditions. It is expected that 100% of the planned sampling points will be collected. The completeness goal for field measurements will be greater than 90%. Laboratory analysis for this project will have a completeness goal greater than 95% to account for unanticipated results that may be rejected during data validation. Completeness can be calculated using the following equation.

$$\%Completeness = \frac{No.\ of\ Valid\ Tests}{Total\ Tests\ Taken} x100$$

  The FTL, acting on behalf of the Project Team, will determine whether deviations from the scheduled sample collection or analyses occurred. If they have occurred and the Resolution Consultants TOM determines that the deviations compromise the ability to meet project objectives he will consult with the Navy RPM and other project team members, as necessary (determined by the Navy RPM), to develop appropriate corrective actions.

- *Precision* — Precision measures the reproducibility of measurements and methods and is defined for qualitative data as a group of values' variability compared with its average value. To assess the precision of the measurement systems used in this project, field duplicates will be obtained and analyzed with the samples collected. Precision of laboratory analysis will be assessed by comparing the relative percent difference (RPD) of analytical results between matrix spike (MS) and matrix spike duplicates (MSDs) or sample duplicates and the measurement quality objectives will be those cited in Worksheets #12 and #28. The RPD will be calculated for each pair of duplicate analysis using the following equation:

$$RPD = \frac{(S \quad D)}{(S + D)/2} x100$$

Where:

S	=	sample result
D	=	duplicate result

The project chemist, acting on behalf of the Project Team, will determine whether precision goals for field duplicates and laboratory duplicates were met. This will be accomplished by comparing duplicate results to precision goals identified in Worksheets #12 and #28. This also will include a comparison of field and laboratory precision with the expectation that laboratory duplicate results will be no less precise than field duplicate results. If the goals are not met or data have been flagged as estimated (J qualifier), limitations on the use of the data will be described in the project report.

- *Accuracy* — Accuracy is the degree to which a given result agrees with the true value. The accuracy of an entire measurement system is an indication of any bias that exists. Spiked sample results provide information needed to assess the accuracy of analyses. Specifically, surrogate spike, MS/MSD, and laboratory control sample (LCS) percent recoveries (%Rs) are used to assess accuracy. Every organic sample is spiked with known quantities of non-target surrogate compounds. Five percent of all samples analyzed are spiked with target chemicals for the MS/MSD (or sample duplicates). If the calculated %Rs for the known spike concentrations are within defined control limits set by each method, the reported sample concentrations are considered accurate. The accuracy measurement quality objectives will be those cited in Worksheets #12 and #28. Accuracy is calculated using the following equation:

$$\%R = \frac{(SSR \quad SR)}{SA} x100$$

Where:

SSR	=	spike sample recovery
SR	=	sample recovery
SA	=	concentration of spike added

The project chemist, acting on behalf of the Project Team, will determine whether the accuracy/bias goals were met for project data. This assessment will include an evaluation of field and laboratory contamination; instrument calibration variability; and analyte recoveries for surrogates, MS/MSD, and LCS against the goals identified in Worksheets #24 and #28. If the goals are not met, limitations on the use of the data will be described in the project report. Bias of the qualified results and a description of the impact of identified non-compliances on a specific data package or on the overall project data will be described in the project report.

- *Representativeness* — A project scientist, identified by the Resolution Consultants TOM and acting on behalf of the Project Team, will determine whether the data are adequately representative of intended populations, both spatially and temporally. This will be accomplished by verifying that samples were collected and analyzed in accordance with this SAP, by reviewing spatial and temporal data variations, and by comparing these characteristics to expectations. The usability report will describe the representativeness of the data for each matrix and analytical fraction. This will not require quantitative comparisons unless professional judgment of the project scientist indicates that a quantitative analysis is required.

- *Comparability* — The project chemist, acting on behalf of the Project Team, will determine whether the data generated under this project are sufficiently comparable to historical property data generated by different methods and for samples collected using different procedures and under different property conditions. This will be accomplished by comparing overall precision and bias among data sets for each matrix and analytical fraction. This will not require quantitative comparisons unless the project chemist indicates that such quantitative analysis is required.

- *Sensitivity* — The project chemist, acting on behalf of the Project Team, will determine whether project sensitivity goals listed in Worksheet #15 are achieved. The overall sensitivity and quantitation limits from multiple data sets for each matrix and analysis will be compared. If sensitivity goals are not achieved, the limitations on the data will be described.

Describe the evaluative procedures used to assess overall measurement error associated with the project:

After completion of the data validation, the data and data quality will be reviewed to determine whether sufficient data of acceptable quality are available for decision making. In addition to the evaluations described above, a series of inspections and statistical analyses will be performed to estimate these characteristics. The statistical evaluations will include simple summary statistics for target analytes, such as maximum concentration, minimum concentration, number of samples exhibiting non-detected results, number of samples exhibiting positive results, and the proportion of samples with detected and non-detected results. The Project Team members, identified by the Resolution Consultants TOM, will assess whether the data collectively support the attainment of project objectives. They will consider whether any missing or rejected data have compromised the ability to make decisions or to make the decisions with the desired level of confidence. The data will be evaluated to determine whether missing or rejected data can be compensated by other data.

Identify the personnel responsible for performing the usability assessment:

The Resolution Consultants TOM, project chemist, and FTL will be responsible for conducting the listed data usability assessments. The data usability assessment will be reviewed with the Project Team. If deficiencies affecting the attainment of project objectives are identified, the review will take place either in a face to face meeting or a teleconference depending on the extent of identified deficiencies. If no significant deficiencies are identified, the data usability assessment will simply be documented in the project report and reviewed during the normal document review cycle.

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:

The data will be presented in tabular format, including data qualifications such as estimation (J, UJ) or rejection (R). The project report will identify and describe the data usability limitations and suggest re-sampling or other corrective actions, if necessary. Graphical presentations of the data such as concentration tag maps will be generated as part of the overall data evaluation process.

REFERENCES

Naval Facilities Engineering Command. *Final Environmental Restoration Recordkeeping Manual*. Washington DC. September 2009.

Texas Commission on Environmental Quality (TCEQ). *Guidance for Conducting Ecological Risk Assessments at Remediation Sites in* Texas. 2001.

— *Update to Guidance for Conducting Ecological Risk Assessments at Remediation Sites in Texas RG-263 (Revised)*. January 2006.

— *Regulatory Guidance RG-411 Investigating and Reporting Releases from Petroleum Storage Tanks*. August 2012.

— *Regulatory Guidance RG-366/TRRP-13 Review and Reporting of COC Concentration Data under TRRP*. May 2010.

— *Texas PST Program Action Levels.* August 2011.

United States Department of Defense. *Department of Defense Quality Systems Manual for Environmental Laboratories.* Version 4.2. October 2010.

United States Environmental Protection Agency (U.S. EPA). *Guidance for Quality Assurance Project Plans*. EPA QA/G-5. EPA/240/R-02/009. December 2002.

— *Uniform Federal Policy for Quality Assurance Plans Evaluating, Assessing, and Documenting Environmental Data Collection and Use Programs, Parts 1, 2A, 2B, and 2C*. (Final Version 1). EPA-505-B-04-900A. March 2005.

— Guidance on Systematic Planning Using the Data Quality Objectives Process. EPA QA/G-4. EPA/240/B-06/001. U.S. EPA Office of Environmental Information. Washington DC. February 2006.

— *Contract Laboratory Program National Functional Guidelines for Superfund Organic Methods Data Review*. Office of Solid Waste and Emergency Response, 9240.1-48; EPA-540-R-08-001. Washington, DC. June 2008.

— *1988 RCRA Facility Assessment Evaluation Preliminary Review Visual Site Inspection and Sampling Visit.* Region 6, RCRA Closure Section. December 1989.

— *Technical Memorandum: Recommendation for States, Tribes and EPA Regions to Investigate and Clean Up Lead Scavengers When Present at Leaking Underground Storage Tank (LUST) Sites.* May 2010.

— *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods (SW-846)*, Third Edition Update IVB. Washington, DC. January 2008.

United States Navy 1984. *Initial Assessment Study of Naval Air Station Corpus Christi, Texas.* NEESA 13-039. Naval Energy and Environmental Support Activity. Port Hueneme, California. February.

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Appendix A
Field Standard Operating Procedures

Utility Clearance

Procedure 3-01

1.0 Purpose and Scope

1.1 This standard operating procedure (SOP) describes the process for determining the presence of subsurface utilities and other cultural features at locations where planned site activities involve the physical disturbance of subsurface materials.

1.2 This procedure is the Program-approved professional guidance for work performed by Resolution Consultants under the Comprehensive Long-Term Environmental Action Navy (CLEAN) contract (Contract Number N62470-11-D-8013).

1.3 The procedure applies to the following activities: soil gas surveying, excavating, trenching, drilling of borings and installation of monitoring and extraction wells, use of soil recovery or slide-hammer hand augers, and all other intrusive sampling activities.

1.4 The primary purpose of the procedure is to minimize the potential for damage to underground utilities and other subsurface features, which could result in physical injury, disruption of utility service, or disturbance of other subsurface cultural features.

1.5 If there are procedures, whether it be from Resolution Consultants, state, and/or federal, that are not addressed in this SOP and are applicable to utility clearance, those procedures should be added as an appendix to the project specific SAP.

1.6 As guidance for specific activities, this procedure does not obviate the need for professional judgment. Deviations from this procedure while planning or executing planned activities must be approved in accordance with Program requirements for technical planning and review.

2.0 Safety

2.1 Field and subcontractor personnel shall adhere to a site-specific health and safety plan (HASP).

3.0 Terms and Definitions

3.1 **Utility**

For the proposes of this SOP, a utility is defined as a manmade underground line or conduit, cable, pipe, vault or tank that is, or was, used for the transmission of material or energy (e.g., gas, electrical, telephone, steam, water or sewage, product transfer lines, or underground storage tanks).

3.2 **As-Built Plans**

As-built plans are plans or blueprints depicting the locations of structures and associated utilities on a property.

3.3 **One-Call**

The Utility Notification Center is the one-call agency for nationwide call before you dig. The Utility Notification Center is open 24 hours a day, and accepts calls from anyone planning to dig. The phone number 811 is the designated call before you dig phone number that directly connects you to your local one-call center. Additional information can be found at www.call811.com.

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Calling before you dig ensures that any publicly owned underground lines will be marked so that you can dig around them safely. Having the utility lines marked not only prevents accidental damage to the lines, but prevents property damage and personal injuries that could result in breaking a line.

The following information will need to be provided when a call is placed to One-Call:

- Your name, phone number, company name (if applicable), and mailing address.
- What type or work is being done.
- Who the work is being done for.
- The county and city the work is taking place in.
- The address or the street where the work is taking place.
- Marking instructions, (specific instructions as to where the work is taking place).

Under normal circumstances it takes between 2 to 5 days from the time you call (not counting weekends or holidays) to have the underground lines marked. Because these laws vary from state to state, exactly how long it will take depends on where your worksite is located. You will be given an exact start time and date when your locate request is completed, which will comply with the laws in your area.

In the event of an emergency (any situation causing damage to life or property, or a service outage), lines can be marked sooner than the original given time if requested.

3.4 **Toning**

Toning is the process of surveying an area utilizing one or more surface geophysical methods to determine the presence or absence of underground utilities. Typically, toning is conducted after identifying the general location of utilities and carefully examining all available site utility plans. Each location is marked according to the type of utility being identified. In addition, areas cleared by toning are flagged or staked to indicate that all identified utilities in a given area have been toned.

4.0 Training and Qualifications

4.1 The **Contract Task Order (CTO) Manager** is responsible for verifying that these utility locating procedures are performed prior to the initiation of active subsurface exploration.

4.2 The **Program Quality Manager** is responsible for ensuring overall compliance with this procedure.

4.3 The **Field Manager** is responsible for ensuring that all utility locating activities are performed in accordance with this procedure.

4.4 All **Field Personnel** are responsible for the implementation of this procedure.

5.0 Equipment and Supplies

5.1 Equipment and supplies necessary for locating subsurface utilities will be provided by the subcontractor; however, the project **Field Manager/Field Personnel** will provide any additional equipment and supplies as needed as well as maintain information regarding the utility clearance activities in the field logbook.

6.0 Procedure

Proceed wtih the following steps where subsurface exploration will include excavations, drilling, or any other subsurface investigative method that could damage utilities at a site. In addition to the steps outlined below, always exercise caution while conducting subsurface exploratory work.

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6.1 Prepare Preliminary Site Plan

- Prepare a preliminary, scaled site plan depicting the proposed exploratory locations as part of the project specific Sampling and Analysis Plan (SAP) or Work Plan. Include as many of the cultural and natural features as practical in this plan.

6.2 Review Background Information

- Search existing plan files to review the as-built plans to identify the known location of utilities at the site. Plot the locations of utilities identified onto a preliminary, scaled site plan. Inform the CTO Manager if utilities lie within close proximity to a proposed exploration or excavation location. The CTO Manager will determine if it is necessary to relocate proposed sampling or excavation locations.
- Include the utility location information gathered during previous investigations (e.g., remedial investigation or remedial site evaluation) in the project design documents for removal or remedial actions. In this manner, information regarding utility locations collected during implementation of a CTO can be shared with the subcontractor during implementation of a particular task order. In many instances, this will help to reduce the amount of additional geophysical surveying work the subcontractor may have to perform.
- Conduct interviews with onsite and facility personnel familiar with the site to obtain additional information regarding the known and suspected locations of underground utilities. In addition, if appropriate, contact shall be made with local utility companies to request their help in locating underground lines. Pencil in the dimensions, orientation, and depth of utilities, other than those identified on the as-built plans, at their approximate locations on the preliminary plans. Enter the type of utility, the personnel who provided the information, and the date the information was provided into the field log.
- During the pre-field work interviewing process, the interviewer will determine which site personnel should be notified in the event of an incident involving damage to existing utilities. Record this information in the field logbook with the corresponding telephone numbers and addresses.

6.3 Site Visit/Locate Utilities/Toning

- Prior to the initiation of field activities, the Field Task Manager or similarly qualified field personnel shall visit the site and note existing structures and evidence of associated utilities, such as fire hydrants, irrigation systems, manhole and vault box covers, standpipes, telephone switch boxes, free-standing light poles, gas or electric meters, pavement cuts, and linear depression. Compare notes of the actual site configuration to the preliminary site plan. Note deviations in the field logbook and on the preliminary site plan. Accurately locate or survey and clearly mark with stakes, pins, flags, paint, or other suitable devices all areas where subsurface exploration is proposed. These areas shall correspond with the locations drawn on the preliminary site plan.
- Following the initial site visit by the Field Task Manager, a trained utility locating subcontractor will locate, identify, and tone all utilities depicted on the preliminary site plan. The Field Task Manager or similarly qualified field personnel shall visit the site and identify the areas of subsurface disturbance with white spray paint, chalk, white pin flags or some other easily identifiable marking. The utility locator should utilize appropriate sensing equipment to attempt to locate utilities that might not have appeared on the as-built plans. At a minimum, the utility subcontractor should utilize a metal detector and/or magnetometer; however, it is important to consider the possibility that non-metallic utilities or tanks might be present at the site. Use other appropriate surface geophysical methods such as Ground Penetrating Radar, Radiodetection, etc. as appropriate. Clear proposed exploration areas of all utilities in the immediate area where subsurface exploration is proposed. Clearly tone all anomalous areas. Clearly identify all toned areas on the preliminary site plan. All utilities near the area of subsurface disturbance should also be marked out by the utility subcontractor using the universal colors for subsurface utilities (i.e., red – electric; blue – water; green – sewer; yellow – gas; etc.). After toning the site and plotting all known or suspected buried utilities on the preliminary site plan, the utility locator shall provide the Field Task Manager with a copy of the completed preliminary

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site plan. Alternatively, the Field Task Manager or designee shall document the results of the survey on the preliminary site plan.

- Report to the Field Task Manager anomalous areas detected and toned that are in close proximity to the exploration or excavation areas. The Field Task Manager shall determine the safe distance to maintain from the known or suspected utility. It may be necessary to relocate the proposed exploration or excavation areas. If this is required, the Field Task Manager or designee shall relocate them and clearly mark them using the methods described above. Completely remove the markings at the prior location. Plot the new locations on the site plan and delete the prior locations from the plan. In some instances, such as in areas extremely congested with subsurface utilities, it may be necessary to dig by hand or use techniques such as air knife to determine the location of the utilities.

6.4 **Prepare Site Plan**

- Prior to the initiation of field activities, draft a final site plan that indicates the location of subsurface exploration areas and all known or suspected utilities present at the site. Provide copies of this site plan to the Navy Technical Representative (NTR), the CTO Manager, and the subcontractor who is to conduct the subsurface exploration/excavation work. Review the site plan with the NTR to verify its accuracy prior to initiating subsurface sampling activities.

7.0 Quality Control and Assurance

7.1 Utility locating must incorporate quality control measures to ensure conformance to these and the project requirements.

8.0 Records, Data Analysis, Calculations

8.1 A bound field logbook will be kept detailing all activities conducted during the utility locating procedure.

8.2 The logbook will describe any changes and modifications made to the original exploration plan. The trained utility locator shall prepare a report and keep it in the project file. Also, a copy of the final site plan will be kept in the project file.

9.0 Attachments or References

Department of Defense, United States (DoD). 2005. *Uniform Federal Policy for Quality Assurance Project Plans, Part 1: UFP-QAPP Manual.* Final Version 1. DoD: DTIC ADA 427785, EPA-505-B-04-900A. In conjunction with the U. S. Environmental Protection Agency and the Department of Energy. Washington: Intergovernmental Data Quality Task Force. March. On-line updates available at: http://www.epa.gov/fedfac/pdf/ufp_qapp_v1_0305.pdf.

Author	Reviewer	Revisions (Technical or Editorial)
Caryn DeJesus Senior Scientist	Bob Shoemaker Senior Scientist	Rev 0 – Initial Issue (June 2012)

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Logbooks

Procedure 3-02

1.0 Purpose and Scope

1.1 This standard operating procedure (SOP) describes the activities and responsibilities pertaining to the identification, use, and control of logbooks and associated field data records.

1.2 As guidance for specific activities, this procedure does not obviate the need for professional judgment. Deviations from this procedure while planning or executing planned activities must be approved in accordance with Program requirements for technical planning and review.

2.0 Safety

2.1 In order to keep the logbook clean, store it in a clean location and use it only when outer gloves used for PPE have been removed.

3.0 Terms and Definitions

3.1 **Logbook**

A logbook is a bound field notebook with consecutively numbered, water-repellent pages that is clearly identified with the name of the relevant activity, the person assigned responsibility for maintenance of the logbook, and the beginning and ending dates of the entries.

3.2 **Data Form**

A data form is a predetermined format utilized for recording field data that may become, by reference, a part of the logbook (e.g., soil boring logs, trenching logs, surface soil sampling logs, groundwater sample logs, and well construction logs are data forms).

4.0 Training and Qualifications

4.1 The **Contract Task Order (CTO) Manager** or **designee** is responsible for determining which team members shall record information in field logbooks and for obtaining and maintaining control of the required logbooks. The **CTO Manager** shall review the field logbook on at least a monthly basis. The **CTO Manager** or **designee** is responsible for reviewing logbook entries to determine compliance with this procedure and to ensure that the entries meet the project requirements.

4.2 A knowledgeable individual such as the **Field Manager**, **CTO Manager**, or **Program Quality Manager** shall perform a technical review of each logbook at a frequency commensurate with the level of activity (weekly is suggested, or, at a minimum, monthly). Document these reviews by the dated signature of the reviewer on the last page or page immediately following the material reviewed.

4.3 The **Program Quality Manager** is responsible for ensuring overall compliance with this procedure.

4.4 The **Field Manager** is responsible for ensuring that all **field personnel** follow these procedures and that the logbook is completed properly and daily. The **Field Manager** is also responsible for submitting copies to the **CTO Manager**, who is responsible for filing them and submitting a copy (if required by the CTO Statement of Work).

4.5 The **logbook user** is responsible for recording pertinent data into the logbook to satisfy project requirements and for attesting to the accuracy of the entries by dated signature. The **logbook user** is also responsible for safeguarding the logbook while having custody of it.

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4.6 All **field personnel** are responsible for the implementation of this procedure.

5.0 Equipment and Supplies

5.1 Field logbooks shall be bound field notebooks with water-repellent pages.

5.2 Pens shall have indelible black ink.

6.0 Procedure

6.1 The field logbook serves as the primary record of field activities. Make entries chronologically and in sufficient detail to allow the writer or a knowledgeable reviewer to reconstruct the applicable events. Store the logbook in a clean location and use it only when outer gloves used for personal protective equipment (PPE) have been removed.

6.2 Individual data forms may be generated to provide systematic data collection documentation. Entries on these forms shall meet the same requirements as entries in the logbook and shall be referenced in the applicable logbook entry. Individual data forms shall reference the applicable logbook and page number. At a minimum, include names of all samples collected in the logbook even if they are recorded elsewhere.

6.3 Enter field descriptions and observations into the logbook, as described in Attachment 1, using indelible black ink.

6.4 Typical information to be entered includes the following:

- Dates (month/day/year) and times (military) of all on-site activities and entries made in logbooks/forms;
- Site name and description;
- Site location by longitude and latitude, if known;
- Weather conditions, including temperature and relative humidity;
- Fieldwork documentation, including site entry and exit times;
- Descriptions of, and rationale for, approved deviations from the work plan (WP) or field sampling plan;
- Field instrumentation readings;
- Names, job functions, and organizational affiliations of on-site personnel;
- Photograph references;
- Site sketches and diagrams made on site;
- Identification and description of sample morphology, collection locations, and sample numbers;
- Sample collection information, including dates (month/day/year) and times (military) of sample collections, sample collection methods and devices, station location numbers, sample collection depths/heights, sample preservation information, sample pH (if applicable), analysis requested (analytical groups), etc., as well as chain-of-custody (COC) information such as sample identification numbers cross-referenced to COC sample numbers;
- Sample naming convention;
- Field quality control (QC) sample information;
- Site observations, field descriptions, equipment used, and field activities accomplished to reconstruct field operations;

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- Meeting information;
- Important times and dates of telephone conversations, correspondence, or deliverables;
- Field calculations;
- PPE level;
- Calibration records;
- Contractor and subcontractor information (address, names of personnel, job functions, organizational affiliations, contract number, contract name, and work assignment number);
- Equipment decontamination procedures and effectiveness;
- Laboratories receiving samples and shipping information, such as carrier, shipment time, number of sample containers shipped, and analyses requested; and
- User signatures.

6.5 The logbook shall reference data maintained in other logs, forms, etc. Correct entry errors by drawing a single line through the incorrect entry, then initialing and dating this change. Enter an explanation for the correction if the correction is more than for a mistake.

6.6 At least at the end of each day, the person making the entry shall sign or initial each entry or group of entries.

6.7 Enter logbook page numbers on each page to facilitate identification of photocopies.

6.8 If a person's initials are used for identification, or if uncommon acronyms are used, identify these on a page at the beginning of the logbook.

6.9 At least weekly and preferably daily, the **preparer** shall photocopy and retain the pages completed during that session for backup. This will prevent loss of a large amount of information if the logbook is lost.

7.0 Quality Control and Assurance

7.1 Review per Section 4.2 shall be recorded.

8.0 Records, Data Analysis, Calculations

8.1 Retain the field logbook as a permanent project record. If a particular CTO requires submittal of photocopies of logbooks, perform this as required.

8.2 Deviations from this procedure shall be documented in field records. Significant changes shall be approved by the **Program Quality Manager**.

9.0 Attachments or References

9.1 Attachment 1 – Description of Logbook Entries

9.2 Department of Defense, United States (DoD). 2005. *Uniform Federal Policy for Quality Assurance Project Plans, Part 1: UFP-QAPP Manual*. Final Version 1. DoD: DTIC ADA 427785, EPA-505-B-04-900A. In conjunction with the U. S. Environmental Protection Agency and the Department of Energy. Washington: Intergovernmental Data Quality Task Force. March. On-line updates available at: http://www.epa.gov/fedfac/pdf/ufp_qapp_v1_0305.pdf.

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Author	Reviewer	Revisions (Technical or Editorial)
Mark Kromis Program Chemist	Chris Barr Program Quality Manager	Rev 0 – Initial Issue

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Attachment 1
Description of Logbook Entries

Logbook entries shall be consistent with Section A.1.4 *Field Documentation SOPs* of the UFP-QAPP Manual (DoD 2005) and contain the following information, as applicable, for each activity recorded. Some of these details may be entered on data forms, as described previously.

Name of Activity	For example, Asbestos Bulk Sampling, Charcoal Canister Sampling, Aquifer Testing.
Task Team Members and Equipment	Name all members on the field team involved in the specified activity. List equipment used by serial number or other unique identification, including calibration information.
Activity Location	Indicate location of sampling area as indicated in the field sampling plan.
Weather	Indicate general weather and precipitation conditions.
Level of PPE	Record the level of PPE (e.g., Level D).
Methods	Indicate method or procedure number employed for the activity.
Sample Numbers	Indicate the unique numbers associated with the physical samples. Identify QC samples.
Sample Type and Volume	Indicate the medium, container type, preservative, and the volume for each sample.
Time and Date	Record the time and date when the activity was performed (e.g., 0830/08/OCT/89). Use the 24-hour clock for recording the time and two digits for recording the day of the month and the year.
Analyses	Indicate the appropriate code for analyses to be performed on each sample, as specified in the WP.
Field Measurements	Indicate measurements and field instrument readings taken during the activity.
Chain of Custody and Distribution	Indicate chain-of-custody for each sample collected and indicate to whom the samples are transferred and the destination.
References	If appropriate, indicate references to other logs or forms, drawings, or photographs employed in the activity.
Narrative (including time and location)	Create a factual, chronological record of the team's activities throughout the day including the time and location of each activity. Include descriptions of general problems encountered and their resolution. Provide the names and affiliations of non-field team personnel who visit the site, request changes in activity, impact the work schedule, request information, or observe team activities. Record any visual or other observations relevant to the activity, the contamination source, or the sample itself. It should be emphasized that logbook entries are for recording data and chronologies of events. The logbook author must include observations and descriptive notations, taking care to be objective and recording no opinions or subjective comments unless appropriate.
Recorded by	Include the signature of the individual responsible for the entries contained in the logbook and referenced forms.
Checked by	Include the signature of the individual who performs the review of the completed entries.

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Sample Labeling and Chain of Custody Procedures

Procedure 3-03A

1.0 Purpose and Scope

1.1 The purpose of this standard operating procedure is to establish standard protocols for all field personnel for use in maintaining field and sampling activity records, labeling samples, ensuring that proper sample custody procedures are utilized, and completing chain-of-custody/analytical request forms.

1.2 As guidance for specific activities, this procedure does not obviate the need for professional judgment. Deviations from this procedure while planning or executing planned activities must be approved in accordance with Program requirements for technical planning and review.

2.0 Safety

Not applicable

3.0 Definitions

3.1 **Logbook**

A logbook is a bound field notebook with consecutively numbered, water-repellent pages that is clearly identified with the name of the relevant activity, the person responsible for maintenance of the logbook, and the beginning and ending dates of the entries.

3.2 **Chain-of-Custody**

Chain-of-custody (COC) is documentation of the process of custody control. Custody control includes possession of a sample from the time of its collection in the field to its receipt by the analytical laboratory, and through analysis and storage prior to disposal.

4.0 Training and Qualifications

4.1 The **CTO Manager**, or designee, is responsible for determining which team members shall record information in the field logbook and for checking sample logbooks and COC forms to ensure compliance with these procedures. The **CTO Manager**, or designee, shall review COC forms at the completion of each sampling event.

4.2 The **Program Quality Manager** is responsible for ensuring overall compliance with this procedure.

4.3 The **Field Manager** is responsible for ensuring that all field equipment is decontaminated according to this procedure.

4.4 The **Project Chemist**, or designee, is responsible for verifying that the COC/analytical request forms have been completed properly and match the sampling and analytical plan. The **Project Chemist**, or designee, is responsible for notifying the laboratory, data managers, and data validators in writing if analytical request changes are required as a corrective action. These small changes are different from change orders, which involve changes to the scope of the subcontract with the laboratory and must be made in accordance with a respective contract.

4.5 All **Field Personnel** are are responsible for recording pertinent data onto the COC forms to satisfy project requirements and for attesting to the accuracy of the entries by dated signature.

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5.0 Procedure

This procedure provides standards for labeling the samples, documenting sample custody, and completing COC/analytical request forms. The standards presented in this section shall be followed to ensure that samples collected are maintained for their intended purpose and that the conditions encountered during field activities are documented.

5.1 Sample Labeling

Affix a waterproof sample label with adhesive backing to each individual sample container. Record the following information with a waterproof marker on each label:

- Project name or number (optional)
- COC sample number
- Date and time of collection
- Sampler's initials
- Matrix (optional)
- Sample preservatives (if applicable)
- Analysis to be performed on sample (This shall be identified by the method number or name identified in the subcontract with the laboratory)

These labels may be obtained from the analytical laboratory or printed from a computer file onto adhesive labels.

5.2 Custody Procedures

For samples intended for chemical analysis, sample custody procedures shall be followed through collection, transfer, analysis, and disposal to ensure that the integrity of the samples is maintained. A description of sample custody procedures is provided below.

Sample Collection Custody Procedures

According to the EPA guidelines, a sample is considered to be in custody if one of the following conditions is met:

- It is in one's actual physical possession or view
- It is in one's physical possession and has not been tampered with (i.e., it is under lock or official seal)
- It is retained in a secured area with restricted access
- It is placed in a container and secured with an official seal such that the sample cannot be reached without breaking the seal

Place custody seals on shipping coolers (and sample jars, if required) if the cooler/container is to be removed from the sampler's custody. Place a minimum of two custody seals in such a manner that they must be broken to open the containers or coolers. Label the custody seals with the following information:

- Sampler's name or initials
- Date and time that the sample/cooler was sealed

These seals are designed to enable detection of sample tampering. An example of a custody seal is shown in Attachment 1.

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Field personnel shall also log individual samples onto COC forms (carbon copy or computer generated) when a sample is collected. These forms may also serve as the request for analyses. Procedures for completing these forms are discussed in Section 0, indicating sample identification number, matrix, date and time of collection, number of containers, analytical methods to be performed on the sample, and preservatives added (if any). The samplers will also sign the COC form signifying that they were the personnel who collected the samples. The COC form shall accompany the samples from the field to the laboratory. When a cooler is ready for shipment to the analytical laboratory, the person delivering the samples for transport will sign and indicate the date and time on the accompanying COC form. One copy of the COC form will be retained by the sampler and the remaining copies of the COC form shall be placed inside a self-sealing bag and taped to the inside of the cooler. Each cooler must be associated with a unique COC form. Whenever a transfer of custody takes place, both parties shall sign and date the accompanying carbon copy COC forms, and the individual relinquishing the samples shall retain a copy of each form. One exception is when the samples are shipped; the delivery service personnel will not sign or receive a copy because they do not open the coolers. The laboratory shall attach copies of the completed COC forms to the reports containing the results of the analytical tests. An example COC form is provided in Attachment 2.

5.3 Completing COC/Analytical Request Forms

COC form/analytical request form completion procedures are crucial in properly transferring the custody and responsibility of samples from field personnel to the laboratory. This form is important for accurately and concisely requesting analyses for each sample; it is essentially a release order from the analysis subcontract.

Attachment 2 is an example of a completed COC/analytical request form that may be used by field personnel, with box numbers identified and discussed in text below. Multiple copies may be tailored to each project so that much of the information described below need not be handwritten each time. Each record on the form (Attachment 2) is identified with a bold number corresponding to the instructions given below.

1. Record the project name, site location.
2. Record the site location, including the state.
3. Record the Contract Task Order number
4. Record the Resolution Consultants Task Order Manager
5. Record the sampler/site phone or cell number (if applicable).
6. Record the laboratory name where the samples were sent.
7. Record the requested turnaround time, in days. If a specific turnaround time is required to meet project objectives, but was not indicated on the laboratory service request form submitted to the purchasing department, the sampler, project manager, or site manager should contact the purchasing department so the laboratory contract can be modified.
8. Record the COC number that is defined by the sampler and should be unique throughout the project's history. An example would be to use the sampler's initials followed by the data. If multiple custodies are generated on a given day, use a unique sequential identifier. Example: CRC040105A, CRC040105B
9. Record the purchase order number provided by the purchasing department.
10. Record the page and total number of COC forms used in a shipment.
11. Record the project, and phase applicable to the sampling task.
12. Record the two-character code corresponding to the *chemical* preservation type, which is found on the bottom of the COC form. If no chemical preservation was added to the sample, the field should be left blank. Temperature preservation need not be documented at this location, but will be indicated elsewhere on the COC form (see 33).

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13. List the requested analysis. Whenever possible, list the corresponding analytical method. (e.g., VOCs, 8260).

14. For Lab identification use only.

15. Record the full *unique* sample identification as detailed in the Site's Sampling and Analysis Plan.

16. Record the location identification, which is a shortened ID used for presentation and mapping, as detailed in the Site's Sampling and Analysis Plan.

17. Record the sample date using the format mm/dd/yy.

18. Record the sample time using the military format of hhmm.

19. Record the matrix code of the sample, which is located at the bottom of the COC form. The matrix code is a crucial element of the Navy's data management system. For simplicity, only typical matrix codes are listed on the bottom COC form, but below is a complete listing of all applicable Navy matrix codes:

Table 1
Navy Matrix Codes

Matrix Code	Matrix Code Description	Matrix Code	Matrix Code Description
AA	Ambient air	RK	Rock
AC	Composite air sample	SB	Bentonite
AD	Air - Drilling	SBS	Sub-surface soil (> 6")
AIN	Integrated air sample (under sample form of gas)	SC	Cement/Concrete
AQ	Air quality control matrix	SD	Drill cuttings — solid matrix
AQS	Aqueous	SE	Sediment
ASB	Asbestos	SEEP	SEEP
ASBF	Asbestos-Fibrous	SF	Filter sand pack
ASBNF	Asbestos-Non-Fibrous	SJ	Sand
AVE	Air-Vapor extraction, effluent	SK	Asphalt
AX	Air sample from unknown origin	SL	Sludge
BK	Brick	SM	Water filter (solid material used to filter water)
BS	Brackish sediment	SN	Miscellaneous solid/building materials
CA	Cinder ash	SO	Soil
CK	Caulk	SP	Casing (PVC, stainless steel, cast iron, iron pipe
CN	Container	SQ	Soil/Solid quality control matrix
CR	Carbon (usually for a remediation system)	SS	Scrapings
DF	Dust/Fallout	SSD	Subsurface sediment
DR	Debris/rubble	STKG	Stack gas
DS	Storm drain sediment	STPM	Stripper Tower Packing Media
DT	Trapped debris	SU	Surface soil (less than 6 inches)
EF	Emissions flux	SW	Swab or wipe
EW	Elutriate water	SZ	Wood
FB	Fibers	TA	Animal tissue
FL	Forest litter	TP	Plant tissue
GE	Soil gas effluent — stack gas (from system)	TQ	Tissue QC
GI	Soil gas influent (into system)	TX	Tissue
GL	Headspace of liquid sample	UNK	Unknown
GQ	Gaseous or Headspace QC	W	Water (not groundwater, unspecified)
GR	Gravel	WA	Drill cuttings - aqueous mix
GS	Soil gas	WB	Brackish Water

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Table 1
Navy Matrix Codes

Matrix Code	Matrix Code Description	Matrix Code	Matrix Code Description
GT	Grit	WC	Drilling water (used for well construction)
IC	IDW Concrete	WD	Well development water
IDD	IDW Solid	WF	Freshwater (not groundwater)
IDS	IDW soil	WG	Ground water
IDW	IDW Water	WH	Equipment wash water
IW	Interstitial water	WI	Ground water influent (into system)
LA	Aqueous phase of a multiphase liquid/soil	WL	Leachate
LF	Product (floating or free)	WM	Marine water
LQ	Organic liquid quality control matrix	WN	Pore water
MA	Mastic	WO	Ocean water
MO	Mortar	WP	Drinking water
MR	Marine sediment	WQ	Water for QC samples
MS	Metal shavings	WR	Ground water effluent (from system)
NS	Near-surface soil	WS	Surface water
PA	Paper	WT	Composite groundwater sample
PC	Paint Chips	WU	Storm water
PP	Precipitate	WW	Waste water
RE	Residue		

Field QC blanks will require matrix codes that identify the type of blank associated with parent sample. Aqueous field QC blanks are not automatically identified with a matrix code of "WQ," indicating a water quality control blank; they are only identified with a matrix code of "WQ" if the associated samples are also aqueous. Trip blanks, field blanks, and equipment rinsate blanks collected in association with ***soil*** samples will be identified with a matrix code of "SQ," even though the actual matrix is aqueous, because the blanks were collected to assess potential contamination imparted during decontamination activities or transport of ***soil*** samples.

20. Record the sample type code, which is located at the bottom of the COC form. The sample type is a crucial element of the EQuIS data management system. For simplicity, only typical sample type codes are listed on the bottom of the COC form, but below is a list of all applicable Navy field sample type codes:

Table 2
Navy Sample Type Codes

Sample Type Code	Sample Type Code Description
AB	Ambient condition blank
BIOCON	Bioassay control sample
BS	Blank spike
BSD	Blank spike duplicate
EB	Equipment blank
EBD	Equipment blank/rinsate duplicate
FB	Field blank
FD	Field duplicate
FS	Field spike
IDW	Purge and rinsate water
LB	Lab Blank

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Table 2
Navy Sample Type Codes

Sample Type Code	Sample Type Code Description
LR	Lab Replicate
MB	Material blank
MIS	Multi-Incremental Sample
MS	Matrix spike
N	Normal (Regular)
PE	Performance evaluation
PURGE	Purge water sample
RD	Regulatory duplicate
SB	Source blank
SBD	Source blank duplicate
SCREEN	Screening Sample
SD	Matrix spike duplicate
SPLIT	Sample split
SRM	Standard reference material
TB	Trip Blank
TBD	Trip blank duplicate
TBR	Trip blank replicate

Field duplicate samples — Field duplicates will be identified using the format detailed in the Site's Sampling and Analysis Plan. However, field duplicates will also be differentiated from the parent sample on the chain-of-custody form. The parent sample will have a sample type code of "N," for normal environmental sample; while its duplicate will have a sample type code of "FD."

21. Record whether the sample is field filtered with a "Y" or not field filtered with an "N." If a project requires collecting samples for both total and dissolved constituents, the same sample and location ID is used for both (see 15 and 16); however, the sampler will indicate whether the sample is field filtered at this location on the COC form. This field must always be filled out; even when soil samples are collected (where "N" appropriately applies, in most cases).

22. Record the total number of containers that are submitted for all of the tests. This must add up to the total number of containers listed for each individual test in 23.

23. Record the number of containers for each test. Do not use Xs, rather indicate the number of containers submitted for each test listed in 14. For example, Sample 010MW007002 requires analysis for VOCs (8260), and SVOCs (8270). Record 3 under the VOC analysis and 2 under the SVOC (assuming 3 containers were submitted for VOCs and 2 were submitted for SVOCs). The total number of containers in this example is 5, which should be the total number of containers listed in 22. Extra containers submitted for matrix spike/matrix spike duplicates (MS/MSDs) will be appropriately recorded.

24. Indicate if extra sample volume was included for MS/MSD analysis using an "X." Samples to be used for MS/MSDs will use the same sample ID and location ID (see 15 and 16), but will be collected in triplicate, particularly for liquid samples, to ensure the analytical laboratory receives sufficient volume for the analyses.

25. Indicate if the samples should be held by the laboratory for future testing using an "X."

26. Record any field comments.

27. Reserved for laboratory comments.

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28. Indicate the total number of coolers in each shipment. *Note*: When multiple coolers are submitted, each should contain a COC form.

29. Signature(s) of the person(s) relinquishing sample custody.

30. Signature(s) of the person(s) receiving sample custody.

31. Indicate whether the samples are iced, by checking the appropriate response.

32. Indicate the method of shipment (e.g., FedEx, hand-delivered, laboratory courier).

33. Record the airbill number when a commercial courier is used. This is particularly important when multiple coolers are sent in the same shipment or when the laboratory is sent the COC form in advance of receiving samples because it aids in tracking lost coolers.

34. Record the date the coolers were shipped.

COC forms tailored to each CTO can be drafted and printed onto multiple forms. This eliminates the need to rewrite the analytical methods column headers each time. It also eliminates the need to write the project manager, name, and number; QC Level; turnaround time; and the same general comments each time.

Complete one COC form per cooler. Whenever possible, place all volatile organic analyte vials into one cooler in order to reduce the number of trip blanks. Complete all sections and be sure to sign and date the COC form. One copy of the COC form must remain with the field personnel.

6.0 Records

The COC/analytical request form shall be faxed or emailed approximately daily to the Project Chemist, or designee for verification of accuracy. Following the completion of sampling activities, the sample logbook and COC forms will be transmitted to the CTO Manager for storage in project files. The original COC/analytical request form shall be submitted by the laboratory along with the data delivered. Any changes to the analytical requests that are required shall be made in writing to the laboratory. A copy of this written change shall be sent to the data validators and placed in the project files. The reason for the change shall be included in the project files so that recurring problems can be easily identified.

7.0 References and Attachments

Department of Defense, United States (DoD). 2005. *Uniform Federal Policy for Quality Assurance Project Plans, Part 1: UFP-QAPP Manual*. Final Version 1. DoD: DTIC ADA 427785, EPA-505-B-04-900A. In conjunction with the U. S. Environmental Protection Agency and the Department of Energy. Washington: Intergovernmental Data Quality Task Force. March. On-line updates available at: http://www.epa.gov/-fedfac/pdf/ufp_qapp_v1_0305.pdf.

Attachment 1: Chain-of-Custody Seal

Attachment 2: Generic Chain-of-Custody/Analytical Request Form

Author	Reviewer	Revisions (Technical or Editorial)
Tina Cantwell QA Officer	Ben Brantley Project Manager	Rev 0 — Initial Issue

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Attachment 1
Chain-of-Custody Seal

EXAMPLE CHAIN-OF-CUSTODY SEAL

[LABORATORY]	SAMPLE NO.	DATE	SEAL BROKEN BY
	SIGNATURE		DATE
	PRINT NAME AND TITLE *(Inspector, Analyst or Technician*		

Attachment 2
Example Chain-of-Custody / Analytical Request Form

RESOLUTION CONSULTANTS

CHAIN OF CUSTODY AND ANALYTICAL REQUEST RECORD

Project Name: 1		COC No. 7	Page of 9
Site Location: 2		PO No. 8	Project No. 10
Contract Task Order No. 3			Lab Name 11

Sample Analysis Requested (Enter number of containers for each test)

Sampler/Site Phone# 4

Send Results To: 5

Data Shipping Address: 6

Lab ID	Sample ID (sys_samp_code)	Location ID (sys_loc_code)	Date (mm/dd/yy)	Time (Military) (hhmm)	Matrix Code (1)	Sample Type (2)	Field Filtered (Y/N)	Total No. of Containers	12 / 13									Extra Volumen for MS/MSD	HOLD
14	15	16	17	18	19	20	21	22	23									24	25

Turnaround Time(specify): 26 Final _____ days Email (if applicable) _____ days

Deliverable(check): 27 Level 2_____ Level 3_____ Full/Level 4_____ TX TRRP-13_____

Field Comments: 28

Lab Comments: 29

Sample Shipment and Delivery Details

Number of coolers in shipment: 30

Relinquished by (signature)	Date	Time	Received by (signature)	Date	Time
1 31			1 32		
2			2		
3			3		

Samples Iced?(check) 33 Yes___ No___

Method of Shipment: 34

Airbill No: 35

Date Shipped: 36

(1) **AA**=Ambient air, **AQ**=Air quality control, **ASB**=Asbestos, **CK**=Caulk, **DS**=Storm drain sediment, **GS**=Soil gas, **IC**=IDW Concrete, **IDD**=IDW Solid, IDS=IDW soil, **IDW**=IDW Water, **LF**=Free Product, **MA**=Mastic, **PC**=Paint Chips, **SC**=Cement/Concrete, **SE**=Sediment, **SL**=Sludge, **SO**=Soil, **SQ**=Soil/Solid quality control, **SSD**=Subsurface sediment, **SU**=Surface soil (<6 in), **SW**=Swab or wipe, **TA**=Animal tissue, **TP**=Plant tissue, **TQ**=Tissue quality control, **WG**=Ground water, **WL**=Leachate, **WO**=Ocean water, **WP**=Drinking water, **WQ**=Water quality control, **WR**=Ground water effluent, **WS**=Surface water, **WU**=Storm water, **WW**=Waste water

(2) **Sample Type: AB**=Ambient Blk, **EB**=Equipment Blk, **FB**=Field Blk, **FD**=Field Duplicate Sample, **IDW**=Investigative-Derived Waste, **MIS**=Incremental Sampling Methodology, **N**=Normal Environmental Sample, **PE**=Performance Eval., **TB**=Trip Blk

(3) **Preservative added: HA**=Hydrochloric Acid, **NI**=Nitric Acid, **SH**=Sodium Hydroxide, **SA**=Sulfuric Acid, **AA**=Ascorbic Acid, **HX**=Hexane, **ME**=Methanol, **SB**=sodium bisulfate, **ST**=Sodium Thiosulfate, If **NO preservative** added leave blank

Sample Handling, Storage, and Shipping of Low Level Environmental Samples

Procedure 3-04A

1.0 Purpose and Scope

1.1 This Standard Operating Procedure (SOP) sets forth the methods for use by personnel engaged in handling, storing, and transporting low level environmental samples.

1.2 As guidance for specific activities, this procedure does not obviate the need for professional judgment. Deviations from this procedure while planning or executing planned activities must be approved in accordance with Program requirements for technical planning and review.

2.0 Safety

2.1 To avoid lifting injuries associated with heavy coolers, use the large muscles of the legs, not the back. Use dollies if possible.

2.2 When using tools for cutting purposes, cut away from yourself. The use of appropriate, task specific cutting tools is recommended.

2.3 Wear proper gloves, such as blue nitrile and latex, as defined in the site-specific project health and safety plan, when handling sample containers to avoid contacting any materials that may have spilled out of the sample containers.

3.0 Terms and Definitions

DOT — Department of Transportation

4.0 Training and Qualifications

4.1 The **Contract Task Order** (CTO) **Manager** is responsible for verifying that these procedures are performed prior to the initiation of active subsurface exploration.

4.2 The **Program Quality Manager** is responsible for ensuring overall compliance with this procedure.

4.3 The **Field Manager** is responsible for ensuring that sample handling, storage, and shipping are performed in accordance with this procedure.

4.4 All **Field Personnel** are responsible for the implementation of this procedure.

5.0 Procedures

5.1 Handling and Packaging

Environmental samples should be packaged prior to shipment using the following procedures:

1. Allow sufficient headspace in all bottles (except volatile organic analysis containers with a septum seal) to compensate for any pressure and temperature changes (approximately 1 percent of the volume of the container).

2. Ensure that the lids on all bottles are tight (will not leak).

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3. Glass bottles should be wrapped in bubble wrap — preferably sealable bubble wrap sample bags, if available. Place bottles in separate and appropriately-sized polyethylene bags and seal the bags.

4. Select a sturdy cooler in good repair. Secure and tape the drain plug with fiber or duct tape inside and outside. Line the cooler with a large heavy-duty plastic bag.

5. Place cushioning/absorbent material in the bottom of the cooler, if available, and then place the containers in the cooler with sufficient space to allow for the addition of cushioning between the containers.

6. Put "blue ice" (or ice that has been "double bagged" in heavy-duty polyethylene bags and properly sealed) on top of and/or between the containers. Fill all remaining space between the containers with bubble wrap or other suitable absorbent material.

7. Securely fasten the top of the large garbage bag with packaging tape.

8. Place the completed Chain-of-Custody (COC) Record into a sealed plastic bag, and tape the bag to the inner side of the cooler lid.

9. Close the cooler and securely tape (preferably with fiber tape) the top of the cooler shut. COC seals should be affixed to opposing sides of the cooler within the securing tape so that the cooler cannot be opened without breaking the seal.

5.2 Shipping

Follow all appropriate DOT regulations (e.g., 49 Code of Federal Regulations, Parts 171-179) for shipment of air, soil, water, and other samples. Elements of these procedures are summarized in the following subsections.

5.2.1 Non-hazardous Materials Shipment

If the samples are suspected to be non-hazardous based on previous site sample results, field screening results, or visual observations, if applicable, then samples may be shipped as non-hazardous.

When a cooler is ready for shipment to the laboratory, prepare standard air bill paperwork for shipment of the samples to the laboratory. Write the shippers tracking/airbill number on the COC form. Place two copies of the COC form inside a self-sealing bag and tape it to the inside of the cooler. Seal the cooler with waterproof tape and label it with "Fragile," "This-End-Up" (or directional arrows pointing up), or other appropriate notices. Affix a label stating the destination (laboratory address) to each cooler. Personnel should be aware of carrier weight or other policy restrictions.

5.2.2 Hazardous Materials Shipment

Shipment of Hazardous Material is not covered in this SOP; all samples handled under this SOP are anticipated to be non-hazardous or not dangerous goods. The CTO Manager, or designee, is responsible for determining if samples collected during a specific field investigation meet the definitions for dangerous goods. If a sample is collected of a material that is listed in the Dangerous Goods List, Section 4.2, of International Air Transport Authority (IATA), then that sample must be identified, packaged, marked,

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labeled, and shipped according to the instructions given for that material. If the composition of the collected sample(s) is unknown, and the project leader knows or suspects that it is a regulated material (dangerous goods), the sample may not be offered for air transport. If the composition and properties of a waste sample or a highly contaminated soil, sediment, or water sample are unknown, or only partially known, the sample may not be offered for air transport.

6.0 Records

Maintain all copies of chain of custodies and air bills with the project file. .

7.0 Attachments or References

International Air Transport Authority (IATA). Dangerous Goods Regulations

http://www.iata.org/whatwedo/cargo/dangerous_goods/Documents/DGR52-significant-changes.pdf

Department of Defense, United States (DoD). 2005. *Uniform Federal Policy for Quality Assurance Project Plans, Part 1: UFP-QAPP Manual*. Final Version 1. DoD: DTIC ADA 427785, EPA-505-B-04-900A. In conjunction with the U. S. Environmental Protection Agency and the Department of Energy. Washington: Intergovernmental Data Quality Task Force. March. On-line updates available at: http://www.epa.gov/fedfac/pdf/ufp_qapp_v1_0305.pdf.

Author	Reviewer	Revisions (Technical or Editorial)
Ben Brantley	Tina Cantwell	Rev 0 — Initial Issue
Program Manager	QA Officer	

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1.0 PURPOSE

This standard operating procedure (SOP) describes the activities regarding the management of investigation-derived waste (IDW) at project sites in the state of Texas. The purpose of this procedure is to provide guidance for the minimization, handling, labeling, temporary storage, inventory, classification, and disposal of IDW. This procedure will also apply to personal protective equipment (PPE), sampling equipment, decontamination fluids, non-IDW trash, non-indigenous IDW, and hazardous waste generated during implementation of remedial actions. If there are procedures whether it is from Resolution Consultants, state and/or federal, that are not addressed in this SOP and are applicable to IDW, then those procedures may be added as an appendix to the project-specific Sampling and Analysis Plan.

2.0 SCOPE

This procedure shall serve as management-approved professional guidance for and is consistent with protocol in the Uniform Federal Policy-Quality Assurance Project Plan (DoD 2005). As professional guidance for specific activities, this procedure is not intended to obviate the need for professional judgment during unforeseen circumstances. Deviations from this procedure while planning or executing planned activities must be approved by both the Contract Task Order (CTO) Manager and the Quality Assurance (QA) Manager.

This procedure was developed to serve as management-approved professional guidance for the management of IDW in the state of Texas. It focuses on the requirements for minimizing, segregating, handling, labeling, storing, and inventorying IDW in the field. Certain drum inventory requirements related to the screening, sampling, classification, and disposal of IDW are also noted in this procedure. This procedure was developed based on the rules promulgated in Title 30, Texas Administrative Code (TAC), Chapter 335, and Title 40 Code of Federal Regulations (CFR), Subchapter I.

3.0 DEFINITIONS

3.1 Logbook

A logbook is a bound field notebook with consecutively numbered, water-repellent pages that is clearly identified with the name of the relevant activity, the person assigned responsibility for maintenance of the logbook, and the beginning and ending dates of the entries.

3.2 Hazardous Waste

A waste is defined as hazardous by the U.S. Environmental Protection Agency (USEPA) if it is one of over 400 wastes listed in the CFR as hazardous or if it exhibits one or more of four hazardous characteristics; i.e., it is ignitable, corrosive, reactive or toxic. (40 CFR 261.3)

3.3 Class 1 Industrial Waste

A waste that, because of its concentration or physical or chemical characteristics, is toxic; corrosive; flammable; a strong sensitizer or irritant; a generator of sudden pressure by decomposition, heat or other means; or may pose a substantial present or potential danger to human health or the environment when improperly processed, stored , transported, disposed of or otherwise managed. (30 TAC 335.1[14])

A waste that contains specific constituents which equal or exceed the levels listed in 335.521(a)(1) is a Class 1 waste. Generators should document that a waste with significant concentrations of Table 2 constituents is not Class 1 (335.521 Table 2). A waste is classified as Class 1 if a liquid has a flash point of less than 65.6 degrees Celsius (150 degrees Fahrenheit), or is a solid or semi-solid capable of causing fires through friction, or retained heat from process, or ignited readily and burns vigorously and persistently, creating serious hazard. A waste is classified as Class 1 if it is a semi-solid or solid which when mixed with distilled water produces a solution with pH less than 2 or greater than 12.5; if total recoverable cyanides are greater than 20 parts per million; if absence of analytical data and/or process knowledge which proves waste is Class 2 or Class 3; if identified as Class 1 in 335.508 (Specific Wastes); or if not a hazardous waste and generator chooses to classify as Class 1.

3.4 Class 2 Industrial Waste

Any waste that cannot be described as a hazardous waste or as a non-hazardous Class 1 or Class 3 waste. (30 TAC 335.1[15]) A generator can choose not to classify waste as Class 3.

3.5 Class 3 Industrial Waste

A waste that is inert and essentially insoluble, usually including materials such as rock, brick, glass, dirt, certain plastics, rubber, and similar materials that are not readily decomposable. (30 TAC 335.1[16])

4.0 RESPONSIBILITIES

The CTO Manager is responsible for identifying instances of non-compliance with this procedure and ensuring that IDW is properly handled and managed in accordance with this SOP and any site-specific or project-specific planning documents. The CTO Manager is responsible for ensuring that all personnel involved in IDW management shall have the appropriate education, experience, and training to perform their assigned tasks. The QA Manager or CTO Manager is responsible for ensuring overall compliance with this procedure. The Field Manager is responsible for ensuring that all IDW is managed according to this procedure. Field personnel are responsible for the implementation of this procedure and will be accountable for the comprehension and implementation of this SOP during all field activities, as well as obtaining the appropriate field logbooks, forms, labels, records and equipment needed to complete the field activities.

5.0 PROCEDURE

5.1 Equipment / Supplies

The equipment and supplies required for implementation of this SOP include the following:

- Containers for waste (e.g., U.S. Department of Transportation (DOT) approved 55-gallon open or closed top drums) and material to cover waste to protect it from weather (e.g., plastic covering)
- Equipment (i.e., pumps, generators, water/interface level indicators, safety monitoring equipment, drum sampling equipment, wrenches to secure drum bungs or lids)
- Hazardous/non-hazardous waste drum labels (weatherproof)
- Permanent marking pens
- Inventory forms for project file
- Plastic garbage bags, zip lock storage bags, rolls of plastic sheeting
- Steel-toed boots, chemical resistant gloves, coveralls, safety glasses, and any other PPE required in the site-specific Site Health and Safety Plan (SHSP).

5.2 Drum Handling

IDW shall be containerized using DOT-approved drums. The drums shall be made of steel or plastic, have a 55-gallon capacity, be completely painted or opaque, and have removable lids or bungs (i.e., United Nations Code 1A2 or 1H2). Typically, 55-gallon drums are used; however, smaller drums may be used depending on the amount of waste generated. New steel drums are preferred over recycled drums.

Recycled drums should not be used for hazardous waste, polychlorinated biphenyl compounds or other regulated shipments. For sites where large quantities of liquids will be generated, double-walled bulk steel or plastic storage tanks may be used. For this scenario, consider the scheduling and cost-effectiveness of this type of bulk storage, treatment, and discharge system or offsite disposal versus longer-term drum storage.

When DOT-approved drums with removable lids are used, verify the integrity of any foam or rubber sealing ring located on the underside the drum lids prior to sealing drums containing IDW liquids. If the ring is only partially attached to the drum lid, or if a portion of the ring is missing, select another drum lid with a sealing ring that is in sound condition.

To prepare IDW drums for labeling, wipe clean the outer wall surfaces and drum lids of all material that might prevent legible and permanent labeling. If potentially contaminated material adheres to the outer surface of a drum, wipe that material from the drum and segregate the paper towel or rag used to remove the material with visibly soiled PPE and disposable sampling equipment. Label all IDW drums and place them on pallets or within secondary containment in the designated storage area.

5.3 Labeling

Containers used to store IDW must be properly labeled. Two general conditions exist: 1) waste characteristics are known to be either hazardous or nonhazardous from previous studies or onsite data; or 2) waste characteristics are unknown until additional data are obtained.

For situations where the waste characteristics are known, the waste containers should be packaged and labeled in accordance with appropriate state and federal regulations that may govern the labeling of waste.

The following information shall be placed on all non-hazardous waste labels:

- Description and source of waste (i.e., purge water from MW-1, soil cuttings from HA-2)
- Contact information, including name and telephone number
- Date when the container becomes full

The following information shall be placed on all hazardous waste labels:

- Description and source of waste (i.e., purge water from MW-1, soil cuttings from HA-2)
- Generator information (i.e., name, address, contact telephone number)
- USEPA identification number and Texas Solid Waste Registration number (supplied by onsite client representative)
- Date when the container becomes full

When the final characterization of a waste is unknown, a notification label should be placed on the drum with the words "waste characterization pending analysis" and the following information included on the label:

- Description and source of waste (i.e., purge water from MW-1, soil cuttings from HA-2)
- Contact information, including name and telephone number
- Date when the container becomes full

Once the waste has been characterized, the label should be changed as appropriate for a non-hazardous or hazardous waste.

Waste labels should be constructed of a weatherproof material and filled out with a permanent marker to prevent being washed off or becoming faded by sunlight. It is recommended that waste labels be placed on the side of the container, since the top is more subject to weathering. However, when multiple containers are accumulated together, it also may be helpful to include labels on the top of the containers to facilitate organization and disposal.

Each container of waste generated shall be recorded in the logbook used by the person responsible for labeling the waste. After the waste is disposed, either by transportation offsite or disposal onsite in an approved disposal area, an appropriate record shall be made in the same logbook to document proper disposition of IDW.

5.4 Types of Site Investigation Waste

Several types of waste are generated during site investigations that may require special handling. These include soil and drilling fluids, groundwater, decontamination water, and used PPE, as discussed further in the following subsections.

5.4.1 Soil and Drilling Fluids

Soil cuttings from boreholes can be shoveled back into the borehole after drilling is complete, if feasible. If all of the soil cuttings cannot be returned to the borehole, soil cutting should be placed in an open-top 55-gallon drum. Drilling mud generated during investigation activities shall be collected in 55-gallon drums as well. Containers must remain closed at all times unless waste is being added. The containers shall be labeled in accordance with this SOP. An inventory containing the source, volume, and description of material put in the containers shall be logged on prescribed forms and kept in the project file.

5.4.2 Groundwater or Decontamination Water

Groundwater generated during monitoring well development, purging, and sampling can be collected in truck-mounted containers and/or other transportable containers (i.e., 55-gallon drums). Wastewater generated during decontamination of field and sampling equipment will be collected and containerized in drums. Using bung style drums helps prevent leaks when drums are moved. Lids or bungs on drums must be secured at all times and only open during filling or pumping activities. The containers shall be labeled in accordance with this SOP.

5.4.3 Personal Protective Equipment

PPE that is generated throughout investigation activities shall be placed in plastic garbage bags. If the solid or liquid waste that was being handled is characterized as hazardous waste, then the corresponding PPE should also be disposed as hazardous waste. If not, all PPE should be disposed as Texas Class 2 non-hazardous waste in municipal sanitary landfill. Trash that is generated as part of field activities may be disposed in a municipal sanitary landfill as long as the trash was not exposed to hazardous media.

5.5 Waste Accumulation Onsite

IDW generated during investigation activities may be subject to storage times dictated by the site's hazardous waste generator status. Hazardous waste can either be stored in the designated waste management unit either 90 days (large quantity generator), 180 days (small quantity generator), or 12 months (conditionally exempt small quantity generator). This information can be obtained from the site or client point of contact. Until final offsite disposal, such containers should be inventoried, stored as securely as possible, and inspected weekly, as a general good practice.

The following requirements for the hazardous waste storage area must be implemented:

- Proper hazardous waste signs shall be posted as required by any state or federal statutes that may govern the labeling of waste
- Secondary containment to contain spills
- Spill containment equipment must be available
- Fire extinguisher
- Adequate aisle space for unobstructed movement of personnel

More requirements may be enforced by the client or site point of contact based on generator status. Weekly storage area inspections shall be performed and documented to ensure compliance with these requirements. Throughout the project, an inventory shall be maintained to itemize the type and quantity of the waste generated.

5.6 Waste Disposal

IDW will be characterized for disposal through the use of client knowledge, laboratory analytical data created from soil or groundwater samples gathered during the field activities, and/or composite samples from individual containers.

All waste generated during field activities will be stored, transported, and disposed according to applicable state, federal, and local regulations. In Texas, IDW will be classified as hazardous, Industrial Class 1, Industrial Class 2, or Industrial Class 3 based on the waste

determination process. Hazardous waste must be handled and disposed offsite at an approved hazardous waste disposal facility. Class 1 non-hazardous waste must be disposed at a facility permitted to accept Class 1 waste. Class 2 waste can be disposed at a municipal landfill, Class 1 landfill, or hazardous waste facility. All wastes classified as industrial Class 3 or general rubbish will be disposed at a municipal sanitary landfill, or in the case of construction and demolition (C&D) debris, must be disposed of at a facility that can accept C&D material.

In general, waste disposal should be carefully coordinated with the client or site point of contact, which would be considered the "generator" of the waste. Waste profiles should be carefully reviewed to ensure accuracy, as well as waste manifests prior to transportation offsite for disposal. In addition, facilities receiving waste have specific requirements that vary even for non-hazardous waste, so characterization should be conducted to support both applicable regulations and facility requirements during the profile approval process.

5.7 Regulatory Requirements

The following federal and state regulations shall be used as resources for determining waste characteristics and requirements for waste storage, transportation, and disposal:

- CFR, Title 40, Part 261
- CFR, Title 49, Parts 172, 173, 178, and 179
- 30 TAC, Title 30, Chapter 335

5.8 Waste Transport

A state-licensed and DOT-registered hazardous waste hauler shall transport all wastes classified as hazardous, or DOT hazardous. Typically, the facility receiving any waste can coordinate a hauler to transport the waste. Shipped hazardous waste shall be disposed in accordance with all Resource Conservation and Recovery Act (RCRA)/USEPA requirements. All waste manifests or bills of lading will be signed either by the client or the client's designee.

6.0 RECORDS

Describe all IDW management activities in the field logbook. This should include all handling activities from when a container becomes full until it is transported offsite for disposal. Tracking of IDW will include applicable dates and weekly inspections.

7.0 HEALTH AND SAFETY

The CTO Manager or designee shall prepare a site-specific health and safety plan. All onsite personnel shall adhere to the site-specific SHSP.

8.0 REFERENCES

Department of Defense, United States (DoD). 2005. *Uniform Federal Policy for Quality Assurance Project Plans, Part 1: UFP-QAPP Manual*. Final Version 1. DoD: DTIC ADA 427785, EPA-505-B-04-900A. In conjunction with the U.S. Environmental Protection Agency and the Department of Energy. Washington: Intergovernmental Data Quality Task Force. March. On-line updates available at: http://www.epa.gov/-fedfac/pdf/ufp_qapp_v1_0305.pdf.

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— 1992b. Guide to Management of Investigative-Derived Wastes. Quick reference fact sheet. OSWER Dir. 9345.3-03FS. Office of Solid Waste and Emergency Response. January.

— 1997a. Sending Wastes Off Site? OSC and RPM Responsibilities under the Off-Site Rule. EPA/540-F-97-006, Office of Solid Waste and Emergency Response. September.

— 1997b. Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW-846. 3rd ed., Final Update IIIA. Office of Solid Waste. Updates available: www.epa.gov/epaoswer/hazwaste/test/new-meth.htm.

— 1998. Management of Remediation Waste under RCRA. EPA/530-F-98-026. Office of Solid Waste and Emergency Response. October.

— (No Date). Compliance with the Off-Site Rule During Removal Actions. Office of Regional Counsel (Region 3). Hendershot, Michael.

9.0 ATTACHMENTS

None.

Equipment Decontamination

Procedure 3-06

1.0 Purpose and Scope

1.1 This standard operating procedure (SOP) describes methods of equipment decontamination, to be used for activities where samples for chemical analysis are collected or where equipment will need to be cleaned before leaving the site or before use in subsequent activities.

1.2 As guidance for specific activities, this procedure does not obviate the need for professional judgment. Deviations from this procedure while planning or executing planned activities must be approved in accordance with Program requirements for technical planning and review.

2.0 Safety

It is the responsibility of the **Site Safety Officer (SSO)** to set up the site zones (i.e., exclusion, transition, and clean) and decontamination areas. Generally the decontamination area is located within the transition zone, upwind of intrusive activities, and serves as the washing area for both personnel and equipment to minimize the spread of contamination into the clean zone. Typically, for equipment, a series of buckets are set up on a visqueen-lined bermed area. Separate spray bottles containing cleaning solvents as described in this procedure or the Contract Task Order (CTO) Work Plan (WP) and distilled water are used for final rinsing of equipment. Depending on the nature of the hazards and the site location, decontamination of heavy equipment, such as augers, pump drop pipe, and vehicles, may be accomplished using a variety of techniques.

All **Field Personnel** responsible for equipment decontamination must adhere to the site-specific health and safety plan (HSP) and must wear the personal protective equipment (PPE) specified in the site-specific HSP. Generally this includes, at a minimum, Tyvek® coveralls, steel-toed boots with boot covers or steel-toed rubber boots, safety glasses, American National Standards Institute-standard hard hats, and hearing protection (if heavy equipment is in operation). Air monitoring by the **SSO** may result in an upgrade to the use of respirators and cartridges in the decontamination area; therefore, this equipment must be available on site. If safe alternatives are not achievable, discontinue site activities immediately.

In addition to the aforementioned precautions, the following sections describe safe work practices that will be employed.

2.1 Chemical Hazards associated with Equipment Decontamination

- Avoid skin contact with and/or incidental ingestion of decontamination solutions and water.
- Utilize PPE as specified in the site-specific HSP to maximize splash protection.
- Refer to material safety data sheets, safety personnel, and/or consult sampling personnel regarding appropriate safety measures (i.e., handling, PPE including skin and respiratory).
- Take the necessary precautions when handling detergents and reagents.

2.2 Physical Hazards associated with Equipment Decontamination

- To avoid possible back strain, it is recommended to raise the decontamination area 1 to 2 feet above ground level.
- To avoid heat stress, over exertion, and exhaustion, it is recommended to rotate equipment decontamination among all site personnel.

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- Take necessary precautions when handling field sampling equipment.

3.0 Terms and Definitions

None.

4.0 Training and Qualifications

4.1 The **CTO Manager** is responsible for ensuring that decontamination activities comply with this procedure. The **CTO Manager** is responsible for ensuring that all personnel involved in equipment decontamination shall have the appropriate education, experience, and training to perform their assigned tasks.

4.2 The **Program Quality Manager** is responsible for ensuring overall compliance with this procedure.

4.3 The **Field Manager** is responsible for ensuring that all field equipment is decontaminated according to this procedure.

4.4 All **Field Personnel** are responsible for the implementation of this procedure.

5.0 Procedure

Decontamination of equipment used in soil/sediment sampling, groundwater monitoring, well drilling and well development, as well as equipment used to sample groundwater, surface water, sediment, waste, wipe, asbestos, and unsaturated zone, is necessary to prevent cross-contamination and to maintain the highest integrity possible in collected samples. Planning a decontamination program requires consideration of the following factors:

- Location where the decontamination procedures will be conducted
- Types of equipment requiring decontamination
- Frequency of equipment decontamination
- Cleaning technique and types of cleaning solutions appropriate to the contaminants of concern
- Method for containing the residual contaminants and wash water from the decontamination process
- Use of a quality control measure to determine the effectiveness of the decontamination procedure

The following subsections describe standards for decontamination, including the frequency of decontamination, cleaning solutions and techniques, containment of residual contaminants and cleaning solutions, and effectiveness.

5.1 Decontamination Area

Select an appropriate location for the decontamination area at a site based on the ability to control access to the area, the ability to control residual material removed from equipment, the need to store clean equipment, and the ability to restrict access to the area being investigated. Locate the decontamination area an adequate distance away and upwind from potential contaminant sources to avoid contamination of clean equipment.

5.2 Types of Equipment

Drilling equipment that must be decontaminated includes drill bits, auger sections, drill-string tools, drill rods, split barrel samplers, tremie pipes, clamps, hand tools, and steel cable. Decontamination of monitoring well development and groundwater sampling equipment includes submersible pumps, bailers, interface probes, water level meters, bladder pumps, airlift pumps, peristaltic pumps, and lysimeters. Other sampling equipment that requires decontamination includes, but is not limited to, hand trowels,

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hand augers, slide hammer samplers, shovels, stainless-steel spoons and bowls, soil sample liners and caps, wipe sampling templates, composite liquid waste samplers, and dippers. Equipment with a porous surface, such as rope, cloth hoses, and wooden blocks, cannot be thoroughly decontaminated and shall be properly disposed of after one use.

5.3 Frequency of Equipment Decontamination

Decontaminate down-hole drilling equipment and equipment used in monitoring well development and purging prior to initial use and between each borehole or well. Down-hole drilling equipment, however, may require more frequent cleaning to prevent cross-contamination between vertical zones within a single borehole. When drilling through a shallow contaminated zone and installing a surface casing to seal off the contaminated zone, decontaminate the drilling tools prior to drilling deeper. Initiate groundwater sampling by sampling groundwater from the monitoring well where the least contamination is suspected. Decontaminate groundwater, surface water, and soil sampling devices prior to initial use and between collection of each sample to prevent the possible introduction of contaminants into successive samples.

5.4 Cleaning Solutions and Techniques

Decontamination can be accomplished using a variety of techniques and fluids. The preferred method of decontaminating major equipment, such as drill bits, augers, drill string, and pump drop-pipe, is steam cleaning. To steam clean, use a portable, high-pressure steam cleaner equipped with a pressure hose and fittings. For this method, thoroughly steam wash equipment and rinse it with potable tap water to remove particulates and contaminants.

A rinse decontamination procedure is acceptable for equipment such as bailers, water level meters, new and re-used soil sample liners, and hand tools. The decontamination procedure shall consist of the following: (1) wash with a non-phosphate detergent (Alconox®, Liquinox®, or other suitable detergent) and potable water solution; (2) rinse with potable water; (3) spray with laboratory-grade isopropyl alcohol; (4) rinse with deionized or distilled water; and (5) spray with deionized or distilled water. If possible, disassemble equipment prior to cleaning. Add a second wash at the beginning of the process if equipment is very soiled.

Decontaminating submersible pumps requires additional effort because internal surfaces become contaminated during usage. Decontaminate these pumps by washing and rinsing the outside surfaces using the procedure described for small equipment or by steam cleaning. Decontaminate the internal surfaces by recirculating fluids through the pump while it is operating. This recirculation may be done using a relatively long (typically 4 feet) large-diameter pipe (4-inch or greater) equipped with a bottom cap. Fill the pipe with the decontamination fluids, place the pump within the capped pipe, and operate the pump while recirculating the fluids back into the pipe. The decontamination sequence shall include: (1) detergent and potable water; (2) potable water rinse; (3) potable water rinse; and (4) deionized water rinse. Change the decontamination fluids after each decontamination cycle.

Solvents other than isopropyl alcohol may be used, depending upon the contaminants involved. For example, if polychlorinated biphenyls or chlorinated pesticides are contaminants of concern, hexane may be used as the decontamination solvent; however, if samples are also to be analyzed for volatile organics, hexane shall not be used. In addition, some decontamination solvents have health effects that must be considered. Decontamination water shall consist of distilled or deionized water. Steam-distilled water shall not be used in the decontamination process as this type of water usually contains elevated concentrations of metals. Decontamination solvents to be used during field activities will be specified in the CTO WP.

Rinse equipment used for measuring field parameters, such as pH (indicates the hydrogen ion concentration – acidity or basicity), temperature, specific conductivity, and turbidity with deionized or distilled water after each measurement. Also wash new, unused soil sample liners and caps with a fresh

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detergent solution and rinse them with potable water followed by distilled or deionized water to remove any dirt or cutting oils that might be on them prior to use.

5.5 Containment of Residual Contaminants and Cleaning Solutions

A decontamination program for equipment exposed to potentially hazardous materials requires a provision for catchment and disposal of the contaminated material, cleaning solution, and wash water.

When contaminated material and cleaning fluids must be contained from heavy equipment, such as drill rigs and support vehicles, the area must be properly floored, preferably with a concrete pad that slopes toward a sump pit. If a concrete pad is impractical, planking can be used to construct solid flooring that is then covered by a nonporous surface and sloped toward a collection sump. If the decontamination area lacks a collection sump, use plastic sheeting and blocks or other objects to create a bermed area for collection of equipment decontamination water. Situate items, such as auger flights, which can be placed on metal stands or other similar equipment, on this equipment during decontamination to prevent contact with fluids generated by previous equipment decontamination. Store clean equipment in a separate location to prevent recontamination. Collect decontamination fluids contained within the bermed area and store them in secured containers as described below.

Use wash buckets or tubs to catch fluids from the decontamination of lighter-weight drilling equipment and hand-held sampling devices. Collect the decontamination fluids and store them on site in secured containers, such as U.S. Department of Transportation-approved drums, until their disposition is determined by laboratory analytical results. Label containers in accordance with Procedure 3-05, *IDW Management*.

6.0 Quality Control and Assurance

A decontamination program must incorporate quality control measures to determine the effectiveness of cleaning methods. Quality control measures typically include collection of equipment blank samples or wipe testing. Equipment blanks consist of analyte-free water that has been poured over or through the sample collection equipment after its final decontamination rinse. Wipe testing is performed by wiping a cloth over the surface of the equipment after cleaning. These quality control measures provide "after-the fact" information that may be useful in determining whether or not cleaning methods were effective in removing the contaminants of concern.

7.0 Records, Data Analysis, Calculations

Any project where sampling and analysis is performed shall be executed in accordance with an approved sampling and analysis plan. This procedure may be incorporated by reference or may be incorporated with modifications described in the plan.

Deviations from this procedure or the sampling and analysis plan shall be documented in field records. Significant changes shall be approved by the **Program Quality Manager**.

8.0 Attachments or References

8.1 ASTM Standard D5088. 2008. *Standard Practice for Decontamination of Field Equipment Used at Waste Sites.* ASTM International, West Conshohocken, PA. 2008. DOI: 10.1520/D5088-02R08. www.astm.org.

8.2 NAVSEA T0300-AZ-PRO-010. *Navy Environmental Compliance Sampling and Field Testing Procedures Manual*. August 2009.

8.3 Procedure 3-05, *IDW Management*.

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Author	Reviewer	Revisions (Technical or Editorial)
Mark Kromis Program Chemist	Chris Barr Program Quality Manager	Rev 0 – Initial Issue

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Land Surveying

Procedure 3-07

1.0 Purpose and Scope

1.1 The purpose of this document is to define the standard operating procedure (SOP) for acquiring land surveying data to facilitate the location and mapping of geologic, hydrologic, geotechnical data, and analytical sampling points and to establish topographic control over project sites.

1.2 This procedure is the Program-approved professional guidance for work performed by Resolution Consultants under the Comprehensive Long-Term Environmental Action Navy (CLEAN) contract (Contract Number N62470-11-D-8013).

1.3 As guidance for specific activities, this procedure does not obviate the need for professional judgment. Deviations from this procedure while planning or executing planned activities must be approved in accordance with Program requirements for technical planning and review. If there are procedures whether it be from Resolution Consultants, state and/or federal that are not addressed in this SOP and are applicable to surface water sampling then those procedures may be added as an appendix to the project specific SAP.

1.4 It is fully expected that the procedures outlined in this SOP will be followed. Procedural modifications may be warranted depending upon field conditions, equipment limitations, or limitations imposed by the procedure. Substantive modification to this SOP will be approved in advance by the Program Quality Manager. Deviations to this SOP will be documented in the field records.

1.5 If there are procedures, whether it be from Resolution Consultants, state and/or federal, that are not addressed in this SOP and are applicable to land surveying then those procedures may be added as an appendix to the project specific Sampling and Analysis Plan (SAP).

2.0 Safety

2.1 Depending upon the site-specific contaminants, various protective programs must be implemented prior to conducting fieldwork. All **field sampling personnel** must review the project-specific health and safety plan (HASP) paying particular attention to the control measures planned for the specific field tasks. Conduct preliminary area monitoring to determine the potential hazard to field sampling personnel. If significant contamination is observed, minimize contact with potential contaminants in both the vapor and liquid phase through the use of respirators and disposable clothing.

2.2 In addition, observe standard health and safety practices according to the project-specific HASP. Suggested minimum protection includes inner disposable vinyl gloves, outer chemical-protective nitrile gloves, rubberized steel-toed boots, and an American National Standards Institute-standard hard hat. Half-face respirators and cartridges and Tyvek® suits may be necessary depending on the contaminant concentrations, and shall always be available on site.

2.3 Daily safety briefs will be conducted at the start of each working day before any work commences. These daily briefs will be facilitated by the **Site Safety Officer (SSO)** or designee to discuss the day's events and any potential health risk areas covering every aspect of the work to be completed. Weather conditions are often part of these discussions. As detailed in the HASP, everyone on the field team has the authority to stop work if an unsafe condition is perceived until the conditions are fully remedied to the satisfaction of the SSO.

2.4 The health and safety considerations for the work associated with land surveying include:

- Slip, trips and falls associated with work in the field;

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- Biological hazards associated with work in the field; and,
- Potential hazards associated with contaminants of concern (COC) that may be located in the survey area,

3.0 Terms and Definitions

3.1 Boundary Survey

Boundary surveys are conducted by Certified Land Surveyors in order to delineate a legal property line for a site or section of a site.

3.2 Global Positioning System (GPS)

A system of satellites, computers, and receivers that is able to determine the latitude and longitude of a receiver on Earth by calculating the time difference for signals from different satellites to reach the receiver.

4.0 Interferences

4.1 Commercially available GPS units typically have a level of precision of (±) 3 to 5 meters. Field corrections can be made as described in Section 8.3 below.

5.0 Training and Qualifications

5.1 Qualifications and Training

5.1.1 The individual executing these procedures must have read, and be familiar with, the requirements of this SOP.

5.2 Responsibilities

5.2.1 The **Contract Task Order (CTO) Manager** is responsible for ensuring that land surveying activities comply with this procedure. The CTO Manager is responsible for ensuring that all field sampling personnel involved in land surveying shall have the appropriate education, experience, and training to perform their assigned tasks.

5.2.2 The **Program Quality Manager** is responsible for ensuring overall compliance with this procedure.

5.2.3 The **Field Manager (FM)** is responsible for ensuring that all field personnel follow these procedures. In virtually all cases, subcontractors will conduct these procedures. The FM or designee is responsible for overseeing the activities of the subcontractor and ensuring that sampling points and topographic features are properly surveyed.

6.0 Equipment and Supplies

6.1 The following equipment list contains materials that may be needed in carrying out the procedures outlined in this SOP. Not all equipment listed below may be necessary for a specific activity. Additional equipment may be required, pending field conditions.

- Personal protective equipment (PPE) and other safety equipment, as required by the HASP;
- Commercially available GPS unit; and,
- Field Logbook.

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7.0 Calibration or Standardization

7.1 An authorized manufacturer's representative shall inspect and calibrate survey instruments in accordance with the manufacturer's specifications regarding procedures and frequencies. At a minimum, instruments shall be calibrated no more than six months prior to the start of the survey work.

7.2 Standards for all survey work shall be in accordance with National Oceanic and Atmospheric Administration standards and, at a minimum, with accuracy standards set forth below. The horizontal accuracy for the location of all grid intersection and planimetric features shall be (±) 0.1 feet. The horizontal accuracy for boundary surveys shall be 1 in 10,000 feet (1:10,000). The vertical accuracy for ground surface elevations shall be (±) 0.1 feet. Benchmark elevation accuracy and elevation of other permanent features, including monitoring wellheads, shall be (±) 0.01 feet.

8.0 Procedure

8.1 Theodolite/Electronic Distance Measurement (EDM)

Follow the procedures listed below during theodolite/EDM land surveying conducted under the NAVFAC CLEAN Program:

- A land surveyor registered in the state or territory in which the work is being performed shall directly supervise all surveying work.
- Reference surveys to the local established coordinate systems and base all elevations and benchmarks established on U.S. Geological Survey datum, 1929 general adjustment.
- Reference surveyed points to Mean Sea Level (Lower Low Water Level).
- Jointly determine appropriate horizontal and vertical control points prior to the start of survey activities. If discrepancies in the survey (e.g., anomalous water level elevations) are observed, the surveyor may be required to verify the survey by comparison to a known survey mark. If necessary, a verification survey may be conducted by a qualified third party.
- All field notes, sketches, and drawings shall clearly identify the horizontal and vertical control points by number designation, description, coordinates, and elevations. Map all surveyed locations using a base map or other site mapping, as specified by the project Work Plan or SAP.
- Begin and end all surveys at the designated horizontal and vertical control points to determine the degree of accuracy of the surveys.
- Iron pins used to mark control points shall be made of reinforcement steel or an equivalent material and shall be 18 inches long with a minimum diameter of 5/8 inch. Drive pins to a depth of 18 inches into the soil.
- Stakes used to mark survey lines and points shall be made from 3-foot lengths of 2-inch by 2-inch lumber and pointed at one end. Clearly mark them with brightly colored weatherproof flagging and paint.
- Clearly mark the point on a monitoring well casing or well riser that is surveyed by filing grooves into the casing/riser on either side of the surveyed point, or by marking the riser with a permanent ink marker.

8.2 Global Positioning System (GPS) to Conduct Land Survey

Follow the procedures listed below during land surveying using GPS:

- A land surveyor registered in the state or territory in which the work is being performed shall directly supervise all surveying work.
- Reference surveys to the local established coordinate systems and base all elevations and benchmarks established on U.S. Geological Survey datum, 1929 general adjustment.

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- All field notes, sketches, and drawings shall clearly identify the horizontal and vertical control points by number designation, description, coordinates, and elevations. Map all surveyed locations using a base map or other site mapping, as specified in the project Work Plan or SAP.
- Begin and end all surveys at the designated horizontal and vertical control points (as applicable) to determine the degree of accuracy of the surveys.
- Iron pins used to mark control points shall be made of reinforcement steel or an equivalent material and shall be 18 inches long with a minimum diameter of 5/8 inch. Drive pins to a depth of 18 inches into the soil.
- Stakes used to mark survey lines and points shall be made from 3-foot lengths of 2-inch by 2-inch lumber and pointed at one end. Clearly mark them with brightly colored weatherproof flagging and paint.
- Clearly mark the point on a monitoring well casing that is surveyed by filing grooves into the casing on either side of the surveyed point.

8.3 Global Positioning System (GPS) to Position Sample Locations or Locate Site Features

Experienced field personnel may use a GPS system unit to position sample locations (e.g. grid positioned samples, soil boring locations) at a site. The decision to use field personnel or a licensed land surveyor will depend on the objectives of the survey (e.g. vertical elevation is not required) and the levels of precision required. Typically when a level of precision greater than (±) 3 to 5 meters is required, a licensed surveyor will be required. When a level of precision of (±) 3 to 5 meters is sufficient to meet project requirements (i.e. when laying sampling grids, identifying significant site features, or locating features identified in GIS figures) experienced field personnel may use commercially available, consumer-grade GPS units. Follow the procedures listed below to locate samples or site features using GPS:

- A commercially available GPS unit with Wide Angle Averaging System (WAAS), topographic map display, and waypoint storage capabilities should be used.
- If waypoints are to be imported into a GIS database, the same grid projection system should be used.
- If a permanent reference point near the site is available, it is recommended that a waypoint at this location be taken every day waypoints are stored.
- When laying out a sampling grid from a GIS map, upload the coordinates from GIS to the GPS unit, including coordinates for an easily identified, permanent, nearby feature (i.e. building corner, roadway intersection, or USGS benchmark).
- If during the initial site walk, the permanent feature identified does not overlay within (±) 5 meters as identified in the GPS unit, field corrections of the waypoints should be made.
- Field corrections can be made by adding/subtracting the difference in x,y coordinates between the field measurement of the permanent site feature and the anticipated x,y coordinates. This correction should then be applied to the x,y coordinates for each sampling location to be marked. Corrected x,y coordinates can then be uploaded into the GPS unit.
- Sampling points and site features can then be located in the field using the GPS units “Go To” function. When the distance to the sampling point or feature remains close to zero, the location can be marked.
- If no field corrections to the sampling location need to be made, or if sampling locations are to be surveyed by a licensed surveyor at a later date, no additional waypoints need to be taken. If significant changes to the sampling location are made, GPS coordinates at the corrected location shall be stored and labeled.

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- It is recommended that GPS coordinates be uploaded to a storage device such as PC at the end of each day.
- Field logs shall indicate manufacturer and model number for GPS unit used, map datum and projection used, and any field corrections made. If the GPS unit cannot lock onto a WAAS system at the site, this should also be noted.

9.0 Quality Control and Assurance

None.

10.0 Data and Records Management

The surveyor shall record field notes daily using generally accepted practices. The data shall be neat, legible, in indelible ink, and easily reproducible. Copies of the surveyor's field notes and calculation forms generated during the work shall be obtained and placed in the project files.

Surveyor's field notes shall, at a minimum, clearly indicate:

- The date of the survey;
- General weather conditions;
- The name of the surveying firm;
- The names and job titles of personnel performing the survey work;
- Equipment used, including serial numbers; and,
- Field book designations, including page numbers.

A land surveyor registered in the state or territory in which the work was done shall sign, seal, and certify the drawings and calculations submitted by the surveyor.

Dated records of land surveying equipment calibration shall be provided by the surveyor and placed in the project files. Equipment serial numbers shall be provided in the calibration records.

11.0 Attachments or References

Department of Defense, United States (DoD). 2005. *Uniform Federal Policy for Quality Assurance Project Plans, Part 1: UFP-QAPP Manual*. Final Version 1. DoD: DTIC ADA 427785, EPA-505-B-04-900A. In conjunction with the U. S. Environmental Protection Agency and the Department of Energy. Washington: Intergovernmental Data Quality Task Force. March. On-line updates available at: http://www.epa.gov/fedfac/pdf/ufp_qapp_v1_0305.pdf.

Author	*Reviewer*	*Revisions (Technical or Editorial)*
Robert Shoemaker Senior Scientist	Naomi Ouellette, Project Manager	Rev 0 – Initial Issue

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GEOPHYSICS

Procedure 3-09

1.0 Purpose and Scope

1.1 This Standard Operating Procedure (SOP) introduces the general methodologies, terms, and procedures for geophysical techniques. Geophysics deploys artificially induced signals or naturally occurring signals to investigate the physical properties of materials through arrays of airborne, surface, or subsurface sensors, and examines how these properties vary spatially and temporally.

A large number of geophysical techniques are employed in the industry, and some applications are rapidly evolving. Accordingly, this SOP describes in broad terms the main methods available, quality control procedures, and interpretation guidelines for subsurface environmental assessments. Project-specific criteria, including performance standards, are specified in Sampling and Analysis Plans (SAPs) or Work Plans (WPs), while further details on emerging technologies may be surmised in a supplemental SOP. Ultimately, the implementation of geophysical technologies should generally be reserved for locations where standard subsurface invasive investigation techniques (e.g., digging, drilling, puncturing, etc.) are deemed too costly or unsafe without supplemental information captured from the geophysical surveys. Even when used in favorable locations, however, geophysical techniques have inherent limitations that must be carefully considered in their deployment.

1.2 As guidance for specific activities, this procedure does not obviate the need for professional judgment. Deviations from this procedure while planning or executing planned activities must be approved in accordance with Program requirements for technical plans and reviews, inclusive of direct notification from at least one of the two program-level geophysicists within Resolution Consultants: (1) Larry Hughes, PG [lhughes@EnSafe.com] and (2) Brian Brunette, PGP [brian.brunette@aecom.com].

2.0 Safety

2.1 The health and safety considerations for the work associated with this SOP, including both potential physical and chemical hazards, will be addressed in the project Health and Safety Plan (HASP). In the absence of a HASP, work will be conducted according to the Contract Task Order (CTO) WP and/or direction from the Site Safety Officer.

2.2 Some geophysical techniques, especially those with active transmitters (e.g., resistivity, radar, etc.), pose method-specific hazards. The hazards and procedures for minimizing risk must be explicitly stated in the HASP for all project sites; unexploded ordnance (UXO) sites may require additional Explosive Safety Submission or Hazards of Electromagnetic Radiation to Ordnance certifications.

3.0 Terms and Definitions

3.1 **Available Technologies**. Geophysical methods commonly applied to environmental issues generally fall into three broad categories: seismic (using a vibration/acoustic signal), electrical (using direct-current, inductive, or naturally occurring electromagnetic field sources), and potentiometric (using natural gravity or magnetic properties). These methods can be applied in boreholes (downhole logging), at the surface, underwater, within subsurface voids, from airborne platforms, and from space, or in various combinations of these configurations. Typical methods include (referring to definitions in Section 3.2):

3.1.1 **Reflection seismic:** Creates a seismic wave using an impact source (hammer on a plate, weight drop, explosive, vibrating device), and measures amplitudes and arrival times of reflected seismic waves from subsurface geology though geophones either planted in the soil or dragged along the surface ("streaming" array). Typically used to map deep structure and lithology for energy exploration, but in recent decades, evolving technology has allowed work in the sub-10 meter depth

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range of interest in many environmental investigations. Overall, perhaps the most powerful, highest-resolution geophysical method, though infrequently used for environmental issues.

3.1.2 **Refraction seismic:** Uses an impact source (typically hammer on a plate) and detects refracted waves from a higher-velocity material at depth. Typical application is mapping bedrock at depths of less than 30 meters. Refraction delivers reasonably high resolution. Limitations can arise from the large source-receiver spread, which can extend beyond the bounds of the survey area or be interrupted by surface features.

3.1.3 **Surface wave seismic:** Uses an impact source (typically hammer on a plate) to induce surface waves in the shallow subsurface to measure shear-wave velocity variations, often indicative of matrix stiffness. Used to evaluate landfills, engineering properties of the ground, and map shallow geology. The dominant method is multichannel analysis of surface waves (MASW). Occasionally passive MASW (refraction microtremor, or ReMi) is used to monitor deeper seismic activity, for example from oilfield fracking operations, or image geology in a manner similar to MASW.

3.1.4 **Electrical Resistivity (ER):** Uses multiple grounded electrodes to transmit low-frequency electrical current and receive voltage responses, which are used to construct resistivity images of the subsurface; a less commonly used, shallower application employs capacitively-coupled (ungrounded) electrodes as a towed array. ER uses either frequency-domain or time-domain technologies, which deliver similar results; typical depths of exploration are 1 to 100 meters (but up to 1,000 meters for specially designed surveys). Commonly used in environmental applications, particularly in mapping hydrogeology and karst structure. In addition to its surface-based applications, resistivity is a standard borehole tool. Resistivity has limited effectiveness in areas with highly conductive surface material (e.g., surface water inundation or saturated clays) due to current channeling.

3.1.5 **Induced polarization (IP):** A more powerful version of ER that, in addition to the resistivity parameter, measures voltages at multiple frequencies or time gates to infer the capacitive effect, or electrical polarization, due to certain materials such as clays, sulfide minerals, and alteration environments. Sometimes IP is called spectral induced polarization or complex resistivity. Less frequently used than ER for environmental issues, despite its superior qualities, which are especially useful in landfill and leachate delineation. Applications include hydrogeology, karst, 3D landfill characterization, and alteration from contaminants or remedial processes.

3.1.6 **Spontaneous potential (SP):** A passive method measuring potential differences due to electrochemical effects from variations in lithology, geochemical alteration, or mineralization; or, alternatively, measuring electrokinetic-flow phenomena from leaky membranes such as dams or liners in landfills or ponds. SP uses simple equipment consisting of a high-impedance digital voltmeter, insulated cable, and several nonpolarizing electrodes. In addition to its surface-based applications, SP is a standard borehole tool.

3.1.7 **Frequency domain electromagnetic (FDEM):** Pulses a small coil with a current (typically around 10 kiloHertz) and measures the response from subsurface conductors in a second coil. The response is separated into two components: quadrature (giving the conductivity of the ground) and in-phase (related to metal responses). FDEM is reliable only for low induction numbers (ground resistivity greater than 10 ohm-meters). Generally used to characterize the bulk conductivity of the ground, though some configurations allow limited depth profiling; typical depth penetration is to 5 meters. Surface-based deployment is fast and efficient. Airborne FDEM is commonly used for mining, less so for smaller-sized environmental projects.

3.1.8 **Transient electromagnetic methods:** These typically pulse an antenna with a sharp current and measure the ground's response in a second antenna after current turn-off. Transient methods roughly divide into two categories according to measurement times, which affect depths of investigation: **transient electromagnetics (TEM)** and **metal detectors**. TEM measures the signal decay

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immediately after current turnoff to investigate subsurface hydrogeology; this method is excellent for finding conductive features but poor for resistive features. Metal detectors analyze the decay curves at later times, after the signals due to natural geology should have dissipated to zero, for sustained signals from metal objects. The latter application is sometimes called time domain electromagnetics (TDEM), often used with a simple antenna configuration at limited time "windows" for fast ground coverage to map metal utilities, drums, tanks, etc. within the top several meters. UXO-focused TEM analyzes a broad time range to detect UXO, discriminate it from inert scrap, and determine the type and burial geometry of the ordnance; these often use 3-axis antennas and sophisticated software. These applications deploy TEM at the ground level or on airborne platforms. Electromagnetic limitations include discerning individual items in cluttered areas, working close to large metal features, and detecting deeper items due to deteriorating signal-to-noise ratios.

3.1.9 **Controlled source audiofrequency magnetotellurics (CSAMT):** Current is injected into a distant array of electrodes; measurements of electric field voltages and the magnetic field are used to map subsurface resistivity patterns. CSAMT is typically used for deeper energy-sector exploration, but occasionally to map aquifers for environmental applications. Natural source variants magnetotellurics (low frequency, deep) and audiofrequency magnetotellurics (intermediate depths) are rarely used in environmental work. A distant cousin to CSAMT, very low frequency, is occasionally used to map shallow bedrock fracturing in water studies.

3.1.10 **Ground penetrating radar (GPR):** GPR transmits signals in the low-MegaHertz (MHz) to GigaHertz range and measures the response due to changes in subsurface dielectric properties, which are largely driven by water content. GPR is a moderate to high resolution method commonly used to map stratigraphy, water saturation, permafrost, and anthropogenic features such as utilities, tanks, and drums. These applications require close coupling of antennas and the ground surface; an adaptation using non-coupled ("air launched") antennas is used for roadway delamination studies, and satellite-based radar (often in the form of synthetic aperture radar) is used for remote sensing. Depth penetration is limited to nearly zero in heavy clay environments, water inundated areas, or reinforced concreted, but can be tens of meters in dry sands.

3.1.11 **Gravity:** A passive method that measures local variations in the earth's gravitational field due to subsurface density changes. Classic applications include mapping voids beneath paved surfaces, caves and other karst features (such as sinkholes), mine shafts and tunnels, and depth to bedrock. Environmental applications typically demand very high precision, for which the term "microgravity" is often applied; the work requires expensive equipment and accurate elevation surveying, making the cost per station rather high.

3.1.12 **Magnetics:** A passive method that measures local variations in the earth's magnetic field due to subsurface changes in ferrous metal. Classic applications include mapping UXO, drums, underground storage tanks, and old building artifacts. The method is specific to ferrous metal and is less effective in high-magnetic environs such as volcanic areas. Anomalies are usually dipolar in nature, complicating interpretation with respect to TEM; but processing often can identify target positions and depths. In ground use, magnetics is often deployed in the vertical gradient mode, which uses two vertically-stacked magnetometers to distinguish local magnetic changes from regional ones. Airborne magnetics is sometimes used, typically on UXO projects, though TEM is more common for UXO.

3.1.13 **Emergent technologies:** Several promising technologies are in research stages, particularly nuclear magnetic resonance, a sensitive detector of water content with ties to geotechnical properties. Ultrasonic methods have been used for mapping fine-scale delamination and voids in concrete, and are being expanded to other targets relevant to environmental interests.

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Global positioning system (GPS) equipment is often used for geophysical positioning; GPS standards are covered in SOP 3-07.

3.2 **Definitions:** Geophysical terms are numerous enough to fill an industry dictionary, but some common terms used in environmental work are:

3.2.1 **Arrival:** The return of a transmitted signal after passing through a material.

3.2.2 **Culture:** Anthropogenic features such as fences, pipelines, powerlines, metal well casings, buried debris, etc. that interfere with imaging a target.

3.2.3 **Geophysics:** A collection of techniques that utilize physical property contrasts in the subsurface to detect or image features of interest.

3.2.4 **MEC:** Munitions and explosives of concern.

3.2.5 **Reflection:** The bounce of waves from an interface. Use of the term usually implies the wavelength is much smaller than the target dimensions and depth.

3.2.6 **Refraction:** The bending of waves (usually seismic in geophysics) as the pass between media of different densities.

3.2.7 **UXO:** Unexploded ordnance, an older term still commonly used in geophysics but supplanted by "MEC" in military circles.

4.0 Interferences

4.1 Seismic methods (surface applications):

- Poor geophone coupling, for example in loose sands.
- Connection problems in stressed geophone cables.
- Poor source signal amplitude or frequency.
- High vibrational noise due to surface vibrations or wind.
- Strong topographic relief (surface-wave methods).
- Inadequate gain or stacking in the field.
- Poor target-to-surroundings velocity contrast.
- Terrain, vegetation, water bodies, hazards, site size, and other obstructions to deployment of contiguous lines.

4.2 Electrical methods (direct coupled, surface applications):

- Poor (high impedance) electrode contact.
- Electromagnetic coupling between transmitting and receiving cables (IP systems, especially frequency domain).
- Inadequate hardware and software to reliably record IP data (IP surveys only).
- Strong, undocumented changes in line orientations or electrode spacings; undocumented terrain changes.
- Inadequate signal amplitude for array size.
- Culture, especially parallel to lines, networked, or near electrodes.
- Anthropogenic signals, especially powerlines with poor frequency regulation and cathodically protected pipelines.
- Noise from local or global thunderstorms.
- Inadequate gain or stacking in the field.
- Poor target-to-surroundings resistivity/chargeability contrast.
- Highly conductive surface layer.
- Terrain, vegetation, water bodies, hazards, and obstructions to deployment.

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4.3 SP (surface applications):

- Nonpolarizing electrodes insufficiently planted in soil, unprotected from drying or large temperature changes.
- Uncharacterized regional SP drift because of failure to monitor a reference electrode or base station.
- Depending on project objective, interference from redox-alteration effects, electrokinetic (active flow) effects, or biological effects (e.g., algae).
- Poor target-to-surroundings SP contrast.
- Terrain, vegetation, water bodies, hazards, and obstructions to deployment.

4.4 Electromagnetic methods, FDEM (simple surface applications, FDEM):

- Failure to properly set up and verify operation of the instrument according to manufacturer's recommendations.
- Highly conductive geology violates the low induction number assumption.
- Extreme cultural signals such as major overhead powerlines.
- Surface/subsurface clutter and culture (when not the survey objective).
- For subtle targets requiring high data precision and density: acquisition speed too high (leveling errors), line-direction (reciprocity) bias, unmonitored instrument drift, inadequate GPS-positioning accuracy with respect to station spacings.
- Inadequate spatial coverage for size of targets sought.
- Target too small or deep for method.
- Poor target-to-surroundings contrast.
- Terrain, vegetation, water bodies, hazards, and obstructions to deployment.

4.5 Electromagnetic methods, TDEM (surface applications, simple target searches):

- Failure to properly set up and verify operation of the instrument according to manufacturer's recommendations; failure to null the instrument in a nonmetallic area.
- Extreme cultural signals such as major overhead powerlines.
- Metal clutter and culture (when not the survey objective).
- For subtle targets requiring high data precision and density: acquisition speed too high (leveling errors), line-direction (reciprocity) bias, unmonitored instrument drift, inadequate GPS-positioning accuracy with respect to station spacing.
- Inadequate spatial coverage for size of targets sought.
- Target too small or deep for method.
- Poor target-to-surroundings contrast.
- Terrain, vegetation, water bodies, hazards, and obstructions to deployment.

4.6 Electromagnetic methods, TEM (surface applications):

- Failure to properly set up and verify operation of the instrument according to manufacturer's recommendations.
- Extreme cultural signals such as major overhead powerlines.
- Metal clutter and culture, especially culture not symmetric with antenna configurations.
- Target too small or deep for method.
- Poor target-to-surroundings resistivity contrast.
- Unsuitable target, especially a smaller resistive target in a conductive environment.
- Conductivity-thickness ambiguity for a thin conductive layer.
- Inadequate quality control procedures, especially for UXO detection and discrimination (e.g., library target responses, in situ seed target calibrations, noise studies, etc.).
- Inadequate or incorrect application of processing.
- Terrain, vegetation, water bodies, hazards, and obstructions to deployment.

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4.7 CSAMT:

- Improper survey design of transmitting antenna location(s) to maximize far-field data.
- Inadequate transmitter signal.
- Infrequent magnetic field characterization in geology where magnetic field changes.
- Use of scalar data for 3-dimensional targets.
- Culture, especially parallel to lines, networked, or near electrodes.
- Anthropogenic signals, especially powerlines with poor frequency regulation and cathodically protected pipelines.
- Natural signals from regional thunderstorms.
- Target too shallow for expected skin depth range.
- Inadequate gain or stacking in the field.
- Terrain, vegetation, water bodies, hazards, and obstructions to deployment.

4.8 GPR:

- Failure to verify the GPR unit is licensed by the Federal Communications Commission or similar agencies for use in the designated country.
- Failure to coordinate high-powered GPR transmissions with nearby airports.
- At UXO sites: failure to verify that GPR is safe to operate in the presence of potentially live electronically-fused ordnance.
- Failure to properly set up and verify operation of the instrument according to manufacturer's recommendations.
- Survey design (antenna frequency/signal wavelength, separation) inadequately matched to expected target.
- Surface/subsurface clutter causing multiple signals.
- Airwaves from nearby trees or structures (particularly for antenna frequencies below 200 MHz).
- Strong radio transmissions nearby (occasional problem).
- Response shifts with changes in ground saturation.
- Inadequate penetration in conductive environments.
- Target too small or deep for method.
- Poor target-to-surroundings dielectric contrast.
- Terrain, vegetation, water bodies, hazards, and obstructions to deployment.

4.9 Gravity:

- Failure to properly set up and verify operation of the instrument according to manufacturer's recommendations.
- Inadequate protection of gravimeter during transport; failure to maintain internal heater temperature in the days preceding and during use.
- Inadequate leveling before acquisition.
- Inadequate base ties to correct instrument drift.
- Survey design (station spacing) inadequately matched to expected target size.
- Surrounding buildings and structures perturbing the gravitational field.
- Inadequate accuracy of station elevations.
- Poor target-to-surroundings density contrast.
- Terrain, vegetation, water bodies, hazards, and obstructions to deployment.

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4.10 Magnetics (surface based):

- Failure to properly set up and verify operation of the instrument according to manufacturer's recommendations.
- Heading error when using alkali vapor instruments.
- Application in high magnetic noise environments such as heavy culture (including reinforced concrete pavement), or in areas with magnetic surface geology (e.g., volcanics or sedimentary outwash of volcanic fragments).
- Magnetic items on operator (belt, keys, steel-toed boots).
- Survey design (station spacing) inadequately matched to expected target size.
- Inadequate characterization of ambient magnetic field drift (for total field surveys).
- Metal targets are not ferrous.
- Poor target-to-surroundings ferrous-metal contrast.
- Terrain, vegetation, water bodies, hazards, and obstructions to deployment.

4.11 Airborne FDEM, TEM, Magnetics (in addition to ground-based interferences):

- Inability to minimize flight elevation due to trees and other obstructions.
- Inadequate accuracy of sensor elevation and orientation.
- Improper survey design (flight speed, line spacing, data redundancy and ties, etc.).
- Inadequate correction for helicopter-induced noise.
- Safety issues such as weather, remoteness of the site, flight hazards, etc.

5.0 Training and Qualifications

5.1 Qualifications and Training

The individual executing these procedures must have read, and be familiar with, the requirements of this SOP.

5.2 Responsibilities

5.2.1 **CTO Managers** are responsible for issuing SAPs that reflect the procedures and specifications presented in this procedure. The **CTO Manager** shall be familiar with current local and state regulations, and ensure that these regulations are followed. The **CTO Manager** is responsible for ensuring that all personnel involved in geophysics shall have the appropriate education, experience, and training to perform their assigned tasks.

5.2.2 The **Program Quality Manager** is responsible for ensuring overall compliance with this procedure.

5.2.3 The **Field Manager** is responsible for direct supervision of geophysical acquisition and ensuring that procedures and specifications are implemented in the field in accordance with the approved SAP. The qualifications for the **Field Manager** must be in accordance with local jurisdictions with authority over the operations conducted.

5.2.4 All field personnel are responsible for the implementation of this procedure.

6.0 Equipment and Supplies

6.1 Materials provided by either Resolution Consultants or its subcontractors shall be sufficient to accomplish the survey objectives. The Field Manager shall have, at a minimum:

- Personal protective equipment for all personnel as required by the HASP.
- Planning documents including the site-specific HASP and SAP.
- Copies of other plans and agreements, for example, those in conjunction with UXO sites.
- Field logbook/field forms/site maps.
- Sufficient tools to analyze data adequacy on site.

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7.0 Procedure

7.1 **General Note**: because of the wide range of available geophysical techniques and even wider range of variations, as well as varying project objectives, details of required survey procedures appear in individual project SAPs. The following are intended as overall guidelines in executing and interpreting geophysical data.

7.2 **Survey Design**

- Work through the data quality objectives (DQOs): determine the overall project objectives, define the information desired from geophysics, define specific geophysical targets, and determine how the positive or negative outcome of the geophysics will impact resolution of the project objectives.
- Considering the target's anticipated physical properties, depth, size, and environs, develop a short list of potentially applicable techniques. If appropriate, run a forward model for each considered technology to evaluate the probability of detection/characterization in the presence of expected interferences; run multiple models if there is uncertainty in any of the input parameters. An alternative to modeling is hand-calculations based on expected target geometry and properties, or professional experience based on those properties.
- Determine the most appropriate technology to use. Establish a preliminary level of effort and ballpark cost. Then ask the question: is there a simpler, more cost-effective, or less ambiguous way to define the target with a non-geophysical approach? If not, based on the chosen technology, does geophysics merely add *data* (stuff to go in a report appendix) or does it add *information* (decision-making value)? If the latter, proceed with the survey design.
- Begin the survey design using best professional practices to ensure the target is adequately characterized. Examples of factors to consider: sample density with respect to the smallest likely target size (apply spatial aliasing criteria); adequate signal characteristics to resolve target; adequate depth penetration to reliably sample at the deepest likely target depth; signal-to-noise; interferences; best choice of equipment type and supplier for the site; robust survey logistics to meet challenges such as terrain, obstructions, and property constraints; quality control and verification procedures. Restate these in terms of data quality objectives.
- Envision how the report will be written if everything goes well: how will your project summary materially enhance project decisions? What can be changed now, in the survey-design stage, to maximize the decision-making impact?
- Incorporate these determinations in a SAP, stating performance criteria such as data density, repeatability, and verification.

7.3 Field Execution

- Determine if the field work will be done by Resolution Consultants directly or by a subcontractor. Follow standard procurement procedures for ordering equipment or selecting a subcontractor. Subcontracting requires a Statement of Work. All personnel, including subcontractors, must follow the field execution procedures outlined below.
- Equipment must be assembled and tested for correct functioning according to the manufacturer's recommendations. Initial tests may consist of, as examples: internal or external calibrations; comparing instrument response to a known regional response; testing response over visible cultural or geologic features; or tests over buried "seed" items of known physical characteristics. The tests should be sufficient to demonstrate that the equipment is operating within normal and project-specified tolerances before data acquisition begins. Tests should consider both precision and accuracy, as appropriate to the method and project objectives.
- For appropriate applications and methods (e.g., FDEM, TDEM, gravity and total-field magnetometry), establish a base station in a nominally responsive area on or near the site. Repeat measurements at the base station before, during, and after data collection to ensure proper functioning of the instrument and to establish a response curve for later correction of instrument or field drift. The frequency of base

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station ties depends upon the variability of the drift being monitored and the DQOs of the survey. For some surveys, particularly total-field magnetometry, a continuously recording base station monitor is desirable. In other cases, such as GPR, the "base station" might be a base line, over which data are repeated to determine effects of rain on target delineation and penetration depth. Base station data are considered part of the official project electronic data record.

- Obtain data in a manner that adheres to the SAP or WP, constitutes reasonable and customary professional geophysical practice, and is continually focused on meeting project objectives.
- Check and document battery levels periodically. Some systems have an incipient data bias as battery voltage drops below a certain threshold, making it difficult to determine what parts of the data are reliable and what parts are not.
- All data should be stored electronically, if practical, and circumstances of field logistics and anything affecting data quality recorded in the field notebook (see Section 9.0).

7.4 Data Processing

- All raw data files downloaded from the instrument must be preserved without modification. Processing is to be performed on *copies* of the raw files.
- The processing stream, including filename protocol and processing algorithms used, must be documented sufficiently to be understandable to and reproducible by a geophysicist with no previous knowledge of the project.
- The level of effort in processing should be appropriate to the project DQOs.
- Whenever possible, data processing should incorporate ground truth information to achieve a more accurate solution. Joint processing of multi-method data sets may be similarly productive.
- A summary of data processing procedures and their rationale should be presented in the project report.

8.0 Quality Control and Assurance

8.1 Field personnel will follow specific quality assurance guidelines as outlined in the SAP and any additional procedures identified in the field as necessary to maintain the integrity of the data.

8.2 System calibration, checks, and live tests shall be analyzed in the field before and during data collection to ensure data accuracy and precision.

9.0 Records, Data Analysis, Calculations

All geophysical data should be stored in a data recorder or laptop during acquisition, if practical. At the earliest practical time, and at least at the conclusion of each field day, data should be downloaded to a separate computer and backed up via external drive or email attachments.

Field notes will be recorded in the field logbook, which is a primary document of record for the project. Accordingly, any circumstances potentially affecting the interpretability of the data should be recorded in the notebook as they occur. Examples: times of arrival/departure and key field activities; health and safety factors and pre-work safety meeting (in addition to the required daily safe work assessment and permit form); weather; calibration/test results; records of base station ties; illustrations of instrument setup; details of instrument deployment; survey lines or points acquired; data results as appropriate; identification of anomalies encountered; records of interfering factors such as culture or ambient noise; descriptions of problems encountered, the data blocks affected, and remedy achieved; sketch maps; notes for subsequent processing; and any deviations from the procedures in this SOP and other project plans.

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10.0 Attachments or References

10.1 Butler, D.K., Ed., 1991. Near-Surface Geophysics: Investigations in Geophysics no.13, Society of Exploration Geophysicists.

10.2 Dobrin, M. B., and C. H. Savit, 1988. *Introduction to Geophysical Prospecting*: McGraw-Hill Publishing Environmental.

10.3 Nabighian, M.N., Ed., 1991. Electromagnetic Methods in Applied Geophysics: Investigations in Geophysics no.3, Society of Exploration Geophysicists.

10.4 Sheriff, R. E., 1991. *Encyclopedic Dictionary of Exploration Geophysics*: Society of Exploration Geophysicists.

10.5 Telford, W. M., L. P. Geldart, R. E. Sheriff, and D.A. Keys, 1998. *Applied Geophysics*: Cambridge University Press.

10.6 Ward, S.H., Ed., 1990. Geotechnical and Environmental Geophysics: Investigations in Geophysics no.5, Society of Exploration Geophysicists.

Author	Reviewer	Revisions (Technical or Editorial)
Larry Hughes Senior Geophysicist	Brian Brunette, PGP Technical Lead MMRP	Rev 0 — Initial Issue (April 2013)

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Monitoring Well Sampling

Procedure 3-14

1.0 Purpose and Scope

1.1 This standard operating procedure (SOP) describes the actions to be used during monitoring well sampling activities and establishes the method for sampling groundwater monitoring wells for water-borne contaminants and general groundwater chemistry. The objective is to obtain groundwater samples that are representative of aquifer conditions with as little alteration to water chemistry as possible.

1.2 This procedure is the Program-approved professional guidance for work performed by Resolution Consultants under the Comprehensive Long-Term Environmental Action Navy (CLEAN) contract (Contract Number N62470-11-D-8013).

1.3 As guidance for specific activities, this procedure does not obviate the need for professional judgment. Deviations from this procedure while planning or executing planned activities must be approved in accordance with Program requirements for technical planning and review.

2.0 Safety

2.1 Depending upon the site-specific contaminants, various protective programs must be implemented prior to sampling the first well. All field sampling personnel responsible for sampling activities must review the project-specific health and safety plan (HASP) paying particular attention to the control measures planned for the well sampling tasks. Conduct preliminary area monitoring of sampling wells to determine the potential hazard to field sampling personnel. If significant contamination is observed, minimize contact with potential contaminants in both the vapor phase and liquid matrix through the use of of appropriate personal protective equipment (PPE).

2.2 Observe standard health and safety practices according to the project-specific HASP. Suggested minimum protection during well sampling activities includes inner disposable vinyl gloves, outer chemical-protective nitrile gloves and rubberized steel-toed boots. Half-face respirators and cartridges and Tyvek® suits may be necessary depending on the contaminant concentrations. Refer to the project-specific HASP for the required PPE.

2.3 Physical Hazards associated with Well Sampling

- To avoid lifting injuries associated with pump and bailers retrieval, use the large muscles of the legs, not the back.
- Stay clear of all moving equipment, and avoid wearing loose fitting clothing.
- When using tools for cutting purposes, cut away from yourself. The use of appropriate, task specific cutting tools is recommended.
- To avoid slip/trip/fall conditions as a result of pump discharge, use textured boots/boot cover bottoms.
- To avoid heat/cold stress as a result of exposure to extreme temperatures and PPE, drink electrolyte replacement fluids (1 to 2 cups per hour is recommended) and, in cases of extreme cold, wear fitted insulating clothing.
- Be aware of restricted mobility due to PPE.

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3.0 Terms and Definitions

None.

4.0 Interferences

4.1 Potential interferences could result from cross-contamination between samples or sample locations. Minimization of the cross-contamination will occur through the following:

- The use of clean sampling tools at each location as necessary.
- Avoidance of material that is not representative of the media to be sampled.

5.0 Training and Qualifications

5.1 **Qualifications and Training**

The individual executing these procedures must have read, and be familiar with, the requirements of this SOP.

5.2 **Responsibilities**

5.2.1 The **Contract Task Order (CTO) Manager** is responsible for ensuring that monitoring well sampling activities comply with this procedure. The **CTO Manager** is responsible for ensuring that all field sampling personnel involved in monitoring well sampling shall have the appropriate education, experience, and training to perform their assigned tasks.

5.2.2 The **Program Quality Manager** is responsible for ensuring overall compliance with this procedure.

5.2.3 The **Field Manager** is responsible for ensuring that all field sampling personnel follow these procedures.

5.2.4 **Field sampling personnel** are responsible for the implementation of this procedure.

5.2.5 The field sampler and/or task manager is responsible for directly supervising the groundwater sampling procedures to ensure that they are conducted according to this procedure and for recording all pertinent data collected during sampling.

6.0 Equipment and Supplies

6.1 Purging and Sampling Equipment

- Pump (Peristaltic, Portable Bladder, Submersible)
- Polyethylene or Teflon bladders (for portable bladder pumps)
- Bladder pump controller (for portable bladder pumps)
- Air compressor (for portable bladder pumps)
- Nitrogen cylinders (for portable bladder pumps)
- 12-volt power source
- Polyethylene inlet and discharge tubing (except for VOC analysis which requires Teflon tubing)
- Silicone tubing appropriate for peristaltic pump head
- Teflon bailer appropriately sized for well

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- Disposable bailer string (polypropylene)
- Individual or multi-parameter water quality meter(s) with flow-through cell to measure temperature, pH, specific conductance, dissolved oxygen (DO), oxidation reduction potential (ORP), and/or turbidity
- Turbidity meter
- Water level meter
- Oil/water interface probe

6.2 General Equipment

- Sample kit (i.e., bottles, labels, preservatives, custody records and tape, cooler, ice)
- Sample Chain-of-Custody (COC) forms
- Sample Collection Records
- Sample packaging and shipping supplies
- Waterproof marker or paint
- Distilled/deionized water supply
- Water dispenser bottles
- Flow measurement cup or bucket
- 5-gallon buckets
- Instrument calibration solutions
- Stopwatch or watch
- Disposable Nitrile gloves
- Paper towels
- Trash bags
- Zipper-lock bags
- Equipment decontamination supplies
- Health and safety supplies (as required by the HASP)
- Approved plans such as: project-specific HASP and Sampling and Analysis Plan (SAP)
- Well keys or combinations
- Monitoring well location map(s)
- Field project logbook/pen

7.0 Calibration or Standardization

7.1 Field instruments will be calibrated daily according to the requirements of the SAP and manufacturer's specifications for each piece of equipment. Equipment will be checked daily with the calibration solutions at the end of use of the equipment. Calibration records shall be recorded in the field logbook or appropriate field form.

7.2 If readings are suspected to be inaccurate, the equipment shall be checked with the calibration solutions and/or re-calibrated.

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8.0 Procedure

8.1 Preparation

8.1.1 Site Background Information

Establish a thorough understanding of the purposes of the sampling event prior to field activities. Conduct a review of all available data obtained from the site and pertinent to the water sampling. Review well history data including, but not limited to, well locations, sampling history, purging rates, turbidity problems, previously used purging methods, well installation methods, well completion records, well development methods, previous analytical results, presence of an immiscible phase, historical water levels, and general hydrogeologic conditions.

Previous groundwater development and sampling logs give a good indication of well purging rates and the types of problems that might be encountered during sampling, such as excessive turbidity and low well yield. They may also indicate where dedicated pumps are placed in the water column. To help minimize the potential for cross-contamination, well purging and sampling and water level measurement collection shall proceed from the least contaminated to the most contaminated well as indicated by previous analytical results. This order may be changed in the field if conditions warrant it, particularly if dedicated sampling equipment is used. A review of prior sampling procedures and results may also identify which purging and sampling techniques are appropriate for the parameters to be tested under a given set of field conditions.

8.1.2 Groundwater Analysis Selection

Establish the requisite field and laboratory analyses prior to water sampling. Decide on the types and numbers of quality assurance/quality control (QA/QC) samples to be collected (refer to the project-specific SAP), as well as the type and volume of sample preservatives, the type and number of sample containers, the number of coolers required, and the quantity of ice or other chilling materials. The field sampling personnel shall ensure that the appropriate number and size sample containers are brought to the site, including extras in case of breakage or unexpected field conditions. Refer to the project-specific SAP for the project analytical requirements.

8.2 Groundwater Sampling Procedures

Groundwater sampling procedures at a site shall include:

1) An evaluation of the well security and condition prior to sampling;
2) Decontamination of equipment;
3) Measurement of well depth to groundwater;
4) Assessment of the presence or absence of an immiscible phase;
5) Assessment of purge parameter stabilization;
6) Purging of static water within the well and well bore; and
7) Obtaining a groundwater sample.

Each step is discussed in sequence below. Depending upon specific field conditions, additional steps may be necessary. As a rule, at least 24 hours should separate well development and well sampling events. In all cases, consult the State and local regulations for the site, which may require more stringent time separation between well development and sampling.

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8.2.1 Well Security and Condition

At each monitoring well location, observe the conditions of the well and surrounding area. The following information may be noted on a Groundwater Sample Collection Record (Attachment 1) or in the field logbook:

- Condition of the well's identification marker.
- Condition of the well lock and associated locking cap.
- Integrity of the well – well pad condition, protective outer casing, obstructions or kinks in the well casing, presence of water in the annular space, and the top of the interior casing.
- Condition of the general area surrounding the well.

8.2.2 Decontamination of Equipment

Where possible, dedicated supplies should be used at each well location to minimize the potential for cross-contamination and minimize the amount of investigation derived waste (IDW) fluids resulting from the decontamination process. If decontamination is necessary, establish a decontamination station before beginning sampling. The station shall consist of an area of at least 4 feet by 2 feet covered with plastic sheeting and be located upwind of the well being sampled. The station shall be large enough to fit the appropriate number of wash and rinse buckets, and have sufficient room to place equipment after decontamination. One central cleaning area may be used throughout the entire sampling event. The area around the well being sampled shall also be covered with plastic sheeting to prevent spillage. Further details are presented in SOP 3-06, Equipment Decontamination.

Decontaminate each piece of equipment prior to entering the well. Also, conduct decontamination prior to sampling at a site, even if the equipment has been decontaminated subsequent to its last usage. Additionally, decontaminate each piece of equipment used at the site prior to leaving the site. It is only necessary to decontaminate dedicated sampling equipment prior to installation within the well. Do not place clean sampling equipment directly on the ground or other contaminated surfaces prior to insertion into the well. Dedicated sampling equipment that has been certified by the manufacturer as being decontaminated can be placed in the well without on-site decontamination.

8.2.3 Measurement of Static Water Level Elevation

Before purging the well, measure water levels in all of the wells within the zone of influence of the well being purged. The best practice, if possible, is to measure all site wells (or wells within the monitoring well network) prior to sampling. If the well cap is not vented, remove the cap several minutes before measurement to allow water levels to equilibrate to atmospheric pressure.

Measure the depth to standing water and the total depth of the well to the nearest 0.01 foot to provide baseline hydrologic data, to calculate the volume of water in the well, and to provide information on the integrity of the well (e.g., identification of siltation problems). If not already present, mark an easily identified reference point for water level measurements which will become the measuring point for all water level measurements. This location and elevation must be surveyed.

The device used to measure the water level surface and depth of the well shall be sufficiently sensitive and accurate in order to obtain a measurement to the nearest 0.01 foot reliably. An electronic water level meter will usually be appropriate for this measurement; however, when the groundwater within a particular well is highly contaminated, an inexpensive weighted tape measure can be used to determine well depth to prevent adsorption of contaminants onto the meter tape. The presence of light, non-aqueous phase liquids (LNAPLs) and/or dense, non-aqueous phase liquids (DNAPLs) in a well requires measurement of the elevation of the top and the bottom of the product, generally using an interface probe. Water levels in such wells must then be corrected for density effects to accurately determine the elevation of the water table.

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At each location, measure water levels several times in quick succession to ensure that the well has equilibrated to atmospheric conditions prior to recording the measurement. As stated above, measure all site wells (or wells within the monitoring well network) prior to sampling whenever possible. This will provide a water level database that describes water levels across the site at one time (a synoptic sampling). Prior to sampling, measure the water level in each well immediately prior to purging the well to ascertain that static conditions have been achieved prior to sampling.

8.2.4 Detection of Immiscible Phase Layers

Complete the following steps for detecting the presence of LNAPL and DNAPL before the well is purged for conventional sampling. These procedures may not be required for all wells. Consult the project-specific SAP to determine if assessing the presence of LNAPL and/or DNAPL is necessary.

1) Sample the headspace in the wellhead immediately after the well is opened for organic vapors using either a PID or an organic vapor analyzer, and record the measurements.
2) Lower an interface probe into the well to determine the existence of any immiscible layer(s), LNAPL and/or DNAPL, and record the measurements.
3) Confirm the presence or absence of an immiscible phase by slowly lowering a clear bailer to the appropriate depth, then visually observing the results after sample recovery.
4) In rare instances, such as when very viscous product is present, it may be necessary to utilize hydrocarbon- and water-sensitive pastes for measurement of LNAPL thickness. This is accomplished by smearing adjacent, thin layers of both hydrocarbon- and water-sensitive pastes along a steel measuring tape and inserting the tape into the well. An engineering tape showing tenths and hundredths of feet is required. Record depth to water, as shown by the mark on the water-sensitive paste, and depth to product, as shown by the mark on the product-sensitive paste. In wells where the approximate depth to water and product thickness are not known, it is best to apply both pastes to the tape over a fairly long interval (5 feet or more). Under these conditions, measurements are obtained by trial and error and may require several insertions and retrievals of the tape before the paste-covered interval of the tape encounters product and water. In wells where approximate depths of air-product and product-water interfaces are known, pastes may be applied over shorter intervals. Water depth measurements should not be used in preparation of water table contour maps until they are corrected for depression by the product.
5) If the well contains an immiscible phase, it may be desirable to sample this phase separately. Section 8.2.6 presents immiscible phase sampling procedures. It may not be meaningful to conduct water sample analysis of water obtained from a well containing LNAPLs or DNAPLs. Consult the **CTO Manager** and **Program Quality Manager** if this situation is encountered.

8.2.5 Purging Equipment and Use

General Requirements

The water present in a well prior to sampling may not be representative of in situ groundwater quality and shall be removed prior to sampling. Handle all groundwater removed from potentially contaminated wells in accordance with the IDW handling procedures in SOP 3-05, IDW Management. Purging shall be accomplished by methods as indicated in the project-specific SAP or by those required by State requirements. For the purposes of this SOP, purging methods will be described by removing groundwater from the well using low-flow techniques.

According to the U.S. Environmental Protection Agency (EPA) (EPA, 1996), the rate at which groundwater is removed from the well during purging ideally should be less than 0.2 to 0.3 liters/minute. EPA further states that wells should be purged at rates below those used to develop the well to prevent further development of the well, to prevent damage to the well, and to avoid disturbing accumulated

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corrosion or reaction products in the well. EPA also indicates that wells should be purged at or below their recovery rate so that migration of water in the formation above the well screen does not occur.

Realistically, the purge rate should be low enough that substantial drawdown in the well does not occur during purging. In addition, a low purge rate will reduce the possibility of stripping volatile organic compounds (VOCs) from the water, and will reduce the likelihood of increasing the turbidity of the sample due to mobilizing colloids in the subsurface that are immobile under natural flow conditions.

The field sampler shall ensure that purging does not cause formation water to cascade down the sides of the well screen. Wells should not be purged to dryness if recharge causes the formation water to cascade down the sides of the screen, as this will cause an accelerated loss of volatiles. This problem should be anticipated based on the results of either the well development task or historical sampling events. In general, place the intake of the purge pump in the middle of the saturated screened interval within the well to allow purging and at the same time minimize disturbance/overdevelopment of the screened interval in the well. Water shall be purged from the well at a rate that does not cause recharge water to be excessively agitated unless an extremely slow recharging well is encountered where complete evacuation is unavoidable. During the well purging procedure, collect water level and/or product level measurements to assess the hydraulic effects of purging. Sample the well when it recovers sufficiently to provide enough water for the analytical parameters specified. If the well is purged dry, allow the well to recover sufficiently to provide enough water for the specified analytical parameters, and then sample it.

Evaluate water samples on a regular basis during well purging and analyze them in the field preferably using in-line devices (i.e., flow through cell) for temperature, pH, specific conductivity, dissolved oxygen (DO), and oxidation-reduction (redox) potential. Turbidity should be measured separately (outside of the flow-through cell) with a nephelometer or similar device.

Readings should be taken every 2 to 5 minutes during the purging process. These parameters are measured to demonstrate that the natural character of the formation waters has been restored.

Purging shall be considered complete per the requirements set forth in the project-specific SAP, State requirements, or when three consecutive field parameter measurements of temperature, pH, specific conductivity, DO and ORP stabilize within approximately 10 percent and the turbidity is at or below 10 nephelometric turbidity units (NTU) or within ± 10% if above 10 NTU. This criterion may not be applicable to temperature if a submersible pump is used during purging due to the heating of the water by the pump motor. Enter all information obtained during the purging and sampling process into a groundwater sampling log. Attachment 1 shows an example of a groundwater sampling log and the information typically included in the form. Whatever form is used, all blanks need to be completed on the field log during field sampling.

Groundwater removed during purging shall be stored according to the project-specific SAP or per SOP 3-05, IDW Management.

Purging Equipment and Methods

Submersible Pump

A stainless steel submersible pump may be utilized for purging both shallow and deep wells prior to sampling the groundwater for semivolatile and non-volatile constituents, but are generally not preferred for VOCs unless there are no other options (e.g., well over 200 feet deep). For wells over 200 feet deep, the submersible pump is one of the few technologies available to feasibly accomplish purging under any yield conditions. For shallow wells with low yields, submersible pumps are generally inappropriate due to overpumpage of the wells (<1 gallon per minute), which causes increased aeration of the water within the well.

Steam clean or otherwise decontaminate the pump and discharge tubing prior to placing the pump in the well. The submersible pump shall be equipped with an anti-backflow check valve to limit the amount of

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water that will flow back down the drop pipe into the well. Place the pump in the middle of the saturated screened interval within the well and maintain it in that position during purging.

Bladder Pump

A stainless steel bladder pump can be utilized for purging and sampling wells up to 200 feet in depth for volatile, semivolatile, and non-volatile constituents. Use of the bladder pump is most effective in low to moderate yield wells and are often the preferred method for low-flow sampling. When sampling for VOCs and/or SVOCs, Teflon bladders should be used. Polyethylene bladders may be used when sampling for inorganics.

Either compressed dry nitrogen or compressed dry air, depending upon availability, can operate the bladder pump. The driving gas utilized must be dry to avoid damage to the bladder pump control box. Decontaminate the bladder pump prior to use.

Centrifugal, Peristaltic, or Diaphragm Pump

A centrifugal, peristaltic, or diaphragm pump may be utilized to purge a well if the water level is within 20 feet of ground surface. New or dedicated tubing is inserted into the midpoint of the saturated screened interval of the well. Water should be purged at a rate that satisfies low-flow requirements (i.e., does not cause drawdown). Centrifugal, peristaltic, or diaphragm pump are generally discouraged for VOCs sampling; however, follow methods allowed per the project-specific SAP or State requirements.

Air Lift Pump

Airlift pumps are not appropriate for purging or sampling.

Bailer

Avoid using a bailer to purge a well because it can result in overdevelopment of the well and create excessive purge rates. If a bailer must be used, the bailer should either be dedicated or disposable. Teflon-coated cable mounted on a reel is recommended for lowering the bailer in and out of the well.

Lower the bailer below the water level of the well with as little disturbance of the water as possible to minimize aeration of the water in the well. One way to gauge the depth of water on the reel is to mark the depth to water on the bailer wire with a stainless steel clip. In this manner, less time is spent trying to identify the water level in the well.

8.2.6 Monitoring Well Sampling Methodologies

Sampling Light, Non-Aqueous Phase Liquids (LNAPL)

Collect LNAPL, if present, prior to any purging activities. The sampling device shall generally consist of a dedicated or disposable bailer equipped with a bottom-discharging device. Lower the bailer slowly until contact is made with the surface of the LNAPL, and to a depth less than that of the immiscible fluid/water interface depth as determined by measurement with the interface probe. Allow the bailer to fill with LNAPL and retrieve it.

When sampling LNAPLs, never drop bailers into a well and always remove them from the well in a manner that causes as little agitation of the sample as possible. For example, the bailer should not be removed in a jerky fashion or be allowed to continually bang against the well casing as it is raised. Teflon bailers should always be used when sampling LNAPL. The cable used to raise and lower the bailer shall be composed of an inert material (e.g., stainless steel) or coated with an inert material (e.g., Teflon).

Sampling Dense, Non-Aqueous Phase Liquids (DNAPL)

Collect DNAPL prior to any purging activities. The best method for collecting DNAPL is to use a double-check valve, stainless steel bailer, or a Kemmerer (discrete interval) sampler. The sample shall be collected by slow, controlled lowering of the bailer to the bottom of the well, activation of the closing device, and retrieval.

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Groundwater Sampling Methodology

The well shall be sampled when groundwater within it is representative of aquifer conditions per the methods described in Section 8.2.5. Prior to sampling the flow-through cell shall be removed and the samples collected directly from the purge tubing. Flow rates shall not be adjusted once aquifer conditions are met. Additionally, a period of no more than 2 hours shall elapse between purging and sampling to prevent groundwater interaction with the casing and atmosphere. This may not be possible with a slowly recharging well. Measure and record the water level prior to sampling in order to monitor drawdown when using low-flow techniques and gauge well volumes removed and recharged when using non-low-flow techniques.

Sampling equipment (e.g., especially bailers) shall never be dropped into the well, as this could cause aeration of the water upon impact. Additionally, the sampling methodology utilized shall allow for the collection of a groundwater sample in as undisturbed a condition as possible, minimizing the potential for volatilization or aeration. This includes minimizing agitation and aeration during transfer to sample containers, minimizing exposure to sunlight, and immediately placing the sample on ice once collected.

Sampling equipment shall be constructed of inert material. Equipment with neoprene fittings, polyvinyl chloride (PVC) bailers, Tygon® tubing, silicon rubber bladders, neoprene impellers, polyethylene, and Viton® are not acceptable when sampling for organics. If bailers are used, an inert cable/chain (e.g., fluorocarbon resin-coated wire or stainless steel wire or cable) shall be used to raise and lower the bailer. Dedicated equipment is highly recommended for all sampling programs.

Submersible Pumps

The submersible pump must be specifically designed for groundwater sampling (i.e., pump composed of stainless steel and Teflon, sample discharge lines composed of Teflon) and must have a controller mechanism allowing the required low-flow rate. Adjust the pump rate so that flow is continuous and does not pulsate to avoid aeration and agitation within the sample discharge lines. Run the pump for several minutes at the low-flow rate used for sampling to ensure that the groundwater in the lines was obtained at the low-flow rate.

Bladder Pumps

A gas-operated stainless steel bladder pump with adjustable flow control and equipped with a Teflon bladder and Teflon-lined tubing can be effectively utilized to collect a groundwater sample and is considered to be the best overall device for sampling inorganic and organic constituents. If only inorganics are being sampled, polyvinyl bladders and tubing may be used. Operate positive gas displacement bladder pumps in a continuous manner so that they minimize discharge pulsation that can aerate samples in the return tube or upon discharge.

When using a compressor, take several precautions. If the compressor is being powered by a gasoline generator, position the generator downwind of the well. Ground fault circuit interrupters (GFCIs) should always be used when using electric powered equipment. Do not connect the compression hose from the compressor to the pump controller until after the engine has been started.

When all precautions are completed and the compressor has been started, connect the compression hose to the pump controller. Slowly adjust the control knobs to discharge water in the shortest amount of time while maintaining a near constant flow. This does not mean that the compressor must be set to discharge the water as hard as possible. The optimal setting is one that produces the largest volume of purge water per minute (not per purge cycle) while maintaining a near constant flow rate.

Prior to sampling, adjust the flow rate (purge rate) to yield 100 to 300 mL/minute. Avoid settings that produce pulsating streams of water instead of a steady stream if possible. Operate the pump at this low flow rate for several minutes to ensure that drawdown is not occurring. At no time shall the sample flow rate exceed the flow rate used while purging.

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For those samples requiring filtration, it is recommended to use an in-line high capacity filter after all non-filtered samples have been collected.

***Peristaltic Pumps*:**

A peristaltic pump is a type of positive displacement pump that moves water via the process of peristalsis. The pump uses a flexible hose fitted inside a circular pump casing. A rotor with cams compresses the flexible tube as the rotor turns, which forces the water to be pumped to move through the tube. In peristaltic pumps, no moving parts of the pump are in contact with the water being pumped. Displacement is determined by tube size, so delivery rate can only be changed during operation by varying pump speed. Peristaltic pumps are simple and quite inexpensive for the flow rates they provide.

There are several methods available for transferring the sample into the laboratory containers. The selected method may vary based on State requirements and should be documented in the project-specific SAP. Samples typically can be collected directly from the discharge end of the Teflon tubing, after it has been disconnected from the flow through cell. For volatile analyses, the sampler should make sure that the pump is set such that a smooth laminar flow is achieved. In all cases, the project team should consult their local regulatory requirements and document the selected sample collection procedure in the project-specific SAP.

Bailers

A single- or double-check valve Teflon or stainless steel bailer equipped with a bottom discharging device can be utilized to collect groundwater samples. Bailers have a number of disadvantages, however, including a tendency to alter the chemistry of groundwater samples due to degassing, volatilization, and aeration; the possibility of creating high groundwater entrance velocities; differences in operator techniques resulting in variable samples; and difficulty in determining where in the water column the sample was collected. Therefore, use bailers for groundwater sampling only when other types of sampling devices cannot be utilized for technical, regulatory, or logistical reasons.

Dedicated or disposable bailers should always be used in order to eliminate the need for decontamination and to limit the potential of cross-contamination. Each time the bailer is lowered to the water table, lower it in such a way as to minimize disturbance and aeration of the water column within the well.

8.2.7 Sample Handling and Preservation

Many of the chemical constituents and physiochemical parameters to be measured or evaluated during groundwater monitoring programs are chemically unstable and require preservation. The U.S. EPA document entitled, *Test Methods for Evaluating Solid Waste – Physical/Chemical Methods (SW-846)* (EPA 1997), includes a discussion of appropriate sample preservation procedures. In addition, SW-846 provides guidance on the types of sample containers to use for each constituent or common set of parameters. In general, check with specific laboratory or State requirements prior to obtaining field samples. In many cases, the laboratory will supply the necessary sample bottles and required preservatives. In some cases, the field sampling personnel may add preservatives in the field.

Improper sample handling may alter the analytical results of the sample. Therefore, transfer samples in the field from the sampling equipment directly into the container that has been prepared specifically for that analysis or set of compatible parameters as described in the project-specific SAP. It is not an acceptable practice for samples to be composited in a common container in the field and then split in the laboratory, or poured first into a wide mouth container and then transferred into smaller containers.

Collect groundwater samples and place them in their proper containers in the order of decreasing volatility and increasing stability. A preferred collection order for some common groundwater parameters is:

1. VOCs and total organic halogens (TOX)

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2. Dissolved gases, total organic carbon (TOC), total fuel hydrocarbons
3. Semivolatile organics, pesticides
4. Total metals, general minerals (unfiltered)
5. Dissolved metals, general minerals (filtered)
6. Phenols
7. Cyanide
8. Sulfate and chloride
9. Nitrate and ammonia
10. Radionuclides

When sampling for VOCs, collect water samples in vials or containers specifically designed to prevent loss of VOCs from the sample. The analytical laboratory performing the analysis shall provide these vials. Collect groundwater from the sampling device in vials by allowing the groundwater to slowly flow along the sides of the vial. Sampling equipment shall not touch the interior of the vial. Fill the vial above the top of the vial to form a positive meniscus with no overflow. No headspace shall be present in the sample container once the container has been capped. This can be checked by inverting the bottle once the sample is collected and tapping the side of the vial to dislodge air bubbles. Sometimes it is not possible to collect a sample without air bubbles, particularly water that has high concentrations of dissolved gasses. In these cases, the field sampling personnel shall document the occurrence in the field logbook and/or sampling worksheet at the time the sample was collected. Likewise, the analytical laboratory shall note in the laboratory analysis reports any headspace in the sample container(s) at the time of receipt by the laboratory.

Special Handling Considerations

In general, samples for organic analyses should not be filtered. However, high turbidity samples for PCB analysis may require filtering. Consult the project-specific SAP for details on filtering requirements. Samples shall not be transferred from one container to another because this could cause aeration or a loss of organic material onto the walls of the container. TOX and TOC samples should be handled in the same manner as VOC samples.

When collecting total and dissolved metals samples, the samples should be collected sequentially. The total metals sample is collected from the pump unfiltered. The dissolved metals sample is collected after filtering with a 0.45-micron membrane in-line filter. Allow at least 500 mL of effluent to flow through the filter prior to sampling to ensure that the filter is thoroughly wetted and seated in the filter capsule. If required by the project-specific SAP, include a filter blank for each lot of filters used and always record the lot number of the filters.

Field Sampling Preservation

Preserve samples immediately upon collection. Ideally, sampling containers will be pre-preserved with a known concentration and volume of preservative. Certain matrices that have alkaline pH (greater than 7) may require more preservative than is typically required. An early assessment of preservation techniques, such as the use of pH strips after initial preservation, may therefore be appropriate. Guidance for the preservation of environmental samples can be found in the U.S. EPA *Handbook for Sampling and Sample Preservation of Water and Wastewater* (EPA 1982). Additional guidance can be found in other U.S. EPA documents (EPA 1992, 1996).

Field Sampling Log

A groundwater sampling log provided as Attachment 1 shall document the following:

- Identification of well

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- Well depth
- Static water level depth and measurement technique
- Presence of immiscible layers and detection method
- Well yield
- Purge volume and pumping rate
- Time that the well was purged
- Sample identification numbers
- Well evacuation procedure/equipment
- Sample withdrawal procedure/equipment
- Date and time of collection
- Types of sample containers used
- Preservative(s) used
- Parameters requested for analysis
- Field analysis data
- Field observations on sampling event
- Name of sampler
- Weather conditions

9.0 Quality Control and Assurance

9.1 Field personnel will follow specific quality assurance (QA) guidelines as outlined in the project-specific SAP. The goal of the QA program should be to ensure precision, accuracy, representativeness, completeness, and comparability in the project sampling program.

9.2 Quality control (QC) requirements for sample collection are dependent on project-specific sampling objectives. The project-specific SAP will provide requirements for sample preservation and holding times, container types, sample packaging and shipment, as well as requirements for the collection of various QC samples such as trip blanks, field blanks, equipment rinse blanks, and field duplicate samples.

10.0 Data and records management

10.1 Records will be maintained in accordance with SOP 3-03, Recordkeeping, Sample Labelling, and Chain-of-Custody. Various forms are required to ensure that adequate documentation is made of the sample collection activities. These forms may include:

- Sample Collection Records;
- Field logbook;
- Chain-of-custody forms; and
- Shipping labels.

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10.2 Sample collection records (Attachment 1) will provide descriptive information for the purging process and the samples collected at each monitoring well.

10.3 The field logbook is kept as a general log of activities and should not be used in place of the sample collection record.

10.4 Chain-of-custody forms are transmitted with the samples to the laboratory for sample tracking purposes.

10.5 Shipping labels are required is sample coolers are to be transported to a laboratory by a third party (courier service).

11.0 Attachments or References

Attachment 1 – Groundwater Sampling Collection Record

ASTM Standard D5088. 2008. *Standard Practice for Decontamination of Field Equipment Used at Waste Sites.* ASTM International, West Conshohocken, PA. 2008. DOI: 10.1520/D5088-02R08. www.astm.org.

Environmental Protection Agency, United States (EPA). 1982. *Handbook for Sampling and Sample Preservation of Water and Wastewater.* EPA-600/4-82-029. Cincinnati: EPA Office of Research and Development, Environmental Monitoring and Support Laboratory.

EPA. 1992. *RCRA Groundwater Monitoring Draft Technical Guidance*. EPA/530/R-93/001. Office of Solid Waste. November.

EPA. 1996. *Ground Water Issue: Low-Flow (Minimal Drawdown) Ground-Water Sampling Procedures*. EPA/540/S-95/504. Office of Solid Waste and Emergency Response. April.

EPA. 1997. *Test Methods for Evaluating Solid Waste, Physical/Chemical Method (SW-846)*. 3rd ed., Final Update IIIA. Office of Solid Waste. Online updates at: http://www.epa.gov/epaoswer/hazwaste/test/new-meth.htm.

NAVSEA T0300-AZ-PRO-010. *Navy Environmental Compliance Sampling and Field Testing Procedures Manual*. August 2009.

SOP 3-03, *Recordkeeping, Sample Labelling, and Chain-of-Custody*.

SOP 3-05, *IDW Management.*

SOP 3-06, *Equipment Decontamination*.

Author	*Reviewer*	*Revisions (Technical or Editorial)*
Mark Kromis Program Chemist	Chris Barr Program Quality Manager	Rev 0 – Initial Issue (May 2012)

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Attachment 1
Groundwater Sample Collection Record

Well ID:

Groundwater Sample Collection Record

Client: _____ Date: _____ Time: Start _____ am/pm
Project No: _____ Finish _____ am/pm
Site Location: _____
Weather Conds: _____ Collector(s): _____

1. WATER LEVEL DATA: (measured from Top of Casing)

a. Total Well Length _____ **c.** Length of Water Column _____ (a-b)

Casing Diameter/Material _____

b. Water Table Depth _____ **d.** Calculated Well Volume (see back) _____

2. WELL PURGEABLE DATA

a. Purge Method: _____

b. Acceptance Criteria defined (see SAP or Work Plan)
- Minimum Required Purge Volume (@ _____ well volumes) _____
- Maximum Allowable Turbidity _____ NTUs
- Stabilization of parameters _____ %

c. Field Testing Equipment used: Make Model Serial Number

Time (min)	Volume Removed (gal)	Temp. (°C)	pH s.u.	Spec. Cond. (µS/cm)	DO (mg/L)	ORP (mV)	Turbidity (NTU)	Flow Rate (ml/min)	Drawdown (m)	Color/Odor/etc.

d. Acceptance criteria pass/fail

	Yes	No	N/A
Has required volume been removed	☐	☐	☐
Has required turbidity been reached	☐	☐	☐
Have parameters stabilized	☐	☐	☐

(continued on back)

If no or N/A - Explain below.

_____

3. SAMPLE COLLECTION: Method: _____

Sample ID	Container Type	No. of Containers	Preservation	Analysis Req.	Time

Comments _____

Signature _____ Date _____

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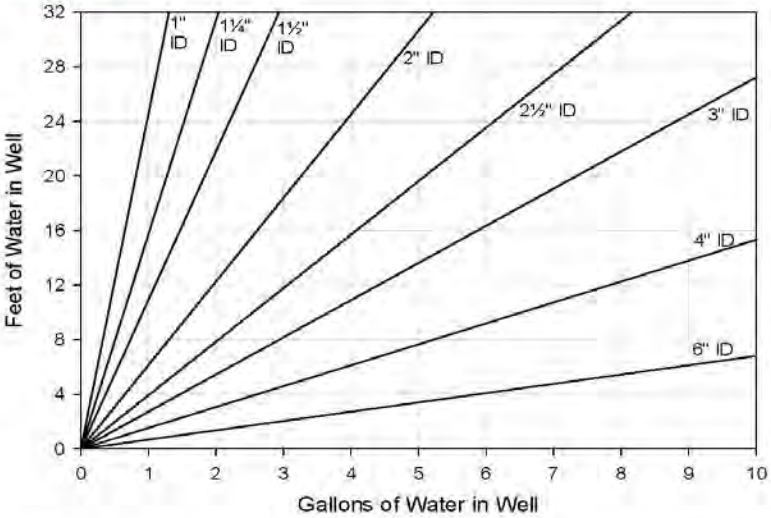
Purge Volume Computation

Well ID:



Volume / Linear Ft. of Pipe		
ID (in)	Gallon	Liter
¼	0.0025	0.0097
⅜	0.0057	0.0217
½	0.0102	0.0386
¾	0.0229	0.0869
1	0.0408	0.1544
1¼	0.0637	0.2413
1½	0.0918	0.3475
2	0.1632	0.6178
2½	0.2550	0.9653
3	0.3672	1.3900
4	0.6528	2.4711
6	1.4688	5.5600

(continued from front)

Time (min)	Volume Removed (gal)	Temp. (°C)	pH s.u.	Spec. Cond. (µS/cm)	DO (mg/L)	ORP (mV)	Turbidity (NTU)	Flow Rate (ml/min)	Drawdown (m)	Color/Odor/etc.

Signature _____ Date _____

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Soil and Rock Classification

Procedure 3-16

1.0 Purpose and Scope

1.1 The purpose of this document is to define the standard operating procedure (SOP) to thoroughly describe the physical characteristics of the sample and classify it according to the Unified Soil Classification System (USCS).

1.2 This procedure is the Program-approved professional guidance for work performed by Resolution Consultants under the Comprehensive Long-Term Environmental Action Navy (CLEAN) contract (Contract Number N62470-11-D-8013).

1.3 As guidance for specific activities, this procedure does not obviate the need for professional judgment. Deviations from this procedure while planning or executing planned activities must be approved in accordance with Program requirements for technical planning and review. If there are procedures whether it be from Resolution Consultants, state and/or federal that are not addressed in this SOP and are applicable to surface water sampling then those procedures may be added as an appendix to the project specific SAP.

1.4 It is fully expected that the procedures outlined in this SOP will be followed. Procedural modifications may be warranted depending upon field conditions, equipment limitations, or limitations imposed by the procedure. Substantive modification to this SOP will be approved in advance by the Program Quality Manager. Deviations to this SOP will be documented in the field records.

2.0 Safety

2.1 Depending upon the site-specific contaminants, various protective programs must be implemented prior to sampling. All **field sampling personnel** responsible for sampling activities must review the project-specific health and safety plan (HASP) paying particular attention to the control measures planned for the sampling tasks. Conduct preliminary area monitoring to determine the potential hazard to field sampling personnel. If significant contamination is observed, minimize contact with potential contaminants in both the vapor and liquid phase through the use of respirators and disposable clothing.

2.2 In addition, observe standard health and safety practices according to the project-specific HASP. Suggested minimum protection during well sampling activities includes inner disposable vinyl gloves, outer chemical-protective nitrile gloves, rubberized steel-toed boots, and an American National Standards Institute-standard hard hat. Half-face respirators and cartridges and Tyvek® suits may be necessary depending on the contaminant concentrations, and shall always be available on site.

2.3 Daily safety briefs will be conducted at the start of each working day before any work commences. These daily briefs will be facilitated by the **Site Safety Officer (SSO)** or designee to discuss the day's events and any potential health risk areas covering every aspect of the work to be completed. Weather conditions are often part of these discussions. As detailed in the HASP, everyone on the field team has the authority to stop work if an unsafe condition is perceived until the conditions are fully remedied to the satisfaction of the SSO.

2.4 The health and safety considerations for the work associated with soil classification include:

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- At no time during classification activities are personnel to reach for debris near machinery that is in operation, place any samples in their mouth, or come in contact with the soils/rocks without the use of gloves.
- Stay clear of all moving equipment and be aware of pinch points on machinery. Avoid wearing loose fitting clothing.
- When using cutting tools, cut away from yourself. The use of appropriate, task specific cutting tools is recommended.
- To avoid heat/cold stress as a results of exposure to extreme temperatures and PPE, drink electrolyte replacement fluids (1 to 2 cups per hour is recommended) and in case of extreme cold, wear insulating clothing.

3.0 Terms and Definitions

None.

4.0 Interference

None.

5.0 Training and Qualifications

5.1 The **Contract Task Order (CTO) Manager** is responsible for ensuring that the soil and rock classification procedures comply with this procedure. The **CTO Manager** is responsible for ensuring that all personnel involved in soil and rock classification shall have the appropriate education, experience, and training to perform their assigned tasks.

5.2 The **Program Quality Manager** is responsible for ensuring overall compliance with this procedure.

5.3 The **Field Manager** is responsible for ensuring that all project **field personnel** follow these procedures.

5.4 Field personnel are responsible for the implementation of this procedure. Minimum qualifications for **field sampling personnel** require that one individual on the field team shall have a minimum of 6 months of experience with soil and rock classification.

5.5 The **project geologist** and/or **task manager** is responsible for directly supervising the soil and rock classification procedures to ensure that they are conducted according to this procedure, and for recording all pertinent data collected. If deviations from the procedure are required because of anomalous field conditions, they must first be approved by the **Program Quality Manager** and then documented in the field logbook and associated report or equivalent document.

6.0 Equipment and Supplies

6.1 The following equipment list contains materials which may be needed in carrying out the procedures outlined in this SOP. Not all equipment listed below may be necessary for a specific activity. Additional equipment may be required, pending field conditions.

- Personal protective equipment (PPE) and other safety equipment, as required by the HASP
- Field log book and pen with indelible ink
- Boring log

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- Munsell Soil Color Chart
- Scoopula, spatula, and/or other small hand tools
- California Sampler
- Hand-held penetrometer

7.0 Calibration or Standardization

None.

8.0 Procedure

8.1 Soil Classification

The basic purpose of the classification of soil is to thoroughly describe the physical characteristics of the sample and to classify it according to an appropriate soil classification system. The USCS was developed so that soils could be described on a common basis by different investigators and serve as a "shorthand" description of soil. A classification of a soil in accordance with the USCS includes not only a group symbol and name, but also a complete word description.

Describing soil on a common basis is essential so that soil described by different site qualified personnel is comparable. Site individuals describing soil as part of site activities *must* use the classification system described herein to provide the most useful geologic database for all present and future subsurface investigations and remedial activities.

The site geologist or other qualified individual shall describe the soil and record the description in a boring log, logbook, and/or electronic field data collection device. The essential items in any written soil description are as follows:

- Classification group name (e.g., silty sand)
- Color, moisture, and odor
- Range of particle sizes and maximum particle size
- Approximate percentage of boulders, cobbles, gravel, sand, and fines
- Plasticity characteristics of the fines
- In-place conditions, such as consistency, density, and structure
- USCS classification symbol

The USCS serves as ”shorthand“ for classifying soil into 15 basic groups:

GW[1] Well graded (poorly sorted) gravel (>50 percent gravel, <5percent fines)

GP[1] Poorly graded (well sorted) gravel (>50percent gravel, <5percent fines)

GM[1] Silty gravel (>50 percent gravel, >15 percent silt)

GC[1] Clayey gravel (>50 percent gravel, >15 percent clay)

SW[1] Well graded (poorly sorted) sand (>50 percent sand, <5 percent fines)

SP[1] Poorly graded (well sorted) sand (>50 percent sand, <5 percent fines)

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[1] If percentage of fine is 5 percent to 15 percent, a dual identification shall be given (e.g., a soil with more than 50 percent poorly sorted gravel and 10 percent clay is designated GW-GC.

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SM[1] Silty sand (>50 percent sand, >15 percent silt)

SC[1] Clayey sand (>50 percent sand, >15 percent clay)

ML[2] Inorganic, low plasticity silt (slow to rapid dilatancy, low toughness, and plasticity)

CL[2] Inorganic, low plasticity (lean) clay (no or slow dilatancy, medium toughness and plasticity)

MH[2] Inorganic elastic silt (no to slow dilatancy, low to medium toughness and plasticity)

CH[2] Inorganic, high plasticity (fat) clay (no dilatancy, high toughness, and plasticity)

OL Organic low plasticity silt or organic silty clay

OH Organic high plasticity clay or silt

PT Peat and other highly organic soil

Figure8-1 defines the terminology of the USCS. Flow charts presented in Figure 8-2 and indicate the process for describing soil. The particle size distribution and the plasticity of the fines are the two properties of soil used for classification. In some cases, it may be appropriate to use a borderline classification (e.g., SC/CL) if the soil has been identified as having properties that do not distinctly place the soil into one group.

8.1.1 Estimation of Particle Size Distribution

One of the most important factors in classifying a soil is the estimated percentage of soil constituents in each particle size range. Being proficient in estimating this factor requires extensive practice and frequent checking. The steps involved in determining particle size distribution are listed below:

1. Select a representative sample (approximately 1/2 of a 6-inch long by 2.5-inch diameter sample liner).
2. Remove all particles larger than 3 inches from the sample. Estimate and record the percent by volume of these particles. Only the fraction of the sample smaller than 3 inches is classified.
3. Estimate and record the percentage of dry mass of gravel (less than 3 inches and greater than 1/4 inch).
4. Considering the rest of the sample, estimate, and record the percentage of dry mass of sand particles (about the smallest particle visible to the unaided eye).
5. Estimate and record the percentage of dry mass of fines in the sample (do not attempt to separate silts from clays).
6. Estimate percentages to the nearest 5 percent. If one of the components is present in a quantity considered less than 5 percent, indicate its presence by the term “trace”.
7. The percentages of gravel, sand, and fines must add up to 100 percent. “Trace” is not included in the 100 percent total.

8.1.2 Soil Dilatancy, Toughness, and Plasticity

8.1.2.1 Dilatancy

To evaluate dilatancy, follow these procedures:

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[2] If the soil is estimated to have 15 percent to 25 percent sand or gravel, or both, the words “with sand” or “with gravel” (whichever predominates) shall be added to the group name (e.g., clay with sand, CL; or silt with gravel, ML). If the soil is estimated to have 30 percent or more sand or gravel, or both, the words “sandy” or “gravely” (whichever predominates) shall be added to the group name (e.g., sandy clay, CL). If the percentage of sand is equal to the percent gravel, use “sandy.”

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1. From the specimen, select enough material to mold into a ball about 1/2 inch (12 millimeters [mm]) in diameter. Mold the material, adding water if necessary, until it has a soft, but not sticky, consistency.
2. Smooth the soil ball in the palm of one hand with the blade of a knife or small spatula. Shake horizontally, striking the side of the hand vigorously against the other hand several times. Note the reaction of water appearing on the surface of the soil. Squeeze the sample by closing the hand or pinching the soil between the fingers, and note the reaction as none, slow, or rapid in accordance with the criteria in Table 8-1. The reaction is the speed with which water appears while shaking, and disappears while squeezing.

Table 8-1: Criteria for Describing Dilatancy

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

8.1.2.2 Toughness

Following the completion of the dilatancy test, shape the test specimen into an elongated pat and roll it by hand on a smooth surface or between the palms into a thread about 1/8 inch (3 mm) in diameter. (If the sample is too wet to roll easily, spread it into a thin layer and allow it to lose some water by evaporation.) Fold the sample threads and re-roll repeatedly until the thread crumbles at a diameter of about 1/8 inch. The thread will crumble at a diameter of 1/8 inch when the soil is near the plastic limit. Note the pressure required to roll the thread near the plastic limit. Also, note the strength of the thread. After the thread crumbles, lump the pieces together and knead it until the lump crumbles. Note the toughness of the material during kneading. Describe the toughness of the thread and lump as low, medium, or high in accordance with the criteria in Table 8-2.

Table 8-2: Criteria for Describing Toughness

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

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DEFINITION OF TERMS

MAJOR DIVISIONS			SYMBOLS	TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS More Than Half of Material is Larger Than No. 200 Sieve Size	GRAVELS More Than Half of Coarse Fraction is Smaller Than No. 4 Sieve	CLEAN GRAVELS (Less than 6% Fines)	GW	Well graded gravels, gravel-sand mixtures, little or no fines
			GP	Poorly graded gravels, gravel-sand mixtures, little or no fines
		GRAVELS With Fines	GM	Silty gravels, gravel-sand-silt mixtures, non-plastic fines
			GC	Clayey gravels, gravel-sand-clay mixtures, plastic fines
	SANDS More Than Half of Coarse Fraction is Smaller Than No. 4 Sieve	CLEAN SANDS (Less than 6% Fines)	SW	Well graded sands, gravelly sands, little or no fines
			SP	Poorly graded sands, gravelly sands, little or no fines
		SANDS With Fines	SM	Silty sands, sand-silt mixtures, non-plastic fines
			SC	Clayey sands, sand-clay mixtures, plastic fines
FINE GRAINED SOILS More Than Half of Material is Smaller Than No. 200 Sieve Size	SILTS AND CLAYS Liquid Limit is Less Than 50%		ML	Inorganic silts, rock flour, fine sandy silts or clays, and clayey silts with non- or slightly-plastic fines
			CL	Inorganic clays of low to medium plasticity, gravelly clays, silty clays, sandy clays, lean clays
			OL	Organic silts and organic silty clays of low plasticity
	SILTS AND CLAYS Liquid Limit is Greater Than 50%		MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts, clayey silt
			CH	inorganic clays of high plasticity, fat clays
			OH	Organic clays of medium to high plasticity, organic silts
HIGHLY ORGANIC SOILS			PT	Peat and other highly organic soils

GRAIN SIZES

SILTS AND CLAYS	SAND			GRAVEL		COBBLES	BOULDERS
	FINE	MEDIUM	COARSE	FINE	COARSE		

200 40 10 4 3/4" 3" 12"

U.S. STANDARD SERIES SIEVE — CLEAR SQUARE SIEVE OPENINGS

Figure8-1: Unclassified Soil Classification System (USCS)

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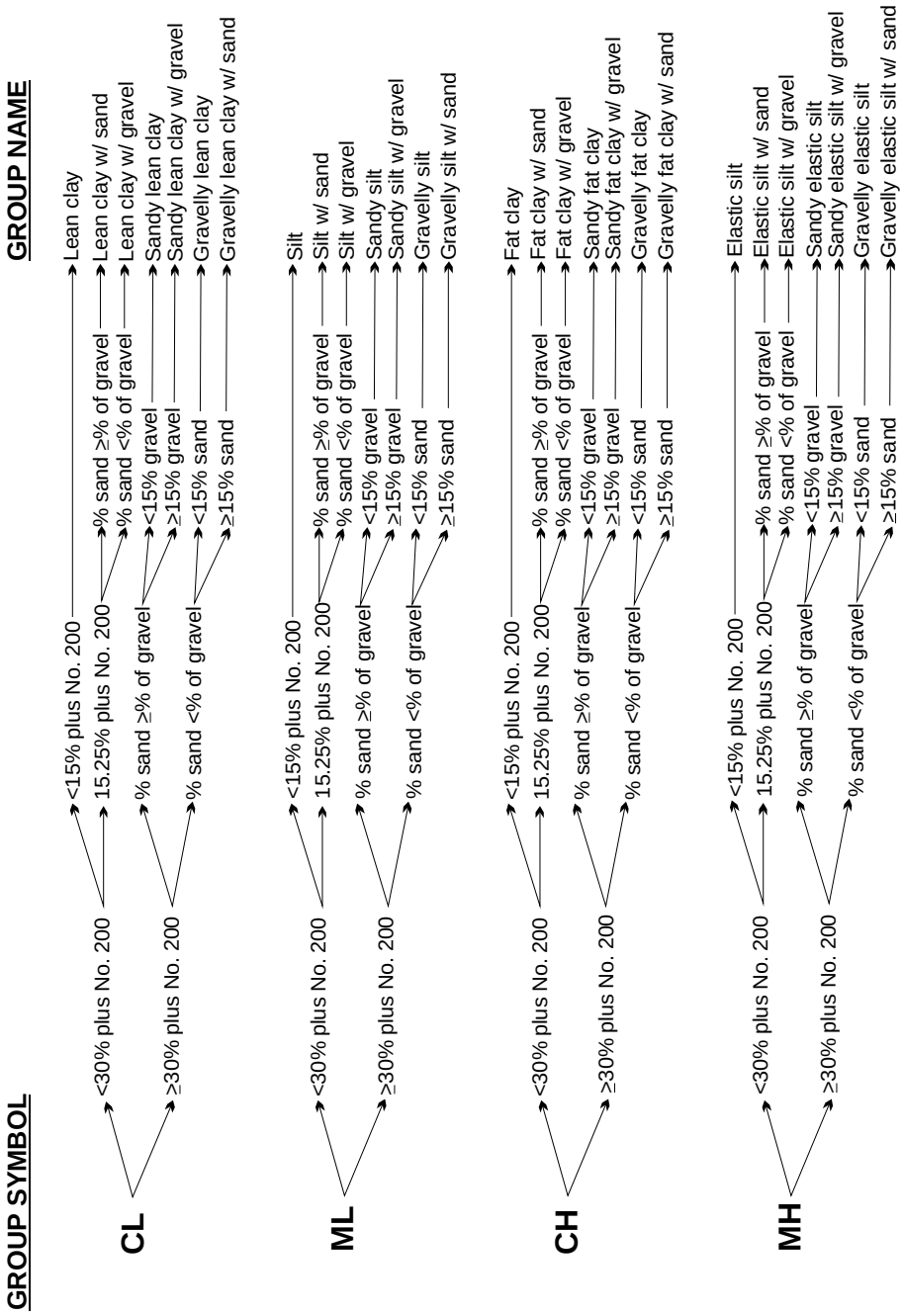

Figure 8-2: Flow Chart for Fine Grain Soil Classification

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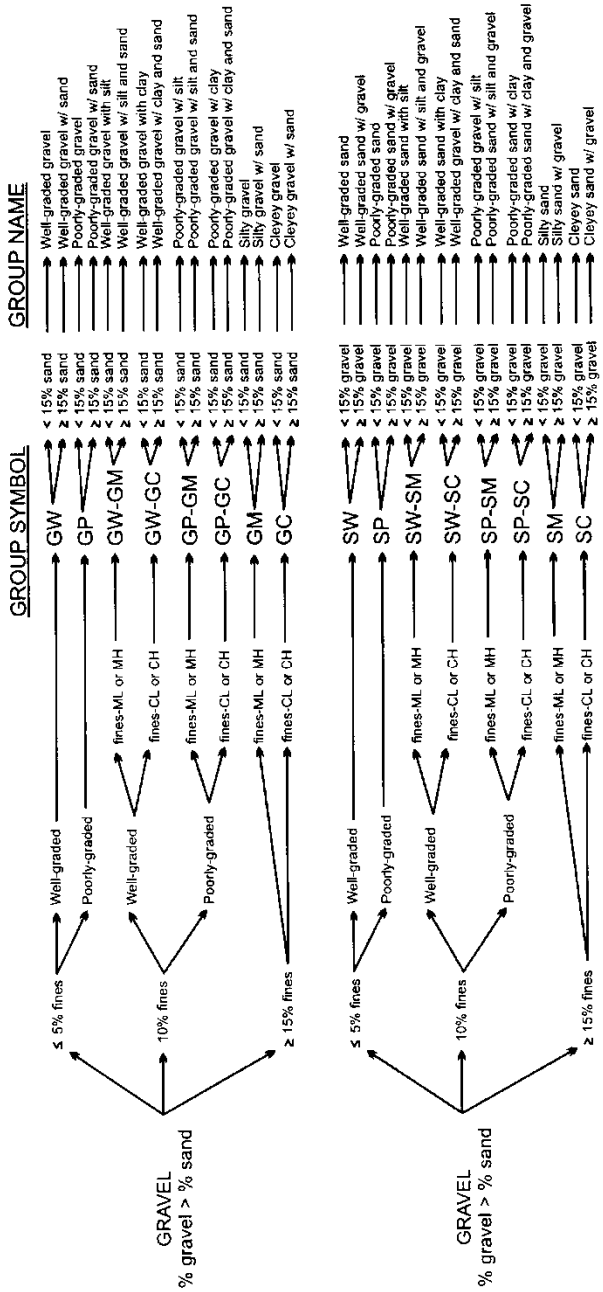

Figure 8-3: Flow Chart for Soil with Gravel

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8.1.2.3 Plasticity

The plasticity of a soil is defined by the ability of the soil to deform without cracking, the range of moisture content over which the soil remains in a plastic state, and the degree of cohesiveness at the plastic limit. The plasticity characteristic of clays and other cohesive materials is defined by the liquid limit and plastic limit. The liquid limit is defined as the soil moisture content at which soil passes from the liquid to the plastic state as moisture is removed. The test for the liquid limit is a laboratory, not a field, analysis.

The plastic limit is the soil moisture content at which a soil passes from the plastic to the semi-solid state as moisture is removed. The plastic limit test can be performed in the field and is indicated by the ability to roll a 1/8-inch (0.125-inch) diameter thread of fines, the time required to roll the thread, and the number of times the thread can be re-rolled when approaching the plastic limit.

The plasticity tests are not based on natural soil moisture content, but on soil that has been thoroughly mixed with water. If a soil sample is too dry in the field, add water prior to performing classification. If a soil sample is too sticky, spread the sample thin and allow it to lose some soil moisture.

Table 8-3 presents the criteria for describing plasticity in the field using the rolled thread method.

Table 8-3: Criteria for Describing Plasticity

Description	Criteria
Non-Plastic	A 1/8-inch thread cannot be rolled.
Low Plasticity	The thread can barely be rolled.
Medium Plasticity	The thread is easy to roll and not much time is required to reach the plastic limit.
High Plasticity	It takes considerable time rolling the thread to reach the plastic limit.

8.1.3 Angularity

The following criteria describe the angularity of the coarse sand and gravel particles:

- **Rounded** particles have smoothly-curved sides and no edges.
- **Subrounded** particles have nearly plane sides, but have well-rounded corners and edges.
- **Subangular** particles are similar to angular, but have somewhat rounded or smooth edges.
- **Angular** particles have sharp edges and relatively plane sides with unpolished surfaces. Freshly broken or crushed rock would be described as angular.

8.1.4 Color, Moisture, and Odor

The natural moisture content of soil is very important. Table **8-4** shows the terms for describing the moisture condition and the criteria for each.

Table 8-4: Soil Moisture Content Qualifiers

Qualifier	Criteria
Dry	Absence of moisture, dry to the touch
Moist	Damp but no visible water
Wet	Visible water, usually soil is below water table

Color is described by hue and chroma using the Munsell Soil Color Chart (Munsell 2000). For uniformity, all site geologists shall utilize this chart for soil classification. Doing so will facilitate correlation of geologic units between boreholes logged by different geologists. The Munsell Color Chart is a small booklet of numbered color chips with names like “5YR 5/6, yellowish-red.” Note mottling or banding of colors. It is particularly important to note and describe staining because it may indicate contamination.

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In general, wear a respirator if strong organic odors are present. If odors are noted, describe them if they are unusual or suspected to result from contamination. An organic odor may have the distinctive smell of decaying vegetation. Unusual odors may be related to hydrocarbons, solvents, or other chemicals in the subsurface. An organic vapor analyzer may be used to detect the presence of volatile organic contaminants.

8.1.5 In-Place Conditions

Describe the conditions of undisturbed soil samples in terms of their density/consistency (i.e., compactness), cementation, and structure utilizing the following guidelines:

8.1.5.1 Density/Consistency

Density and consistency describe a physical property that reflects the relative resistance of a soil to penetration. The term “density” is commonly applied to coarse to medium-grained sediments (i.e., gravels, sands), whereas the term “consistency” is normally applied to fine-grained sediments (i.e., silts, clays). There are separate standards of measure for both density and consistency that are used to describe the properties of a soil.

The density or consistency of a soil is determined by observing the number of blows required to drive a 1 3/8-inch (35 mm) diameter split barrel sampler 18 inches using a drive hammer weighing 140 lbs (63.5 kilograms [kg]) dropped over a distance of 30 inches (0.76 meters). Record the number of blows required to penetrate each 6 inches of soil in the field boring log during sampling. The first 6 inches of penetration is considered to be a seating drive; therefore, the blow count associated with this seating drive is recorded, but not used in determining the soil density/consistency. The sum of the number of blows required for the second and third 6 inches of penetration is termed the “standard penetration resistance,” or the “N-value.” The observed number of blow counts must be corrected by an appropriate factor if a different type of sampling device (e.g., Modified California Sampler with liners) is used. For a 2 3/8-inch inner diameter (I.D.) Modified California Sampler equipped with brass or stainless steel liners and penetrating a cohesionless soil (sand/gravel), the N-value from the Modified California Sampler must be divided by 1.43 to provide data that can be compared to the 1 3/8-inch diameter sampler data.

For a cohesive soil (silt/clay), the N-value for the Modified California Sampler should be divided by a factor of 1.13 for comparison with 1 3/8-inch diameter sampler data.

Drive the sampler and record blow counts for each 6-inch increment of penetration until one of the following occurs:

- A total of 50 blows have been applied during any one of the three 6-inch increments; a 50-blow count occurrence shall be termed “refusal” and noted as such on the boring log.
- A total of 150 blows have been applied.
- The sampler is advanced the complete 18 inches without the limiting blow counts occurring, as described above.

If the sampler is driven less than 18 inches, record the number of blows per partial increment on the boring log. If refusal occurs during the first 6 inches of penetration, the number of blows will represent the N-value for this sampling interval. Table 8-5 and Table 8-6 present representative descriptions of soil density/consistency vs. N-values.

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Table 8-5: Measuring Soil Density with a California Sampler – Relative Density (Sands, Gravels)

Description	Field Criteria (N-Value)	
	1 3/8 in. ID Sampler	2 in. ID Sampler using 1.43 factor
Very Loose	0–4	0–6
Loose	4–10	6–14
Medium Dense	10–30	14–43
Dense	30–50	43–71
Very Dense	> 50	> 71

Table 8-6: Measuring Soil Density with a California Sampler – Fine Grained Cohesive Soil

Description	Field Criteria (N-Value)	
	1 3/8 in. ID Sampler	2 in. ID Sampler using 1.13 factor
Very Soft	0–2	0–2
Soft	2–4	2–4
Medium Stiff	4–8	4–9
Stiff	8–16	9–18
Very Stiff	16–32	18–36
Hard	> 32	> 36

For undisturbed fine-grained soil samples, it is also possible to measure consistency with a hand-held penetrometer. The measurement is made by placing the tip of the penetrometer against the surface of the soil contained within the sampling liner or shelby tube, pushing the penetrometer into the soil a distance specified by the penetrometer manufacturer, and recording the pressure resistance reading in pounds per square foot (psf). The values are as follows (Table 8-7):

Table 8-7: Measuring Soil Consistency with a Hand-Held Penetrometer

Description	Pocket Penetrometer Reading (psf)
Very Soft	0–250
Soft	250–500
Medium Stiff	500–1000
Stiff	1000–2000
Very Stiff	2000–4000
Hard	>4000

Consistency can also be estimated using thumb pressure using Table 8-8.

Table 8-8: Measuring Soil Consistency Using Thumb Pressure

Description	Criteria
Very Soft	Thumb will penetrate soil more than 1 inch (25 mm)
Soft	Thumb will penetrate soil about 1 inch (25 mm)
Firm	Thumb will penetrate soil about 1/4 inch (6 mm)
Hard	Thumb will not indent soil but readily indented with thumbnail
Very Hard	Thumbnail will not indent soil

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8.1.5.2 *Cementation*

Cementation is used to describe the friability of a soil. Cements are chemical precipitates that provide important information as to conditions that prevailed at the time of deposition, or conversely, diagenetic effects that occurred following deposition. Seven types of chemical cements are recognized by Folk (1980). They are as follows:

- Quartz – siliceous
- Chert – chert-cemented or chalcedonic
- Opal – opaline
- Carbonate – calcitic, dolomitic, sideritic (if in doubt, calcareous should be used)
- Iron oxides – hematitic, limonitic (if in doubt, ferruginous should be used)
- Clay minerals – if the clay minerals are detrital or have formed by recrystallization of a previous clay matrix, they are not considered to be a cement. Only if they are chemical precipitates, filling previous pore space (usually in the form of accordion-like stacks or fringing radial crusts) should they be included as “kaolin-cemented,” “chlorite-cemented,” etc.
- Miscellaneous minerals – pyritic, collophane-cemented, glauconite-cemented, gypsiferous, anhydrite-cemented, baritic, feldspar-cemented, etc.

The degree of cementation of a soil is determined qualitatively by utilizing finger pressure on the soil in one of the sample liners to disrupt the gross soil fabric. The three cementation descriptors are as follows:

- Weak – friable; crumbles or breaks with handling or slight finger pressure
- Moderate – friable; crumbles or breaks with considerable finger pressure
- Strong – not friable; will not crumble or break with finger pressure

8.1.5.3 *Structure*

This variable is used to qualitatively describe physical characteristics of soil that are important to incorporate into hydrogeological and/or geotechnical descriptions of soil at a site. Appropriate soil structure descriptors are as follows:

- Granular – spherically shaped aggregates with faces that do not accommodate adjoining faces
- Stratified – alternating layers of varying material or color with layers at least 6 mm (1/4 inch) thick; note thickness
- Laminated – alternating layers of varying material or color with layers less than 6 mm (1/4 inch) thick; note thickness
- Blocky – cohesive soil that can be broken down into small angular or subangular lumps that resist further breakdown
- Lensed – inclusion of a small pocket of different soil, such as small lenses of sand, should be described as homogeneous if it is not stratified, laminated, fissured, or blocky. If lenses of different soil are present, the soil being described can be termed homogeneous if the description of the lenses is included
- Prismatic or Columnar – particles arranged about a vertical line, ped is bounded by planar, vertical faces that accommodate adjoining faces; prismatic has a flat top; columnar has a rounded top
- Platy – particles are arranged about a horizontal plane

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8.1.5.4 Other Features

- Mottled – soil that appears to consist of material of two or more colors in blotchy distribution
- Fissured – breaks along definite planes of fracture with little resistance to fracturing (determined by applying moderate pressure to sample using thumb and index finger)
- Slickensided – fracture planes appear polished or glossy, sometimes striated (parallel grooves or scratches)

8.1.6 **Development of Soil Description**

Develop standard soil descriptions according to the following examples. There are three principal categories under which all soil can be classified. They are described below.

8.1.6.1 Coarse-grained Soil

Coarse-grained soil is divided into sands and gravels. A soil is classified as a sand if over 50 percent of the coarse fraction is "sand-sized." It is classified as a gravel if over 50 percent of the coarse fraction is composed of "gravel-sized" particles.

The written description of a coarse-grained soil shall contain, in order of appearance: Typical name including the second highest percentage constituent as an adjective, if applicable (underlined); grain size of coarse fraction; Munsell color and color number; moisture content; relative density; sorting; angularity; other features, such as stratification (sedimentary structures) and cementation, possible formational name, primary USCS classification, secondary USCS classification (when necessary), and approximate percentages of minor constituents (i.e., sand, gravel, shell fragments, rip-up clasts) in parentheses.

Example: <u>POORLY-SORTED SAND WITH SILT</u>, medium- to coarse-grained, light olive gray, 5Y 6/2, saturated, loose, poorly sorted, subrounded clasts, SW/SM (minor silt with approximately 20 percent coarse-grained sand-sized shell fragments, and 80 percent medium-grained quartz sand, and 5 percent to 15 percent ML).

8.1.6.2 Fine-grained Soil

Fine-grained soil is further subdivided into clays and silts according to its plasticity. Clays are rather plastic, while silts have little or no plasticity.

The written description of a fine-grained soil should contain, in order of appearance: Typical name including the second highest percentage constituent as an adjective, if applicable (underlined); Munsell color; moisture content; consistency; plasticity; other features, such as stratification, possible formation name, primary USCS classification, secondary USCS classification (when necessary), and the percentage of minor constituents in parentheses.

Example: <u>SANDY LEAN CLAY</u>, dusky red, 2.5 YR 3/2, moist, firm, moderately plastic, thinly laminated, CL (70 percent fines, 30 percent sand, with minor amounts of disarticulated bivalves [about 5 percent]).

8.1.6.3 Organic Soil

For highly organic soil, describe the types of organic materials present as well as the type of soil constituents present using the methods described above. Identify the soil as an organic soil, OL/OH, if the soil contains enough organic particles to influence the soil properties. Organic soil usually has a dark brown to black color and may have an organic odor. Often, organic soils will change color, (e.g., from black to brown) when exposed to air. Some organic soils will lighten in color significantly when air-dried. Organic soils normally will not have a high toughness or plasticity. The thread for the toughness test will be spongy.

8.2 Example: <u>ORGANIC CLAY</u>, black, 2.5Y, 2.5/1, wet, soft, low plasticity, organic odor, OL (100 percent fines), weak reaction to HCl.

8.3 Rock Classification

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The purpose of rock classification is to thoroughly describe the physical and mineralogical characteristics of a specimen and to classify it according to an established system. The generalized rock classification system described below was developed because, unlike the USCS for soils, there is no universally accepted rock classification system. In some instances, a more detailed and thorough rock classification system may be appropriate. Any modifications to this classification system, or the use of an alternate classification system should be considered during preparation of the site work plan. Both the CTO Manager and the QA Manager or Technical Director must approve any modifications to this classification system, or the use of another classification system.

Describing rock specimens on a common basis is essential so that rocks described by different site geologists are comparable. Site geologists describing rock specimens as a part of investigative activities must use the classification system described herein, or if necessary, another more detailed classification system. Use of a common classification system provides the most useful geologic database for all present and future subsurface investigations and remedial activities.

In order to provide a more consistent rock classification between geologists, a rock classification template has been designated as shown in **Error! Reference source not found.**. The template includes classification of rocks by origin and mineralogical composition. When classifying rocks, all site geologists shall use this template.

The site geologist shall describe the rock specimen and record the description in a boring log or logbook. The items essential for classification include (i.e., metamorphic foliated):

- Classification Name (i.e., schist)
- Color
- Mineralogical composition and percent
- Texture/Grain size (i.e., fine-grained, pegmatitic, aphlitic, glassy)
- Structure (i.e., foliated, fractured, lenticular)
- Rock Quality Designation (sum of all core pieces greater than two times the diameter of the core divided by the total length of the core run, expressed as a percentage)
- Classification symbol (i.e., MF)

Example: Metamorphic foliated schist: Olive gray, 5Y, 3/2, Garnet 25 percent, Quartz 45 percent, Chlorite 15 percent, Tourmaline 15 percent, Fine-grained with Pegmatite garnet, highly foliated, slightly wavy, MF.

9.0 Quality Control and Assurance

None

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DEFINITION OF TERMS					
PRIMARY DIVISIONS				SYMBOLS	SECONDARY DIVISIONS
SEDIMENTARY ROCKS	Clastic Sediments	CONGLOMERATE		CG	Coarse-grained Clastic Sedimentary Rock types including: Conglomerates and Breccias
		SANDSTONE		SS	Clastic Sedimentary Rock types including: Sandstone, Arkose and Greywacke
		SHALE		SH	Fine-grained Clastic Sedimentary Rock types including: Shale, Siltstone, Mudstone and Claystone
	Chemical Precipitates	CARBONATES		LS	Chemical Precipitates including: Limestone, Crystalline Limestone, Fossiliferous Limestone Micrite and Dolomite
		EVAPORITES		EV	Evaporites including: Anhydrite, Gypsum, Halite, Travertine and Caliche
IGNEOUS ROCKS	EXTRUSIVE (Volcanic)			IE	Volcanic Rock types including: Basalt, Andesite, Rhyolite, Volcanic Tuff, and Volcanic Breccia
	INTRUSIVE (Plutonic)			II	Plutonic Rock types including: Granite, Diorite and Gabbro
METAMORPHIC ROCKS	FOLIATED			MF	Foliated Rock types including: Slate, Phyllite, Schist and Gneiss
	NON-FOLIATED			MN	Non-foliated Rock types including: Metaconglomerate, Quartzite and Marble

Figure 8-4: Rock Classification System

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10.0 Data and Records Management

10.1 Document soil classification information collected during soil sampling onto the field boring logs, field trench logs, and into the field notebook. Copies of this information shall be sent to the **CTO Manager** for the project files.

10.2 Field notes will be kept during coring activities in accordance with SOP 3-03 – Recordkeeping, Sample Labeling, and Chain of Custody. The information pertinent to soil classification activities includes chronology of events, sample locations (x,y,z), time/date, sampler name, methods (including type of core liner/barrel, if applicable), sampler penetration and acceptability, sample observations, and the times and type of equipment decontamination. Deviations to the procedures detailed in the SOP should be recorded in the field logbook.

11.0 Attachments or References

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Author	*Reviewer*	*Revisions (Technical or Editorial)*
Robert Shoemaker Senior Scientist	Naomi Ouellette, Project Manager	Rev 0 – Initial Issue

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1.0 PURPOSE

This standard operating procedure (SOP) provides procedures for use of direct push sampling methods for collecting soil and groundwater samples. If there are additional procedures required by state and/or federal requirements that are not addressed in this SOP and are applicable to direct push sampling then those procedures may be added as an appendix to the project specific Sampling and Analysis Plan.

2.0 SCOPE

This procedure shall serve as management-approved professional guidance and is consistent with protocol in the Uniform Federal Policy-Quality Assurance Project Plan (DoD 2005). As professional guidance for specific activities, this procedure is not intended to obviate the need for professional judgment during unforeseen circumstances. Deviations from this procedure while planning or executing planned activities must be approved by either the Contract Task Order (CTO) Manager or the Quality Assurance (QA) Manager, and documented.

The physical nature of the subsurface materials, water depth, regulatory buy-in, data quality objectives, and other issues will play an important part in deciding whether direct push methods are suitable for the project and should be discussed in the project-specific planning documents. Before field implementation of direct push methods, the following aspects will need to be considered:

- Permits required by local/state water Board/Districts, etc.
- Waste generation and handling
- Health and safety issues associated with chemical and physical hazards
- Locating subsurface and overhead utilities before field activities and adjust locations as necessary to account for impediments and obstacles.

If direct push methods are used for constructing small diameter monitoring wells, the following aspects should also be considered:

- Well locations and depths
- Permanent or temporary wells
- Screen length(s)
- Well completion specifications.

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3.0 RESPONSIBILITIES

The CTO Manager is responsible for ensuring that the described direct push methods are followed and that all field personnel involved shall have the appropriate education, experience, and training to perform their assigned tasks. QA Manager or Technical Director is responsible for ensuring overall compliance with this procedure. The Field Manager is responsible for implementing or ensuring that all project field staff follow these procedures.

4.0 BACKGROUND

4.1 Direct Push Techniques

Direct push techniques (DPT) rely on use of hydraulically powered machines that utilize static and percussion forces to advance various tools in the subsurface for a variety of uses including soil and groundwater sampling, logging, grouting and materials injections. The machines are very portable and their small size makes them ideal for working inside buildings and confined areas. They are also very fast and generate very little investigative derived waste resulting in direct push methods being a very cost-effective sampling approach compared to traditional drilling methods. A variety of systems are available under several trade names, such as Geoprobe and Strataprobe. Equipment may be skid-mounted, trailered, or mounted directly on the frame of a vehicle. Major limitations of direct push techniques are their inability to penetrate rock or cobbles and a shallow maximum depth of penetration. The capabilities of direct push systems vary significantly among vendors. Consider these differences in capabilities when evaluating the method for a subsurface exploration program.

5.0 PROCEDURES

5.1 Soil Sampling

Vendors of direct push equipment offer a variety of sampling systems designed specifically for their equipment. Both continuous and discreet soil samples may be obtained using direct push sampling equipment and there are generally two methods for soil sampling, using either an open-tube sampler or closed-point sampler. The open tube sampler enables the continuous collection of soil cores from the ground surface to a depth dependent on the core hole staying open. Upon retrieving the sampler, the plastic liner and soil core are removed, the sampler properly decontaminated, reassembled with a new liner and inserted back down the same hole to collect the next soil core. The plastic liners are split lengthwise and the soil core within is described, screened and/or sampled as specified in the project-specific planning documents. Since a new liner is used

with each sampler, the potential cross-contamination risk is minimized, resulting in an inherently safe soil sampling method.

Sandy soils or material collapsing from the probe side wall can make it difficult to collect representative soil cores from significant depths with an open tube sampler. A closed-point sampler (or piston sampler) seals the leading end of the sampler with a point assembly that is held in place with a center rod. Once the sampler is advanced to the top of the sampling interval, the probe rod string is removed which disengages the piston point, allowing soil to enter the sampler. The sampler is retrieved, the plastic liner and soil core are removed and the process is repeated until reaching the desired completion depth.

5.2 Groundwater Sampling

Groundwater samples can be collected in-situ using a groundwater sampling device or through constructing small diameter (< 1.5 inch) monitoring wells, either permanent or temporary, inside the drilling rods.

In-situ Groundwater Sampling

1. Place a drive cap on the assembled direct push sampler and drive it into the subsurface.

2. Continue driving by adding probe rods until the sampler tip has been driven approximately two feet below the groundwater target sampling depth.

3. Disengage the expendable drive point by pulling the rods back a distance of about 2 feet and remove the drive cap.

4. Lower the sensor of an electric water level indicator until the audio signal sounds and record the depth to groundwater. The measurement tape scale (0.01 ft intervals) on the water level indicator wire is read at the top of the probe rod after pulling the tape out and extending it to the ground surface.

5. After recording the water-level depth measurement, the indicator sensor is removed from the probe rods.

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6. Lower a 0.25 to 0.375-inch outer diameter (OD) polyethylene or Teflon tube inside the probe rods and evacuate groundwater with a peristaltic pump. When lowering tubing inside the rod string, ensure that it enters the screen interval. The leading end of the tubing will sometimes catch at the screen head giving the illusion that the bottom of the screen has been reached. An up-and-down motion combined with rotation helps move the tubing past the lip and into the screen.

7. Retrieve the sampler, clean all parts thoroughly, replace the O-rings, and prepare for the next sample.

Typically less than a gallon of water is purged until turbidity levels are stable and sampling follows. Since in-situ groundwater samples are usually collected as "screening" data and are a means to focus permanent monitoring wells, water quality parameters (pH, conductivity, turbidity, temperature) are not normally collected; however, field personnel should defer to the requirements of the project-specific planning documents. If sampling for volatile organic compounds (VOCs), the sample should not be circulated through the peristaltic pump since low level VOCs may be stripped from the sample, causing low bias in analyses. The methods described in SOP 14, *Monitoring Well Sampling* for sampling with a peristaltic pump should be adhered to for groundwater sampling.

In cases where the water depth is greater than 28 feet and the water cannot be lifted, groundwater samples may also be collected by attaching a check valve (with check ball) to the bottom end of the tubing and oscillating the tubing up and down until water exits the top of the tube.

Monitoring Well Installations with Direct Push Methods

1. Place a drive cap on the first section of 2.125-in. probe rod with an expendable drive point installed and advance the rod into the ground.

2. Continue driving by adding probe rods, with O-ring seals between each rod, until the sampler tip reaches approximately one foot below the screen installation depth.

3. After reaching the installation depth, the PVC well screen is lowered into the probe rods while adding threaded lengths of PVC riser pipe as needed. Care must be taken to tighten the threaded sections to prevent leakage at the joints. New, clean, rubber gloves are worn

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while handling all well screen and riser pipe materials to provide the highest quality samples from the well after installation.

4. After the screen and riser are set at the installation depth, the probe rods are retracted slightly while holding down pressure on the riser pipe. This disengages the expendable point from the bottom section of drive rod.

5. After disengaging the drive point, the screen is exposed to the aquifer. Before proceeding with the well installation, it is prudent to measure the static water level in the well. This allows for adjustment of the proper screen depth if required.

6. After assuring the proper installation depth, if pre-packed screens are not used, filter-pack sand is slowly poured within the annular space between the well screen and probe rods.

7. Filter sand is added, while retracting the probe rods, until the sand reaches approximately two feet above the screen length.

8. If the native formation is well-sorted sand, coarse enough to filter and not pass through the well screen filter sand may be unnecessary. Retracting the probe rods to approximately two feet above the top of the screen will allow collapse of the native formation around the screen.

9. Above the filter pack, a minimum two-foot thick bentonite seal is installed to prevent any infiltration from above reaching the sand pack and/or well screen. The bentonite seal is tremied from the bottom (top of the filter pack), with the high-pressure grout pump while retracting the probe rods.

10. A bentonite slurry can be used to grout the entire well annulus, or alternatively above the required minimum two-foot thick bentonite seal, the annulus can be grouted with neat cement.

11. Following 24 hours, the development and sampling of the well can proceed as for typical larger diameter wells.

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Small-diameter (< 1.25 inch) monitoring wells can be installed using direct push methods and are commonly considered permanent, depending upon local and State regulations. The limitations and abilities of wells constructed using direct push methods should be understood, taking into consideration the following:

1. The method effectively protects the well screen from exposure to contaminated overburden soils during installation.

2. Effective filter packing is placed around the well screen (commercially available pre-packed well screens ensure adequate filter packing around well screen).

3. The well screen to be effectively sealed against the downward infiltration of overlying groundwater or surface precipitation.

4. Well materials are compatible with the intended sampling and analysis goals of the project.

5. The well screen is properly sized and slotted for the needs of the project.

The project-specific planning documents should evaluate the appropriateness of direct push systems and whether collected data will meet the project objectives. As part of this evaluation, regulatory concurrence/approval should also be sought.

5.3 Equipment Decontamination

To avoid cross-contamination, thoroughly decontaminate equipment used for direct push exploration and sampling. Decontaminate sampling tools and downhole equipment between each sampling event and between penetration points. At a minimum, steam clean or wash and rinse the equipment with a combination of soapy water and a double rinse of clean water. The inside of the of the sample and extension rods should be cleaned with nylon brushes. Use clean water and phosphate-free soap, cycle the brush inside the probe rod or sample tube to remove contaminants. Rinse with clean water and allow to air dry.

5.4 Borehole Abandonment

Some direct push boreholes will close naturally as the drive rods and sampling tools are withdrawn. This may occur in loose, unconsolidated soils, such as sands. Abandon shallow boreholes using one of the procedures described below unless natural caving precludes such closure.

1. Add granulated or pelletized bentonite and hydrate in layers, proceeding from the bottom of the hole to the surface.

2. Pour premixed cement/water/bentonite into the hole.

3. Fill the entire hole with granular or pelletized bentonite and hydrate by means of a previously emplaced water tube that is gradually withdrawn as water is supplied to the bentonite.

For deeper holes, use a conductor (tremie) pipe to carry the grout mix to the far reaches of the borehole. Lower the conductor pipe to within 2 inches of the bottom and gradually withdraw it as grout is added, keeping the lower end of the pipe submerged in grout at all times. Seal boreholes to within 0.5 to 2.0 feet of the surface. Inspect the abandoned borehole after 24 hours to ensure that grout settlement has notoccured. If significant settlement has occurred, add grout to the borehole. Fill the remaining portion of the hole with local topsoil or appropriate paving materials.

6.0 RECORDS

Record all DPT field activities in the appropriate field log book. Depending on the project objectives, soil classification may or may not be required. If it is required, complete a soil boring log as provided in Attachment 1. Monitoring wells constructed with direct push methods require both a well construction log and groundwater sampling log which are also provided in Attachments 2 and 3. Field personnel should provide copies of all completed forms to the Field Team Leader who is responsible for forwarding the forms to the CTO Manager who will review them for completeness before incorporating them into the project files.

7.0 HEALTH AND SAFETY

The primary hazards associated with direct push sampling are the mechanical hazards associated with machinery. Only qualified personnel should operate the equipment and field personnel should always maintain a safe distance from it. The minimum personal protective equipment (PPE) is safety glasses, hearing protection, steel-toed boots, and a hard hat. Depending upon the site-specific contaminants, additional PPE requirements may be required as designated in the site-specific Health and Safety Plan (HASP).

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Employ the following safe work practices:

- Avoid skin contact with and/or incidental ingestion of purge water.

- Use eye protection and gloves when handling acid or caustic preservatives.

- Avoid breathing constituents venting from the borehole by positioning rig upwind between field personnel/operators and the borehole.

- If historical knowledge or evidence of free-phase is present, use a flame or photo ionization detector to ensure the breathing zone is safe.

- If monitoring indicates organic vapors above action levels specified in the HASP, be prepared to upgrade PPE to Level C protection or implement appropriate engineering controls to mitigate vapors.

8.0 REFERENCES

Department of Defense, United States (DoD). 2005. *Uniform Federal Policy for Quality Assurance Project Plans, Part 1: UFP-QAPP Manual*. Final Version 1. DoD: DTIC ADA 427785, EPA-505-B-04-900A. In conjunction with the U. S. Environmental Protection Agency and the Department of Energy. Washington: Intergovernmental Data Quality Task Force. March. On-line updates available at: http://www.epa.gov/fedfac/pdf/-ufp_qapp_v1_0305.pdf.

SOP-3-12, Monitoring Well Installation

SOP-3-14, Monitoring Well Sampling

SOP-3-17, Direct Push Sampling Techniques

SOP-3-18 (Mid South), Direct Push Sampling

9.0 ATTACHMENTS

Attachment 1 Boring Log

Attachment 2 Monitoring Well Construction Form

Attachment 3 Groundwater Sample Collection Record

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Attachment 1
Boring Log

RESOLUTION CONSULTANTS

Boring ID:

Page 1 of _____

Project Name:	Drilling Company:	Type of Surface Material:
Project Number:	Drilling Method:	Patching Material:
Date Started Drilling:	Rig Type:	Drilling Water Level:
Date Finished Drilling:	Core Size:	Boring Total Depth (bgs):
Physical Location:		Logged By:

(Note: bgs = below ground surface)

Depth Range	Recovery ft/ft	PID (ppm)	Moisture Content	GA Class.	USCS	GA Class: Garfield Avenue Sites classification & Modified Unified Soil Clasiffication System	
						Ground Surface Cover and Thickness:	Sample name & #:
0-1							
1-2							
2-3							
3-4							
4-5							
5-6							
6-7							
7-8							
8-9							
9-10							
10-11							
11-12							
12-13							
13-14							
14-15							
15-16							
16-17							
17-18							
18-19							
19-20							

Stratigraphic Unit Intervals:		Comments:
1.)	5.)	
2.)	6.)	
5.)	6.)	

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Attachment 2
Monitoring Well Construction Form

RESOLUTION CONSULTANTS	*Client:*	***WELL ID:***
	Project Number:	
	Site Location:	*Date installed:*
	Well Location: *Coords:*	*Inspector:*
	Method:	*Contractor:*

MONITORING WELL CONSTRUCTION DETAIL

	Depth from G.S. (feet)	Elevation(feet) Datum _____
Top of Steel Guard Pipe		
Measuring Point for Surveying & Water Levels — Top of Riser Pipe		
Ground Surface (G.S.)	0.0	
Cement, Bentonite, Bentonite Slurry Grout, or Native Materials — Riser Pipe:		
Length _____		
Inside Diameter (ID) _____		
Type of Material _____		
% Cement		
Bottom of Steel Guard Pipe		
% Bentonite		
% Native Materials		
Top of Bentonite		
Bentonite Seal Thickness _____		
Top of Sand		
Top of Screen		
▼ Stabilized Water Level		
Screen:		
Length _____		
Inside Diameter (ID) _____		
Slot Size _____		
Type of Material _____		
Type/Size of sand _____		
Sand Pack Thickness _____		
Bottom of Screen		
Bottom of Tail Pipe:		
Length _____		
Bottom of Borehole		

Borehole Diameter _____ Approved:

Describe Measuring Point:

Signature _____ Date _____

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Attachment 3
Groundwater Sample Collection Record

Well ID:

Groundwater Sample Collection Record

Client: _____ Date: _____ Time: Start _____ am/pm
Project No: _____ Finish _____ am/pm
Site Location: _____
Weather Conds: _____ Collector(s): _____

1. WATER LEVEL DATA: (measured from Top of Casing)

a. Total Well Length _____ **c.** Length of Water Column _____ (a-b)

Casing Diameter/Material _____

b. Water Table Depth _____ **d.** Calculated Well Volume (see back) _____

2. WELL PURGEABLE DATA

a. Purge Method: _____

b. Acceptance Criteria defined (see SAP or Work Plan)
- Minimum Required Purge Volume (@ _____ well volumes) _____
- Maximum Allowable Turbidity _____ NTUs
- Stabilization of parameters _____ %

c. Field Testing Equipment used: Make Model Serial Number

Time (min)	Volume Removed (gal)	Temp. (°C)	pH s.u.	Spec. Cond. (µS/cm)	DO (mg/L)	ORP (mV)	Turbidity (NTU)	Flow Rate (ml/min)	Drawdown (m)	Color/Odor/etc.

d. Acceptance criteria pass/fail

	Yes	No	N/A
Has required volume been removed	☐	☐	☐
Has required turbidity been reached	☐	☐	☐
Have parameters stabilized	☐	☐	☐

(continued on back)

If no or N/A - Explain below.

_____

3. SAMPLE COLLECTION: Method: _____

Sample ID	Container Type	No. of Containers	Preservation	Analysis Req.	Time

Comments _____

Signature _____ Date _____

Page 1 of 2

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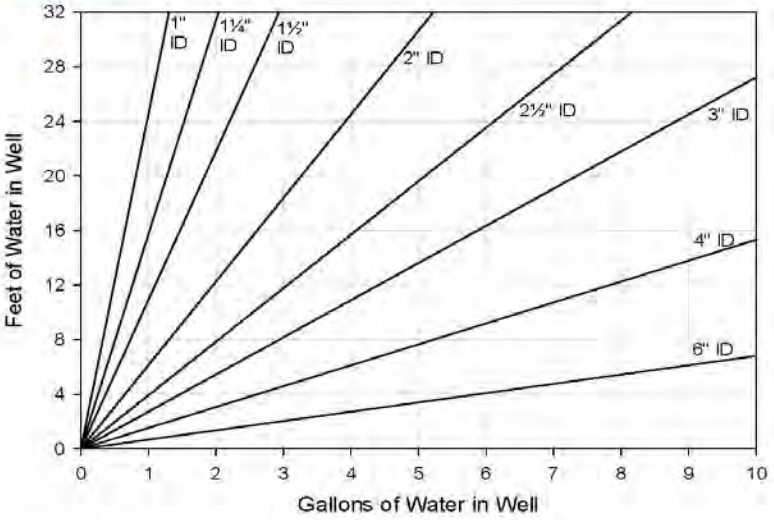
Purge Volume Computation

Well ID:



Volume / Linear Ft. of Pipe		
ID (in)	Gallon	Liter
¼	0.0025	0.0097
⅜	0.0057	0.0217
½	0.0102	0.0386
¾	0.0229	0.0869
1	0.0408	0.1544
1¼	0.0637	0.2413
1½	0.0918	0.3475
2	0.1632	0.6178
2½	0.2550	0.9653
3	0.3672	1.3900
4	0.6528	2.4711
6	1.4688	5.5600

(continued from front)

Time (min)	Volume Removed (gal)	Temp. (°C)	pH s.u.	Spec. Cond. (µS/cm)	DO (mg/L)	ORP (mV)	Turbidity (NTU)	Flow Rate (ml/min)	Drawdown (m)	Color/Odor/etc.

Signature _____ Date _____

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Headspace Screening for Total VOCs

Procedure 3-19

1.0 Purpose and Scope

1.1 This standard operating procedure (SOP) describes the basic techniques for using headspace analysis to screen for volatile organics in contaminated soils using a portable Photo Ionization Detector (PID) or Flame Ionization Detector (FID).

1.2 As guidance for specific activities, this procedure does not obviate the need for professional judgment. Deviations from this procedure while planning or executing planned activities must be approved in accordance with Program requirements for technical planning and review.

2.0 Safety

2.1 The health and safety considerations for the work associated with this SOP will be addressed in the project Health and Safety Plan (HASP). In the absence of a HASP, work will be conducted according to the Contract Task Order (CTO) Work Plan (WP) and/or direction from the **Site Safety Officer (SSO)**. Note that headspace screening usually requires Level D personal protection unless there is a potential for airborne exposure to site contaminants. Under circumstances where potential airborne exposure is possible respiratory protective equipment may be required based on personal air monitoring results. Upgrades to Level C will be coordinated with the Site Safety Officer (SSO) or **CTO Manager**.

2.2 Health and safety hazards and corresponding precautions include, but are not limited to, the following:

2.2.1 Dermal contact with contaminated soil. Personnel should treat all soil as potentially contaminated and wear chemically impervious gloves. Minimize skin contact with soil by using sampling instruments such as stainless steel spades or spoons. Do not touch any exposed skin with contaminated gloves.

2.2.2 Inhalation hazards. Appropriate air monitoring should be conducted to ensure that organic vapor concentrations in the breathing zone do not exceed action levels as specified in the Site-Specific HASP. When ambient temperatures are low enough to require warming samples using the vehicle heater, the vehicle's windows should be opened enough to prevent the build-up of any organic vapors. Use the PID or FID to verify the airborne concentrations in the vehicle remain below applicable action levels. Note that many volatile organic compounds (VOCs) are flammable and all precautions must be observed to eliminate any potential ignition sources.

2.2.3 Shipping limitations. Follow applicable regulations when shipping FID/PID equipment. When shipping an FID by air, the hydrogen tank must be bled dry. Calibration gas canisters are considered dangerous goods and must be shipped according to IATA and DOT regulations. Consult your EHS Coordinator and check with your shipping company to determine the correct shipping procedures

3.0 Terms and Definitions

None.

4.0 Interferences

4.1 Regardless of which gas is used for calibration, the instrument will respond to all analytes present in the sample that can be detected by the type of lamp used in the PID.

4.2 Moisture will generate a positive interference in the concentration measured for a PID and is characterized by a slow increase in the reading as the measurement is made. Care must be taken to

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minimize uptake of moisture to the extent possible. Refer to the manufacturers' instructions for care, cleaning, and maintenance.

4.3 Uptake of soil into the PID must be avoided as it will compromise instrument performance by blocking the probe, causing a positive interference, or dirtying the PID lamp. Refer to the manufacturers' instructions for care, cleaning, and maintenance.

4.4 The user should listen to the pitch of the sampling pump. Any changes in pitch may indicate a blockage and corrective action should be initiated.

5.0 Training and Qualifications

5.1 Qualifications and Training

The individual executing these procedures must have read, and be familiar with, the requirements of this SOP.

5.2 Responsibilities

5.2.1 The CTO Manager is responsible for ensuring that the collection of headspace readings comply with this procedure. The CTO Manager is responsible for ensuring that all personnel involved in the collection of headspace readings shall have the appropriate education, experience, and training to perform their assigned tasks.

5.2.2 The Program Quality Manager is responsible for ensuring overall compliance with this procedure.

5.2.3 The Field Manager is responsible for ensuring that all headspace readings are conducted according to this procedure as well as verifying that the PID/FID is in proper operating condition prior to use and for implementing the calibration.

5.2.4 All Field Personnel are responsible for the implementation of this procedure.

6.0 Equipment and Supplies

6.1 The following materials must be on hand in good operating condition and/or in sufficient quantity to ensure that proper field analysis procedures may be followed:

- Calibrated PID/FID instrument;
- Top-sealing "Zip-Loc" type plastic bags – or – 16 ounces of soil or "mason-" type glass jars and aluminum foil;
- Project field book and/or boring logs;
- Personal Protective Equipment (PPE) as specified in the project HASP; and
- Material Safety Data Sheets (MSDSs) for any chemicals or site-specific contaminants.

7.0 Procedure

7.1 Preparation

Review available project information to determine the types of organic vapors that will likely be encountered to select the right instrument. The two basic types of instruments are FIDs and PIDs.

FIDs work well with organic compounds that have relatively lightweight molecules, but may have problems detecting halogenated compounds or heavier organic compounds; FIDs can detect methane for example. Since the FID uses a flame to measure organic compounds, ensure that work is conducted in an atmosphere, which is free of combustible vapors. If ambient temperatures are below 40°F, the flame of the FID may be difficult to light.

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When using a PID, select an instrument that can measure the ionization potential of the anticipated contaminants of concern. PIDs work well with a range of organic compounds and can detect some halogenated hydrocarbons; PIDs cannot detect methane. The correct ultraviolet (UV) light bulb must be selected according to the types of organic vapors that will likely be encountered. The energy of the UV light must equal or exceed the ionization potential of the organic molecules that the PID will measure. The NIOSH Pocket Guide to Chemical Hazards is one source for determining ionization potentials for different chemicals. Bulbs available for PIDs include 9.4 eV, 10.6 (or 10.2) eV, and 11.7 eV bulbs. The 10.6 eV bulb is most commonly used as it detects a fairly large range of organic molecules and does not burn out as easily as the 11.7 eV bulb. The 9.4 eV bulb is the most rugged, but detects only a limited range of compounds. Under very humid or very cold ambient conditions, the window covering the UV light may fog up, causing inaccurate readings. Ask the **SSO** about correction factors when high humidity conditions exist.

After selecting the correct instrument, calibrate the PID/FID according to the manufacturer's instructions. Record background/ambient levels of organic vapors measured on the PID/FID after calibration and make sure to subtract the background concentration (if any) from your readings. Check the PID/FID readings against the calibration standard every 20 readings or at any time when readings are suspected to be inaccurate, and recalibrate, if necessary. Be aware that, after measuring highly contaminated soil samples, the PID/FID may give artificially high readings for a time.

7.2 Top-Sealing Plastic Bag

Place a quantity of soil in a top-sealing plastic bag and seal the bag immediately. The volume of soil to be used should be determined by the **CTO Manager** or **Field Manager**. The volume of soil may vary between projects but should be consistent for all samples collected for one project. Ideally, the bag should be at least 1/10th-filled with soil and no more than half-filled with soil. Once the bag is sealed, shake the bag to distribute the soil evenly. If the soil is hard or clumpy, use your fingers to gently work the soil (through the bag) to break up the clumps. Do not use a sampling instrument or a rock hammer since this may create small holes in the plastic bag and allow organic vapors to escape. Alternatively, the sample may be broken up before it is placed in the bag. Use a permanent marker to record the following information on the outside of the bag:

- Site identification information (i.e., borehole number);
- Depth interval; and
- Time the sample was collected. For example: "SS-12, 2-4 ft, @1425".

Headspace should be allowed to develop before organic vapors are measured with a PID/FID. The amount of time required for sufficient headspace development will be determined by the project-specific sampling plan and the ambient temperature. Equilibration time should be the same for all samples to allow an accurate comparison of organic vapor levels between samples. However, adjustments to equilibration times may be necessary when there are large variations in ambient temperature from day to day. When ambient temperatures are below 32°F, headspace development should be within a heated building or vehicle. When heating samples, be sure there is adequate ventilation to prevent the build-up or organic vapors above action levels.

Following headspace development, open a small opening in the seal of the plastic bag. Insert the probe of a PID/FID and seal the bag back up around the probe as tightly as possible. Alternatively, the probe can be inserted through the bag to avoid loss of volatiles. Since PIDs and FIDs are sensitive to moisture, avoid touching the probe to the soil or any condensation that has accumulated inside of the bag. Since the PID/FID consumes organic vapors, gently agitate the soil sample during the reading to release fresh organic vapors from the sample. Erratic meter response may occur at high organic vapor concentrations or conditions of elevated headspace moisture, in which case, headspace data should be discounted. Record the highest reading on the field form or in the field notebook as described in Section 9.

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7.3 **Jar and Aluminum Foil (Alternate Method)**

Half-fill a clean glass jar with the soil sample to be screened. Quickly cover the jar's opening with one to two sheets of clean aluminum foil and apply the screw cap to tightly seal the jar. Allow headspace development for at least ten minutes. Vigorously shake the jar for 15 seconds, both at the beginning and at the end of the headspace development period. Where ambient temperatures are below 32°F (0°C), headspace development should be within a heated area. When heating samples, be sure there is adequate ventilation to prevent the build-up of organic vapors above action levels.

Subsequent to headspace development, remove the jar lid and expose the foil seal. Quickly puncture the foil seal with the instrument sampling probe, to a point about one-half of the headspace depth. Exercise care to avoid uptake of water droplets or soil particulates. As an alternative, use a syringe to withdraw a headspace sample, and then inject the sample into the instrument probe or septum-fitted inlet. This method is acceptable contingent upon verification of methodology accuracy using a test gas standard. Following probe insertion through the foil seal or sample injection to probe, record the highest meter response on the field form or in the field notebook. Using foil seal/probe insertion method, maximum response should occur between two and five seconds. Erratic meter response may occur at high organic vapor concentrations or conditions of elevated headspace moisture, in which case, headspace data should be discounted.

8.0 Quality Control and Assurance

Quality Assurance/Quality Control (QA/QC) will include the collection of duplicate samples. In general, one duplicate will be collected per 20 samples. Organic vapor concentrations measured in the primary and duplicate samples should be similar within plus or minus 20 percent. The frequency of headspace duplicate collection will be determined by the project manager/task manager. The PID/FID instrument must be calibrated according to the manufacturer's instructions before beginning screening, and checked or recalibrated every 20 analyses or when readings are suspected to be inaccurate. Record ambient organic vapor levels in the field notebook and on the field form. Periodically check ambient organic vapor levels. If ambient levels have changed more than 20 percent, recalibrate the PID/FID. Make sure readings are not collected near a vehicle exhaust or downwind of a drill rig exhaust. If grossly contaminated soil is encountered, decontaminate sampling instruments between samples and/or change contaminated gloves to avoid cross contaminating less contaminated samples.

9.0 Records, Data Analysis, Calculations

9.1 All data generated (results and duplicate comparisons) will be recorded in the field notebook and/or on the field form. Any deviation from the outlined procedure will also be noted. Field conditions (ambient temperature, wind, etc.) should also be recorded in the field notebook.

9.2 Readings may be recorded in a field notebook, on a boring log, or on an appropriate form specific to the project. The form should include the following information:

- When the PID/FID was calibrated (date/time) and calibration standard used;
- Background/ambient concentrations measured after PID/FID calibration;
- Location of sample (i.e., bore-hole number);
- Depth interval of sample measured;
- Lithology of material measured; and
- PID/FID reading and units of measure.

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9.3 Note that if PID/FID measurements are recorded on a boring log, it is not necessary to duplicate information in the column where the PID/FID readings are recorded (e.g., borehole number, depth interval, lithology type).

9.4 All documentation will be stored in the project files and retained following completion of the project.

10.0 Attachments or References

SOP 3-20 Operation and Calibration of a Photoionization Detector

Author	Reviewer	Revisions (Technical or Editorial)
Robert Shoemaker Senior Scientist	Chris Barr Program Quality Manager	Rev 0 – Initial Issue (May 2012)

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Operation and Calibration of a Photoionization Detector

Procedure 3-20

1.0 Purpose and Scope

1.1 Purpose and Applicability

1.1.1 This standard operating procedure (SOP) describes the procedures that will be followed by field staff for operation and calibration of a photoionization detector (PID). The PID is primarily used by AECOM personnel for safety and survey monitoring of ambient air, determining the presence of volatiles in soil and water, and detecting leakage of volatiles.

1.1.2 PIDs routinely used by field personnel include the Photovac Microtip, Thermoelectron 580EZ, and MiniRAE 2000. Personnel responsible for using the PID should first read and thoroughly familiarize themselves with the instrument instruction manual.

1.2 Principle of Operation

1.2.1 The PID is a non-specific vapor/gas detector. The unit generally consists of a hand-held probe that houses a PID, consisting of an ultraviolet (UV) lamp, two electrodes, and a small fan which pulls ambient air into the probe inlet tube. The probe is connected to a readout/control box that consists of electronic control circuits, a readout display, and the system battery. Units are available with UV lamps having an energy from 9.5 electron volts (eV) to 11.7 eV.

1.2.2 The PID analyzer measures the concentration of trace gas present in the atmosphere by photoionization. Photoionization occurs when an atom or molecule absorbs a photon of sufficient energy to release an electron and become a positive ion. This will occur when the ionization potential of the molecule (in electron volts (eV)) is less than the energy of the photon. The source of photons is an ultraviolet lamp in the probe unit. Lamps are available with energies ranging from 9.5 eV to 11.7 eV. All organic and inorganic vapor/gas compounds having ionization potentials lower than the energy output of the UV lamp are ionized and the resulting potentiometric change is seen as a positive reading on the unit. The reading is proportional to the concentration of organics and/or inorganics in the vapor.

1.2.3 Sample gases enter the probe through the inlet tube and enter the ion chamber where they are exposed to the photons emanating from the UV lamp. Ionization occurs for those molecules having ionization potentials near to or less than that of the lamp. A positive- biased polarizing electrode causes these positive ions to travel to a collector electrode in the chamber. Thus the ions create an electrical current which is amplified and displayed on the meter. This current is proportional to the concentration of trace gas present in the ion chamber and to the sensitivity of that gas to photoionization.

1.2.4 In service, the analyzer is first calibrated with a gas of known composition equal to, close to, or representative of that to be measured. Gases with ionization potentials near to or less than the energy of the lamp will be ionized. These gases will thus be detected and measured by the analyzer. Gases with ionization potentials greater than the energy of the lamp will not be detected. The ionization potentials of the major components of air, i.e., oxygen, nitrogen, and carbon dioxide, range from about 12.0 eV to 15.6 eV and are not ionized by any of the lamps available. Gases with ionization potentials near to or slightly higher than the lamp are partially ionized, with low sensitivity.

1.3 Specifications

1.3.1 Refer to the manufacturer's instructions for the technical specifications of the instrument being used. The operating concentration range is typically 0.1 to 2,000 ppm isobutylene equivalent.

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2.0 Safety

2.1 The health and safety considerations for the work associated with this SOP, including both potential physical and chemical hazards, will be addressed in the project Health and Safety Plan (HASP). In the absence of a HASP, work will be conducted according to the Contract Task Order (CTO) Work Plan (WP) and/or direction from the **Site Safety Officer (SSO)**.

2.2 Only PIDs stamped Division I Class I may be used in explosive atmospheres. Refer to the project HASP for instructions pertaining to instrument use in explosive atmospheres.

3.0 Terms and Definitions

None.

4.0 Interferences

4.1 Regardless of which gas is used for calibration, the instrument will respond to all analytes present in the sample that can be detected by the type of lamp used in the PID.

4.2 Moisture will generate a positive interference in the concentration measured for a PID and is characterized by a slow increase in the reading as the measurement is made. Care must be taken to minimize uptake of moisture to the extent possible. Refer to the manufacturers' instructions for care, cleaning, and maintenance.

4.3 Uptake of soil into the PID must be avoided as it will compromise instrument performance by blocking the probe, causing a positive interference, or dirtying the PID lamp. Refer to the manufacturers' instructions for care, cleaning, and maintenance.

4.4 The user should listen to the pitch of the sampling pump. Any changes in pitch may indicate a blockage and corrective action should be initiated.

5.0 Training and Qualifications

5.1 Qualifications and Training

The individual executing these procedures must have read, and be familiar with, the requirements of this SOP.

5.2 Responsibilities

5.2.1 The CTO Manager is responsible for ensuring that the operation and calibration activities comply with this procedure. The CTO Manager is responsible for ensuring that all personnel involved in the operation and calibration shall have the appropriate education, experience, and training to perform their assigned tasks.

5.2.2 The Program Quality Manager is responsible for ensuring overall compliance with this procedure.

5.2.3 The Field Manager is responsible for ensuring that all operation and calibration activities are conducted according to this procedure.

5.2.4 All Field Personnel are responsible for the implementation of this procedure.

6.0 Equipment and Supplies

- Calibration Gas: Compressed gas cylinder of isobutylene in air or similar stable gas mixture of known concentration. The selected gas should have an ionization potential similar to that of the vapors to be monitored, if known. The concentration should be at 50-75% of the range in which the instrument is to be calibrated;

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- Regulator for calibration gas cylinder;
- Approximately 6 inches of Teflon® tubing;
- Tedlar bag (optional);
- Commercially-supplied zero grade air (optional);
- "Magic Marker" or "Sharpie" or other waterproof marker;
- Battery charger;
- Moisture traps;
- Spare lamps;
- Manufacturer's instructions; and
- Field data sheets or logbook/pen.

7.0 Procedure

7.1 Preliminary Steps

7.1.1 Preliminary steps (battery charging, check-out, calibration, maintenance) should be conducted in a controlled or non-hazardous environment.

7.2 Calibration

7.2.1 The PID must be calibrated in order to display concentrations in units equivalent to ppm. First a supply of zero air (ambient air or from a supplied source), containing no ionizable gases or vapors is used to set the zero point. A span gas, containing a known concentration of a photoionizable gas or vapor, is then used to set the sensitivity.

7.2.2 Calibrate the instrument according to the manufacturer's instructions. Record the instrument model and identification number, the initial and adjusted meter readings, the calibration gas composition and concentration, and the date and the time in the field records.

7.2.3 If the calibration cannot be achieved or if the span setting resulting from calibration is 0.0, then the lamp must be cleaned (Section 7.4).

7.3 Operation

7.3.1 Turn on the unit and allow it to warm up (minimum of 5 minutes). Check to see if the intake fan is functioning; if so, the probe will vibrate slightly and a distinct sound will be audible when holding the probe casing next to the ear. Also, verify on the readout display that the UV lamp is lit.

7.3.2 Calibrate the instrument as described in Section 7.2, following the manufacturer's instructions. Record the calibration information in the field records.

7.3.3 The instrument is now operational. Readings should be recorded in the field records.

7.3.4 When the PID is not being used or between monitoring intervals, the unit may be switched off to conserve battery power and UV lamp life; however, a "bump" test should be performed each time the unit is turned on and prior to taking additional measurements. To perform a bump test, connect the outlet tubing from a Tedlar bag containing a small amount of span gas to the inlet tubing on the unit and record the reading. If the reading is not within the tolerance specified in the project plan, the unit must be recalibrated.

7.3.5 At the end of each day, recheck the calibration. The check will follow the same procedures as the initial calibration (Section 7.2) except that no adjustment will be made to the instrument. Record the information in the field records.

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7.3.6 Recharge the battery after each use (Section 7.4).

7.3.7 When transporting, ensure that the instrument is packed in its stored condition in order to prevent damage.

7.4 **Routine Maintenance**

7.4.1 Routine maintenance associated with the use of the PID includes charging the battery, cleaning the lamp window, replacing the detector UV lamp, replacing the inlet filter, and replacing the sample pump. Refer to the manufacturer's instructions for procedures and frequency.

7.4.2 All routine maintenance should be performed in a non-hazardous environment.

7.5 **Troubleshooting Tips**

7.5.1 One convenient method for periodically confirming instrument response is to hold the sensor probe next to the tip of a magic marker. A significant reading should readily be observed.

7.5.2 Air currents or drafts in the vicinity of the probe tip may cause fluctuations in readings.

7.5.3 A fogged or dirty lamp, due to operation in a humid or dusty environment, may cause erratic or fluctuating readings. The PID should never be operated without the moisture trap in place.

7.5.4 Moving the instrument from a cool or air-conditioned area to a warmer area may cause moisture to condense on the UV lamp and produce unstable readings.

7.5.5 A zero reading on the meter should not necessarily be interpreted as an absence of air contaminants. The detection capabilities of the PID are limited to those compounds that will be ionized by the particular probe used.

7.5.6 Many volatile compounds have a low odor threshold. A lack of meter response in the presence of odors does not necessarily indicate instrument failure.

7.5.7 When high vapor concentrations enter the ionization chamber in the PID the unit can become saturated or "flooded". Remove the unit to a fresh air environment to allow the vapors to be completely ionized and purged from the unit.

8.0 Quality Control and Assurance

8.1 The end use of the data will determine the quality assurance requirements that are necessary to produce data of acceptable quality. These quality assurance requirements will be defined in the site-specific workplan or Sampling and Analysis Plan (SAP), hereafter referred to as the project plan.

8.2 Calibration of the PID will be conducted at the frequency specified in the project plan. In the absence of project-specific guidance, calibration will be performed at the beginning of each day of sampling and will be checked at the end of the sampling day or whenever instrument operation is suspect. The PID will sample a calibration gas of known concentration. The instrument must agree with the calibration gas within ±10%. If the instrument responds outside this tolerance, it must be recalibrated.

8.3 Checks of the instrument response (Section 7.5) should be conducted periodically and documented in the field records.

9.0 Records, Data Analysis, Calculations

Safety and survey monitoring with the PID will be documented in a bound field logbook, or on standardized forms, and retained in the project files. The following information is to be recorded:

- Project name and number;
- Instrument manufacturer, model, and identification number;

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- Operator's signature;
- Date and time of operation;
- Calibration gas used;
- Calibration check at beginning and end of day (meter readings before adjustment);
- Span setting after calibration adjustment;
- Meter readings (monitoring data obtained);
- Instances of erratic or questionable meter readings and corrective actions taken; and
- Instrument checks and response verifications – e.g., battery check, magic marker response (Section 7.5) or similar test.

10.0 Attachments or References

United States Environmental Protection Agency. Environmental Investigations Standard Operating Procedures and Quality Assurance Manual (EISOPQAM). USEPA, Region 4, SESD, Enforcement and Investigations Branch, Athens, GA. November 2001.

Author	Reviewer	Revisions (Technical or Editorial)
Robert Shoemaker Senior Scientist	Chris Barr Program Quality Manager	Rev 0 – Initial Issue (May 2012)

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Surface and Subsurface Soil Sampling Procedures

Procedure 3-21

1.0 Purpose and Scope

1.1 This standard operating procedure (SOP) describes the procedures for soil sampling. The procedure includes surface and subsurface sampling by various methods using hand auguring, test pit, direct-push, and split-spoon equipment.

1.2 The procedure includes soil sampling for volatile organic compounds (VOCs). For project specific information (e.g. sampling depths, equipment to be used, and frequency of sampling), refer to the Sampling and Analysis Plan (SAP), which takes precedence over these procedures. Surface soil sampling, typically considered to be up to two feet below ground surface by EPA standards, is typically accomplished using hand tools such as shovels or hand augers. Test pit samples are considered subsurface samples, although normally collected via hand tools similar to surface soil sampling or by excavation machinery. Direct-push and split-spoon sampling offer the benefit of collecting soil samples from a discrete or isolated subsurface interval, without the need of extracting excess material above the target depth. These methods dramatically reduce time and cost associated with disposal of material from soil cuttings when compared to test pit sampling. In addition, direct-push and split-spoon sampling methods can obtain samples at targeted intervals greater than 15 feet in depth, allowing for discrete depth soil sampling while speeding up the sampling process. Direct-push methods work best in medium to fine-grained cohesive materials such as medium to fine sands, silts, and silty clay soils. Split-spoon sampling works well in all types of soil, but is somewhat slower than direct-push methods. Samples are composited so that each sample contains a homogenized representative portion of the sample interval. Due to potential loss of analytes, samples for volatile analysis are not composited. Samples for chemical analysis can be collected by any of the above-mentioned sampling methods, as disturbed soil samples. Undisturbed samples are collected, sealed, and sent directly to the laboratory for analysis. For undisturbed samples, the samples are not homogenized.

2.0 Safety

2.1 The health and safety considerations for the work associated with this SOP, including both potential physical and chemical hazards, will be addressed in the project Health and Safety Plan (HASP). In the absence of a HASP, work will be conducted according to the Contract Task Order (CTO) Work Plan (WP) and/or direction from the **Site Safety Officer (SSO)**.

2.2 Before soil sampling commences, appropriate entities (e.g. DigSafe, local public works departments, company facilities) must be contacted to assure the anticipated soil sampling locations are marked for utilities, including electrical, telecommunications, water, sewer, and gas.

3.0 Terms and Definitions

None.

4.0 Interferences

4.1 Low recovery of soil from sampling equipment will prevent an adequate representation of the soil profile and sufficient amount of soil sample. If low recovery is a problem, the hole may be offset and re-advanced, terminated, or continued using a larger diameter sampler.

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4.2 Asphalt in soil samples can cause false positive results for hydrocarbons. To ensure samples are free of asphalt, do not collect samples that may contain asphalt. If the collection of samples potentially containing asphalt is unavoidable, note the sampling depths at which the presence of asphalt are suspected.

4.3 Instrumentation interferences addressed in SOPs for Calibration of the Photoionization Detector (PID), Headspace Screening for Total Volatile Organics, and Equipment Decontamination must also be considered.

4.4 Cross contamination from sampling equipment must be prevented by using sampling equipment constructed of stainless steel that is adequately decontaminated between samples.

5.0 Training and Qualifications

5.1 Qualifications and Training

The individual executing these procedures must have read, and be familiar with, the requirements of this SOP.

5.2 Responsibilities

5.2.1 The CTO Manager is responsible for ensuring that soil sampling activities comply with this procedure. The CTO Manager is responsible for ensuring that all personnel involved in soil sampling shall have the appropriate education, experience, and training to perform their assigned tasks.

5.2.2 The Program Quality Manager is responsible for ensuring overall compliance with this procedure.

5.2.3 The Field Manager is responsible for ensuring that all soil sampling activities are conducted according to this procedure.

5.2.4 All Field Personnel are responsible for the implementation of this procedure.

6.0 Equipment and Supplies

The depth at which samples will be collected and the anticipated method of sample collection (direct-push, split-spoon, hand auger, shovel, or test pits) will be presented in the SAP. The following details equipment typically needed for soil sampling, based on the various methods. See the SAP for specific detail of equipment and supply needs.

6.1 Depending on the nature of suspected contamination, field screening instrumentation may be used for direct sampling. Appropriate instrumentation and calibration standards should be available. If volatile organic contaminants are suspected and a PID will be used, refer to the equipment and instrumentation listed in SOP 3-20 Operation and Calibration of a Photoionization Detector. Equipment in this SOP includes but is not limited to:

- PID/FID;
- Calibration gas; and
- Tedlar® gas bags (for calibration).

6.2 If field screening methods include jar headspace screening for volatile organics, refer to the equipment and procedure in SOP 3-19 Headspace Screening for Total VOCs. Equipment in this SOP includes but is not limited to:

- Clean soil ("drillers jars") jars; and
- Aluminium foil.

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6.3 Appropriate decontamination procedures must be followed for sampling equipment. Refer to SOP 3-06 Equipment Decontamination. Equipment in this SOP includes but is not limited to:

- Phosphate-free detergent;
- Isopropyl Alcohol;
- Tap water;
- Deionized Ultra-Filtered (DIUF) Water;
- Plastic buckets or washbasins;
- Brushes; and
- Polyethylene sheeting.

6.4 The following general equipment is needed for all soil sampling, regardless of method:

- Stainless steel bowls;
- Stainless steel trowels;
- Appropriate sample containers for laboratory analysis;
- Personal Protective Equipment (PPE);
- Logbook;
- Cooler and ice for preservation; and
- Stakes and flagging to document sampling location.

6.5 The following additional equipment is needed for volatile organic sampling:

- Electronic pan scale and weights for calibration; and
- Syringes or other discrete soil core samplers.

6.6 The following additional equipment may be needed for surface and test pit soil sampling:

- Hand Auger

6.7 The following additional equipment may be needed for soil sampling from direct push and/or split-spoon equipment:

- Tape measure or folding carpenter's rule for recording the length of soil recovered.

Note: All subsurface drilling equipment will be provided and maintained by the subcontractor.

7.0 Procedure

7.1 General Soil Sampling Procedure for All Soil Sampling Methods

7.1.1 Record the weather conditions and other relevant on-site conditions.

7.1.2 Select the soil sampling location, clear vegetation if necessary, and record the sampling location identification number and pertinent location details.

7.1.3 Verify that the sampling equipment is properly decontaminated, in working order, and situated at the intended sampling location.

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7.1.4 Place polyethylene sheeting on the ground and assemble all necessary sampling equipment on top of it. Cover surfaces onto which soils or sampling equipment will be placed (i.e. tables with polyethylene sheeting).

7.1.5 Follow the appropriate procedures listed below for either surface, split-spoon, direct push, or test pit sample collection (7.2, 7.3, 7.4, and 7.5 respectively).

7.1.6 Collect soil samples according to procedures listed in Section 7.6 depending on project specific analyses.

7.1.7 Record date/time, sample ID, and sample descriptions in the field logbook or field form. A sketch or description of the location may also be recorded so the sample location can be re-constructed, especially if the location will not be recorded using global positioning satellite (GPS) equipment.

7.1.8 Immediately label the sample containers and place them on ice, if required for preservation. Complete the chain-of-custody form(s) as soon as possible.

7.1.9 Dispose of all excess excavated soil in accordance with the SAP.

7.1.10 If required, mark the sample location with a clearly labelled wooden stake or pin flag. If the location is on a paved surface, the location may be marked with spray paint.

7.1.11 Decontaminate the sampling equipment according to SOP 3-06 Equipment Decontamination.

7.2 Surface Sampling

7.2.1 The criteria used for selecting surface soil locations for sampling may include the following:

- Visual observations (soil staining, fill materials);
- Other relevant soil characteristics;
- Site features;
- Screening results;
- Predetermined sampling approach (i.e. grid or random); and
- Sampling objectives as provided in the SAP.

7.2.2 The following procedures are to be used to collect surface soil samples. Surface soils are considered to be soils that are up to two feet below ground surface, though state regulations and project objectives may define surface soils differently; therefore, the SAP should be consulted for direction on the depth from which to collect the surface soil samples. Sampling and other pertinent data and information will be recorded in the field logbook and/or on field forms. Photographs may be taken as needed or as specified in the SAP.

1. Gently scrape any vegetative covering until soil is exposed. Completely remove any pavement.
2. Remove soil from the exposed sampling area with a trowel, hand auger, or shovel. Put soils within the sampling interval in a stainless steel bowl for homogenizing. Monitor the breathing zone and sampling area as required in the HASP.
3. For VOC analyses, collect representative soil samples directly from the recently-exposed soil using a syringe or other soil coring device (e.g., TerraCore®, EnCore®). Follow procedures in Section 7.6.1 for VOC sampling.
4. Collect sufficient soil to fill all remaining sample jars into a stainless steel bowl. Homogenize the soil samples to obtain a uniform soil composition which is representative of the total soil sample collected according to the following procedure:
   a) Remove all rocks and non-soil objects using a stainless steel spoon or scoop.

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b) Form a cone shaped mound with the sample material, then flatten the cone and split the sample into quarters.

c) Use the stainless steel spoon/scoop to mix the quarter samples that are opposite.

d) After mixing the opposite quarters, reform the cone shaped mound.

e) Repeat this procedure a minimum of five (5) times, removing any non-soil objects and breaking apart any clumps.

7.3 Split-Spoon Sampling

7.3.1 At each boring location, the frequency and depth of split-spoon samples will be determined from the SAP. Split-spoon samples may be collected continuously, intermittently, or from predetermined depths.

7.3.2 Split-spoon samplers shall be driven into undisturbed soil by driving the spoon ahead of the drill augers/casing. In cohesive soils, or soils where the borehole remains open (does not collapse), two split-spoon samples may be taken prior to advancing the augers/casing.

7.3.3 After split-spoons are retrieved, open the split-spoon and measure the recovery of soil. If a PID will be used for screening, immediately scan the recovered sample for VOCs using the PID. Scan the recovered soil boring by making a hole in the soil with a decontaminated trowel and placing the PID inlet very close to the hole. Be very careful not to get soil on the tip of the PID. Take PID readings every 6 inches along the split-spoon and/or in any areas of stained or disturbed soil. Record the highest PID reading and the depth at which it was observed along with all other pertinent observations. If required in the SAP, VOC and headspace samples should be collected (see Section 7.6.1) prior to logging the sample.

7.3.4 If headspace screening for VOCs is required in the SAP, collect a soil sample (as defined in the SAP) and perform headspace screening according to SOP 3-19 Headspace Screening for Total VOCs.

7.3.5 Soils collected using the split-spoon sampler will be logged by the field representative using the procedure required in the SAP.

7.3.6 Collect the remainder of the sample volume required into a stainless steel bowl. Homogenize the soil so the material is uniform in composition and representative of the total soil sample collected. Follow homogenizing techniques as described in Section 7.2.

7.3.7 The SAP may specify that intervals to be sent to the laboratory be determined by visual observation and/or highest PID screening or headspace results, which can only be determined once the boring is complete. In this instance, a VOC sample should be collected at each interval. The remainder of the soil from that interval will be set aside in a clearly labelled stainless steel bowl covered with aluminium foil. Once the boring has been completed and the sample interval has been determined, the remainder of the soil can be homogenized according to Section 7.2 and submitted for laboratory analysis.

7.3.8 Once a boring is complete and all required samples have been collected, the boring must be completed as specified in the SAP (e.g., completed as a monitoring well, backfilled with bentonite, etc).

7.4 Direct Push Sampling

At each boring location, the frequency of direct-push samples will be determined from the SAP. Typically, samples with direct-push equipment are collected in 4 foot (ft) intervals, but smaller (e.g., 2 ft) and larger (e.g., 5 ft) intervals are also possible.

1. Sample using Macro-Core samplers with acetate liners to obtain discrete soil samples at the depths specified in the SAP.

2. Cut open the acetate liner. If required in the SAP, immediately scan the recovered soil boring for VOCs using a PID by making a hole in the soil with a decontaminated trowel and placing the PID inlet very close to the hole. Be very careful not to get soil on the tip of the PID. Take PID readings every 6 inches along the split-spoon and/or in any areas of stained or disturbed soil. Record the

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highest PID reading and the depth at which it was observed along with all other pertinent observations. VOC and headspace samples, if required in the SAP should be collected (see Section 7.6.1) prior to logging the sample.

3. If required in the SAP, collect a soil sample (as defined in the SAP) and perform headspace screening according to SOP 3-19 Headspace Screening for Total VOCs.
4. Soils collected using the direct-push sampler will be logged by the by the field representative using the procedure required in the SAP.
5. Collect the remainder of the sample into a stainless steel bowl. Homogenize the soil collected so that the material is uniform in composition and representative of the total soil sample collected. Follow homogenizing techniques as described in Section 7.2.
6. Once a boring is complete and all required samples have been collected, the boring must be completed as specified in the SAP (e.g., completed as a monitoring well, backfilled with bentonite, etc).

7.5 Test Pit Sampling

7.5.1 Excavate the test pit to the desired depth.

7.5.2 Using the excavator bucket, collect soil samples as specified in the SAP. Collect a sample and perform screening analyses as required by the SAP. If VOCs contamination is suspected, perform headspace screening according to SOP 3-19 Headspace Screening for Total VOCs.

7.5.3 Collect the sample from center of the bucket to avoid potential contamination from the bucket.

7.5.4 VOC samples should also be collected from an undisturbed section soil in the excavator bucket. The top layer of exposed soil should be scraped away just prior to collecting the VOC samples.

7.5.5 Collect the remainder of the sample volume required into a stainless steel bowl. Homogenize the soil so the material is uniform in composition and representative of the total soil sample collected. Follow homogenizing techniques as described in Section 7.2.

7.5.6 Dispose of all excavated soil according to the SAP.

7.6 Sample Collection Methods

7.6.1 Volatile Organics Sampling

For soils collected for analyses of volatile organics, including Volatile Petroleum Hydrocarbons (VPH) or other purgable compounds, a closed system is maintained. From collection through analysis, the sample bottles are not opened. The bottle kit for a routine field sample for these analyses will typically include three 40-mL VOA vials and one soil jar. Two 40-mL VOA vials will contain either 5 mL reagent water or 5 mL sodium bisulfate and magnetic stir bars (i.e., low level vials). The third VOA vial will contain 15 mL methanol with no magnetic stir bar (i.e., high level vial). These vials are usually provided by the laboratory and are pre-weighed, with the tare weight recorded on the affixed sample label. No additional sample labels are affixed to the VOA vials, as addition of a label would alter the vial weight. All information is recorded directly on the sample label using an indelible marker. The soil jar is provided for percent solids determination. For VOC or VPH analyses, samples are collected prior to sample homogenization. Collect the VOC sample in accordance with the procedure described below.

1. Determine the soil volume necessary for the required sample weight, typically 5 grams:
   a) Prepare a 5 mL sampling corer (e.g., Terra Core®) or cut-off plastic syringe.
   b) Tare the sampler by placing it on the scale, and zeroing the scale.
   c) Draw back the plunger to the 5 gram mark or 5mL (5cc) mark on cut-off syringe, and insert the open end of the sampler into an undisturbed area of soil with a twisting motion, filling the

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sampler with soil. Note the location of the plunger with respect to the milliliter (cc) or other graduation printed on the sampler.

d) Weigh the filled sampler, and remove or add soil until the desired weight is obtained. Note the location of the plunger which corresponds to this weight. Do not use this sample for laboratory analysis.

2. Once the required soil volume has been determined, pull the plunger back to this mark and hold it there while filling the syringe for each sample.

3. Collect 5 grams of soil using the cut-off syringe or Terra Core® sample device. Extrude the 5-grams of soil into one of the low level 40-mL VOA vials. Quickly wipe any soil from the threads of the VOA vial with a clean Kimwipe® and immediately close the vial. It is imperative that the threads be free from soil or other debris prior to replacing the cap on the vial in order to maintain the closed system necessary for the analysis.

4. Gently swirl the vial so that all of the soil is fully wetted with the preservative.

5. Fill the other low level 40 mL VOA vial in this manner.

6. Repeat the process for the high level VOA vials, only for the high level VOA vial three 5 gram aliquots (i.e., 15 grams total) should be extruded into the high level VOA vial.

   NOTE: Depending on the laboratory, some high level VOA vials only contain 5 mL or 10 mL of methanol. If this is the case, either 5 grams total or 10 grams total, respectively, should be extruded into the high level VOA vial. In other words, the mass of soil in grams should be identical to the volume of methanol in mL (i.e., 1:1 ratio of soil to methanol).

7. Collect any additional QC sample collected (e.g., field duplicate, MS, and MSD) in the same manner as above.

8. Fill the 4-oz glass jar with soil from the same area for percent moisture determination.

7.6.2 Soil Sampling Method (All other analyses except VOC/VPH)

When all the required soil for a sampling location has been obtained, the soil can be homogenized as described in section 7.2. Collect sufficient volume to fill all of the remaining sample containers at least ¾ full for all other analyses. Homogenize the soil in a decontaminated stainless steel bowl, removing rocks, sticks, or other non-soil objects and breaking apart any lumps of soil prior to filling the remaining sample containers.

NOTE: Soil samples must contain greater than 30% solids for the data to be considered valid.

8.0 Quality Control and Assurance

8.1 Sampling personnel should follow specific quality assurance guidelines as outlined in the SAP. Proper quality assurance requirements should be provided which will allow for collection of representative samples from representative sampling points. Quality assurance requirements outlined in the SAP typically suggest the collection of a sufficient quantity of field duplicate, field blank, and other samples.

8.2 Quality control requirements are dependent on project-specific sampling objectives. The SAP will provide requirements for equipment decontamination (frequency and materials), sample preservation and holding times, sample container types, sample packaging and shipment, as well as requirements for the collection of various quality assurance samples such as trip blanks, field blanks, equipment blanks, and field duplicate samples.

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9.0 Records, Data Analysis, Calculations

All data and information (e.g., sample collection method used) must be documented on field data sheets, boring logs, or within site logbooks with permanent ink. Data recorded may include the following:

- Weather conditions;
- Arrival and departure time of persons on site;
- Instrument type, lamp (PID), make, model and serial number;
- Calibration gas used;
- Date, time and results of instrument calibration and calibration checks;
- Sampling date and time;
- Sampling location;
- Samples collected;
- Sampling depth and soil type;
- Deviations from the procedure as written; and
- Readings obtained.

10.0 Attachments or References

SOP 3-06, *Equipment Decontamination*

SOP 3-19, *Headspace Screening for Total VOCs*

SOP 3-20, *Operation and Calibration of a Photoionization Detector*

Author	Reviewer	Revisions (Technical or Editorial)
Robert Shoemaker Senior Scientist	Chris Barr Program Quality Manager	Rev 0 – Initial Issue (May 2012)

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Water Quality Parameter Testing for Groundwater Sampling

Procedure SOP-3-24

1.0 Purpose and Scope

1.1 This standard operating procedure (SOP) This standard operating procedure (SOP) describes methods for measuring water quality parameters during well purging activities.

1.2 As guidance for specific activities, this procedure does not obviate the need for professional judgment. Deviations from this procedure while planning or executing planned activities must be approved in accordance with Program requirements for technical planning and review.

2.0 Safety

Safety glasses with side shields or goggles and disposable gloves shall be worn during calibration activities.

3.0 Terms and Definitions

3.1 **Barometric Pressure (BP)**

The density of the atmosphere, which varies according to altitude and weather conditions.

3.2 **Conductivity/Specific Conductance**

A measure of the ability of water to pass electrical current, which increases with the amount of dissolved ionic substances (i.e., salts). Conductivity is inversely related to the resistance of a solution and is measured in units of mhos per centimeter (mhos/cm) (inverse ohms/cm, Siemens/cm). The conductivity of water increases with increasing temperature. *Specific Conductance is corrected for 25 degrees Celsius (°C); for this reason, it is best to record Specific Conductance. If Conductivity is recorded, the temperature of the sample MUST recorded.*

3.3 **Dissolved Oxygen (DO)**

The amount of oxygen present in water and available for respiration. DO is typically measured in milligrams per liter (mg/L). Oxygen is less soluble in warm and salty waters, so the instrument compensates the apparent percent saturation for changes in temperature and conductivity. Most probes measure the current resulting from the electrochemical reduction of oxygen (at a gold cathode) diffusing through a selective membrane. Because oxygen is being removed from the sample to perform the measurement, sample flow is required to prevent false low readings due to depletion of oxygen in the solution in front of the probe. Optical DO probes do not remove oxygen from the sample and are less affected by salts. The common range of DO in groundwater is 0.0 to 3.0 mg/L. Measurements outside of this range suggest that the meter may not be operating correctly.

3.4 **Nephelometric Turbidity Unit (NTU)**

The measurement of light passing through a sample based on the scattering of light caused by suspended particles.

3.5 **pH**

A measure of acidity and alkalinity of a solution using a logarithmic scale on which a value of 7 represents neutrality, lower numbers indicate increasing acidity, and higher numbers are increasingly basic.

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3.6 **Oxidation-Reduction Potential (ORP)**

Also known as redox or eH, ORP is a measurement of the potential for a reaction to occur, which generally indicates the oxygen status of a sample. The probe consists of a platinum electrode, the potential of which is measured with respect to a reference electrode that rapidly equilibrates with the potential of the sample solution. A positive value indicates that oxygen is present. A negative value indicates an anaerobic environment or reducing condition. For this reason, negative ORP readings should be associated with DO readings of less than 0.5 mg/l; with negative ORP readings the water may exhibit a sulfur odor or gray color. Positive ORP readings should be associated with DO readings greater than 0.5 mg/L and lack of sulfur odors. Because of the complex relationship between ORP and temperature, no compensation is attempted; it is thus best to report both the ORP and temperature of a water sample.

3.7 **Total Dissolved Solids**

A measure of the quantity of materials in water that is either dissolved or too small to be filtered.

3.8 **Turbidity**

Measure of the clarity of water in NTUs. Potable water typically has NTU values between 0.0 and 0.3 NTUs, depending on the state or regulatory program.

4.0 Responsibilities

4.1 The CTO Manager is responsible for ensuring that this standard operating procedure is followed and shall review all groundwater sampling forms at the conclusion of a sampling event decontamination activities comply with this procedure. The CTO Manager is responsible for ensuring that all personnel involved in water quality measurements have the appropriate education, experience, and training to perform their assigned tasks.

4.2 The Program Quality Manager is responsible for ensuring overall compliance with this procedure.

4.3 The Field Manager is responsible for ensuring that all field equipment is decontaminated according to this procedure.

4.4 All Field Personnel are responsible for the implementation of this procedure.

5.0 Procedures

5.1 **Purpose**

The procedures will vary depending on parameters being measured, method of sampling, and the method of measurement used. The information here is a general guidance and the site-specific documents and manufacturer manuals supersede these procedures.

5.2 **Cautions**

Improper use of water quality testing equipment could result in equipment damage or compromised sampling results. Personnel should be trained to operate the test equipment being used for a field operation and should be trained in the proper techniques for collecting and logging water quality parameters. Personnel should also be able to recognize problems with test equipment and have someone available for basic troubleshooting and repair.

5.3 **Interferences**

During field testing, water quality data that is documented from field testing equipment may be influenced by certain outside factors that are unrelated to the actual site water quality. Such parameters and equipment include the following:

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pH Meters

- Coatings of oils, greases, and particles may impair the electrode's response. Pat the electrode bulb dry with lint-free paper or cloth and rinse with de-ionized water. For cleaning hard-to-remove films, use isopropyl alcohol very sparingly so that the electronic surface is not damaged.
- Poorly buffered solutions with low specific conductance (less than 200 microsiemens per centimeter) may cause fluctuations in the pH readings. Equilibrate electrode by immersing in several aliquots of sample before taking pH.

Dissolved Oxygen

- Dissolved gases (e.g., hydrogen sulfide, halogens, sulfur dioxide) are a factor with the performance of DO probes. The effect is less pronounced on optical DO meters. Meter type and potential interferences should be considered based on potential sulfate/sulfide or nitrate/nitrite reducing environments.
- Exposure of the sample to the atmosphere will cause elevated DO measurements.

Turbidity Meter

- If the weather is warm and humidity is high, condensation may collect on the cuvet. To avoid this, allow the sample to warm and dry the outside of the cuvet before making the measurement. One method used to accomplish this is to place the cuvet against one's body (armpits work well).

Temperature

- Sample temperature will change rapidly when there are significant differences between the sample and ambient air.

5.4 Apparatus and Materials

Field personnel shall consult the site work plan and SAP to review the equipment requirements for the sampling procedures to be followed during the sampling effort. The specific apparatus and materials required will depend on the water quality parameters being monitored. Table 1 shows the common equipment used in water quality parameter testing.

Table 1
Water Quality Parameter Testing — Common Equipment

Water Quality Parameter Instrument	Calibration Standards Required	Other Equipment
pH Meter	Yes — 2 or 3 Point Standards depending on groundwater range. Calibration must cover the range to be measured. If samples are above or below typical buffer standards (4, 7 and 10), special order buffers that fall outside groundwater pH range.	Container or flow thru cell for holding sample
Specific Conductance	Yes	Container or flow thru cell for holding sample
ORP Meter	Yes	Container or flow thru cell for holding sample
Turbidity Meter	Yes	Container or flow thru cell for holding sample
DO	No	Container or flow thru cell for holding sample
Thermometer	No	Container or flow thru cell for holding sample
Flow Rate	No	Calibrated Container

Notes:
ORP = Oxidation-Reduction Potential
DO = Dissolved Oxygen

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5.5 Instrument or Method Calibration

Most monitoring instruments require calibration before use, and this calibration must be conducted in the field under the ambient climatic conditions that will be present during field sampling. Calibration of monitoring instruments shall be performed in accordance with the manufacturer's specifications and recorded in the provided form in Attachment 1. Site-specific instrument calibration requirements should be specified in the SAP. The following minimum calibration requirements apply to the various types of meters used to gather water quality measurements.

Initial Calibration (IC): Before use, the instrument or meter electronics are adjusted (manually or automatically) to a theoretical value (e.g., DO saturation) or a known value of a calibration standard. An IC is performed in preparation for the first use of an instrument or if a calibration verification does not meet acceptance criteria.

Initial Calibration Verification (ICV): The instrument or meter calibration is checked or verified directly following IC by measuring a calibration standard of known value as if it were a sample and comparing the measured result to the calibration acceptance criteria for the instrument/parameter. If an ICV fails to meet acceptance criteria, immediately recalibrate the instrument using the applicable initial calibration procedure or remove it from service.

Continuing Calibration Verification (CCV): After use, the instrument or meter calibration is checked or verified by measuring a calibration standard of known value as if it were a sample and comparing the measured result to the calibration acceptance criteria for the instrument/parameter.

5.5.1 Calibration Checks

Calibration checks are conducted by measuring a known standard. They must be completed after calibration and should be performed at least one other time (i.e., after lunch) and anytime suspect measurements are encountered. Table 2 provides general acceptance ranges to be used during calibration checks. If a meter is found to be outside of the acceptance range, the meter **must** be recalibrated. If the meter remains out of range, the project manager and/or the supplier of the meter should be contacted to determine alternative measures.

Table 2
Calibration Check Acceptance Limits

Parameter	Acceptance Criteria
Dissolved Oxygen	±0.3 mg/L of the theoretical oxygen solubility
Oxidation-Reduction Potential	±10 mv from the theoretical standard value at that temperature
pH	±0.2 Standard pH Units
Specific Conductance	±5% of the standard
Turbidity	0.1 to 10 NTU: ±10% of the standard 11 to 40 NTU: ±8% of the standard 41 to 100 NTU: ±6.5% of the standard

Notes:

mg/L = milligrams per liter
mv = millivolts
NTU = nephelometric turbidity units

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5.5.2 Possible and Suspected Ranges

The concentration for each parameter range should be known so that concentrations outside of the range can be noted. Table 3 presents the maximum range of the parameter in groundwater. The table also presents the suspected range. Measurements outside of the maximum/minimum range should be considered in error and the measurement method should be checked. Concentrations outside the normal range should be treated as suspect but may be the result of contaminant impact. For example, a pH of 2.0 would be out of the normally suspected range for groundwater but not at a site impacted with an acid.

Table 3
Minimum and Maximum Result Ranges

Parameter	Units	Possible Min	Possible Max	Normal Min	Normal Max	Notes
Dissolved Oxygen	mg/L	0.0	14.6 (0°C) 10.1 (15°C) 8.3 (2°C)	0.0	5	The colder the sample, the higher the DO reading. DO greater than 1 mg/L, ORP positive should not have sulfur odor, sulfide, ferrous iron and/or gray color. DO less than 1 mg/L, ORP negative, may have sulfur odor, sulfide, ferrous iron and/or gray color.
pH	SU	0	14	5	9	pH values exceeding 10 could indicate grout contamination
ORP	mv					DO greater than 1 mg/L, ORP positive should not have sulfur odor, sulfide, ferrous iron and/or gray color. DO less than 1 mg/L, ORP negative, may have sulfur odor, sulfide, ferrous iron and/or gray color.
Specific Conductance	µS/cm			varies	varies	
Temperature	°C	0	100	5	30	
Turbidity	NTU	0	Greater than 1,000	0	Greater than 1,000	50 NTU or greater suggests cloudiness.

Notes:

mg/L = milligrams per liter
°C = degrees Celsius
DO = dissolved oxygen
SU = standard units
ORP = oxidation reduction potential
mv = millivolts
mS/cm = micro Siemens per cm
NTU = nephelometric turbidity units

5.5.3 Field Instruments and Calibration Criteria

The calibration acceptance criteria for each instrument are summarized in Table 4 along with special considerations related to each field instrument.

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Table 4
Calibration Check Acceptance Limits

Parameter	Acceptance Criteria
Dissolved Oxygen	±0.3 mg/L of the theoretical oxygen solubility.
Oxidation-Reduction Potential	±10 mv from the theoretical standard value at that temperature.
pH	±0.2 Standard pH Units
Specific Conductance	±5% of the standard
Turbidity	0.1 to 10 NTU: ±10% of the standard 11 to 40 NTU: ±8% of the standard 41 to 100 NTU: ±6.5% of the standard

Notes:
mg/L = milligrams per liter
mv = millivolts
NTU = nephelometric turbidity units

pH Meters

- For the most accurate of pH measurements, pH meters should receive a three-point calibration. However, if a two-point calibration will bracket the groundwater pH of the site, a two-point calibration is acceptable. Three-point calibrations typically include calibrating to solutions of pH 7.00, 4.00, and 10.00. If groundwater pH is outside the calibration range of the solution standards, special buffers must be ordered to bracket the pH. Some meters will report the slope of the calibration and this may be used in checking the meter calibration (refer to the meter's manual). When performing an ICV, the result must be within +/- 0.2 pH units of the stated buffer value.

- pH meters should be calibrated across the range of values to be measured. The maximum and minimum calibration solutions shall be outside the range of anticipated values. For example, if the expected range is between 7.50 and 9.00, the 7.00 and the 10.00 standard should be used for calibration. Perform the IC using at least two buffers, and always use the pH 7.00 buffer first. A reading that is above the maximum (or below the minimum) calibration standard is an estimate only and is not valid. This condition requires obtaining a new standard that is above (or below) the reported value, depending on the measurement.

- A percent slope of less than 90 percent indicates a bad electrode that must be changed or repaired. If percent slope cannot be determined, or the manufacturer's optimum specifications are different, follow the manufacturer's recommendation for maintaining optimum meter performance.

Specific Conductivity Meters

- For IC, when the sample measurements are expected to be 100 microsiemens per centimeter (µS/cm) or greater, use two standard potassium chloride (KCl) solutions that bracket the range of expected sample conductivities. Calibrate the instrument with the first standard. Verify the calibration of the instrument with the second standard, bracketing the range of expected sample values.

- If the instrument can be calibrated with more than one standard, choose additional calibration standards within the range of expected sample values.

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- When the sample measurements are expected to be less than 100 µS/cm, a lower bracket is not required, but one standard (KCl) solution that is within the range of expected measurements must be used for the IC and the ICV.

- Accept the calibration if the meter reads within +/- 5 percent of the value of any calibration standard used to verify the calibration.

- Most field instruments read conductivity directly. Record all readings and calculations in the calibration records.

- For CCV, check the meter with at least one KCl standard with a specific conductance in the range of conductivity measured in environmental samples. The reading for the calibration verification must also be within +/- 5 percent of the standard value.

- If new environmental samples are encountered outside the range of the IC, verify the instrument calibration with two standards bracketing the range of sample values. If these calibration verifications fail, recalibrate the instrument.

Dissolved Oxygen Meters

- Before calibrating, check the probe membrane for bubbles, tears, or wrinkles. These conditions require replacement of the membrane in accordance with the manufacturer's directions.

- If the meter provides readings that are off-scale, will not calibrate, or drift, check the leads, contacts, etc., for corrosion and/or short circuits. These conditions require replacement maintenance in accordance with the manufacturer's directions.

- Most DO meters must be calibrated based on an environment of 100 percent humidity and a known elevation and barometric pressure (BP).

- For 100 percent humidity, place the probe in the calibration container with a moist towel and allow the probe to remain, undisturbed, for 10 to 20 minutes.

- The IC is an air calibration at 100% saturation. Before use, verify the meter calibration in water-saturated air to make sure it is properly calibrated and operating correctly. Make a similar verification at the end of the day or sampling event. Follow the manufacturer's instructions for your specific instrument. Allow an appropriate warm up period before IC. Wet the inside of the calibration chamber with water, pour out the excess water (leave a few drops), wipe any droplets off the membrane/sensor and insert the sensor into the chamber (this ensures 100 percent humidity). Allow adequate time for the DO sensor and the air inside the calibration chamber to equilibrate. Once the probe/calibration chamber is stable at ambient temperature, check the air temperature and determine, from the DO versus temperature table (see Attachment 2) what DO should measure. The acceptance criterion for DO ICV is +/- 0.3 mg/L.

- Use the same procedure as above for CCV.

ORP Meters

- Verify electrode response before use in the field.

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- Equilibrate the standard solution to the temperature of the sample. The standard solution is based on a 25°C temperature; however, the calibration solution standard's value will require adjustment based on the temperature.

- Immerse the electrodes and gently stir the standard solution in a beaker (or flow cell). Turn the meter on, placing the function switch in the millivolt (mv) mode.

- Let the electrode equilibrate and record the reading to the nearest millivolt. The reading must be within ±10 mv from the theoretical redox standard value at that temperature. If not, determine the problem and correct it before proceeding. Switch to temperature display and read the value.

- Record the mv reading and temperature in the field notebook or in form. Rinse the electrode with distilled water and proceed with the sample measurement, unless using a flow cell. If a flow cell is used, rinse between sample locations.

Turbidity Meters

- Perform an initial calibration using at least two primary standards.

- If the instrument cannot be calibrated with two standards, calibrate the instrument with one standard and verify with a second standard.

- Perform an ICV by reading at least one primary standard as a sample. The acceptance criterion for the ICV depends on the range of turbidity of the standard value:

  1. Standard Value = 0.1 to 10 NTU: the response must be within 10 percent of the standard;

  2. Standard Value = 11 to 40 NTU: the response must be within 8 percent of the standard;

  3. Standard Value = 41 to 100 NTU: the response must be within 6.5 percent of the standard; and

  4. Standard Value greater than 100 NTU: the response must be within 5 percent of the standard.

- Determining the Values of Secondary Standards: Use only those certified by the manufacturer for a specific instrument. Secondary standards may be used for CCVs. To initially determine the value of a secondary standard, assign the value that is determined immediately after an ICV or verification with primary standards. This is done by reading the secondary standard as a sample. This result must be within the manufacturer's stated tolerance range and +/- 10 percent of the assigned standard value. If the +/- 10 percent criterion is not met, assign this reading as the value of the standard. If the reading is outside the manufacturer's stated tolerance range, discard the secondary standard.

- CCV: Perform a CCV using at least one primary or secondary standard. The calibration acceptance criteria are the same as those for an ICV.

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5.6 Direct Measurements

Direct measurements with meters are the most common methods and can be accomplished by placing a sample in a container with the probe or by allowing the water to flow past the probe in a flow cell. The use of a flow-through cell improves measurement quality by allowing the constant flow of water over the probes and reduces interaction of the sample with the atmosphere. Sample cups should be avoided. The quantity of samples, timing, and methodology should be described in the project SAP.

Following calibration of required probes, connect the bottom flow-cell port to the discharge line of the pump. Connect the top port to a discharge line directed to a bucket to collect the purge water. Allow the flow cell to completely fill. As the water flows over the probe, record the measurements. Continue to record the measurements at regular intervals, as specified in the SAP.

When the ambient air temperatures are much higher or lower than the temperature of the water sample, it is best to keep the length of tubing between the wellhead and the flow cell as short as possible to prevent heating or cooling of the water. Tubing and flow-through cell should not be exposed to direct sunlight, particularly in the summer, if at all possible, to avoid heating of water samples.

5.7 Data Acquisitions, Calculations, and Data Reduction

5.7.1 Specific Conductivity Correction Factions

If the meter does not automatically correct for temperature (i.e., read Specific Conductivity) record Conductivity and adjust for temperature upon returning to the office. The following equation can be used to convert Conductivity to Specific Conductivity.

$$K = \frac{(Km)(C))}{1 + 0.0191(\mathrm{T} - 25)}$$

Where:

K = Conductivity in μmhos/cm at 25°C

Km = Measured conductivity in μmhos/cm at T degrees Celsius

C = Cell constant

T = Measured temperature of the sample in degrees Celsius;

If the cell constant is 1, the formula for determining conductivity becomes:

$$K = \frac{(Km)}{1 + 0.0191(\mathrm{T} - 25)}$$

5.7.2 Percentage Difference Calculation

For evaluating slope of readings from either a flow cell or a sample cup.

$$\%Difference = \frac{(Highest\ Value - Lowest\ Value)}{(Highest\ Value)}\ x\ 100$$

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5.7.3 Convert mm mercury (mmHG) to inches mercury (inHG)

$$mmHG = inHG\ x\ 25.4$$

5.7.4 True Barometric Pressure

For converting BP obtained from a public domain source that is expressed in BP at sea level to BP at the subject site.

$$TrueBP = (BP) - \frac{(2.5\ x\ [Local\ Altitude])}{100}$$

Where: BP is in mmHG and Local Altitude is in feet

Example: BP at site A is 30.49 inHg and elevation is 544 feet, calculate TrueBP

Convert inHG to mmgHG:

mmHg = 30.49 inHg x 25.4 = 774.4 mmHg

Calculate True BP:

TrueBP = (774.4 mmHg) – [2.5 * (544 /100)] = 774.4-13.6 = 760.8 mmHg

6.0 Quality Control and Assurance

Instrument calibration and verification requirements specified in Section 5.5 are used to verify instruments are operating properly and are reliable. If calibration criteria fall outside the acceptance criteria specified in Table 4, the user should consult the instrument operation manual for appropriate corrective action. Data will be recorded promptly, legibly, and in indelible ink on the appropriate logbooks and forms.

7.0 Records

All field data forms and calibration logs shall be scanned and made electronically available to the Project Team at the end of the field effort. Original paper records shall be maintained with the log book in the project file.

8.0 Attachments and References

Attachment 1: Example Field Instrument Calibration Form

Attachment 2: Solubility of Oxygen at Given Temperatures

Attachment 3: Example Field Data Form

Author	Reviewer	Revisions (Technical or Editorial)
David Doyle Project Geologist	Ben Brantley Project Manager	Rev 0 — Initial Issue

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Attachment 1

Example Field Instrument Calibration Form

Field Instrument Calibration Form

Site: _____

Sampling Event: _____

Calibrated by: _____

Date: _____

Equipment (Make/Model/Serial#): _____

Equipment (Make/Model/Serial#): _____

Equipment (Make/Model/Serial#): _____

pH (su) — Standard: ± 0.2 standard units

	Initial Calibration		Initial Calibration Verification	
	Brand & Solution Lot #	Reading	Std. Brand	Reading
pH7				
pH4				
pH 10				

Continuing Calibration Verification

		Reading	Deviation	Acceptable Variance (Y/N)
pH7				
pH4				
pH 10				

DO (mg/L) — Standard: ± 0.3 mg/L of theoretical*

IC (Temp:)		ICV (Temp:)	
Saturation (%)	Reading (%)	Theoretical (mg/L)	Reading (mg/L)
100			

Continuing Calibration Verification

Saturation (%)	Reading (%)	Deviation	Acceptable Variance (Y/N)
100			

Theoretical (mg/L)	Reading (mg/L)	Deviation	Acceptable Variance (Y/N)

ORP (mV) — Standard: NA

	Initial Calibration		Initial Calibration Verification	
	TCS & Solution Lot # (Std/Temp)	Reading	(Std/Temp)	Reading

Continuing Calibration Verification

TCS (Std/Temp)	Reading	Deviation	Acceptable Variance (Y/N)

Turbidity (ntu) — Standard: ±10% of Standard

Initial Calibration

Brand & Solution Lot #	Reading

Continuing Calibration Verification

Standard	Reading	Deviation	Acceptable Variance (Y/N)

Conductivity (ms^C/cm) — Standard: ± 5% of standard value

	Initial Calibration		Initial Calibration Verification	
	Brand & Solution Lot #			
	Standard	Reading	Standard	Reading

Continuing Calibration Verification

Standard	Reading	Deviation	Acceptable Variance (Y/N)

Comments:

Notes:

SL	solution lot	su	standard units
TCS	temperature corrected standard	mV	millivolts
Std	standard	%	percent
Temp	temperature	mg/L	milligrams per liter
ntu	Nephelometric Turbidity Units		
°C	degrees Celsius		
ms^C/cm	millisiemens per centimeter (temperature corrected)		
*	Theoretical value listed on Table FT 1500-1 (attached)		

Attachment 2

Solubility of Oxygen at Given Temperatures

ORP Calibration Adjustments for Temperature

Solubility of Oxygen in Water at Atmospheric Pressure			
Temperature	**Oxygen Solubility**	**Temperature**	**Oxygen Solubility**
°C	**mg/L**	**°C**	**mg/L**
0.0	14.621	26.0	8.113
1.0	14.216	27.0	7.968
2.0	13.829	28.0	7.827
3.0	13.460	29.0	7.691
4.0	13.107	30.0	7.559
5.0	12.770	31.0	7.430
6.0	12.447	32.0	7.305
7.0	12.139	33.0	7.183
8.0	11.843	34.0	7.065
9.0	11.559	35.0	6.950
10.0	11.288	36.0	6.837
11.0	11.027	37.0	6.727
12.0	10.777	38.0	6.620
13.0	10.537	39.0	6.515
14.0	10.306	40.0	6.412
15.0	10.084	41.0	6.312
16.0	9.870	42.0	6.213
17.0	9.665	43.0	6.116
18.0	9.467	44.0	6.021
19.0	9.276	45.0	5.927
20.0	9.092	46.0	5.835
21.0	8.915	47.0	5.744
22.0	8.743	48.0	5.654
23.0	8.578	49.0	5.565
24.0	8.418	50.0	5.477
25.0	8.263		

Notes:
The table provides three decimals to aid interpolation
Under equilibrium conditions, the partial pressure of oxygen in air-saturated water is equal to that of the oxygen in water saturated
°C = degrees Celsius
mg/L = milligrams per liter

ORP (Zobell) Temperature Adjustments

Temperature (°C)	Zobell Solution Value (mV)	Temperature (°C)	Zobell Solution Value (mV)
1	262.2	26	229.7
2	260.9	27	228.4
3	259.6	28	227.1
4	258.3	29	225.8
5	257	30	224.5
6	255.7	31	223.2
7	254.4	32	221.9
8	253.1	33	220.6
9	251.8	34	219.3
10	250.5	35	218
11	249.2	36	216.7
12	247.9	37	215.4
13	246.6	38	214.1
14	245.3	39	212.8
15	244	40	211.5
16	242.7	41	210.2
17	241.4	42	208.9
18	240.1	43	207.6
19	238.8	44	206.3
20	237.5	45	205
21	236.2	46	203.7
22	234.9	47	202.4
23	233.6	48	201.1
24	232.3	49	199.8
25	231	50	198.5

Attachment 3

Example Field Data Form

WELL DEVELOPMENT & GROUNDWATER SAMPLING FORM

DATE:	JOB NUMBER:	EQUIPMENT (Make/Model #/Serial #):
PROJECT:	EVENT:	/ /
WELL ID:	LOCATION:	/ /
WEATHER CONDITIONS:	AMBIENT TEMP:	/ /
REVIEWED BY:	PERSONNEL:	/ /

WELL DIA:	**WELL DEVELOPMENT**	
TOTAL DEPTH from TOC (ft.):	START:	FINISH:
DEPTH TO WATER from TOC (ft.):	VOLUME PURGED (gal):	
LENGTH OF WATER COL. (ft.):	**GROUNDWATER SAMPLING**	
1 VOLUME OF WATER (gal):	START:	FINISH:
3 VOLUMES OF WATER (gal):	VOLUME PURGED (gal):	
	ANALYSIS:	

WELL DEVELOPMENT PARAMETERS		GW SAMPLING PARAMETERS	
Temperature:	± 1.0° C	Temperature:	± 0.2° C
pH:	± 0.5 standard units	pH:	± 0.2 standard units
Specific Conductance:	± 10% of the past measurement	Specific Conductance:	± 5% of the past measurement
Turbidity:	relatively stable	DO:	≤ 20% saturation
		ORP:	± 10 millivolts
		Turbidity:	≤ 10 NTU

IN-SITU TESTING

Circle one: DEVELOPMENT SAMPLING ☐ Bailer ☐ Pump Description:

Time (hh:mm):												
pH (units):												
Conductivity (mS/cm):												
Turbidity (NTU):												
DO (mg/L): YSI 556												
DO (mg/L): YSI 550												
Temperature (C°):												
ORP (mV):												
Volume Purged (gal):												
Depth to Water (ft):												
								Well Goes Dry While Purging ☐				

SAMPLE DATA

☐ Bailer ☐ Pump Description:

Sample ID	Date (m/d/y)	Time (hh:mm)	Bottles (total to lab)	Filtered (0.45 µm)	Remarks
Purging/Sampling Device Decon Process:					

COMMENTS:

Purge water placed in drum#_____

Figure: 30 TAC §350.77(b)

TIER 1: EXCLUSION CRITERIA CHECKLIST

This exclusion criteria checklist is intended to aid the person and the TCEQ in determining whether or not further ecological evaluation is necessary at an affected property where a response action is being pursued under the Texas Risk Reduction Program (TRRP). Exclusion criteria refer to those conditions at an affected property which preclude the need for a formal ecological risk assessment (ERA) because there are **incomplete or insignificant ecological exposure pathways** due to the nature of the affected property setting and/or the condition of the affected property media. This checklist (and/or a Tier 2 or 3 ERA or the equivalent) must be completed by the person for all affected property subject to the TRRP. The person should be familiar with the affected property but need not be a professional scientist in order to respond, although some questions will likely require contacting a wildlife management agency (i.e., Texas Parks and Wildlife Department or U.S. Fish and Wildlife Service). The checklist is designed for general applicability to all affected property; however, there may be unusual circumstances which require professional judgement in order to determine the need for further ecological evaluation (e.g., cave-dwelling receptors). In these cases, the person is strongly encouraged to contact TCEQ before proceeding.

Besides some preliminary information, the checklist consists of three major parts, **each of which must be completed unless otherwise instructed.** PART I requests affected property identification and background information. PART II contains the actual exclusion criteria and supportive information. PART III is a qualitative summary statement and a certification of the information provided by the person. **Answers should reflect existing conditions and should not consider future remedial actions at the affected property.** Completion of the checklist should lead to a logical conclusion as to whether further evaluation is warranted. Definitions of terms used in the checklist have been provided and users are strongly encouraged to familiarize themselves with these definitions before beginning the checklist.

Name of Facility:

Affected Property Location:

Mailing Address:

TCEQ Case Tracking #s:

Solid Waste Registration #s:

Voluntary Cleanup Program #:

EPA I.D. #s:

Definitions[1]

Affected property - The entire area (i.e., on-site and off-site; including all environmental media) which contains releases of chemicals of concern at concentrations equal to or greater than the assessment level applicable for residential land use and groundwater classification.

Assessment level - A critical protective concentration level for a chemical of concern used for affected property assessments where the human health protective concentration level is established under a Tier 1 evaluation as described in §350.75(b) of this title (relating to Tiered Human Health Protective Concentration Level Evaluation), except for the protective concentration level for the soil-to-groundwater exposure pathway which may be established under Tier 1, 2, or 3 as described in §350.75(i)(7) of this title, and ecological protective concentration levels which are developed, when necessary, under Tier 2 and/or 3 in accordance with §350.77(c) and/or (d), respectively, of this title (relating to Ecological Risk Assessment and Development of Ecological Protective Concentration Levels).

Bedrock - The solid rock (i.e., consolidated, coherent, and relatively hard naturally formed material that cannot normally be excavated by manual methods alone) that underlies gravel, soil or other surficial material.

Chemical of concern - Any chemical that has the potential to adversely affect ecological or human receptors due to its concentration, distribution, and mode of toxicity. Depending on the program area, chemicals of concern may include the following: solid waste, industrial solid waste, municipal solid waste, and hazardous waste as defined in Texas Health and Safety Code, §361.003, as amended; hazardous constituents as listed in 40 Code of Federal Regulations Part 261, Appendix VIII, as amended; constituents on the groundwater monitoring list in 40 Code of Federal Regulations Part 264, Appendix IX, as amended; constituents as listed in 40 CFR Part 258 Appendices I and II, as amended; pollutant as defined in Texas Water Code, §26.001, as amended; hazardous substance as defined in Texas Health and Safety Code, §361.003, as amended, and the Texas Water Code, §26.263, as amended; other substances as defined in Texas Water Code, §26.039(a), as amended; and daughter products of the aforementioned constituents.

Community - An assemblage of plant and animal populations occupying the same habitat in which the various species interact via spatial and trophic relationships (e.g., a desert community or a pond community).

Complete exposure pathway - An exposure pathway where a human or ecological receptor is exposed to a chemical of concern via an exposure route (e.g., incidental soil ingestion, inhalation of volatiles and particulates, consumption of prey, etc).

De minimus **-** The description of an area of affected property comprised of one acre or less where the ecological risk is considered to be insignificant because of the small extent of contamination, the absence of protected species, the availability of similar unimpacted habitat nearby, and the lack of adjacent sensitive environmental areas.

Ecological protective concentration level - The concentration of a chemical of concern at the point of exposure within an exposure medium (e.g., soil, sediment, groundwater, or surface water) which is determined in accordance with §350.77(c) or (d) of this title (relating to Ecological Risk Assessment and Development of Ecological Protective Concentration Levels) to be protective for ecological receptors. These concentration levels are primarily intended to be protective for more mobile or wide-ranging ecological receptors and, where appropriate, benthic invertebrate communities within the waters in the state. These concentration levels are not intended to be directly protective of receptors with limited mobility or range (e.g., plants, soil invertebrates, and small rodents), particularly those residing within active areas of a facility, unless these receptors are threatened/endangered species or unless impacts to these receptors result in disruption of the ecosystem or other unacceptable consequences for the more mobile or wide-ranging receptors (e.g., impacts to an off-site grassland habitat eliminate rodents which causes a desirable owl population to leave the area).

Ecological risk assessment - The process that evaluates the likelihood that adverse ecological effects may occur or are occurring as a result of exposure to one or more stressors; however, as used in this context, only chemical stressors (i.e., COCs) are evaluated.

Environmental medium - A material found in the natural environment such as soil (including non-waste fill materials), groundwater, air, surface water, and sediments, or a mixture of such materials with liquids, sludges, gases, or solids, including hazardous waste which is inseparable by simple mechanical removal processes, and is made up primarily of natural environmental material.

Exclusion criteria - Those conditions at an affected property which preclude the need to establish a protective concentration level for an ecological exposure pathway because the exposure pathway between the chemical of concern and the ecological receptors is not complete or is insignificant.

Exposure medium - The environmental medium or biologic tissue in which or by which exposure to chemicals of concern by ecological or human receptors occurs.

Facility - The installation associated with the affected property where the release of chemicals of concern occurred.

Functioning cap - A low permeability layer or other approved cover meeting its design specifications to minimize water infiltration and chemical of concern migration, and prevent ecological or human receptor exposure to chemicals of concern, and whose design requirements are routinely maintained.

Landscaped area - An area of ornamental, or introduced, or commercially installed, or manicured vegetation which is routinely maintained.

Off-site property (off-site) - All environmental media which is outside of the legal boundaries of the on-site property.

On-site property (on-site) - All environmental media within the legal boundaries of a property owned or leased by a person who has filed a self-implementation notice or a response action plan for that property or who has become subject to such action through one of the agency's program areas for that property.

Physical barrier - Any structure or system, natural or manmade, that prevents exposure or prevents migration of chemicals of concern to the points of exposure.

Point of exposure - The location within an environmental medium where a receptor will be assumed to have a reasonable potential to come into contact with chemicals of concern. The point of exposure may be a discrete point, plane, or an area within or beyond some location.

Protective concentration level - The concentration of a chemical of concern which can remain within the source medium and not result in levels which exceed the applicable human health risk-based exposure limit or ecological protective concentration level at the point of exposure for that exposure pathway.

Release - Any spilling, leaking, pumping, pouring, emitting, emptying, discharging, injecting, escaping, leaching, dumping, or disposing into the environment, with the exception of:

> (A) A release that results in an exposure to a person solely within a workplace, concerning a claim that the person may assert against the person's employer;

(B) An emission from the engine exhaust of a motor vehicle, rolling stock, aircraft, vessel, or pipeline pumping station engine;

(C) A release of source, by-product, or special nuclear material from a nuclear incident, as those terms are defined by the Atomic Energy Act of 1954, as amended (42 U.S.C. §2011 *et seq*.), if the release is subject to requirements concerning financial protection established by the Nuclear Regulatory Commission under §170 of that Act;

(D) For the purposes of the environmental response law §104, as amended, or other response action, a release of source, by-product, or special nuclear material from a processing site designated under §102(a)(1) or §302(a) of the Uranium Mill Tailings Radiation Control Act of 1978 (42 U.S.C. §7912 and §7942), as amended; and

(E) The normal application of fertilizer.

Sediment - Non-suspended particulate material lying below surface waters such as bays, the ocean, rivers, streams, lakes, ponds, or other similar surface water body (including intermittent streams). Dredged sediments which have been removed from below surface water bodies and placed on land shall be considered soils.

Sensitive environmental areas - Areas that provide unique and often protected habitat for wildlife species. These areas are typically used during critical life stages such as breeding, hatching, rearing of young, and overwintering. Examples include critical habitat for threatened and endangered species, wilderness areas, parks, and wildlife refuges.

Source medium - An environmental medium containing chemicals of concern which must be removed, decontaminated and/or controlled in order to protect human health and the environment. The source medium may be the exposure medium for some exposure pathways.

Stressor - Any physical, chemical, or biological entity that can induce an adverse response; however, as used in this context, only chemical entities apply.

Subsurface soil - For human health exposure pathways, the portion of the soil zone between the base of surface soil and the top of the groundwater-bearing unit(s). For ecological exposure pathways, the portion of the soil zone between 0.5 feet and 5 feet in depth.

Surface cover - A layer of artificially placed utility material (e.g., shell, gravel).

Surface soil - For human health exposure pathways, the soil zone extending from ground surface to 15 feet in depth for residential land use and from ground surface to 5 feet in depth for commercial/industrial land use; or to the top of the uppermost groundwater-bearing unit or bedrock, whichever is less in depth. For ecological exposure pathways, the soil zone extending from ground surface to 0.5 feet in depth.

Surface water - Any water meeting the definition of surface water in the state as defined in §307.3 of this title (relating to Abbreviations and Definitions), as amended.

PART I. Affected Property Identification and Background Information

1) Provide a description of the specific area of the response action and the nature of the release. Include estimated acreage of the affected property and the facility property, and a description of the type of facility and/or operation associated with the affected property. Also describe the location of the affected property with respect to the facility property boundaries and public roadways.

Attach available USGS topographic maps and/or aerial or other affected property photographs to this form to depict the affected property and surrounding area. Indicate attachments:

☐ Topo map ☐ Aerial photo ☐ Other

2) Identify environmental media known or suspected to contain chemicals of concern (COCs) at the present time. Check all that apply:

Known/Suspected COC Location	Based on sampling data?	
☐ Soil ≤5 ft below ground surface	☐ Yes	☐ No
☐ Soil >5 ft below ground surface	☐ Yes	☐ No
☐ Groundwater	☐ Yes	☐ No
☐ Surface Water/Sediments	☐ Yes	☐ No

Explain (previously submitted information may be referenced):

3) Provide the information below for the nearest surface water body which has become or has the potential to become impacted from migrating COCs via surface water runoff, air deposition, groundwater seepage, etc. Exclude wastewater treatment facilities and storm water conveyances/impoundments authorized by permit. Also exclude conveyances, decorative ponds, and those portions of process facilities which are:

a. Not in contact with surface waters in the State or other surface waters which are ultimately in contact with surface waters in the State; and

b. Not consistently or routinely utilized as valuable habitat for natural communities including birds, mammals, reptiles, etc.

The nearest surface water body is _____ feet/miles from the affected property and is named _____. The water body is best described as a:

☐ freshwater stream: _____ perennial (has water all year)
_____ intermittent (dries up completely for at least 1 week a year)
_____ intermittent with perennial pools
☐ freshwater swamp/marsh/wetland
☐ saltwater or brackish marsh/swamp/wetland
☐ reservoir, lake, or pond; approximate surface acres:
☐ drainage ditch
☐ tidal stream ☐ bay ☐ estuary
☐ other; specify

Is the water body listed as a State classified segment in Appendix C of the current Texas Surface Water Quality Standards; §§307.1 - 307.10?

☐ Yes Segment # _____ Use Classification:

☐ No

If the water body is not a State classified segment, identify the first downstream classified segment.

Name:

Segment #:

Use Classification:

As necessary, provide further description of surface waters in the vicinity of the affected property:

PART II. Exclusion Criteria and Supportive Information
Subpart A. Surface Water/Sediment Exposure

1) Regarding the affected property where a response action is being pursued under the TRRP, have COCs migrated and resulted in a release or imminent threat of release to either surface waters or to their associated sediments via surface water runoff, air deposition, groundwater seepage, etc.? Exclude wastewater treatment facilities and storm water conveyances/impoundments authorized by permit. Also exclude conveyances, decorative ponds, and those portions of process facilities which are:

a. Not in contact with surface waters in the State or other surface waters which are ultimately in contact with surface waters in the State; and

b. Not consistently or routinely utilized as valuable habitat for natural communities including birds, mammals, reptiles, etc.

☐ Yes ☐ No

Explain:

If the answer is Yes to Subpart A above, the affected property does not meet the exclusion criteria. However, complete the remainder of Part II to determine if there is a complete and/or significant soil exposure pathway, then complete PART III - Qualitative Summary and Certification. If the answer is No, go to Subpart B.

Subpart B. Affected Property Setting

In answering "Yes" to the following question, it is understood that the affected property is not attractive to wildlife or livestock, including threatened or endangered species (i.e., the affected property does not serve as valuable habitat, foraging area, or refuge for ecological communities). (May require consultation with wildlife management agencies.)

1) Is the affected property wholly contained within contiguous land characterized by: pavement, buildings, landscaped area, functioning cap, roadways, equipment storage area, manufacturing or process area, other surface cover or structure, or otherwise disturbed ground?

☐ Yes ☐ No

Explain:

If the answer to Subpart B above is Yes, the affected property meets the exclusion criteria, assuming the answer to Subpart A was No. Skip Subparts C and D and complete PART III - Qualitative Summary and Certification. If the answer to Subpart B above is No, go to Subpart C.

Subpart C. Soil Exposure

1) Are COCs which are in the soil of the affected property solely below the first 5 feet beneath ground surface **or** does the affected property have a physical barrier present to prevent exposure of receptors to COCs in surface soil?

☐ Yes ☐ No

Explain:

If the answer to Subpart C above is Yes, the affected property meets the exclusion criteria, assuming the answer to Subpart A was No. Skip Subpart D and complete PART III - Qualitative Summary and Certification. If the answer to Subpart C above is No, proceed to Subpart D.

Subpart D. *De Minimus* Land Area

In answering "Yes" to the question below, it is understood that all of the following conditions apply:

The affected property is not known to serve as habitat, foraging area, or refuge to threatened/endangered or otherwise protected species. (Will likely require consultation with wildlife management agencies.)

Similar but unimpacted habitat exists within a half-mile radius.

The affected property is not known to be located within one-quarter mile of sensitive environmental areas (e.g., rookeries, wildlife management areas, preserves). (Will likely require consultation with wildlife management agencies.)

There is no reason to suspect that the COCs associated with the affected property will migrate such that the affected property will become larger than one acre.

1) Using human health protective concentration levels as a basis to determine the extent of the COCs, does the affected property consist of one acre or less and does it meet all of the conditions above?

☐ Yes ☐ No

Explain how conditions are met/not met:

If the answer to Subpart D above is Yes, then no further ecological evaluation is needed at this affected property, assuming the answer to Subpart A was No. Complete PART III - Qualitative Summary and Certification. If the answer to Subpart D above is No, proceed to Tier 2 or 3 or comparable ERA.

PART III. Qualitative Summary and Certification (Complete in all cases.)

Attach a brief statement (not to exceed 1 page) summarizing the information you have provided in this form. This summary should include sufficient information to verify that the affected property meets or does not meet the exclusion criteria. The person should make the initial decision regarding the need for further ecological evaluation (i.e., Tier 2 or 3) based upon the results of this checklist. After review, TCEQ will make a final determination on the need for further assessment. **Note that the person has the continuing obligation to re-enter the ERA process if changing circumstances result in the affected property not meeting the Tier 1 exclusion criteria.**

Completed by: _____ (Typed/Printed Name)

_____ (Title)

_____ *(Date)*

I believe that the information submitted is true, accurate, and complete, to the best of my knowledge.

_____ *(Typed/Printed Name of Person)*

_____ *(Title of Person)*

_____ *(Signature of Person)*

_____ *(Date Signed)*

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1 These definitions were taken from 30 TAC §350.4 and may have both ecological and human health applications. For the purpose of this checklist, it is understood that only the ecological applications are of concern.