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FINAL TIER II SAMPLING AND ANALYSIS PLAN SUPPLEMENTAL INVESTIGATION FOR
CHICORA TANK FARM CNC CHARLESTON SC
7/11/2013
RESOLUTION CONSULTANTS

TIER II SAMPLING AND ANALYSIS PLAN

**SUPPLEMENTAL INVESTIGATION
CHICORA TANK FARM
CHARLESTON NAVAL COMPLEX
CHARLESTON, SOUTH CAROLINA**

Version Number: 1

Prepared For:



**Department of the Navy
Naval Facilities Engineering Command, Southeast
BRAC Program Management Office, SE
4130 Faber Place Drive
North Charleston, South Carolina 29405**

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 JM29**

Original Date: 30 May 2013

Revision Date: 11 July 2013

SAP WORKSHEET #1: TITLE AND APPROVAL PAGE
(UFP-QAPP Manual Section 2.1)

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30 May 2013

Mark Kromis, Resolution Consultants
Quality Assurance Officer

Date

Judy Solomon, NAVFAC
Quality Assurance Officer/Chemist

Date

Digitaly signed by SOLOMON, JUDITH A, 1461885000
DN: cn=Judy Solomon, o=NAVFAC, ou=USN,
cn=SOLOMON, JUDITH A, 1461885000
Date: 2013.05.21 07:06:28 -0400

Shawn Dolan/ Resolution Consultants
Task Order Manager

Date

Art Sanford, NAVFAC Southeast
Remedial Project Manager

Date

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Shawn E Dolan

Digitally signed by Dolan, Shawn
DN: dc=com, dc=accomnet, dc=na, ou=AECOMUsers,
ou=USSouth, ou=USNCH1, cn=Dolan, Shawn
Date: 2013.05.30 09:31:45 -0400

Shawn Dolan/ Resolution Consultants
Task Order Manager

Date

SANFORD.ARTHUR
.F.1229009083

Digitally signed by SANFORD.ARTHUR.F.1229009083
DN: c=US, o=U.S. Government, ou=DoD, ou=PKI,
ou=CONTRACTOR,
cn=SANFORD.ARTHUR.F.1229009083
Date: 2013.05.29 11:11:25 -0400

Art Sanford, NAVFAC Southeast
Remedial Project Manager

Date

EXECUTIVE SUMMARY

Resolution Consultants has prepared this Sampling and Analysis Plan (SAP) for Supplemental Investigation efforts at the former Chicora Tank Farm (CTF) associated with Charleston Naval Complex in North Charleston, South Carolina. This work is being performed under the Comprehensive Long-Term Environmental Action Navy Contract No. N62470-11-D-8013 Contract Task Order JM29.

The CTF is situated on a maintained, vacant lot secured by a chain-link fence in North Charleston, South Carolina. The Site is bordered to the northwest by the Charleston County Military Magnet School, to the north by undeveloped areas, to the east by Chicora Avenue and residential housing, to the south by Clement Avenue and residential housing, and to the west by Carner Avenue, followed by several industrial facilities. Much of the **Site's** original topography has been modified by human activities (i.e., buried demolition debris, backfill, grading, etc.). The Site slopes towards a retention pond at the northern end of the property. An earthen drainage ditch at the eastern property boundary, and subsurface French, drain system discharge to the retention pond. The Site is underlain by interbedded silty, clayey sand, followed by the Cooper Marl regional aquitard, which is typically in excess of 100 feet thick in this area. Shallow groundwater flows to the east and northeast toward the Cooper River, approximately one-half mile to the east. Depth to groundwater ranges from 3 to 9 feet below ground surface across the Site. Potable water in the vicinity is supplied by the city of North Charleston. No public or private groundwater wells exist within 1,000 feet.

Constructed in late 1943, the CTF historically consisted of six partially buried, reinforced concrete, bulk marine fuel storage tanks, which supplied fuel to Charleston Naval Complex, approximately one-half mile to the east, via underground piping. During decommissioning efforts from 1988 through 1999, residual contents were removed from the tanks and appropriately disposed offsite, and tanks and all associated piping and equipment were cleaned. Pumping equipment and aboveground portions of the tanks, pump rooms, and lines were removed and disposed offsite. Underground transfer piping was grouted in place. Underground portions of pump room walls and the deepest eight feet of tank walls and tank bottoms were crushed and buried. Approximately 3,300 tons of petroleum-contaminated soil was excavated from around tanks and underground lines. Impacted soil was removed and disposed offsite. Clean backfill was used to fill excavation pits and any voids associated with buried debris. The Site was capped with 12 inches of clay to limit infiltration by rainwater. The Site has remained vacant from 1999 through present. In early 2000, the Navy transferred the fully decommissioned property to the Charleston County School Board. In June 2010, the property was purchased by the current property owner, the city of North Charleston. The city of North Charleston anticipates future land use as recreational fields.

During investigations performed following decommissioning efforts, total petroleum hydrocarbons were not reported above applicable screening guidelines for soil (left-in-place); however, isolated pockets of light non-aqueous phase liquid (LNAPL) was measured at select monitoring wells and naphthalene was reported above the applicable screening level for groundwater.

A 2008 Corrective Action Plan, implemented Long-Term Monitoring (LTM) to gauge LNAPL and track naphthalene concentrations in groundwater and prescribed land-use controls to prohibit disturbance to the surface cover and the use of groundwater beneath the Site. From August 2008 through the most recent LTM event, in August 2012, naphthalene remains the only contaminant above screening guidelines for groundwater, with exceedances limited to samples collected from wells MW-2 and MW-34R. As of August 2012, naphthalene remains above the screening guideline at MW-34R, with an increasing trend noted for groundwater samples collected at MW-2 from August 2010 through August 2012. A spike of naphthalene was noted at MW-34R in August 2012. The fundamental source of contamination is likely historical releases of marine petroleum products from the CTF system, specifically Tank L, positioned upgradient of impacted wells MW-2, MW-33, and MW-34R, and underground lines in the vicinity. The tanks and associated pumps and piping were effectively eliminated as potential continuing sources during decommissioning efforts. It is expected that the majority of secondary sources, in the form of contaminated soil beneath and surrounding the tank and/or underground transfer lines, were removed during historical excavations; however, based on the presence of LNAPL at MW-34R (in February 2012) and MW-33 (in August 2012) contaminated soil may remain in place.

In accordance with South Carolina Department of Health and Environmental Control (SCDHEC) guidance and as documented in the Corrective Action Plan, LTM efforts will continue until LNAPL thickness is reduced to less than 0.01 foot and the applicable screening guideline is achieved for naphthalene in groundwater. Per recent discussions between the Base Realignment and Closure Cleanup Team and SCDHEC, the supplemental investigation will confirm the presence and determine the extent of LNAPL beneath the CTF. Furthermore, the supplemental investigation will evaluate an increasing trend of naphthalene in recent groundwater samples collected from monitoring well MW-2 and an August 2012 spike of naphthalene at MW-34R. Results from the supplemental investigation will be used to determine the need for supplemental remedial actions at the Site.

This SAP outlines the organization, objectives, planned activities, and data review/reporting procedures associated with supplemental investigation efforts. Protocols for sample collection, handling, and storage, chain-of-custody, laboratory and field analyses, data validation, and reporting are included herein. This SAP was generated for, and complies with, applicable United States Department of the Navy (Navy), United States Environmental Protection Agency (USEPA) Region 4, and SCDHEC requirements, regulations, guidance, and technical standards, as appropriate. This includes the Department of Defense, Department of Energy, and USEPA Interagency Data Quality Task Force environmental requirements regarding federal facilities, as specified in the Uniform Federal Policy Quality Assurance Project Plan guidance (USEPA, 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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List of Acronyms

°C	Celsius
µg/L	Microgram per liter
bgs	Below ground surface
BRAC	Base Realignment and Closure
CA	Corrective action
CAP	Corrective Action Plan
CAS	Chemical Abstracts Service
CNC	Charleston Naval Complex
CSM	Conceptual site model
CTO	Contract task order
DoD QSM	Department of Defense Quality Systems Manual
DoD	Department of Defense
DPT	Direct Push Technology
DQI	Data quality indicator
DQO	Data quality objective
DVM	Data Validation Manager
EB	Equipment blank
EICP	Extracted ion current profile
ft bgs	Feet below ground surface
FTL	Field Team Leader
GCAL	Gulf Coast Analytical Laboratories
GPS	Global positioning system
ICAL	Initial calibration
IDW	Investigative Derived Waste
LCS	Laboratory control sample
LIF	Laser Induced Fluorescence
LNAPL	Light non-aqueous phase liquid
LOQ	Limit of quantitation
LTM	Long-Term Monitoring
MI	Milliliter
mmddyy	Month/day/year
MPC	Measurement performance criteria
MS	Mass spectrometer
MS/MSD	Matrix spike/matrix spike duplicate
NA	Not applicable
NAPL	non-aqueous phase liquid
NAVFAC	Naval Facilities Engineering Command
NAFAC LANT	Naval Facilities Engineering Command Mid-Atlantic

Navy	United States Navy
NIRIS	Naval Installation Restoration Information Solution
NIST	National Institute of Standards and Technology
PALs	Project action levels
PM	Project Manager
POC	Point of Contact
PQOs	Project quality objectives
PSQ	Principal Study Questions
QA	Quality assurance
QA/QC	Quality assurance/quality control
QAO	Quality assurance officer
QAPP	Quality assurance project plan
QC	Quality control
QSM	Quality systems manual
RBSL	Risk Based Screening Level
RPD	Relative percent difference
RPM	Remedial project manager
SAP	Sampling and analysis plan
SCDHEC	South Carolina Department of Health and Environmental Control
SOP	Standard operating procedure
SSO	Site Safety Officer
SSTL	Site Specific Target Levels
TB	Trip blank
TBD	To be determined
TCLP	Toxicity characteristic leaching procedure
TOM	Task Order Manager
UFP	Uniform Federal Policy
UFP-SAP	Uniform Federal Policy-Sampling and Analysis Plan
USEPA	United States Environmental Protection Agency
UST	Underground storage tank
UVOST	UltraViolet Optical Screening Tool
VOC	Volatile organic compounds
WG	Groundwater

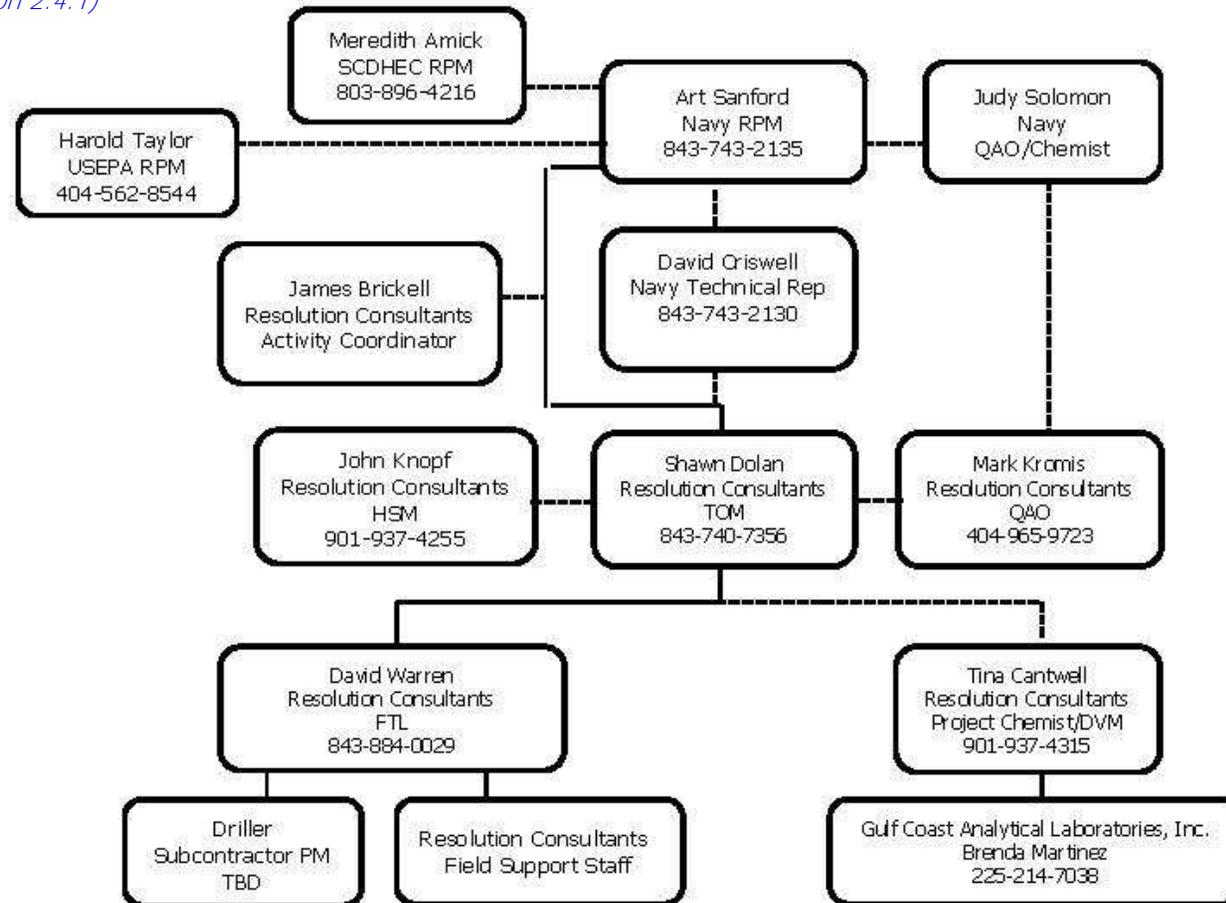


SAP WORKSHEET #5: PROJECT ORGANIZATIONAL CHART

(UFP-QAPP Manual Section 2.4.1)

Line of Authority

 Lines of Communication
 - - - - -



Notes:

DVM = Data Validation Manager
 HSM = Health & Safety Manager
 RPM = Remedial Project Manager
 TBD = To be determined

TOM = Task Order Manager
 POC = Point of Contact
 QAO = Quality Assurance Officer
 PM = Project Manager

SCDHEC = South Carolina Department of Health and Environmental Control
 USEPA = United States Environmental Protection Agency
 FTL = Field Team Leader



SAP WORKSHEET #6: COMMUNICATION PATHWAYS

(UFP-QAPP Manual Section 2.4.2)

The communication pathways for this Sampling and Analysis Plan (SAP) are shown below.

Communication Drivers	Responsible Entity	Name	Phone Number	Procedure (Timing, Pathway To/From, etc.)
Regulatory Agency Interface	Navy RPM	Art Sanford	843-743-2135	The Navy RPM informs regulatory agency of work progress on a periodic basis.
Progress Reports	Resolution Consultants TOM Resolution Consultants FTL Navy RPM	Shawn Dolan David Warren Art Sanford	843-740-7356 843-884-0029 843-743-2135	FTL verbally informs the TOM on a daily basis field updates. TOM provides a weekly update to the RPM either by phone message and/or e-mail each Friday afternoon field activities are taking place.
Gaining Site Access	Resolution Consultants FTL Navy RPM and CNC point of contact	David Warren Art Sanford	843-884-0029 843-743-2135	The Resolution Consultants FTL will contact the CNC point of contact verbally or via e-mail at least 3 days prior to commencement of field work to arrange for access to the site for all field personnel.
Obtaining Utility Clearances for Intrusive Activities	Resolution Consultants FTL Navy RPM and Charleston Naval Complex point of contact	David Warren Art Sanford	843-884-0029 843-743-2135	The Resolution Consultants FTL will coordinate verbally or via e-mail with CNC point of contact at least 14 days in advance of site access to initiate the utility clearance process for all intrusive sampling locations.
Stop Work due to Safety Issues	Resolution Consultants FTL/SSO Resolution Consultants TOM Resolution Consultants HSM Navy RPM	David Warren Shawn Dolan John Knopf Art Sanford	843-884-0029 843-740-7356 901-937-4255 843-743-2135	Any field team member who observes an unsafe situation has the authority to stop work. The responsible party verbally informs the FTL, TOM, 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. If a subcontractor is the responsible party, the subcontractor project manager must verbally inform the Resolution Consultants SSO within 15 minutes, and the Resolution Consultants SSO will then follow the procedure listed above.
SAP Changes prior to Field/ Laboratory work	Resolution Consultants TOM Navy RPM	Shawn Dolan Art Sanford	843-740-7356 843-743-2135	Any change of the approved SAP will be made only upon authorization of 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.
SAP Changes in the Field	Resolution Consultants FTL Resolution Consultants TOM Navy RPM	David Warren Shawn Dolan Art Sanford	843-884-0029 843-740-7356 843-743-2135	FTL informs TOM verbally within same day; TOM informs Navy RPM via e-mail within 24 hours; TOM sends a concurrence letter to RPM, if warranted, within 7 calendar days and RPM signs the letter within 5 business days of receipt. 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).



Communication Drivers	Responsible Entity	Name	Phone Number	Procedure (Timing, Pathway To/From, etc.)
Field Corrective Actions	Resolution Consultants FTL Resolution Consultants TOM Navy RPM	David Warren Shawn Dolan Art Sanford	843-884-0029 843-740-7356 843-743-2135	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.
Recommendations to stop work and initiate work upon corrective action	Resolution Consultants FTL Resolution Consultants TOM Resolution Consultants OAO Navy RPM	David Warren Shawn Dolan Mark Kromis Art Sanford	843-884-0029 843-740-7356 404-965-9723 843-743-2135	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.
Sample Receipt and Laboratory Quality Variances	GCAL PM Resolution Consultants Project Chemist Resolution Consultants FTL Resolution Consultants TOM	Brenda Martinez Tina Cantwell David Warren Shawn Dolan	225-214-7038 901-937-4315 843-884-0029 843-740-7356	<p>The Laboratory PM will notify (verbally or via e-mail) the Resolution Consultants project chemist and FTL immediately upon receipt of any chain of custody/sample receipt variances for clarification or direction from the Resolution Consultants FTL.</p> <p>The Resolution Consultants FTL will notify (verbally or via e-mail) the Resolution Consultants TOM within 1 business day, if corrective action is required.</p> <p>The Resolution Consultants TOM will notify (verbally or via e-mail) the Laboratory PM, Resolution Consultants project chemist and the Resolution Consultants FTL within 1 business day of any required corrective action.</p>
Analytical Corrective Actions	GCAL PM Resolution Consultants Project Chemist	Brenda Martinez Tina Cantwell	225-214-7038 901-937-4315	The laboratory shall notify the Resolution Consultants' project chemist of any analytical data anomaly within 1 business day of discovery. After the laboratory receives guidance from Resolution Consultants' chemist , the laboratory shall initiate any corrective action to prevent further anomalies.
Analytical Data Quality Issues	GCAL PM Resolution Consultants Project Chemist Resolution Consultants FTL Resolution Consultants TOM Navy RPM	Brenda Martinez Tina Cantwell David Warren Shawn Dolan Art Sanford	225-214-7038 901-937-4315 843-884-0029 843-740-7356 843-743-2135	<p>The laboratory PM notifies (verbally or via e-mail) the Resolution Consultants' project chemist within 1 business day of when an issue related to laboratory data is discovered. Resolution Consultants' project chemist notifies Resolution Consultants' TOM and FTL within 1 business day.</p> <p>Resolution Consultants' chemist notifies the Resolution Consultants' TOM and FTL 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 or FTL verbally advises the Navy RPM within 24 hours of notification from the project chemist. The Navy RPM will engage the NAVFAC chemist to ensure the issues with this project can be evaluated to determine impact to other DoD projects.</p>



Communication Drivers	Responsible Entity	Name	Phone Number	Procedure (Timing, Pathway To/From, etc.)
Reporting Data Validation Issues/Data Validation Corrective Actions	Resolution Consultants Project Chemist/DVM Resolution Consultants FTL Resolution Consultants TOM	Tina Cantwell David Warren Shawn Dolan	901-937-4315 843-884-0029 843-740-7356	<p>If a Resolution Consultants Data Validator identifies non-usable data during the data validation process that requires corrective action, the Resolution Consultants TOM or FTL will coordinate with the Resolution Consultants DVM to take corrective action appropriate for the identified deficiency to ensure the project objectives are met.</p> <p>Corrective action may include resampling and/or reanalyzing the affected samples, as determined by the Resolution Consultants TOM or FTL.</p>
Notification of Non-Usable Data	GCAL Laboratory PM Resolution Consultants Project Chemist/DVM Resolution Consultants TOM Navy RPM SCDHEC RPM	Brenda Martinez Tina Cantwell Shawn Dolan Art Sanford Meredith Amick	225-214-7038 901-937-4315 843-740-7356 843-743-2135 803-896-4218	<p>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.</p> <p>The Resolution Consultants project chemist will notify (verbally or via e-mail) 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 effected samples.</p> <p>If a 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.</p> <p>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 on 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 will engage the NAVFAC LANT chemist to ensure issues with this project can be evaluated to determine impact to other Department of Defense projects. Such notification will be made within 1 business day of when the issue is discovered. The Navy RPM will notify the SCDHEC RPM when any significant corrective action is taken.</p>

Notes:

- | | |
|--|----------------------------------|
| FTL = Field team leader | RPM = Remedial project manager |
| NAVFAC LANT = Naval Facilities Engineering Command Mid-Atlantic | TOM = Task order manager |
| HSM = Health and safety manager | SSO = Site safety officer |
| QAO = Quality assurance officer | SAP = Sampling and analysis plan |
| GCAL = Gulf Coast Analytical Laboratories | DVM = Data validation manager |
| SCDHEC = South Carolina Department of Health and Environmental Control | PM = Project manager |
| | CNC = Charleston Naval Complex |



SAP WORKSHEET #9: PROJECT PLANNING SESSION PARTICIPANTS SHEET

(UFP-QAPP Manual Section 2.5.1)

Project/Site Name: Charleston Naval Complex			
Site Location: North Charleston, South Carolina			
Date of Session: 9 October 2012 (BRAC Cleanup Team Meeting)			
Scoping Session Purpose: Partnering team meeting to discuss various sites, including Chicora Tank Farm			
Name	Title	Affiliation	E-mail Address
Art Sanford	Remedial Project Manager	NAVFAC BRAC	art.sanford.ctr@navy.mil
David Criswell	Program Manager	NAVFAC BRAC	david.criswell@navy.mil
Meredith Amick	Remedial Project Manager	SCDHEC	amickms@dhec.sc.gov
Annie Gerry	Hydrogeologist	SCDHEC	gerryam@dhec.sc.gov
Kent Kreig	Risk Assessor	SCDHEC	kreigkm@dhec.sc.gov
Steve Thompson	Engineer	City of North Charleston	sthompson@northcharleston.org
David Warren	Field Team Leader	Resolution Consultants	dwarren@ensafe.com
Shawn Dolan	Task Order Manager	Resolution Consultants	shawn.dolan@aecom.com
Geoff Pope	Project Manager	Tetra Tech	geoff.pope@tetrattech.com

Resolution Consultants presented slides to the Charleston Naval Complex (CNC) Base Re-alignment and Closure (BRAC) Cleanup Team and led the discussion on upcoming supplemental investigation efforts to be conducted at the Chicora Tank Farm (CTF). The following topics were covered: general site description, planned future use, historical sampling results, contaminants of concern, conceptual site model (CSM), data quality objectives, and proposed sampling design.

Comments/Decisions:

The following issues were discussed and decisions reached during the meeting:

1. **Issue:** Light non-aqueous phase liquid (LNAPL) has historically been measured at monitoring well MW-34R and was measured at monitoring well MW-33, during the August 2012 Long-Term Monitoring (LTM) event.



Decision: Supplemental investigation should be performed to confirm the presence and evaluate the extent of LNAPL beneath the Site. The need for supplemental remedial actions will be evaluated based on results of the supplemental investigation.

- Issue:** Naphthalene remains above the applicable South Carolina Department of Health and Environmental Control (SCDHEC) Risk Based Screening Level (RBSL) of 25 micrograms per liter ($\mu\text{g/L}$). During LTM groundwater sampling from February 2010 through February 2012, an increasing trend of naphthalene has been noted at monitoring well MW-2. A spike in naphthalene was also noted at MW-34R, during the most recent August 2012 sampling event. Regulatory closure requires restoration of naphthalene in groundwater to below the RBSL.

Decision: During the supplemental investigation, soil and groundwater sampling will be performed to evaluate a potential residual source of naphthalene, in the form of LNAPL or impacted soil, in the vicinity of monitoring wells MW-2 and MW-34R. The need for supplemental remedial actions will be evaluated based on results of the supplemental investigation.

- Issue:** As documented in the *Additional Groundwater Assessment Report* (GEL, 2012), a separate contaminant plume exists in the southwestern portion of the Site and outside of the spatial boundaries of the current LTM program.

Decision: Per the above referenced report, the contaminant plume in the southwestern portion of the property is attributed to historical benzene and chlorinated volatile organic compound (VOC) releases at adjacent properties. Available data indicates that this contaminant plume is not related to historical operations at the CTF and thus does not require incorporation into the LTM program. No additional action is required by the United States Department of the Navy (Navy) for contamination in the southwestern portion of the Site.



Action Items:

Resolution Consultants will prepare a Uniform Federal Policy Sampling and Analysis Plan (UFP-SAP) for supplemental investigation efforts. A draft version of the UFP-SAP will be submitted to SCDHEC for review and comment.

Consensus Decisions:

Because the discussion was intended to be informational and provide the team with a generalized description of the technical approach, formal consensus on specific aspects of the technical approach for this project was not sought. However, the team was in general agreement with the approach and will defer providing specific comments pending review of the draft UFP-SAP.



SAP WORKSHEET #10: CONCEPTUAL SITE MODEL

(UFP-QAPP Manual Section 2.5.2 — Worksheet #10)

This worksheet presents general background information and the current CSM, which serves as the basis for developing the sampling and analysis program at the CTF.

10.1 Introduction

Based on data generated during previous studies and ongoing LTM efforts, supplemental investigation is necessary to confirm the presence and determine the extent of LNAPL beneath the CTF. Furthermore, the supplemental investigation will evaluate an increasing trend of naphthalene in recent groundwater samples collected from monitoring well MW-2 and an August 2012 spike of naphthalene at MW-34R. Results of the supplemental investigation, in conjunction with chemical data obtained during 2013 LTM groundwater sampling, will be used to determine the need for supplemental remedial actions.

10.2 Site Description

The Site lies on a vacant lot secured by a chain-link fence at the intersection of Chicora Avenue and Clement Avenue in North Charleston, South Carolina (Figure 10-1). A dry, earthen ditch runs parallel to Chicora Avenue, along the eastern boundary. A lined retention pond exists at the northern boundary. Structures consist of a former storage building (in the central portion of the property) and two former utility sheds (one at the north end and one at the south end of the property) (Advent, 2011). A figure showing the site layout is included as Figure 10-2.

10.3 Physical Setting

In general, the Site slopes towards the retention pond at the northern end of the property. Much of the original topography has been modified by human activities (i.e., backfill, grading, etc.). The Site is located within the Coastal Plain Physiographic Province. Coastal plain soils generally consist of marine deposits of interbedded limestone, sands, silts, clays, gravel, and organics. The Site is underlain by Pleistocene deposits of interbedded silty clayey sand to an approximate depth of 26 feet below ground surface (bgs). The Ashley Formation of the Cooper Group, commonly referred to as the Cooper Marl regional aquitard, is encountered at approximately 26 feet bgs. The Cooper Marl is typically in excess of 100 feet thick in this area.



Legend

Property Boundary



FIGURE 10-1
SITE LOCATION MAP
CHICORA TANK FARM
CHARLESTON, SOUTH CAROLINA



REQUESTED BY: D. WARREN

DATE: 2/28/2013

DRAWN BY: B. LIPSCOMB

TASK ORDER NUMBER: JM29



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-  Monitoring Well
-  Monitoring Well (LTM Well Network)
-  Excavation/Trench
-  Underground Transfer Line (abandoned in place)
-  Underground Power Line
-  Underground French Drain
-  Property Boundary
-  Pump House (demolished)
-  Petroleum Storage Tank (demolished)
-  Retention Pond

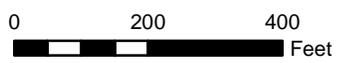


FIGURE 10-2
SITE LAYOUT MAP
CHICORA TANK FARM
CHARLESTON, SOUTH CAROLINA



REQUESTED BY: D. WARREN	DATE: 3/26/2013
DRAWN BY: B. LIPSCOMB	TASK ORDER NUMBER: JM29

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Previous investigations indicate that shallow groundwater flows to the east and northeast toward the Cooper River, approximately one-half mile to the east. Based on historical studies, depth to groundwater ranges from 3 to 9 feet bgs across the Site. Potable water in the vicinity is supplied by the city of North Charleston. No public or private groundwater wells exist within 1,000 feet of the Site (Advent, 2008).

The Site is bordered to the northwest by the Charleston County Military Magnet School, to the north by undeveloped areas, to the east by Chicora Avenue and residential housing, to the south by Clement Avenue and residential housing, and to the west by Carner Avenue, followed by several industrial facilities.

10.4 Site History

Prior to acquisition by the Navy in 1941, development at the Site was limited to residential. Following demolition of residential structures, the CTF was constructed in late 1943. As shown on Figure 10-2, the CTF historically consisted of four 2.1 million gallon and two 1.1 million gallon partially buried, reinforced concrete, bulk storage tanks. Materials stored consisted of diesel fuel, Bunker C, F-76 Diesel Fuel Marine, Navy Fuel Oil, Special Navy Fuel Oil, lube oil, oily-waste water, and sludge. Each tank was equipped with a pump room, buried approximately seven feet bgs. The tanks supplied fuel to the primary distribution system at CNC, approximately one-half mile to the east. The majority of transfer piping was buried between 3 to 8 feet bgs. The tanks were surrounded by a subsurface French drain system, constructed at approximately 8 feet bgs. The French drain discharged to a lined retention pond, equipped with an oil-water separator, at the north end of the Site. A 12,000-gallon underground storage tank (UST) historically stored fuel oil to power a boiler inside the storage building in the central portion of the property.

Documented spills are limited to those resulting from a cracked sludge/oil line in 1981 and a 1983 overfilling incident in the eastern portion of the property. Additional information on such spills and respective clean-up efforts was unavailable.

Decommissioning efforts were performed under the BRAC Program from 1988 through 1999. Residual contents were removed from the tanks and appropriately disposed offsite. Tanks and all associated piping and equipment were cleaned in accordance with a SCDHEC approved work plan. Pumping equipment and aboveground portions of the tanks, pump rooms, and lines were removed and disposed offsite. Underground transfer piping was grouted in place. Underground portions of pump room walls and the deepest eight feet of tank walls and tank bottoms were



crushed and buried. Approximately 3,500 tons of petroleum-contaminated soil was encountered during decommissioning efforts. Confirmatory sampling results indicate that soil impacted above SCDHEC Site Specific Target Levels (SSTLs) was successfully removed. Clean backfill was used to fill excavations and any voids. The fuel oil UST was closed pursuant to applicable SCDHEC protocol. The Site was contoured and sloped to channel drainage away from buried debris. The area above buried debris was capped with 12 inches of clay to limit infiltration by rainwater. The oil-water separator, associated with the retention pond, was removed; however, the French drain system and retention pond were left in place.

The Site has remained vacant from 1999 through present. In early 2000, the Navy transferred the fully decommissioned property to the Charleston County School Board. In June 2010, the property was purchased by the current property owner, the city of North Charleston. The city of North Charleston anticipates future land use as recreational fields.

10.5 Previous Studies and Corrective Action

Details associated with previous investigations are presented in the *Preliminary Contamination Assessment Report* (Kemron, 1992), *Corrective Action Plan (CAP)* (Advent, 2008), and *June 2012 LTM Report* (Tetra Tech, 2012).

As previously discussed, soil impacted above SCDHEC SSTLs was successfully removed during decommissioning efforts. During historical groundwater investigations performed from 1992 through 2008, LNAPL was measured at monitoring well MW-34, later replaced by MW-34R, in the eastern portion of the Site, and naphthalene was reported above the applicable RBSL in Site groundwater. To gauge LNAPL and track naphthalene concentrations in groundwater, the 2008 CAP (Advent, 2008) recommended LTM, consisting of semi-annual groundwater sampling at 28 monitoring wells for analysis of benzene, toluene, ethylbenzene, and xylene, and naphthalene by United States Environmental Protection Agency (USEPA) Method 8260B, polycyclic aromatic hydrocarbons by USEPA Method 8270C, and ethylene dibromide by USEPA Method 8011. As part of the CAP, land-use controls were implemented to prohibit disturbance to the surface cover and the use of groundwater beneath the Site. The LTM program was reduced to include sampling of monitoring wells MW-2, MW-21R, MW-33, and MW-34R, following the February 2010 event.

Based on SCDHEC comments associated with a draft work plan, the current scope for 2013 LTM efforts, as detailed in the Work Plan Addendum for CTF (Resolution Consultants, 2013), consists of semi-annual groundwater sampling at six monitoring wells (MW-2, MW-21R, MW-33, MW-34R,



MW-31, and MW-32) for benzene, toluene, ethylbenzene, and xylene and naphthalene by USEPA Method 8260B, polycyclic aromatic hydrocarbons by USEPA Method 8270C, and ethylene dibromide by USEPA Method 8011.

In summary, LNAPL has historically been measured at MW-34R, with increasing thickness from February 2010 through February 2012; however, no LNAPL was encountered at this well during the most recent August 2012 LTM event. In August 2012, LNAPL was measured for the first time at MW-33, approximately 100 feet to the south of MW-34R. Based on the comprehensive groundwater dataset, naphthalene has been the only contaminant measured above RBSLs, with exceedances limited to samples collected from wells MW-2 and MW-34/34R. As of August 2012, naphthalene remains above the RBSL at MW-34R, with an increasing trend noted for samples collected at MW-2 from August 2010 through August 2012. A spike of naphthalene was recently noted at MW-34R, in August 2012.

10.6 Conceptual Site Exposure Model

Resolution Consultants used information presented in the preceding sections to refine the CSM, as most recently presented in the *June 2012 Long-Term Monitoring Report* (Tetra Tech, 2012). The updated CSM is provided as Figure 10-3.

10.6.1 Source of Contaminants

The fundamental source of contamination is likely historical releases of marine petroleum products from the CTF system, specifically F-76 bulk diesel fuel marine and Navy Fuel Oil, Special Navy Fuel Oil, historically stored in Tank L, positioned upgradient of impacted wells MW-2, MW-33, and MW-34R, and transferred via underground lines in the vicinity. The tanks and associated pumps and piping were effectively eliminated as potential continuing sources during decommissioning efforts. It is expected that the majority of secondary sources, in the form of contaminated soil beneath and surrounding the tank and/or underground transfer lines, were removed during historical excavations; however, based on the presence of LNAPL at MW-34R (in February 2012) and MW-33 (in August 2012), contaminated soil may remain in place. Buried tank bottoms, walls, and footers, pump room foundations, and demolition debris, and underground piping and utility cavities are likely serving as preferential pathways or residual contaminated zones within or near the saturated zone.

10.6.2 Nature and Extent of Contamination

Although recent data suggests that residual petroleum impacted soil may remain in the vicinity of MW-34R, all known soil contamination above applicable SSTLs has been removed. Ongoing LTM efforts serve to monitor groundwater, considered the primary media of concern at the Site. In accordance with SCDHEC guidance and as documented in the CAP, LTM efforts will continue until LNAPL thickness is reduced to less than 0.01 feet and RBSLs are achieved for naphthalene in groundwater.

From August 2009 through February 2012, LNAPL was measured between approximately 0.02 foot and 0.58 foot thick at MW-34R; however, no LNAPL was encountered at this well during the most recent August 2012 event. To date, no LNAPL has been measured at wells MW-2 and MW-21R, positioned approximately 100 feet sidegradient and 50 feet downgradient of MW-34R, respectively. In August 2012, LNAPL was measured at approximately 0.58 foot thick at MW-33. LNAPL has not been historically measured at this well. MW-33 is approximately 150 feet sidegradient of MW-34R. Historical LNAPL thickness, along with historical excavations limits, is depicted on Figure 10-4.

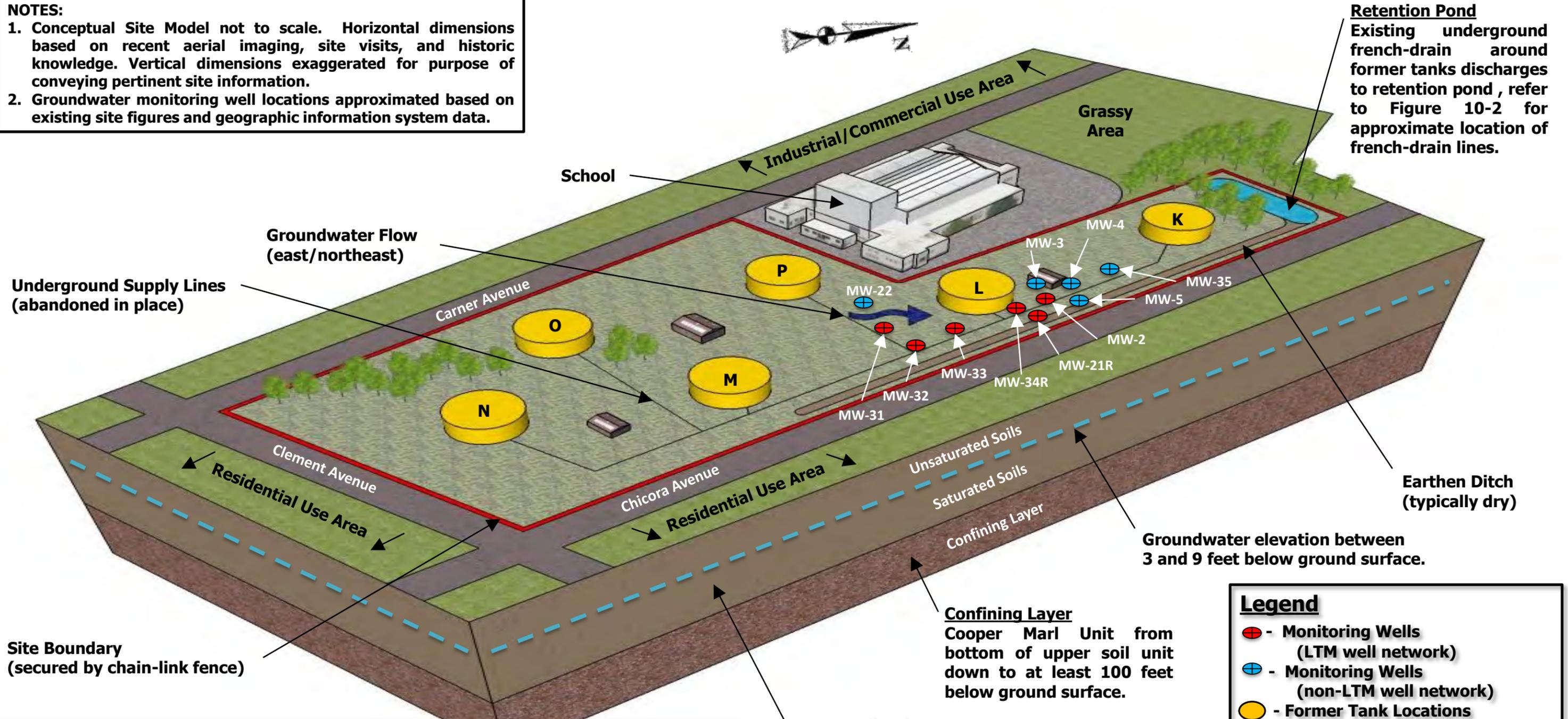
Through the most recent August 2012 event, naphthalene has been the only contaminant measured above RBSLs, with exceedances limited to monitoring wells MW-2 and MW-34R. During the August 2012 sampling event, naphthalene was not detected above laboratory detection limits in groundwater samples collected from MW-21R and MW-33, both positioned at the downgradient property line. Historical naphthalene concentrations in Site groundwater are depicted on Figure 10-5.

10.6.3 Fate and Transport Mechanisms

A fate and transport pathway describes mechanisms whereby contaminants are transported from the source to a human or ecological receptor. Preliminary fate and transport mechanisms are summarized below and will be refined during the investigation. Historical petroleum releases may have consisted of spills to the ground surface and/or leaks from underground portions of the tank, pumps, or supply lines to subsurface soil. Spills to the ground surface may have been transported via surface runoff or infiltration mechanisms. Surface runoff at the Site is collected by a retention pond to the north. Based on historical sampling results, the retention pond has not been impacted by historical operations. Due to highly disturbed soils and permeable backfill material near the surface, it is more likely that surface spills would have infiltrated to subsurface soil. However, infiltration has been reduced due to emplacement of a 12-inch clay cover over areas of buried demolition debris. Any groundwater movement through the Site is expected to originate from upgradient sources.

NOTES:

1. Conceptual Site Model not to scale. Horizontal dimensions based on recent aerial imaging, site visits, and historic knowledge. Vertical dimensions exaggerated for purpose of conveying pertinent site information.
2. Groundwater monitoring well locations approximated based on existing site figures and geographic information system data.



Contaminant Source: Fundamental source is marine petroleum products historically stored in Tank P and transferred via underground lines. Secondary source may exist in the form of contaminated soil in the vicinity of the tank and underground lines.

Groundwater COCs: Marine petroleum constituents, with only naphthalene above screening guidelines.

Receptors:

Human: LUCs prohibit residential use, disturbance of the surface cover, and the use of groundwater beneath the Site; thus, exposure pathways are incomplete.

Ecological: Exposure pathways associated with terrestrial and aquatic ecosystems are considered incomplete due to insufficient habitat.

Upper Soil Unit
 Silty Clayey Sand from ground surface down to approximately 26 feet below ground surface. The top 10 feet of soil beneath the Site contains buried debris related to tank decommissioning activities. Voids were filled with clean backfill. A 12-inch layer of clay was placed over the entire site surface during final grading.

Legend

- ⊕ - Monitoring Wells (LTM well network)
- ⊕ - Monitoring Wells (non-LTM well network)
- - Former Tank Locations (demolished/debris located under former tank locations)

Figure 10-3
 Conceptual Site Model
 Chicora Tank Farm
 Charleston Naval Complex

NAFAC
 Naval Facilities Engineering Command

RESOLUTION CONSULTANTS

REQUEST BY: David Warren	DATE: 02/26/2013
DRAWN BY: David Myers	CTO NO. JM29



MW34R
 Unknown Thickness (Nov 05)
 0.41 ft (May 06)
 Unknown Thickness (Aug 09)
 Unknown Thickness (Feb 10)
 Unknown Thickness (Aug 10)
 0.50 ft (Feb 11)
 0.02 ft (Aug 11)
 0.58 ft (Feb 12)

MW33
 0.58 ft (Aug 12)

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◆ Monitoring Well	○ Petroleum Storage Tank (demolished)
◆ Monitoring Well (LTM Well Network)	○ Pump House (demolished)
▶ Estimated Groundwater Flow Direction	○ Retention Pond
— Underground Transfer Line (abandoned in place)	
— Underground Power Line	
— Underground French Drain	
■ Excavation/Trench	
□ Property Boundary	

Notes:
 Units are feet of LNAPL
 DTW= Depth to Water (below top of well casing)

0 200
 Feet

FIGURE 10-4
HISTORICAL LNAPL THICKNESS
IN SITE GROUNDWATER
CHICORA TANK FARM
CHARLESTON, SOUTH CAROLINA

REQUESTED BY: D. WARREN	DATE: 3/26/2013
DRAWN BY: B. LIPSCOMB	TASK ORDER NUMBER: JM29

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FIGURE 10-5
HISTORICAL NAPHTHALENE CONCENTRATIONS
IN SITE GROUNDWATER
CHICORA TANK FARM
CHARLESTON, SOUTH CAROLINA



REQUESTED BY: D. WARREN	DATE: 3/26/2013
DRAWN BY: B. LIPSCOMB	TASK ORDER NUMBER: JM29

- Monitoring Well
 - Monitoring Well (LTM Well Network)
 - Estimated Groundwater Flow Direction
 - Underground Transfer Line (abandoned in place)
 - Underground French Drain
 - Excavation/Trench
 - Property Boundary
 - Petroleum Storage Tank (demolished)
 - Pump House (demolished)
 - Retention Pond
- Notes:
 All Concentrations Shown in Parts Per Billion (ppb)
 ND= Not Detected (below laboratory detection limits)
 Red Font Indicates Exceedance of Risk Based Screening Level = 25 ppb
- 0 200 Feet

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Petroleum products released to the subsurface may occur as a non-aqueous phase liquid (NAPL) and can potentially migrate vertically until the soil pore volume achieves residual saturation or residual product reaches the top of the water table. NAPL at the Site may have migrated laterally within buried layers of concrete debris, cavities associated with underground lines and utilities, or areas backfilled with more permeable soil. If sufficient product is released, it can collect at the top of the water table in the form of LNAPL. Fuel constituents tend to adsorb to soil particles; the degree of adsorption is related to the organic and clay content of the soil, and to the chemical properties of the fuel, especially water solubility and organic partitioning coefficient. Factors working to reduce the mass of soil contamination include dissolution in groundwater, volatilization, and biodegradation. It should be noted that wells MW-34R and MW-33, where LNAPL has been historically measured, are immediately adjacent to abandoned underground transfer piping and a subsurface power line, which may be acting as a localized conduit.

LNAPL and/or elevated concentrations of petroleum constituents in soil can act as a long-term source of dissolved contaminants to groundwater. As precipitation travels through soil containing residual NAPL, the water leaches some of the adsorbed contaminants, thus contributing additional dissolved contamination to the groundwater plume. Mechanisms affecting transport of the contaminant plume are advection, adsorption, dispersion, dilution, and biodegradation. Advection is migration of dissolved contaminants along with groundwater movement. In general, the contaminant plume migration rate is slower than groundwater because of contaminant adsorption to soil and organic matter. Dispersion causes the plume to spread both vertically and laterally during migration. Generally, vertical spreading is an order of magnitude less than horizontal spreading. Dilution by recharge can reduce contaminant concentrations in the downgradient plume. However, biodegradation naturally reduces fuel components in the plume as a result of degradation by microbial organisms. Significant attenuation is evident based on historical results at MW-05 and MW-21R, positioned immediately downgradient of impacted wells, MW-2 and MW-34R. The combined effect of advection, adsorption, dispersion, dilution, and biodegradation likely limits the extent of the plume despite the presence of LNAPL.

10.6.4 Exposure Pathways and Receptors

An exposure pathway links a source area with one or more receptors, but the pathway must be complete for exposure to occur. Potential exposure pathways at CTF are discussed below. Data obtained during the supplemental investigation and future LTM efforts will be evaluated to ensure that the LTM program remains a protective remedy.



Human Health Exposures — The Site currently consists of vacant land secured by a locked chain-link fence. Anticipated future land use is recreational. Available results indicate that exposures to soil contaminants have been eliminated through historical excavation. Groundwater exceedances of RBSLs are limited to naphthalene at MW-34R, and historically, MW-2. Thus, human exposure would require direct contact with or ingestion of impacted groundwater. Direct contact with contaminants in groundwater is possible for future construction workers at the Site. Future recreational users would only come into contact with contaminated groundwater if drinking water wells were installed at the Site. LNAPL has been measured at MW-34R and MW-33; however, LNAPL is not being discharged to ground surface or presenting any exposure risks. As detailed in the CAP, land-use controls prohibit disturbance of the surface cover and the use of groundwater beneath the Site; thus, these exposure pathways are considered incomplete.

Ecological Exposures — The Site consists of a vacant, grassy lot, which is maintained by the city of North Charleston. Due to extensive demolition, excavation, backfill, and grading activities, terrestrial habitats are considered insufficient. The nearest potential aquatic habitat is the retention pond at the northern property boundary. Historical studies indicate that this retention pond has not been impacted by historical operations at the CTF. Furthermore, monitoring wells nearest to the retention pond (MW-4 and MW-35) have not historically exhibited groundwater impacts. Exposure pathways associated with terrestrial and aquatic ecosystems are considered incomplete.



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

(UFP-QAPP Manual Section 2.6.1)

11.1 Problem Statement

Measurable LNAPL, defined as LNAPL thickness measured at greater than 0.01 foot, has historically been encountered at monitoring well MW-34R and was also encountered at monitoring well MW-33 during the August 2012 LTM event. Naphthalene remains above the applicable RBSL of 25 µg/L at monitoring well MW-34R. Increasing naphthalene concentration trends have been noted at monitoring well MW-2 and a recent spike was observed at MW-34R. Regulatory closure requires LNAPL thickness to be reduced below 0.01 foot in thickness and restoration of naphthalene in groundwater to below the applicable RBSL of 25 µg/L. Results of supplemental investigation efforts will be used to determine the need for modifications to the LTM program and/or the CAP.

11.2 Goals of the Study

Goals of the supplemental investigation are to:

- Determine the extent of LNAPL in the vicinity of monitoring wells MW-34R and MW-33
- Evaluate increasing trends of naphthalene concentrations at MW-2 and the recent spike at MW-34R

Findings will provide information to support the development, evaluation, and selection of appropriate response alternatives, if necessary.

Principal study questions (PSOs) developed to define decision statements to resolve the problems are as follows:

PSQ1: Does measurable LNAPL exist beneath the Site?

PSQ2: If determined to be present, what is the lateral extent of such LNAPL?

PSQ3: Does a residual source of naphthalene, in the form of LNAPL locked in underground cavities or impacted soil, exist in the vicinity of monitoring wells MW-2 and MW-34R?

11.3 INFORMATION INPUTS

Data that are required to resolve the problem described in Section 11.1 are as follows:

- **Field Data:** A Laser Induced Fluorescence (LIF) study will be performed to identify potential residual source material and further evaluate the extent of LNAPL beneath the Site. Temporary wells will be installed, and along with existing wells, gauged for LNAPL. Bail-down tests will be performed to evaluate LNAPL volume and recoverability. Field data will be used, in conjunction with chemical data, to support the decision making process.
- **Chemical Data:** Subsurface soil and groundwater samples will be collected and analyzed to confirm results of field screening and to supplement the existing dataset. Concentrations of detected analytes will be compared to Project Action Levels (PALs), as identified in Worksheet #15. Chemical data will be projected onto Site maps to assist in identifying contaminant sources and determining the extent of contamination. Chemical data from previous and ongoing LTM events and other historical studies may be used in the evaluation. Chemical data will serve as the primary tool to support decisions.
- **Project Action Limits:** PALs for both soil and groundwater consist of SCDHEC RBSLs. Chemical data will be compared to PALs, as detailed on Worksheet #15, as an initial screening value to determine if follow up actions are necessary.
- **Geologic/Hydrogeologic Information:** Historical information on site-specific geology will be supplemented through observations made during temporary well installation and soil and groundwater sampling. Onsite geologists/engineers will use the Unified Soil Classification System to thoroughly describe soil characteristics. Depth to groundwater will be measured at new and existing wells to provide information regarding the potentiometric surface. Such information will be incorporated into the CSM.
- **Screening Data:** A photoionization detector will be used to measure organic vapors during soil sampling activities. Field screening data will assist with characterization and the selection of sample depth intervals. Results of field screening are not considered definitive; thus, will not be used for decision making.



- Groundwater Stabilization Parameters: Parameters, including pH, temperature, specific conductivity, oxidation-reduction potential, dissolved oxygen, and turbidity, will be used to confirm groundwater samples are representative of the formation being investigated. Field parameters may also be used to evaluate degradation processes at the Site.
- Sample location data: Horizontal coordinates and vertical elevations will be recorded at each sample location. Such data will be used to create site maps. Horizontal coordinates may be measured with equal effectiveness using a hand-held global positioning system or by professional land survey techniques. Top of well casings and ground surface elevations will be measured using professional land survey instruments to obtain elevation data of sufficient accuracy to establish the potentiometric surface and infer groundwater flow direction. Depth intervals are best measured using a tape measure or other device with similar accuracy and precision (e.g., water level meter).

11.4 Study Area Boundaries

Based on historical information, the horizontal boundaries for the supplemental investigation are assumed to be between MW-35 to the north, MW-31 and MW-32 to the south, MW-05 and MW-21R to the east, and Tank L to the west. The vertical boundary for this study extends from the ground surface to the terminal depth of planned temporary wells and existing monitoring wells, screened across the shallow water table. This terminal depth is estimated to be encountered at approximately 18 feet bgs. The shallow formation contains environmental media most likely to have been impacted by historical operations at the Site. The temporal boundaries of the investigation include the estimated duration of field activities, as described herein.

11.5 Analytical Approach

The supplemental investigation will provide additional information on the extent of LNAPL, if determined to be present, and evaluate an increasing trend of naphthalene at MW-2 and a recent spike at MW-34R. Initial sampling locations will be biased based on results of previous investigations and LTM efforts. Subsequent sampling locations will be determined based on field observations/measurements and professional judgment. Findings will be used to update the CSM, prior to implementing the following decision rules:

Decision Rule 1: If LNAPL thickness is not measured at greater than 0.01 feet at any sampling points or temporary/existing monitoring wells, then no follow-up action is required for LNAPL. If LNAPL thickness is measured at greater than 0.01 feet at sampling points or temporary/existing monitoring wells, then the CAP will require modification to address LNAPL.

Decision Rule 2: If LNAPL thickness is not measured at greater than 0.01 feet at sampling points or temporary/existing monitoring wells, then such sampling points or temporary/existing monitoring wells will be considered outside of the extent of LNAPL. If LNAPL thickness is measured at greater than 0.01 feet at sampling points or temporary/existing monitoring wells, then such sampling points or temporary/existing monitoring wells will be considered within the extent of LNAPL. Such information will be considered in subsequent modifications to the CAP.

Decision Rule 3: If naphthalene does not exceed its PAL at soil sampling locations positioned in the vicinity of monitoring wells MW-2 and MW-34R, it will be concluded that increasing concentrations of LNAPL are not due to residual contaminated soil and no follow-up action is required. If naphthalene exceeds its PAL at soil sampling locations positioned in the vicinity of MW-2 and MW-34R, it will be concluded that residual contaminated soil may be contributing to increasing naphthalene concentrations and the CAP will require modification.

11.6 Decision 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— The sampling design was developed to further evaluate LNAPL and increasing naphthalene at select monitoring wells. Judgmental sampling will be used to place soil borings and temporary monitoring wells. This sampling approach was determined to be the most appropriate due to the availability of previous sampling data at the site.

Sources of Error— Sources of error 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 USEPA identifies the **combination of all these errors as a "total study error"** (USEPA, 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. 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 maintaining active SCDHEC Environmental Laboratory certification 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 judgmental 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.

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 (QA)/quality control (QC) samples are summarized in the 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 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 QC measurements (i.e., analytical sample duplicate and sample matrix spike/matrix spike duplicate [MS/MSD]). 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 Naval Facilities Engineering Command (NAVFAC) Atlantic Administrative Record, and uploaded onto the Naval Installation Restoration Information Solution (NIRIS) 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 Data Collection Plan

Non-statistical methods (professional judgment), based on historical sampling locations, will be used as the primary basis for the sampling design. This method of sampling will be biased to **represent "worst-case" constituent concentrations. This approach was chosen** to estimate the maximum level of contamination to help define the extent of the problem. The sample design and rationale is presented in Worksheet #17.



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	Naphthalene	One per sample cooler	Accuracy/Bias/ Contamination/ Representativeness	analyte > ½ LOQ
Field Duplicates	Naphthalene	One per 20 field samples per matrix	Precision	Values > 5X LOQ: RPD must be ≤30 (aqueous) ; ≤50 (solids)
Equipment Blanks	Naphthalene	One per 20 field samples per matrix per sampling equipment ⁽¹⁾	Accuracy/Bias/ Contamination/ Representativeness	analyte > ½ LOQ
Matrix Spike/Matrix Spike Duplicate	Naphthalene	One pair per 20 field samples per matrix	Accuracy/Bias/ Precision	Percent recoveries — DoD QSM Limits RPD must be ≤ 30
Cooler Temperature Indicator	Naphthalene	One per sample cooler	Representativeness	Temperature less than 6 degrees Celsius

Notes:

- (1) = Equipment rinsate blanks will be collected if decontamination is required and will not apply if dedicated equipment is used
- QC = Quality control
- LOQ = Limit of quantitation
- DoD QSM = *Department of Defense Quality Systems Manual for Environmental Laboratories*, Version 4.2, October 2010, or most recent version at the time of sampling
- RPD = Relative percent difference



SAP WORKSHEET #17: SAMPLING DESIGN AND RATIONALE

(UFP-QAPP Manual Section 3.1.1)

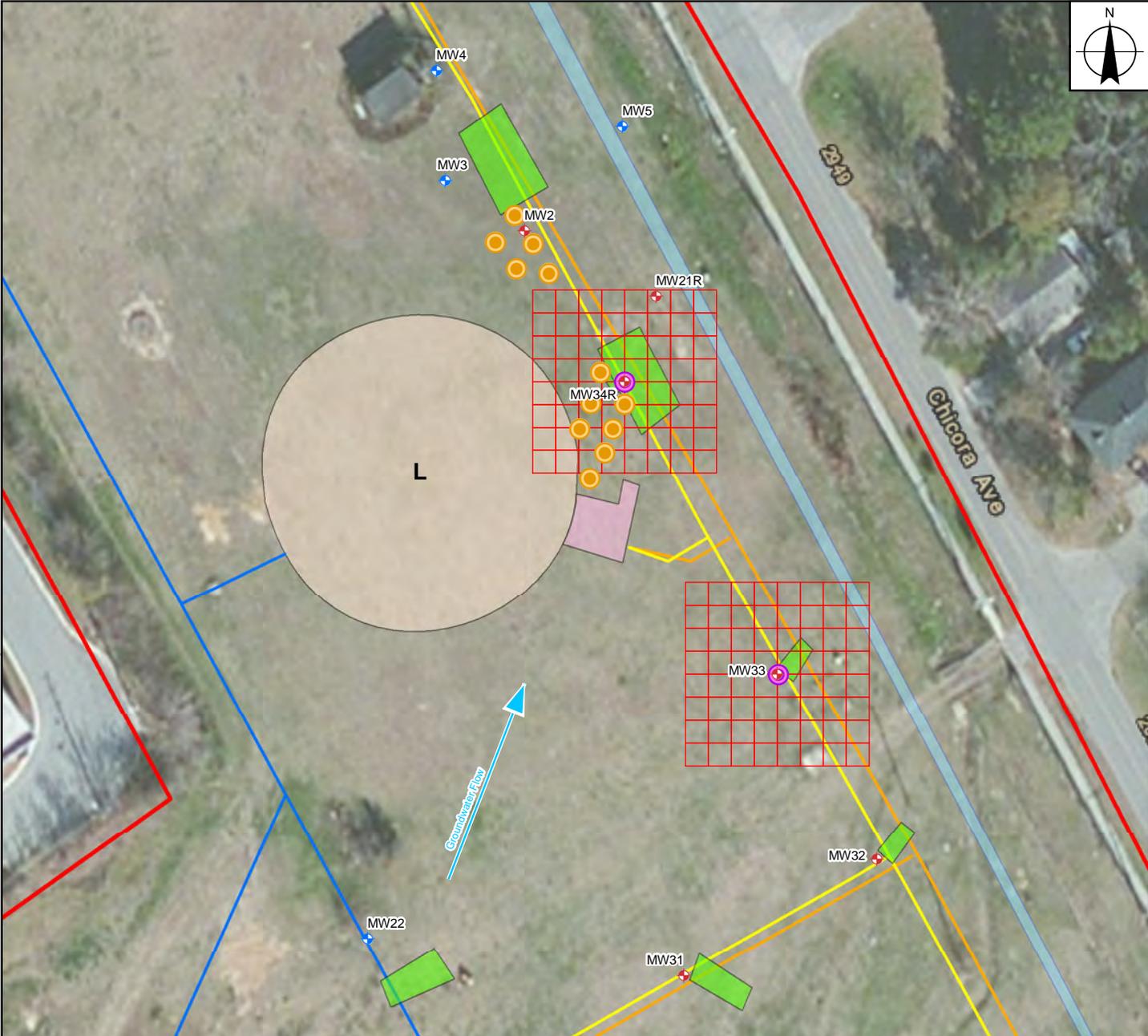
17.1 Sampling Approach

As previously described in Worksheet #11, additional data are necessary to determine the extent of LNAPL in the vicinity of monitoring wells MW-34R and MW-33, evaluate an increasing trend of naphthalene at MW-2, and a recent spike at MW-34R. Findings will be used to determine the need for modifications to the CAP.

This worksheet presents the design and rationale of the sampling and analysis program to be conducted under this investigation. The sampling approach, based on professional judgment, is biased to determine the boundaries of LNAPL and naphthalene contamination identified during previous investigations. Specifically, the sampling plan was developed using information from historical investigations, corrective actions, and the CSM, as presented in Worksheet #10. Proposed sampling locations, based on current data, are illustrated on Figure 17-1. A summary table, including sample identification numbers, depth, relevant SOPs, and applicable laboratory and field analyses, is included as combined Worksheets #18, 19, 20, and 30. SOPs for field activities are summarized in Worksheet #21 and included as Appendix A. Field observations/measurements and professional judgment will be used to adjust proposed sampling locations and position subsequent sampling locations and/or depths. Examples of criteria, which may lead to changes to the sampling plan may include, (but not limited to) visual observations/staining, odors, elevated headspace organic vapor readings, results of the LIF study, LNAPL encountered in temporary wells, etc.

Samples collected during the supplemental investigation will be submitted to GCAL for chemical analyses. Analytical methods are identified in Worksheet #23. Laboratory SOPs are listed in Worksheet #23. The total numbers of sample analyses to be performed for each target analyte or analytical group are identified in combined Worksheets #18, 19, 20, and 30. Combined Worksheets #18, 19, 20, and 30 present a summary of the sample analyses, container types and volumes, preservation requirements, and holding times.

Planned field QC samples will include field duplicates and equipment rinsate blanks. Worksheet #12 presents the field QC sample summary. Additional sample volume will be collected as necessary for laboratory QC analysis of MS/MSD samples.



Notes:
 *Additional LIF borings will be performed until delineated in each direction and to evaluate potential underground conduits. Up to 10 temporary monitoring wells will be installed to evaluate LNAPL based on findings of the LIF study
 **Actual locations of DPT borings will be adjusted based on field observations/measurements and professional judgment
 2 Soil Samples will be collected (highest headspace/above water table) from each DPT boring. Groundwater samples will be collected from up to 6 DPT borings (to be determined in field)

Service Layer Credits: Copyright: © 2012 Esri, DeLorme, NAVTEQ, TomTom
 Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, and the GIS User Community

- | | |
|--|---------------------------------------|
| ◆ Monitoring Well | — Underground Power Line |
| ◆ Monitoring Well (LTM Well Network) | — Underground French Drain |
| ● Proposed LIF Boring* | ▭ Property Boundary |
| ● Proposed DPT Boring** | ▭ Pump House (demolished) |
| → Estimated Groundwater Flow Direction | ▭ Petroleum Storage Tank (demolished) |
| — Underground Transfer Line (abandoned in place) | ▭ Retention Pond |
| ▭ Proposed LIF Grid | |
| ▭ Excavation/Trench | |



FIGURE 17-1
PROPOSED SAMPLING LOCATIONS
CHICORA TANK FARM
CHARLESTON, SOUTH CAROLINA



REQUESTED BY: D. WARREN DATE: 3/26/2013
 DRAWN BY: A. ZIMMERMAN TASK ORDER NUMBER: JM29

X:\Navy\NCN\Figure17-1_proposed.mxd

17.2 LNAPL Evaluation

The LNAPL evaluation will be performed using a 2-step process. As an initial qualitative assessment, the presence and extent of LNAPL will be evaluated using Dakota Technologies' patented UltraViolet Optical Screening Tool (UVOST) LIF technology. A LIF probe, deployed using a Direct Push Technology (DPT) rig operated by South Carolina-licensed drillers, will provide real-time, qualitative LNAPL data. A UVOST trained operator and Resolution Consultants field geologist/engineer will review results in an effort to identify LNAPL hotspots and determine the extent of LNAPL. To allow for instrument calibration checks, initial LIF borings will be positioned adjacent to monitoring wells MW-34R and MW-33, considered within the area most likely to contain LNAPL. Subsequent LIF borings will be advanced outward in each of four directions from these wells, until results indicate LNAPL no longer extends in that direction. The initial step-out grid for LIF borings will be approximately 10 feet. LIF borings will also be positioned adjacent to subsurface utilities or historical supply lines in the vicinity, to evaluate such features as potential conduits for LNAPL. Ideally, the LIF study would continue until horizontal delineation has been achieved for LNAPL, or following five consecutive LIF study days, whichever occurs first. The approximate area of the LIF study and initial LIF boring locations are presented on Figure 17-1. Subsequent LIF boring locations will be determined in the field.

Based on the results of the LIF investigation, up to 10 temporary monitoring wells will be installed at the Site. Every attempt will be made to locate at least one temporary monitoring well in the area most likely to contain LNAPL at the greatest thickness. The remaining temporary monitoring wells will be positioned to evaluate the horizontal extent of LNAPL beneath the Site. During well drilling, geologic conditions will be logged. The screened interval will be set to intersect the water table, thus capturing any LNAPL. Additional details on installation methods and well construction specifications are included in Worksheet #14. Temporary monitoring wells will be developed within 48 hours after installation. Development water and soil cuttings will be handled temporarily staged onsite, prior to characterization and offsite disposal.

Following a 72 hour post-development equilibration period, an oil-water interface probe will be used to gauge LNAPL and measure water levels at new temporary monitoring wells and existing monitoring wells in the vicinity. To evaluate hydrogeologic conditions and estimate the rate of recovery, LNAPL bail-down tests will be performed at up to three temporary wells. Bail-down test locations will be based on findings of the LIF study and LNAPL gauging.



Within 10 days of installation, temporary monitoring wells will be abandoned in accordance with applicable SCDHEC well standards.

17.3 Naphthalene Evaluation

To evaluate an increasing trend of naphthalene at MW-2 and a recent spike at MW-34R, DPT will be used to advance up to 12 soil borings in the vicinity of these wells. Approximate soil boring locations are shown on Figure 17-1; however, actual locations will be adjusted based on field observations/measurements and professional judgment. Soil borings will be advanced from the ground surface to the water table and continuously logged for lithology. A photoionization detector will be used to screen soil for organic vapors at a minimum of 2 foot intervals. One soil sample will be collected at the depth interval exhibiting the highest organic vapors, with an additional soil sample collected from the 2-foot depth interval immediately above the water table at each boring. Soil samples will be submitted to GCAL for analysis of naphthalene by USEPA Method 8260B.

DPT technology and patented Geoprobe tooling and water samplers will be used to collect up to six groundwater samples from borings advanced upgradient of MW-2 and MW-34R. DPT groundwater samples will be submitted to GCAL for analysis of naphthalene by USEPA Method 8260B. Such data will be used to supplement the soil data set in evaluating increasing trends of naphthalene.



SAP WORKSHEET #14: FIELD PROJECT TASKS

(UFP-QAPP Manual Section 2.8.1)

Field Project Implementation (Field Project Instructions)

In general, this project includes the advancement of soil borings, installation of temporary monitoring wells, and the collection and analysis of soil and groundwater samples. Project-specific SOPs and field forms for field tasks referenced in this worksheet are identified by title in Worksheet #21 and copies of each SOP are provided in Appendix A. Field tasks are as follows:

The supplemental investigation program includes the following tasks:

- Field tasks, including:
 - Mobilization/demobilization
 - Utility clearance
 - Field instrument calibration
 - LIF study
 - Temporary well installation and development
 - LNAPL and groundwater level measurements
 - Bail-down tests
 - Soil sampling
 - Groundwater sampling
 - QC samples
 - Land surveying
 - Investigative derived waste handling
 - Site restoration
 - Decontamination
 - Field documentation
- Analytical tasks
- Data handling and management
- Data review and validation
- Data tracking and control
- Data storage, archiving, and retrieval
- Supplemental Investigation report

These **tasks are summarized in the following sections.** The Resolution Consultants' SOPs and field documents referenced in this and other worksheets are included in Appendix A.



Field Tasks

Mobilization/Demobilization — Mobilization will consist of the delivery, assembly, and secure storage of necessary equipment, materials, and supplies, along with the acquisition of personnel and vehicle base access badges. The Resolution Consultants Field Team Leader (FTL) or designee will coordinate with the CNC point of contact (POC) to identify appropriate locations for the temporary storage of equipment and supplies.

Site-specific health and safety training for all Resolution Consultants field personnel and subcontractors will be conducted as part of mobilization. There are no specialized/non-routine project-specific training requirements or certifications needed by personnel to successfully complete the project tasks. 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 the Occupational Safety and Health Administration 40-hour Hazardous Waste Operations and Emergency Response course and 8-hour refresher, if applicable. Additional health and safety requirements will be addressed in greater detail in the *Site-Specific Health and Safety Plan* (EnSafe, 2012).

Demobilization will consist of the prompt and timely removal of equipment, materials, and supplies from the site at the completion of fieldwork. Demobilization also includes the cleanup and removal of waste generated during the investigation.

Utility Clearance — A minimum of two weeks prior to the commencement of any intrusive activities, Resolution Consultants will coordinate utility clearance with the CNC POC and Palmetto Utility Protection Services, a South Carolina public utility locating service, in accordance with SOP-3-01. In addition, Resolution Consultants will subcontract a private utility locating firm to use Ground Penetrating Radar and other non-intrusive equipment to identify potential subsurface utilities and underground fuel lines, which may serve as conduits for contaminants in the study area. The objective of this task is to identify potential source areas (i.e., fuel lines) for evaluation. The locating firm will clearly mark areas of potential subsurface utilities using flagging or paint, as appropriate. Proposed locations will be modified, based on the findings of the utility locating efforts.

Field Instrument Calibration — Field Instrument Calibration procedures are described in SOP-3-24. At a minimum, field equipment will be calibrated at the beginning and end of each day, unless stated otherwise by the equipment manufacturer. Documentation of field equipment calibration is required.

LIF Study — The LIF study will be performed using Dakota Technologies' patented UVOST probe, advanced using conventional DPT. UVOST effectively detects petroleum, oil, and lubricant constituents via their fluorescence response. Typical detection limits range between 10 and 500 parts per million. The fluorescence response scales proportionally with NAPL concentration, thus allowing for identification of hotspots and delineation of LNAPL. One inch data density coupled with nearly instantaneous response provides continuous detailed logs of LNAPL distribution and heterogeneity. Real-time results, as presented on a three-dimensional map, will be evaluated by a UVOST trained operator and field geologist/engineer. Additional details on the UVOST technology are provided in Appendix A and at Dakota Technologies web site: <http://www.dakotatechnologies.com/>. LIF soil borings will be properly abandoned per South Carolina Well Standards R.61-71 (SCDHEC, 2010).

Temporary Monitoring Well Installation/Development — To confirm results of the LIF study, DPT will be used to install up to 10 temporary monitoring wells, in accordance with South Carolina Well Standards R.61-71. The screened interval will be set to intersect the water table, thus capturing any LNAPL. Temporary monitoring wells will be constructed using 2-inch diameter Schedule 40 PVC riser and either 10-feet (shallow well) or 5-feet (deep well) of a .010-inch slotted PVC screen. A 30/40 silica sand filter pack will be placed in the annular space between the well screen and borehole wall, from the bottom of the borehole to approximately 2 feet above the top of the well screen. Bentonite pellets will be placed on top of the filter pack and hydrated (for at least 1 hour) to form a seal approximately 2 to 3 feet thick. A watertight expansion cap will be installed on top of the 2-inch diameter casing and secured using a padlock. Each temporary monitoring well will be surrounded by orange safety fencing, mounted on steel posts driven into the ground surface. Additional details on the installation and construction are included in SOP-3-12. Following installation, monitoring wells will be developed in accordance with SOP-3-13. Development water and soil cuttings will be handled as meeting non-hazardous criteria and temporarily staged onsite prior to offsite disposal. Within 10 days of installation, temporary monitoring wells will be abandoned in accordance with SOP-3-15. While the physical abandonment process will be in accordance with South Carolina Well Standards R.61-71, a variance will be requested in the form of the monitoring well permit application to be submitted for approval by SCDHEC, to allow temporary wells to remain in place for a period of 10 days. This extra time may be necessary to allow for equilibration, prior to well gauging and bail-down tests.

Groundwater Level Measurements and LNAPL Bail-down Tests — After allowing a minimum of 24 hours equilibration time following development, wells will be checked for LNAPL and the depth to the static water level will be measured in accordance with SOP-3-14. Depth-to-water will be measured in units of feet (to the nearest 0.01 foot) with respect to the top of the inner well riser. Water levels will be recorded on a Resolution Consultant water level measurement form. To evaluate hydrogeologic conditions and estimate the rate of free product recovery, disposable bailers will be used to extract LNAPL from up to three temporary monitoring wells. Once LNAPL has been removed, to the greatest extent possible, recovery will be recorded by measuring LNAPL thickness over time.

Soil Sampling — The sampling and analysis program is outlined in Worksheet #17. Subsurface soil samples will be collected from soil borings advanced via DPT tooling, in accordance with SOP-3-17 and SOP-3-21. Representative soil will be obtained, at a minimum of 2-foot depth intervals, for lithologic logging and field screening for organic vapors per SOP-3-19. Sample collection and handling will be in accordance with SOP-3-03, SOP-3-04, and SOP-3-21 as described in Worksheet #21. A soil boring log will be prepared for each boring with soil descriptions and all relevant information, observations, depth-to-water, and field screening results. Sample depths will be included on each log. After sampling, each borehole will be backfilled to within 6 inches of grade using soil cuttings removed from the borehole and/or bentonite grout. The surface cover will be repaired using ready-mix concrete or asphalt.

Groundwater Sampling — As outlined in Worksheet #17, groundwater samples will be collected from DPT borings and temporary monitoring wells in accordance with SOP-3-14. Groundwater samples will be collected using **USEPA's low-flow** (low stress) sampling protocol. Field measurements of dissolved oxygen, oxidation-reduction potential, turbidity, pH, temperature, and specific conductance will be made every 5 minutes. Once parameters are stable, samples will be obtained using the same pump and flow rate. If the water-quality parameters do not stabilize, three to five well volumes will be purged from the well (unless pumped dry) and then the well will be sampled using low-flow techniques. Samples will be collected using a peristaltic pump, connected to Teflon discharge tubing that is dedicated to each location. The tubing intake will be placed in the center of the screened interval. See combined Worksheet #18, 19, 20, and 30 for designated sample identifications, analyses, the required bottle types, preservation, target analytes, analytical methods, and holding times for this investigation. Sample handling will be in accordance with SOP-3-03 and SOP-3-04.



Surveying — Borings and new temporary monitoring wells will be surveyed by a professional surveyor licensed in the State of South Carolina in accordance with SOP-3-07. The Resolution Consultants FTL or designee will provide the surveyor with the coordinate designation nomenclature and all coordinate systems will be pre-approved prior to commencement of the survey. All measurements will be reported and recorded in U.S. Survey Feet. The surveyor will establish the horizontal location and vertical elevation for temporary monitoring wells. One horizontal measurement and two vertical measurements will be required per well. The two vertical measurements are: (1) the top of the inner casing riser pipe (herein referred to as “top of casing”), and (2) the top of ground adjacent to the pipe. All of the vertical measurements should be taken from marked positions on each temporary well or, if missing a mark, on the north side of the riser pipe. The surveyor will find and use existing survey control. It is anticipated that adequate control is located within one mile of the Site. Horizontal position should be referenced to South Carolina State Plane Coordinate System, North American Datum 1983 and accurate to 0.10 foot. Vertical elevation should be referenced to North American Vertical Datum of 1988 and accurate to 0.01 foot. The surveyor will document all work in a clear, legible, and complete manner. The field record will contain a complete description of the nature and location of the new and existing points. The record will also include a sketch of the point locations and the benchmark witness points for both project control and local control.

Quality Control Samples — Field QC samples, including field duplicates, trip blanks, and equipment rinsate blanks, will be collected as outlined in combined Worksheet #18, 19, 20, and 30.

Decontamination — Decontamination of reusable sampling equipment will be conducted prior to sampling and between samples at each location, in accordance with SOP-3-06. An area for a temporary decontamination pad and a source of potable water for steam cleaning will be arranged by the FTL through the CNC POC.

Investigative-Derived Waste — Investigative derived waste (IDW) will be managed in accordance with the SOP-3-05. IDW may consist of soil cuttings, personal protective equipment, decontamination fluids, and purged groundwater. IDW will be containerized in adequately labeled 55-gallon department of transportation approved drums. Characterization samples, including one composite soil sample and one composite aqueous sample will be collected and submitted to GCAL for analysis of Toxicity Characteristic Leaching Potential VOCs and Toxicity Characteristic Leaching Potential semi-volatile organic compounds. Pending characterization data, the drums will be temporarily staged onsite, as instructed by the CNC POC.



Based on characterization results, IDW will be transported and appropriately disposed at a Navy-approved and SCDHEC certified offsite disposal facility. Personal protective equipment, including gloves, wipes, discarded paper towels, and disposable equipment (i.e., tubing), will be bagged and properly discarded to a solid waste dumpster, as identified by the CNC POC.

Analytical Laboratory Tasks — Chemical analysis of soil and groundwater will be performed by GCAL, under subcontract to Resolution Consultants. GCAL is SCDHEC certified and Department of Defense Environmental Laboratory Accreditation Program-accredited, as documented on certificates in Appendix B. Analyses will be performed in accordance with analytical methods identified in Worksheet #23 and combined Worksheets #18, 19, 20, and 30. GCAL will strive to meet the PALs shown in Worksheet #15 and will perform chemical analyses following laboratory-specific SOPs cited on Worksheet #23. GCAL will provide fully validatable chemical data packages, which will include summary forms containing all quality control information and raw data. Soil results will be reported on an adjusted dry-weight basis. Results of percent moisture will be reported in each analytical data package and associated electronic data deliverable files. This information will also be captured in the project database, which will eventually be uploaded to the NIRIS database. Full laboratory SOPs are available upon request.

Data Handling and Management — The principal data generated for this project will be from field data and laboratory analytical data. Upon completion of field activities, all secondary data from field sampling forms will be organized by date and entered into Excel for electronic archiving/data evaluation. 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. 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 located on a secure network, which is password protected. The Resolution Consultants TOM (or designee) is responsible for the overall tracking and control of data generated for the project.

Data Review and Validation — Following 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 data will undergo validation, as cited in Worksheets #34 through #36. After the data are validated, the reviewer will then prepare



a technical memorandum presenting changes in the data, if necessary, and the rationale for making such changes. The final data validation report will include a technical memorandum, qualified analytical results, results reported by the laboratory, and documentation to support data qualification. All data that requires qualification will be flagged with an appropriate qualifying symbol.

Data Tracking and Control — The 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. 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 RPM.

Data Storage, Archiving, and Retrieval — After the data are validated, the data packages are entered into the Resolution Consultants' Navy Comprehensive Long-Term Environmental Action Navy file system and archived in secure files. The field records including field log books, sample logs, chain-of-custody records, and field calibration logs will be submitted by the Resolution Consultants FTL to be entered into the Navy Comprehensive Long-Term Environmental Action Navy 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, and at the completion of the Navy contract; records will be stored by Resolution Consultants and eventually transferred to the Navy. Final validated environmental data will be uploaded into the NIRIS database.

Supplemental Investigation Report — A brief technical memorandum will be prepared to summarize supplemental investigation activities at the Site. The document will present project objectives, provide an overview of site background information, describe field activities, present findings through text, tables, and figures, and offer recommendations for modifications to the CAP, if required.



SAP WORKSHEET #21: FIELD SOPS REFERENCE TABLE

(UFP-QAPP Manual Section 3.1.2)

Field SOPS Reference Table					
SOP Reference Number	Title/Author	Revision Date or Version Number	Location of SOP (if not included in the SAP)	Any planned deviation for Project Work	Comments
3-01	Utility Clearance/Resolution Consultants	June 2012	Appendix A	No	
3-02	Field Log Books/Resolution Consultants	May 2012	Appendix A	No	
3-03	Record Keeping, Sample Labeling, and Chain-of-Custody Procedures/Resolution Consultants	May 2012	Appendix A	No	
3-04	Sample Handling, Storage, and Shipping Procedures/Resolution Consultants	May 2012	Appendix A	No	
3-05	Investigative Derived Waste Management/Resolution Consultants	May 2012	Appendix A	No	
3-06	Equipment Decontamination (Water levels only)/Resolution Consultants	May 2012	Appendix A	No	
3-07	Land Surveying/Resolution Consultants	August 2012	Appendix A	No	
3-12	Monitoring Well Installation/Resolution Consultants	May 2012	Appendix A	No	
3-13	Monitoring Well Development/Resolution Consultants	June 2012	Appendix A	No	
3-14	Monitoring Well Sampling/Resolution Consultants	May 2012	Appendix A	No	
3-15	Monitoring Well Abandonment/Resolution Consultants	June 2012	Appendix A	No	
3-17	Direct Push Sampling Techniques/Resolution Consultants	May 2012	Appendix A	No	



Field SOPs Reference Table					
SOP Reference Number	Title/Author	Revision Date or Version Number	Location of SOP (if not included in the SAP)	Any planned deviation for Project Work	Comments
3-19	Headspace Screening for VOCs/Resolution Consultants	May 2012	Appendix A	No	
3-20	Operation and Calibration of a Photoionization Detector/Resolution Consultants	May 2012	Appendix A	No	
3-21	Surface and Subsurface Soil Sampling/Resolution Consultants	May 2012	Appendix A	No	
3-24	Water Quality Parameter Testing/Resolution Consultants	June 2012	Appendix A	No	
NA	Dakota Technologies UltraViolet Optical Screening Tool	2013	Appendix A	No	

Notes:

- SOP = Standard operating procedure
- SAP = Sampling and analysis plan



SAP WORKSHEETS #18, 19, 20, AND 30: LOCATION-SPECIFIC SAMPLING METHODS/SOP REQUIREMENTS TABLE

(UFP-QAPP Manual Sections 3.1.1 and 3.5.2.3)

Charleston Naval Complex – Chicora Tank Farm Contract Task Order JM29 Long-Term Groundwater Monitoring/Supplemental Investigation				Analysis Group:		Naphthalene	
Supplemental Investigation				Analytical Method ³ :		SW846/8260B	
				Analytical Laboratory SOP Reference:		GCMSV-003	
Gulf Coast Analytical Laboratories, Inc., 7979 GSRI Avenue, Baton Rouge, LA 70820, (225) 769-4900, Brenda Martinez, brenda.martinez@gcal.com				Data Package Turnaround Time:		14 Days	
				Container Type/Volume Required:		3 — 40 mL glass vials	
				Preservative:		Cool to ≤ 6°C;	
				Holding Time (Preparation/Analysis) ¹ :		7 days	
Site	Matrix	Boring ID	Sample ID	X	Y	Depth Interval (ft bgs) ²	
CTF	Soil	SB01	CTFSB01-SOXX-MMDDYY	TBD	TBD	Highest headspace	
CTF	Soil	SB01	CTFSB01-SOXX-MMDDYY	TBD	TBD	Above water table	
CTF	Soil	SB02	CTFSB02-SOXX-MMDDYY	TBD	TBD	Highest headspace	
CTF	Soil	SB02	CTFSB02-SOXX-MMDDYY	TBD	TBD	Above water table	
CTF	Soil	SB03	CTFSB03-SOXX-MMDDYY	TBD	TBD	Highest headspace	
CTF	Soil	SB03	CTFSB03-SOXX-MMDDYY	TBD	TBD	Above water table	
CTF	Soil	SB04	CTFSB04-SOXX-MMDDYY	TBD	TBD	Highest headspace	
CTF	Soil	SB04	CTFSB04-SOXX-MMDDYY	TBD	TBD	Above water table	
CTF	Soil	SB05	CTFSB05-SOXX-MMDDYY	TBD	TBD	Highest headspace	
CTF	Soil	SB05	CTFSB05-SOXX-MMDDYY	TBD	TBD	Above water table	
CTF	Soil	SB06	CTFSB06-SOXX-MMDDYY	TBD	TBD	Highest headspace	
CTF	Soil	SB06	CTFSB06-SOXX-MMDDYY	TBD	TBD	Above water table	
CTF	Soil	SB07	CTFSB07-SOXX-MMDDYY	TBD	TBD	Highest headspace	
CTF	Soil	SB07	CTFSB07-SOXX-MMDDYY	TBD	TBD	Above water table	
CTF	Soil	SB08	CTFSB08-SOXX-MMDDYY	TBD	TBD	Highest headspace	
CTF	Soil	SB08	CTFSB08-SOXX-MMDDYY	TBD	TBD	Above water table	
CTF	Soil	SB09	CTFSB09-SOXX-MMDDYY	TBD	TBD	Highest headspace	
CTF	Soil	SB09	CTFSB09-SOXX-MMDDYY	TBD	TBD	Above water table	
CTF	Soil	SB10	CTFSB10-SOXX-MMDDYY	TBD	TBD	Highest headspace	
CTF	Soil	SB10	CTFSB10-SOXX-MMDDYY	TBD	TBD	Above water table	
CTF	Soil	SB11	CTFSB11-SOXX-MMDDYY	TBD	TBD	Highest headspace	
CTF	Soil	SB11	CTFSB11-SOXX-MMDDYY	TBD	TBD	Above water table	
CTF	Soil	SB12	CTFSB12-SOXX-MMDDYY	TBD	TBD	Highest headspace	
CTF	Soil	SB12	CTFSB12-SOXX-MMDDYY	TBD	TBD	Above water table	
CTF	Field Duplicate	SB01	CTFSB01-SOXX-MMDDYY-D	TBD	TBD	Highest headspace	
CTF	Field Duplicate	SB12	CTFSB12-SOXX-MMDDYY-D	TBD	TBD	Above water table	
CTF	Equipment Blank	SB01	CTFSB01-SOXX-MMDDYY-EB	TBD	TBD	Highest headspace	
CTF	Equipment Blank	SB12	CTFSB12-SOXX-MMDDYY-EB	TBD	TBD	Above water table	
CTF	Trip Blank	NA	TBMMDDYY	NA	NA	NA	
CTF	Matrix Spike	SB03	CTFSB03-SOXX-MMDDYY- MS	TBD	TBD	Highest headspace	
CTF	Matrix Spike	SB09	CTFSB09-SOXX-MMDDYY-MS	TBD	TBD	Above water table	
CTF	Matrix Spike Duplicate	SB03	CTFSB03-SOXX-MMDDYY- MSD	TBD	TBD	Highest headspace	
CTF	Matrix Spike Duplicate	SB09	CTFSB09-SOXX-MMDDYY-MSD	TBD	TBD	Above water table	



Charleston Naval Complex – Chicora Tank Farm Contract Task Order JM29 Long-Term Groundwater Monitoring/Supplemental Investigation				Analysis Group:		Naphthalene	
				Analytical Method ³ :		SW846/8260B	
Supplemental Investigation				Analytical Laboratory SOP Reference:		GCMSV-003	
				Data Package Turnaround Time:		14 Days	
Gulf Coast Analytical Laboratories, Inc., 7979 GSRI Avenue, Baton Rouge, LA 70820, (225) 769-4900, Brenda Martinez, brenda.martinez@gcal.com				Container Type/Volume Required:		3 – 40 mL glass vials	
				Preservative:		Cool to ≤ 6°C;	
				Holding Time (Preparation/Analysis) ¹ :		7 days	
Site	Matrix	Boring ID	Sample ID	X	Y	Depth Interval (ft bgs) ²	
CTF	Groundwater	SBXX	CTFSB09-SOXX-MMDDYY-MSD	TBD	TBD	Water table	1
CTF	Groundwater	DP01	CTFDP01-WGXX-MMDDYY	TBD	TBD	Water table	1
CTF	Groundwater	DP02	CTFDP02-WGXX-MMDDYY	TBD	TBD	Water table	1
CTF	Groundwater	DP03	CTFDP03-WGXX-MMDDYY	TBD	TBD	Water table	1
CTF	Groundwater	DP04	CTFDP04-WGXX-MMDDYY	TBD	TBD	Water table	1
CTF	Groundwater	DP05	CTFDP05-WGXX-MMDDYY	TBD	TBD	Water table	1
CTF	Groundwater	DP06	CTFDP06-WGXX-MMDDYY	TBD	TBD	Water table	1
CTF	Field Duplicate	DP01	CTFDP01-WGXX-MMDDYY-D	TBD	TBD	Water table	1
CTF	Equipment Blank	DP03	CTFDP03-WGXX-MMDDYY-EB	TBD	TBD	Water table	1
CTF	Trip Blank	NA	TBMMDDYY	NA	NA	NA	2
CTF	Matrix Spike	DP06	CTFDP06-WGXX-MMDDYY-MS	TBD	TBD	Water table	1
CTF	Matrix Spike Duplicate	DP06	CTFDP06-WGXX-MMDDYY-MSD	TBD	TBD	Water table	1

Notes:

- ¹ Maximum holding time is calculated from the time the sample is collected to the time the sample is prepared/extracted. Actual
- ² depths to be determined in field.
- ³ Soil samples will be prepared by method SW846 5035A and the groundwater samples will be prepared by method SW846 5030B
- SOP = Standard operating procedure
- CTF = Chicora Tank Farm
- °C = Degrees Celsius
- mL = Milliliters
- HCL = Hydrochloric acid
- ft bgs = feet below ground surface
- XX = 2 digit value corresponding to terminal sample depth in feet below ground surface
- D = Duplicate
- EB = Equipment blank
- MS = Matrix spike
- MSD = Matrix spike duplicate
- TB = Trip blank
- WG = Groundwater
- MMDDYY = Two digit calendar month, day, year
- NA = Not Applicable
- TBD = To be determined (data not yet available)
- YYYY = Four digit calendar year



SAP WORKSHEET #15: REFERENCE LIMITS AND EVALUATION TABLES

(UFP-QAPP Manual Section 2.8.1)

Matrix:	Soil						
Analytical Group (Preparation and Analysis Method):	Volatile Organic Compounds (SW-846 5035A and SW846 8260B)						
Analyte	CAS No.	Project Action Level (mg/kg)	Project Action Level Source	Project Quantitation Limit Goal (mg/kg)	Laboratory Limit of Quantitation¹ (mg/kg)	Laboratory Limit of Detection¹ (mg/kg)	Laboratory Method Detection Limit¹ (mg/kg)
Naphthalene	91-20-3	0.036	SCDHEC RBSLs	0.012	0.0050	0.00050	0.00039

Matrix:	Groundwater						
Analytical Group (Preparation and Analysis Method):	Volatile Organic Compounds (SW-846 5030B and SW846 8260B)						
Analyte	CAS No.	Project Action Level (µg/L)	Project Action Level Source	Project Quantitation Limit Goal (µg/L)	Laboratory Limit of Quantitation¹ (µg/L)	Laboratory Limit of Detection¹ (µg/L)	Laboratory Method Detection Limit¹ (µg/L)
Naphthalene	91-20-3	25	SCDHEC RBSLs	8.3	5.0	0.20	0.18

Notes:

- ¹ = Laboratory Limit of Quantitation, Laboratory Limit of Detection, and Detection Limits are provided by Gulf Coast Analytical Laboratories and may vary during the course of project. Notification is required if the Laboratories Limit of Detection study results in a Limit of detection greater than the Project Action Level.
- CAS = Chemical Abstracts Service
- No. = number
- mg/kg = Milligram per kilogram
- µg/L = Microgram per liter
- SCDHEC RBSLs = South Carolina Department of Health and Environmental Control Risk Based Screening Levels per *South Carolina Risk-Based Corrective Action for Petroleum Releases*, dated May 15, 2001.



SAP WORKSHEET #23: ANALYTICAL SOP REFERENCES TABLE

(UFP-QAPP Manual Section 3.2.1)

Laboratory Name and Address: GCAL, 7979 GSRI Road, Baton Rouge, Louisiana 70820

Laboratory Point of Contact/Project Manager: Brenda Martinez, brenda.martinez@gcal.com, 225-769-4900

GCAL SOP Number	Title, Revision Date, and/or Number	Definitive or Screening Data	Matrix and Analytical Group	Instrument	Variance to QSM	Modified for Project Work? (Yes/No)
GCMSV-003	<i>SOP for the Analysis of Volatile Samples by 8260B, Revision 23, 12/12/11</i>	Definitive	Groundwater and Soil, Naphthalene	GC Agilent 6890 and 7890 with MS Agilent 5973 and 5975 or HP5890 with 5972 MS	No	No

Notes:

- GCAL = Gulf Coast Analytical Laboratory
- SOP = Standard operating procedure
- QSM = *Department of Defense Quality Systems Manual for Environmental Laboratories*, Version 4.2, October 2010 (and subsequent revisions)
- GC = Gas chromatograph
- MS = Mass spectrometer



SAP WORKSHEET #28: LABORATORY QC SAMPLES TABLE

(UFP-QAPP Manual Section 3.4)

Matrix		Groundwater, Soil				
Analytical Group		Naphthalene				
Analytical Method		SW-846 8260B				
SOP Reference		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 preparatory batch	No analytes detected > 1/2 LOQ and > 1/10 the amount measured in any sample or 1/10 the regulatory limit (whichever is greater). For common laboratory contaminants, no analytes detected > LOQ (see Box D-1 in QSM V4.2).	Correct problem; reanalyze any sample associated with a blank that fails criteria.	Analyst, Supervisor, QA Manager	Bias Contamination	No analytes detected > 1/2 LOQ and > 1/10 the amount measured in any sample or 1/10 the regulatory limit (whichever is greater). For common laboratory contaminants, no analytes detected > LOQ (see Box D-1 in QSM V4.2).
Surrogates	All field and QC samples	QC acceptance criteria specified in DoD QSM Version 4.2	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
LCS	One LCS per preparatory batch	QC acceptance criteria specified in DoD QSM Version 4.2	Reanalyze all associated samples.	Analyst, Supervisor, QA Manager	Accuracy Bias	QC acceptance criteria specified in 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	Retention time ± 30 seconds; EICP area within -50% to +100% of midpoint of ICAL
MS/MSD	One per preparatory batch per matrix	For matrix evaluation, use LCS recovery criteria; RPD ≤30%.	Contact the client to determine if additional measures are required.	Analyst, Supervisor, QA Manager	Accuracy Bias Precision	For matrix evaluation, use LCS recovery criteria; RPD ≤30%.

Notes:

- | | |
|---|--|
| VOCs = Volatile organic compounds
SOP = Standard operating procedure
GCAL = Gulf Coast Analytical Laboratories
QC = Quality assurance
LOQ = Limit of quantitation
QA = Quality assurance
DoD QSM = Department of Defense Quality Systems Manual | 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 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)

The data verification and validation for the SAP are shown below. Processes described in this worksheet will be documented in the appropriate format for the specific interaction. Appropriate forms of documentation include, but are not limited to: sample receipt checklists, laboratory case narrative, validation report, emails, field logbook notations, field forms.

Data Review Input	Description	Responsible for Verification (name, organization)	Internal/ External
Verification (Step I) 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.	Laboratory sample custodians and analysts, GCAL Laboratory	Internal
Verification (Step I) 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.	Project chemist or data validators, Resolution Consultants	External
Verification (Step I) SAP sample tables	Verify that all proposed samples listed in the SAP tables have been collected.	FTL or designee, Resolution Consultants	External
Verification (Step I) Sample log sheets and field notes	Verify that information recorded in the log sheets and field notes are accurate and complete.	FTL or designee, Resolution Consultants	External
Verification (Step I) Field QC samples	Check that field QC samples described in Worksheet #12 and listed in Worksheet #20 were collected as required.	FTL or designee, Resolution Consultants	External
Verification (Step I) Analytical data package	Confirm 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.	Laboratory project manager, GCAL Laboratory	Internal
Verification (Step I) 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.	FTL, Project chemist or data validators, Resolution Consultants	External
Verification (Step I) Electronic data deliverables	Verify the electronic data against the chain-of-custody and hard copy data package for accuracy and completeness.	Data manager and/or validator, Resolution Consultants	External



Data Review Input	Description	Responsible for Verification (name, organization)	Internal/ External
Validation (Step 11a) 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.	Project chemist or data validators, Resolution Consultants	External
Validation (Step 11a) 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.	Project chemist or data validators, Resolution Consultants	External
Validation (Steps 11a/11b) 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.	Project chemist or data validators, Resolution Consultants	External
Validation (Steps 11a/11b) 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.	Project chemist or data validators, Resolution Consultants	External
Validation (Steps 11a/11b) 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.	Project chemist or data validators, Resolution Consultants	External
Validation (Steps 11a/11b) 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 chemist or data validators, Resolution Consultants	External
Validation (Steps 11a/11b) 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.	Project chemist or data validators, Resolution Consultants	External
Validation (Steps 11a/11b) 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.	Project chemist or data validators, Resolution Consultants	External
Validation (Step 11b) 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.	Project chemist or data validators, Resolution Consultants	External
Validation (Step 11b) Project quantitation limits for sensitivity	Ensure that the project detection limits were achieved.	Project chemist or data validators, Resolution Consultants	External



Data Review Input	Description	Responsible for Verification (name, organization)	Internal/ External
Validation (Steps IIa/IIb) Soil and Groundwater — Naphthalene	Assess VOC (naphthalene) data using SW846 8260B method-specific criteria, the DoD QSM, and those listed in Worksheets # 12, 19, and 28. <i>USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review</i> , (October 2008) will be used to apply qualifiers to data.	Project chemist or data validators, Resolution Consultants	External

Notes:

- SAP = Sampling and analysis plan
- 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
- VOCs = Volatile organic compounds
- DoD QSM = *Department of Defense Quality Systems Manual for Environmental Laboratories*, Version 4.2, October 2010
- USEPA = U.S Environmental Protection Agency

Appendix A
Site Specific Field Standard Operating Procedures and Field Forms

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 purposes 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.

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 of 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 with 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.

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

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](http://www.epa.gov/fedfac/pdf/ufp_qapp_v1_0305.pdf). 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)

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 filling 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.

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;

- 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.

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

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 OC 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)	<p>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.</p> <p>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.</p>
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.

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 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.

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.

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).

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

**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

**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.

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

Attachment 1
Chain-of-Custody Seal

EXAMPLE CHAIN-OF-CUSTODY SEAL

[LABORATORY]	SAMPLE NO.	DATE	SEAL BROKEN BY
	SIGNATURE		DATE
	PRINT NAME AND TITLE (<i>Inspector, Analyst or Technician</i>)		

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

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).

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,

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 Program Manager	Tina Cantwell QA Officer	Rev 0 — Initial Issue

Investigation Derived Waste Management

Procedure 3-05

1.0 Purpose and Scope

This standard operating procedure (SOP) describes activities and responsibilities of the United States (U.S.) Navy Environmental Restoration (ER) Program, Naval Facilities Engineering Command, Atlantic (NAVFAC Atlantic) with regard to management of investigation-derived waste (IDW). The purpose of this procedure is to provide guidance for the minimization, handling, labelling, temporary storage, inventory, classification, and disposal of IDW generated under the ER Program. 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 removal or remedial actions. The information presented will be used to prepare and implement work plans (WPs) for IDW-related field activities. The results from implementation of WPs will then be used to develop and implement final IDW disposal plans.

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 IDW then those procedures may be added as an appendix to the project specific SAP.

This procedure applies to all Navy ER projects performed in the NAVFAC Atlantic Area of Responsibility.

This procedure shall serve as management-approved professional guidance for the ER Program 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 or Technical Director, and documented.

This procedure was developed to serve as management-approved professional guidance for the management of IDW generated under the ER Program. 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.

2.0 Safety

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 CTO WP and/or direction from the **Site Safety Officer (SSO)**.

All **Field Personnel** responsible for IDW management must adhere to the HASP and must wear the PPE specified in the site-specific HASP. Generally, this includes, at a minimum, steel-toed boots or steel-toed rubber boots, safety glasses, American National Standards Institute-standard hard hats, and hearing protection (if heavy equipment is in operation). If safe alternatives are not achievable, discontinue site activities immediately.

3.0 Terms and Definitions

None.

4.0 Training and Qualifications

- 4.1 The **CTO Manager** is responsible for ensuring that IDW management activities comply with this procedure. 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.
- 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 IDW is managed according to this procedure.
- 4.4 All **Field Personnel** are responsible for the implementation of this procedure.

5.0 Equipment and 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 and closed top drums) and material to cover waste to protect from weather (e.g., plastic covering);
- Hazardous /non-hazardous waste drum labels (weatherproof);
- Permanent marking pens;
- Inventory forms for project file;
- Plastic garbage bags, zip lock storage bags, roll of plastic sheeting; and
- Steel-toed boots, chemical resistant gloves, coveralls, safety glasses, and any other PPE required in the HASP.

6.0 Procedure

The following procedures are used to handle the IDW.

6.1 Drum Handling

- 6.1.1 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 (i.e., United Nations Code 1A2 or 1H2). Typically 55-gallon drums are used, however small drums may be used depending on the amount of waste generated. New steel drums are preferred over recycled drums.
- 6.1.2 Recycled drums should not be used for hazardous waste, PCBs or other regulated shipments. For short-term storage of liquid IDW prior to discharge, 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 versus longer-term drum storage.
- 6.1.3 For long-term IDW storage at other project locations, the DOT approved drums with removable lids are recommended. Verify the integrity of the foam or rubber sealing ring located on the underside of some drum lids prior to sealing drums containing IDW liquids.
- 6.1.4 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.
- 6.1.5 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 prior to storage.

6.2 **Labelling**

- 6.2.1 Containers used to store IDW must be properly labelled. Two general conditions exist: 1) from previous studies or on-site data, waste characteristics are known to be either hazardous or nonhazardous; or 2) waste characteristics are unknown until additional data are obtained.
- 6.2.2 For situations where the waste characteristics are known, the waste containers should be packaged and labelled in accordance with state regulations and any federal regulations that may govern the labelling of waste.
- 6.2.3 The following information shall be placed on all non-hazardous waste labels:
- Description of waste (i.e., purge water, soil cuttings);
 - Contact information (i.e., contact name and telephone number);
 - Date when the waste was first accumulated.
- 6.2.4 The following information shall be placed on all hazardous waste labels:
- Description of waste (i.e., purge water, soil cuttings);
 - Generator information (i.e., name, address, contact telephone number);
 - EPA identification number (supplied by on-site client representative);
 - Date when the waste was first accumulated.
- 6.2.5 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 of waste (i.e., purge water, soil cuttings);
 - Contact information (i.e., contact name and telephone number);
 - Date when the waste was first accumulated.
- 6.2.6 Once the waste has been characterized, the label should be changed as appropriate for a nonhazardous or hazardous waste.
- 6.2.7 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.
- 6.2.8 Each container of waste generated shall be recorded in the field notebook used by the person responsible for labelling the waste. After the waste is disposed of, either by transportation off-site or disposal on-site in an approved disposal area, an appropriate record shall be made in the same field notebook to document proper disposition of IDW.

6.3 **Types of Site Investigation Waste**

Several types of waste are generated during site investigations that may require special handling. These include solid, liquid, and used PPE, as discussed further below.

Solid Waste

Soil cuttings from boreholes will typically be placed in containers unless site specific requirements allow for soil cuttings to be placed back into the borehole after drilling is complete. Drilling mud generated during investigation activities shall be collected in containers. Covers should be included on the containers and must be secured at all times and only open during filling activities. The containers shall be labelled 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.

Non-hazardous solid waste can be disposed on-site in the designated site landfill or in a designated evaporation pond if it is liquefied. Hazardous wastes must be disposed off-site at an approved hazardous waste landfill.

Liquid Waste

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). Lids or bungs on drums must be secured at all times and only open during filling or pumping activities. The containers shall be labelled in accordance with this SOP. Non-hazardous liquid waste can be disposed of in one of the designated lined evaporation ponds on-site. Hazardous wastes must be handled separately and disposed off-site at an approved hazardous waste facility.

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 non-hazardous waste in the designated on-site landfill. Trash that is generated as part of field activities may be disposed of in the landfill as long as the trash was not exposed to hazardous media.

6.4 **Waste Accumulation On-Site**

6.4.1 Solid, liquid, or PPE waste generated during investigation activities that are classified as nonhazardous or "characterization pending analysis" should be disposed of as soon as possible. Until disposal, such containers should be inventoried, stored as securely as possible, and inspected regularly, as a general good practice.

6.4.2 Solid, liquid, or PPE waste generated during investigation activities that are classified as hazardous shall not be accumulated on-site longer than 90 days. All hazardous waste containers shall be stored in a secured storage area. 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 labelling of waste;
- Secondary containment to contain spills;
- Spill containment equipment must be available;
- Fire extinguisher;
- Adequate aisle space for unobstructed movement of personnel.

- 6.4.3 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.

6.5 Waste Disposal

- 6.5.1 Solid, liquid, and PPE waste 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.
- 6.5.2 All waste generated during field activities will be stored, transported, and disposed of according to applicable state, federal, and local regulations. All wastes classified as hazardous will be disposed of at a licensed treatment storage and disposal facility or managed in other approved manners.
- 6.5.3 In general, waste disposal should be carefully coordinated with the facility receiving the waste. 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.

6.6 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:

- Code of Federal Regulations (CFR), Title 40, Part 261;
- CFR, Title 49, Parts 172, 173, 178, and 179.

6.7 Waste Transport

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

7.0 Quality Control and Assurance

- 7.1 Management of IDW must incorporate quality control measures to ensure conformance to these and the project requirements.

8.0 Records, Data Analysis, Calculations

- 8.1 Maintain records as required by implanting the procedures in this SOP.
- 8.2 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**.

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.

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NAVFAC NW Standard Operating Procedure Number I-F, *Equipment Decontamination*.

NAVFAC NW Standard Operating Procedure Number III-D, *Logbooks*.

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

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.

- 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,

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

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*.

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

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;

- 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 (\pm) 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.

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 (\pm) 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 (\pm) 0.1 feet. Benchmark elevation accuracy and elevation of other permanent features, including monitoring wellheads, shall be (\pm) 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.

- 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 (\pm) 3 to 5 meters is required, a licensed surveyor will be required. When a level of precision of (\pm) 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 (\pm) 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.

- 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.

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

Monitoring Well Installation

Procedure 3-12

1.0 Purpose and Scope

- 1.1 This standard operating procedure (SOP) describes the methods to be used during the installation of groundwater monitoring wells. It describes the components of monitoring well design and installation and sets forth the rationale for use of various well installation techniques in specific situations.
- 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, 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 well installation commences, appropriate entities (e.g. DigSafe, local public works departments, company facilities) must be contacted to assure the anticipated well locations are marked for utilities, including electrical, telecommunications, water, sewer, and gas.
- 2.3 Physical Hazards Associated with Well Installation
- Stay clear of all moving equipment and avoid wearing loose fitting clothing.
 - When using an approved retractable-blade knife, always cut away from one self and make sure there are no other people in the cutting path or the retractable-blade knife.
 - To avoid slip/trip/fall conditions during drilling activities, keep the area clear of excess soil cuttings and groundwater. Use textured boots/boot cover bottoms in muddy areas.
 - To avoid heat/cold stress as a result of exposure to extreme temperatures and personal protective equipment (PPE), drink electrolyte replacement fluids (1 to 2 cups per hour is recommended) and, in cases of extreme cold, wear fitted insulating clothing.
 - To avoid hazards associated with subsurface utilities, ensure all sampling locations have been properly surveyed as described in SOP 3-01, Utility Clearance.
 - Be aware of restricted mobility caused by PPE.

3.0 Terms and Definitions

- 3.1 **Annulus:** The annulus is the down-hole space between the borehole wall and the well casing and screen.
- 3.2 **Bridge:** A bridge is an obstruction in the drill hole or annulus. A bridge is usually formed by caving of the wall of the well bore, by the intrusion of a large boulder, or by the placement of filter pack materials during well completion. Bridging can also occur in the formation during well development.
- 3.3 **Filter Pack:** Filter pack is sand or gravel that is smooth, uniform, clean, well-rounded, and siliceous. It is placed in the annulus of the well between the borehole wall and the well screen to prevent formation materials from entering the well and to stabilize the adjacent formation.
- 3.4 **Grout:** Grout is a fluid mixture of cement and water that can be forced through a tremie pipe and emplaced in the annular space between the borehole and casing to form an impermeable seal. Various additives, such as sand, bentonite, and polymers, may be included in the mixture to meet certain requirements.
- 3.5 **Heaving (Running) Sands:** Loose sands in a confined water-bearing zone or aquifer which tend to rise up into the drill stem when the confining unit is breached by the drill bit. Heaving sands occur when the water in the aquifer has a pressure head great enough to cause upward flow into the drill stem with enough velocity to overcome the weight of the sand.
- 3.6 **Sieve Analysis:** Sieve analysis is the evaluation of the particle-size distribution of a soil, sediment, or rock by measuring the percentage of the particles that will pass through standard sieves of various sizes.

4.0 Interferences

- 4.1 Heaving sands may be problematic in unconsolidated sands encountered below the water table.
- 4.2 Rotary drilling methods requiring bentonite-based drilling fluids should be used with caution to drill boreholes that will be used for monitoring well installation. The bentonite mud builds up on the borehole walls as a filter cake and permeates the adjacent formation, potentially reducing the permeability of the material adjacent to the well screen.
- 4.3 If water or other drilling fluids have been introduced into the boring during drilling or well installation, samples of these fluids should be obtained and analyzed for chemical constituents that may be of interest at the site. In addition, an attempt should be made to recover the quantity of fluid or water that was introduced, either by flushing the borehole prior to well installation and/or by overpumping the well during development.
- 4.4 Track-mounted drill rigs are suitable for travelling on many types of landscapes that truck-mounted units cannot access, but may have limitations on extremely uneven or soft terrain.
- 4.5 Care should be taken to prevent cross-contamination between well locations. All drilling equipment coming in contact with potentially contaminated soil and/or groundwater will be decontaminated by the drilling subcontractor prior to initial drilling activities and between drilling locations in accordance with SOP 3-06, Equipment Decontamination.

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 **Contract Task Order (CTO) Managers** are responsible for issuing sampling and analysis plans (SAPs) that reflect the procedures and specifications presented in this procedure. Individual municipalities, county agencies, and possibly state regulatory agencies enforce regulations that may include well construction and installation requirements. 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 monitoring well installation 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 the installation of monitoring wells and ensuring that procedures and specifications are implemented in the field in accordance with the approved SAP and well installation permits. 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.
- 5.2.5 The on-site hydrogeologist/engineer is expected to obtain a description of the lithologic samples obtained during the excavation and construction of a monitoring well. These data are often required to provide guidance regarding the installation of specific components of the monitoring well. Guidance for lithologic sample collection and sample description is contained within SOP 3-16, Soil and Rock Classification.

6.0 Equipment and Supplies

6.1 Materials provided by the drilling contractor may include:

- Drill rig, drill rods, hollow stem augers, etc.
- Decontamination equipment (e.g., steam cleaner, high-pressure washer, brushes, etc.)
- Decontamination pad materials
- Well screen/riser pipe with flush-threaded couplings including riser and bottom caps
- Clean, filter sand
- Bentonite chips or pellets
- Cement grout and tremie pipe
- Portland cement for well pad completion
- Steel protective riser covers and locking caps
- Weighted calibrated tape
- Split-spoon samplers
- 55-gallon drums or containers for drill cuttings, decontamination fluids, etc.

6.2 In addition to those materials provided by the drilling contractor, equipment and materials required by the project geologist/engineer may include, but is not limited to, the following:

- Photoionization Detector (PID)
- Spill kit, including at a minimum sorbent pads and shovel (if not provided by subcontractor)

- Plastic sheeting
- Teaspoon or spatula
- Resealable plastic bags
- Boring Log Records
- Decontamination materials (per SOP No. 3-06 - Equipment Decontamination)
- Weighted measuring tape for depth measurement
- Soil logging materials (e.g. USCS classification field card, millimeter rule, hand lens, etc.)
- Survey lathes or pin flags
- Digital camera
- PPE as required by the HASP
- Planning documents including the site-specific HASP and SAP
- Large indelible ink or paint pen
- Field logbook/field forms/site maps (water **proof**)

7.0 Procedure

7.1 General Procedures

- Specific drilling, sampling, and installation equipment and methodology will be dictated by the type of well to be installed (e.g., single case (Type II), double case (Type III), bedrock, etc.), geologic characteristics of the site, the type of contaminants being monitored, and local and state regulations.
- For access to locations when travelling over difficult terrain, an appropriate line should be chosen before mobilizing the drill rig or other support vehicles. If clearing of trees or ground cover is required, perform these activities in advance to avoid down time. Avoid wet or soft areas where possible or use ground mats and/or timbers to aid in supporting the rig as it travels. If drilling on soft material, place geomatting and ground mats under the rig tracks or stabilizers prior to drilling.
- A utility locate must be conducted to identify all underground utilities at the site prior to drilling (refer to SOP 3-01, Utility Clearance). Proper clearance procedures for aboveground/overhead utilities must also be followed as specified in the HASP.
- Although new well materials (well screen and riser pipe) generally arrive at the site boxed and sealed within plastic bags, it is sometimes necessary to decontaminate the materials prior to their use. Well materials should be inspected by the project geologist/engineer upon delivery to check for cleanliness. If the well materials appear dirty, or if local or regional regulatory guidance requires decontamination, then well material decontamination should be performed by the drilling subcontractor in accordance with SOP 3-06, Equipment Decontamination.
- The diameter of the borehole must be a minimum of 2 inches greater than the outside diameter of the well screen or riser pipe used to construct the well. This is necessary so that sufficient annular space is available to install filter packs, bentonite seals, and grout seals, and allow the passage of tremie pipe where grouting at depth is required. Bedrock wells may require reaming after coring in order to provide a large enough borehole diameter for well installation.
- When soil sampling is required (refer to the SAP), soil samples will be collected for visual logging by advancing split-spoon samplers through the augers. The soil will be visually logged by a field geologist and include lithologic characteristics (i.e., soil type, color, density, moisture content, etc.) using the the

methods described in SOP 3-16, Soil and Rock Classification. This information will be recorded on a boring/well log form, along with well construction details.

7.2 Drilling Techniques

Drilling of monitoring well boreholes may be accomplished by a variety of methods as described below. Preferred methods include those that temporarily case the borehole during drilling (i.e., hollow stem auger and sonic methods) using an override system. Other methods can be used where specific subsurface conditions or well design criteria dictate.

- Hollow stem auger (HSA) – Borings are advanced by rotating steel hollow stem augers with an attached cutting head. Soil cuttings are displaced by the cutting head and transported to the surface via continuous spiral flights attached to each auger stem. This method is widely used for unconsolidated soils that have a tendency to collapse within the boring. A bottom plug can be placed in the bottom auger to prevent soils from entering and clogging the auger, especially in the case of heaving sands. However, a bottom plug cannot be used when soil samples are to be collected through the augers. Soil plugs that accumulate in the bottom of the auger must be removed or knocked out prior to sampling or well installation.
- Solid stem auger – This type of drilling method is similar to HSA drilling using a solid stem or sealed hollow stem auger flights to advance the boring. Solid stem, continuous flight auger use is limited to semi-consolidated sediments or to cohesive or semi-cohesive unconsolidated sediments that don't have a tendency to collapse when disturbed.
- Sonic methods – Sonic drilling consists of advancing concentric hollow drill casings (inner and outer) using rotation in conjunction with axial vibration of the drill casing. Once the casings are advanced to the appropriate depth, the inner string is removed with a core of drill cuttings while the outer casing remains in place to keep the borehole open. Cuttings are removed from the inner casing relatively intact for logging or sampling purposes. This drilling method is used for a variety of soil types, from heaving sands to consolidated or indurated formations. Smearing of the formation along the borehole walls is minimal since moderate vibration and rotation techniques are used to advance the casings. Since the total borehole diameter in sonic drilling is only incrementally larger than the inner casing diameter, care should be taken during installation of the monitoring well to ensure the well is centered and adequate space is available for annular materials.
- Rotary methods (water or mud) – Rotary drilling methods consist of drill rods coupled to a drill bit that rotates and cuts through the soils to advance the borehole. Water or drilling fluid ("mud") is forced through the hollow drill rods and drill bit as the rods are rotated. The soil cuttings are forced up the borehole with the drilling fluids to the surface and the fluids recirculated. The drilling fluid provides a hydrostatic pressure that reduces or prevents the borehole from collapsing. Clean, potable water must be used for water-rotary drilling to prevent introducing trace contaminants. A sample of the potable water should be collected during the course of well installation for analysis of the same parameters defined for the groundwater samples. If mud-rotary is used to advance boreholes, potable water and bentonite drilling mud should only be used. No chemical additives shall be mixed in the drilling fluid to alter viscosity or lubricating properties. Adequate well development is essential for removal of drilling mud and fluids from the formation materials and ensure collection of representative groundwater samples.
- Rotary methods (Air) – Air rotary methods are similar to water rotary but use high air velocities in place of drilling fluids to rotate the drill bit and carry the soil cuttings up the borehole to the surface. Care must be taken to ensure that contaminants are not introduced into the air stream from compressor oils, etc. Most compressor systems are compatible with a coalescing filter system. Cuttings exiting the borehole under pressure must be controlled, especially when drilling in a zone of potential contamination. This can be accomplished by using an air diverter with hose or pipe to carry the cuttings to a waste container. Letting the cuttings blow uncontrolled from the borehole is not acceptable.

7.3 Well Construction and Installation

- If rotary drilling techniques are used, the borehole should be flushed or blown free of material prior to well installation. If hollow stem augers are used, the soil or bottom plug should be removed and the augers raised approximately six inches above the bottom of the borehole, while slowly rotating the augers to remove cuttings from the bottom of the boring. The depth of the borehole should be confirmed with a weighted, calibrated tape.
- The riser pipe and screen should be connected with flush-threaded joints and assembled wearing clean, disposable gloves. No solvent or anti-seize compound should be used on the connections. The full length of the slotted portion of the well screen and unslotted riser pipe should be measured and these measurements recorded on a well construction form (Attachment 1).
- If placed in an open borehole, the assembled well should be carefully lowered and centered in the borehole so that the well is true, straight, and vertical throughout. Centering can also be accomplished with the use of centralizers, if necessary. However, centralizers should be placed so that they do not inhibit the installation of filter sand, bentonite seal, and annular grout. Wells less than 50 deep generally do not require centralizers.
- If hollow stem augers are used, the well should be lowered through the augers and each auger flight removed incrementally as the filter sand, bentonite seal, and grout are tremmied or poured into the annular space of the well. The well should be temporarily capped before filter sand and other annular materials are installed.
- Clean, silica sand should be placed around the well screen to at least 1 foot above the top of the screen. The filter sand should be appropriately graded and compatible with the selected screen size and surrounding formation materials. In general, the filter pack should not extend more than 3 feet above the top of the screen to limit the thickness of the monitoring zone. As the filter pack is placed, a weighted tape should be lowered in the annular space to verify the depth to the top of the layer. This measurement will be recorded on the well construction form (Attachment 1). If necessary, to eliminate possible bridging or creation of voids, placement of the sand pack may require the use of a tremie pipe. Tremie pipe sandpack installations are generally suggested for deeper wells and for wells which are screened some distance beneath the water table.
- A minimum 2-foot thick layer of bentonite pellets or slurry seal will be installed immediately above the filter sand to prevent vertical flow within the boring from affecting the screened interval. Bentonite chips/pellets must be hydrated if placed above the water table prior to grouting. If bridging is of concern as in the case of deep wells, powdered bentonite may be mixed with water into a very thick slurry and a tremie pipe used to place the seal to the desired depth. Placement of the bentonite seal in the borehole will be recorded on the well construction form (Attachment 1).
- The remaining annular space around the well will be grouted from the top of the bentonite seal to the surface with a grout composed of neat cement, a bentonite cement mixture, or high solids sodium bentonite grout.
- Each well riser will be secured with an expandable, locking cap (vented if possible). Optionally, a hole can be drilled in the upper portion of the riser to allow venting of the well.
- The well will be completed within a concrete well pad consisting of a Portland cement/sand mixture. Well pads are generally 3 feet by 3 feet square but may be larger or smaller depending on site conditions and state-specific well construction standards. Round concrete well pads are also acceptable. A minimum of 1 inch of the finished pad should be below grade to prevent washing and undermining by soil erosion.
- If completed as a flush-mount well, the well riser will be cut off approximately 4 to 6 inches below ground surface and an expandable, locking cap placed on the well riser. The area around the riser is dug out and a steel well vault or manhole cover placed over the riser and set almost flush to the ground

to protect the well. The manhole cover should be water-tight and secured with bolts to prevent casual access. The well pad will then be constructed around the well vault and slightly mounded at the center and sloping away to prevent surface water from accumulating in the well vault.

- If completed as a stick-up well, the well riser is cut approximately 2.5 to 3 feet above the ground surface and an expandable, locking cap placed on the well riser. A steel guard pipe with hinged, locking cap is placed over the well riser as a protective casing. The bottom of the guard pipe will be set approximately 2 feet below ground surface and sealed by pouring concrete from the top of the annular grout around the pipe to grade. The concrete well pad should be completed at the same time. Weep holes will be drilled in the base of the guard pipe to facilitate draining of rainwater or purge water from inside the guard pipe.
- Bumper posts or bollards may be necessary for additional well protection, especially in high traffic areas. The bumper posts should be placed around the well pad in a configuration that provides maximum protection to the well and extend a minimum of 3 feet above the ground.

7.4 Double Cased Wells

Under certain site conditions, the use of a double-cased or telescoping (Type III) well may be necessary. Installation of double-cased wells may be required to prevent the interconnection of two separate aquifers, seal off a perched aquifer without creating a vertical hydraulic conduit, prevent cross-contamination during construction of wells in deeper aquifers hydro-stratigraphically below impacted aquifers, or case off highly impacted soils present above the aquifer to prevent potential "dragging down" of contaminants.

Similar to conventional wells, construction of double-cased wells can be accomplished using a variety of drilling methods. Well construction is initiated by "keying" a large diameter, outer casing into a stratigraphic zone of low permeability (clay layer or bedrock). The size of the outer casing should be a minimum of 2 inches greater than the outside diameter of the inner casing to allow installation of annular seal materials during well completion. A pilot borehole should be drilled through the overburden soil and/or contaminated zone into a clay confining layer or bedrock. The borehole for the outer casing should be of sufficient size to contain the outer casing with a minimum of 2 inches around the outside diameter to allow sufficient annular space for tremie or pressure grouting. The boring should extend a minimum of 2 feet into a clay layer and a minimum of 1 foot into bedrock, if possible, to ensure an adequate seal. The boring should never breach a confining layer or keyed zone under any circumstances.

Once the boring is completed, the outer casing can be set in the borehole and sealed with grout. The outer casing can be set two ways, with or without a bottom cap. If no bottom cap is applied, the casing is usually driven approximately 6 inches into the clay confining unit. A grout plug is generally placed in the bottom of the casing and once set, standing water in the casing is evacuated prior to drilling below the casing. As an alternative, a cap can be placed on the bottom of the casing and if set below the water table, the casing can be filled with clean, potable water to hold down the casing in the boring. Grouting should be conducted using tremie-grouting or pressure-grouting methods by pumping grout into the annular space between the outer casing and the borehole wall from the bottom of the casing to the ground surface. Grout around the casing should be allowed to cure at least 24 hours before attempting to drill through the bottom.

Once the grout is cured, a smaller diameter drill pipe/bit is used to bore through the grout plug or bottom cap to the desired well depth. The well is then constructed as described in Section 7.3 above.

7.5 Post Installation Procedures

- Wells should be permanently labelled or marked for identification. Well tags can be used to record the site name, well number, total depth, installation date, etc. At a minimum, the well number will be written in indelible marker or paint on both the outside of the protective casing and inside beneath the casing lid, as well as on the riser pipe.

- A measuring point will be marked on the top of the riser pipe for taking water level measurements. The measuring point can be notched using a knife or saw or can be marked with a waterproof marker or paint. The measuring point will also be the point which will be surveyed for vertical elevation data.
- Upon completion, the following measurements will be taken by the field geologist/engineer and recorded on the well construction diagram.
 - Depth to static water level
 - Depth of non-aqueous phase liquid (NAPL), if present
 - Total depth of well measured from top of casing (TOC)
 - Height of well casing above ground surface
 - Height of protective casing above ground surface
- All monitoring wells will be surveyed for horizontal and vertical control by a licensed surveyor.
- Investigation-derived waste (IDW) including drill cuttings, spent materials (e.g., PPE), and decontamination water should be properly managed in accordance with SOP 3-05, IDW Management.

8.0 Quality Control and Assurance

- 8.1 Field personnel will follow specific quality assurance (QA) guidelines as outlined in the SAP. Certain quality control (QC) measures should be taken to ensure proper well installation and construction in accordance with this SOP, project specific SAP, and applicable well standards.
- 8.2 The borehole will be checked for total open depth, and extended by further drilling or shortened by backfilling, as required before installation of the well materials.
- 8.3 Water level and NAPL presence will be checked during well installation to ensure that the positions of well screen, filter sand, and seals relative to water level conform to project requirements
- 8.4 The depth to top of each layer of annular materials (i.e., filter sand, bentonite, grout) will be verified and adjusted as necessary for proper placement.

9.0 Records, Data Analysis, Calculations

All field information will be recorded in the field logbook and/or standardized field forms by field personnel. Field data recorded will include drilling contractor information, drilling methods, well material and construction information provided on the boring logs and well construction forms, observations or problems encountered during drilling, fluid level data, and any deviations from the procedures in this SOP and other project plans. Well Construction Forms (Attachment 1) will provide visual and descriptive information the monitoring well and are often the most critical form of documentation generated during the installation of a monitoring well. The field logbook is kept as a general log of activities and should not be used in place of the boring log.

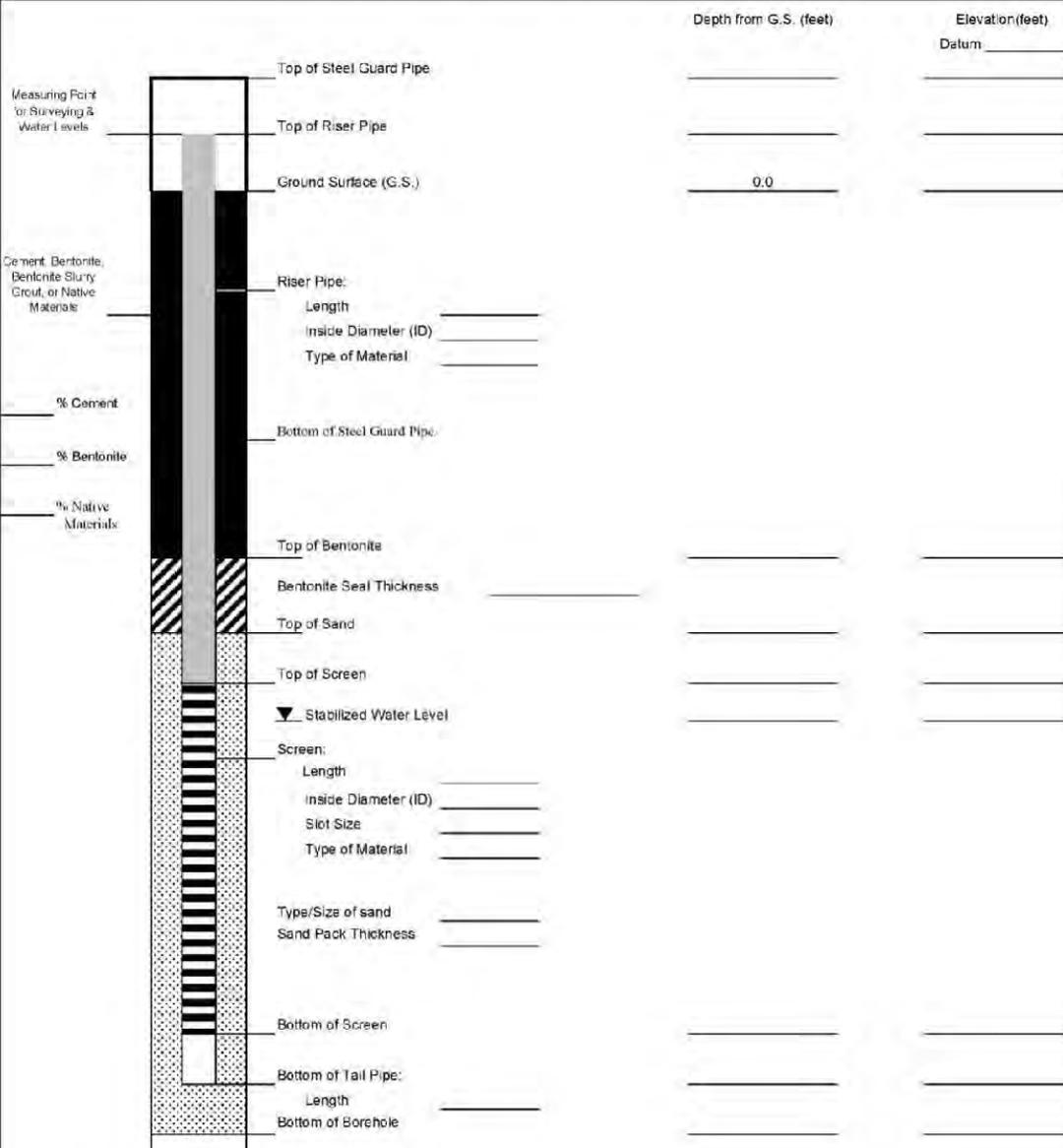
10.0 Attachments or References

- 10.1 Attachment 1 – Monitoring Well Construction Form

- 10.2 Environmental Protection Agency, United States (EPA). 1987. *A Compendium of Superfund Field Operations Methods*. Office of Solid Waste and Emergency Response. EPA/540/P-87/001.
- 10.3 EPA. 1990. *Handbook of Suggested Practices for the Design and Installation of Groundwater Monitoring Wells*. EPA/600/4-89/034. Office of Research and Development, Washington. March.
- 10.4 EPA. 1992. *RCRA Groundwater Monitoring Draft Technical Guidance*. EPA/530/R-93/001. Office of Solid Waste. November.
- 10.5 EPA, 2008. *SESD Operating Procedure SESDGUID-101-R0: Design and Installation of Monitoring Wells*. USEPA, Science and Ecosystem Support Division (SESD), Athens, Georgia. Effective Date February 18, 2008.
- 10.6 U.S. Army Corps of Engineers. 2008. Manual No. EM 385-1-1. *Safety and Health Requirements*. 15 November 2008. http://140.194.76.129/publications/eng-manuals/em385-1-1/2008_English/toc.html.
- 10.7 SOP 3-01, *Utility Clearance*.
- 10.8 SOP 3-05, *IDW Management*
- 10.9 SOP 3-06, *Equipment Decontamination*.
- 10.10 SOP 3-16, *Soil and Rock Classification*.

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

Attachment 1 Monitoring Well Construction Form

	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			_____	_____
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 _____				
Bottom of Steel Guard Pipe			_____	_____
% Cement _____ % 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 _____

Monitoring Well Development

Procedure 3-13

1.0 Purpose and Scope

- 1.1 This standard operating procedure (SOP) describes the procedures used for developing newly installed monitoring wells and/or redeveloping existing wells.
- 1.2 The purpose of well development is to remove interferences from a well to provide better connection between the well and the formation, to improve pumping performance of the well, and to be able to collect more representative information from the well (e.g., samples, test results, etc.). Proper well development will:
- Remove drilling residuals (e.g., water, mud) from the borehole and surrounding formations;
 - Improve or restore hydraulic conductivity of the surrounding formations which may have been disturbed during the drilling process;
 - Remove residual fines from the well screen and sand pack (filter pack) materials, thus reducing turbidity of groundwater and permitting the collection of more representative groundwater samples.
- 1.3 There may be circumstances where well development is not desirable, for example, in the presence of non-aqueous phase liquids (NAPL) or other significant contamination if development could worsen the contaminant impact. If NAPL begins to intrude during development, the development process will be halted. This situation will be considered a cause for sample modification requiring approval by the CTO Manager and other stakeholders, as applicable.
- 1.4 The applicable well development procedures for a particular site may be subject to State or local regulatory requirements. In all cases, the project team should consult their local regulatory requirements and document the selected well development procedure in the project-specific Sampling and Analysis Plan (SAP). For project-specific information refer to the SAP, which takes precedence over these procedures.
- 1.5 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).
- 1.6 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 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) SAP and/or direction from the Site Safety Officer (SSO).
- 2.2 Monitoring well development may involve chemical hazards associated with potential contaminants in the soil or aquifer being characterized and may involve physical hazards associated with use of well development equipment.

3.0 Terms and Definitions

None.

4.0 Interferences

- 4.1 Equipment/materials used for development may react with the groundwater during development. Appropriate development equipment has been selected for the anticipated condition of the groundwater.
- 4.2 Appropriate development methods such as using a surge-block to flush suspended fines in the groundwater in and out of the well screen can improve the yield of wells and improve their potential to be developed successfully. However, the effectiveness of development can be significantly reduced in wells that do not yield sufficient water to allow this flushing to take place.
- 4.3 For formations with a significant content of fine-grained materials (silts and clays), or wells with improperly sized screens, it may not be possible to reduce turbidity to commonly acceptable levels. Possible solutions may include collecting a sample even if excessively turbid, or installing a replacement well.
- 4.4 Development itself disturbs the surrounding formation and disrupts equilibrium conditions within the well. Groundwater samples will not be collected until a minimum of 24 hours after a well is developed to allow conditions to stabilize. For sites with fine-grained formations (silts and clays) and highly sorptive contamination, a longer time period between development and sampling should be considered.

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 well development activities comply with this procedure. The **CTO Manager** is responsible for ensuring that all personnel involved in well development 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 well development activities are conducted according to the either this procedure or the applicable procedure presented in the project-specific SAP.
- 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 well development 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 This equipment list was developed to aid in field organization and should be used in planning and preparation. Depending on the site-specific requirements and the development method selected, additional or alternative material and equipment may be necessary. In addition, for sites where groundwater is expected to be contaminated, the materials to be placed down the well and in contact with groundwater should be evaluated so that they are compatible with the chemical conditions expected in the well.
- 6.2 Equipment and materials used for well development may include, but is not limited to:

Well development equipment

- Surge block

- Disposable Teflon bailers, appropriate to the diameter of the well(s): 1-inch to 1.5-inch for 2-inch inside diameter (ID) monitoring wells.
- Watterra® footvalve
- Electric submersible pump
- 12-volt power source for electric pump
- High density polyethylene (HDPE) tubing appropriately sized for Watterra® footvalve and/or electric submersible pump
- Drums or containers for storage of purge water
- Nephelometer to measure turbidity
- Multi-parameter water quality meter(s) to measure temperature, pH, conductivity, dissolved oxygen (DO), oxidation reduction potential (ORP)
- Instrument calibration solutions
- Water level meter
- Oil/water interface probe

General equipment

- Project-specific plans including the site-specific HASP and SAP
- Field notebook/field forms/site maps
- Indelible markers/pens
- 5-gallon buckets

Equipment decontamination supplies (refer to SOP 3-06, Equipment Decontamination)

- Health and safety supplies, including personal protective equipment (PPE)
- Appropriate hand tools
- Keys or combinations to access monitoring wells
- Distilled/deionized water supply
- Disposable bailer string (polypropylene)
- Plastic trash bags

7.0 Procedure

Development generally consists of removing water and entrained sediment from the well until the water is clear (to the extent feasible) and the turbidity is reduced, which indicates the well is in good hydraulic connection with the surrounding formation. In addition to simply removing water, development can be improved when flushing through the well screen and gravel pack takes place in both directions, that is, both into the well and into the formation. This action breaks down sediment bridges that can occur in the formation or sand pack, which reduce the connection between the well and the formation

7.1 General Preparation

- All down-well equipment should be decontaminated prior to use and between well locations in accordance with SOP 3-06, Equipment Decontamination
- Although equipment is decontaminated between well locations, if wells are known or suspected to be contaminated based on observations during well installation, it is recommended that well development be conducted in order from the least contaminated to the most contaminated well to minimize the chances of cross-contamination.
- Management of investigation-derived waste (IDW), including development purge water and miscellaneous expendable materials generated during the development process, will be conducted in accordance with SOP 3-05, IDW Management.

- Prior to accessing the well, the wellhead should be cleared of debris and/or standing water. Nothing from the ground surface should be allowed to enter the well.
- The depth to water and total well depth should be measured with a water level meter and recorded in the field logbook or on a Well Development Record (Attachment 1). This information will be used to calculate the volume of standing water (i.e., the well volume) within the well, and plan the specific details of the well development. If wells are suspected to contain NAPL, an oil/water interface probe should be used to measure liquid levels and depth to bottom of the well.
- Permanent monitoring wells will be developed no sooner than 24 hours after well installation is completed in order to allow well completion materials to set properly.

7.2 Monitoring Well Development Procedures

Generally, development will begin by gently surging the well with a surge block or bailer as described in Sections 7.2.1 and 7.2.2, respectively. Surging can become more vigorous as development progresses but initially the well must be gently surged to allow material blocking the screen to become suspended without damaging the well. Next, a bailer can be used to remove the sediment settled at the base of the well. A bailer, Watterra[®] pump, or electric submersible pump will then be used to purge the well, per Sections 7.2.2, 7.2.3, or 7.2.4, respectively. The well will be purged until the removed water becomes less turbid or per the requirements of the project-specific SAP, or State or local requirements. At this point the well will be surged again with a surge block or bailer. The well can be surged more vigorously at this point. After surging, the well will be purged again until the turbidity once again decreases. The surge/purge cycle should be completed at least three times during the development process. After the last surge, the well will be purged until the development completion criteria outlined in 7.3.2 or per the project-specific SAP are met.

7.2.1 Surge Block

The default method of well development is the use of a surge block in conjunction with pumping or bailing to remove sediment-laden water.

- The construction of the surge block must be appropriate for the diameter of the well. The surge block must be mounted on rods or other stiff materials to extend it to the appropriate depths and to allow for the surge block to be moved up and down in the well.
- Insert the surge block into the well and lower it slowly to the screened or open interval below the static water level. Start the surge action by slowly and gently moving the surge block up and down in the well. A slow initial surging, using plunger strokes of approximately 1 meter or 3 feet, will allow material which is blocking the screen to separate and become suspended.
- After 5 to 10 plunger strokes, remove water from the well using a separate bailer (Section 7.2.2) or pumping techniques (Sections 7.2.3 or 7.2.4). The returned water should be heavily laden with suspended fines. The water will be discharged to 5-gallon buckets or 55-gallon drums to be managed per the requirements presented in the project-specific SAP.
- In some cases, the bailer or Watterra[®] foot valve can act as a surge block, flushing water in and out of the well screen as groundwater is removed.
- Repeat the process of surging and pumping/bailing. As development continues, slowly increase the depth of surging to the bottom of the well screen. Surging within the riser portion of the well is neither necessary nor effective.

7.2.2 Bailer

- Tie a string or other cable securely to the bailer. Lower it to the screened or open interval of the monitoring well below the static water level.
- The bailer may be raised and lowered repeatedly within the screened interval to attempt to simulate the action of a surge block by pulling fines through the well screen, and pushing water out into the formation to break down bridging.

- With the bailer full of water, remove it from the well and discharge the water into 5-gallon buckets or 55-gallon drums to be managed per the requirements presented in the project-specific SAP.
- The Watterra® system (Section 7.2.3) or electric submersible pump (Section 7.2.4) may be used as a complementary development method to the bailer, especially when removal of additional water at a faster rate is beneficial.
- Continue alternately surging and bailing, monitoring the purge water periodically (Section 7.3.1) until development completion criteria are met (Section 7.3.2).

7.2.3 Watterra® system

- Attach high-density polyethylene (HDPE) tubing to the decontaminated Watterra® pump foot valve
- Lower the foot valve and tubing assembly near the bottom of the well.
- Lift and lower the tubing to allow water to enter the Watterra® foot valve and travel up the tubing and discharge the water into 5-gallon buckets or 55-gallon drums to be managed per the requirements presented in the project-specific SAP.
- The lifting and lowering action of the Watterra® system will cause some surging action to aid in breaking up fine material in the surrounding formation.
- A bailer (Section 7.2.2) may be used as a complementary development method to the Watterra® system, especially during the initial stages of development when a high volume of sediment may be required to be removed.
- An electric submersible pump (Section 7.2.4) may also be used as a complementary development method to the Watterra® system, especially when more volume of water is desired to be pumped or the turbidity criteria cannot be met due to the surging action of the Watterra® system.
- Continue alternately surging and pumping, monitoring the purge water periodically (Section 7.3.1) until well development completion criteria are met (Section 7.3.2).

7.2.4 Electric Submersible Pump

- Attach HDPE tubing to the decontaminated electric submersible pump.
- Lower the pump and tubing assembly near the bottom of the well, at least a few inches above the well total depth.
- Begin pumping, discharging the water into 5-gallon buckets or 55-gallon drums to be managed per the requirements presented in the project-specific SAP.
- Continue alternately surging and pumping, monitoring the purge water discharge periodically (Section 7.3.1) until well development completion criteria are met (Section 7.3.2).

7.3 Discharge Monitoring

7.3.1 Monitoring the Progress of Development

The progress of the development is evaluated through visual observation of the suspended sediment load and measurement of the turbidity and other parameters in the purged discharge water. As development progresses, the water should become clearer, measured turbidity should decrease, and specific capacity (pumping rate divided by drawdown) should stabilize. Water quality parameters, including DO, conductivity, ORP, pH, temperature, and turbidity may be measured and recorded periodically to determine the progress of development using the criteria outlined in Section 7.3.2 or per the project-specific SAP. Water quality parameters should be measured on each well volume removed.

7.3.2 Completion of Development

The well will be considered developed when the following criteria are met or per the criteria set forth in the project-specific SAP:

- A minimum of three times the standing water volume in a well (to include the well screen and casing plus saturated annulus, assuming 30 percent porosity) is removed.

- Groundwater parameters for three consecutive standing water volumes are within the following:
 - pH – within ± 0.2 units
 - Specific conductivity – within $\pm 3\%$
 - ORP – within ± 10 mV
 - Temperature – within ± 1 degree Celsius
 - Turbidity – at or below 10 nephelometric turbidity units (NTU) or within $\pm 10\%$ if above 10 NTU.
- The sediment thickness remaining within the well is less than 1 percent of the screen length or less than 30 millimeters (0.1 ft) for screens equal to or less than 10 feet long.

Dissolved oxygen (DO) readings may be recorded but DO readings will not be used as development completion criteria because DO may not stabilize.

If the well has slow groundwater recharge and is purged dry, the well will be considered developed when bailed or pumped dry three times in succession and the turbidity has decreased, or per the requirements set forth in the project-specific SAP. Water quality parameters may be recorded if feasible using the flow-through cell.

If any water is added to the well's borehole during development or drilling, three times the volume of water added will also be removed during well development, or per the requirements set forth in the project-specific SAP.

7.4 Development of Wells with Low Yield

Water is the primary mechanism to remove fines and flush water through the gravel pack for effective development. Therefore, development can be a challenge in wells that do not yield sufficient water to recharge when water is removed. However, often these wells are the most in need of development to improve their performance as they are typically installed in low permeability formations with a high content of fines. Development of these wells can improve their yield.

The surging portion of the development can be successfully performed in a well with standing water regardless of its yield. It is the subsequent removal of fine materials that is hindered when insufficient water is recharged to the well. When wells go dry or drawdown significantly during development, development can be performed intermittently, allowing sufficient water to recharge prior conducting the next stage of surging. These intermittent procedures can take place hours or even days apart, depending on project-specific time constraints.

7.5 Wells containing NAPL

Additional care should be taken when planning development of wells that contain NAPL. If the NAPL is flammable, there are health and safety as well as handling issues to consider. If NAPL in excess of a persistent sheen is noted, the recharge rate will be evaluated through hand bailing. In most cases, it is generally preferable to remove NAPL by bailing to the extent practical prior to performing development. Groundwater parameters, excluding turbidity, will not be collected during well development if NAPL or excessive sheen is noticed in the purged water during development to ensure the meter probes are not fouled or destroyed. Well development will be halted.

Development by surging or pumping the well dry can result in the spreading of NAPL vertically in the soil column around the well. These methods can be used, if information exists describing the vertical thickness of the NAPL smear zone around the well, and if the methods do not result in mounding or drawdown that exceeds this thickness. Alternate methods such as bailing may also be used, but any method should not allow the well to be pumped dry or result in significant drawdown that would spread the NAPL vertically.

7.6 Temporary Well Points

For certain projects, temporary well points (TWPs) may be installed to collect groundwater samples at a site. Since no sand pack, bentonite chips, or bentonite grout are generally used in the construction of the TWPs, development can proceed as soon as sufficient water has entered the well to static conditions. Due to the small diameter of these wells, generally ¾-inch to 1-inch ID, development will be performed using either a small diameter (0.5-inch) bailer and/or a peristaltic pump with dedicated tubing. The TWPs will have minimal water column and may purge dry during development. However, attempts will be made to remove fines from the well prior to sampling. Purging and sampling may occur as soon as approximately 80% of the static water has re-entered the TWP, or per the requirements set forth in the project-specific SAP.

8.0 Quality Control and Assurance

- 8.1 Field personnel will follow specific quality assurance (QA) guidelines as outlined in the project-specific SAP.
- 8.2 Quality control (QC) requirements are dependent on project-specific sampling objectives. The project-specific SAP will provide requirements for equipment decontamination (frequency and materials) and IDW handling.

9.0 Records, Data Analysis, Calculations

- 9.1 All data and information (e.g., development method used) must be documented on field data sheets (Attachment 1) or within site logbooks with permanent ink. Data recorded may include the following:
- Well Location
 - Weather conditions
 - Date and Time
 - Purge Method
 - Reading/measurements obtained

10.0 Attachments or References

Attachment 1 – Well Development Record

SOP 3-05, *IDW Management*.

SOP 3-06, *Equipment Decontamination*.

<i>Author</i>	<i>Reviewer</i>	<i>Revisions (Technical or Editorial)</i>
Shawn Dolan Senior Scientist	Chris Barr Program Quality Manager	Rev 0 – Initial Issue (June 2012)

Attachment 1 Well Development Record



Well/Piezometer Development Record

Well ID:

Client: _____

Project No: _____ Date: _____ Developer: _____

Site Location: _____

Well/Piezometer Data

Well Piezometer Diameter _____ Material _____

Measuring Point Description _____ Geology at Screen Interval _____
(if known) _____

Depth to Top of Screen (ft.) _____

Depth to Bottom of Screen (ft.) _____ Time of Water Level Measurement _____

Total Well Depth (ft.) _____ Calculate Purge Volume (gal.) _____

Depth to Static Water Level (ft.) _____ Disposal Method _____

Headspace _____

Original Well Development Redevelopment Date of Original Development _____

DEVELOPMENT METHOD

PURGE METHOD

Time	Total Volume Purged (gal.)	Flow Rate (gpm)	Turbidity (NTU)	Color	pH	Temp	Other

ACCEPTANCE CRITERIA (from workplan)

Minimum Purge Volume Required _____ gallons

Maximum Turbidity Allowed _____ NTUs

Stabilization of parameters _____ %

Has required volume been removed

Has required turbidity been reached

Has parameters stabilized

If no or N/A explain below:

Yes No N/A

Signature _____

Date: _____

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 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.

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

- 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.

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.

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.

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

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 $\pm 10\%$ 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

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.

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.

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)

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

- 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.

- 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*.

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

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	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 (continue on back)
- Has required volume been removed
- Has required turbidity been reached
- Have parameters stabilized
- 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 _____

Monitoring Well Abandonment

Procedure 3-15

1.0 Purpose and Scope

- 1.1 This standard operating procedure (SOP) describes the methods used for the abandonment of groundwater monitoring wells and peizometers.
- 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 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 Physical hazards associated with well installation include:
 - To avoid lifting injuries associated with well abandonment practices, use the large muscles of the legs, not the back. The drilling contractor should use the drill rig wenching cables and appropriate heavy equipment to minimize manual lifting.
 - Stay clear of all moving equipment and avoid wearing loose fitting clothing.
 - When using an approved retractable-blade knife, cut away from one self.
 - To avoid slip/trip/fall conditions during site activities, keep the area clear of excess soil cuttings and formation groundwater and use textured boots/boot cover bottoms in muddy areas.
 - To avoid heat/cold stress because of exposure to extreme temperatures and PPE, drink electrolyte replacement fluids (1 - 2 cups per hour is recommended) and, in cases of extreme cold, wear fitted insulating clothing.
 - Be aware of restricted mobility caused by PPE.

3.0 Terms and Definitions

- 3.1 **Annulus:** The annulus is the down-hole space between the borehole wall and the well casing and screen.
- 3.2 **Bridge:** A bridge is an obstruction in the drill hole or annulus. A bridge is usually formed by caving of the wall of the well bore, by the intrusion of a large boulder, or by the placement of filter pack materials during well completion. Bridging can also occur in the formation during well development.
- 3.3 **Filter Pack:** Filter pack is sand or gravel that is smooth, uniform, clean, well-rounded, and siliceous. It is placed in the annulus of the well between the borehole wall and the well screen to prevent formation materials from entering the well and to stabilize the adjacent formation.

- 3.4 **Grout:** Grout is a fluid mixture of cement and water that can be forced through a tremie pipe and emplaced in the annular space between the borehole and casing to form an impermeable seal. Various additives, such as sand, bentonite, and polymers, may be included in the mixture to meet certain requirements.

4.0 Interferences

- 4.1 The total depth of the monitoring well will be measured and the measurement will be compared to the original well completion log prior to abandonment.
- 4.2 A map with the location of the well to be abandoned and the surrounding wells, if any, will be utilized in the field to confirm the location of the well to be abandoned.
- 4.3 Information from the well identification tags/markings will be noted and the information compared to both the well completion log and the total depth measurement obtained in the field to confirm the identity of the well being abandoned.

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 well abandonment activities comply with this procedure. The **CTO Manager** is responsible for ensuring that all personnel involved in well abandonment 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 well abandonment activities are conducted according to the either this procedure or the applicable procedure presented in the project-specific SAP.
- 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 well abandonment 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 Equipment and materials used during monitoring well and piezometer abandonment include the following:

- Drill rig or trailer-mounted mixer and grout pump
- Filter pack material
- Pure sodium bentonite with no additives
- Bentonite pellets/chips
- Bentonite grout
- Portland Type II cement
- Water from an approved source

- Weighted tape measure
- Flexible hose
- Tremie pipe (small-diameter, rigid polyvinyl chloride [PVC] pipe)
- Weatherproof bound field logbook with numbered pages
- Appropriate health and safety equipment

7.0 Procedure

7.1 General Procedures

The following procedure applies to the abandonment of wells aborted prior to completion and existing wells determined to be ineffective or otherwise in need of closure. Prior to abandoning any developed well, you may need to acquire a permit from the State or local governing body in which you are working. The permit application may require a detailed design of the well abandonment. In addition, prior to abandonment, all obstructions (e.g., pumps, lost equipment) must be removed from the well. Some States are strict in requiring the removal of all lost equipment prior to abandonment and will not allow the closure of a well with lost equipment in it. The State may require the removal of all objects to allow a proper seal during abandonment. Great lengths must be taken to reclaim lost items, such as the use of downhole video cameras to inspect and aid in the recovery of items. Prior to abandonment, confirm that the well selected for abandonment is properly located and identified to avoid abandoning the wrong well.

At locations where a well log is not available, the following procedure shall be implemented:

- The casing should be pulled, drilled out, or thoroughly pierced.
- With the use of a tremie pipe, grout should be placed from the bottom of the hole to within 3 feet of the ground surface.
- The material should be allowed to settle for 24 hours.
- The remainder of the hole should be filled with concrete.
- All historical sample data and abandonment procedures should be included in the records of work.

At locations where a well completion log is available, the following procedure shall be implemented:

- With the use of a tremie pipe, grout should be placed from the bottom of the hole to within 3 feet of the ground surface.
- The material should be allowed to settle for 24 hours.
- The remainder of the hole should be filled with concrete.
- All boring logs, historical sample data, completion records, and abandonment procedures should be included in the records of work.

Depending on the regulatory body under which you are working, the procedures listed above may differ. All work shall be performed by a licensed well driller in the State work is being performed. The licensed well driller is responsible for documenting the abandonment of the monitoring well with the appropriate State agency.

7.2 Replacement Wells

Replacement wells (if any) should normally be offset at least 15 feet from any abandoned well in an upgradient or crossgradient groundwater flow direction. Site-specific conditions may necessitate variation of this placement requiring the replacement well to be located either closer or further in proximity to the original well. To avoid potential issues related to grout migration into a well filter pack and/or screen section, replacement wells should be installed after the original/adjacent well is properly abandoned.

7.3 Grout

Bentonite grout is preferred for the abandonment of monitoring wells. Cement grout, if used for abandonment, should be composed of the following by weight:

- 20 parts cement (Portland cement, Type II or V)
- 0.4 to 1 part (maximum) (2 to 5 percent) bentonite
- 8 gallons (maximum) approved water per 94-pound bag of cement

Neither additives nor borehole cuttings should be mixed with the grout. Bentonite should be added after the required amount of cement has been mixed with the water. All grout material should be combined in an aboveground container and mechanically blended to produce a thick, lump-free mixture. The mixed grout should be recirculated through the grout pump prior to placement. The mixture can be combined and recirculated through a drill rig equipped for mud rotary drilling or through a mixer and grout pump mounted on a trailer.

Grout should be placed with the use of a commercially available grout pump and a rigid tremie pipe. Casing and grouting should be removed in stages, aquifer by aquifer, sealing the boring from the bottom to ground surface. This should be accomplished by placing a tremie pipe to the bottom and pumping grout through the pipe until undiluted grout reaches the bottom of the next higher section of casing or, for the topmost section, until grout flows from the boring at the ground surface.

After 24 hours, the abandoned drilling site should be checked for grout settlement. Any settlement depression should be filled with grout and rechecked 24 hours later. This process should be repeated until firm grout remains at the ground surface.

Be aware that when the drillers are finished, they will need a large supply of water to rinse out their equipment. This wash water must be containerized as IDW in accordance with SOP 3-05, *IDW Management*. Also, any materials (such as the removed protective casing, manhole covers, and concrete collars) shall be disposed of properly, or per the requirements of the project-specific SAP.

8.0 Quality Control and Assurance

8.1 Field personnel will follow specific quality assurance (QA) guidelines as outlined in the project-specific SAP.

8.2 Quality Control (QC) measures should be taken to ensure proper well abandonment in accordance with this SOP, project-specific SAP, and applicable well standards.

9.0 Records, Data Analysis, Calculations

9.1 All field information must be documented in the field logbook and/or on field data sheets with permanent ink. Data recorded may include the following:

- Date/time
- Well/piezometer location
- Personnel/subcontractor on site
- Abandonment method
- Depth of well/piezometer
- Materials used to seal each stratum
- Detailed description of procedure
- Date/time of return visit(s)
- Activities performed on return visit(s)
- Observations or problems encountered during abandonment

10.0 Attachments or References

Environmental Protection Agency, United States (EPA). 1987. *A Compendium of Superfund Field Operations Methods*. Office of Solid Waste and Emergency Response. EPA/540/P-87/001.

SOP 3-05, *IDW Management*.

<i>Author</i>	<i>Reviewer</i>	<i>Revisions (Technical or Editorial)</i>
Shawn Dolan Senior Scientist	Chris Barr Program Quality Manager	Rev 0 – Initial Issue (June 2012)

Direct Push Sampling Techniques

Procedure 3-17

1.0 Purpose and Scope

- 1.1 This standard operating procedure (SOP) provides guidance on the use of direct push techniques for the United States Navy Environmental Restoration (ER) Program, Naval Facilities Engineering Command, Atlantic (NAVFAC Atlantic).
- 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 This procedure shall serve as management-approved professional guidance for the ER Program 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 or Technical Director, and documented.
- 1.4 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 direct push sampling then those procedures may be added as an appendix to the project specific SAP.

2.0 Safety

- 2.1 Field personnel shall perform work in accordance with the site-specific health and safety plan (HASP). During monitoring well installation, subcontractors in direct contact with potentially contaminated media shall wear the proper personal protective equipment (PPE) as outlined in the site-specific health and safety plan. Failure to comply will result in disciplinary action.
- 2.2 If circumstances warrant, a real-time immediate response instrument, such as a Miniram Dust Monitor, organic vapor analyzer, HNu, Thermo, Draeger or Sensidyne tubes, or explosimeter, should be used to monitor the work area. When real/time instrument response exceeds the permissible exposure limit, personnel shall don the appropriate PPE and alternate control measures to ensure personnel safety. If safe control measures are not achievable, field activities shall be discontinued immediately. Company-specific HASPs offer guidelines on air surveillance and on selection of PPE. In addition, the site-specific HASP includes an air monitoring program and suggested PPE.
- 2.3 In addition to the aforementioned precautions and depending upon the type of contaminant expected, employ the following safe work practices:
 - Particulate or Metal Compounds
 1. Avoid skin contact and/or incidental ingestion of soil.
 2. Wear protective clothing, steel-toed boots, gloves, safety glasses, and hearing protection as warranted.
 - VOCs
 1. Avoid breathing constituents venting from holes by approaching upwind, and/or by use of respiratory protection.

2. Pre-survey the area with a flame ionization detector (FID) or photoionization detector (PID) prior to sampling.
3. If monitoring results indicate organic vapors that exceed action levels as specified in the site-specific HASP, sampling activities may need to be conducted in Level C protection. At a minimum, skin protection will be required by use of gloves and Tyvek or other media that is protective against the media being encountered.

Flammable or Explosive Conditions

1. Monitor explosive gases as continuously as possible using an explosimeter and oxygen meter.
2. Place all ignition sources upwind or crosswind of the borehole.
3. If explosive gases exceed the designated action levels as specified in the site-specific HASP, cease operations and evaluate conditions.

Physical Hazards Associated With Soil Sampling

1. To avoid possible back strain associated with sample collection, use the large muscles of the legs, not the back, when retrieving soil samplers.
2. Stay clear of all moving equipment, and avoid wearing loose fitting clothing.
3. To avoid slip/trip/fall hazards, be wary of open trenches, pits, or holes.
4. Be aware of restricted mobility due to PPE.
5. To avoid hand, wrist, arm, shoulder, and back trauma due to the use of slide hammers or hand augers, rotate sampling among field personnel

3.0 Terms and Definitions

- 3.1 Direct push techniques are methods for subsurface sampling or monitoring that involve the application of downward pressure (usually supplied through hydraulic means) without the benefit of cutting tool rotation to enter soil. A variety of systems are available under several trade names, such as GeoProbe®. Equipment may be skid-mounted, trailered, or mounted directly on the frame of a vehicle.

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 **CTO Manager** is responsible for ensuring that these standard direct push technique procedures are followed during projects conducted under the ER Program and that a qualified individual conducts or supervises the projects. A qualified individual for subsurface sampling or monitoring using direct push techniques is defined as a person with a degree in geology, hydrogeology, or geotechnical/civil engineering with at least 1 year of experience supervising soil boring construction using conventional drilling or direct push techniques. The CTO Manager

or designee is responsible for ensuring that all personnel involved in direct push sampling techniques shall have the appropriate education, experience, and training to perform their assigned tasks as specified in Chief of Naval Operations Instruction 5090.1c (DON 2007).

- 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 personnel follow these procedures.
- 5.2.4 All Field Personnel are responsible for the implementation of this procedure.
- 5.2.5 The Field Personnel and/or Field Manager is responsible for directly supervising the direct push 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

In addition to those materials provided by the subcontractor, the project **Field Manager/Field Personnel** will require:

- Boring Logs;
- Spoons or scoops;
- Sample kit (bottles, labels, custody records and tape, cooler, ice), if laboratory analysis is required;
- Sample collection pan;
- Folding rule or tape measure;
- Plastic sheeting;
- Utility knife;
- Equipment decontamination materials (as described in SOP 3-06, *Equipment Decontamination*);
- Health and safety equipment (as required by HASP); and
- Field project notebook/pen.

7.0 Procedure

Direct push techniques may be used as a cost-effective alternative to conventional drilling techniques for obtaining subsurface soil and groundwater samples and for monitoring subsurface conditions.

7.1 Method Selection

Base the decision to use direct push techniques on: (1) their ability to achieve the required information at the required level of quality control and (2) their cost-effectiveness compared to conventional drilling methods. 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.

Use direct push techniques to obtain groundwater samples for confirmatory analyses only if the screen placement method protects the screen from clogging during installation and allows the installation of a sand-pack around the exterior of the well screen.

7.2 Inspection of Equipment

Inspect direct push equipment prior to use for signs of fluid leakage, which could introduce contaminants to the soil. If, at any time during equipment operation, fluid is observed leaking from the rig, cease

operations and immediately repair or contain the leak. Collect, containerize, and label soil and other materials affected by the leak for proper disposal (see SOP 3-05, *IDW Management*).

7.3 **Preparation of Work Site**

Inspect the work site prior to commencing operations to ensure that no overhead hazards exist that could impact the direct push equipment, and the work area should be cleared and/or marked by the local underground utility locating service (e.g., DigSafe). In addition, clear locations planned for subsurface exploration using either geophysical methods and/or hand excavate locations to a depth of 2 to 3 feet prior to soil penetration, unless it is certain (by virtue of subsurface clearing activities) that no utilities or other hazardous obstructions will be encountered in the first 2 to 3 feet. Hand excavation may be waived when it is not practical.

Locate the direct push rig so that it is downslope from the penetration point, if the work is to be performed on a grade. Locate the rig downwind or crosswind of the penetration point, if possible. Cover the area surrounding, and in the vicinity of, the penetration point with plastic. Establish required exclusion zones using plastic tape or cones to designate the various areas.

7.4 **Equipment Decontamination**

To avoid cross-contamination, thoroughly decontaminate equipment used for direct push exploration and sampling as described in SOP 3-06, *Equipment Decontamination*. 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. Collect, containerize, and label all wash and rinse water for proper disposal. Clean equipment (e.g., drive rods and samplers) shall not come into contact with contaminated soils or other contaminated materials. Keep equipment on plastic or protect it in another suitable fashion. Store push rods and other equipment removed from a hole on plastic sheeting until properly decontaminated.

7.5 **Soil Sampling**

This SOP assumes that the subcontractor will perform sampling; therefore, detailed procedures regarding sample acquisition are not provided. Vendors of direct push equipment offer a variety of sampling systems designed specifically for their equipment. Both continuous and discrete soil samples may be obtained using sampling equipment similar to that described in Procedure 3-21, *Surface and Subsurface Soil Sampling*. The preferred methods for soil sampling using direct push techniques use brass or stainless steel split-tube samplers that are driven through the horizon to be sampled. Use plastic sample tubes (e.g., Macro-Core Samplers) only for screening purposes or, in the case of confirmatory sampling, if samples will not be analyzed for volatile organic compounds (VOCs) or semivolatile organic compounds (SVOCs).

7.6 **Groundwater Sampling**

Direct push vendors offer numerous methods for obtaining groundwater samples. Key differences among methods involve: (1) the maximum well diameter achievable; (2) the ability to protect the well screen from exposure to contaminated overburden soils during installation; (3) the ability to install packing around the screen; (4) flexibility in the size, materials of construction, and design of well screens; and (5) the ability to convert sampling points into permanent monitoring wells. The limitations and abilities of a given system must be thoroughly understood and matched to the needs of the project before committing to the collection of groundwater samples using direct push techniques.

Use direct push techniques only to collect screening samples unless it is confirmed that the system:

1. Effectively protects the well screen from exposure to contaminated overburden soils during installation
2. Allows the installation of effective packing around the well screen

3. Allows the well screen to be effectively sealed against the downward infiltration of overlying groundwater or surface precipitation
4. Is constructed of materials compatible with the intended sampling and analysis goals of the project
5. Allows the use of a well screen properly sized and slotted for the needs of the project

Additional information on the collection of groundwater samples can be found in SOP 3-14 Monitoring Well Sampling.

It is the responsibility of the **CTO Manager** to evaluate and determine the appropriateness of direct push systems prior to committing to their use on any project involving groundwater sampling. As part of this evaluation, it is recommended to obtain concurrence from regulatory authorities in advance for the method selection.

7.7 **Borehole Abandonment**

Methods for abandoning boreholes created with direct push systems will vary among vendors. Coordinate the desired method for abandonment with the vendor in the planning stages of the project to ensure proper 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. Close all boreholes using one of the procedures described in this procedure, unless natural caving precludes such closure.

The three methods for closing direct push boreholes are:

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 (or cement/water/bentonite) mixture 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.

The second method is recommended. For shallow holes less than 10 feet in depth, pour a cement/water/bentonite mix directly into the opening using a funnel. 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.

The recommended grout mixture for well abandonment is 7 to 9 gallons of water per 94-pound bag of Portland cement, with 3 percent to 5 percent by weight of powdered bentonite added to the mixture. Commercial products, such as Volcay are acceptable with pre-approval of the **CTO Manager**.

Seal boreholes to within 0.5 to 2.0 feet of the surface. Inspect the abandoned borehole after 24 hours to ensure that grout shrinkage does not occur. If significant shrinkage has occurred, re-grout the borehole. Fill the remaining portion of the hole with local topsoil or appropriate paving materials.

8.0 **Quality Control and Assurance**

- 8.1 Collection of representative samples will be ensured through adherence to the procedures in this SOP and the sampling strategy outlined in the SAP. The field quality control samples identified in the SAP must be collected. These samples may include field duplicates, equipment rinse blanks, trip blanks, and matrix spike/matrix spike duplicates

9.0 **Records, Data Analysis, Calculations**

- 9.1 Various forms are required to ensure that adequate documentation is made of the sample collection activities. These forms may include:

- Boring logs;
- Field logbook;
- Sample collection records;
- Chain-of-custody forms; and
- Shipping labels.

- 9.2 Boring logs (Attachment 1) will provide visual and descriptive information for samples collected at each soil boring and are often the most critical form of documentation generated during a soil sampling program.
- 9.3 The field logbook is kept as a general log of activities and should not be used in place of the boring log.
- 9.4 Chain-of-custody forms are transmitted with the samples to the laboratory for sample tracking purposes.
- 9.5 Shipping labels are required if sample coolers are to be transported to a laboratory by a third party (courier service).

10.0 Attachments or References

- 10.1 Attachment 1 – Boring Log
- 10.2 NAVSEA T0300-AZ-PRO-010. *Navy Environmental Compliance Sampling and Field Testing Procedures Manual*. August 2009.
- 10.3 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.
- 10.4 Department of the Navy (DON). 2007. *Navy Environmental and Natural Resources Program Manual*. OPNAV Instruction 5090.1c. October.
- 10.5 SOP 3-05, *IDW Management*.
- 10.6 SOP 3-06, *Equipment Decontamination*.
- 10.7 SOP 3-21, *Surface and Subsurface Soil Sampling*.

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

Attachment 1 Boring Log

 RESOLUTION CONSULTANTS		Boring ID:					
		Page <u>1</u> 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 Classification 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.)					

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

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.

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.

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.

- 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)

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.

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;

- 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.

- 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 $\pm 10\%$. 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;

- 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)

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.

- 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.

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.

- 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.

- 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

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

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 $\frac{3}{4}$ 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.

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)

Standard Operating Procedure SOP-3-24
Water Quality Parameter Testing for Groundwater Sampling

1.0 PURPOSE

This standard operating procedure (SOP) represents minimum standard of practice. State and federal requirements may vary, and this SOP does not replace state and federal requirements that must be consulted before work begins. Further, if a project-specific work plan has been created, the work plan should be considered the ruling document. This SOP may be modified to meet specific regulatory, client, or project specific criteria.

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 water quality parameter testing, then those procedures may be added as an appendix to the project-specific Sampling and Analysis Plan (SAP).

2.0 SCOPE

This procedure provides guidance for expected sampling methods and protocols by all personnel related to the measurement of water quality parameters.

Field measurements of water quality parameters are commonly performed to evaluate surface water and groundwater. These tests are often performed to evaluate basic water quality parameters, to evaluate natural attenuation parameters, and to assess the presence of pore water entering a well.

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.

3.0 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.

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 are 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

The CTO Manager, or designee, is responsible for ensuring that these standard groundwater sampling activities are followed and shall review all groundwater sampling forms at the conclusion of a sampling event. The CTO Manager is responsible for ensuring that all personnel involved in monitoring well sampling shall have the appropriate education, experience, and training to perform their assigned tasks. The QA Manager or Technical Director is responsible for ensuring overall compliance with this procedure. The Field Manager is responsible for ensuring that all project field staff follows these procedures.

Field sampling personnel are responsible for the implementation of this procedure. Personnel are required to be knowledgeable of the procedures in this SOP. Training and familiarization with this SOP shall be documented in the training file for each employee. The field sampler and/or Field Manager is responsible for directly supervising the calibration procedures to ensure that they are conducted according to this procedure, and for recording all pertinent data. If deviations from the procedure are required because of anomalous field conditions, they must first be approved by the CTO Manager, QA Manager, or Technical Director and then documented in the field logbook and associated report or equivalent document.

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:

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

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

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
						The colder the sample, the higher the DO reading.
Dissolved Oxygen	mg/L	0.0	14.6 (0°C) 10.1 (15°C) 8.3 (2°C)	0.0	5	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.

**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 ($\mu\text{S}/\text{cm}$) 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.
- When the sample measurements are expected to be less than 100 $\mu\text{S}/\text{cm}$, 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.
- 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.

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 Factors

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.

$$K = \frac{(Km)(C)}{1 + 0.0191(T - 25)}$$

Where:

- K = Conductivity in $\mu\text{mhos/cm}$ at 25°C
- Km = Measured conductivity in $\mu\text{mhos/cm}$ 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:

$$K = \frac{(Km)}{1 + 0.0191(T - 25)}$$

5.7.2 Percentage Difference Calculation

For evaluating slope of readings from either a flow cell or a sample cup.

$$\%Difference = \frac{(Highest\ Value - Lowest\ Value)}{(Highest\ Value)} \times 100$$

5.7.3 Convert mm mercury (mmHG) to inches mercury (inHG)

$$mmHG = inHG \times 25.4$$

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.

$$TrueBP = (BP) - \frac{(2.5 \times [Local\ Altitude])}{100}$$

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 mmHG:

$$\text{mmHg} = 30.49 \text{ inHg} \times 25.4 = 774.4 \text{ mmHg}$$

Calculate True BP:

$$\text{TrueBP} = (774.4 \text{ mmHg}) - [2.5 * (544 / 100)] = 774.4 - 13.6 = 760.8 \text{ mmHg}$$

6.0 RECORDS

Data will be recorded promptly, legibly, and in indelible ink on the appropriate logbooks and forms. At the completion of a field effort, all logbooks, field data forms, and calibration logs shall be scanned and made electronically available to the project team. The original field forms, calibrations logs, and log book will be maintained in the project file.

7.0 HEALTH AND SAFETY

Detailed Health and Safety requirements can be found in the site specific Health and Safety Plan. Ensure that a Safe Work Assessment and Permit form is filled out daily prior to any work in the field and reviewed with all project personnel in a daily safety brief.

Safety glasses with side shields or goggles and disposable gloves shall be worn during calibration activities.

8.0 REFERENCES

None

9.0 ATTACHMENTS

Attachment 1: Example Field Instrument Calibration Form

Attachment 2: Solubility of Oxygen at Given Temperatures

Attachment 3: Example Field Data Form

Attachment 1
Example Field Instrument Calibration Form

Field Instrument Calibration Form

Calibrated by: _____
Date: _____

Equipment (Make/Model/Serial#): _____
Equipment (Make/Model/Serial#): _____

pH (su) Standard: ± 0.2 standard units				DO (mg/L) Standard: ± 0.3 mg/L of theoretical*			
Initial Calibration		Initial Calibration Verification		IC (Temp:)		ICV (Temp:)	
Hach SL	Reading	Pine SL	Reading	Saturation (%)	Reading (%)	Theoretical (mg/L)	Reading (mg/L)
pH7				100			
pH4							
Continuing Calibration Verification				CCV (Temp:)			
Hach SL	Reading	Deviation	Acceptable Variance (Y/N)	Saturation (%)	Reading (%)	Deviation	Acceptable Variance (Y/N)
pH7				100			
pH4				Theoretical (mg/L)	Reading (mg/L)	Deviation	Acceptable Variance (Y/N)
ORP (mV) Standard: NA				Turbidity (ntu) Standard: ±10% of Standard			
IC (Zobell SL:)		ICV (Pine SL:)		Initial Calibration			
TCS (Std/Temp)	Reading	TCS (Std/Temp)	Reading	Standard	Reading		
CCV (Zobell SL:)				Continuing Calibration Verification			
TCS (Std/Temp)	Reading	Deviation	Acceptable Variance (Y/N)	Standard	Reading	Deviation	Acceptable Variance (Y/N)
Conductivity (ms ^c /cm) Standard: ± 5% of standard value				Comments:			
IC (YSI SL:)		ICV (Pine SL:)					
Standard	Reading	Standard	Reading				
CCV (YSI SL:)							
Standard	Reading	Deviation	Acceptable Variance (Y/N)				

Notes: SL solution lot; TCS temperature corrected standard; Std standard; Temp temperature; su standard units; mV millivolts; % percent; mg/L milligrams per liter; ntu Nephelometric Turbidity Units; °C degrees Celsius; ms^c/cm millisiemens per centimeter (temperature corrected); * Theoretical value.

Attachment 2
Solubility of Oxygen at Given Temperatures

Field Measurement of Dissolved Oxygen

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

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	<input type="checkbox"/> Bailer <input type="checkbox"/> 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 <input type="checkbox"/>

SAMPLE DATA

<input type="checkbox"/> Bailer <input type="checkbox"/> 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# _____

Appendix B
Laboratory Accreditation Certificates



CERTIFICATE OF ACCREDITATION

ANSI-ASQ National Accreditation Board/AClass
500 Montgomery Street, Suite 625, Alexandria, VA 22314, 877-344-3044

This is to certify that

Gulf Coast Analytical Laboratories, Inc.
7979 GSRI Avenue
Baton Rouge, LA 70820

has been assessed by AClass
and meets the requirements of

ISO/IEC 17025:2005 and DoD-ELAP

while demonstrating technical competence in the field(s) of

TESTING

Refer to the accompanying Scope(s) of Accreditation for information regarding the types of tests to which this accreditation applies.

ADE-1482

Certificate Number

AClass Approval



Certificate Valid: 08/15/2012-09/09/2014
Version No. 003 Issued: 08/29/2012



This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2005. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (refer to joint ISO-ILAC-IAF Communiqué dated January 2009).



ANSI-ASQ National Accreditation Board

SCOPE OF ACCREDITATION TO ISO/IEC 17025:2005 & DoD-ELAP

Gulf Coast Analytical Laboratories, Inc.

7979 GSRI Avenue, Baton Rouge, LA 70820
 Karen S. Varnado Phone: 225-769-4900

TESTING

Valid to: September 9, 2014

Certificate Number: ADE- 1482

I. Environmental

MATRIX	SPECIFIC TEST or GROUP OF ANALYTES**	SPECIFICATION OR STANDARD METHOD (all EPA unless specified)	* KEY EQUIPMENT OR TECHNOLOGY USED
Water	Flashpoint / Ignitability	1010A	Automated FP Analyzer
Water	Alkalinity	SM 2320B / 310.1	Autotitrator
Water	Acidity	SM 2310B	Autotitrator
Water / Solid	Ammonia	SM 4500 NH3 B & E, 18th ed. SM 4500 NH3 B & C, 20 th ed.	Autotitrator
Water	Mercury	7470A	CVAA
Solid	Mercury	7471B	CVAA
Water	Mercury	245.1 / 245.2	CVAA
Water / Solid	Cyanide	9012B	FIA
Water / Solid	Total Phenols	420.4 / 9066	FIA
Solid	Chloride	9251	FIA
Water / Solid	Chloride	9251 / 325.2 / SM 4500 Cl E	FIA
Water / Solid	Nitrate/Nitrite/N+N	353.2	FIA
Water / Solid	Total Phosphorous	365.1	FIA
Water / Solid	Reactive Cyanide	SW846 Sec 7.3	FIA
Water / Solid	Pesticides	8081A	GC-ECD
Water / Solid	PCB's	8082A	GC-ECD
Water / Solid	Herbicides	8151A	GC-ECD



MATRIX	SPECIFIC TEST or GROUP OF ANALYTES**	SPECIFICATION OR STANDARD METHOD (all EPA unless specified)	* KEY EQUIPMENT OR TECHNOLOGY USED
Water	EDB / DBCP	8011	GC-ECD
Water / Solid	DRO / ORO	8015B	GC-FID
Water / Solid	GRO	8015B	GC-FID
Water / Solid	TPH	TX 1005 / TX 1006	GC-FID
Water / Solid	TPH	Florida PRO	GC-FID
Water / Solid	Aromatic Volatile Organics	8021B	GC-FID/PID
Water	Dissolved Gases	RSK-175	GC-FID/TCD
Water / Solid	VOCs	8260B	GC-MS
Water / Solid	SVOCs	8270C / 8270D / SIM	GC-MS
Water	VOCs	624	GC-MS
Water	SVOCs	625	GC-MS
Water / Solid	OP Pesticides	8141A	GC-NPD
Water	TSS	SM 2540D / 160.2	Gravimetric
Water	TDS	SM 2540C / 160.1	Gravimetric
Water	TS	SM 2540B / 160.3	Gravimetric
Solid	TS	SM 2540B	Gravimetric
Water / Solid	Explosives	8330A	HPLC
Water / Solid	PAH's	8310	HPLC
Water	Anions	300.0	IC
Water / Solid	Anions	9056A	IC
Water	Perchlorate	314.0	IC
Water / Solid	ICP Metals	6010B / 6010C	ICP
Water	ICP Metals	200.7	ICP
Water	Volatile Fatty Acids	GCAL SOP WL-070	Ion Chromatography
Water / Solid	Ammonia	SM 4500 NH3 B & F 18 th ed	Ion Selective Electrode



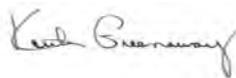
MATRIX	SPECIFIC TEST or GROUP OF ANALYTES	SPECIFICATION OR STANDARD METHOD (all EPA unless specified)	* KEY EQUIPMENT OR TECHNOLOGY USED
Water	Solid Phase Extraction	3535A	N/A
Water	Separatory Funnel Extraction	3510C	N/A
Water	Metals Digestion ICP	3010A	N/A
Solid	Ultrasonic Extraction for SVOA Analysis	3550C	N/A
Solid	Soxhlet Extraction for SVOA Analysis	3540C	N/A
Solid	Metals Digestion ICP	3050B	N/A
Water / Solid	TCLP	1311	N/A
Solid	Paint Filter Test	9095B	N/A
Water	pH	SM 4500 H+B / 9040C	pH Meter
Solid	pH	9045D	pH Meter
Water	VOC's	5030B	Purge and Trap
Solid	VOC's	5035	Purge and Trap
Water	Oil & Grease	1664A	SPE/Gravimetric
Water	Hexavalent Chromium	7196A	Spectrophotometer
Water	Sulfide	SM 4500 S2 D / 376.2	Spectrophotometer
Water	COD	HACH 8000	Spectrophotometer
Water / Solid	Sulfate	9038 / 375.4	Spectrophotometer
Water	Ortho Phosphate	SM 4500 P E	Spectrophotometer
Water	Silica	SM 4500 Si D	Spectrophotometer
Water/Solid	TKN	SM4500 Norg C SM4500 NH3 B SM4500NH3 E	Spectrophotometer
Water	Sulfide	SM 4500 S2 E / 376.1	Titration
Water / Solid	Reactive Sulfide	SW846 Sec 7.3	Titration
Solid	TOC	Lloyd Kahn 9060A	TOC Analyzer
Water	TOC	SM 5310B / 415.1 / 9060A	TOC Analyzer



MATRIX	SPECIFIC TEST or GROUP OF ANALYTES	SPECIFICATION OR STANDARD METHOD (all EPA unless specified)	* KEY EQUIPMENT OR TECHNOLOGY USED
Water	TOX	9020B	TOX Analyzer
Water	Turbidity	SM2130B	Turbidimeter
Solid	Ignitability	1030	N/A
Water	Massachusetts EPH	Massachusetts EPH	GC-FID
Solid	Massachusetts EPH	Massachusetts EPH	GC-FID
Water	Massachusetts VPH	Massachusetts VPH	GC-FID/PID
Solid	Massachusetts VPH	Massachusetts VPH	GC-FID/PID
Water/Solid	ICP-MS Metals	6020A/200.8	ICP-MS
Water	ICP-MS Metals	200.8	ICP-MS

Notes:

1. * = As Applicable
2. **=Refer to accredited analyte listing for exact analyte(s) in which the lab is accredited.
3. This scope is part of and must be included with the Certificate of Accreditation No. ADE- 1482



Vice President



Accredited Analytes/Methods (by matrix)

Gulf Coast Analytical Laboratories, Inc.

Baton Rouge, LA

NELAC Code	Analyte	Matrix														
		Aqueous						Solid								
1000	Aluminum	6010B	6010C	6020A	200.7	200.8					6010B	6010C	6020A			
1005	Antimony	6010B	6010C	6020A	200.7	200.8	3010 A	1311			6010B	6010C	6020A	1311	6010C	
1010	Arsenic	6010B	6010C	6020A	200.7	200.8	3010 A	1311			6010B	6010C	6020A	1311	6010C	
1015	Barium	6010B	6010C	6020A	200.7	200.8	3010 A	1311			6010B	6010C	6020A	1311	6010C	
1020	Beryllium	6010B	6010C	6020A	200.7	200.8	3010 A	1311			6010B	6010C	6020A	1311	6010C	
1025	Boron	6010B	6010C		200.7						6010B	6010C				
1030	Cadmium	6010B	6010C	6020A	200.7	200.8	3010 A	1311			6010B	6010C	6020A	1311	6010C	
1035	Calcium	6010B	6010C	6020A	200.7	200.8					6010B	6010C	6020A			
1040	Chromium	6010B	6010C	6020A	200.7	200.8	3010 A	1311			6010B	6010C	6020A	1311	6010C	
1045	Chromium VI	7196A														
1050	Cobalt	6010B	6010C	6020A	200.7	200.8					6010B	6010C	6020A			
1055	Copper	6010B	6010C	6020A	200.7	200.8					6010B	6010C	6020A			
1070	Iron	6010B	6010C	6020A	200.7	200.8					6010B	6010C	6020A			
1075	Lead	6010B	6010C	6020A	200.7	200.8	3010 A	1311			6010B	6010C	6020A	1311	6010C	
1085	Magnesium	6010B	6010C	6020A	200.7	200.8					6010B	6010C	6020A			
1090	Manganese	6010B	6010C	6020A	200.7	200.8					6010B	6010C	6020A			
1095	Mercury	7470A	245.2	245.1			3010 A	1311			7471B			1311	6010C	
1100	Molybdenum	6010B	6010C	6020A	200.7	200.8					6010B	6010C	6020A			
1105	Nickel	6010B	6010C	6020A	200.7	200.8					6010B	6010C	6020A			
1125	Potassium	6010B	6010C	6020A	200.7	200.8					6010B	6010C	6020A			
1140	Selenium	6010B	6010C	6020A	200.7	200.8	3010 A	1311			6010B	6010C	6020A	1311	6010C	
1150	Silver	6010B	6010C	6020A	200.7	200.8	3010 A	1311			6010B	6010C	6020A	1311	6010C	
1155	Sodium	6010B	6010C	6020A	200.7	200.8					6010B	6010C	6020A			
1160	Strontium	6010B	6010C	6020A	200.7	200.8					6010B	6010C	6020A			
1165	Thallium	6010B	6010C	6020A	200.7	200.8	3010 A	1311			6010B	6010C	6020A	1311	6010C	
1175	Tin	6010B	6010C	6020A	200.7	200.8					6010B	6010C	6020A			
1180	Titanium	6010B	6010C	6020A	200.7	200.8					6010B	6010C	6020A			
1185	Vanadium	6010B	6010C	6020A	200.7	200.8					6010B	6010C	6020A			
1190	Zinc	6010B	6010C	6020A	200.7	200.8	3010 A	1311			6010B	6010C	6020A	1311	6010C	
1192	Zirconium			6020A		200.8							6020A			
1500	Acidity(as CaCO3)	SM 2310B														
1505	Total Alkalinity(as CaCO3)	SM 2320B	EPA 310.1													
1515	Ammonia as N	SM4500 NH3 B & E	SM4500 NH3 B & F	SM4500 NH3 B & C							SM 4500 NH3 BE	SM 4500 NH3 BF	SM4500 NH3 B & C			
1540	Bromide	9056A	EPA 300.0								9056A					
1565	COD	HACH 8000														
1575	Chloride	9056A	EPA 300.0	9251	EPA 325.2				SM 4500 Cl E		9056A	9251				
1625	Corrosivity (pH)	9040C	SM 4500 H+B								9045D					
1645	Total Cyanide	9012B									9012B					
1730	Fluoride	9056A	EPA 300.0								9056A					
1755	Total Hardness (as CaCO3)	6020A	200.8													
1780	Ignitability	1010A									1010A					
1810	Nitrate as N	9056A	EPA 300.0	EPA 353.2							9056A	EPA 353.2				
1820	Nitrate and Nitrite as N	9056A	EPA 300.0	EPA 353.2							9056A	EPA 353.2				
1840	Nitrite as N	9056A	EPA 300.0	EPA 353.2							9056A	EPA 353.2				
1860	Oil & Grease	EPA 1664A														
1870	Orthophosphate as P	SM 4500 PE														
1895	Perchlorate	EPA 314.0									EPA 314.0					
1900	pH	9040C	SM 4500 H+B								9040C					
1905	Total Phenolics (4AAP)	9066	EPA 420.4								9066	EPA 420.4				
1910	Total Phosphorous	EPA 365.1									EPA 365.1					
1925	Reactive sulfide	SW846 Sec 7.3									SW846 Sec 7.3					
-	Reactive Cyanide	SW846 Sec 7.3									SW846 Sec 7.3					
-	Percent Moisture										SM 2540G					
1950	Total Solids	SM 2540B	EPA 160.3								SM2540 G					
1955	Total Dissolved Solids at 180° (TFR)	SM 2540C	EPA 160.1													
1960	Non-Filterable Residue (TSS)	SM 2540D	EPA 160.2													
2000	Sulfate	9056A	EPA 300.0	9038	EPA 375.4						9056A	9038	9038	EPA 375.4		

Accredited Analytes/Methods (by matrix)

Gulf Coast Analytical Laboratories, Inc.

Baton Rouge, LA

NELAC Code	Analyte	Matrix																		
		Aqueous					Solid													
		SM 4500 S2 D	EPA 376.2	SM 4500 S2 E	EPA 376.1															
2005	Sulfide	SM 4500 S2 D	EPA 376.2	SM 4500 S2 E	EPA 376.1															
2040	TOC	SM 5310B	EPA 415.1	9060A							EPA 9060A									
2045	Total Organic Halides	9020B									9020B									
2055	Turbidity	SM 2130 B																		
4315	Acetone	8260B	624								8260B									
4320	Acetonitrile	8260B	624								8260B									
4325	Acrolein	8260B	624								8260B									
4340	Acrylonitrile	8260B	624								8260B									
4375	Benzene	8260B	624	1311							8260B	1311								
4385	Bromobenzene	8260 B									8260 B									
4390	Bromochloromethane	8260B	624								8260B									
4395	Bromodichloromethane	8260B	624								8260B									
4400	Bromoform	8260B	624								8260B									
4410	2-Butanone (MEK)	8260B	624	1311							8260B	1311								
4435	n-Butylbenzene	8260B	624								8260B									
4440	sec-Butylbenzene	8260B	624								8260B									
4445	tert-Butylbenzene	8260B	624								8260B									
4450	Carbon disulfide	8260B	624								8260B									
4455	Carbon tetrachloride	8260B	624	1311							8260B	1311								
4475	Chlorobenzene	8260B	624	1311							8260B	1311								
4485	Chloroethane	8260B	624								8260B									
4500	2-Chloroethylvinylether	8260B	624								8260B									
4505	Chloroform	8260B	624	1311							8260B	1311								
4535	2-Chlorotoluene	8260B	624								8260B									
4540	4-Chlorotoluene	8260B	624								8260B									
4570	1,2-Dibromo-3-chloropropane (DBCP)	8260B	624	8011							8260B									
4575	Dibromochloromethane	8260B	624								8260B									
4585	1,2-Dibromoethane (EDB)	8260B	624	8011							8260B									
4595	Dibromomethane	8260B	624								8260B									
4610	1,2 Dichlorobenzene	8260B	624			8270C	8270D	625			8260B		8270C	8270D						
4615	1,3 Dichlorobenzene	8260B	624			8270C	8270D	625			8260B		8270C	8270D						
4620	1,4 Dichlorobenzene	8260B	624	1311		8270C	8270D	625			8260B	1311	8270C	8270D						
4625	Dichlorodifluoromethane	8260B	624								8260B									
4630	1,1-Dichloroethane	8260B	624								8260B									
4635	1,2 Dichloroethane	8260B	624	1311							8260B	1311								
4640	1,1-Dichloroethene	8260B	624	1311							8260B	1311								
4645	cis-1,2-Dichloroethene	8260B	624								8260B									
4655	1,2-Dichloropropane	8260B	624								8260B									
4660	1,3-Dichloropropane	8260B	624								8260B									
4665	2,2-Dichloropropane	8260B	624								8260B									
4670	1,1-Dichloropropene	8260B	624								8260B									
4680	cis-1,3-Dichloropropylene	8260B	624								8260B									
4685	trans-1,3-Dichloropropene	8260B	624								8260B									
4700	trans-1,2-Dichloroethene	8260B	624								8260B									
4740	p-Dioxane					8270C	8270D	625												
4765	Ethylbenzene	8260B	624								8260B									
4835	Hexachlorobutadiene	8260B	624	1311		8270C	8270D	625			8260B	1311	8270C	8270D						
4840	Hexachloroethane			1311		8270C	8270D	625				1311	8270C	8270D						
4860	2-Hexanone	8260B	624								8260B									
4900	Isopropylbenzene	8260B	624								8260B									
4910	p-Isopropyltoluene	8260B	624								8260B									
4950	Bromomethane	8260B	624								8260B									
4960	Chloromethane	8260B	624								8260B									
	Methyl Acetate	8260B									8260B									
4975	Methylene Chloride	8260B	624								8260B									
	Methylcyclohexane	8260B									8260B									
4995	4-Methyl-2-pentanone (MIBK)	8260B	624								8260B									

Accredited Analytes/Methods (by matrix)

Gulf Coast Analytical Laboratories, Inc.

Baton Rouge, LA

NELAC Code	Analyte	Matrix													
		Aqueous						Solid							
5000	Methyl tert-butyl ether (MTBE)	8260B	624							8260B					
5005	Naphthalene	8260B	624	8310	8270 C	8270D		625	8260B		8270C	8270D			8310
5015	Nitrobenzene	8330 A		1311	8270C	8270D		625		1311	8270C	8270D		8330A	
5090	n-Propylbenzene	8260B	624						8260B						
5095	Pyridine			1311	8270C	8270D		625		1311	8270C	8270D			
5100	Styrene	8260B	624						8260B						
5105	1,1,1,2-Tetrachloroethane	8260B	624						8260B						
5110	1,1,2,2-Tetrachloroethane	8260B	624						8260B						
	1,2,4,5-Tetrachlorobenzene	8260B							8260B						
5115	Tetrachloroethene	8260B	624	1311					8260B	1311					
5140	Toluene	8260B	624						8260B						
5145	o-Toluidine				8270C	8270D		625							
	1,1,2-trichloro-1,2,2-trifluoroethane	8260B							8260B						
5150	1,2,3-Trichlorobenzene	8260B	624						8260B						
5155	1,2,4-Trichlorobenzene	8260B	624		8270C	8270D		625	8260B	8270 C	8270 D				
5160	1,1,1-Trichloroethane	8260B	624						8260B						
5165	1,1,2-Trichloroethane	8260B	624						8260B						
5170	Trichloroethene	8260B	624	1311					8260B	1311					
5175	Trichlorofluoromethane	8260B	624						8260B						
5180	1,2,3-Trichloropropane	8260B	624						8260B						
5210	1,2,4-Trimethylbenzene	8260B	624						8260B						
5215	1,3,5-Trimethylbenzene	8260B	624						8260B						
5225	Vinyl acetate	8260B	624						8260B						
5235	Vinyl chloride	8260B	624	1311					8260B	1311					
5240	m+p-Xylene	8260B	624						8260B						
5250	o-Xylene	8260B	624						8260B						
5260	Xylenes, total	8260B	624						8260B						
5500	Acenaphthene	8310			8270C	8270D		625			8270C	8270D			8310
5505	Acenaphthylene	8310			8270C	8270D		625			8270C	8270D			8310
	Acetophenone				8270C						8270C				
5545	Aniline				8270C	8270D		625			8270C	8270D			
5555	Anthracene	8310			8270C	8270D		625			8270C	8270D			8310
	Benzaldehyde				8270C						8270C				
5575	Benzo(a)anthracene	8310			8270C	8270D		625			8270C	8270D			8310
5580	Benzo(a)pyrene	8310			8270C	8270D		625			8270C	8270D			8310
5585	Benzo(b)fluoranthene	8310			8270C	8270D		625			8270C	8270D			8310
5590	Benzo(g,h,i)perylene	8310			8270C	8270D		625			8270C	8270D			8310
5595	Benzidine				8270C	8270D		625			8270C	8270D			
5600	Benzo(k)fluoranthene	8310			8270C	8270D		625			8270C	8270D			8310
5610	Benzoic acid				8270C	8270D		625			8270C	8270D			
5630	Benzyl alcohol				8270C	8270D		625			8270C	8270D			
	Biphenyl				8270C						8270C				
5660	4-Bromophenyl-phenylether				8270C	8270D		625			8270C	8270D			
5670	Butyl benzyl phthalate				8270C	8270D		625			8270C	8270D			
5680	Carbazole				8270C	8270D		625			8270C	8270D			
5700	4-Chloro-3-methylphenol				8270C	8270D		625			8270C	8270D			
5745	4-Chloroaniline				8270C	8270D		625			8270C	8270D			
5760	bis(2-Chloroethoxy)methane				8270C	8270D		625			8270C	8270D			
5765	bis(2-Chloroethyl)ether				8270C	8270D		625			8270C	8270D			
5780	bis(2-Chloroisopropyl) ether				8270C	8270D		625			8270C	8270D			
5795	2-Chloronaphthalene				8270C	8270D		625			8270C	8270D			
5800	2-Chlorophenol				8270C	8270D		625			8270C	8270D			
5825	4-Chlorophenyl-phenylether				8270C	8270D		625			8270C	8270D			
5855	Chrysene	8310			8270C	8270D		625			8270C	8270D			8310
5895	Dibenzo(a,h)anthracene	8310			8270C	8270D		625			8270C	8270D			8310
5905	Dibenzofuran				8270C	8270D		625			8270C	8270D			
5925	Di-n-butylphthalate				8270C	8270D		625			8270C	8270D			

Accredited Analytes/Methods (by matrix)

Gulf Coast Analytical Laboratories, Inc.

Baton Rouge, LA

NELAC Code	Analyte	Matrix																
		Aqueous						Solid										
5945	3,3'-Dichlorobenzidine					8270C	8270D			625				8270C	8270D			
6000	2,4-Dichlorophenol					8270C	8270D			625				8270C	8270D			
6005	2,6-Dichlorophenol					8270C	8270D			625				8270C	8270D			
6070	Diethyl phthalate					8270C	8270D			625				8270C	8270D			
6130	2,4-Dimethylphenol					8270C	8270D			625				8270C	8270D			
6135	Dimethyl phthalate					8270C	8270D			625				8270C	8270D			
6160	1,3-Dinitrobenzene	8330 A											8330A					
6175	2,4-Dinitrophenol					8270C	8270D			625				8270C	8270D			
6185	2,4-Dinitrotoluene	8330 A	1311			8270C	8270D			625		1311		8270C	8270D		8330A	
6190	2,6-Dinitrotoluene	8330 A				8270C	8270D			625				8270C	8270D		8330A	
6200	Di-n-octylphthalate					8270C	8270D			625				8270C	8270D			
6255	bis(2-ethylhexyl) phthalate					8270C	8270D			625				8270C	8270D			
6265	Fluoranthene	8310				8270C	8270D			625				8270C	8270D			8310
6270	Fluorene	8310				8270C	8270D			625				8270C	8270D			8310
6275	Hexachlorobenzene		1311			8270C	8270D			625		1311		8270C	8270D			
6285	Hexachlorocyclopentadiene					8270C	8270D			625				8270C	8270D			
6315	Indeno(1,2,3, cd)pyrene	8310				8270C	8270D			625				8270C	8270D			8310
6320	Isophorone					8270C	8270D			625				8270C	8270D			
6360	2-Methyl-4,6-Dinitrophenol					8270C	8270D			625				8270C	8270D			
6380	1-Methylnaphthalene					8270C	8270D			625								
6385	2-Methylnaphthalene	8310				8270C	8270D			625				8270C	8270D			8310
6400	2-Methylphenol		1311			8270C	8270D			625		1311		8270C	8270D			
6410	4-Methylphenol (and/or 3-Methylphenol)		1311			8270C	8270D			625		1311		8270C	8270D			
6415	Tetryl (Methyl-2,4,6-trinitrophenylnitramine)	8330 A											8330 A					
6460	2-Nitroaniline					8270C	8270D			625				8270C	8270D			
6465	3-Nitroaniline					8270C	8270D			625				8270C	8270D			
6470	4-Nitroaniline					8270C	8270D			625				8270C	8270D			
6490	2-Nitrophenol					8270C	8270D			625				8270C	8270D			
6500	4-Nitrophenol	8151 A				8270C	8270D			625		8151 A		8270C	8270D			
6525	N-Nitrosodiethylamine					8270C	8270D			625				8270C	8270D			
6530	N-Nitrosodimethylamine					8270C	8270D			625				8270C	8270D			
6535	N-Nitrosodiphenylamine					8270C	8270D			625				8270C	8270D			
6545	N-Nitroso-di-n-propylamine					8270C	8270D			625				8270C	8270D			
6590	Pentachlorobenzene					8270C	8270D			625				8270C	8270D			
6605	Pentachlorophenol	8151 A	1311			8270C	8270D			625		8151 A	1311	8270C	8270D			
6615	Phenanthrene	8310				8270C	8270D			625				8270C	8270D			8310
6625	Phenol					8270C	8270D			625				8270C	8270D			
6665	Pyrene	8310				8270C	8270D			625				8270C	8270D			8310
6715	1,2,4,5-Tetrachlorobenzene					8270C	8270D			625				8270C	8270D			
6735	2,3,4,6-Tetrachlorophenol					8270C	8270D			625				8270C	8270D			
6835	2,4,5-Trichlorophenol		1311			8270C	8270D			625		1311		8270C	8270D			
6840	2,4,6-Trichlorophenol		1311			8270C	8270D			625		1311		8270C	8270D			
6885	1,3,5-Trinitrobenzene	8330 A																8330A
7025	Aldrin	8081B															8081B	
7075	Azinphos-methyl (Guthion)	8141B											8141B					
7105	delta-BHC	8081B															8081B	
7110	alpha-BHC	8081B															8081B	
7115	beta-BHC	8081B															8081B	
7120	gamma-BHC (Lindane)	8081B	1311									1311					8081B	
7240	alpha-Chlordane	8081B															8081B	
7245	gamma-Chlordane	8081B															8081B	
7250	Chlordane (total)	8081B															8081B	
7355	DDD (4,4)	8081B															8081B	
7360	DDE (4,4)	8081B															8081B	
7365	DDT (4,4)	8081B															8081B	
7410	Diazinon	8141B											8141B					
7470	Dieldrin	8081B															8081B	

Accredited Analytes/Methods (by matrix)

Gulf Coast Analytical Laboratories, Inc.

Baton Rouge, LA

NELAC Code	Analyte	Matrix											
		Aqueous						Solid					
7510	Endosulfan I	8081B											8081B
7515	Endosulfan II	8081B											8081B
7520	Endosulfan sulfate	8081B											8081B
7530	Endrin aldehyde	8081B											8081B
7535	Endrin ketone	8081B											8081B
7540	Endrin	8081B	1311						1311				8081B
7685	Heptachlor	8081B	1311						1311				8081B
7690	Heptachlor Epoxide (beta)	8081B	1311						1311				8081B
7770	Malathion	8141B							8141B				
7775	MCPA	8151A							8151A				
7780	MCPP	8151 A							8151 A				
7810	Methoxychlor	8081B	1311						1311				8081B
7825	Parathion, methyl	8141B							8141B				
7955	Parathion, ethyl	8141B							8141B				
7985	Phorate	8141B							8141B				
8110	Ronnel	8141B							8141B				
8200	Stirophos	8141B							8141B				
8250	Toxaphene (total)	8081B											8081B
8505	Acifluorfen	8151 A							8151 A				
8530	Bentazon	8151 A							8151 A				
8540	Chloramben	8151 A							8151 A				
8545	2,4-D	8151 A	1311						8151A	1311			
8550	Dacthal (DCPA)	8151 A							8151 A				
8555	Dalapon	8151 A							8151 A				
8560	2,4-DB	8151 A							8151A				
8595	Dicamba	8151 A							8151A				
8600	3,5-Dichlorobenzoic acid	8151 A							8151 A				
8605	2,4-DP (Dichlorprop)	8151 A							8151 A				
8620	Dinoseb (2-sec-butyl-4,6-dinitrophenol, DNBP)	8151 A							8151A				
8625	Disulfoton	8141B							8141B				
8645	Picloram	8151 A							8151 A				
8650	2,4,5-TP (Silvex)	8151 A	1311							1311			8151A
8655	2,4,5-T	8151 A							8151A				
8880	Aroclor 1016	8082A							8082A				
8885	Aroclor 1221	8082A							8082A				
8890	Aroclor 1232	8082A							8082A				
8895	Aroclor 1242	8082A							8082A				
8900	Aroclor 1248	8082A							8082A				
8905	Aroclor 1254	8082A							8082A				
8910	Aroclor 1260	8082A							8082A				
9303	2-Amino-4,6-dinitrotoluene	8330 A											8330A
9306	4-Amino-2,6-dinitrotoluene	8330 A											8330A
9369	Diesel range organics (DRO)	8015C							8015C				
9432	RDX (Hexahydro-1,3,5-trinitro-1,3,5-triazine)	8330 A											8330A
9507	2-Nitrotoluene	8330 A											8330A
9510	3-Nitrotoluene	8330 A											8330A
9513	4-Nitrotoluene	8330 A											8330A
9522	HMX (Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine)	8330 A											8330A
9651	2,4,6-Trinitrotoluene	8330 A											8330A
	Methane	RSK-175											
	Ethane	RSK-175											
	Ethene	RSK-175											
	Carbon Dioxide	RSK-175											
	Lactic Acid	GCAL SOP WL-070											
	Formic Acid	GCAL SOP WL-070											
	Acetic Acid	GCAL SOP WL-070											
	Propionic Acid	GCAL SOP WL-070											

Accredited Analytes/Methods (by matrix)

Gulf Coast Analytical Laboratories, Inc.

Baton Rouge, LA

NELAC Code	Analyte	Matrix											
		Aqueous						Solid					
	Butyric Acid	GCAL SOP WL-070											
	1-Chlorohexane	8260B											
	1-Chlorohexane							8260B					
	1,2-Diphenylhydrazine	8270C	8270D										
	1,2-Diphenylhydrazine							8270C	8270D				
	Chlordane	8082B	1311					1311	8082B				
	Toxaphene	8082 A	1311					1311	8082 A				
	Paint Filter Test	9095B						9095B					
	Oil Range Organics	8015C						8015C					
	Petroleum Hydrocarbons	Florida PRO						Florida PRO					
	Ignitability							1030					
9408	Gasoline	8015C						8015C					
4375	Benzene	8021B						8021B					
4765	Ethyl Benzene	8021B						8021B					
5140	Toluene	8021B						8021B					
5260	Xylene	8021B						8021B					
9375	DIPE	8260B						8260B					
4770	ETBE	8260B						8260B					
5000	MTBE	8260B						8260B					
4370	TAME	8260B						8260B					
4420	tert-Butyl alcohol	8260B						8260B					
9369	Diesel	8015C						8015C					
2050	Total Petroleum Hydrocarbon	TNRCC 1005						TNRCC 1005					
	Total Petroleum Hydrocarbon	TNRCC 1006						TNRCC 1006					
	GRO-Total	TNRCC 1006						TNRCC 1006					
	DRO-Total	TNRCC 1006						TNRCC 1006					
	ORO-Total	TNRCC 1006						TNRCC 1006					
	GRO-aliphatic	TNRCC 1006						TNRCC 1006					
	DRO-aliphatic	TNRCC 1006						TNRCC 1006					
	ORO-aliphatic	TNRCC 1006						TNRCC 1006					
	GRO-aromatic	TNRCC 1006						TNRCC 1006					
	DRO-aromatic	TNRCC 1006						TNRCC 1006					
	ORO-aromatic	TNRCC 1006						TNRCC 1006					
-	C5-C8 Alliphatic Hydrocarbons	MADEP VPH						MADEP VPH					
-	C9-C12 Alliphatic Hydrocarbons	MADEP VPH						MADEP VPH					
-	C9-C10 Aromatic Hydrocarbons	MADEP VPH						MADEP VPH					
-	C9-C18 Alliphatic Hydrocarbons	MADEP EPH						MADEP EPH					
-	C19-C36 Alliphatic Hydrocarbons	MADEP EPH						MADEP EPH					
-	C11-C22 Aromatic Hydrocarbons	MADEP EPH						MADEP EPH					



**STATE OF LOUISIANA
DEPARTMENT OF ENVIRONMENTAL QUALITY**

Is hereby granting a Louisiana Environmental Laboratory Accreditation to



**Gulf Coast Analytical Laboratories LLC
7979 GSRI Ave
Baton Rouge, Louisiana 70820-7402**

Agency Interest No. 3476

According to the Louisiana Administrative Code, Title 33, Part I, Subpart 3, LABORATORY ACCREDITATION, the State of Louisiana formally recognizes that this laboratory is technically competent to perform the environmental analyses listed on the scope of accreditation detailed in the attachment.

The laboratory agrees to perform all analyses listed on this scope of accreditation according to the Part I, Subpart 3 requirements and acknowledges that continued accreditation is dependent on successful ongoing compliance with the applicable requirements of Part I. Please contact the Department of Environmental Quality, Louisiana Environmental Laboratory Accreditation Program (LELAP) to verify the laboratory's scope of accreditation and accreditation status.

Accreditation by the State of Louisiana is not an endorsement or a guarantee of validity of the data generated by the laboratory. To be accredited initially and maintain accreditation, the laboratory agrees to participate in two single-blind, single-concentration PT studies, where available, per year for each field of testing for which it seeks accreditation or maintains accreditation as required in LAC 33:I.4711.

Lourdes Iturralde, Administrator
Notifications and Accreditations Section
Public Participation & Permit Support Services Division

Certificate Number: 01955

**Expiration Date: June 30, 2013
Issued On: July 1, 2012**



Catherine B. Templeton, Director
Promoting and protecting the health of the public and the environment

February 06, 2013

ALLISON NAQUIN PH D
GULF COAST ANALYTICAL LAB
7979 GSRI AVE
BATON ROUGE, LOUISIANA 70820

Laboratory I. D. 73006

Dear Allison Naquin Ph D:

Your amended certificate and associated parameter list(s) are enclosed. These documents now represent the certificate of record for your laboratory. Any certificate(s) and associated parameter list(s) received prior to your receipt of these documents are now null and void and should be destroyed. Please be reminded that all environmental data submitted to the Department is reviewed to ensure that the reporting laboratory possesses the necessary certification. Data reported by laboratories without the proper certification will be addressed by the affected enforcement programs.

If you have any questions, or problems are detected concerning your certificate, please contact this office within ten (10) working days.

Sincerely,

Carol F. Smith, Director
Office of Environmental Laboratory Certification
Bureau of Environmental Services

Enclosures



South Carolina Department of Health
and Environmental Control

Environmental Laboratory Certification Program

In accordance with the provisions of Regulation 61-81, entitled
"State Environmental Laboratory Certification Regulations"

**GULF COAST ANALYTICAL LAB
7979 GSRI AVE
BATON ROUGE, LOUISIANA 70820**

is hereby certified to perform analyses as documented on the attached parameter list(s). This certification does not guarantee validity of data generated, but indicates the laboratory's adherence to prescribed methodology, quality control, records keeping, and reporting procedures. This certificate is the property of S.C. DHEC and must be surrendered upon demand. This certificate is non-transferable and is valid only for the parameters and methodology listed on the attached parameter list(s).

Laboratory Director: ALLISON NAQUIN PH D
Certifying Authority: LA
Date of Issue: February 04, 2013
Date of Expiration: June 30, 2013
Certificate Number: 73006001

Director

Office of Environmental Laboratory Certification

**SOUTH CAROLINA DEPARTMENT OF HEALTH AND ENVIRONMENTAL CONTROL
ENVIRONMENTAL LABORATORY CERTIFICATION PROGRAM**

GULF COAST ANALYTICAL LAB (Laboratory ID 73006)
Laboratory Director: ALLISON NAQUIN PH D
Certifying Authority: LA
Certificate Number: 73006001

Date of Issue: February 04, 2013
Expiration Date: June 30, 2013

CLEAN WATER ACT

INORGANIC - DEMAND

BIOCHEMICAL OXYGEN DEMAND(BOD)	SM 5210B (18TH)
CHEMICAL OXYGEN DEMAND (COD)	HACH 8000 (1979)

INORGANIC - MINERAL

ALKALINITY	SM 2320B (18TH)
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INORGANIC - NUTRIENT

AMMONIA-NITROGEN	SM 4500NH3E (18TH)
KJELDAHL-NITROGEN	SM 4500NH3E (18TH)
NITRATE-NITRITE (NO2&NO3)	EPA 353.2 (1993)
NITRATE-NITROGEN	NO3-NO2 MINUS NO2
ORTHOPHOSPHATE	SM 4500PE (18TH)
TOTAL ORGANIC NITROGEN	EPA TKN-NH3-N

INORGANIC - RESIDUE

RESIDUE, FILTERABLE (TDS)	SM 2540C (18TH)
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SOLID & HAZARDOUS WASTES

INORGANIC - HAZARDOUS WASTE CHARACTERISTICS

CORROSIVITY - TOWARDS STEEL	EPA 1110A
IGNITABILITY	EPA 1010A
IGNITABILITY OF SOLIDS	EPA 1030
PAINT FILTER LIQUIDS TEST	EPA 9095B
TCLP - BOTTLE EXTRACTION	EPA 1311
TCLP - ZERO HEADSPACE	EPA 1311

INORGANIC - MINERAL

FLUORIDE	EPA 9056A
HYDROGEN-ION CONC. (PH)	EPA 9040C
HYDROGEN-ION CONC. (PH) (SOIL AND WAST)	EPA 9045D

INORGANIC - MISCELLANEOUS

BOMB PREPARATION METHOD	EPA 5050
BROMIDE	EPA 9056A
CYANIDE	EPA 9012B
CYANIDE AMEN. TO CHLORINATION	EPA 9012B
PHENOLICS, TOTAL RECOVERABLE	EPA 9066

**SOUTH CAROLINA DEPARTMENT OF HEALTH AND ENVIRONMENTAL CONTROL
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SOLID & HAZARDOUS WASTES

INORGANIC - TRACE METAL

ALUMINUM	EPA 6010C
ANTIMONY	EPA 6010C
ARSENIC	EPA 6010C
BARIUM	EPA 6010C
BERYLLIUM	EPA 6010C
CADMIUM	EPA 6010C
CALCIUM	EPA 6010C
CHROMIUM	EPA 6010C
CHROMIUM, HEXAVALENT	EPA 7196A
COBALT	EPA 6010C
COPPER	EPA 6010C
IRON	EPA 6010C
LEAD	EPA 6010C
MAGNESIUM	EPA 6010C
MANGANESE	EPA 6010C
MERCURY	EPA 7470A
MERCURY	EPA 7471B
MOLYBDENUM	EPA 6010C
NICKEL	EPA 6010C
POTASSIUM	EPA 6010C
SELENIUM	EPA 6010C
SILVER	EPA 6010C
SODIUM	EPA 6010C
STRONTIUM	EPA 6010C
THALLIUM	EPA 6010C
TIN	EPA 6010C
VANADIUM	EPA 6010C
ZINC	EPA 6010C

PCBS AND PESTICIDES

ORGANOCHLORINE PESTICIDES BY GC	EPA 8081B	EPA 3510C
ORGANOCHLORINE PESTICIDES BY GC	EPA 8081B	EPA 3550C
ORGANOCHLORINE PESTICIDES BY GC	EPA 8081B	EPA 3580A
POLYCHLORINATED BIPHENYLS BY GC	EPA 8082A	EPA 3510C
POLYCHLORINATED BIPHENYLS BY GC	EPA 8082A	EPA 3550C
POLYCHLORINATED BIPHENYLS BY GC	EPA 8082A	EPA 3580A

SEMI-VOLATILES

EDB & DBCP BY MICROEXTRACTION AND GC	EPA 8011	
POLYNUCLEAR AROMATIC HYDROCARBONS BY HP	EPA 8310	EPA 3510C
POLYNUCLEAR AROMATIC HYDROCARBONS BY HP	EPA 8310	EPA 3550C
SEMIVOLATILE ORGANICS BY GC/MS	EPA 8270D	EPA 3510C
SEMIVOLATILE ORGANICS BY GC/MS	EPA 8270D	EPA 3550C
SEMIVOLATILE ORGANICS BY GC/MS	EPA 8270D	EPA 3580A

**SOUTH CAROLINA DEPARTMENT OF HEALTH AND ENVIRONMENTAL CONTROL
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SOLID & HAZARDOUS WASTES

SEMI-VOLATILES

TPH - DIESEL RANGE ORGANICS (DRO)	EPA 8015C (DRO)	EPA 3510C
TPH - DIESEL RANGE ORGANICS (DRO)	EPA 8015C (DRO)	EPA 3550C

VOLATILES (VOCS)

OXYGENATE VOLATILE ORGANICS BY GC/MS	EPA 8260B-OXY	EPA 5030B
TPH - GASOLINE RANGE ORGANICS (GRO)	EPA 8015C (GRO)	EPA 5035
TPH - GASOLINE RANGE ORGANICS (GRO)	EPA 8015C (GRO)	EPA 5030B
VOLATILE ORGANICS BY GC/MS	EPA 8260B	EPA 5035
VOLATILE ORGANICS BY GC/MS	EPA 8260B	EPA 5030B

**SOUTH CAROLINA DEPARTMENT OF HEALTH AND ENVIRONMENTAL CONTROL
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SOLID & HAZARDOUS WASTES

-----PCBS AND PESTICIDES-----

<p>EPA 8081B EPA 3510C</p> <p>4,4'-DDD 4,4'-DDE 4,4'-DDT ALDRIN ALPHA-BHC ALPHA-CHLORDANE BETA-BHC DELTA-BHC DIELDRIN ENDOSULFAN I ENDOSULFAN II ENDOSULFAN SULFATE ENDRIN ENDRIN ALDEHYDE ENDRIN KETONE GAMMA-BHC (LINDANE) GAMMA-CHLORDANE HEPTACHLOR HEPTACHLOR EPOXIDE METHOXYCHLOR TOXAPHENE</p> <p>EPA 8081B EPA 3550C</p> <p>4,4'-DDD 4,4'-DDE 4,4'-DDT ALDRIN ALPHA-BHC ALPHA-CHLORDANE BETA-BHC DELTA-BHC DIELDRIN ENDOSULFAN I ENDOSULFAN II ENDOSULFAN SULFATE ENDRIN ENDRIN ALDEHYDE ENDRIN KETONE GAMMA-BHC (LINDANE) GAMMA-CHLORDANE HEPTACHLOR HEPTACHLOR EPOXIDE METHOXYCHLOR TOXAPHENE</p> <p>EPA 8082A EPA 3510C</p> <p>PCB-1016 (AROCLOR-1016) PCB-1221 (AROCLOR-1221) PCB-1232 (AROCLOR-1232) PCB-1242 (AROCLOR-1242) PCB-1248 (AROCLOR-1248) PCB-1254 (AROCLOR-1254) PCB-1260 (AROCLOR-1260)</p> <p>EPA 8082A EPA 3550C</p> <p>PCB-1016 (AROCLOR-1016) PCB-1221 (AROCLOR-1221)</p>	<p>EPA 8081B EPA 3550C</p> <p>HEPTACHLOR EPOXIDE METHOXYCHLOR TOXAPHENE</p> <p>EPA 8081B EPA 3580A</p> <p>4,4'-DDD 4,4'-DDE 4,4'-DDT ALDRIN ALPHA-BHC ALPHA-CHLORDANE BETA-BHC DELTA-BHC DIELDRIN ENDOSULFAN I ENDOSULFAN II ENDOSULFAN SULFATE ENDRIN ENDRIN ALDEHYDE ENDRIN KETONE GAMMA-BHC (LINDANE) GAMMA-CHLORDANE HEPTACHLOR HEPTACHLOR EPOXIDE METHOXYCHLOR TOXAPHENE</p> <p>EPA 8082A EPA 3510C</p> <p>PCB-1016 (AROCLOR-1016) PCB-1221 (AROCLOR-1221) PCB-1232 (AROCLOR-1232) PCB-1242 (AROCLOR-1242) PCB-1248 (AROCLOR-1248) PCB-1254 (AROCLOR-1254) PCB-1260 (AROCLOR-1260)</p> <p>EPA 8082A EPA 3550C</p> <p>PCB-1016 (AROCLOR-1016) PCB-1221 (AROCLOR-1221)</p>	<p>EPA 8082A EPA 3550C</p> <p>PCB-1232 (AROCLOR-1232) PCB-1242 (AROCLOR-1242) PCB-1254 (AROCLOR-1254) PCB-1260 (AROCLOR-1260)</p> <p>EPA 8082A EPA 3580A</p> <p>PCB-1016 (AROCLOR-1016) PCB-1221 (AROCLOR-1221) PCB-1232 (AROCLOR-1232) PCB-1242 (AROCLOR-1242) PCB-1248 (AROCLOR-1248) PCB-1254 (AROCLOR-1254) PCB-1260 (AROCLOR-1260)</p> <p>-----SEMI-VOLATILES-----</p> <p>EPA 8011</p> <p>1,2-DIBROMO-3-CHLOROPROPANE(DBCP) 1,2-DIBROMOETHANE (EDB)</p> <p>EPA 8015C (DRO) EPA 3510C</p> <p>TPH - HIGH BOIL. PT. (DIESEL)</p> <p>EPA 8015C (DRO) EPA 3550C</p> <p>EPA 8270D EPA 3510C</p> <p>1,2,4-TRICHLOROBENZENE 1,2-DICHLOROBENZENE 1,3-DICHLOROBENZENE 1,4-DICHLOROBENZENE 2,4,5-TRICHLOROPHENOL 2,4,6-TRICHLOROPHENOL 2,4-DICHLOROPHENOL 2,4-DIMETHYLPHENOL</p>	<p>EPA 8270D EPA 3510C</p> <p>2,4-DINITROPHENOL 2,4-DINITROTOLUENE (2,4-DNT) 2,6-DINITROTOLUENE (2,6-DNT) 2-CHLORONAPHTHALENE 2-CHLOROPHENOL 2-NITROPHENOL 3,3-DICHLOROBENZIDINE 4,6-DINITRO-2-METHYLPHENOL 4-BROMOPHENYLPHENYL ETHER 4-CHLORO-3-METHYLPHENOL 4-CHLOROPHENYL PHENYL ETHER 4-NITROPHENOL ACENAPHTHENE ACENAPHTHYLENE ANTHRACENE BENZO(A)ANTHRACENE BENZO(A)PYRENE BENZO(B)FLUORANTHENE BENZO(G,H,I)PERYLENE BENZO(K)FLUORANTHENE BIS(2-CHLORO-1-METHYLETHYL)ETHER BIS(2-CHLOROETHOXY)METHANE BIS(2-CHLOROETHYL)ETHER BIS(2-ETHYLHEXYL)PHTHALATE BUTYL BENZYL PHTHALATE CHRYSENE DI-N-BUTYL PHTHALATE DI-N-OCTYL PHTHALATE DIBENZO(A,H)ANTHRACENE DIETHYL PHTHALATE DIMETHYL PHTHALATE FLUORANTHENE FLUORENE HEXACHLOROBENZENE HEXACHLOROETHANE INDENO(1,2,3-CD)PYRENE ISOPHORONE N-NITROSODI-N-PROPYLAMINE N-NITROSODIMETHYLAMINE N-NITROSODIPHENYLAMINE NAPHTHALENE NITROBENZENE (NB) PENTACHLOROPHENOL PHENANTHRENE PHENOL</p>
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**SOUTH CAROLINA DEPARTMENT OF HEALTH AND ENVIRONMENTAL CONTROL
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GULF COAST ANALYTICAL LAB (Laboratory ID 73006)

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SOLID & HAZARDOUS WASTES

-----SEMI-VOLATILES-----

EPA 8270D
EPA 3510C

PYRENE

EPA 8270D
EPA 3550C

1,2,4-TRICHLOROBENZENE
1,2-DICHLOROBENZENE
1,3-DICHLOROBENZENE
1,4-DICHLOROBENZENE
2,4-DICHLOROPHENOL
2,4-DIMETHYLPHENOL
2,4-DINITROPHENOL
2,4-DINITROTOLUENE (2,4-DNT)
2,6-DINITROTOLUENE (2,6-DNT)
2-CHLORONAPHTHALENE
2-NITROANILINE
3,3-DICHLOROBENZIDINE
3-NITROANILINE
4,6-DINITRO-2-METHYLPHENOL
4-BROMOPHENYLPHENYL ETHER
4-CHLORO-3-METHYLPHENOL
4-CHLOROANILINE
4-CHLOROPHENYL PHENYL ETHER
4-NITROANILINE
ACENAPHTHENE
ACENAPHTHYLENE
ANILINE
ANTHRACENE
BENZO(A)ANTHRACENE
BENZO(A)PYRENE
BENZO(B)FLUORANTHENE
BENZO(G,H,I)PERYLENE
BENZO(K)FLUORANTHENE
BENZOIC ACID
BENZYL ALCOHOL
BIS(2-CHLORO-1-METHYLETHYL)ETHER
BIS(2-CHLOROETHOXY)METHANE
BIS(2-CHLOROETHYL)ETHER
BIS(2-ETHYLHEXYL)PHTHALATE
BUTYL BENZYL PHTHALATE
CHRYSENE
DI-N-BUTYL PHTHALATE
DI-N-OCTYL PHTHALATE

EPA 8270D
EPA 3550C

DIBENZO(A,H)ANTHRACENE
DIBENZOFURAN
DIETHYL PHTHALATE
DIMETHYL PHTHALATE
FLUORANTHENE
FLUORENE
HEXACHLOROBENZENE
HEXACHLOROCYCLOPENTADIENE
HEXACHLOROETHANE
INDENO(1,2,3-CD)PYRENE
ISOPHORONE
N-NITROSODI-N-PROPYLAMINE
N-NITROSODIMETHYLAMINE
N-NITROSODIPHENYLAMINE
NAPHTHALENE
NITROBENZENE (NB)
PENTACHLOROPHENOL
PHENANTHRENE
PHENOL
PYRENE
PYRIDINE

EPA 8270D
EPA 3580A

1,2,4-TRICHLOROBENZENE
1,2-DICHLOROBENZENE
1,3-DICHLOROBENZENE
1,4-DICHLOROBENZENE
2,4,5-TRICHLOROPHENOL
2,4,6-TRICHLOROPHENOL
2,4-DICHLOROPHENOL
2,4-DIMETHYLPHENOL
2,4-DINITROPHENOL
2,4-DINITROTOLUENE (2,4-DNT)
2,6-DINITROTOLUENE (2,6-DNT)
2-CHLORONAPHTHALENE
2-CHLOROPHENOL
2-NITROPHENOL
3,3-DICHLOROBENZIDINE
4,6-DINITRO-2-METHYLPHENOL
4-BROMOPHENYLPHENYL ETHER
4-CHLORO-3-METHYLPHENOL
4-CHLOROPHENYL PHENYL ETHER
4-NITROPHENOL

EPA 8270D
EPA 3580A

ACENAPHTHENE
ACENAPHTHYLENE
ANTHRACENE
BENZO(A)ANTHRACENE
BENZO(A)PYRENE
BENZO(B)FLUORANTHENE
BENZO(G,H,I)PERYLENE
BENZO(K)FLUORANTHENE
BIS(2-CHLORO-1-METHYLETHYL)ETHER
BIS(2-CHLOROETHOXY)METHANE
BIS(2-CHLOROETHYL)ETHER
BIS(2-ETHYLHEXYL)PHTHALATE
BUTYL BENZYL PHTHALATE
CHRYSENE
DI-N-BUTYL PHTHALATE
DI-N-OCTYL PHTHALATE
DIBENZO(A,H)ANTHRACENE
DIETHYL PHTHALATE
DIMETHYL PHTHALATE
FLUORANTHENE
FLUORENE
HEXACHLOROBENZENE
HEXACHLOROETHANE
INDENO(1,2,3-CD)PYRENE
ISOPHORONE
N-NITROSODI-N-PROPYLAMINE
N-NITROSODIMETHYLAMINE
N-NITROSODIPHENYLAMINE
NAPHTHALENE
NITROBENZENE (NB)
PENTACHLOROPHENOL
PHENANTHRENE
PHENOL
PYRENE

EPA 8310
EPA 3510C

ACENAPHTHENE
ACENAPHTHYLENE
ANTHRACENE
BENZO(A)ANTHRACENE
BENZO(A)PYRENE
BENZO(B)FLUORANTHENE
BENZO(G,H,I)PERYLENE
BENZO(K)FLUORANTHENE
CHRYSENE
DIBENZO(A,H)ANTHRACENE
FLUORANTHENE
FLUORENE
INDENO(1,2,3-CD)PYRENE
NAPHTHALENE
PHENANTHRENE
PYRENE

EPA 8310
EPA 3510C

BENZO(K)FLUORANTHENE
CHRYSENE
DIBENZO(A,H)ANTHRACENE
FLUORANTHENE
FLUORENE
INDENO(1,2,3-CD)PYRENE
NAPHTHALENE
PHENANTHRENE
PYRENE

EPA 8310
EPA 3550C

ACENAPHTHENE
ACENAPHTHYLENE
ANTHRACENE
BENZO(A)ANTHRACENE
BENZO(A)PYRENE
BENZO(B)FLUORANTHENE
BENZO(G,H,I)PERYLENE
BENZO(K)FLUORANTHENE
CHRYSENE
DIBENZO(A,H)ANTHRACENE
FLUORANTHENE
FLUORENE
INDENO(1,2,3-CD)PYRENE
NAPHTHALENE
PHENANTHRENE
PYRENE

-----VOLATILES (VOCS)-----

EPA 8015C (GRO)
EPA 5030B

TPH - LOW BOIL. PT. (GAS.)

EPA 8015C (GRO)
EPA 5035

TPH - LOW BOIL. PT. (GAS.)

SOUTH CAROLINA DEPARTMENT OF HEALTH AND ENVIRONMENTAL CONTROL
ENVIRONMENTAL LABORATORY CERTIFICATION PROGRAM

GULF COAST ANALYTICAL LAB (Laboratory ID 73006)

Certifying Authority: LA

Certificate Number: 73006001

Date of Issue: February 04, 2013

Expiration Date: June 30, 2013

SOLID & HAZARDOUS WASTES

-----VOLATILES (VOCS)-----

EPA 8260B
EPA 5030B

1,1,1,2-TETRACHLOROETHANE
1,1,1-TRICHLOROETHANE
1,1,2,2-TETRACHLOROETHANE
1,1,2-TRICHLOROETHANE
1,1-DICHLOROETHANE
1,1-DICHLOROETHENE
1,1-DICHLOROPROPENE
1,2,3-TRICHLOROBENZENE
1,2,3-TRICHLOROPROPANE
1,2,4-TRICHLOROBENZENE
1,2,4-TRIMETHYLBENZENE
1,2-DIBROMO-3-CHLOROPROPANE(DBCP)
1,2-DIBROMOETHANE (EDB)
1,2-DICHLOROBENZENE
1,2-DICHLOROETHANE
1,2-DICHLOROPROPANE
1,3,5-TRIMETHYLBENZENE
1,3-DICHLOROBENZENE
1,3-DICHLOROPROPANE
1,4-DICHLOROBENZENE
2,2-DICHLOROPROPANE
2-CHLOROETHYL VINYL ETHER
2-CHLOROTOLUENE
2-HEXANONE
4-CHLOROTOLUENE
4-METHYL-2-PENTANONE
ACETONE
ACROLEIN
ACRYLONITRILE
BENZENE
BROMOBENZENE
BROMOCHLOROMETHANE
BROMODICHLOROMETHANE
BROMOFORM
BROMOMETHANE
CARBON DISULFIDE
CARBON TETRACHLORIDE
CHLOROBENZENE
CHLORODIBROMOMETHANE
CHLOROETHANE
CHLOROFORM
CHLOROMETHANE
CIS-1,2-DICHLOROETHENE

EPA 8260B
EPA 5030B

CIS-1,3-DICHLOROPROPENE
DIBROMOMETHANE
DICHLORODIFLUOROMETHANE
ETHYLBENZENE
METHYL ETHYL KETONE (MEK)
METHYL TERT BUTYL ETHER (MTBE)
METHYLENE CHLORIDE
N-BUTYLBENZENE
N-PROPYLBENZENE
NAPHTHALENE
SEC-BUTYLBENZENE
STYRENE
TERT-BUTYLBENZENE
TETRACHLOROETHENE
TOLUENE
TRANS-1,2-DICHLOROETHENE
TRANS-1,3-DICHLOROPROPENE
TRANS-1,4-DICHLORO-2-BUTENE
TRICHLOROETHENE
TRICHLOROFLUOROMETHANE
VINYL ACETATE
VINYL CHLORIDE
XYLENE, TOTAL

EPA 8260B
EPA 5035

1,1,1,2-TETRACHLOROETHANE
1,1,1-TRICHLOROETHANE
1,1,2,2-TETRACHLOROETHANE
1,1,2-TRICHLOROETHANE
1,1-DICHLOROETHANE
1,1-DICHLOROETHENE
1,1-DICHLOROPROPENE
1,2,3-TRICHLOROBENZENE
1,2,3-TRICHLOROPROPANE
1,2,4-TRICHLOROBENZENE
1,2,4-TRIMETHYLBENZENE
1,2-DIBROMO-3-CHLOROPROPANE(DBCP)
1,2-DIBROMOETHANE (EDB)
1,2-DICHLOROBENZENE
1,2-DICHLOROETHANE
1,2-DICHLOROPROPANE
1,3,5-TRIMETHYLBENZENE
1,3-DICHLOROBENZENE

EPA 8260B
EPA 5035

1,3-DICHLOROPROPANE
1,4-DICHLOROBENZENE
2,2-DICHLOROPROPANE
2-CHLOROETHYL VINYL ETHER
2-CHLOROTOLUENE
2-HEXANONE
4-CHLOROTOLUENE
4-METHYL-2-PENTANONE
ACETONE
ACROLEIN
ACRYLONITRILE
BENZENE
BROMOBENZENE
BROMOCHLOROMETHANE
BROMODICHLOROMETHANE
BROMOFORM
BROMOMETHANE
CARBON DISULFIDE
CARBON TETRACHLORIDE
CHLOROBENZENE
CHLORODIBROMOMETHANE
CHLOROETHANE
CHLOROFORM
CHLOROMETHANE
CIS-1,2-DICHLOROETHENE
CIS-1,3-DICHLOROPROPENE
DIBROMOMETHANE
DICHLORODIFLUOROMETHANE
ETHYLBENZENE
METHYL ETHYL KETONE (MEK)
METHYL TERT BUTYL ETHER (MTBE)
METHYLENE CHLORIDE
N-BUTYLBENZENE
N-PROPYLBENZENE
NAPHTHALENE
SEC-BUTYLBENZENE
STYRENE
TERT-BUTYLBENZENE
TETRACHLOROETHENE
TOLUENE
TRANS-1,2-DICHLOROETHENE
TRANS-1,3-DICHLOROPROPENE
TRICHLOROETHENE
TRICHLOROFLUOROMETHANE
VINYL ACETATE

EPA 8260B
EPA 5035

VINYL CHLORIDE
XYLENE, TOTAL

EPA 8260B-OXY
EPA 5030B

3,3-DIMETHYL-1-BUTANOL
DIISOPROPYL ETHER
ETHANOL
ETHYL TERT BUTYL ETHER
T-AMYL ALCOHOL
T-AMYL METHYL ETHER
T-BUTYL ALCOHOL
T-BUTYL FORMATE